QTest 2.1 TUTORIAL

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QTEST: Quantitative Testing of Theories of Binary Choice (Regenwetter et al., 2014) henceforth 'QTBC1'—and QTEST 2.1: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference (Regenwetter et al., 2017)—henceforth 'QTBC2'—present a general quantitative diagnostic framework for testing theories of binary choice. However, QTBC1 and QTBC2 do not provide the prospective user of QTEST with the knowledge and tools for using the software. This QTEST Tutorial—henceforth 'the tutorial'—is a companion document to QTBC1 and QTBC2 and will allow one to recreate all the figures and replicate the tables of results in QTBC1. It will also allow one to recreate one figure and replicate the tables of results in QTBC2. Ideally, after completing the tutorial, a prospective user of QTEST will know how to use QTEST for their research. QTBC1 and QTBC2 also have supplements posted online (*Online Supplement to QTEST* and *Online Supplement to QTEST 2.1*) and references to these documents will be henceforth made as 'online supplement 1' and 'online supplement 2', respectively.

If you need to reference this tutorial, please cite QTBC1 and QTBC2 (*QTEST: Quantitative Testing of Theories of Binary Choice* and *QTEST 2.1: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference*). While every attempt has been made to ensure the accuracy of the QTEST software program, we cannot guarantee that a user of QTEST will not find an error.

This tutorial will teach a prospective user of the QTEST software interface all the functions by way of recreating the figures and tables of QTBC1 and one figure and tables of QTBC2. The tutorial contains 5 parts:

Part I: Downloads Part II: Generating the Figures Part III: Data Analysis Part IV: Online Supplements Part V: QTEST Options

Part I: Downloads This provides instructions for downloading and installing the QTEST software.

Part II: Generating the Figures

This provides detailed instructions and screenshots to recreate all the Figures of QTBC1 and Figure 4 of QTBC2. Figures 1-3 of QTBC2 are easy to show following the steps of sections A-E of the tutorial.

Part III: Data Analysis This provides instructions for analyzing data and using QTEST to generate the results of the Tables of QTBC1 and QTBC2.

Part IV: Online Supplements

Part V: QTEST Options

Parts II, III and IV are further subdivided by sections, denoted by capital letters (e.g. A or C). Part II encompasses section A through section F, Part III encompasses section G through section N while Part IV includes section O through section R. Almost all sections have subsections, denoted by a number following the section letter (e.g. section A.1 or section C.3). These section headers organize the tutorial, clarify internal tutorial references and enable a reader of the tutorial to navigate the document.

The Microsoft Word format of this tutorial was designed with the Navigation Pane and the Adobe Acrobat format allows a user to use Bookmarks to easily navigate the entire document. Please visit the following link for more guidance on using the Navigation Pane in Word or Bookmarks in Adobe, if you are not already familiar with these tools: http://labs.psychology.illinois.edu/DecisionMakingLab/qtest/Tutorial/.

PART I: Downloads

The main QTEST website is located at: http://internal.psychology.illinois.edu/labs/DecisionMakingLab/qtest/

From this website, you can download the QTEST software, tutorial files and the tutorial.

QTEST software

Download the QTEST software from: http://internal.psychology.illinois.edu/labs/DecisionMakingLab/qtest/Software

QTEST is written in Matlab code; but Matlab does not need to be installed on a computer to run QTEST. When visiting the website to download QTEST, you will need to download both a version of QTEST and an MCR installer. For computers with Windows operating systems, the bit size of both the QTEST software and the Matlab MCR installer need to match the bit-size of your computer (e.g. Windows 32-bit or Windows 64-bit).

QTEST tutorial files

Download the data, QTEST input files, and QTEST output files referenced in the tutorial from: <u>http://internal.psychology.illinois.edu/labs/DecisionMakingLab/qtest/Files</u> This webpage contains a zipped file with all the files needed for the entire tutorial. (Alternatively, one may download these zip files one section at a time.)

You will find two sets of files in the folder "AllTutorialFiles." File names that do not end with 2.1 contain results that match the ones in *QTEST: Quantitative Testing of Theories of Binary Choice* obtained using an older version of QTEST. File names that end with 2.1 contain results that are obtained when following the steps in the tutorial using QTEST 2.1. You might also obtain slightly different results for the analyses due to different operating systems, different versions of MATLAB, or from using different random seeds.

QTEST tutorial

Finally, a Microsoft Word and Adobe Acrobat PDF version of this tutorial can be found at: http://internal.psychology.illinois.edu/labs/DecisionMakingLab/qtest/Tutorial/

PART II: GENERATING THE FIGURES

Part II of the tutorial provides step-by-step instructions for creating the figures in *QTEST: Quantitative Testing of Theories of Binary Choice* and one figure in *QTEST2.1: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference.* It is designed in such a way so that each of the sections below labeled Section A through Section F, leads to different figures in QTBC1 and QTBC2. All files referenced in Part II for QTBC1 of this tutorial are in the folder "SectionsA-F_Figures", which can be downloaded by following the instructions in Part I of the tutorial (above).

Because we have figures in QTBC1 and QTBC2 and figures that result from QTEST, we use a different notation to refer to each of these figure types. Figures referenced in QTBC1 follow the format: Figure # of QTBC1. The "F" of Figure is capitalized, the "#" represents a figure number of QTBC1 (e.g. "2") and "of QTBC1" means, specifically, that Figure # of the paper *QTEST: Quantitative Testing of Theories of Binary Choice.* Figures referenced in QTBC2 follow the format: Figure # of QTBC2. The "F" of Figure is capitalized, the "#" represents a figure number of QTBC2 follow the format: Figure # of QTBC2. The "F" of Figure is capitalized, the "#" represents a figure number of QTBC2 (e.g. "3") and "of QTBC2" means, specifically, that Figure # of the paper *QTEST 2.1: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference.*

The QTEST software interface also generates figures. These are always denoted as figures, with a lower case "f" and never referenced by figure numbers. QTEST automatically produces a figure number in the upper left-hand corner of each window each time it generates a new figure. This figure number is determined by the number of existing figure windows open. If only the QTEST interface is open, and a figure is generated, the resulting figure will be labeled "Figure 1" by QTEST. If one figure window is already open, and a new figure is generated, QTEST labels this as "Figure 2." We NEVER refer to a figure label generated by QTEST in this tutorial. Any correspondence between figure labels from QTEST output and Figure numbers of the papers are coincidental.

The figures in Part II and Part IV of this tutorial can be generated three different ways. These methods are now described in more detail.

Method 1 for generating figures of the papers

The first method is designed to allow a user to simply follow the instructions within the tutorial, section by section, to generate all figures of QTBC1 and one figure of QTBC2. The advantage to this method is that one can see step by step screen shots for creating the figures. Continue reading this tutorial to take advantage of this method.

Method 2 for generating figures of the papers

If you are only interested in looking at the figures themselves, you may load the file corresponding with the Figure number of the paper directly into QTEST. These files are found within the QTEST tutorial files on the website. (See Part 1: Downloads, above, on the location of these files.) These files have the format "Figure#.png", where "#" denotes a Figure number of QTBC1.

Method 3 for generating figures of the papers

The third method is basically a shortcut of Method 1. Instead of reading Parts II and IV of the tutorial, one can load a file in QTEST that already has the options specified and contains the necessary input files. In the folder 'SectionA-F_Figures', for instance, one will find files of the type "Figure#.mat", where "#" denotes a Figure number of QTBC1. With the QTEST GUI open, one selects 'Load' (instructions below) and navigates to the .mat file of interest. In this same folder, one will also find files of the type "Figure#Note.txt", which has a very truncated version of the instructions needed to successfully generate the figure, once you have loaded the .mat file. The notes in these text files are a highly compressed set of instructions that are spelled out in more detail in the tutorial for each figure.

QTEST allows a user to save their work at any point in time, load it and resume where they left off. Another approach some users of this tutorial may adopt is to work through each of the sections independently, where, after completing one section, the user does not save their work, closes QTEST and begins a new section with a new session of QTEST later. The tutorial can accommodate both strategies.

Gamble pairs	Theories		Hypothesis testing
Number of gambles: 0 Change Set	Vertices: Add Remove	Reference volume Use reference volume Weight	Run test Multicore Theories Specifications O Selected Selected
None	Add Duplicate Remove Load Save Save	Determine volume from current settings: Set Set volume manually	All All All Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling: Sample size: 5000 Change
Data Observations: 20 Enter Load Clear Default	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (U): Supermum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Random preference:	Figure Visualize Over last figure Color scheme: Default Close all figures File	Burn-In size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
	Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear

When you first open QTEST it looks like the following screenshot:

The QTEST interface has 7 spatially distinct areas, which contain a set of related functions. From left to right, and top to bottom, these are: "Gamble Pairs", "Theories", "Hypothesis Testing", "Data", "Probabilistic specifications", "Figure" and "File." These 7 names are circled in the screenshot below:



We now illustrate how to save and load a file. Suppose you have completed a section of this tutorial and wish to save your work. In the QTEST interface, under "File", select "Save...". Then navigate to a location on your computer to save the QTEST session, which will have a "*.mat" format, where the asterisk represents the file name and the ".mat" extensions stand for a Matlab file.



And then, when you are ready to resume, under "File" select "Load..." and navigate to the location of your saved "*.mat" file. Once again, the asterisk represents your file name and the .mat is a Matlab file extension.



This demonstration of saving and loading a file illustrates notation carried throughout the tutorial. First, the tutorial will begin instructions by indicating the location referenced, like "File" was just used. Then the functions within that location are demonstrated. We just learned how to use "Save..." and "Load...". And usually these are illustrated by screenshots. So, whenever you see words in double quotation marks, " ", these refer to an explicit representation on the QTEST interface. These are words that currently exist on the interface or user input to be entered (or user input entered previously). Black arrows on top of screenshots point to an input selection the user needs to make with their cursor. Black open ovals on top of the QTEST interface screenshots draw the users' attention to something that has been updated because of an action taken by the user.

We now turn to the first section of the tutorial, A, where we recreate Figure 2 of QTBC1.

A. Theory ABC (Figure 2 of QTBC1)

Upon completion of section A of the tutorial, a version of Figure 2 of QTBC1 will be created. To create this figure, we will learn how to use QTEST to create gamble pairs, define a decision theory, specify the theory's prediction and finally create (and visualize in 3-dimensional space) the 0.50-majority/modal choice specification of this theory.

A.1 Create the gamble pairs

The basic entity on which QTEST builds every analysis is a set of gamble pairs. We start with the gambles in Figure 2 of QTBC1, labeled *A*, *B*, and *C*. In the QTEST interface, under "Gamble pairs", select "Change".

		QTEST	
Gamble pairs Number of gambles: O Change Set	Vertices:	Add Remove Remove Reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications O Selected Selected All All
All	Duplicate Remove	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Sample size N: 20 Enter Load Save Clear Name Default 🗘	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Random preference: Form file: Load	E Figure Visualize Over last figure Color scheme: Default © E Close all figures File	Burn-in sze: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
	Mixture from vertices Save	Load Options	Table Remove Export Details Clear

In the "Gambles" dialogue box that pops up, type "3". Then select "OK".

🔴 🕘 🔘 Gambles
Number of gambles: 3
OK Cancel

Notice the "Number of gambles" under "Gamble pairs" in the QTEST interface is "3". Next, select "All" under "Gamble pairs". This will create all possible pairs of gambles from 3 gambles.

Under "Gamble pairs", the list of gambles has updated to include "(A,B)", "(A,C)" and "(B,C)", which are all the possible pairs of gambles.

Gamble pairs Number of gambles: 3 Change	Theories Vertices:	Add	Hypothesis testing Multico Run test Auto sa	ve
(A,C) (B,C) None	Add	emove Weight	Selected All All All All All	cted
LA L	Dupicate Remove	Determine volume from current settings: Set	Type of test	
Data	Probabilistic specifications	Set volume manually	Sample size: 5000 Change Burn-in size: 1000 Change	
Observations:	Aggregation-based: Supermajority level: 0.5 Change	Visualize Over last figure	Chi-bar squared weights Random number simulation sample size: seed:	ər Set
Enter	Distance-based: Max-distance (U): Supremum 0.5 Change	Color scheme: Default	Results:	
Clear	City-block 0.5 Change Euclidean 0.5 Change	Close all figures		
Name Default 🗘	Random preference: From file: Load Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear	

A.2 Define one decision theory, ABC

Having created the gamble pairs, we now define a decision theory. In the QTEST interface, under "Theories", select "Add...".

	QTEST		
Gamble pairs 3 Change (A.5) (A.6) (B,C) Set	Theories Vertices: Ad Rer	Id Use reference volume weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected At
None All	Add Duplicate Remove Load Se	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
Data Sample size N: 20 Enter Load Save Clear Default \$	Save Probabilistic specifications Aggregation-based: Supermajority 0.5 Bordra score Distance-based: Max-distance (U): O.5 Charge City-block 0.5 Charge Euclidean 0.5 Charge Enclidean 0.5 Charge Enclidean 0.5 Charge Enclidean 0.5 Charge Bardem preference: Load Maxture from vertices Bave	Set volume manually Figure Visualize Over last figure Color scheme: Default Close all figures File Load Options Save About	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: Seed: 1000 Change 1 Set Results: Table Remove Export Details Clear

In the "Theory" dialogue box that pops up, enter "ABC". Select "OK".

🛑 😑 🔿 Theory
Enter name for theory: ABC
OK Cancel

Notice "ABC" listed under "Theories".

• •	(QTEST	
Gamble pairs Number of gambles: 3 Change (A.B) (A.C) (B,C)	ABC Vertices:	Add Reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
None	Add Duplicate Remove Load	Determine volume from current Set Set	All All Type of test Bayes Factor Bayes Factor Prequentist
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data Observations: 20 Observations:	Probabilistic specifications Aggregation-based: Supermajority level: Borda score	Figure Visualize Over last figure	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set
Load Save	Distance-based: Supremum 0.5 Change City-block 0.5 Change	Close al figures	
Clear Default 🗘	Euclidean 0.5 Change Random preference:	File	
	Mixture from vertices Save.	Save About	Table Remove Export Details Clear

A.3 Specify the prediction of decision theory ABC

We can now specify the prediction of theory ABC. Under "Theories", select "Add...", just right of "Vertices:".

	QTEST	•	
Gamble pairs Number of gambles: 3 Change (AC) (B,C) Set None	QTEST	dd Wight	Hypothesis testing Multicore Run test Auto save Theories Specifications O Selected O Selected All All
AI	Duplicate Remove Load Save	Determine volume from current settings: Set Set volume manually	Type of test Bayes Factor Bayes p & DIC Frequentist Gibbs sampling: Sample size: Burn-in size: 1000 Change
Data Observations: Sample size N: 20 Enter Load Save Clear	Probabilistic specifications	Figure Visualize Over last figure Color scheme: Default Close all figures	Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Set Results:
Name Default 📀	Random preference: From file: Mixture from vertices Save	Fie Options Save About	Table Remove Export Details Clear

Enter "ABC", as a name for the ranking ABC, in the "Vertex" dialogue box that pops up. Then select "OK."

e o Vertex
Enter name for vertex:
ABC
OK Cancel

In Figure 2 of QTBC1, the vertex ABC is represented geometrically by a corner of the 3-D cube. Specify the coordinates of this vertex by selecting "Set...".

	QTEST		
Gamble pairs Number of gambles: 3 Change (A.B) (A.C) (B.C) Set	ABC Vertices: ABC 0.5 Add Remov	Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
None All	Add Duplicate (A.C): 0 Remove (B,C): 0 Set	Determine volume from current settings: Set	All All All All All All Type of test Bayes Factor Bayes p & DIC Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Observations: 20 Enter Load Save Clear	Probabilistic specifications Aggregation-based: Supermajority Output Borda score Distance-based: Max-distance (U): Supermum Ofly-block Output Euclidean Output	Figure Visualize Visualize Over last figure Color scheme: Default Close all figures	Chi-bar squared weights seed: 1000 Change 1 Set Results:
Name Default ᅌ	Random preference: From file: Mixture from vertices	File Options Save About	Table Remove Export Details Clear

The "Set Vertex (Preference)" window pops up. For each gamble pair, select the gamble preferred under the ranking ABC. Since A is preferred to B in pair (A,B), select "A". Likewise, A is preferred to C in pair (A,C), so select "A". Finally, B is preferred to C in pair (B,C) so select "B".

And then select "OK".

	Set Vertex (Preference)		
-	,B)		
	A B		
-6	, c)		
-0	А.С.)		
	B C Cancel		

Above, MAC Users Selections window (Windows users will have each selection option blue high-lighted) The QTEST interface now shows theory "ABC" with the vertex representation corresponding to the ranking ABC that has coordinates (1,1,1). These coordinates are listed in the bottom half of "Vertices:". Note that the Vertex label "ABC" is only a name and QTEST does not know what it stands for, so the user must specify the coordinates of the vertex.

	QTE	ST	
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 3 Change (A, E) (B, C)	ABC Vertices: ABC [0.5]	Add Remove Reference volume Weight	Run test Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
None	Add Dupicate Remove	Determine volume from current settings: Set	All All All All Type of test Bayes Factor Bayes p & DIC Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Observations: Data Observations: Data Observations: Data Observations: Observatio	Probabilistic specifications Aggregation-based: Supermajority level: Borda score Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Bandom preference:	Figure Visualize Over last figure Color scherne: Default Colose all figures	Chi-bar squared weights seed: simulation sample size: 1000 Change 1 Set Results:
Name Default 🗘	From file: Load Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear

A.4 The 0.50-Majority/modal choice specification of theory ABC

Now we use QTEST to create a 0.50-majority/modal choice specification for vertex ABC. Select "ABC" under "Theories". It will be highlighted in blue if selected.

Gamble pairs	Theories	Hypothesis testing
Number of gambles: 3 Change (A.D) (A.C)	ABC Vertices: ABC (0.5) Add Remove	Reference volume Multicore Use reference volume Run test Auto save Weight Specifications Data sets Selected Selected Selected
None	Add Duplcate Remove Load Save	All All Determine volume from current settings: Set Set volume manually Set volume manually
Data Observations: Sample size N: 20	Probabilistic specifications veri Aggregation-based: © Supermajority 0.5 Change	Figure Burn-in size: 1000 Change Visualize Chi-bar squared weights simulation sample size: Random number seed: Over last figure 1000 Change 1 Set.
Enter Load Save	Distance-based: Supremum 0.5 Change City-block 0.5 Change	Color scheme: Results:
Clear Default \$	Euclidean 0.5 Change Random preference:	File Load Options Save About Details Clear

Under "Probabilistic specifications", the radio button left of "Supermajority" should be selected, and the "Supermajority level" should be set to "0.5".

	QTES	ST	
Gamble pairs Number of gambles: 3 Change (A.B) (A.C) (B.C) Set	ABC Vertices:	Add Use reference volume Remove Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
None	Add Duplicate (A,B): 1 (A,C): 1 (B,C): 1 Load	Determine volume from current settings: Set	All All Type of test Bayes Factor Bayes p & DIC Frequentist
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data Observations: 20 Enter Load Save Olear Default \$	Probabilistic specifications use Aggregation-based: Supermajority 0.5 Change Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Random preference: From file: Load	Figure Visualize Over last figure Color scheme: Default Close all figures File Load Options	Chi-bar squared weights simulation sample size: seed: 1000 Change 1 Set Results: Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

To create a rudimentary version of Figure 2 of QTBC1, press "Visualize", under "Figure".

	QTEST		
Gamble pairs Number of gambles: 3 Change (A.C) (B.C) (B.C) Set	ABC Vertices: ABC [0.5] Add Remove	Reference volume Use reference volume Weight Hypothesis testing Run test Run test Specifications Data s Selected Sele	lticore o save sets Selected
None	Add Duplicate (A.B): 1 (A,C): 1 (B,C): 1 Load	Determine volume from current settings: Type of test Type of test Bayes Factor Bayes Factor Bayes p & Di • Frequentist All	IC
	Save	Set volume manually Gibbs sampling: Sample size: 5000 Cha	inge
Data Observations: 20 Enter Load Save Olear Observations: Enter Load Save Observations: Enter Default \diamondsuit	Probabilistic specifications Image: Constraint of the specification	Urren suce. 1000 Charles under the constraint of the constr	set

A new figure window will pop up, like the one on the left, below. This figure can be rotated, printed, saved, etc., as indicated with the menu buttons in the top of the window. For instance, press once on the circle with an arrow icon inside, and then drag the cursor into the 3-D figure. Press the button on the mouse and then rotate the figure, to get the figure on the bottom.



This completes the 0.50-majority specification of vertex ABC for Theory ABC. Notice that Figure 2 of QTBC1 shows additional information, namely seven other preference patterns. These are BAC, ABCA, BCA, ACBA, CBA, CAB and ACB. We do not discuss here how those were added, since they were added only for explanatory purposes in QTBC1.

B. KT-V4 (Figures 3-5 of QTBC1)

After finishing Section B of the tutorial, we will have created Figures 3, 4 and 5 of QTBC1. There are two important differences between the figures created in Section A and those created now in Section B. First, we use a different theory and different vertex. Second, Figures 3, 4 and 5 of QTBC1 are based on the gambles A, B, C, D and E in Table 1 of QTBC1. And of those 5 gambles we only consider gambles A, C, and D for the present section.

B.1 Create the gamble pairs

QTEST • • • Hypothesis testing Gamble pairs Multicore 3 Chang Number of gambles: Vertices Run test Auto save Add.. Use reference volume Theories Specifications Data sets (A,C) (B,C) Weight... Remove Selected Selected Selected) All) All Add.. None Type of test Duplicate. Determine volum All Bayes Factor Baves p & DIC Remove Set... settings: Set Frequentist AI Load. Gibbs sampling: Set volume manually Save. Change.. 5000 Sample size: Change... Burn-in size: 1000 Probabilistic specifications Data Chi-bar squared weights simulation sample size: Random number Aggregation-based: Visualize Observ Supermajority level: Sample size N: Supermajority Change... Set. 1000 1 Over last figure 0.5 Change... 20 Borda score Color scheme: Results Enter e-hased Default Max-distance (LI): Load Change. 0.5 Save City-block 0.5 Change.. Close all figures Clear Euclidean 0.5 Change. Random preference Name. Defaul \$ From file: Load... Options Load... Remove Export. Table.. Mixture from vertices Save.. Save... About. Details Clear

In the QTEST interface, under "Gamble pairs", select "Change".

This will bring up the "Gambles" dialogue box. Enter "5" and press "OK."

🔴 😑 🔘 Gambles
Number of gambles:
5
OK Cancel

Under "Gamble pairs" notice the "Number of gambles:" has updated to "5". Also notice that the rest of the interface has been cleared. This will always happen when the gamble pairs are changed.

	QTE	ST	
Gamble pairs Number of gambles 5 Change Set	Theories Vertices: Add	Add Use reference volume Weight	Hypothesis testing Run test Run test Auto save Theories Specifications Data sets Selected All All All All
	Duplicate Remove Load	Determine volume from current Set Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Observations: 20 Enter Clear	Probabilistic specifications Aggregation-based: Supermajority level: 0,5 Change Distance-based: Max-distance (U): Supremum 0.5 Change Euclidean 0.5 Change Bandom underance:	Figure Visualize Over last figure Color scheme: Default	Chi-bar squared weights seed: 1000 Change 1 Set Results:
Name Default	Random preference:	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

In Section A.1, with the 3 gambles A, B and C, we selected "All" in the "Gamble Pairs" section to create all 3 pairs of gambles. If we selected "All" for the 5 gambles A, B, C, D and E, this would result in the construction of 10 gamble pairs. However, in Figure 3 of QTBC1, to stay in 3-D space, we focus only on 3 of these 10 possible pairs: AC, AD and CD. So, we now show how to create this subset of 3 gamble pairs from the 10 pairs that are possible. Under "Gamble pairs" select "Set".

	QTEST	
Gamble pairs Number of gambles 5 Change Set	Theories Vertices: Add Remove Weight	Hypothesis testing Run test Theories Selected Auto save Data sets Selected Auto save Data sets Selected Auto save
None All	Add Duplicate Remove Load Set Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs samolino:
Data Deta Deta Deta Deta Deta Deta Deta	Save Save Probabilistic specifications Figure Aggregation-based: Visualize Supermajority 0.5 Change Over last figure Oistance-based: Max-distance (U): Oistonce-based: Max-distance (U): City-block 0.5 Change Close all figures Flandom preference: File	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
Name Default 🗘	From file: Load Options Mixture from vertices Save Save About	. Table Remove Export Detais Clear

In the "Choose gamble pairs" dialogue box that pops up, select the boxes next to gamble pairs "(A,C)", "(A,D)" and "(C,D)" and then select "OK".

😑 😑 💿 Choose gamb	Choose gamble pairs	
(A,B)		
🗹 (A,C)		
🗹 (A,D)		
(A,E)		
(B,C)		
(B,D)	None	
(B,E)	All	
🔽 (C,D)		
(C,E)	ок	
(D,E)	Cancel	

Under "Gamble pairs", only the 3 gamble pairs selected are listed.

00	QTEST	г	
Gamble pairs Gamble pairs Change	Add	Add Beference volume Weight Determine volume from current	Hypothesis testing Run test Auto save Theories Specifications Selected Selected All All Typo of test Bayes Factor Bayes p & DIC
Data Data Sample size N: 20	Protoce Save Probabilistic specifications Aggregation-based: Supermajority level: Borda score O.5 Change	Set settings: Set Set volume manually Fiqure Visualize Over last figure	Frequentist All Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: 1000 Change 1 Set
Enter Load Save Clear Name Default ‡	Distance-based: Max-distance (U): Supremum 0.5 CRy-block 0.5 Euclidean 0.5 Change Random preference: From file: Load Mixture from vertices Save	Coor screme: Default \$ Close all figures File Load Options About	Table Remove Export Details Clear

This is how to create a subset of gamble pairs if all gamble pairs are not needed. We now define our next decision theory.

B.2 Define one decision theory, CPT-KT

This time we will use the decision theory specified in Figure 3 of QTBC1: $CPT \sim \mathcal{KT}$, or Cumulative Prospect Theory with a "Kahneman-Tversky" weighting function. Under "Theories" select "Add". In the "Theory" dialogue box that pops up, enter "CPT-KT". Then select "OK".

🛑 😑 🔘 Theory
Enter name for theory:
СРТ-КТ
OK Cancel

Under "Theories", "CPT-KT" is listed.

	QTE	ST	
Ambie pairs Number of gambles: 5 Change (A, D) (C, D) Set	Vertices:	Add Remove Remove Rem	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected All All All
None All	Add Dupicate Remove	Determine volume from current Set Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Sample size N: 20 Enter Load Save Clear	Probabilistic specifications Aggregation-based: Supermajority level: Supermajority 0.5 Change Borda score ? Distance-based: Distance-based: Max-distance (U): Supremum City-block 0.5 Change Euclidean 0.5 Change	Figure Visualize Visualize Over last figure Color scheme: Default Close all figures	Chi-bar squared weights Random number serial seed: 1000 Change 1 Set. Results:
Name Default ᅌ	Random preference: From file: Load Mixture from vertices Save	File Options Save About	Table Remove Export Details Clear

B.3 Specify a prediction of decision theory CPT - KT

Having defined $CPT \ \mathcal{K}T$, we now specify a prediction of the theory. Under "Theories", just right of "Vertices:", select "Add."

	QTEST		
Gamble pairs Gamble pairs 5 Change (A,C) (A,D) (C,D) (C,D) Set Name	CPT-KT Vertices:	dd	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected All All
	Duplicate Remove Load Save	Determine volume from current settings: Set Set volume manually	Type of test Bayes Factor Bayes p & DIC Frequentist Gibbs sampling: Sample size: 5000 Change
Data Observations:	Probabilistic specifications Aggregation-based:	Figure Visualize Visualize Visualize Visualize Color scheme: Default Close all figures File Load Options Save About	Burn-In size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results: Table Remove Export Details Clear

The "Vertex" dialogue box that pops up will prompt you for a label name of the vertex associated with theory $CPT \ KT$. Figure 3 of QTBC1 labels this vertex KT-V4. Enter "KT-V4". Select "OK."

e o Vertex
Enter name for vertex:
KT-V4
OK Cancel

Next, specify the coordinates of this vertex. Under "Vertices:" select "Set...

0	QTE	ST	
Amble pairs Number of gambles: 5 Change (A.C) (A.D) (C.D) Set None	QTE:	Add Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Selected Selected All All All
Al	Dupicate Remove Load Save	Set Determine volume from current settings: Set Set Set volume manually	Type of test Bayes Factor Bayes p & DIC Frequentist Gibbs sampling: Sample size: 5000 Change
Data Observations: 20	Probabilistic specifications Aggregation-based: Supermajority levet 0.5 Change	Figure Visualize Over last figure	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: seed: 1000 Change 1 Set
Enter Load Save Clear	Distance-based: Max-distance (U): Supremum City-block Distance (U): City-block Distance (U): City-block Distance (U): City-block Distance (U): City-block Distance (U): Distance (U): Dista	Close all figures	Hesuits:
Name Default 🗘	Random preference: From file: Mixture from vertices Save	File Load Options Save About	Table Remove Export Details Ciear

The "Set Vertex (Preference)" window pops up. For each gamble pair, select the button associated with the preferred gamble according to the ranking DAC. A is preferred to C in pair (A,C) so select "A". D is preferred to both A and C so select "D" from pairs (A,D) and (C,D), respectively.

Set Vertex (Preference)
C D Cancel

Then select "OK".

	Set Vertex (Preference)
	A C
(C,D)	
	C D Cancel

Under "Theories" the QTEST interface shows theory "CPT-KT". Under "Vertices", the top half lists vertex, "KT-V4 [0.5]" and the bottom half lists the coordinates (1,0,0).

	QT	EST	
Gamble pairs Number of gambles: 5 Change (A,C) (C,D) Set	Theories	Add Use reference volume Remove Weight	Hypothesis testing Run test Theories Selected Selected Multicore Auto save Data sets Selected Selected
None All	Add Duplcate Remove Load	Determine volume from current Set Set	All All Type of test Bayes Factor Bayes Factor Bayes p & DIC • Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Observations: 20 Enter Load Save Clear Name Defaut C	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Distance-based: Oistance-based: Oistance-based: Max-distance (U): Supermum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Random preference: From file:	Figure Visualize Over last figure Color scheme: Default \$ Close all figures File Load Optione	Chi-bar squared weights seed: simulation sample size: 1000 Change 1 Set Results:
	Mixture from vertices Save	Save About	Lable Hemove Export Details Clear

B.4 The 0.50-Majority/modal choice specification of KT-V4 for theory CPT - KT

We now use QTEST to construct the 0.50-majority/modal choice specification for KT-V4. First, under "Theories", select "CPT-KT" and "KT-V4". They will be highlighted in blue once selected.

	QTES	1	
mble pairs	Theories	Reference volume	Hypothesis testing Multicore
Number of gambles: 5 Change	CPT-KT /Vertices: KT-V4 [0.5]	Add Use reference volume	Run test Auto save
A,C) A,D) C,D) Set		Weight	Theories Specifications Data sets Selected Selected Selected
None	Add		
AI	Duplicate (A, C): 1 (A, D): 0 (C, D): 0	Determine volume from current Set Set	Type of test Bayes Factor Bayes p & DIC Frequentiet
	Load Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
	- Probabilistic specifications	Finue	Burn-in size: 1000 Change
Observations:	Aggregation-based:	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N:	Supermajority Borda score O	Over last figure	1000 Change 1 Set.
Enter	Distance-based:	Color scheme:	Results:
Load	Max-distance (U):	Detaut	
Save	City-block 0.5 Change	Close all figures	
Clear	Euclidean 0.5 Change		
Name Default \$	Random preference:	File	
	From file:	Load Options	Table Remove Export

Under "Probabilistic specifications", verify the radio button left of "Supermajority" is checked and that the "Supermajority level:" is set to "0.5".

	QTEST		
Gamble pairs Number of gambles: 5 Change (A, C) (A, D) (C, D) Set	CPT-KT Vertices: KT-V4 [0.5] Add Rem	Reference volume i Use reference volume ove Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
None Al	Add [A:0]:1 Duplicate (A:D):0 Remove (C.D):0 Load Save	Determine volume from current settings: Set Set volume manually	All All All All All Type of test Bayes Factor Bayes p & DIC • Frequentis All Gibbs sampling: Sample size: 5000 Change
Data Description D	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (J): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change From file: Load From file: Load	Figure Visualize Visualize Visualize Over last figure Color scheme: Default Close all figures File Load Options	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Results: Image: Change in the section of the

To create a version of Figure 3 of QTBC1, under "Figure", select "Visualize".

	901		
amble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices: KT-V4 [0.5]	Add Use reference volume	Run test Auto save
A.C) A.D) C.D) Set		Remove Weight	Selected Selected Selected Selected
None	Add		
Al	Duplicate [A, C): 1 (A, D): 0 (A, D): 0 Remove (C, D): 0	Determine volume from current Set Set	Type of test Bayes Factor Bayes p & DIC • Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
ataObservations:	Probabilistic specifications Aggregation-based:	Figure	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N:	Supermajority level: Supermajority 0.5 Change	Over last figure	1000 Change 1 Set
Enter		Color scheme:	Results:
	Distance-based: Max-distance (U):	Default 🗘	
Load	Supremum 0.5 Change		
Save	City-block 0.5 Change	Close all figures	
Clear	Euclidean 0.5 Change		
Name Default 0	Random preference:	File	
	From file: Load	Load Options	Table Remove Export
	0		

A figure, like the one below, pops up in a separate window. This figure is the leftmost panel in Figure 3 of QTBC1 (without the data points).



This completes the 0.50-majority specification of KT-V4 for theory CPT-KT. QTEST can create more than just a 0.50-majority/modal choice specification. Figure 4 of QTBC1, for instance, depicts the 0.75-supermajority specification of KT-V4 for theory CPT-KT. We now show how to create this probabilistic specification in QTEST.

<u>B.5 The 0.75-Supermajority specification of KT-V4 for theory</u> <u>CPT-KT</u>

We will now create the 0.75-supermajority probabilistic specification for KT-V4 in Figure 4 of QTBC1. Under "Theories", select "CPT-KT" and "KT-V4" so they are blue highlighted.

	QTEST		
Gamble pairs Number of gambles: 5 Change (A.C) (A.D) (C.D) Set	CPT-KT Verices: KT-V4 (0.5) Add Remove	Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
None All	Add Image: Constraint of the second	Determine volume from current settings: Set Set volume manually	Type of test Bayes Factor Frequentist Gibbs sampling: Sample size: 5000 Change
Data Sample size N: 20 20 Enter Load Save Clear Default 🗘	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (U): Supermum O.5 Change City-block O.5 Change Euclidean O.5 Change Random preference: From file: Mixture from vertices	Figure Visualize Visualize Over last figure Color scheme: Default Close all figures File Load Options Save About	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Set Set Results: Image: Change Table Remove Export Details Clear

Under "Probabilistic specifications", under "Aggregation-based:", verify the radio button left of "Supermajority" is selected. Adjust the "Supermajority level:" by selecting "Change".

Gamble pairs Number of gambles: 5 Change (A.D) (C.D) Set	CPT-KT Vertices: Add. KT-V4 (0.5) Add. Remov	Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Al Al Al
All None	Add Duplicate (AC): 1 (AD): 0 (C.D): 0 Set	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All Bayes annulari
Data Observations: 20 Enter Load Save Clear Name Defaut C	Save Probablistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Fandom preference: From file: Load Mixture from vertices Save	Figure Visualize Over last figure Color scheme: Default Close all figures File Load Save About	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results: Table Remove Export Datais. Clear

The dialogue box that pops up asks the user to specify the "Supermajority Level (Lambda):". Enter ".75" into the box. Select "OK".

🔴 🕘 🔘 Change Param
Supermajority Level (Lambda):
0.75
OK Cancel

Notice two changes to the QTEST interface. First, under "Theories", under "Vertices", the vertex "KT-V4 [0.75]" now has the 0.75-supermajority specification contained in square brackets. Second, the "Supermajority level" under "Probabilistic specifications" has been updated to "0.75".

• •	QTEST			
Gamble pairs Number of gambles: 5 Change (A.0) (C.D) Set	CPT-KT Vertices: (CPT-KT Vertices: (KT-V4 [0,75] Add Remove	Reference volume Use reference volume Weight	Hypothesis testing Run test Theories Specifications Selected Selected	Multicore Auto save Data sets Selected
None All	Add Duplicate (A.C): 1 (A.D): 0 C.D): 0 Set	Determine volume from current settings: Set	Type of test Bayes Factor Frequentist All Othe semplore	es p & DIC
Data Observations: 20 Enter	Save Probabilistic specifications Aggregation-based: Supermajority level: 0.75 Change Distance-based:	Figure Visualize Over last figure Color scheme:	Sample size: 5000 Burn-in size: 1000 Chi-bar squared weights simulation sample size: se 1000 Change Results:	Change Change ndom number ed: 1 Set
Load Save Clear Name Default	Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Random preference:	Ciose al figures	Table Remove	Export
	Mixture from vertices Save	Save About	Details Clear	

• •	Q	TEST	
Gamble pairs Number of gambles: 5 Change	Theories Vertices: CPT-KT Vertices: KT-V4 [0.75] KT-V4 [0.75]	Add Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets
(c.b) Set	Add Dupicate (A,O): 1 (A,O): 0 (C,D): 0	Determine volume from current settings: Set	Selected Selected All All Type of test Bayes Factor Brayes Factor Bayes p & DIC Frequentist All
_ Data	Probabilistic specifications	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Observations:	Aggregation-based: Supermajority level: Borda score ? Supermajority level: 0.75 Change	Visualze Over last figure	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set
Enter	Distance-based: Max-distance (U): Supremum 0.5 Change	Color scheme:	Results:
Clear	City-block 0.5 Change Euclidean 0.5 Change	Close all figures	
Name Default 🗘	From file: Load Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear

To create a version of Figure 4 of QTBC1, press "Visualize" under "Figure".

A new figure will pop up in a separate window. In this case the resulting figure is the left panel in Figure 4 of QTBC1 (without the data points).



This completes the 0.75-supermajority specification of KT-V4 for theory $CPT \cdot KT$. QTEST can also create distance-based specifications, such as supremum, cityblock and Euclidean. Figure 5 of QTBC1 depicts the 0.5-city-block specification of KT-V4 for theory $CPT \cdot KT$. We now show how to create this probabilistic specification in QTEST. (For a formal derivation and fuller treatment of aggregation- and distance-based specifications, we refer the interested reader to Appendix B of QTBC1: Probabilistic Specification.)

<u>B.6 The 0.50-city-block specification of KT-V4 for theory $CPT \sim \underline{KT}$ </u>

We now create the 0.50-city-block distance-based probabilistic specification for KT-V4 in Figure 5 of QTBC1. First, make sure "CPT-KT" and "KT-V4" are blue highlighted under "Theories".

Gamble pairs	Theories		_ ⊢Hypothesis testing
Number of gambles: 5 Change (A.C) (C.D) Set	CPT-KT Vertices: [KT-V4 [0.5]	Add Use reference volume Remove Weight	Run test Multicore Theories Specifications Data sets O Selected Selected Selected
None Al	Add Duplicate Remove Load Save	Set Determine volume from current settings: Set Set Set volume manually	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling: Sample size: 5000 Change
Data Observations: 20 Enter	Probabilistic specifications Aggregation-based: Supermajority level: Borda score Distance-based:	Figure Visualize Over last figure Color scheme: Detruit	Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
Load Save Clear	Max-distance (J): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change	Close all figures	
Name Default 🗘	Random preference: From file: Load Mixture from vertices Save	File Options Save About	Table Remove Export Details Clear

Under "Probabilistic specifications", under "Distance-based:", the radio button left of "City-block" should be selected. Leave the "Max-distance (U):" set to 0.5, as shown below.

Gamble pairs			
Number of gambles: 5 Change [A,C] (A,D) (C,D) Set	Theories	Add Remove Re	Hypothesis testing Run test Run test Hypothesis testing Run test R
None	Add Duplicate Remove Load	Determine volume from current settings: Set	All All Type of test Bayes Factor Bayes Factor Bayes p & DIC • Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Observations: 20 Enter Load Save Clear Name Default	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Oty-block Oty-bl	Figure Visualize Visualize Visualize Visualize Visualize Visualize Color scheme: Default Close all figures File Load Options Comp	Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results: Table Remove Export

To create a version of Figure 5 of QTBC1, press "Visualize" under "Figure".

Gamble pairs Number of gambles: 5 Change	ries	Add Reference volume	Hypothesis testing Multicore Run test Auto save
		Remove Weight	Specifications Data sets Selected Selected All All
Al	Add Duplicate (AD): 0 (C,D): 0 Load	Determine volume from current settings: Set	Type of test Bayes Factor Frequentist All Bayes Factor
Data Data Data Default	Save Save Supermajority level: Supermajority level: Supermajority level: O.75 Change Supermum O.5 Change Chy-block O.5 Change Euclidean O.5 Change Therefore ce: From file: Load Save.	File Load Options	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results: Table Remove Export

A figure will pop up in a separate window. In this case it is the left panel in Figure 5 of QTBC1 (without the data points). Please note that distance-based specifications with values greater than 0.50 will lead to a warning message, indicating that the regions are overlapping. In this case the user needs to think carefully about how to proceed.



C. KT-V4 vs. *LH* (Figure 6 of QTBC1)

We build on Section B by introducing a second theory and demonstrating how the theories compare in the same 3-D geometric space. In Section B.4 we created the 0.50-majority/modal choice specification for CPT - KT for the vertex KT-V4 for the 3 gambles A, C and D. We use the same 0.50-majority/modal choice specification from B.4. But we also create a specification for the lexicographic heuristic, or LH, in Figure 6 of QTBC1.

C.1 Create the gamble pairs

If you are continuing from Section B.6 (or starting from a saved session of B.6), your QTEST interface needs to match the following screenshot under "Gamble pairs". Specifically, set the "Number of gambles" to "5". Then verify the 3 gamble pairs "(A,C)", "(A,D)" and "(C,D)" are listed under "Gamble pairs".



承 Set Vertex	(Preference)	-	- (×
ſ	(A,C)		ī		
	A	С			
	(A,D)		1		
	Α	D			
	(C,D)		Oł	<	
	С	D	Can	cel	

Above, the Selection Box appears for **Windows Users** (the selected letters will be blue highlighted, and non-selected letters will appear gray)

Set Vertex (Preference)
(A,C) A C (A,D) A D (C,D) (C,D) OK C D Cancel

Above, the Selection Box Appears as such for **Mac Users** (the selected letters will remain dark gray, and the non-selected letters become white highlighted)

C.2 Define two decision theories, CPT-KT and LH

Figure 6 of QTBC1 compares two theories: CPT - KT and LH. We already introduced CPT - KT in Section B.2. If you are starting a new session of QTEST (or do not have a saved session), please return to Section B.2 and define CPT-
\mathcal{KT} before proceeding. The correct QTEST interface will look like the following. Notice "CPT-KT" is defined under "Theories".

	QTEST		
Gamble pairs Number of gambles: 5 Change (A.C) (A.D) (C.D) Set	CPT-KT Vertices: KT-V4 [0.5] Add Remo	Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected All
None All	Add Duplicate (A.O): 1 Remove (C,D): 0 Set. Load Save Save Set.	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling: Sample size: 5000 Change
Data Observations: 20 Enter Clear Observations: Clear Default O	Probabilistic specifications Aggregation-based: • Supermajority 0.5 Borda score ? Distance-based: Max-distance (U): Supremum 0.5 City-block 0.5 Euclidean 0.5 Random preference:	Figure Visualize Over last figure Color scheme: Default Close all figures File Load Options Save About	Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set. Results: Table Remove Export Details Clear

Next add the \mathcal{LH} . Under "Theories" select "Add...".

nble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	Vertices: KT=V4 [0.5]	Add Reference volume Use reference volume	Run test Auto save
.D) ;,D) Set		Remove Weight	Selected All All All
None	Add Duplicate (A.C): 1 (A.C): 0 (A.D): 0 (C.D): 0	Determine volume from current	Type of test Bayes Factor Bayes p & DIC
	Load	Set Set	Frequentist All
	Save	Set volume manually	Sample size: 5000 Change
ita	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations:	Supermajority level:	Visualize	simulation sample size: seed:
20	Supermajority Borda score O.5 Change	Over last figure	1000 Change 1 Set
Enter	Distance-based:	Color scheme:	Hesuits:
Load	Max-distance (U):		
Save	City-block 0.5 Change.	Close all figures	
Clear	Euclidean 0.5 Change		
Name Default	Random preference:	File	
	From file: Load	Load Options	Table Remove Export
	Save		

Enter "LH" in the "Theory" dialogue box that pops up. Then select "OK".



Notice that the updated "Theories" list now contains both "CPT-KT" and "LH".

Gamble pairs	Theories				Hypothesis testing		
Number of gambles: 5 Change	CPT-KT	/ertices:		Reference volume	Ru	in test	Multicore
		^	Add	Use reference volume			Auto save
(A,D)			Remove	Weight	Ineories	Specifications	Data sets
(C,D) Set	2				Selected	Selected	Selected
None	Add	~					
All	Duplicate	^		Determine volume from current	Type of test		
	Remove		Set	settings: Set	Bayes Freque	ntist OAll	p & DIC
	Save			Set volume manually	Gibbs samplin	g:	Ohanan
`					Sample s	ize: 5000	Change
Data	Probabilistic specifications		Fie	nure		1000	Change
000	Aggregation-based:		— II.,	juic .	Chi-bar squared	weights Ran	dom number
Observations: Sample size N:		Supermajority level:		Visualize	sinuation samp	ie 512e. 5ee	u.
	(a) Supermajority						
20	Gupermajority	0.5 Change		Over last figure	1000	Change	1 Set.
20	Borda score ?	0.5 Change		Over last figure	1000 Results:	Change	1 Set.
20 Enter	Borda score ? Distance-based:	0.5 Change Max-distance (U):		Over last figure Color scheme: Default	1000 Results:	Change	1 Set.
20 Enter	Distance-based:	0.5 Change Max-distance (U): 0.5 Change		Over last figure Color scheme: Default	1000 Results:	Change	1 Set.
20 Enter Load Save	Borda score ? Distance-based: O Supremum O City-block	0.5 Change Max-distance (U): 0.5 Change 0.5 Change		Over last figure Color scheme: Default V	1000 Results:	Change	1 Set.
20 Enter Load Save Clear	Osuperintigitity Borda score ? Distance-based: Osupremum Ocity-block DEuclidean	0.5 Change Max-distance (U): 0.5 Change 0.5 Change Change 0.5 Change Change		Over last figure Color scheme: Default v Close all figures	1000 Results:	Change	1 Set.
20 Enter Load Save Clear	Osuperindipitity Borda score Distance-based: O Supremum O City-block O Euclidean Random preference:	0.5 Change Max-distance (U): 0.5 0.5 Change 0.5 Change]]	Over last figure Color scheme: Default v Close all figures	1000 Results:	Change	1 Set.
20 Enter Load Save Clear Default	Superindigitity Borda score Distance-based: O Supremum City-block Euclidean Random preference: From file:	0.5 Change Max-distance (U); 0.5 Change 0.5 Change Change 0.5 Change Change 0.5 Change Change		Over last figure Color scheme: Default v Close all figures Close all figures	1000 Results: Table	Change Remove	1 Set.

Now we have defined 2 theories in one QTEST session.

<u>C.3 Specify predictions of decision theories LH and CPT-KT</u>

Having defined the theory \mathcal{LH} , we now specify its one prediction. Under "Theories", select "LH" (it will be highlighted in gray) and then select "Add…".

nble pairs Number of gambles: 5 Change	CPT-KT Vertices:	Reference volume	Run test Auto save
(C) (AD) (C) (C) (C) (C) (C) (C) (C) (C) (C) (C	Add v Duplicate Remove Load	betermine volume from current t	Theories Specifications Data sets Selected All All All Type of test Bayes Factor Bayes p & DIC Frequentist All
•	Save v	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Aata Observations: 20 Fate	Probabilistic specifications Aggregation-based: © Supermajority level: Borda score ? Change	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights Random number simulation sample size: Reed: 1000 Change 1 Set. Results:
Load Save	Distance-based: Max-distance (U): Supremum 0.5 Change	Default v	^
	O Euclidean 0.5 Change	Crose all ngures	
Clear			
Clear v Name Default v	Random preference: O From file: Load	File Load Options	Table Remove Export

In the "Vertex" dialogue box that pops up, enter the vertex "LH". Select "OK".



nble pairs		Theories					Hypothesis testing		_
Number of gambles: 5	Change	CPT-KT	Vertices:		Reference volur	me	ī 🛛 👘	Run test	Multicore
(C)		LH	H [0.5]	^ _ Ad	d Use referer	nce volume	Theories	Specifications	Data sets
.,D) .,D)	Set	v		Ren	Nove Weig	ght	Selected	Selected	Selected
							() All	OAI	OAII
	None	Add		~					
	All	Duplicate	A,D): 0 A,D): 0 C,D): 0	Se	Determine vo from current settings:	Set	Type of test Baye Frequencies	s Factor OBa uentist OAll	iyes p & DIC
~		Save		~	Set volum	e manually	Gibbs samp Sample	ling: e size: 5000	Change
							Burn-in	size: 1000	Change
obs	ervations:	Probabilistic specification Aggregation-based:	Supermaio	rity level	Figure Visuali	ize	Chi-bar squar simulation sar	ed weights nple size:	Random number seed:
Sample size N:	^	 Supermajority 	0.5	Change	Over last	figure	1000	Change	1 Set.
20		O Borda score ?			Color sche	me:	Results:		
Enter		Distance-based:	May-dista	nce (II):	Default	~			^
Load		OSupremum	0.5	Change					
		O City-block	0.5	Change	Close all f	figures			
Save		OEuclidean	0.5	Change					
Save Clear	~				- File				~
Save Clear	v ult v	Random preference:			rile				
Clear Defa	ult v	Random preference:		Load	Load	Options	Table	Remove	Export

All gamble pairs are set to "0" by default under "Vertices". Press "Set" to specify the predictions.

In the "Set Vertex (Preference)" dialogue box that pops up, select "A" from the pair "(A,C)", "D" from the pair "(A,D)" and "C" from the pair "(C,D)". Then select "OK".

承 Set Vertex (P	reference)				×
_ (A	,C)				
	A	С			
(A	,D)		1		
	Α	D			
(C	,D)			ок 🔶	<u> </u>
	С	D	С	ancel	

▲ QTEST		- 🗆 X
Gamble pairs Number of gambles: 5 (A,C) ^ (A,D) _ (C,D) _	CPT-KT Vertices: LH (0.5) Add Use refe	Hypothesis testing Multicore Run test Auto save rence volume eight Specifications Selected Selected Selected
None	Add Duplicate (A.C): 1 Determine from currer from currer settings:	volume nt Set OAI OAI OAI Set OBayes Factor OBayes p & DIC © Frequentist OAI
v	Save v	Gibbs sampling: Sample size: 5000 Change
Data Observations:	Probabilistic specifications Aggregation-based: Supermaiority level: Visu	Chi-bar squared weights Random number simulation sample size: seed:
20	Supermajority O.5 Change Color sci	st figure 1000 Change 1 Set heme: Results:
Load Save	Distance-based: Max-distance (U): O Supremum 0.5 Change	
Clear	OEuclidean 0.5 Change	
Name Default v	Random preference:	· · · · · · · · · · · · · · · · · · ·
	Load Load	Options Table Remove Export
	O Mixture from vertices Save Save	About Details Clear

Notice the gambles are updated under "Vertices" for "LH".

The prediction for LH is now specified. The prediction for CPT-KT should already be set. Check this by clicking once on "CPT-KT" under "Theories". "CPT-KT" will now be highlighted in blue, "KT-V4" is highlighted in gray under "Vertices" and the gambles are defined as in the following screenshot.

amble pairs			Theories	1					Hypothesis testing		_
Number of gambles:	5	Change	CPT-KT	Vertices:		Re	erence volur	me	F	Run test	Auto save
(A,C) (A,D) (C,D)	^	Set		K1+V4 [0,5]	Re	nove	Use referen	nce volume ght	Theories Selected	Specifications Selected	Data sets Selecte
		None	Add		/				OAI	OAII	OAII
		All	Duplicate Remove	(A,C): 1 (A,D): 0 (C,D): 0	s	łt	Determine vo rom current settings:	Set	Type of test Baye Frequ	s Factor OBa ientist OAl	ayes p & DIC
	~		Save		~		Set volum	e manually	Gibbs sampl Sample	ing: size: 5000	Change
Data			Probabilistic specificati	ione		Eigure			Burn-in	size: 1000	Change
Sample size N	Observ	ations:	Aggregation-based:	Superma	ijority level:	rigure	Visuali	ize	Chi-bar square simulation san	ed weights nple size:	Random number seed:
20		^	Supermajority	0.5	Change	[Over last	figure	1000	Change	1 Set
Enter			O Borda score	1			Color sche	me:	Results:		
Linter			Distance-based:	Max-dist	tance (U):		Default	~			^
Load			OSupremum	0.5	Change						
Save			O City-block	0.5	Change		Close all f	figures			
Clear			Euclidean	0.5	Change						
Name	Default		Random preference:			File					~
	seraun		O From file:		Load		Load	Options	Table	Remove	Export

If your session of QTEST does not have the prediction for KT-V4, please see Section B.3.

<u>C.4 The 0.50-Majority specification of KT-V4 (theory *CPT-KT*) and LH (theory *LH*)</u>

We are now ready to create the 0.50-majority/modal choice specification for both KT-V4 of CPT-KT and LH. We will specify KT-V4 first. Under "Theories" in the QTEST interface click on "CPT-KT" and "KT-V4" so they are both highlighted in gray. Under "Probabilistic specifications", the radio button left of "Supermajority" should be selected and the "Supermajority level:" should be "0.5".



mble pairs	Theories					Hypothesis testing		
Number of gambles: 5 Change	CPT-KT	Vertices:		Reference volume		F	Run test	Multicore
A,C)	LH	KT-V4 [0.5]	∧ Ad	d Use reference	volume	Theories	Specifications	Data sets
A,D) C,D) Set	~		Ren	Weight.		 Selected 	 Selected 	 Selected
None	Add		~					
All	Duplicate Remove	(A,C): 1 (A,D): 0 (C,D): 0	Se	Determine volum from current settings:	Set	Type of test Baye Frequ	s Factor O Bay uentist O All	yes p & DIC
~	Save		~	Set volume m	ianually	Gibbs samp Sample Burn-in	ling: size: 5000	Change
lata	Probabilistic specificat	ions		Figure		0111	1000	Change
Observations:	Aggregation-based:	Companyation	ter la carlo	Visualize		simulation sar	ed weights F nple size: s	eed:
Sample size N:	Supermajority	0.5 (Change	Over last figu	ire	1000	Change	1 Set
Entor	O Borda score	>		Color scheme		Results:		
Linei	Distance-based:	Max-distance	e (U):	Default	~			^
Load	◯ Supremum	0.5	Change					
Save	City-block	0.5	Change	Close all figu	res			
Clear	CEuclidean	0.5	Change					
Name Default	Random preference:			File				~
	O From file:		Load	Load	Options	Table	Remove	Export
	Mixture from verti	ces	Save					

To see this 0.50-majority/modal choice specification in 3-D space, press "Visualize" under "Figure".

The resulting figure (below) is like Figure 3 of QTBC1 which is also the figure we created in the previous section. Do not close this figure window yet. Minimize or move it to the side, as we will add a second figure to this same window.



We are now ready to create the 0.50-majority/modal choice specification for LH. Under "Theories" in the QTEST interface click on "LH" and under "Vertices", make sure "LH[0.5]" is selected. Both should be highlighted in gray. In the "Probabilistic specifications" section, the radio button left of "Supermajority" should be selected and the "Supermajority level:" should be "0.5".

mble pairs		Theories						Hypothesis testing		Multisore
Number of gambles:	Change	CPT-KT	Vertices: LH (0.5)		مطط	Reference volu	me	F	Run test	Auto save
A,C) ^ A,D) C,D)	Set			R	emove	We	ight	Theories Selected	Specifications	Data sets
	None	Add	(1.0).1	~						
	All	Duplicate Remove	(A,D): 0 (C,D): 1		Set	Determine v from current settings:	Set	Type of test O Baye Frequ	s Factor OBa entist OAll	iyes p & DIC
		Save		~		Set volum	e manually	Gibbs sampl Sample	ng: size: 5000	Change
					_			Burn-in	size: 1000	Change
ata		Aggregation-based:	ons		F	gure		Chi-bar square	d weights	Random number
Sample size N:	servations:	Supermaiority	Supermaj	ority level:		Visua	lize		01	
20		Borda score ?	0.5	Change		Over last	figure	Results:	Change	1 300
Enter		Distance-based:	May-diet	ance (II):		Default	~			^
Load		Supremum	0.5	Change						
Save		City-block	0.5	Change		Close all	figures			
Clear	÷	OEuclidean	0.5	Change						
Name	ault	Random preference:			Fil	e				~
	uun T	O From file:		Load		Load	Options	Table	Remove	Export

We want to visualize this figure also. But the procedure is a little different this time. First, in the QTEST interface, under "Figure", and under "Visualize", check the box next to "Over last figure". Second, directly beneath "Over last figure", from the "Color scheme:" dropdown menu choose "Blue".

mble pairs		Theones			Reference volu	ime	Hypothesis testing		Multicore
Number of gambles: 5	Change	CPT-KT	Vertices: LH (0.5)				F	Run test	Auto save
A,C)					Use refere	ence volume	Theories	Specifications	Data sets
A,D) C,D)	Set	~		Re	nove We	ight	Selected	Selected	Selected
	None	Add		~			() All	() All	
	All	Duplicate	(A,C): 1 (A,D): 0	^	Determine v	olume	Type of test		
	7 41	Remove	(C,D): 1		settings:	Sat	OBayes	s Factor OBa	iyes p & DIC
		Load		3	r	Set	Frequ	ientist OAII	
		Save			Set volum	ne manually	Gibbs sampli	ing:	
×		Save		~			Sample	size: 5000	Change
							Burn-in	size: 1000	Change
ata		Probabilistic specificatio	ins		Figure		Chi-bar square	ed weights	Random number
		riggiegation based.					a mulation com	and a second	a a a di
Observ Sample size N	vations:		Supermajo	ority level:	Visua	lize 🔻	simulation sam	ipie size:	seeu.
Sample size N:	vations:	 Supermajority 	Supermajo	ority level: Change	Visua Over lasi	t figure	1000	Change	1 Set
Sample size N:	vations:	Supermajority Borda score	Supermajo	ority level: Change	Visua Over lasi Color sch	t figure eme:	1000 Results:	Change	1 Set
Observ Sample size N: 20 Enter	vations:	Supermajority Borda score Distance-based:	Supermajo 0.5 Max-dista	Change	Visua Over last Color sch Blue	t figure eme:	1000 Results:	Change	1 Set
Sample size N: 20 Enter	vations:	Supermajority Borda score Distance-based: Supremum	Supermajo 0.5 Max-dista 0.5	Change	Visua Over last Color sch Blue	t figure eme:	1000 Results:	Change	1 Set
Sample size N: 20 Enter Load Save	ations:	Supermajority Borda score P Distance-based: Supremum	Supermajo 0.5 Max-dista 0.5	Change Change	Visua Over last Color sch Blue	t figure eme:	1000 Results:	Change	1 Set
Sample size N: 20 Enter Load Save	rations:	Supermajority Borda score P Distance-based: Supremum City-block	Supermajo 0.5 Max-dista 0.5 0.5	Change Change ance (U): Change Change	Visua Vover last Color sch Blue Close all	lize t figure	Results:	Change	1 Set
Sample size N: 20 Enter Load Clear	rations:	Supermajority Borda score Distance-based: Supremum City-block Euclidean	Supermajo 0.5 Max-dista 0.5 0.5 0.5	Change Change Change Change Change	Visua Over las: Color sch Blue Close all	Ilize t figure	1000 Results:	Change	1 Set
Sample size N: 20 Enter Load Clear Name Default	rations:	Supermajority Borda score Distance-based: Supremum City-block Euclidean Random preference:	Supermajo 0.5 Max-dista 0.5 0.5 0.5	change Change Change Change Change	Visua Over lasi Color sch Blue Close all	lize t figure	Results:	Change	1 Set
Sample size N: 20 Enter Load Save Clear Name Default	vations:	Supermajority Borda score Distance-based: Supremum City-block Euclidean Random preference: From file:	Supermaje 0.5 Max-dista 0.5 0.5 0.5	Change Change Change Change Change Change	Visua Over lasi Color sch Biue Close all File	figure eme:	Table	Remove	1 Set

Now click "Visualize" to get the following figure.



The 0.50-majority/modal choice specification for LH is created as a blue cube in the same figure window as the figure that QTEST used for the 0.50-majority/modal choice specification of KT-V4 for CPT-KT, which is the orange cube.

D. Linear Orders (Figure 7 of QTBC1)

Section B.1 through Section B.4 defined 3 out of 10 possible gamble pairs, defined one vertex (KT-V4) for $CPT \cdot KT$ and constructed a single 0.50-majority/modal choice specification for those 3 gamble pairs. In this section, instead of constructing a single 0.50-majority/modal choice specification, we will construct a 0.50-majority/modal choice specification for *each* of the six linear orders on A, C, D, in a single 3-D figure. Once completed, we will have the left panel of Figure 7 of QTBC1.

D.1 Create the gamble pairs

We continue our QTEST session from Section C.4. Your session should match the information under "Gamble pairs" in the following screenshot. (If it does not, either load a saved session from C.4 or return to Section B.1 to create the 3 gamble pairs "(A,C)", "(A,D)" and "(C,D)".)



D.2 Define a decision theory, Linear Orders

Now add another theory under "Theories" by selecting "Add…" In the "Theory" dialogue box that pops up, enter "Linear Orders" and then press "OK". If this is done correctly, your QTEST interface will match the screenshot below.

nble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT ^ Vertices:	Reference volume	Run test Auto save
NC) (D) (C) (C) (C) (C) (C) (C) (C) (C	Add	Add Use reference volume Remove Weight Determine volume from current settings: Set	Theories Specifications Data sets Selected All All Selected All All Type of test Bayes Factor Bayes p & DIC Encruentist All
~	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Observations:	Aggregation-based: Supermaiority level:	Figure	Chi-bar squared weights Random number simulation sample size: seed:
20	Supermajority Borda score O.5 Change	Over last figure	1000 Change 1 Set
Enter	Distance-based: Max-distance (II):	Blue V	results.
Load	O Supremum 0.5 Change		
Save	Ocity-block 0.5 Change	Close all figures	
Clear	OEuclidean 0.5 Change		
Name Default V	Random preference:	File	
	O From file: Load	Load Options	Table Remove Export

D.3 Specify the predictions of decision theory Linear Orders

We will first specify the prediction DAC, with 3-D coordinates (1,0,0). In the QTEST interface, under "Theories", select "Add...", just right of "Vertices".

mble pairs		Ineories			Deferrerente		Hypothesis testing		Multicore
Number of gambles:	5 Change	CPT-KT	Vertices:	0.044	Reference volur	ne	F	Run test	Auto save
A,C) A,D) C,D)	A Set	Linear Orders		Rem	ove Weig	ght	Theories Selected	Specifications Selected	Data sets
	None	Add		~			O All	() All	
	All	Duplicate Remove		Set	Determine vo from current settings:	Set	Type of test OBaye Frequ	s Factor OB ventist OA	ayes p & DIC
	~	Save		~	Set volume	e manually	Gibbs sampl Sample	ing: size: 5000	Change
							Burn-in	size: 1000	Change
sta	Observations:	Probabilistic specifications Aggregation-based:	Supermajorit	y level:	Figure	ze	Chi-bar square simulation san	ed weights nple size:	Random number seed:
20	^	Supermajority Borda score ?	0.5	Change	Over last	figure	1000	Change	1 Set.
Enter		Distance-based:	Max-distanc	e (U):	Blue	~	Results.		^
Load		Supremum	0.5	Change					
Save		O City-block	0.5	Change	Close all f	īgures			
Clear	, , , , , , , , , , , , , , , , , , ,	OEuclidean	0.5	Change					
	Default	Random preference:			File				~
Name		O From file:		Load	Load	Options	Table	Remove	Export
Name		0							- apportant

In the "Vertex" dialogue box that pops up, type "DAC" and press "OK".



Now "DAC [0.5]" appears in the list of "Vertices" under "Theories" in the QTEST interface. Notice that the 3 gamble pairs, (A,C), (A,D) and (C,D) are all followed by a "0" under "Theories". This is the default. To specify the prediction for DAC, press "Set" under "Vertices:".

	Theories		
Samble pairs Number of gambles: 5 Change (A.C) (A.D)	CPT-KT LH Linear Orders	Add Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets
(C,D) Set	Add	×	OAli OAli
All	Duplicate (A,C): 0 (A,D): 0 (A,D): 0 Remove (C,D): 0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	Load Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Observations:	Probabilistic specifications Aggregation-based: Supermaiority lev	Figure Visualize	Chi-bar squared weights Random number simulation sample size: seed:
20	Supermajority Borda score O.5 Char	ge	1000 Change 1 Set
Enter	Distance-based: Max-distance (U	Blue V	
Load	O Supremum 0.5 Cha	ge	
Save	O City-block 0.5 Cha	ge Close all figures	
Clear	O Euclidean 0.5 Cha	ge	
Name Default ~	Random preference:	File	
		Load Options	Table Remove Export

In the "Set Vertex (Preference)" dialogue box that pops up, select A from the gamble pair (A,C), D from the gamble pair (A,D) and D from the gamble pair (C,D). Then press "OK".



The QTEST interface should match the following screenshot. Note that there is now a "1" following the gamble pair "(A,C)" while "(A,D)" and "(C,D)" are both followed by a "0" under "Vertices:".

Number of gambles: 5	Change	CPT-KT ^ Y	Vertices: AC [0.5]	Ad	Reference volu	ime	F	tun test	Multicore
s,C) ^ ,D) ;,D)	Set	Linear Orders		Rem	ove Wei	ight	Theories Selected	Specifications Selected All	Data sets Selected
	All	Add Duplicate Remove	,C): 1 ,D): 0 ;D): 0) Set	Determine vi from current settings:	olume	Type of test OBayes Frequence	s Factor OBa entist OAII	iyes p & DIC
~		Save		~	Set volum	ne manually	Gibbs sampli Sample	ng: size: 5000	Change
ata Ob Sample size N:	servations:	Probabilistic specifications Aggregation-based:	Supermajo	rity level: Change	Figure Visual Over last Color sche	lize figure eme:	Chi-bar square simulation sam 1000 Results:	d weights ple size: Change	Random number seed: 1 Set
Load Save		Oistance-based:	Max-dista 0.5 0.5	nce (U): Change Change	Blue Close all	v			^
Clear		Euclidean	0.5	Change	File				~
Clear Name Defa	ult v	Random preference:		Load	Load	Options	Table	Remove	Export

This completes the first prediction. Creating the remaining 5 rankings follows the same procedures as the first. We only provide a verbal description of the rankings, leaving it to the reader to make the changes in QTEST.

Select "Add" just right of "Vertices" in QTEST. In the "Vertex" dialogue box that pops up enter "DCA" and then press "OK". Make sure "DCA" is highlighted in gray under "Vertices" in the QTEST interface and then press "Set". In the "Set Vertex (Preference)" dialogue box that pops up, make sure "C" from gamble pair "(A,C)" is selected, "D" from gamble pair "(A,D)" is selected and "D" from gamble pair "(C,D)" is selected. Then select "OK".

Select "Add" just right of "Vertices" in QTEST. In the "Vertex" dialogue box that pops up enter "CDA" and then press "OK". Make sure "CDA" is highlighted in gray under "Vertices" in the QTEST interface and then press "Set". In the "Set Vertex (Preference)" dialogue box that pops up, make sure "C" from gamble pair "(A,C)" is selected, "D" from gamble pair "(A,D)" is selected and "C" from gamble pair "(C,D)" is selected. Then select "OK".

Select "Add" just right of "Vertices" in QTEST. In the "Vertex" dialogue box that pops up enter "CAD" and then press "OK". Make sure "CAD" is highlighted in gray under "Vertices" in the QTEST interface and then press "Set". In the "Set Vertex (Preference)" dialogue box select "C" from gamble pair "(A,C)", "A" from gamble pair "(A,D)" and "C" from gamble pair "(C,D)". Then select "OK".

Select "Add" just right of "Vertices" in QTEST. In the "Vertex" dialogue box that pops up enter "ADC" and then press "OK". Make sure "ADC" is highlighted in gray under "Vertices" in the QTEST interface and then press "Set". In the "Set Vertex (Preference)" dialogue box, select "A" from gamble pair "(A,C)", "A" from gamble pair "(A,D)" and "D" from gamble pair "(C,D)".

Select "Add" just right of "Vertices" in QTEST. In the "Vertex" dialogue box that pops up enter "ACD" and then press "OK". Make sure "ACD" is highlighted in gray under "Vertices" in the QTEST interface and then press "Set". In the "Set Vertex (Preference)" dialogue box select "A" from gamble pair "(A,C)", "A" from gamble pair "(A,D)" and "C" from gamble pair "(C,D)".

The QTEST interface should now match the following screenshot. Note the list of "Vertices" contains "DAC [0.5]", "DCA [0.5]", "CDA [0.5]", "CAD [0.5]", "ADC [0.5]" and "ACD [0.5]". By selecting one of these vertices (it will be highlighted) the gambles specified by that vertex are shown in the box directly beneath the list of "Vertices:".

mble pairs		Theories			Hypothesis testing	
Number of gambles: 5	Change	CPT-KT	Vertices:	Reference volume	Run test	Multicore
A,C)	C at	LH Linear Orders	DAC [0.5] DCA [0.5] DDA [0.5] CAD [0.5]	Add Use reference volume Weight	Theories Specifica	tions Data sets
,	None	Add	ADC [0.5] ACD [0.5]			Oali
	All	Duplicate Remove	A,C): 1 A,D): 1 C,D): 1	Set Determine volume from current settings: Set	Type of test O Bayes Factor	◯ Bayes p & DIC ◯ All
*		Load Save	v	Set volume manually	Gibbs sampling: Sample size:	5000 Change
					Burn-in size:	1000 Change
ata		Probabilistic specification	ns -	Figure	Chi-bar squared weights	Random number
Obs Sample size N:	ervations:	0	Supermajority level:	Visualize	simulation sample size:	seed:
20	^	Supermajority Rorda score 2	0.5 Change	Over last figure	1000 Change	. 1 Set
Enter		- Bolda scole		Color scheme:	Results:	
Entert		Distance-based:	Max-distance (U):	Blue		^
		Supremum	0.5 Change			
Load		City-block	0.5 Change	Close all figures		
Load Save		City-block				
Load Save Clear	,	OEuclidean	0.5 Change			
Load Save Clear	v dt	Euclidean	0.5 Change	File		~
Load Save Clear Name Defa	v ult v	Cult-block	0.5 Change Load	File Load Options	Table Remo	ve Export

Now that the 6 predictions, or vertices, of Figure 7 of QTBC1 have been defined, we can create the 0.50-majority/modal choice specification for each of these 6 predictions.

D.4 The 0.50-Majority specification of 6 predictions for theory Linear Orders

Under "Theories" make sure "Linear Orders" is selected--it will be highlighted in blue.

nble pairs					Reference volu	me	Hypothesis testing		Multicore
Number of gambles:	5 Change	LH	DAC [0.5]				F	tun test	Auto save
.,C)	^	Linear Orders	DCA [0.5]		USe Telefe	ince volume	Theories	Specifications	Data sets
;,D)	Set	~	CAD [0.5] ADC [0.5]	Ref	vve	ignt	Selected	Selected	Selecter
	None	Add	ACD [0.5]	~			All		
	All	Duplicate	(A,C): 1 (A,D): 1	^	Determine ve	olume	Type of test		
		Remove	(C,D): 1	Se	settings:	Set	OBaye	Factor Ba	ayes p & DIC
		Load					() Frequ	entist () Al	
		Save			Set volum	ne manually	Gibbs sampli	ng:	Change
	~						Sample	size: 5000	Change
ata		Probabilistic enecificatio			Eiguro		Burn-In	size: 1000	Change
ata	0	Aggregation-based:			Viewel	F=-	Chi-bar square	d weights nle size:	Random number
Sample size N:	Observations:	Supermajority	Supermajor	ity level:	Visual	lize	1000	0.	d Cat
20		Borda soore	0.5	Change	✓ Over last	figure	1000	Change	1 Set
Enter					Color sche	eme:	Results:		
		Distance-based:	Max-distan	ce (U):	Blue	~			^
Load		Supremum	0.5	Change					
Save		City-block	0.5	Change	Close all	figures			
		Euclidean	0.5	01					
Clear	*	Lucidean	0.5	Change					
Clear		Random preference:			File				~
Clear Name	Default ~			boad	beol	Ontions	Table	Berneure	Enand
Clear Name	Default 🗸	O From file:		Load	Lodu	Options	Table	Remove	Export



Under "Probabilistic specifications", verify that the "Supermajority" radio button is selected and that the "Supermajority level:" is set to "0.5".

Now, under "Figure" in the QTEST interface, press "Visualize" once. The resulting figure is a version of the left-hand side of Figure 7 of QTBC1.



How can we create the right-hand side of Figure 7 of QTBC1? The gamble pairs, theories and vertices are identical for the two figures. The only difference between the left- and right-hand sides of Figure 7 of QTBC1 is the supermajority specification. In the left-hand side the supermajority specification is 0.5 whereas in the right-hand side the supermajority specification is 0.90. We can create this specification by making one change in the QTEST interface.

D.5 The 0.90-Supermajority specification of 6 predictions for Linear Orders

In the QTEST interface, select "Change" under "Probabilistic specifications". In the dialogue box that pops up, enter "0.9" for the "Supermajority Level (Lambda)". Then press "OK". The interface will then look like the following screenshot.



Press "Visualize" once under "Figure" in the QTEST to get the following figure, which is a version of the right-hand side of Figure 7 of QTBC1.



This completes the section for defining one theory, Linear Orders, with multiple predictions and with a separate probabilistic specification for each prediction.

E. CPT-KT vs. LH (Figure 8 of QTBC1)

In this section, we will build on our knowledge from Sections D.1 through D.4 that compared one prediction for CPT-KT and one prediction for LH. Here, we compare these theories again. But this time we consider all predictions for CPT-KT rather than just one. Once we complete this section, we will have replicated a version of Figure 8 of QTBC1.

E.1 Create the gamble pairs

If you are continuing from Section D.5, or loading Section D.5 from a saved session, your QTEST session, under "Gamble pairs" should match the screenshot below. (If you need to create these gamble pairs, please go to Section D.1 above.)

▲ QTEST					
Gamble pairs	Theories			Hypothesis testing	
Number of gambles: 5 Change	CPT-KT Vertices:		Reference volume	Run test	Multicore
(4.0)	LH DAC [0.5]	^ Add	Use reference volume	Theories	Auto save
(A,D) (C,D) Set	CDA [0.5]	Remove	Weight	Selected Selected	ed
	ADC [0.5] ACD [0.5]) All
None	Dunliante (A.C); 1	•	Determine volume	Type of test	
All	(A,D): 1		from current	Bayes Factor	Baves p & DIC
	Remove (C,D): 1	Set	settings: Set	 Frequentist 	
	Load		Catualuma manually	Gibbs sampling:	
~	Save	~	Set volume manually	Sample size:	Change
				Burn-in size:	000 Change
Data	Probabilistic specifications		Figure	Chi-bar squared weights	Random number
Observations:	Aggregation-based:	ority level:	Visualize	simulation sample size:	seed:
Sample size N:	Supermajority	Oheeee	Over last figure	1000 Change	1 Set
20	Borda score ?	Change			
Enter	Distance-based:		Color scheme:	Results:	
	Max-dista	ance (U):	Dide		^
Load	O Supremum 0.5	Change			
Save	O City-block 0.5	Change	Close all figures		
Clear	O Euclidean 0.5	Change			
Name Default	Random preference:		File		~
	O From file:	Load	Load Options	Table Remov	e Export
	Mixture from vertices	Save	Save About	Details Clear	

E.2 Define two decision theories, CPT - KT and LH

Under "Theories", "CPT-KT", "LH" and "Linear Orders" are listed. If you do not see "CPT-KT" and "LH" listed, return to Section C.2 to define these theories in QTEST.

▲ QTEST							- 🗆
Gamble pairs	Theories	Vertices:		Reference volume	Hypothesis testing		Multicore
(A,C)	LH Linear Orders	DAC [0.5] DCA [0.5]	^ Ac	d Use reference volume	Theories	Run test	Auto save
(A,D) (C,D) Set		CDA [0.5] CAD [0.5] ADC [0.5]	Ren	Weight	Selected	Selected	Selected
None	Add	ACD [0.5]	~				OAII
All	Duplicate Remove	(A,C): 1 (A,D): 1 (C,D): 1		t Determine volume from current settings: Set	Type of test	s Factor OBa	yes p & DIC
	Load				Freque	ientist OAll	
~	Save		~	Set volume manually	Gibbs sample	size: 5000	Change
r Data	Probabilistic specificati	ons		Figure	Burn-in	size: 1000	Change
Observations:	Aggregation-based:	Supermai	ority level:	Visualize	Chi-bar square simulation san	ed weights i nple size:	Random number seed:
20	Supermajority Borria score	0.5	Change	✓ Over last figure	1000	Change	1 Set
Enter	Distance-based:	•		Color scheme:	Results:		
Load	0	Max-dista	ance (U):	blue			
Save	City-block	0.5	Change	Close all fourse			
Clear) Euclidean	0.5	Change	Close all ligures			
Name Default V	Random preference:			File			~
	O From file:		Load	Load Options	Table	Remove	Export
	O Mixture from vert	ices	Save	Save	Dataila	Class	

Under "Theories", select "CPT-KT" so it is blue highlighted and then select "Remove".

nble pairs		Theories			5.4		Hypothesis testing		Multicore
Number of gambles:	5 Change	CPT-KT	Vertices: KT-V4 (0.9)		Reference volu	ime	F	Run test	Auto save
.,C) ,,D) ;,D)	Set	Linear Orders		Re	nove We	ight	Theories Selected All	Specifications Selected	Data sets
	None	Add Duplicate	(A,C): 1	~	Determine v	rolume	Type of test	0,1	0,1
	All	Remove	(C,D): 0 (C,D): 0	s	from current settings:	Set	⊖ Bayes ● Frequ	s Factor OBa entist OAll	yes p & DIC
	~	Save		~	Set volum	ne manually	Gibbs sampli Sample	ng: size: 5000	Change
							Burn-in	size: 1000	Change
ata	Observations:	Probabilistic specifica Aggregation-based:	Supermai	ority level:	Figure	lize	Chi-bar square simulation sam	d weights I ple size:	Random number seed:
Sample size N:	^	Supermajority Borda score	0.9	Change	Over last	t figure	1000	Change	1 Set
Enter		Distance-based:			Color sch Default	eme:	Results:		^
Load		Supremum	Max-dist	Change					
Save		City-block	0.5	Change	Close all	figures			
Clear	J.	Euclidean	0.5	Change					
Name	Default ~	Random preference			File				~
		O From file:		Load	Load	Options	Table	Remove	Export

Only two theories remain, "LH" and "Linear Orders". Select "Linear Orders" so it is blue highlighted. Then select "Duplicate...".

amble pairs			Theories						Hypothesis testing		
Number of gambles:	5 0	hange	LH	Vertices:			Reference volu	ime	1	Pue test	Multicore
Humber of gambles.		indinge	Linear Orders	DAC [0.9]	^	Add	Use refere	nce volume		Run test	Auto save
(A,C) (A,D)	^			CDA [0.9]		Remove	Wei	ight	Theories	Specifications	Data sets
(0,0)	5	et	, in the second se	ADC [0.9]					Gelected	Gelected	Out
	N	one	Add	ACD [0.9]	~				U AI	O All	() All
		All	Duplicate	(A,C): 1 (A,D): 0 (C,D): 0	Ŷ	Set	Determine vo from current settings:	olume	Type of test	es Factor OB	ayes p & DIC
	~		Load Save		•		Set volum	ne manually	Gibbs sample Sample	ling: e size: 5000	Change
									Burn-in	size: 1000	Change
Data			Probabilistic specifica	itions		1	Figure		Chi-bar square	ed weights	Random number
Comple size N:	Observations	e	Aggregation-based:	Superma	jority level:		Visual	lize	simulation san	mple size:	seed:
Sample size N:		^	 Supermajority 	0.9	Change	1	Over last	figure	1000	Change	1 Se
20			O Borda score	?			Color sche	eme:	Results:		
Enter			Distance-based:	May diet			Default	~			~
Load				0.5	Change						
Save			OCity-block	0.5	Change		Class all	Emuran			
Clear			OSuplack	0.0	Change		Close all	ngures			
Cieal		~	Euclidean	0.5	Change						
Name D	Default	~	Random preference	0		F	ile				~
			O From file:		Load		Load	Options	Table	Remove	Export
			Mixture from ve	rtices	Save						

In the "Duplicate..." dialogue box, enter "CPT-KT". Select "OK".

$\Theta \circ \circ$	Duplicate Th
Enternamefo	rnewtheory:
CPT-KT	
(OK Cancel

"CPT-KT" is listed under "Theories" but now it has identical "Vertices:" as the "Linear Orders" theory. But we will change the predictions of "CPT-KT" next.

mble pairs			Theones					Hypothesis testing		
Number of gambles:	5	Change	LH A	Vertices: DAC [0.9]		Reference volu	me	F	Run test	Auto save
.C) ,D) ;,D)		Set	СРТ-КТ	DCA [0.9] CDA [0.9] CAD [0.9] ADC [0.9]	Rer	vove Wei	ght	Theories Selected	Specifications	Data sets
		None	Add Duplicate Remove	(A,C): 1 (A,D): 0 (C,D): 0	~ ^	Determine vi from current settings:	olume	Type of test	s Factor OBa	iyes p & DIC
	~		Load Save		Se	Set volum	set	Gibbs sample Sample	ing: size: 5000	Change
								Burn-in	size: 1000	Change
ata	Observ	ations:	Aggregation-based:	Supermai	ority level	Figure	ize	Chi-bar square simulation san	nd weights nple size:	Random number seed:
20		^	Supermajority Borda score	? 0.9	Change	Over last	figure	1000	Change	1 Set
Enter			Distance-based:	May dist	anae (11):	Color sche Default	eme:	Results:		^
Load			Supremum	0.5	Change					
Save			O City-block	0.5	Change	Close all	figures			
Clear		_	OEuclidean	0.5	Change					
Name	Default	~	Random preference:	-		File				~
			O From file:		Load	Load	Options	Table	Remove	Export
			Mixture from ver	tices	Save	1	10000			

E.3 Specify the predictions of decision theories LH and $CPT \sim KT$

Select "CPT-KT" so it is blue highlighted.

mble pairs	5 Obarra	LH	Vertices:		Reference volun	ne	Hypothesis testing		Multicore
Number of gambles:	5 Change	Linear Orders	DAC [0.9]	Add	Use referen	ice volume	R	tun test	Auto save
A.C) A.D) C.D)	^ Set	CPT-KT	DCA [0.9] CDA [0.9] CAD [0.9] ADC [0.9]	Remo	we Weig	yht	Theories Selected	Specifications Selected	Data sets
	None	Add	ACD [0.9]	~					OAII
	All	Remove	(A,D): 0 (C,D): 0	Set.	Determine vo from current settings:	Set	Bayes Freque	s Factor O Ba entist O All	yes p & DIC
	~	Save		~	Set volume	e manually	Gibbs sampli Sample	ng: size: 5000	Change
ata		Probabilistic specification	ns		Figure		Chi-bar square	d weights	Change
Sample size N:	Observations:	Supermajority	Supermajorit	ty level:	Visualiz	ze	simulation sam	ple size:	seed:
20		O Borda score ?	0.9	Change	Color scher	ngure	Results:	change	
Enter		Distance-based:	Max-distanc	e (U):	Default	~			^
Load		OSupremum	0.5	Change					
Save		City-block	0.5	Change	Close all f	igures			
Clear	~	Euclidean	0.5	Change					
Name D	lefault v	Random preference:		Land	File				~
		From file:		Load	Load	Options	Table	Remove	Export
		Mixture from vertic	es	Save	Cours	About	Details	01	

Under "Vertices:", select "CAD[0.5]" so it is blue highlighted. Then select "Remove".

mble pairs Number of gambles: 5 Change	LH Vertices:	Reference volume	Hypothesis testing Multicore
A.C) A.D) C.D) Set None	Linear Orders DAC [0.9] CDA [0.9] CDA [0.9] CDA [0.9] ADC [0.9] ACD [0.9] ACD [0.9] CDA [0.	Add Use reference volume Weight	Theories Specifications Data sets Selected All All All
All	Duplicate (A, D): 1 Remove (C, D): 1 Load (C, D): 1	Set	I ype of test Bayes Factor Bayes p & DIC Frequentist All
~	Save v	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications	Figure	Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed:
Inservations:			
Sample size N:	Supermajority Supermajority O.9 Change	Over last figure	1000 Change 1 Set.
Sample size N: 20 Enter	Supermajority level: Supermajority Borda score Distance-based: Max-distance (U):	Color scheme: Default v	1000 Change 1 Set. Results:
Sample size N: 20 Enter Load Save	Supermajority level: Supermajority Borda score O.9 Change Distance-based: Max-distance (U): Supremum O.5 Change Otim black O.5 Change	Over last figure Color scheme: Default ✓	1000 Change 1 Set. Results:
Sample size N: 20 Enter Load Save Clear	Supermajority Supermajority Supermajority level: Borda score 0.9 Change Distance-based: Max-distance (U): O.5 Osupremum 0.5 Change Ocity-block 0.5 Change Euclidean 0.5 Change	Color scheme: Default ✓ Close all figures	1000 Change 1 Set. Results:
Sample size N: 20 Enter Load Save Clear Name Default V	Supermajority level: Supermajority 0.9 Change Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change City-block 0.5 Change Fandom preference: The second sec	Color scheme: Default	1000 Change 1 Set.

A QTEST			×
Gamble pairs Number of gambles: 5 (A,C) ^ (A,D) ^ (C,D) Set	Theories UH Linear Orders CPT-KT CDA (0.9) CCA (0.9) ACC	Reference volume Use reference volume Weight	Hypothesis testing Run test Theories Specifications Selected Selected Selected Selected
None	Add v Duplicate (A.C): 1 Remove (C.D): 0 Load	Determine volume from current settings: Set	Type of test Oall Oall OBayes Factor OBayes p & DIC @ Frequentist Oall
Data	Probabilistic specifications	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number
Sample size N:	Supermajority level: O.9 Change	Visualize Over last figure Color scheme:	simulation sample size: seed: 1000 Change 1 Set Results:
Load Save	Distance-based: Max-distance (U): O Supremum O City-block 0.5 Change	Default ~	^
Clear v Name Default v	O Euclidean 0.5 Change Random preference:	File	
	Original Load O Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear

"CAD" is removed from the "Vertices" list and now only five predictions remain.

Select "CDA[0.5]" under "Vertices:". Again select "Remove".

ble pairs		Theories			Reference volume	Hypothesis testing		Multicore
Number of gambles: 5 Change		LH ^ D	Vertices: AC [0.9]	Ad Ad	I lise reference volume	F	lun test	Auto save
(C) (D) (D)	Set		CA [0.9] DA [0.9] DC [0.9] CD [0.9]	Ren	ve Weight	Theories © Selected All	Specifications Selected All	Data sets Selected
	None	Add	.C): 0	· /	Determine velume	Type of test		
	All	Remove (C	,D): 0 C,D): 1	Set	from current settings: Set	Bayes Freque	s Factor OBa entist OAll	iyes p & DIC
~		Save		~	Set volume manually	Gibbs sample	ng: size: 5000	Change
ta		Probabilistic specifications			Figure	Burn-in	size: 1000	Change
Obse	ervations:	Aggregation-based:	-		Visualize	Chi-bar square simulation sam	d weights ple size:	Random number seed:
Sample size N:	^	Supermajority Borda score ?	Supermajo	rity level: Change	Over last figure	1000	Change	1 Set
Enter		Distance-based:			Color scheme:	Results:		
Load		Summer	Max-distar	nce (U):	Default			
Save		O City-block	0.5	Change	Close all figures			
Clear	,	Euclidean	0.5	Change				
Name Defau	lt v	Random preference:			File			~
bolad		O From file:		Load	Load Options	Table	Remove	Export

The QTEST interface will now match the following screenshot. The list of "Vertices:" only contains the four predictions "DAC [0.5]", "DCA [0.5]", "ADC [0.5]" and "ACD [0.5]".

▲ QTEST			- 🗆 ×
Gamble pairs Number of gambles: 6. (A,D) (C,D)	Theories UH Linear Orders CPT-KT ACD [0.9] ACD [0.9] ACD [0.9] ACD [0.9]	Reference volume Use reference volume Weight	Hypothesis testing Run test Theories Selected Huticore Auto save Data sets Selected Selected Huticore Auto save Data sets Selected
None	Add (A,C): 1 Duplicate (A,C): 1 Remove (C,D): 0 Load	Determine volume from current settings: Set	All All Type of test Bayes Factor Bayes Factor Bayes p & DIC Image: Frequentist All
·	Save v	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Observations: 20	Probabilistic specifications Aggregation-based: Supermajority level: Borda score	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1000 Change 1000 Change 1 Set Results: Chi-bar section
Enter Load Save	Distance-based: Max-distance (U): O Supremum 0.5 Change O City-block 0.5 Change O Euclidean 0.5 Change	Defauit <	
Name Default ~	Random preference:	File Options	Table Remove Export
	OMixture from vertices Save	Save About	Details Clear

Select "LH" so it is blue highlighted. After highlighting "LH", under "Vertices", "LH" is listed in the top half and the coordinates for its vertex are listed in the bottom half. Verify that your session of QTEST matches this screenshot.

mble pairs			Theories					Hypothesis testing		
Number of gambles:	5	Change	LH Linear Orders	Vertices: .H [0.9]	Ad	Reference volu	me	R	un test	Auto save
A,C) A,D) C D)		C-1	СРТ-КТ		Ren	ove Wei	ght	Theories	Specifications	Data sets
(,,)		Set	Add		~			All	All	Ali
		All	Duplicate	A,C): 1 A,D): 0	^	Determine v	olume	Type of test		
			Remove	C,D): 1	Se	settings:	Set	Bayes Freque	Factor Ba entist All	yes p & DIC
	、		Save		•	Set volum	e manually	Gibbs samplin Sample	ng: size: 5000	Change
								Burn-in :	size: 1000	Change
lata	Observat	ions:	Probabilistic specification Aggregation-based:	is Currentia	- it. In	Figure	ize	Chi-bar square simulation sam	d weights ple size:	Random number seed:
Sample size N: 20		^	Supermajority Borda score 2	0.9	Change	Over last	figure	1000	Change	1 Set.
Enter			Distance-based			Color sche	me:	Results:		
Load			Supremum	Max-distar	nce (U):	Deraut	~			^
Save			O City-block	0.5	Change	Close all	figures			
Clear		Ŷ	Euclidean	0.5	Change					
Name	Default	~	Random preference:			File				~
			O From file:		Load	Load	Options	Table	Remove	Export
			Mixture from vertice	es	Save	Save	About	Details	Clear	

E.4 The 0.50-Majority specification of CPT-KT and LH

We are now ready to create the 0.50-majority/modal choice specification for both CPT-KT and LH. Under "Theories" in the QTEST interface click on "CPT-KT" so it is highlighted in gray. Under "Probabilistic specifications", the radio button left of "Supermajority" should be selected and the "Supermajority level:" should be changed or set to "0.5". Under "Theories, select "CPT-KT" and under "Figure" change "Color scheme" to "Default" and uncheck "Over last Figure" (if it is not already unchecked). Then select "Visualize".

▲ QTEST		– 🗆
CTEST	Difference Vertices: Linear Orders DAC [0.5] CPT-KT DAC [0.5] Add Add Duplicate (A,C): 1	Reference volume Hypothesis testing Multicore Use reference volume Run test Auto save Weight Selected All Determine volume All All
Data Observations:	Remove (C,D): 0 Load Set Save v Probabilistic specifications v Aggregation-based: Supermajority level: © Supermajority 0.5	Figure Visualize Visualize Chi-bar squared weights simulation sample size: Set 1000 Chi-bar squared weights Random number simulation sample size:
20 Enter Load Save Clear	Borda score ? Distance-based: Max-distance (U): O Supremum 0.5 C tity-block 0.5 C Euclidean 0.5 C Euclidean 0.5	Color scheme: Default Close all figures
Name Default V	Random preference: Load From file: Load OMixture from vertices Save	File v Load Options Table Remove Export Save About Details Clear

Once this figure has been created, do not close it. Instead, select "LH" under "Theories". Then check "Over last figure" under "Figure". Change "Color scheme" to "Blue". Then select "Visualize", which should give the following figure, which is a version of the left-hand side of Figure 8 of QTBC1.



<u>E.5 The 0.90-supermajority specification of KT-V4 (theory $CPT \sim KT$) and LH (theory LH)</u>

We repeat the same procedure as E.4 but now create a 0.90-supermajority specification. Under "Probabilistic specifications", the radio button left of "Supermajority" should be selected and the "Supermajority level:" should be set to "0.9".



Under "Theories, select "CPT-KT" and under "Figure" change "Color scheme" to "Default" and, if it is checked, uncheck "Over last Figure". Then, under "Figure" select "Visualize". Once this figure has been created, do not close it. Instead, select "LH" under "Theories". Then check "Over last figure" under "Figure". Change "Color scheme" to "Blue". Then select "Visualize", which should give the following figure, which is a version of the right-hand side of Figure 8 of QTBC1.



F. Mixture Models (Figure 9 of QTBC1, Figure 2 of Online Supplement 1, and Figure 4 of QTBC2)

Figure 9 of QTBC1 creates a fundamentally different type of probabilistic specification. The method for specifying these mixture models is different than the one used for the distance-based probabilistic specifications, which comprise all previous sections of the tutorial (Sections A-E). Due to the mathematical aspects involved in specifying these models, the process is not nearly as automated in QTEST as are the models we have considered so far.

F.1.1 Create the gamble pairs for Figure 9 of QTBC1 and Figure 2 of Online Supplement 1

We will use the same gamble pairs as in our QTEST session from Section E. If you are loading a saved session, loading the session from Section D will be most helpful. Your session should match the circled information, under "Gamble pairs", in the following screenshot.

amble pairs	~	Theories			- Deference vol	mo	Hypothesis testing		Multicore
Number of gambles:	5 Change	LH ^	Vertices:		Reference voi	une	R	tun test	Auto save
(A,C) (A,D) (C,D)	^	CPT-KT	DCA [0.5] DCA [0.5] CDA [0.5] CAD [0.5] ADC [0.5] ACD [0.5]	Rer	Id Use refer	ence volume eight	Theories Selected All	Specifications Selected All	Data sets
	All	Duplicate Remove	(A,C): 0 (A,D): 1 (C,D): 1	Se	Determine from curren settings:	volume t Set	Type of test Bayes Frequ	s Factor OBa ventist OAll	yes p & DIC
	~	Load		~	Set volur	ne manually	Gibbs samp Sample	ing: size: 5000	Change
D -4-		Derbehöfen er eifertig					Burn-in	size: 1000	Change
Data	Observations:	Aggregation-based:	Superma	iority level:	Visua	alize	Chi-bar square simulation sam	ed weights F nple size: s	Random number seed:
20	^	Supermajority Borda score	0.5	Change	Over las	st figure	1000	Change	1 Set
Enter		Distance based			Color sch	eme:	Results:		
		bisurec-bused.	Max-dist	ance (U):	Default	~			^
Load		OSupremum	0.5	Change					
Save		O City-block	0.5	Change	Close al	I figures			
Clear	v	OEuclidean	0.5	Change					
Name	Default	Random preference:			File				~
		O From file:		Load	Load	Options	Table	Remove	Export
		Mixture from vertic	201	Save					

<u>F.1.2 Define one decision theory, Random CPT - KT for Figure 9 of QTBC1 and Figure 2 of Online Supplement 1</u>

mble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change.	LH Vertices: DAC [0.5]	Artri	Run test Auto save
A.C) A.D) C,D) Set	CPT-KT DCA [0.5] ADC [0.5] ACD [0.5]	Remove Weight	Theories Specifications Data sets Selected Selected Selected
None	Add Duplicate (A,C):1 (A,D):1 (C,D):1 (C,D):1	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	Save V	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Observations:	Probabilistic specifications Aggregation-based: Sunormaiority level:	Figure Visualize	Chi-bar squared weights Random number simulation sample size: seed:
20	Supermajority Borda score P	Over last figure	1000 Change 1 Set
Enter	Distance-based: Max-distance (U):	Default ~	^
Save	City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Default ~	Random preference: C From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save.	Sava About	Details Clear

For mixture models, we use the "Mixture-based" panel.

F.1.3 Mixture model specification of CPT - KT for Figure 9 of QTBC1 and Figure 2 of Online Supplement 1

The mixture model specification of $CPT \cdot KT$ can be generated in two different ways. These methods are now described in more detail.

<u>Method 1: generating the mixture model specification of CPT - KT if using PORTA directly</u>

The vertices for the mixture model are defined differently than for all previous sections of the tutorial. We need to create a special text file (with a .txt extension), which contains information that QTEST reads. We will now look at the specific requirements of this text file. Specifying and testing a mixture model is recommended for more advanced users, e.g., because it requires that the user first solves the relevant mathematics problems to determine the facet structure of the polytope that characterizes the mixture model.

We call our text file "Figure9_MixtureInput.txt".

The first line of "Figure9_MixtureInput.txt" must contain two numbers, separated by a space. The first number represents the number of linear inequalities while the second number represents the number of gambles under consideration. To obtain the system of facet defining inequalities, one must use software like PORTA which is discussed in QTBC1 under the section 'Random Preference and Random Utility Models' and in Online Supplement 1 to QTEST. After entering the vertices "ACD", "ADC", "DAC" and "DCA" (or the 3-D coordinates 111, 110, 100 and 000) into PORTA, one will obtain the following system of 4 linear inequalities:

$$\begin{array}{l} 0*P_{AC}+\ 0*P_{AD}-\ 1*P_{CD}\ \leq 0\\ -1*P_{AC}+\ 1*P_{AD}+\ 0*P_{CD}\ \leq 0\\ 0*P_{AC}+\ -1*P_{AD}+\ 1*P_{CD}\ \leq 0\\ 1*P_{AC}+\ 0*P_{AD}+\ 0*P_{CD}\ \leq 1 \end{array}$$

We now have 4 linear inequalities (where each row is 1 linear inequality). So, the first number of the first row of the input file is 4, to denote the number of linear inequalities. The second number, determined by the number of gambles (recall we have 3 in Figure 9: A, D and C), is 3. The first line of "Figure9_MixtureInput.txt" looks like the following screenshot.

4 3 | The next row is an optional blank row. The row after contains the coefficients of everything to the left of the inequality signs in the system of linear inequalities provided above, with each column separated by a tab (or a single space). The inequalities must be formulated precisely as above, with the \leq sign and the constant on the right-hand side of the inequality. Since there are 4 rows of inequalities, we have 4 rows of coefficients. Be sure to include any 0 coefficients. Adding these coefficients to the "Figure9_MixtureInput.txt" file yields the following.

0 0	0		Figure9_MixtureInput.txt
43			
0	0	-1	
0	-1	0 1	

Again, the next row is an optional blank row. Then the constants of the system of linear inequalities (i.e. everything to the right of the \leq operator in the system of inequalities above) are listed, one per row. (NOTE: The order of the constants must have the correct sign (positive or negative.) Since we have 4 rows of inequalities, we also have 4 rows of constants.

0	0		Figure 9	9_MixtureInp	out.txt		
43							
0 -1	0 1	-1					
0	-1	1					
1	0	0					
0 0							
0 1							

This file contains all the required information QTEST needs to analyze a mixture model. Alternatively, the file might look like the following, which does not have the optional spaces between rows.

00		📑 Figu	ire9_MixtureInput.tx	t	
43					
0 0 -1 1 0 -1 100	-1 0 1 1				
0 0 0 1					

(instead of tab), their file mi	ght look like one of the following two files.
00	Figure9_MixtureInput.txt
4 3	
0 0 -1	
-1 1 0 0 -1 1	
100	
0	
0	
1	
	Figure9_MixtureInput.txt
0 0 -1	
-1 1 0 0 -1 1	
1 0 0	
0	
0	
1	

Or if one used spaces in between the coefficients of the linear inequalities (instead of tab), their file might look like one of the following two files.
Finally, while not necessary for QTEST to do the analysis, it can be helpful to have more informative labels than the generic ones that QTEST will generate. After the last constant from the last inequality, (with an optional blank row), one can include the optional name "Vertices", the coordinate and/or even the labels (in double quotes) for each vertex name. Once again, none of this information is required by QTEST—they are useful primarily for purposes of documentation and for 3-D visualizations.

•	00		Figure9_MixtureInput.txt	
43 0	0	-1		
-1 0 1	1 -1 0	0 1 0		
0 0 0 1				
Ver 1 0 1 1 0 0 1 1	tices 0 "DAC" 0 "ADC" 0 "DCA" 1 "ACD"			

In this method, this is all the information QTEST needs to analyze a mixture model. Save this "Figure9_MixtureInput.txt" file. In the following section we will use this file to complete the analysis of the mixture model in the QTEST interface.

ι.

Method 2: generating the mixture model specification of CPT - KT if using the QTEST interface to access PORTA

Under "Probabilistic specifications", select the radio button left of "Mixture from vertices". Then under "Probabilistic specifications", select "Save..." and save this file as "Figure9_MixtureInput.mat". Your session should match the circled information, under "Probabilistic specifications", in the following screenshot.

Number of gambles: 5	Change	LH	Vertices:		Reference vo	lume	Hypothesis testing	un test	Multicore
(A,C) (A,D) (C,D)	Set	CPT-KT	DAC DCA ADC ACD	Ar Rer	dd Use refe	rence volume	Theories Selected All	Specifications	Auto save Data sets Selected All
	All	Duplicate Remove	(A,C): 1 (A,D): 1 (C,D): 1	Se	Determine from currer settings:	volume nt Set	Type of test Bayes Frequ	s Factor OBa ventist OAll	yes p & DIC
~		Save		~	Set volu	me manually	Gibbs sample	ing: size: 5000	Change
Data Observ	ations:	Probabilistic specificati Aggregation-based Supermajority Borda score 2	Supermaj	ority level: Change	Figure Visu Over la Color sc	alize st figure heme:	Chi-bar square simulation sam 1000 Results:	ad weights in the size:	Change Random number seed: 1 Set
Enter Load Save		Distance-based: Supremum City-block	Max-dista	Change	Default Close a	✓ If figures			^
Clear Default	*	C Euclidean	0.5	Change	File				Ŷ
Denus		O From file:		Load	Load	Options	Table	Remove	Export
		 Mixture from vertice 	ces	Save	Save	About	Details	Clear	

A window matching the following screenshot will appear, asking if you would like to run PORTA and save the output; select "Yes".



Another window matching the following screenshot will appear showing that PORTA is running.

• • •	Running PORTA on CPT-KT	
	Please wait	

In the following section we will show how to complete the analysis of the mixture model in the QTEST interface.

<u>F.1.4 Mixture model analysis of Random CPT - KT for Figure 9 of QTBC1 and Figure 2 of Online Supplement 1</u>

The mixture model analysis of Random CPT - KT can be generated in two different ways. These methods are now described in more detail.

Method 1: generating the mixture model analysis of Random CPT - KT if PORTA was used directly in the previous section

In the QTEST interface, under "Probabilistic specifications", under "Mixturebased", select the radio button next to "From file:". Then select "Load...".

▲ QTEST			- ×
Gamble pairs Number of gambles: 5 Change (A.C) (A.D) (C.D) Set None	Theories LH Linear Orders CPT-KT ACC ACC ACC ACC CPT-KT ACC CPT-KT ACC CPT-KT ACC CPT-KT	Reference volume dd Use reference volume Weight	Hypothesis testing Run test Multicore Auto save Theories Selected All All All All All
All	Duplicate (A.C): 1 (A.D): 1 (C.D): 1 Load Sr	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist Gibbs sampling:
Data	Probabilistic specifications Aggregation-based	Figure	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights crimetarine cample size: Random number
Observations:	Supermajority level: Supermajority level: 0.5 Change	Visualize Over last figure Color scheme:	Initiation sample size seed. 1000 Change 1 Set Results:
Load	Distance-based: Supremum City-block Max-distance (U): Change Change	Default v	^
Clear v	Culidean 0.5 Change	File	·
	From file: Load Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear

In the "Load Specification" dialogue box that pops up, change the "Files of type:" to "Text files (*.txt)" and then navigate to the location of the "Figure9_MixtureInput.txt" file. Then select "Open".

Load Specification							
*				Q.			
DataSets SectionA-F_Fig SectionG-H_Da SectionJ_3Meth SectionJ_Tables SectionK_Table	ures	Figure7_LeftNote.txt Figure7_right.mat Figure7_right.png Figure7_RightNote.txt Figure8_left.mat Figure8_left.png Figure8_lef	4 3 0 -1 0 1	0 1 -1 0	-1 0 1 0		
SectionL_NS	upplement 🕨	 Figure8_leftNote.txt Figure8_right.mat Figure8_right.png Figure8_RightNote.txt Figure9_MixtureData.txt Figure9_MixtureInput.txt Figure9_mat Figure9_Note.txt 		L	Name Kind Size Created Modified .ast opened	Figure9_MixtureInput.txt Plain Text Document 116 bytes Thursday, January 9, 2014 at 11:42 AM Thursday, January 9, 2014 at 11:42 AM Thursday, January 9, 2014 at 11:42 AM	
Enable: Text files (*.txt) Cancel Open							

Now "Figure9_MixtureInput.txt" appears under "Mixture-based". Under "Figure", select "Visualize".

nble pairs		Theories			D-(Hypothesis testing		Multicoro
Number of gambles: 5	Change	LH ^	Vertices:	0.44	Reference volume	R	un test	Auto save
(C) (D) (D)	Set	CPT-KT	ADC ADC ACD	Remove	Use reference volume Weight	Selected	Specifications Selected	Data sets
	None	Add Duplicate Remove	(A,C): 1 (A,D): 1 (C,D): 1	Cat	Determine volume from current settings:	Type of test	Factor O Bay	es p & DIC
~		Load Save	~	oet	Set volume manually	Frequ Gibbs sample Sample	entist O All ing: size: 5000	Change
ata Obs Sample size N:	ervations:	Probabilistic specificati Aggregation-based:	ions Supermajority level:	F	igure Visualize	Burn-in s Chi-bar square simulation sam	size: 1000 d weights R ple size: si	Change andom number eed:
20		Borda score	0.5 Change		Over last figure Color scheme:	1000 Results:	Change	1 Se
Load		Distance-based:	Max-distance (U):		Default			^
Save		City-block	0.5 Change		Close all figures			
Clear	~	O Euclidean	0.5 Change					
Name Defa	ult 🗸	From file: Figu	ure9_MixtureInpi	>	Load Options	Table	Remove	Export
		Mixture from verti	Save		Saus About	Dataila	Clear	



The figure that pops up is a version of Figure 9 of QTBC1.

Method 2: generating the mixture model analysis of Random CPT - KT if the <u>QTEST interface was used to access PORTA in the previous section</u> Under "Theories", select "CPT-KT" and under "Figure", select "Visualize".



The figure that pops up is a version of Figure 9 of QTBC1.



This completes the 3-D example for the mixture model specification for Figure 9 of QTBC1, and is the last figure of QTBC1.

F.2.1 Create the gamble pairs for Figure 4 of QTBC2

We will use a modification of the gamble pairs as in our QTEST session from Section E to create the gamble pairs for Figure 4 of QTBC2. If you are loading a saved session, loading the session from Section D will be most helpful. Your session should match the circled information, under "Gamble pairs", in the following screenshot.



F.2.2 Define one decision theory, Random CPT-KT for Figure 4 of QTBC2

Under "Theories", select "CPT-KT" so it is blue highlighted. Then select "Remove". We will create a new random CPT-KT in this section.

Q TEST				_	
Gamble pairs Number of gambles: 5 Change (A,C) (A,D) (C,D) Set	LH Linear Orders CPT-KT CPT-KT ACD (0.5) ACD (0.5) ACD (0.5) ACD (0.5)	Add Remove	Reference volume Use reference volume Weight	Hypothesis testing Run test Theories Selected Selected Selected	Multicore Auto save Data sets Selected
None	Add Duplicate (A, C) : 1 (A, D): 1 (C, D): 1 (C, D): 1	Set	Determine volume from current settings: Set	All All Type of test Bayes Factor Bayes Factor Baye Image: Construction of the sector	O All sp & DIC
	Save	~	Set volume manually	Gibbs sampling: Sample size: 5000 Burn-in size: 1000	Change
Data Observations: 20	Probabilistic specifications Aggregation-based: Supermajority Borda score 2	ority level: Change	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights Ra simulation sample size: see 1000 Change Results:	ndom number ed: 1 Set
Enter	Distance-based: Supremum City-block Max-dista	Change	Default ~		^
Clear v Name Default v	Euclidean 0.5 Random preference: From file:	Change Load	File Options	Table Remove	✓ Export
	O Mixture from vertices	Save	Save About	Details Clear	

Under "Theories", select "Add...".

Gamble pairs Increase Vertices: Reference volume Mumber of gambles 5 Charge. Multicore A AD Add. Add. Add. Add. A CD Add. Add. Add. Add. Add. Data Add. Add. Add. Add. Add. Add. Add. Data CD.1 Set. Set. Set. Set. Set. Add.		Theories		
Save Set volume mandaly Sample size: 5000 Change Data Observations: Aggregation-based: Supermajority level: Over last figure Over last figure Over last figure Over last figure 1000 Change 1 Set. 20 Enter Observations: Supermajority 0.5 Change Over last figure 1000 Change 1 Set. Dota Observations: Observations: Observations: Supermajority 0.5 Change Over last figure 1000 Change 1 Set. Dota Observations: Observations: Observations: Supermajority 0.5 Change Default Name Default Observations: File Ioad File Ioad Table Remove Export	Gamble pairs Number of gambles: 5 Change (A.C) (A.D) (C,D) Set None All	Add. Duplicate Load	Reference volume dd. Use reference volume Weight. Determine volume from current settings: Set	Hypothesis testing Run test Auto save Theories Selected All Type of test Bayes Factor Frequentist All Gibbs sampling: Carter All Carter Al
Name Default Random preference: File Image: Constraint of the state	Data Data Determine Sample size N: 20 Enter Load. Save. Clear V	Save Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (U): Supermum Change City-block Change Euclidean Change 	Figure Figure Visualize Over last figure Color scheme: Default Visualize Close all figures	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
Mixture from vertices Save	Name Default ~	Random preference: From file: Load Mixture from vertices Save	File Options	Table Remove Export

 \sim

In the "Theory" dialogue box that pops up, enter "CPT-KT". Select "OK".

• • •	Theory	
Entername	fortheory:	
CPT-KT		
	ОК	Cancel

Under "Theories", select "Add...", just right of "Vertices:".

▲ QTEST			- 🗆 X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Reference volume	Run test Auto save
(A,C)	CPT-KT	Add. Use reference volume	Theories Specifications Data sets
(A,D) (C,D) Set	~	Remove Weight	Selected Selected Selected
None	Add		
All	Duplicate	Determine volume	Type of test
	Remove	Set Set	Bayes Factor Bayes p & DIC Erequentist All
	Load		Gibbs sampling:
~	Save	Set volume manually	Sample size: 5000 Change
	Deskehillefe en elfenfere		Burn-in size: 1000 Change
Data	Aggregation-based:	Figure	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N:	Supermajority level:	Over last figure	1000 Change 1 Set
20	Borda score ?	Color scheme:	Results
Enter	Distance-based: Max distance (II):	Default ~	
Load	Supremum 0.5 Change		
Save	O City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
×	Bandom preference:	File	
Name Default	O From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

Enter "DAC", as a name for the ranking DAC, in the "Vertex" dialogue box that pops up. Then select "OK".

left left left left left left left left	
Entername for vertex:	
DAC	
ОК	Cancel

QTEST			- 🗆 X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices: Linear Orders DAC [0.5]	Add	Run test Auto save
(A,C) (A,D) (C,D) Set		Remove Weight	Theories Specifications Data sets • Selected • Selected • Selected
None	Add		
All	Duplicate (A, C): 0 Remove (G, D): 0	Determine volume from current settings: Set	Type of test O Bayes Factor O Bayes p & DIC O Frequentist O All
~	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Dete	- Drahabilistia anasifisationa		Burn-in size: 1000 Change
Observations:	Aggregation-based: Supermajority level:	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
20	Supermajority O.5 Change	Over last figure	1000 Change 1 Set
Enter	Distance-based:	Color scheme:	Results:
Load	Max-distance (U):	Delaut	
Save	Supremum 0.5 Change		
	Ocity-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Default	Random preference:	File	· · · · ·
	O From file:	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

Specify the coordinates of this vertex by selecting "Set...".

The "Set Vertex (Preference)" window pops up. For each gamble pair, select the gamble preferred under the ranking DAC. Since D is preferred to A in pair (A,D), select "D". Likewise, A is preferred to C in pair (A,C), so select "A". Finally, D is preferred to C in pair (D,C) so select "D". And then select "OK".

	Set Vertex (Preference)			
File				
	(A,C)			
	A	С		
	(A,D)	· · · · · · · · · · · · · · · · · · ·		
	A	D		
	(C,D)		ок	
	С	D	Cancel	
	P		,	

Select "Add" just right of "Vertices" in QTEST. In the "Vertex" dialogue box that pops up enter "ADC" and then press "OK". Make sure "ADC" is highlighted in gray under "Vertices" in the QTEST interface and then press "Set". In the "Set Vertex (Preference)" dialogue box, select "A" from gamble pair "(A,C)", "A" from gamble pair "(A,D)" and "D" from gamble pair "(C,D)".

Select "Add" just right of "Vertices" in QTEST. In the "Vertex" dialogue box that pops up enter "ACD" and then press "OK". Make sure "ACD" is highlighted in gray under "Vertices" in the QTEST interface and then press "Set". In the "Set Vertex (Preference)" dialogue box select "A" from gamble pair "(A,C)", "A" from gamble pair "(A,D)" and "C" from gamble pair "(C,D)".

Select "Add" just right of "Vertices" in QTEST. In the "Vertex" dialogue box that pops up enter "CAD" and then press "OK". Make sure "CAD" is highlighted in gray under "Vertices" in the QTEST interface and then press "Set". In the "Set Vertex (Preference)" dialogue box select "C" from gamble pair "(A,C)", "A" from gamble pair "(A,D)" and "C" from gamble pair "(C,D)". Then select "OK".

The QTEST interface should now match the following screenshot. Note the list of "Vertices" contains "DAC", "ADC", "ACD", and "CAD". By selecting one of these vertices (it will be gray highlighted) the gambles specified by that vertex are shown in the box directly beneath the list of "Vertices:".



Now that the 4 predictions, or vertices, of Figure 4 of QTBC2 have been defined, we can create the mixture model specification of CPT - KT.

<u>F.2.3 Mixture model specification of *CPT-KT* for Figure 4 of <u>QTBC2</u></u>

The mixture model specification of CPT - KT will now be generated using the QTEST interface to access PORTA.

Under "Probabilistic specifications", select the radio button left of "Mixture from vertices". Then under "Probabilistic specifications", select "Save…" and save this file as "2.0Figure4_MixtureInput.mat". Your session should match the circled information, under "Probabilistic specifications", in the following screenshot.

CILSI		
Gamble pairs Number of gambles: 5 Change (A,C) (C,D) (C,D) Set None All	Theories H Vertices: Reference volume Linear Orders DAC ADC Add Use reference volume QPT-KT CAD Remove Weight Add CAD Duplicate CD): 1 Remove CO): 1 Set Determine volume from current setings:	Hypothesis testing Run test Theories Selected All Type of test Frequentist All Chibe acomplexe All Chibe acomplexe Chibe acomplexe
v	Save v	Gibbs sampling: Sample size: 5000 Change
Data Observations: Observations: Observations: Observations: Clear Observations: Obser	Probabilistic specifications Figure Aggregation-based: Supermajority level: O Supermajority 0.5 Distance-based: Max-distance (U): O Supermum 0.5 Change Close all figures City-block 0.5 Change Close all figures	Chi-bar squared weights seed: 1000 Change 1 Set Results:
Name Vefault	Random preference. File Coad Options	Table Remove Export
_	Mixture from vertices Save Save About	Details Clear

A window matching the following screenshot will appear, asking if you would like to run PORTA and save the output; select "Yes".



Another window matching the following screenshot will appear showing that PORTA is running.

• • •	Running PORTA on CPT-KT	
	Please wait	

In the following section we will show how to complete the analysis of the mixture model in the QTEST interface.

F.2.4 Mixture model analysis of Random CPT-KT for Figure 4 of QTBC2

The mixture model analysis of Random CPT - KT will now be generated using the QTEST interface to access PORTA.

Method 2: generating the mixture model analysis of Random CPT - KT if the

QTEST interface was used to access PORTA in the previous section

Under "Theories", select "CPT-KT" and under "Figure", select "Visualize". 承 QTEST \times Theories Hypothesis testing Gamble pairs Multicore Reference volume Vertices Number of gambles: 5 Change... LH ^ Run test Linear Orders CPT-KT Auto save DAC ADC Add... Use reference volur Theories Specifications Data sets ACD CAD Remove Weight... (C.D) Selected Selected Selected Set... Add. None Determine volume from current settings: Type of test Duplicate All (A,D): 1 (C,D): 1 O Bayes Factor O Bayes p & DIC Remove Set... Set Frequentist Load. Gibbs sampling: Set volume manually... Save. 5000 Change.. Sample size: Burn-in size: Change... 1000 Probabilistic specifications Data Figure Chi-bar squared weights simulation sample size: Random number seed: Aggregation-based: Observations Visualize Supermajority level Sample size N: Supermaiority 1000 Change... 1 Set... Over last figure 0.5 Change ... 20 Borda score ? Results Color scheme Enter Distance-based: \sim Default Max-distance (U): Load 0.5 Change... Osupremum Save. O City-block 0.5 Change. Close all figures Clear Euclidean Change... 0.5 Random preference Default Name. O From file: Load.. Options. Load... Table Remove Export. Mixture from vertices Save... About.. Save. Details. Clear



After rotating, the figure that pops up is a version of Figure 4 of QTBC2.

This completes the 3-D example for the mixture model specification for Figure 4 of QTBC2.

PART III: Data Analysis

Part II of the tutorial exclusively dealt with 5 parts of the QTEST interface: "Gamble Pairs", "Theories", "Probabilistic Specifications", "Figure" and "File". In this last part of the tutorial, we build on this knowledge and learn how to use the "Data" and "Hypothesis Testing" parts of the QTEST interface to test theories on data.

Part II of the tutorial analyzed part of the data set called Cash II to generate the Figures. Part III of the tutorial analyzes the entire datasets for both Cash I and Cash II.

The objective of this Data Analysis section is to allow a user of QTEST to recreate the results shown in Tables 5 and 6 of the paper QTEST: Quantitative Testing of Theories of Binary Choice made accessible and Tables 1, 2, and 3 of QTEST 2.0: Quantitative Testing of Theories of Binary Choice Using Bayesian Inference. Just as Part II of the tutorial was organized around the creation of each Figure of QTBC1 and Figure 4 of QTBC2, so Part III is organized around the generation of each Table of QTBC1 and QTBC2.

In Part II of the tutorial, it was reasonable to manually enter all the information needed to generate the Figures of QTBC1 and Figure 4 of QTBC2 because we only used 3 gamble pairs. In Part III, the data analysis requires 10 gamble pairs, necessarily increasing the amount of information QTEST needs to run analyses. While it is certainly possible to enter all this information manually, that process becomes laborious and error-prone. To circumvent this problem, and approximate research settings (which often have lots of gamble pairs and large data sets), most of the analyses that follow require loading an appropriate input file provided with this tutorial. We will show how one can enter the required information into the QTEST interface manually and, thereafter, will show how to use the input files. Moreover, a set of corresponding output files is also provided so the user of this tutorial can match their work with these files.

Part III of the tutorial encompasses Sections G through K. Sections G and H present detailed examples of data analysis. Section I provides some general guidelines on file nomenclature and different ways to replicate the tables of QTBC1. Sections J and K allow a user of QTEST to reproduce Tables 5 and 6 of QTBC1. Sections L and M allow a user of QTEST to reproduce Tables 1, 2, and 3 of QTBC2.

G. Data analysis of one theory with one vertex

All files needed for Section G can be found within the folder "SectionG-H_DataAnalysis", which is downloadable from the QTEST website. If one loads the file "LH_.5_Maj.mat" into QTEST then it will contain all the steps of Section G of this tutorial. We begin with the upper half of Table 5, which is the 0.50-majority/modal choice specification and we analyze LH first.

G.1 Gamble pairs

Starting with a clear (or new) QTEST interface, under "Gamble pairs", "Change" the "Number of gambles:" to "5" and then select "All". QTEST should look like the following screenshot.



G.2 Theory and vertex

Now we need to define the vertices for \mathcal{LH} . Under "Theories", select "Add…". In the "Theory" dialogue box that pops up, enter "LH". Then select "OK". Under "Vertices:", select "Add…". In the "Vertex" dialogue box that pops up, enter "LH" and then select "OK". QTEST will now look like the following screenshot.





Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Reference volume	Run test Auto save
(A,B) (A,C) (A,D) (A,E) (B,C) (B,C)	Add	move Weight	Theories Specifications Data sets • Selected • Selected • Selected • All • All • All
(B,E) (C,D) (C,E) (D,E)	Duplicate (A.B): 0 (A,C): 0 (A,D): 0 (A,D): 0 (A,D): 0 (A,E): 0 (B,C): 0	Determine volume from current settings: Set	Type of test O Bayes Factor Bayes p & DIC Image: The state of th
~	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications	Figure	Change
Observations:	Aggregation-based:	Visualize	chi-bar squared weights Random number simulation sample size: seed:
Sample size N:	Supermajority OBorda score	Over last figure	1000 Change 1 Set
Enter	Distance-based: Max distance (II):	Default ~	
Load	Supremum 0.5 Change		
Save	O City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Namo	Random preference:	File	~ · · · · · · · · · · · · · · · · · · ·
Delaur	O From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	Course About	Details

From QTBC1, if a decision maker follows \mathcal{LH} , they will prefer the first gamble in pairs (A,B), (B,C), (C,D) and (D,E). In the coding of 1's and 0's, the decision maker would have a 1 for these four pairs. The decision maker would prefer the second gamble in pairs (A,C), (A,D), (A,E), (B,D), (B,E) and (C,E), which would be coded as a 0 for these 6 pairs. We now translate this logic into QTEST. In the "Set Vertex (Preference)" dialogue box that popped up (after pressing "Set..." under "Vertices:"), select the following gambles from each pair in the window. You should only have to change 4 of the 10 gambles from their default selections:

"A" in pair "(A,B)"
"B" in pair "(A,C)" (default selection)
"D" in pair "(A,D)" (default selection)
"E" in pair "(A,E)" (default selection)
"B" in pair "(B,C)"
"D" in pair "(B,D)" (default selection)
"E" in pair "(B,E)" (default selection)
"C" in pair "(C,D)"
"E" in pair "(C,E)" (default selection)

If you have done this correctly, the pop up window should look like the following screenshot. (An arrow is only shown on the screenshot where it was necessary to change the default selection of each pair.) Then press "OK".



🛋 QTEST		
Gamble pairs Number of gambles: 5 Change (A.B) (A.C) (A.D) (A.E) Set	Theories H CH[0.5] Add. Reference volume Weight	Hypothesis testing Run test Theories Selected Selected Multicore Auto save Data sets Selected Selected
(B, C) (B, D) (B, E) (C, D) (C, E) (D, E) (D, E)	Add v Duplicate (A,C): 0 Remove (A,D): 0 (A,E): 0 Set Load (B,C): 1 (B,D): 0 Set	All All Type of test Bayes Factor Brequentist All
	Save BE: 0 Set volume manually	Sample size: 5000 Change Burn-in size: 1000 Change
Data Observations: 20 Enter Load Save Clear	Probabilistic specifications Aggregation-based Supermajority levet Supermajority 0.5 Distance-based: Max-distance (U): Supermum 0.5 City-block 0.5 City-block 0.5 Change Close all figures Bandom preference File	Chi-bar squared weights Random number seed: 1000 Change 1 Set Results:
Name Vefault	C From file: Load Dotions	Table Remove Export
	Mixture from vertices Save Save About	Details Clear

Under "Vertices:", notice the predictions have been updated.

To check if these predictions are correctly defined, the number following each gamble pair in the bottom half of the "Vertices:" section should match the following vector of 1's and 0's:

(A,B): 1 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 1 (B,D): 0 (B,E): 0 (C,D): 1 (C,E): 0 (D,E): 1

<u>G.3 Data</u>

Now that we have defined the gamble pairs and the vertex for LH, we need to enter data, under "Data" in the QTEST interface. For this step, we will briefly overview how one would enter data manually into QTEST using the data from Decision Maker 1 (DM1) and Decision Maker 13 (DM13) of Table 2 of QTBC1. We will load the data from a file for our analysis of Table 5 of QTBC1, however, because, with 18 participants and 10 gamble pairs for both Cash I and Cash II data sets, individual data entry would take much time and lead to an increased chance of making an error.

At this point we recommend that *at least* 20 observations per gamble pair, per person be used in a QTEST analysis. This ensures the assumptions of the asymptotic distributions are reasonably met. Of course, one may use more than 20 observations. But with less than 20 observations the results may be compromised. However, there are exceptions—see Online Supplement 1 for more details.

Samble pairs	Theories			Hypothesis testing	
Number of gambles: 5 Change	LH Vertices:	bbA	Reference volume	Run test	Multicore
(A,C) (A,C) (A,D) (A,E) (A,C) (A,C)		Remove	e Weight	Theories Specifications Selected All All	Data sets
(G, D) None (B, E) (C, D) All (C, E) (D, E)	Add Duplicate (A B) 1 (A C): 0 (A D): 0 (A D): 0 (A C): 0 (A C): 0 (A C): 0 (B C): 1	Set	Determine volume from current settings: Set	Type of test Bayes Factor Baye Frequentist All	es p & DIC
~	(B,D): 0 (B,E): 0 (C,D): 1	~	Set volume manually	Gibbs sampling: Sample size: 5000	Change
Data Observations:	Probabilistic specifications Aggregation-based: Supermajority 0.5	najority level:	Figure Visualize	Chi-bar squared weights Resimulation sample size: se	Indom number .ed: 1 Set.
Enter Load	Distance-based: Max-di Supremum 0.5	stance (U):	Color scheme: Default	Results:	^
Save	City-block 0.5 Euclidean 0.5	Change	Close all figures		
Name Default	Random preference:	Load	File Load Options	Table Remove	✓ Export
	O Mixture from vertices	Save	Save About	Details Clear	

Under "Data", the first selection listed for a user of QTEST is "Sample size N:".

This "Sample size N:" represents the number of decisions *each* participant made on *each* gamble pair in the entire experiment. The default sample size is "20". To change the sample size, simply select "20" and in the dialogue box that pops up, enter the "Observations per pair:". And then press "OK" when finished.

😑 😑 🔿 Data Generation	😑 🔘 Data Generation		
Observations per pair:			
20			
OK Cancel)		

The next button, "Enter..." allows the user to specify the number of times the *first* gamble (i.e., the gamble "coded as Gamble 1" in Table 2 of QTBC1) in the gamble pair was selected.

🛃 QTEST			- 🗆 X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Add Use reference volume	Run test Auto save
(A,C) (A,D) (A,E) (B,C)		Remove Weight	Selected All All All
(B.D) None (B.E) (C.D) All (C.E) (D.E)	Add (A.B): 1 Duplicate (A,C): 0 Remove (A,D): 0 (A,E): 0 (A,E): 0 Lead (B,C): 1	Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn in size: 1000 Change
DataObservations:	Probabilistic specifications Aggregation-based:	Figure	Chi-bar squared weights Random number simulation sample size: seed:
20	Supermajority OBorda score	Over last figure	1000 Change 1 Set
Enter	Distance-based: Max-distance (U):	Color scheme: Default ~	Results:
Load	Supremum 0.5 Change		
Clear	City-block 0.5 Change	Close all figures	
Name Default	Random preference:	File	
	O From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

In the "Enter Observations" dialogue box that pops up, there are two choices for entering the data. Option one requires entering the number of times the first gamble was chosen for each gamble pair. We start with DM1 of QTBC1. Use the 2nd to last column from Table 2 of QTBC1 to get the following. Then press "OK".

000	Enter Observations
File	
(A,B):	17
(A,C):	13
(A,D):	5
(A,E):	4
(B,C):	17
(B,D):	8
(B,E):	з ОК 🍗
(C,D):	15 Cancel
(C,E):	9
(D,E):	10 New Set
1 1	CONTROLING REVER.

Option two for data entry is to enter the number of times the first gamble was chosen, enter a comma and then enter the number of times the second gamble (i.e., the gamble "coded as Gamble 0" in Table 1 of QTBC1) was chosen. Here is a different screenshot for the same data as the previous screenshot, but entered in this different format:

00	Enter Observat	ions
File		
(A,B):	17,3	
(A,C):	13,7	
(A,D):	5,15	
(A,E):	4,16	
(B,C):	17,3	
(B,D):	8,12	
(B,E):	3,17	ок 📉
(C,D):	15,5	Cancel
(C,E):	9,11	
(D,E):	10,10	New Set

Under "Data", under "Observations:", notice that each pair of gambles is followed by two values separated by a comma. The first number (before the comma) represents the number of times the first gamble was selected (in this case 17 times out of 20) and the second number (after the comma) represents the number of times the second gamble was selected by the participant. Also notice that the "Name..." is set to "Default". Select "Name..." and in the "Data Set" dialogue box that pops up, enter an appropriate name for this data set. Then press "OK".

 ▲ QTEST			-
Gamble pairs Number of gambles: 5 Change (A,D) (A,C) (A,D) Set	Theories	Reference volume Use reference volume Weight	Hypothesis testing Run test Theories Specifications Selected Selected Selected Selected
(A,E) (B,C) (B,D) (C,D) (C,C) (C,C) (C,E) (D,E) (C,D) (C,E) (C	Add Duplicate (A.B) 1 (A.C; 0 (A.D; 0 (A.D; 0 (A.D; 0 (B.C; 1) Set (B.C; 1)	Determine volume from current settings. Set	All All Type of test Bayes Factor Bayes p & DIC © Frequentist All
	(B,D): 0 (B,E): 0 (C,D): 1 v	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Sample size N: (A.B.) 17.3	Aggregation-based: Supermajority level: Supermajority 0.5	Visualize Over last figure	Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Set
20 (A,D): 5,15 (A,E): 4,16 (B,C): 17,3 (B,D): 8,12	O Borda score Distance-based: Max-distance (U):	Color scheme: Default	Results:
Load (C.D): 15,5 (C.D): 15,5 (C.E): 9,11 (D.E): 10,10	Osupremum 0.5 Change Ocity-block 0.5 Change	Close all figures	
Name Default	C Euclidean 0.5 Change Random preference:	File Options	Table. Remove Export
\smile	Mixture from vertices Save	Save About	Details Clear

Now we enter the data for DM13 from Table 2 of QTBC1, which is the last column of that table. Select "Enter..." again.

💰 QTEST			
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Add	Run test Auto save
(A,B) (A,C) (A,D) (A,E) (A,E) (A,E)		Remove Weight	Theories Specifications Data sets Selected Selected All All
(B,C) (B,D) None	Add 🗸		
(C,D) All (C,E) (D,E)	Duplicate (A, C): 0 Remove (A, D): 0 (A, E): 0 (A, E): 0 Load (B, C): 1	Set Determine volume from current settings: Set	Bayes Factor Bayes p & DIC Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations:	Aggregation-based: Supermajority level:	Visualize	simulation sample size: seed:
20 (A,C): 13,7	Supermajority 0.5 Change	Over last figure	1000 Change 1 Set
(A,D): 5, 15 (A,E): 4,16	O Borda score	Color scheme:	Results:
(B,D): 8,12 (B,D): 3,17	Distance-based: Max-distance (U):	Default ~	^
Load (C,D): 15,5 (C,E): 9 11	O Supremum 0.5 Change		
(D,E): 10,10	City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Default	Random preference:	File	~
	O From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

In the "Enter Observations" dialogue box that pops up, you will see the data from the previous entry, DM1. Select "New Set". (If the user selects "OK" in this dialogue box, it will overwrite the previously entered data set.)

● ○ ○	Enter Observations	
File		
(A,B):	17,3	
(A,C):	13,7	
(A,D):	5,15	
(A,E):	4,16	
(B,C):	17,3	
(B,D):	8,12	
(B,E):	3,17	ОК
(C,D):	15,5	Cancel
(C,E):	9,11	
(D,E):	10,10	New Set
		~

In the QTEST interface, under "Data", notice in the dropdown menu that there are 2 identical data sets. Select "Set 2" so that it is highlighted. Then select "Enter…".

▲ QTEST			×
Gamble pairs Mumber of gambles: 5 Change (A C) (A C) (A C) (A D) (A C) Set	Theories LH Vertices: LH [0.5]	Reference volume Add Use reference volume Remove Weight	Hypothesis testing Run test Theories Specifications All All All All All
(B,D) (B,D) (C,D) (C,C) (C,C) (D,C) (D,C)	Add Duplicate (A.B): 1 (A.C): 0 (A.D): 0 (A.D): 0 (A.D): 0 (B.C): 1 (B.D): 0 (B.C): 1 (B.	SetSet	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling.
Data	Probabilistic specifications	Figure	Sample size: 5000 Change Burn-in size: 1000 Change
Sample size N: (A.B): 17.3 20 (A.C): 13.7 (A.D): e1.6	Aggregation-based: Supermajority level: David ensure 0.5 Change	Visualize Over last figure	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1
(A,E) 4,16 (B,C): 17,3 (B,D): 8,12 Load	Distance-based: Max-distance (U):	Color scheme: Default	Results:
(C, D): 15, 5 Save (C, E): 9,11 (D, E): 10,10 Clear	City-block 0.5 Change Cuclidean 0.5 Change	Close all figures	
Name Set 2 V Set 1	Random preference:	File Load Options	Table Remove Export
Set 2	Mixture from vertices Save	Save About	Details Clear

The "Enter Observations" dialogue box initially contains the gambles chosen by DM1 (labeled <u>"Set 1" by default).</u>

0 0	Enter Observations	
File		
(A,B):	17,3	
(A,C):	13,7	
(A,D):	5,15	
(A,E):	4,16	
(B,C):	17,3	
(B,D):	8,12	
(B,E):	3,17	ОК
(C,D):	15,5	Cancel
(C,E):	9,11	
(D,E):	10,10	New Set

Replace all the entries of this dialogue box with the values for DM13, which can be found in the last column of Table 2 of QTBC1. When finished, it should look like the following screenshot. Then select "OK".

0 0	Enter Observations	
File		
(A,B):	16	
(A,C):	9	
(A,D):	12	
(A,E):	7	
(B,C):	10	
(B,D):	8	
(B,E):	9	ок 🥿
(C,D):	12 Ca	incel
(C,E):	11	
(D,E):	10 Ne	w Set

Under "Observations:", "Set 2" lists the choices of DM13. Replace "Set 2" with "DM13" by selecting "Name...".

▲ QTEST			- D ×
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Reference volume	Run test Auto save
(A,C) (A,C) (A,D) (A,E) (B,C)		Remove Weight	Theories Specifications Data sets • Selected • Selected • Selected • All • All • All
(B,D) None (B,E) (C,D) All (C,E) (D,E)	Add Duplicate (A, D): 0 (A, D): 0 (A, D): 1	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
· · · · · · · · · · · · · · · · · · ·	Load (B,D): 0 (B,E): 0 (C,D): 1	✓ Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications Aggregation-based:	Figure	Chi-bar squared weights Random number
Sample size N: (A,B): 16,4	Supermajority	Change Over last figure	1000 Change 1 Set
20 (A,D): 12,8 (A,E): 7,13	O Borda score	Color scheme:	Results:
(B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance	ce (U): Default ~	^
Load (C,D): 12,8 (C,E): 11,9	O Supremum 0.5	Change	
(D,E): 10,10	City-block 0.5	Change Close all figures	
Clear	O Euclidean 0.5	Change	
Name Set 2 ×	Random preference:	File	
	Mixture from vertices	Load Options	Table Remove Export
	V WIXURE ITON VEHICES	Save About	Details Clear

In the "Data Set" dialogue box, enter "DM13". Then select "OK".



Rename "Set 1" by selecting it from the dropdown menu, select "Name..." and then entering "DM1" in the dialogue box.

🛃 QTEST			- 🗆 X
Gamble pairs Number of gambles: 5 Change (A, C) (A, C) (A, C) (A, D) (A, E) Set (B, C) (B, C) (B, C)	Theories	Reference volume Use reference volume move Weight	Hypothesis testing Run test Theories Selected All All All All
(B.D) (B.E) (C.D) (C.E) (D.E) (D.E)	Add (A B): 1 Duplicate (A,C): 0 (A,C): 0 (A,E): 0 (A,E): 0 (A,E): 0 (B,D): 0 (B,D): 0 Save (B,D): 1	et Determine volume from current settings: Set Set volume manually	Type of test Bayes Factor Bayes p & DIC Image: Frequentist All Gibbs sampling: Sample size: Sample size: 5000
Data Sample size N: 20 (A C) 13,7 (A C) 13,7 (A C) 13,7 (A C) 4,7 (A C) 13,7 (A C) 4,7 (A C) 4,7	Probabilistic specifications Aggregation-based: Supermajority level Ostrong based Dictance based	Figure Visualize Over last figure Color scheme:	Burn-in size: 1000 Change Chi-bati squared weights Readom number simulation sample size: Readom number 1000 Change 1 Set Results:
(B,D) 8,12 (B,D) 8,12 (B,E) 3,17 (C,E) 9,11 (D,E): 10,10 Clear	Osante-usseu Max-distance (U): O Supremum 0.5 City-block 0.5 Change Euclidean 0.5	Default ~	
Name Set 1 V Set 1 DM13	Random preference: Load From file: Load Mixture from vertices Save	File Load Options Save About	Table Remove Export Details Clear

QTEST			_
Samble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Reference volume	Run test Auto sa
(A,B)		Add Use reference volume	Theories Specifications Data set
(A,C) (A,D) Set	~	Remove Weight	Selected Selected Selected
(B,C) (B,D) None	Add 🗸		
(B,E) (C D)	Duplicate (A,B): 1	Determine volume	Type of test
(C,E) (D,E)	Remove (A,D): 0 (A,D): 0	Set Set	O Bayes Factor O Bayes p & DIC
(w , to)	Load (B,C): 1		Frequentist All
	(B,D): 0 (B,E): 0	Set volume manually	Gibbs sampling:
•			Burn in size: South Charles
Data	Probabilistic specifications Aggregation-based:	Figure	Chi-bar squared weights Random num
Observations: Sample size N: (A P) 47.2	Supermajority level:	Visualize	simulation sample size. seed.
20 (A,C): 13,7	0.5 Change	Over last figure	1000 Change 1
(A,D). 3, 13 (A,E): 4,16	O Borda scole	Color scheme:	Results:
(B,C): 17,3 (B,D): 8,12	Distance-based: Max-distance (U):	Default ~	
Load (B,E): 3,17 (C,D): 15,5	O Supremum 0.5 Change		
Save (C,E): 9,11 (D,E): 10,10	City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name DM1	Random preference:	File	
DM1	O From file: Load	Load Options	Table Remove Export
DI MAG			

When finished renaming the 2 data sets, they will look like the following.

Data from DM1 and DM13 are 2 of the 18 decision makers that comprise the Cash I and Cash II data. We will analyze both Cash I and Cash II in the entirety, starting with Cash I. So, we now want to load the Cash I data. Under "Data", first select "Clear".

Q TEST		- 🗆 ×
Gamble pairs	Theories	Hypothesis testing
Number of gambles: 5 Change (A, C) (A, D)	LH Vertices: LH [0.5] Add. Remove Weight.	Run test Multicore Theories Specifications Data sets Selected Selected Selected
(A,E) (B,C) (B,D) (C,D) (C,C) (C,E) (D,E) (D,E)	Add. V Duplicate (A,C): 0 Remove (A,D): 0 (A,E): 0 Set	All All Type of test Bayes Factor Brequentist All
	Codu (B,D): 0 Save (B,E): 0 I(C,D): 1 V	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data Observations:	Probabilistic specifications Aggregation-based: Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 16,4 (A,C): 9,11 (A,C): 9,11	Supermajority Ose change Over last figure	1000 Change 1 Set
(A, D): 12,6 (A, E): 7,13 (B, C): 10,10	Distance-based:	Results:
(B,D) 8,12 (B,E) 9,11 (C,D) 12,8 (C,E) 11,9 (C,E) 11,9 (D,E) 10,10	Max-distance (U): O Supremum 0.5 Change O City-block 0.5 Change	
Clear	Euclidean 0.5 Change	
Name DM13 ~	Random preference:	· · · · · · · · · · · · · · · · · · ·
	O From file: Load Options O Modure from vertices Save Save About	Table Remove Export Details Clear

▲ QTEST			×
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	dd	Run test Auto save
(A,B) (A,C)	Re	move Weight	Theories Specifications Data sets
(A,D) Set			Selected Selected Selected
(B,C) (B,D) None	Add		
(C,D) All (C,E)	Duplicate (A,C): 0 (A,C): 0	Determine volume from current settings:	Bayes Factor Bayes p & DIC
(D,E)	(A,E): 0 (B,C): 1	et Set	Frequentist All
	(B,D): 0 (B,E): 0	Set volume manually	Gibbs sampling:
			Burn-in size: 1000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations Sample size N:	Supermajority level:	Visualize	simulation sample size: seed:
20	Borda score	Over last figure	1000 Change 1 Set
Enter	Distance-based:	Color scheme:	Results:
Load	Max-distance (U):	Deitun	
Save	City-block 0.5 Change	Close all figures	
Clear	Cuclidean 0.5 Change	crose all rightes	
	Bandom preference:	File	
Name Default	O From file: Load	Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

The QTEST interface should now look like the following:

Now we are ready to enter the Cash I data. But before bringing these data into QTEST, we will first examine the specific requirements for this data file. Below is a screenshot of the data file "Cash1.txt", which we will use to illustrate those requirements.



The first line of the data input file must contain 3 values, with a single space between the 1st and 2nd, as well as between the 2nd and 3rd values. Here, the first number of the first line is "10", which represents the number of gamble pairs. The second number of the first line is "2" which represents the 2-column format of the data that follow. The third number of the first line is "18", denoting the number of participants.

The data for the 1st participant begin on the second line. The structure of these data must have the number of times the first gamble was chosen as the first entry (left column) and the number of times the second gamble was chosen as the second entry (right column). Here, these two entries are separated by a tab delimiter; but a single space delimiter will also work.

The data for participant 1 encompass lines 2 through 11, for a total of 10 lines. This is because the participant made decisions on all 10 gamble pairs among the five gambles. The data for the Participant 2 begin immediately on the next line after the end of the data for Participant 1. Participant 2 has their data in lines 12 through 21. And, while not shown in this screenshot, the remaining 16 participants in this Cash I data set are also included in the "Cash1.txt file". (NOTE: optionally, one may separate data sets for each participant with a single blank line, to possibly improve readability.) We now load this file into QTEST.

QIEST			
Samble pairs	Theories	-Deference volume	Hypothesis testing
Number of gambles: 5 Change	LH Vertices: LH [0.5]	dd	Run test Auto save
(A,C) (A,C) (A,D) (A,E) (A,C) (A,C)	Re	move Weight	Theories Specifications Data sets • Selected • Selected • Selected
(B, C) (B, D) (B, E) (C, C) (C, E) (D, E) (D, E)	Add	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC
~	(B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling. Sample size: 5000 Change Burnin size: 4000 Change.
Data Sample size N: 20	Probabilistic specifications Aggregation-based: Supermajority level: Supermajority level: Borda score Change	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights size. Random number simulation sample size. 1000 Change. 1 Set Results:
Load	Distance-based: Supremum 0.5 Change 0.5 Change	Default	^
Clear	O Euclidean 0.5 Change	Close all figures	
Name Default ~	From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

Under "Data" select "Load...".

In the "Load Observations" dialogue box that pops up, navigate to the "Cash1.txt" data input file. Then select "Open".

Load Observations	
\$	Q
DataSets SectionA-F_Figures SectionG-H_DataAnalysis SectionI_3Methods SectionJ_Table5 SectionK_Table6 SectionL_NSupplement	10 2 18 11 9 4 4 16 2 2 18 18 10 10 10 8 12 12 Name Cash1.txt Kind Plain Text Document Size 1 KB Created February 29, 2012 at 1:02 PM Modified February 29, 2012 at 1:02 PM Last opened February 29, 2012 at 1:02 PM
Enable: Text files (*.txt)	•
	Cancel Open

Under "Data" notice the "Observations:" list has now been populated:

A QIESI			
Gamble pairs Number of gambles: 5 Change (A, C) (A, D) Set (A, E)	LH Vertices:	Add Reference volume Use reference volume Remove Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
(B,C) (B,D) (B,E) (C,D) (C,E) (D,E) None None All	Add ✓ Duplicate (A.B.) 1 ∧ (A.C.) 0 ∧ ∧ Remove (A.D.) 0 ∧ (A.D.) 1 ∧ ∧ Load (B.C.) 1 ∧	Determine volume from current settings: Set	All All Type of test Bayes Factor Bayes p & DIC Image: The product of the
~	(B,E): 0 (C, D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data Sample size N: 20 AB) 11.9 AB) 11	Probabilistic specifications Aggregation-based: Supermajority level: Borda score Supermajority 0.5 Change	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights Random number seed. 1000 Change 1 Set Results:
Enter (B, C): 10, 10 (B, D): 8, 12 (B, E): 2, 18 (C, D): 14, 6 (C, D): 14, 6 (C, E): 5, 15 (D, E): 7, 13	Distance-based: Supremum City-block Max-distance (U): Change City-block Change	Default ~	^
Clear Name Set 1	Cuclidean 0.5 Change	File	
	Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear

承 QTEST X Gamble pairs Theories Hypothesis testing Multicore Reference volume Vertices LH Number of gambles: 5 Change... ^ Run test LH [0.5] Auto save ^ Add.. Use reference volum Theories Specifications Data sets Remove (A.C Weight... (A,C) (A,D) (A,E) (B,C) (B,D) (B,E) Set. Selected Selected Selected Add. None Determine volume from current settings: Type of test Duplicate (C,D) (C,E) (D,E) All (A.C): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 1 (B,D): 0 (B,E): 0 (C,D): 1 O Bayes p & DIC Bayes Factor Remove Set... Set Frequentist Load. Gibbs sampling: Set volume manually. Save. Sample size 5000 Change.. Burn-in size: Change.. 1000 Probabilistic specifications Data Figure tot / Chi-bar squared weights simulation sample size: Random number Aggregation-based Visualize Set 6 Supermajority level Sample size N: Set 7 Supermajority 1000 Change... 1 Set... Over last figure 0.5 Change. 20 Set 8 Borda score Set 9 Color scheme Results Set 10 Set 11 Enter Distance-based Default Max-distance (U): Set 12 Load 0.5 Change. Osupremum Set 13 Save Set 14 O City-block 0.5 Change. Close all figures et 15 et 16 Clea OEuclidean 05 Change. 17 Random preference Name Set O From file: Load... Options. Load.. Export. Table Remove O Mixture from vertices Save.. Save About. Clear Details

Under "Data", select the dropdown menu next to "Name..." to see all 18 data sets that have been loaded into the QTEST interface.

Select any set (it will be blue highlighted) to see the data for that participant. The following screenshot shows the data for "Set 18" (Participant 18).



We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

G.4 Probabilistic specification

The results of the top-half of Table 5 of QTBC1 are based upon a 0.50-majority/modal choice specification. To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected and that the "Supermajority level:" is set to "0.5".



G.5 Hypothesis testing

We are now ready for the goodness-of-fit test of LH for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All".



If the radio button for "Theories" under "Hypothesis testing" is set to "Selected", then the analysis will only include the theory highlighted in gray in the "Theories" section. For \mathcal{LH} , there is only one theory, so this radio button is set to "Selected". (If the radio button were set to "All", then all theories under "Theories" would be analyzed).



If the radio button for "Specifications" under "Hypothesis testing" is set to "Selected", then the analysis will only include the selected specification under "Probabilistic specifications" where the radio button is selected. In this case, we only want a 0.50-majority/modal choice specification so "Selected" under "Hypothesis testing" is chosen. (If a user wanted to do "All" the specifications, it would be necessary to first set the level of the specification for all "Aggregation-based" and "Distance-based" under "Probabilistic specifications". Even though only one radio button at a time can be selected under "Probabilistic specifications", once a change has been made for a specification it will continue to be set to that value and used in the analysis.)



Finally, under "Hypothesis testing", we can analyze data sets individually or analyze the data all at one time. For instance, since we have 18 data sets, if we ran each of these 18 data sets individually, that would require selecting a data set under "Data" each time (from the dropdown menu next to "Name...") and then "Run test" under "Hypothesis testing" 18 separate times, one for each data set. But if the radio button next to "All" is chosen under "Data sets" under "Hypothesis testing", then 18 analyses are run all together. But it is important to note that, even when "All" is selected under "Data sets", data are never aggregated. Each data set is always analyzed on its own and never combined, no matter which radio button is selected. In this case, since we want to analyze the data for all 18 participants, change the radio button selection to "All" under "Data sets":


Under "Hypothesis testing" there are two more inputs the user may specify: "Chibar squared weights simulation sample size" and "Random number seed". Only advanced users are likely to use these.

▲ QTEST			-
Gamble pairs Gamble pairs Number of gambles: 5 (A, B) (A, C) (A, D) (A, E) (B, C)	Theories LH Vertices: LH [0.5]	Add Use reference volume Use reference volume Weight	Hypothesis testing Run test Theories Selected All All Hypothesis testing Multicore Auto save Data sets Selected All All
(B,D) None (B,E) (C,D) All (C,E) (D,E)	Aud (A,B):1 Duplicate (A,C):0 (A,C):0 (A,C):0 (A,E):0 (A,E):0 Load (B,C):1 (B,C):0 (B,C):0 Save. (B,E):0	Set Determine volume from current settings: Set Set volume manually	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling: Cool
Data Observations:	Probabilistic specifications Aggregation-based:	Figure	Sample size: Soud Change Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed.
Sample size N: 20 (A,C): 4,16 (A,D): 5,15 (A,E): 2,18 (B,C): 8,12 (A,C): 4,16 (A,C): 4,16 (A,C): 2,18 (B,C): 8,12 (A,C): 4,16 (B,C): 1,2 (A,C): 4,16 (A,C): 4,16	Supermajority Borda score Distance-based: Max distance d Ib:	Over last figure Color scheme: Default	1000 Change 1 Set
Load (B,E) 4,16 (C,D): 8,12 (C,E): 10,10 (D,E): 10,10	Supremum 0.5 Change City-block 0.5 Change	Close all figures	
Name V	Cuclidean 0.5 Change Random preference: Change Load	File Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

The appropriate "Chi-bar squared weights" in the underlying "order-constrained inference" engine that operates 'under the hood' of QTEST are determined based on certain numerical simulations. The simulations use a random sampling process. The larger the sample size, the more accurate the resulting weights, and therefore a more accurate p-value will be computed. Increased accuracy comes at the cost of more computation to reach a result.

If a hypothesis test is repeated on the same data, QTEST produces the exact same chi-bar squared weights because the "random" samples are simulated, based on a seed. To produce another, independent, computation of a hypothesis test, choose a different "Random number seed" under "Hypothesis testing".

For all results in Tables 4 and 5, the default values of both "Chi-bar squared weights" and "Random number seed" are used.

Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



The time for the analysis to complete can vary widely. It depends on many factors: the computer running the analysis, the number of data sets, the type and number of probabilistic specifications, the number of theories, the number of vertices for each theory, the number of simulation sample weights and other factors. (It can be a good idea to just run the hypothesis test for a single data set the first time an analysis is executed to get an approximate baseline expectation of how long QTEST may need to complete the entire analyses for all data sets. Such a baseline computation may sometimes not be representative of other computations, however, if data or theories vary widely from one analysis to another.) Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.



QTEST offers several tools for working with, and examining, the results when the hypothesis testing has completed. Under "Hypothesis testing", under "Results:", select "Table...".



● ○ ○	Re	sults			
	Supermalority	Supremum	City-block	Fucidean	
LH (Set 1/freq/1000/1)	0.1912 (L: 0.5000)		ony block	Lucidoun	
LH (Set 2/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 3/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 4/freq/1000/1)	0.0014 (L: 0.5000)				
LH (Set 5/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 6/freq/1000/1)	0.2030 (L: 0.5000)				
LH (Set 7/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 8/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 9/freq/1000/1)	0.0006 (L: 0.5000)				
LH (Set 10/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 11/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 12/freq/1000/1)	1.0000 (L: 0.5000)				
LH (Set 13/freq/1000/1)	0.0771 (L: 0.5000)				
LH (Set 14/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 15/freq/1000/1)	0.0163 (L: 0.5000)				
LH (Set 16/freq/1000/1)	0.0000 (L: 0.5000)				
LH (Set 17/freq/1000/1)	0.0512 (L: 0.5000)				
LH (Set 18/freq/1000/1)	0.3925 (L: 0.5000)				

A "Results" window pops up that looks like the following screenshot.

Column headers are the probabilistic specifications "Supermajority",

"Supremum", "City-block" and "Euclidean". Each row header contains two lines. The first line denotes the theory name, in this case "LH". The second line "(Set 1/1000/1)" provides the data set ("Set 1"), the number of simulation samples ("1000") and the random seed number ("1"). An entry within the table, at the intersection of each row and column header, will provide the p-value, which is the first line and for the circled entry in the screenshot above, that value is "0.1912". The second line within the table provides the supermajority level. In this case we set it to 0.50 and that is why we see "(L: 0.5000)" in the first cell of the table. (The "L" stands for lambda.)

If the same session of QTEST is used for further analyses, these results will stay in this table. If further results include the same theory and data, but a different probabilistic specification, the appropriate column would be filled in. But if a new theory is used, then the results from this new theory would be appended to the current table.

If a user needs more information, they can select the result for which they wish to see more detail from the "Results:" list and then select "Details...", as shown in the screenshot below.

▲ QTEST			- 🗆 ×			
Gamble pairs Number of gambles: 5 Change	Theories	Reference volume	Hypothesis testing Multicore Run test Auto save			
(A,B) (A,C) (A,D) (A,E) (B,C)	R	move Weight	Theories Specifications Data sets Oselected Oselected Selected All All All			
(B,D) None (B,E) (C,D) All (C,E) (D,E)	Add (A,B) 1 (A,B) 1 (A,C): 0 Remove (A,D): 0 (A,E): 0 (A,E): 0 (A,C): 1	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All			
~	BD: 0 (B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change			
Data Observations: Sample size N: (A, B): 8, 12 20 (A, C): 4, 16 (A, D): 5, 15 (A, D): 5, 15	Probabilistic specifications Aggregation-based: Supermajority level: Borda score Supermajority Level: Change	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights Chi-bar squared weights simulation sample size. 1000 Change 1 Set. Results:			
Enter (B, C) 8 12 (B, D) 7,13 (B, E) 4,16 (C, D) 8,12 (C, D) 8,12 (Save (C, E) 10,10	Distance-based: Max-distance (U): Supremum 0.5 City-block 0.5 Change	Default v	LH (Set 1//reg/1000/1) (major) LH (Set 2//reg/1000/1) (major) LH (Set 4//reg/1000/1) (major) LH (Set 4//reg/1000/1) (major) LH (Set 6//reg/1000/1) (major) LH (Set 6//reg/1000/1) (major)			
Clear	Euclidean 0.5 Change	File	LH (Set //freq/1000/1) (major) LH (Set 8/freq/1000/1) (major) LH (Set 9/freq/1000/1) (major) LH (Set 10/freq/1000/1) (major)			
Name Set 18	O From file: Load	Load Options	Table Remove Export			
	Mixture from vertices Save	Save About	Details. Clear			

A different "Results" window pops up.

⊖ ⊖ ⊖ Res	ults
Type of test: frequentist	
Theory:LH Spec:Supermajority SupermajorityLevel:0.5	
Data set: Set 1 Empirical sample size:20 per pair(Total: Data hash:0.3510	200)
Simulation sample size: 1000 Seed: 1	
Vertex: LH ML parameter: 0.5500 0.2000 0.1000 0.1000 0.500 0.5000 Chi-bar squared weights: 0.2330 0.5180 0.2490 0.0000 0.000 0.0000 0.0000 Log-likelihood ratio: 1.8280 p = 0.1912 wam:	0 0.4000 0.1000 0.7000 0.2500 0 0.0000 0.0000 0.0000 0.0000
C	к

The "Results" window that pops up gives more of the results from the orderconstrained inference algorithm developed in Davis-Stober (2009).

The first 4 lines of text, and the 7th and 8th lines of text, give equivalent information to that already discussed in the earlier table format.

The 5th line of text "Empirical sample size: 20 per pair (Total: 200)" simply provides the number of observations for each gamble pair, which was set in "Data".

The 6th line of text, "Data hash: 0.3510", is an identifier of the data used in this test. It helps identify different data sets in the results table (unless names have been assigned to individual data sets).

The 9th line of text, "Vertex: LH" specifies which vertex was analyzed. In this case, there was only one vertex. But in the event of multiple vertices, there will be a unique set of results for each vertex.

The line of text starting with "ML parameter" contains the maximum likelihood estimates. At least one of these values lies on one of the faces of the supermajority cube that represents the 0.50 supermajority specification. So, here, two best-fitting binary choice probabilities are 0.50. In situations like this, where the point estimates are on the boundary of the parameter space, the log-likelihood statistic does not have a Chi-squared distribution. Rather the statistic

developed by Davis-Stober follows a Chi-bar squared distribution, which is a mixture of Chi-square distributions (2009). Here, QTEST has determined the weights of this mixture with the results in the line starting with "Chi-bar squared weights:"

The second to last line of text contains the log-Likelihood ratio: "1.8280". In the appropriate Chi-bar squared distribution, which is the last line of the output, a log-likelihood ratio value of 1.8280 has a p-value of 0.1912. This represents a non-significant violation. Note that log-likelihood ratio values of different respondents are not directly comparable in a meaningful way because each case is typically modeled by a different Chi-bar squared distribution. Hence, a larger log-likelihood value need not translate into a poorer fit, when comparing two data sets.

Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory, especially when the number of vertices or data sets, or both, are large. Therefore, QTEST can export the results to a spreadsheet format. Under "Hypothesis testing", under "Results:", select "Export...".



An "Export Results As" window pops up. Navigate to the location to save the file. Here we name the file "LH_Cash1_Majority" and save it as a .csv file. Select "Save".

Save As: LH_ Tags:	Cash1_Majority.csv		
*		Q	
nesults			
Formation	Common account of unitary (* and)		
Format:	Comma separated values (*.csv)		
			Cancel Save

The following screenshot shows the "LH_Cash1_Majority.csv" file. In this case, each column is a different participant, labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. All the information in this spreadsheet is identical to what one would see if they selected "Details…" for each participant. The layout is a little different, however.

0	00								LH_C	ash1_Majo	rity.csv								1
2	1 🔛 💿		2 6	👌 🎻 🗵	∩ • ∩ •	Σ • 🛃	• 🏆 • 🛛	£ 🖻	100%							Q- (Sea	arch in Shee	et	
	A Home	Layout	Tables	Charts	Smart	Art For	mulas	Data R	eview										_ ^ ‡
	Edit			Font			Aligr	nment		N	umber		For	mat		Cells		Themer	
F	🖹 🗐 🖬	ill 🔻 Cal	ibri (Body)	v 12	• A• A	-	= ab	c 🔻 📰 Wr	ap Text +	General		-	- N	ormal				Aab	-
												00			- 💽 📋		·	10000 Y	
8	Paste 🥥 🗘	lear • B	$I \cup$		🏈 🔻 🗛				Merge 🔻	🧐 🔻 %	9	So Condit	tting B	ad	In	sert Delet	e Format	Themes 4	Aa≁
	B16	¢ (3) 🔘 (= f	x 0.1911	83														
	A	В	C	D	E	F	G	Н	1	J	K	L	M	N	0	Р	Q	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist	frequentist
3	Theory	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
4	Specificatio	n major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference v	olume																	
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
9	Random see	N 1	1	1		. 1	1	1	1	1	1	1	. 1	1	1	1	1	1	1
10	Gibbs samp	e size																	
12	Vortex	10	10	14	14	10	10	10	14	10	10	10	10	14	10	10	10	10	10
12	Vertex Vertex woid	ht	Lin .	LI	un .	LI1	Lin .	un	un	Lin .	Lin .	un	Lin .	un .	Lin .	un	un	Lin .	un
14	Vertex L/U																		
15	Likelihood r	1 82802	72 4903	95.0223	12 6456	82.019	3 291 34	54 9852	86.0546	14 4736	52 2379	73.0513	0	6.43857	166 355	8 92447	86.0546	5 43282	2 41626
16	p-value	0.191183	6.11E-15	0	0.00143764	4.44E-16	0.202977	4.10E-12	3.33E-16	0.00058004	2.62E-10	1.68E-13	1	0.077139	100.333	0.0163004	00.0040	0.0512241	0.392519
17	Warning	0.101100					0.202077						-	0.011 200					0.000000
18	DIC																		
19	Prior volum	e																	
20	Posterior vo	lume																	
21	Bayes facto	1																	
22	Bayes facto	2																	
23	Bayes facto	exact																	
24	Weighted p	-value																	
25	Weighted D	IC																	
26	Weighted B	ayes factor																	
27	MLE 1	0.55	0.85	0.5	0.9	0.5	0.55	0.5	0.5	0.5	0.5	0.5	0.5	0.500001	0.95	0.5	0.5	0.65	0.5
28	MLE 2	0.2	0.5	1.00E-06	0.5	0.1	0.25	0.1	1.00E-06	0.35	1.00E-06	1.00E-06	0.4	0.5	0.5	0.25	1.00E-06	0.499999	0.2
29	MLE 3	0.1	0.5	1.00E-06	0.2	0.05	0.05	0.15	1.00E-06	0.4	1.00E-06	1.00E-06	0.25	0.25	0.5	0.1	0.3	0.4	0.25
30	MLE 4	0.1	0.5	1.00E-06	1.00E-0E	1.00E-06	1.00E-06	0.05	1.00E-06	0.4	0.05	1.00E-06	0.15	0.15	0.5	0.1	0.3	0.4	0.1
27	MLE 5	0.500001	0.7	1.005.05	0.85	1.005.05	0.7	0.5	1.005.05	0.05	1.005.05	1.005.05	0.8	0.5	0.9999999	0.5	0.5	0.9	0.5
32	MIE 7	0.4	0.5	1.000-06	0.45	1.002-06	1.005.05	0.05	1.002-06	0.3	1.000-06	1.000-06	0.45	0.25	0.5	0.35	1.005.05	0.4	0.35
33	MIE 8	0.1	0.5	1.000-06	0.1	1.002-06	0.500001	0.05	1.000-06	0.25	0.05	1.000-06	0.05	0.3	0.000000	0.1	1.002-06	0.5	0.2
35	MIEG	0.25	0.55	1.005-06	0.15	1.005-06	0.500001	0.05	1.005-06	0.45	0.5	1.005-06	0.03	0.5	0.555555	0.3	1.005-06	0.5	0.499998
36	MLE 10	0.25	0.5	1.002-00	0.15	0.000	0.1	0.05	0.5	0.45	0.1	0.5	0.5	0.5	0.5	0.2	0.5	0.5	0.500002
37	Chi bar so w	0.233	0.019	0.001	0.116	0.006	0.073	0.069	0.001	0.117	0.003	0.001	0.00	0.031	0.002	0.069	0.012	0,128	0.029
38	Chi bar so w	0.518	0.093	0.009	0.403	0.03	0.252	0.229	0.009	0.402	0.048	0.009		0.154	0.029	0.229	0.06	0.37	0.147
39	Chi bar so w	0.249	0.22	0.043	0.366	0.112	0.383	0.404	0.043	0.371	0.159	0.043		0.32	0.115	0.404	0.162	0.362	0.331
		<	H_Cash1_Ma	jority.csv	+/														11

This completes the analysis for Cash I data for LH, which only has 1 vertex. We now consider CPT-GE for the Cash I data, which has 11 vertices.

H. Data analysis of one theory with multiple vertices

There are only two differences between Section G and H. In Section G, we showed how to enter the theory, vertices and data manually. In Section H we show how to load all of this from files, greatly expediting the analysis. The second difference concerns the output. In Section G there was one vertex so there was only one set of results for each experimental data set. But in Section H we have 11 vertices. The structure of these results is different, and we will explore those differences. All files needed for Section H can be found in the folder "SectionG_H_DataAnalysis". Loading the file

"Complete_CPT_GE_Cash1_.5M.mat" will give identical results as following all steps in Section H. To illustrate how to load files into QTEST and interpret results with multiple vertices, we will analyze the Cash I data for CPT - GE with a 0.50-majority/modal choice specification.

H.1 Gamble pairs

Even though QTEST is designed to store multiple theories, each with their own predictions, we will clear everything from QTEST except the "Gamble pairs" to keep the screenshots easier to follow. The following screenshot shows the 3 selections to clear the interface. Select "Clear" under "Data"; under "Hypothesis testing", under "Results:", select "Clear"; and under "Theories", select "Remove" to remove "LH". This will also automatically clear the associated vertex.



The QTEST interface looks like the following screenshot. We only retain the "Gamble pairs". If you are starting a new session of QTEST, match the "Gamble pairs" to the screenshot below.



H.2 Theory and vertices

Under "Theories", select "Load ... ".



In the "Load Theory" dialogue window that opens, navigate to the file "Vertices_Cash1_CPT_GE.csv" and then select "Open".

Load	Theory	
lysis ‡	Q	
DataSets SectionA-F_Figures SectionG-H_DataAnalysis SectionJ_Table5 SectionK_Table6 SectionL_NSupplement	 Cash1.txt Cash2.txt Complete_CPT_GE_Cash15M_weighted.mat Complete_CPT_GE_Cash15M.mat Data_Table1_DM1.mat Data_Table1_DM13.mat LH5_Maj.mat Results_CPT_GE_Cash15M_weighted.csv Results_CPT_GE_Cash15M.csv Vertices_CPT_GE_Cash1_weighted.csv Vertices_CPT_GE_Cash1_csv 	Name Vertices_CPT_GE_Cash1. csv Kind comma-separated values Size 301 bytes Created Feb 28, 2013, 10:57 AM Modified Feb 28, 2013, 10:57 AM Last opened Feb 28, 2013, 10:57 AM
Enable: Comma sepa	rated values (*.csv)	Cancel

Then a "Theory" dialogue box pops up. Enter "CPT_GE_C1", where "C1" stands for Cash I. Select "OK".



The "Theories" list now contains "CPT_GE_C1" and "Vertices:" lists the 11 predictions of Cash I for CPT-GE.

A QTEST			- 🗆 X
Camble pairs Samble pairs Number of gambles: 5 (A,C) (A,D) (A,D) (A,D) (A,D) (B,D) (B,D) (B,D) (C,D) (C,D) (C,D) (D,D)	Add (A) (A) (A) Duplicate (A) (A) (A) Remove (A) (A) (A)	td Use reference volume Weight. Determine volume form current settings: Set	Hypothesis testing Run test Theories Specifications Auto save Theories Selected All Type of test Bayes Factor Bayes p & DIC Data sets Selected
Data Data Descriptions: Description Descri	Load (B,C) 0 (B,D) 0 (B,D) 0 (B,E) 0 (B,E) 0	Figure Visualize Over last figure	Frequentist All Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: seed: 1000 Change 1 Set
Enter Load Save	Distance-based Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change	Color scheme: Default	Results:
Name Default v	Random preference: From file: Load Mixture from vertices Save	File Load Options Save About	Table Remove Export Details Clear

<u>H.3 Data</u>

Next, we will enter the Cash I data. Under "Data" select "Load".

mble pairs	Theories						-Hypothesis testina		
Number of gambles: 5 Change	CPT_GE_C1	Vertices:			Reference volu	me	- F	Run test	Multicore
A.B) A.C) A.D) A.E) B.C)	~	v1 [0.5] v2 [0.5] v3 [0.5] v4 [0.5] v5 [0.5] v6 [0.5]	Ĩ	Add Remove	Use refere	ence volume	Theories Selected	Specifications Selected	Data sets
None None B,E) C.D) All C,E) All D,E	Add Duplicate Remove	v7 I0.51 (A,B): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0		Set	Determine v from current settings:	olume	Type of test Bayes Frequ	s Factor Ba	yes p & DIC
~	Save	(B,D): 0 (B,E): 0 (C,D): 0	~		Set volum	ne manually	Gibbs samp Sample Burn in	ling: e size: 5000	Change
Data Observations: Data Observations: Data Observations: Data	Probabilistic specifica Aggregation-based:	Superma	ijority level:	F	igure Visua Over last Color sche	lize figure eme:	Chi-bar square simulation san 1000 Results:	ed weights I nple size: s Change	Random number seed:
Load	Distance-based:	Max-dist 0.5 0.5	ance (U): Change Change		Default Close all	∽			^
Clear	Euclidean	0.5	Change						
Name Default ~	Random preference		Load	Fi	e	Options	Table	Demons	v Firmet
	O Mixture from ver	tices	Save		Save	About	I able	Cloar	Ехроп

In the "Load Observations" window that pops up, change "Files of type:" to "Text files" and then navigate to the data file "Cash1.txt". Then select "Open".

Load Observations	
\$	٩
DataSets Cash1.txt SectionA-F_Figures SectionG-H_DataAnalysis SectionI_3Methods SectionJ_Table5 SectionK_Table6 SectionL_NSupplement	10 2 18 11 9 4 4 16 2 2 18 18 10 18 18 10 18 18 11 9 4 12 Name Cash1.txt Kind Plain Text Document Size Size 1 KB Created Created February 29, 2012 at 1:02 PM Modified February 29, 2012 at 1:02 PM Last opened February 29, 2012 at 1:02 PM
Enable: Text files (*.txt)	
	Cancel Open

To verify all 18 Cash I data sets loaded properly, under "Data", next to "Name..." select the dropdown menu. If they loaded, the dropdown menu will list "Set 1"-"Set 18".

QTEST								
Gamble pairs	Theories					Hypothesis testing		
Number of gambles: 5	Change	Vertices:	A Add	Reference volun	ne	F	Auto save	
(A,B) (A,C) (A,D) (A,E) (B,C)	Set	v2 [0.5] v3 [0.5] v4 [0.5] v5 [0.5] v6 [0.5]	Remove	Use referer Weig	nce volume	Theories Selected All	Specifications Selected All	Data sets Selected
(B,D) (B,E) (C,D) (C,E) (D,E)	All Duplicate	v7 (0.5) (A,C): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0	Set	Determine vo from current settings:	Set	Type of test Baye Frequ	s Factor OBa lentist OAI	ayes p & DIC
Set 2	Save	(B,D): 0 (B,E): 0 (C,D): 0	~	Set volume	e manually	Gibbs samp Sample	size: 5000	Change
Data Set 3 Set 4 Set 5	Probabilistic specific Aggregation-base	cations		Figure		Chi-bar square	ed weights	Random number
Sample size N: Set 6 Set 7	 Supermajority 	Supermajority lev	vel:	Visuali	ze	1000	Change	1 Set
20 Set 8 Set 9	O Borda score	0.5 Char	ige	Color scher	me:	Results:		
Enter Set 10 Set 11	Distance-based:	Max-distance (U		Default	\sim			^
Load Set 12 Set 13	◯ Supremum	0.5 Char	nge					
Save Set 14 Set 15	City-block	0.5 Char	nge	Close all f	igures			
Clear Set 16 Set 17	Euclidean	0.5 Char	nge					
Name Set 18	Random preference	ce:	F	ile				~
	O From file:	Lo	ad	Load	Options	Table	Remove	Export
	O Mixture from v	ertices Sa	ve	Save	About	Details	Clear	

H.4 Probabilistic specification

Under "Probabilistic specifications", verify that the radio button next to "Supermajority" is selected and that the "Supermajority level:" is set to "0.5", as in the following screenshot.

QTEST			- 🗆 X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT_GE_C1 Vertices:	Reference volume	Run test Auto save
(A,B) (A,C) (A,D)	v2 [0.5] v3 [0.5] v4 [0.5]	nove Weight	Theories Specifications Data sets
(A,E) (A,E) (B,C)	V5 [0.5] V6 [0.5] Add		
(B,D) (B,E) (C,D) All	(A,B): 0 (A,C): 0	Determine volume from current	Type of test
(C,E) (D,E)	Remove (A,D): 0 (A,E): 0 (B,C): 0	t Settings: Set	Bayes Factor Bayes p & DIC Frequentist All
, I	Load (B,D): 0 (B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change
	Deskabilitationen siferationen		Burn-in size: 1000 Change
Data Observations:	Aggregation-based:	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 8,12 20 (A,C): 4,16	Supermajority O.5 Change	Over last figure	1000 Change 1 Set
(A,D): 5,15 (A,E): 2,18 (B,C): 8,12	Distance basen	Color scheme:	Results:
(B,D): 7,13 (B,E): 4,16 (B,E): 4,12	Max-distance (U):	Derault	
(C,D): 8,12 (C,E): 10,10 (D,E): 10,10	City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Set 18	Random preference:	File	▼
	O From file:	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

H.5 Hypothesis Testing

Under "Hypothesis testing" verify that the radio button next to "All" under "Data sets" is selected. Then select "Run test".

nble pairs	Theories			Hypothesis testing		Multimo
Number of gambles: 5 Change	CPT_GE_C1 A Vertic	ces:	Reference volume		Run test	Auto save
,,B) ^ ,,C) ,,D) Set	v2 [0.5] v3 [0.5] v4 [0.5] v5 [0.5]	Add. Remo	ve Weight	Theories Selected	Specifications Selected	Data sets
,C) ,D) None	Add v6 [0.5]					• All
(E) (D) (E) (E)	Duplicate (A, B) (A, C): (A, C): Remove (A, E): (A, E): (A, E): Load (B, C):	0	Determine volume from current settings: Set	Type of test	es Factor O Bay uentist O All	es p & DIC
~	(B,D): (B,D): (B,E): (C,D): (C,D):		Set volume manually	Gibbs samp Sampl	e size: 5000	Change
ata	Probabilistic specifications		Figure	Danim	1000	Change
Observations:	Aggregation-based:		Visualize	Chi-bar squar simulation sa	ed weights F nple size: s	andom number eed:
Sample size N: (A,B): 8,12	Supermajority	upermajority level:	Over last figure	1000	Change	1 Set
20 (A,C): 4,10 (A,D): 5,15 (A,D): 2,18	O Borda score	0.5 Change	Color scheme:	Results:		
Enter (B,C): 2,10 (B,C): 8,12 (B,D): 7,12	Distance-based:	lav.distance (LI):	Default			^
(B,D): 7,13 Load (B,E): 4,16 (C,D): 8,12	◯ Supremum	0.5 Change				
Save (C,E): 10,10 (D,E): 10,10	O City-block	0.5 Change	Close all figures			
Clear	Euclidean	0.5 Change				
▼	Random preference:		File	_		~
Name Set 18	O From file:	Load	Load Options	Table	Remove	Export
	Mixture from vertices	Sava				

Q TEST				- 🗆 X
Gamble pairs	Theories			Hypothesis testing
Number of gambles: 5 Change	CPT_GE_C1 A Vertices:		Reference volume	Run test
	v1 [0.5] v2 [0.5]	Add	Use reference volume	Theories Specifications Data sets
(A,C)	v3 [0.5]	Remove	Weight	
(A,D) Set	v5 [0.5]			
(B,C) (B,D) None	Add vo [0.5]	~		
(B,E) (C,D)	Duplicate (A,B): 0 (A,C): 0	^	Determine volume	Type of test
(C,E)	Remove (A,D): 0	Set	settings: Set	O Bayes Factor Bayes p & DIC
(0,2)	(A,E): 0 Load (B,C): 0			Frequentist All
	(B,D): 0 (B,E): 0		Set volume manually	Gibbs sampling:
· · · · · · · · · · · · · · · · · · ·	(C D): 0			Sample size: 5000 Change
Data	Probabilistic specifications	Fig	aure	Burn-In size: 1000 Change
	Aggregation-based:		Je r	Chi-bar squared weights Random number simulation sample size: seed
Sample size N: (A B): 8 12	Supermajority	ity level:	VISUAIIZE	
20 (A,C): 4,16 (A,D): 5,15	Borda scoro	Change	Over last figure	1 Change 1 Set
(A,E): 0,13			Color scheme:	Results
(B,C): 8,12 (B,D): 7,13	Distance-based: Max-distan	ce (U):	Default ~	CPT_GE_C1 (Set 1/ireq/1000/1) (major) CPT_GE_C1 (Set 2/ireq/1000/1) (major)
Load (B,E): 4,16 (C,D): 8,12	O Supremum 0.5	Change		CPT_GE_C1 (Set 3/freq/1000/1) (major) CPT_GE_C1 (Set 4/freq/1000/1) (major)
Save (C,E): 10,10 (D,E): 10,10	O City-block 0.5	Change	Close all figures	CPT_GE_C1 (Set 5/freq/1000/1) (major) CPT_GE_C1 (Set 5/freq/1000/1) (major)
Clear			olooo ali ngaroo	CPT_GE_C1 (Set 7/freq/1000/1) (major)
		Change		CP1_GE_C1 (Set 8/freq/1000/1) (major) CPT_GE_C1 (Set 9/freq/1000/1) (major)
Name Set 18 ~	Random preference:	File	9	CPT_GE_C1 (Set 10/freq/1000/1) (major)
	From file:	Load	Load Options	Table Remove Export
	O Mixture from vertices	Save	Save About	Details Clear

Once the analyses complete, under "Results:" you will see the following.

To save the results, under "Results:", select "Export…". An "Export Results As" window pops up. Save the file as "Results_CPT_GE_Cash1_.5M.csv". Select "Save".

Export Re	sults As
Save As: Results_CPT_KT_Cas Tags:	h15M.csv
lysis ‡	(q)
 DataSets SectionA-F_Figures SectionG-H_DataAnalysis SectionI_3Methods SectionJ_Table5 SectionK_Table6 SectionL_NSupplement 	 Cash1.txt Cash2.txt Complete_CPT_GE_Cash15M_weighted.mat Complete_CPT_GE_Cash15M.mat Data_Table1_DM1.mat Data_Table1_DM13.mat LH5_Maj.mat Results_CPT_GE_Cash15M_weighted.csv Results_CPT_GE_Cash15M.csv Vertices_CPT_GE_Cash1_weighted.csv Vertices_CPT_GE_Cash1_csv
Format: Comma separa	ted values (*.csv) 🛟
	Cancel Save Save

Now open the "Results_CPT_GE_Cash1_.5SM.csv" file we just saved. (Or open the file in the folder "SectionI-K_DataAnalysis" downloaded from the website.) A screenshot of part of the file is provided below. We have added all the highlighting here. The spreadsheet will not contain highlighted cells. First, notice that for Set 1, there are now 11 columns of results, one column for each vertex, as highlighted in yellow. Second, to identify the best fitting vertex for this decision-maker under a 0.50-majority/modal choice specification for the Cash I data, look at the p-values in row 16. Highlighted in green is the p-value of "0.127187", which is the largest p-value for this participant. Third, each column contains the maximum likelihood estimates for the 10 gamble pairs for this decision maker for each vertex. In order-constrained inference, the best fitting vertex is the one with the largest p-value. The overall p-value of the model is that largest p-value, in the case of Set 1, it is vertex one which has a p-value of 0.127187.

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3	Theory	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_0	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_C	CPT_GE_0	CPT_GE	CCF
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5	Reference	e volume																	
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.	5
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10	Gibbs san	nple size																	
11	Burn-in si	ize																	
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
13	Vertex we	eight																	
14	Vertex L/l	U																	
15	Likelihood	d 3.49165	5.31967	10.5522	7.26084	21.9834	22.7888	37.5114	37.5114	52.234	59.9438	59.7434	107.19	106.384	95.5669	75.7816	68.0718	60.36	2
16	p-value	0.127187	0.083367	0.012699	0.034587	7.25E-05	9.37E-05	2.26E-07	2.29E-07	5.64E-10	3.59E-11	1.86E-11	0	0	0	3.66E-15	5.83E-14	8.36E-1	3 1
17	Warning																		
18	DIC																		
19	Prior volu	ime																	
20	Posterior	volume																	
21	Bayes fac	tor 1																	
22	Bayes fac	tor 2																	
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27	MLE 1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.55	0.5	0.5	0.5	0.5	0.5	0.	5
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This completes the analysis for the Cash I data for CPT-GE with a 0.50-majority/modal choice specification. We learned how to load the theory, vertices and data file to analyze data in QTEST. And we also saw how to interpret results from a theory with more than one vertex. In Section K we learn how to set, and analyze, vertices with different weights for CPT-GE with a 0.50-majority/modal choice specification for Cash I data.

I. Guidelines for Replicating Tables 5 & 6

We first provide nomenclature guidelines for working with the folders and files for Tables 5 and 6 of QTBC1. There is a separate folder for each table. Table 5 code and results are contained in the folder "SectionJ_Table5" while Table 6 code and results are contained in the folder "SectionK_Table6". Both folders are organized as follows.

Within each of the main Table folders, there are 5 sub-folders: "DataSets" "TheoriesVertices" "QTEST_Session_Complete" "QTEST_Session_NoResults" "QTEST_Results"

The "DataSets" folder contains the raw Cash I and Cash II data sets, in a form *ready for analysis* by QTEST. Cash I is named "Cash1.txt" while Cash II is named "Cash2.txt".

The "TheoriesVertices" folder contains the predictions for all the vertices for the theories LH, CPT - KT and CPT - GE for both Cash I and Cash II predictions. To understand the naming structure of these files, consider the example "Vertices_CPT_GE_Cash1.csv". "Vertices" means the file contains the vertices (or predictions). "CPT_GE" means these are the predictions for the theory CPT - GE. And "Cash1" means the predictions are based on the Cash I stimuli. QTEST requires the ".csv" extension format to read these files. (For Table 6, the folder is not called "TheoriesVertices" but instead "TheoriesFDI". And in place of "Vertices" in each file name is "FDI". Otherwise, the nomenclature is identical.)

The folder "QTEST_Session_NoResults" has files that contain the setup of the data set, theory and probabilistic specification—but QTEST has not been run yet. Consider the example file "NR_CPT_GE_Cash1_.5M.mat". The "NR" means this is a QTEST session that has <u>No Results</u>. "CPT_GE_Cash1" specifies the theory CPT-GE and that the predictions are based on Cash I gambles. ".5M" means 0.50-majority/modal choice specification. Finally, these files end in a ".mat" extension, which QTEST requires. One will also see ".9SM" for some files, instead of ".5M", which denotes the 0.90-supermajority specification.

The "QTEST_Session_Complete" folder contains the complete QTEST interface setup for a given data set, theory, set of predictions and probabilistic specification as well as the output of the complete analysis. These file names begin with "Complete", list the theory name next, the data set used, the supermajority specification and end with a .mat extension. Here is an example of this file type: "Complete_CPT_GE_Cash1_.5M.mat". In this case "Complete" denotes this analysis has the complete setup and a completed analysis. "CPT_GE" means the theory analyzed. "Cash1" is the data set. And ".5M" means 0.50-

majority/modal choice specification. One will also see ".9SM" for some files, instead of ".5M", which denotes the 0.90-supermajority specification.

The folder "QTEST_Results" contains .csv spreadsheet files with the output from the analysis. For instance, "Results_CPT_GE_Cash1_.5M.csv".

Using the files provided, a user can replicate the results of Tables 5 and 6 of QTBC1 and of Tables 1, 2, and 3 of QTBC2 using one of the following three methods.

- 1. The first method is like how one might proceed if they have collected experimental data and are ready to do an analysis in QTEST.
 - a. First, in the QTEST interface, set the "Number of gambles:" under "Gamble pairs". For all the tables, 5 gambles (or 10 gamble pairs) are needed.
 - b. Second, under "Data" in the QTEST interface, select "Load". Navigate to one of the data files (either "Cash1.txt" or "Cash2.txt") from the "DataSets" folder downloaded from the website.
 - c. Third, under "Theories" in the QTEST interface, select "Load" and navigate to the "TheoriesVertices" folder and select one of the files. (If one is trying to replicate parts of Table 7 of QTBC1 or parts of Tables 1, 2, or 3 of QTBC2, select "Load" from the "Mixture-based" specification instead of the "Theories" section.)
 - d. Fourth, one will need to select the appropriate probabilistic specification in the QTEST interface.
 - e. Finally, under "Hypothesis testing" in the QTEST interface select all (or a subset) of the data and then select "Run test".
- 2. For the second method the gamble pairs are already defined, the data are automatically loaded, the theories and vertices are set, and the probabilistic specification is defined. The only difference from the first method is that the analysis has not actually been run. This is useful, for instance, if one would like to set up their analysis to run, save it and wait until a computer is available to run the analysis. These files are in the folder "QTEST_Session_NoResults". To use this method, simply select "Load..." under "File" and navigate to the appropriate file. And then select "Run test" under "Hypothesis testing".
- 3. The third method is like how one might proceed if one has already run an analysis in QTEST but would like to look again at that completed analyses. With this method all gamble pairs are defined, the data is automatically loaded, the theories and vertices are set, and the probabilistic specification is automatically loaded. The "Results" are also completed and loaded. One can view those results in table format from the QTEST interface or export them to a .csv file. These files are in the "QTEST_Session_Complete".

We will illustrate all three of the methods now, analyzing the Cash I data for LH with a 0.50-majority/modal choice specification. The files for each method are in the folder "SectionL_3Methods".

Method 1

First, in the QTEST interface, set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed. Second, under "Data" in the QTEST interface, select "Load". Navigate to "Cash1.txt" in the "SectionI_3Methods" folder, in the folder "Method1", and then select "Open". Third, under "Theories", select "Load" and navigate to the file "Vertices_LH_Cash1.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "LH_C1" and then select "OK". Finally, set the "Probabilistic specification" to "Supermajority" at the "0.5" level.



Once these changes have been completed, the QTEST interface should look like the following screenshot. If your session of QTEST matches the screenshot, you can now reproduce the results of Table 5 of QTBC1 for LH for Cash I data with a 0.50-majority/modal choice specification. To reproduce those results, under "Hypothesis testing" in the QTEST interface, select "All" under "Data sets" and then select "Run test". (Load the file "NR_LH_Cash1_.5M.mat" to replicate the following screenshot.)



Method 2

Under "File" of the QTEST interface, select "Load ... ".

- Gamble pairs	Theories		- Hypothesis testing
Number of gambles: 0 Change	Vertices:	Add Remove Reference volume Weight	Run test Auto save Theories Specifications Data sets Selected Selected Selected
None	Add Duplicate Remove Load Save	Determine volume from current settings: Set Set volume manually	All All All All All Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling: Samole size: 5000 Change
Data Observations: 20 Enter Clear Observations	Borda Score Supermajority level: Obstance-based: Supermajority level: Obstance-based: 0.5 Change Obstance-based: Max-distance (U): Supermum Obstance-based: Max-distance (U): Supermum 0.5 Change Obstance-based: Max-distance (U): Supermum 0.5 Change Obstance-based: 0.5 Change	Figure Visualize Visualize Over last figure Color scheme: Default Close all figures	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: seed: 1000 Change 1 Set Results:
Name Default ‡	Handom preference: From file: Mixture from vertices Save	Save About	Table Remove Export Details Clear

Navigate to the file "NR_LH_Cash1_.5M.mat". After completing this step, the QTEST interface should look like the following screenshot. Especially note that the "Results:" are NOT completed yet. At this point one would need to select "Run test" under "Hypothesis testing" if they wanted to complete this analysis.



<u>Method 3</u>

Theories Hypothesis testing Number of gambles: 0 Reference volume Change... Vertices Bun test Auto save Add.. Use reference volu Theories Specifications Data sets Weight... Remove Selected Selected Set... Selected) All 🔿 Ali 🔿 Ali Add. None Duplicate Determine volume from current settings: Type of test-All Bayes Factor O Bayes p & DIC Remove Set Set... Frequentist Load. Gibbs sampling: Sample size: Set volume manually... Save 5000 Change... Change... 1000 Burn-in size: Probabilistic specifications Aggregation-based: Data Random number seed: Chi-bar squared weights simulation sample size: Visualize Observations Supermajority level: Sample size N: Set... Supermajority Over last figure 1000 Change... 1 0.5 Change... 20 Borda score Color scheme: Results Enter Distance-based: Default \$ Max-distance (U): Load. Supremum 0.5 Change... Save. 0.5 Change... O City-block Close all figures Clear O Euclidean 0.5 Change... Name... Random prefer File Default \$ Load... Options.. Save... About... Load...) From file: Options... Remove Export... Table... Save... Mixture from vertices Details... Clear

Under "File" of the QTEST interface, select "Load ... ".

Navigate to the file "Complete_LH_Cash1_.5M.mat" and load it. After finishing this step, the QTEST interface should look like the following screenshot. Especially notice that the "Results:" are automatically loaded.



<u>Results</u>

No matter which of the 3 methods were used, if all the steps were properly completed, the completed QTEST analysis should now look like the following screenshot.



At this point one can verify they have completed the analysis correctly by comparing these results to the appropriate column of Table 5 of QTBC1 or by looking at the file "Results_LH_Cash1_.5M.csv".

For Sections J and K only, the file names and folders are provided for each of the 3 methods just described.

J. Table 5 of QTBC1

The following section will replicate all results of Table 5 of QTBC1. Each of the 10 subsections (J.1, J.2, ..., J.9, J.10) replicate a different column of Table 5.

J.1 Cash I, LH, 0.50-Majority/modal choice

In this section we analyze the Cash I data for LH with a 0.50-majority/modal choice specification. All files are contained in the folder "SectionJ_Table5".

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_LH_Cash1.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "LH_C1" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.5" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load…". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_LH_Cash1_.5M.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

 Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_LH_Cash1_.5M.mat".

• The results for this section are in the folder "QTEST_Results" in the file "Results_LH_Cash1_.5M.csv".



J.2 Cash II, LH, 0.50-Majority/modal choice

In this section we analyze the Cash II data for LH with a 0.50-majority/modal choice specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash2.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_LH_Cash2.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "LH_C2" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.5" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_LH_Cash2_.5M.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_LH_Cash2_.5M.mat".

• The results for this section are in the folder "QTEST_Results" in the file "Results_LH_Cash2_.5M.csv".



J.3 Cash I, CPT-KT, 0.50-Majority/modal choice

In this section we analyze the Cash I data for CPT-KT with a 0.50-majority/modal choice specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_CPT_KT_Cash1.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "CPT_KT_C1" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.5" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_KT_Cash1_.5M.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_KT_Cash1_.5M.mat".

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_KT_Cash1_.5M.csv".



J.4 Cash I, CPT-KT, 0.90-Supermajority

In this section we analyze the Cash I data for CPT - KT with a 0.90-supermajority specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_CPT_KT_Cash1.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "CPT_KT_C1" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.9" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_KT_Cash1_.9SM.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

 Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_KT_Cash1_.9SM.mat".

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_KT_Cash1_.9SM.csv".



J.5 Cash I, CPT-GE, 0.50-Majority/modal choice

In this section we analyze the Cash I data for CPT-GE with a 0.50-majority/modal choice specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_CPT_GE_Cash1.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "CPT_GE_C1" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.5" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_GE_Cash1_.5M.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_GE_Cash1_.5M.mat".

Results

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_GE_Cash1_.5M.csv".



J.6 Cash I, CPT-GE, 0.90-Supermajority

In this section we analyze the Cash I data for CPT-GE with a 0.90-supermajority specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_CPT_GE_Cash1.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "CPT_GE_C1" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.9" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_GE_Cash1_.9SM.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_GE_Cash1_.9SM.mat".

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_GE_Cash1_.9SM.csv".



J.7 Cash II, CPT-KT, 0.50-Majority/modal choice

In this section we analyze the Cash II data for $CPT \cdot KT$ with a 0.50-majority/modal choice specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash2.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_CPT_KT_Cash2.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "CPT_KT_C2" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.5" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_KT_Cash2_.5M.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

 Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_KT_Cash2_.5M.mat".

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_KT_Cash2_.5M.csv".



J.8 Cash II, CPT-KT, 0.90-Supermajority

In this section we analyze the Cash II data for CPT - KT with a 0.90-supermajority specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash2.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_CPT_KT_Cash2.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "CPT_KT_C2" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.9" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_KT_Cash2_.9SM.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_KT_Cash2_.9SM.mat".

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_KT_Cash2_.9SM.csv".



J.9 Cash II, CPT-GE, 0.50-Majority/modal choice

In this section we analyze the Cash I data for CPT-GE with a 0.50-majority/modal choice specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash2.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_CPT_GE_Cash2.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "CPT_GE_C2" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.5" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_GE_Cash2_.5M.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_GE_Cash2_.5M.mat".

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_GE_Cash2_.5M.csv".



J.10 Cash II, CPT-GE, 0.90-Supermajority

In this section we analyze the Cash I data for CPT-GE with a 0.90-supermajority specification.

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash2.txt" in the "DataSets" folder and then select "Open".
- Under "Theories", select "Load" and navigate to the folder "TheoriesVertices". Select the file "Vertices_CPT_GE_Cash2.csv" and then select "Open". In the "Theory" dialogue box that pops up enter "CPT_GE_C2" and then select "OK".
- Set the "Probabilistic specification" to "Supermajority" at the "0.9" level.
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_GE_Cash2_.9SM.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_GE_Cash2_.9SM.mat".

Results

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_GE_Cash2_.9SM.csv".



K. Table 6 of QTBC1

This section of the tutorial allows a user of QTEST to replicate Table 6 of QTBC1. Once again, the 3 different methods for running an analysis are presented.

<u>K.1 Cash I, Random *CPT - KT*</u>

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Probabilistic specifications", under "Mixture-based:" select "Load" and navigate to the folder "TheoriesFDI". Select the file "FDI_CPT_KT_Cash1.txt" and then select "Open".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_KT_Cash1_Mixture.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_KT_Cash1_Mixture.mat".

<u>Results</u>

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_KT_Cash1_Mixture.csv".

mble pairs	Theories				Hypothesis testing		_	
Number of gambles: 5 Change	^	Vertices:		Reference volume	Run test			
A B)		^	Add	Use reference volume	Theories	Specifications	Data cote	
(C)			Remove	Weight	(Reones	© Charles		
A,D) Set	~				Selected	Selected	Selected	
3.C) None	Add	~			O All			
B,E)	Duplicate	^		Determine volume	Type of test			
D,E)	Remove		0.1	from current settings:	Bayes Factor Bayes p & DIC			
D,E)	Remove		Set	Set Set	Frequ	entist OAll		
	Load				Gibbs samp	ina:		
~	Save	~		Set volume manually	Sample	size: 5000	Change	
					Burn-in	size: 1000	Change	
Jata	Probabilistic specificat	ions	Fig	jure	Chi-bar square	d weights 5	andom number	
Observations:	Aggregation-based:	Comparing the levels		Visualize	simulation san	nple size: s	eed:	
Sample size N: (A.B): 11,9	Supermajority	Supermajority level.		Over last figure	1000	Change	1 Set.	
20 (A,C): 4,16 (A,D): 2,18	O Borda score	0.5 Change						
(A,E): 2,18 (B,C): 10,10	Distance based:			Color scheme:	Results:	OT 1/T MA /O M 4/6	(4000/4) (51-)	
(B,D): 8,12	Distance-based.	Max-distance (U):		Default ~	FDI_Cash1_CF	PT_KT.txt (Set 2/freq	/1000/1) (file)	
Load (D,E). 2, 10 (C,D): 14,6	Supremum	0.5 Change			FDI_Cash1_CF FDI_Cash1_CF	PT_KT.txt (Set 3/freq PT_KT.txt (Set 4/frea	/1000/1) (file) /1000/1) (file)	
Save (C,E): 5,15 (D,E): 7,13	City-block	0.5 Change		Close all figures	FDI_Cash1_CF	PT_KT.txt (Set 5/freq	/1000/1) (file)	
Class	05.51			Ciose all'igures	FDI_Cash1_CF	PT_KT.txt (Set 7/freq	/1000/1) (file)	
Clear	Euclidean	0.5 Change			FDI_Cash1_CF FDI_Cash1_CF	PT_KT.txt (Set 8/freq PT_KT.txt (Set 9/freq	/1000/1) (file) /1000/1) (file) v	
Name Set 1	Random preference:		File		<		>	
	O From file: FD	I_Cash1_CPT_KT Load		Load Options	Table	Remove	Export	
	Mixture from vert	icae Sava						

<u>K.2 Cash II, Random *CPT - KT*</u>

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash2.txt" in the "DataSets" folder and then select "Open".
- Under "Probabilistic specifications", under "Mixture-based:" select "Load" and navigate to the folder "TheoriesFDI". Select the file "FDI_CPT_KT_Cash2.txt" and then select "Open".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_KT_Cash2_Mixture.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_KT_Cash2_Mixture.mat".

<u>Results</u>

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_KT_Cash2_Mixture.csv".
QIESI				
Amble pairs Number of gambles: 5 Change (A, C) (A, C) (A, C) (B, C) (B, C) (B, C) (C, C) (C, E)	Add Remove Load	Add Remove	Reference volume Use reference volume Weight Determine volume from current settings: Set	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected All Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling:
Data Sample size N: (AB): 17.3 20 (AC): 13.7 (AD): 5.15 (AE): 4.16 (BEnter	Save Probabilistic specifications Aggregation-based: Supermajority O Borda score Distance-based:	v 'level: :hange	Set volume manually Figure Visualize Over last figure Color scheme:	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 2 Set Results:
(B, D): 8, 12 (B, D): 8, 17 (C, D): 15, 5 Save (C, E): 9, 11 (D, E): 10, 10	Okunic Gutco. Max-distance O Supremum 0.5 O City-block 0.5 O Euclidean 0.5	(U): Change Change	Close all figures	FDI Cash2_CPT_KT txt (Set 2/freq/1000/2) (file) FDI Cash2_CPT_KT txt (Set 3/freq/1000/2) (file)
Name Set 1 v	Random preference: O From file: FDI_Cash2_CPT_KT	Load	Load Options	Table Remove Export
	Mixture from vertices	Save	Save About	Details Clear

K.3 Cash I, Random CPT-GE

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash1.txt" in the "DataSets" folder and then select "Open".
- Under "Probabilistic specifications", under "Mixture-based:" select "Load" and navigate to the folder "TheoriesFDI". Select the file "FDI_CPT_GE_Cash1.txt" and then select "Open".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_GE_Cash1_Mixture.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

 Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_GE_Cash1_Mixture.mat".

Results

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_Ge_Cash1_Mixture.csv".



K.4 Cash II, Random CPT-GE

Method 1

- Set the "Number of gambles:" under "Gamble pairs" to 5. Then select "All" (also under "Gamble pairs") so all 10 gamble pairs are now listed.
- Under "Data", select "Load". Navigate to "Cash2.txt" in the "DataSets" folder and then select "Open".
- Under "Probabilistic specifications", under "Mixture-based:" select "Load" and navigate to the folder "TheoriesFDI". Select the file "FDI_CPT_GE_Cash2.txt" and then select "Open".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 2

- Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_NoResults" folder and open the file "NR_CPT_GE_Cash2_Mixture.mat".
- Under "Hypothesis testing", select "All" under "Data sets" and then select "Run test".

Method 3

• Under "File" of the QTEST interface, select "Load...". Navigate to the "QTEST_Session_Complete" folder and open the file "Complete_CPT_GE_Cash2_Mixture.mat".

<u>Results</u>

• The results for this section are in the folder "QTEST_Results" in the file "Results_CPT_GE_Cash2_Mixture.csv".

amble pairs	Theories			Hypothesis testing		_
Number of gambles: 5 Change	^	Vertices:	Reference volume	F	Run test	Auto save
(A, B) (A, C) (A, D) (A, E) (B, C) (B, C)	Add		Add Use reference volume Weight	Theories Selected All	Specifications Selected All	Data sets Selected All
(B, L) None (B, E) (C, D) All (C, E) (D, E) All	Duplicate Remove		Determine volume from current settings: Set	Type of test Bayes Frequ	s Factor OBayı entist OAll	es p & DIC
~	Save	~	Set volume manually	Gibbs sample Sample Burn-in	ing: size: 5000 size: 1000	Change
Data	Probabilistic specification	ns	Figure	Chi-bar square	d weights R	andom number
Observations: Sample size N: (A D) 47.0	Aggregation-based.	Supermajority level:	Visualize	simulation sam	nple size: se	ed:
(A,B): 17,3 (A,C): 13,7 (A,D): 5,15	Supermajority	0.5 Change	Over last figure	1000	Change	2 Set.
(A,D): 5, 15 (A,E): 4,16 (B,C): 17.2	Borda score		Color scheme:	Results:		
(B,D): 8,12 (B,D): 2,17	Distance-based:	Max-distance (U):	Default	FDI_Cash2_CF FDI_Cash2_CF	PT_GE.txt (Set 1/freq/ PT_GE.txt (Set 2/freq/	1000/2) (file) ^ 1000/2) (file)
Load (C,D): 15,5	O Supremum	0.5 Change		FDI_Cash2_CF FDI_Cash2_CF	PT_GE.txt (Set 3/freq/ PT_GE.txt (Set 4/freq/	1000/2) (file) 1000/2) (file)
Save (D,E): 10,10	O City-block	0.5 Change	Close all figures	FDI_Cash2_CF FDI_Cash2_CF	PT_GE.txt (Set 5/freq/ PT_GE.txt (Set 6/freq/	1000/2) (file) 1000/2) (file)
Clear	CEuclidean	0.5 Change		FDI_Cash2_CF FDI_Cash2_CF FDI_Cash2_CF	PT_GE.txt (Set 7/freq/ PT_GE.txt (Set 8/freq/ PT_GE.txt (Set 9/freq/	1000/2) (file) 1000/2) (file) 1000/2) (file) v
Name Set 1 ~	Random preference:		File	<		>
	O From file: FDI	Cash2_CPT_GE Load	Load Options	Table	Remove	Export
	Mixture from vertice	ses Save	Sava About	Detaile	Clear	

L. Tables 1 and 2 of QTBC2

This section of the tutorial allows a user of QTEST to replicate the Cash 1 Bayes p and DIC values of Tables 1 and 2 in QTBC2.

Section L.2 demonstrates to a user the steps in running the Bayes p & DIC test of CPT-KT for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications.

Section L.3 demonstrates to a user the steps in running the Bayes p & DIC test of CPT-GE for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications.

Then, section L.4 demonstrates to a user the steps in running the Bayes p & DIC test of LH for the .50-majority/modal choice and the .90-supermajority probabilistic specifications.

Finally, section L.5 demonstrates to a user the steps in running the Bayes p & DIC test for the unconstrained model.

L.1 Gamble pairs

Starting with a clear (or new) QTEST interface, under "Gamble pairs", "Change" the "Number of gambles:" to "5" and then select "All". QTEST should look like the following screenshot.



L.2.1 Theory and Vertex: Cash I, CPT-KT

Under "Theories", select "Load...".

amble pairs		Theories			Hypothesis testing	
Number of gambles	: 5 Change		Vertices:	Reference volume	Run test	Multicore
(A.B)			Add	Use reference volume	Theories Specifications	Data sets
(A,C) (A,D)	0.1	~	Remo	we Weight	Selected Selected	Selected
(A,E) (B,C)	Set					
(B,D)	None	Add	~			
(C,D)	All	Duplicate	^	Determine volume from current	Type of test	
(D,E)	H	Remove	Set.	. settings: Set	Bayes Factor Ba Bayes Factor All	yes p & DIC
	、	Save		Set volume manually	Gibbs sampling: Sample size: 5000	Change
					Burn-in size: 1000	Change
Data		Probabilistic specification	s - \	Figure	Chi bar cauared weights	Pandom numbor
	Observations:	Aggregation-based:	Supermainrity level:	Visualize	simulation sample size:	seed:
Sample size N:	^	Supermajority	0.5 Change	Over last figure	1000 Change	1 Set
20		O Borda score	Change	Color schome:	Results:	
Enter		Distance-based:		Default		^
Load		0.5	Max-distance (U):			
Load		Supremum	0.5 Change			
		O City-block	0.5 Change	Close all figures		
Save						
Save Clear	v	OEuclidean	0.5 Change			
Save Clear	V	C Euclidean	0.5 Change	File		~
Save Clear Name	V Default	C Euclidean Random preference: From file:	0.5 Change	File Options	Table Remove	× Export

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "TheoriesVertices" folder and open "Vertices_CPT_KT_Cash1.csv". In the dialog box, type "CPT-KT" and select "OK".

🛑 😑 💿 Theory	
Entername for theory:	
CPT-KT	
ОК	Cancel

On the QTEST interface there should now be a list of 22 vertices for CPT - KT under "Theories". Verify your screen matches the screenshot below.

nble pairs	Theories		Hypothesis testing	A dulaise est
Number of gambles: 5 Change	CPT-KT Vertices:	Reference volume	Run test	Auto save
(,B)	V2 [0.5]	Add Use reference volume	Theories Specifications	Data sets
(C) (D) Set	v3 [0.5] ↓ v4 [0.5]	Remove Weight	Selected Selected	Selected
B,C)	V5 [0.5] V6 [0.5]		⊖ All O All	
8,D) None 8,E)	Puplicate (A,B): 0	Determine volume	Type of test	
CD) All (E) (E)	(A, C): 0 (A, D): 0 (A, E): 0	from current Set Set	Bayes Factor Bayes Bayes Factor All	p & DIC
~	Load. (B,D): 0 (B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000	Change
			Burn-in size: 1000	Change
ata	Probabilistic specifications	Figure	Chi-bar squared weights Bar	dom number
Observations:	Aggregation-based: Supermajority level:	Visualize	simulation sample size: see	d:
Sample size N:	Supermajority 0.5 Change	Over last figure	1000 Change	1 Set.
20	O Borda score	Color scheme:	Results:	
Enter	Distance-based: Max-distance (LI):	Default ~		^
Load	O Supremum 0.5 Change			
Save	O City-block 0.5 Change	Close all figures		
Clear	O Euclidean 0.5 Change			
	Random preference:	File		~
Name Default	O From file:	Load Ontions	Table Remove	Export
Name Default ~	Coad	Coud Options	Tuble Tuble	

<u>L.2.2 Data: Cash I, *CPT-KT*</u>

Under "Data", select "Load…".

QTEST			- 🗆 X
Gamble pairs	Theories		Hypothesis testing
Number of gamples: 5 Change	CPT-KT Vertices:	Reference volume	Bun tect
	V1 [0.5]	dd Use reference volume	Thuritest Auto save
	v3 [0.5]	move Weight	Selected Selected Selected
(A,D) (A,E)	v5 [0.5]		Selected Selected Selected
(B,C) (B,D) None	Add vo [0.5] v7 [0.5]		
(B,E) (C,D)	Duplicate (A,B): 0	Determine volume	Type of test
	(A,D): 0 (A,E): 0	et settings: Set	O Bayes Factor O Bayes p & DIC
(0,0)	Load (B,C): 0		Frequentist All
	(B,D): 0 (B,E): 0	Set volume manually	Gibbs sampling:
×	(C,D): 0		Sample size: 5000 Change
-Data	- Probabilistic specifications	Finne	Burn-in size: 1000 Change
Data	Aggregation-based:	rigure	Chi-bar squared weights Random number
Sample size N:	Supermajority	Visualize	
20	O Borda score O.5 Change	Over last figure	Change
Enter		Color scheme:	Results:
	Distance-based: Max-distance (U):	Default ~	^
Load	O Supremum 0.5 Change		
Save	O City-block 0.5 Change	Close all figures	
Clear	Change		
~	U.S Charge		
Name Default ~	Random preference:	File	✓
	Load	Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "DataSets" folder and open "Cash1.txt".

Under "Data" notice the "Observations:" list has now been populated:

and the second	Theories					Hypothesis testing			
Number of gambles: 5 Change	CPT-KT	Vertices:		Reference volume		Bun test			
(A.B) (A.C) (A.D) (A.E) (B.C)		v1 (0.5) v2 (0.5) v3 (0.5) v4 (0.5) v5 (0.5) v6 (0.5)	Add. Remo	Use referenc	e volume it	Theories Selected All	Specifications Selected All	Data sets Selected	
BD) None (B,E) (C,D) (C,E) All (D,E) (D,E)	Add Duplicate Remove	v7 [0.5] (A.B): 0 (A.C): 0 (A.D): 0 (A.E): 0 (B.C): 0	Set.	Determine volu from current settings:	me Set	Type of test	s Factor OBa entist OAII	yes p & DIC	
~	Save	(B,D): 0 (B,E): 0 (C,D): 0	~	Set volume	manually	Gibbs sampl Sample	ing: size: 5000	Change	
Data Sample size N: 20 A C): 4,16 (A C): 2,18 (A C): 2,18 (A C): 2,18 (A C): 2,18 (B C): 10,10	Probabilistic specificati Aggregation-based: - Supermajority Dictance baced:	Supermajority I	evel: ange	Figure Visualiz Over last fig Color schem	e jure ie:	Chi-bar square simulation san 1000 Results:	d weights I pple size: s	Random number seed: 1 Set.	
Load (B. D): 8,12 (B. D): 2,18 (C. D): 14,6 (C. D): 14,6 (C. E): 5,15 (D. E): 7,13 (D. E): 7,13	City-block	Max-distance (0.5 CH 0.5 CH	U): nange nange	Default Close all fig	jures			Â	
Name Set 1	Random preference:		oad	File	Ortions			~	
				Luad	Options	Table	Remove	Export	

Under "Data", select the dropdown menu next to "Name..." to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

<u>L.2.3 Probabilistic specification: Cash I, CPT-KT, 0.50-</u> <u>Majority/modal choice</u>

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected and that the "Supermajority level:" is set to "0.5".



<u>L.2.4 Hypothesis Testing: Cash I, CPT-KT</u>, 0.50-Majority/modal <u>choice</u>

We are now ready for the Bayes p & DIC test of CPT - KT.50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".



Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test	_	Ū
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

ible pairs		Ineories			5.6	Hypothesis testing	Г	Multicoro
lumber of gambles:	5 Change	CPT-KT	Vertices:		Reference volume	Ru	in test	Auto save
B) C) D)	∧ Sat	~	v2 [0.5] v3 [0.5] v4 [0.5]	Remov	Weight	Theories Selected	Specifications Selected	Data sets
E) C) D)	None	Add	v5 [0.5] v6 [0.5] v7 [0.5]	~) All		All
E) 3) E) E)	All	Duplicate Remove	(A,B): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0	Set	Determine volume from current settings: Set	Type of test Bayes I Frequer	Factor	p & DIC
	~	Save	(B,D): 0 (B,E): 0 (C,D): 0	~	Set volume manually	Gibbs samplin Sample s	g: ize: 5000	Change
						Burn-in si	ize: 1000	Change
a	Observations:	Probabilistic specification Aggregation-based:	Supermajority	/ level:	Figure	Chi-bar squared simulation samp	weights Rand le size: seed	dom number I:
20	(A,B): 11.9 (A,C): 4,16 (A,D): 2,18	 Supermajority Borda score 	0.5	Change	Over last figure	1000	Change	1 Set
Enter	(A,E): 2,18 (B,C): 10,10	Distance-based:			Color scheme:	CPT-KT (Set 1/b	ayes-p/5000/1000/1) (i	major)
Load	(B,D): 8,12 (B,E): 2,18 (C,D): 14,6	O Supremum	0.5	Change		CPT-KT (Set 2/b CPT-KT (Set 3/b CPT-KT (Set 4/b	ayes-p/5000/1000/1) (r ayes-p/5000/1000/1) (r ayes-p/5000/1000/1) (r	major) major) major)
Save	(D,E): 7,13	O City-block	0.5	Change	Close all figures	CPT-KT (Set 5/b CPT-KT (Set 6/b CPT-KT (Set 7/b)	ayes-p/5000/1000/1) (i ayes-p/5000/1000/1) (i ayes-p/5000/1000/1) (i	major) major)
Clear	~	CEuclidean	0.5	Change		CPT-KT (Set 8/b CPT-KT (Set 9/b	ayes-p/5000/1000/1) (i ayes-p/5000/1000/1) (i ayes-p/5000/1000/1) (i	major) major)
Name	Set 1 V	Random preference:			File	CPT-KT (Set 10/	bayes-p/5000/1000/1)	(major)
		O From file:		Load	Load Options	Table	Remove	Export

Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.

承 QTEST × _ Theories Hypothesis testing Gamble pairs Multicore Reference volume Number of gambles: 5 Change... Vertices: CPT-KT ~ Vertic v2 [0.5] v3 [0.5] v4 [0.5] v5 [0.5] v6 [0.5] v7 [0.5] Run test Auto save ~ Add... Use reference volume (A,B) (A,C) (A,D) (A,E) (B,C) (B,C) (B,E) (C,D) (C,E) (D,E) Theories Specifications Data sets Remove Weight... Selected O Selected Selected Set... All None Add.. (A,B): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0 (B,C): 0 (B,C): 0 (C,D): 0 Determine volume from current settings: Set Type of test Duplicate. All O Bayes Factor Bayes p & DIC Remove Set... O Frequentist Load.. Gibbs sampling: Set volume manually... Save. ~ Change... Sample size: 5000 . Change... Burn-in size: 1000 Probabilistic specifications Data Figure Chi-bar squared weights simulation sample size: Random number seed: Aggregation-based: Visualize Observations Supermajority level: (A,B): 11,9 (A,C): 4,16 (A,C): 2,18 (A,E): 2,18 (B,C): 10,10 (B,D): 8,12 (B,E): 2,18 (C,D): 14,6 (C,E): 5,15 (D,E): 7,13 Sample size N: Supermajority 1000 Change... 1 Set... . Over last figure 0.5 Change... 20 Borda score Color scheme: Results: Results: CPT-KT (Set 1/bayes-p65000/1000/1) (major) CPT-KT (Set 2/bayes-p5000/1000/1) (major) CPT-KT (Set 2/bayes-p65000/1000/1) (major) CPT-KT (Set 3/bayes-p65000/1000/1) (major) CPT-KT (Set 5/bayes-p65000/1000/1) (major) CPT-KT (Set 5/bayes-p65000/1000/1) (major) CPT-KT (Set 5/bayes-p65000/1000/1) (major) CPT-KT (Set 5/bayes-p65000/1000/1) (major) CPT-KT (Set 5/bayes-p55000/1000/1) (major) CPT-KT (Set 5/bayes-p55000/1000/1) (major) CPT-KT (Set 1/bayes-p55000/1000/1) (major) CPT-KT (Set 5/bayes-p55000/1000/1) (major) CPT-KT (Set 1/bayes-p55000/1000/1) (major) Enter... Distance-based: Default \sim Max-distance (U): Load.. O Supremum 0.5 Change... Save.. O City-block 0.5 Change... Close all figures Clear OEuclidean 0.5 Change... v Random preference: File Name... Set 1 \sim O From file: Load... Load... Options... O Mixture from vertices Save... Save... About... Details... Clear

The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "OG" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected "Details..." for each participant. The layout is a little different, however.

									CP	T_KT_150	D.csv								
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2 Test ty	pe bay	yes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3 Theory	CP1	Т-КТ	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
4 Specifi	cation ma	ijor	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5 Refere	nce volum	ne																	
6 Lambd	la	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.
7 U																			
8 N																			
9 Rando	m see	1	1	1	. 1	1	. 1	. 1	1	1	. 1	1	. 1	. 1	1	. 1	. 1	. 1	
LO Gibbs s	sample	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	500
1 Burn-ir	n size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	100
L2 Vertex	v1		v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17	v18
13 Vertex	weight																		
L4 Vertex	L/U																		
L5 Likeliho	ood ratio																		
L6 p-value	e	0.3088	0.2048	0.0664	0.1546	0.0058	0.0048	0.0002	0	0	0	0.345	0.0856	0.086	0.003	0.003	0	. 0	
L7 Warnir	ng																		
L8 DIC		17.3199	19.6095	25.1156	21.5019	36.4965	37.816	52.7995	52.7848	67.8022	75.7134	16.7275	24.6387	24.6239	39.6561	39.6413	54.6248	55.9444	52.330
L9 Prior v	olume 0.0	00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.0009765
20 Posteri	ior vol 0.0	00467512	0.00048861	6.59E-06	0.00016155	1.79E-08	4.24E-09	4.69E-13	4.69E-13	5.19E-17	1.87E-19	0.00941455	3.40E-05	3.40E-05	3.76E-09	3.76E-09	4.16E-13	9.87E-14	2.42E-1
21 Bayes	factor 1																		
22 Bayes	factor 2																		
23 Bayes 1	factor	4.78732	0.500337	0.00674513	0.165426	1.83E-05	4.34E-06	4.80E-10	4.80E-10	5.31E-14	1.92E-16	9.6405	0.0348185	0.0348185	3.85E-06	3.85E-06	4.26E-10	1.01E-10	2.48E-0
24 Weight	ted p-	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.325561	0.32556
25 Weight	ted DI	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.8682	17.868
26 Weight	ted Ba	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.68954
27																			
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The weighted p-values are in row 24 of the spreadsheet. Notice the same pvalue repeats for all the columns "B" through "W" listed as "Set 1"—this is the Bayes p value for participant 1, listed under "0.50 Majority Choice" and "KT" in Table 1 of QTBC2. Notice the same holds true for all the columns "X" through "AS" listed as "Set 2", for participant 2, and so on. From this file, column "KT" under "0.50 Majority Choice" of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

The weighted DIC values are in row 25 of the spreadsheet. Again, notice the same DIC value repeats for all the columns "B" through "W" listed as "Set 1"—this is the DIC value for participant 1, listed under "0.50 Majority Choice" and "KT" in Table 2 of QTBC2. Notice the same holds true for all the columns "X" through "AS" listed as "Set 2", for participant 2, and so on. From this file, column "KT" under "0.50 Majority Choice" of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

This completes the analysis for Cash I data for the Bayes p & DIC test of CPT- \mathcal{KT} .50-majority/modal choice probabilistic specification. We will, again, demonstrate the analysis for the Cash I data for the Bayes p & DIC test of CPT- \mathcal{KT} , but now with a .90-supermajority probabilistic specification in the following two sections, L.2.5 and L.2.6.

<u>L.2.5 Probabilistic specification: Cash I, CPT-KT, 0.90-</u> Supermajority

If continuing from section L.2.4, select "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes p & DIC test of $CPT \ KT$.50-majority/modal choice probabilistic specification from the QTEST interface.

Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change (A.C) (A.C) (A.D) (A.C) (A.C)	CPT-KT Vertices: v10.5 v30.5 v40.5 v40.5 v50.5	Reference volume d Use reference volume vove Weight	Run test Multicore Theories Specifications Ø Selected Ø Selected Ø Selected Selected
(B,C) (B,D) (B,D) (C,D) (C,C) (C,C) (D,E) V	Add Vf (0.5) V Duplicate (A, C): 0 A Remove (A, D): 0 A (A, C): 0 (A, C): 0 A (B, C): 0 (B, C): 0 (B, C): 0 (B, C): 0 (B, C): 0 (C, D): 0 Save (C, D): 0 V	Determine volume from current settings. Set Set volume manually	All All Type of test Bayes Factor Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling: Sample size: Sample size: 5000
Data Data Observations: Sample size N: (A, D): 11.9 20 (A, C): 4, 16	Probabilistic specifications Aggregation-based: Supermajority level: Supermajority 0.5 Change	Figure Visualize	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1
Enter (A, E): 2, 18 (B, C): 10, 10 (B, C): 10, 10 (B, C): 10, 10 (B, C)	Distance-based: Distance-based: Max-distance (U): O Supremum 0.5 Change O City-block 0.5 Change	Color scheme: Default v	Results: CPT-KT (Set 1/bayes-p/5000/1000/1) (major) CPT-KT (Set 2/bayes-p/5000/1000/1) (major) CPT-KT (Set 3/bayes-p/5000/1000/1) (major) CPT-KT (Set 4/bayes-p/5000/1000/1) (major) CPT-KT (Set 6/bayes-p/5000/1000/1) (major) CPT-KT (Set 6/bayes-p/5000/1000/1) (major)
Clear v Name Set 1 v	Cuclidean 0.5 Change	File Ontions	CPT-KT (Set 7/bayes-p/5000/1000/1) (major) CPT-KT (Set 8/bayes-p/5000/1000/1) (major) CPT-KT (Set 9/bayes-p/5000/1000/1) (major) CPT-KT (Set 10/bayes-p/5000/1000/1) (major)
	Mixture from vertices Save	Save About	Details Clear

Whether the user is continuing from section L.2.2 or L.2.4, the QTEST interface should match the screenshot below.

▲ QTEST			– 🗆 X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT A Vertices:	Reference volume	Run test Auto save
(A.B)	V1 0.5 V2 [0.5]	Add Use reference volume	Theories Specifications Data sets
(A,C) (A,D) Set	v5 [0.5] v4 [0.5] v5 [0.5]	Remove Weight	Selected Selected Selected
(A,E) (B,C)	Add v6 [0.5] v6 [0.5] v7 [0.5]		
(B,E)	Duplicate (A.B): 0	Determine volume	Type of test
(C,E)	(A, C): 0 (A, D): 0 (A, D): 0	from current Set Set	O Bayes Factor O Bayes p & DIC
	Load (B,C): 0 (B,D): 0		O Frequentist O All
~	(B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change
			Burn-in size: 1000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations: Sample size N: (A B): 11.9	Supermajority level:	Visualize	simulation sample size: seed:
20 (A,C): 4,16 (A,D): 2,18	O Borda score	Over last figure	Change
(A,E): 2,18 (B,C): 10,10	Distance-based:	Color scheme:	Results:
(B,D): 8,12 (B,E): 2,18	Max-distance (U):	Default	
(C,D): 14,6 (C,E): 5,15	U.5 Change		
(D,E): 7,13	City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Set 1 ~	Random preference:	File	v
	O From file:	Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected. To set the "Supermajority level:" to "0.9", select "Change..." and enter "0.9", then select "OK."

	🔵 🔘 Change Para					
Supermajority Level (Lambda):						
0.9						
	OK Cancel					

The QTEST interface should now match the screenshot below.

nble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices:	Reference volume	Run test Auto save
B) ^ (C) (D) Set	V2 (0.9) V3 (0.9) V4 (0.9) V5 (0.9)	terrove Weight	Theories Specifications Data sets Operation Data sets Selected Selected Selected All All All
None None ,E) All ,E) E)	Add Y [0, 9] ✓ Duplicate (A, B): 0 ∧ (A, D): 0 ∧ ∧ Load (B, C): 0 ∧	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	(B.D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 4000 Change
Sample size N: Observations: 20 (A, C): 4, 16 (A, C): 2, 18 (A, C): 2, 18	Probabilistic specifications Aggregation-based:	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights Random number simulation sample size. Seed: 1000 Change 1 Set Results:
Enter (B, C): 10, 10 (B, D): 8, 12 (B, E): 8, 12 Load (B, E): 2, 18 (C, D): 14, 6 (C, E): 5, 15 (D, E): 7, 13 (D, E): 7, 13	Distance-based: Max-distance (U): Supremum 0.5 City-block 0.5 Change	Default v	^
Clear	O Euclidean 0.5 Change		
Name Set 1 ~	Random preference: O From file:	File Ontions	Table Remove Evort

L.2.6 Hypothesis Testing: Cash I, CPT-KT, 0.90-Supermajority

We are now ready for the Bayes p & DIC test of $CPT \cdot KT$.90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".

承 QTEST			- 🗆 🗙
Gamble pairs 5 Change Number of gambles: 5 Change (A.C) (A.C) (A.C) (A.D) (A.E) Set (B.C)	Vertices: Vertices: Vertices: Vertices:	Add Reference volume Add Weight	Hypothesis testing Run test Theories Specifications Data sets Selected All All All All
(B.D) None (B.E) (C.D) All (C.E) (D.E)	Adu V/7 [0,9] V Duplicate (A B) 0 (A C) 0 ^ Remove (A D) 0 (A D) 0 ^ Load (B C) 0 (B D) 0 (B D) 0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist DI Gibbs sampling: DI
Data	Probabilistic specifications Aggregation-based:	Figure	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seet
Sample size N: (A,B): 11.9 20 (A,C): 4,16 (A,D): 2,18 (A,D): 2,18 Enter (B,C): 10: 10	Supermajority level: O Borda score	Visualize Over last figure Color scheme:	International surger succession Sect. 1000 Change 1 Set Results:
(B,D): 8,12 (B,D): 8,12 (B,E): 2,18 (C,D): 14,6 (C,E): 5,15 (D,E): 7,13	Distance-based: Max-distance (U): O Supremum 0.5 Change O City-block 0.5 Change	Default ~	^
Clear V	Cuclidean 0.5 Change	File	т у
Set 1 v	From file: Load Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear

Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with green as each analysis progresses.

承 Computing Bayes p & DIC (vertex	_		\times
Sampling 0/5000)		
		Canc	el

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

QTEST			– 🗆 X
Gamble pairs 5 Change (A. D) (A. C) (A. D) (A. D) (A. D) (A. D) (A. E) (B. D) (B. D) (B. D) (C. D) All	CPT-KT Vertices: v1 (0.9) v2 (0.9) v2 (0.9) v3 (0.9) v4 (0.9) v4 (0.9) </td <td>Add Use reference volume Weight Determine volume from current</td> <td>Hypothesis testing Multicore Run test Auto save Theories Specifications Selected All Selected All All</td>	Add Use reference volume Weight Determine volume from current	Hypothesis testing Multicore Run test Auto save Theories Specifications Selected All Selected All All
Data	Remove (A, D): 0 Load (B, C): 0 (B, D): 0 (B, D): 0 Save (B, E): 0 (B, D): 0 V	Set Set Set Set Volume manually	O Bayes Factor Image: Bayes p & DIC O Frequentist All Gibbs sampling: Sample size: Burn-in size: 1000 Chi-bar squared weights simulation sample size: Random number seed:
Description Description <thdescription< th=""> <thdescription< th=""></thdescription<></thdescription<>	Supermajority O 9 Change Ostrance-based: Max-distance (U): Supremum O.5 Change Otty-block O.5 Change	Over last figure Color scheme: Default	1000 Change 1 Set Reserver: CPT-RC (Set 1/bayses-p/5000/1000/1) (major) CPT-RC (Set 2/bayses-p/5000/1000/1) (major) CPT-RC (Set 3/bayses-p/5000/1000/1) (major) CPT-RC (Set 5/bayses-p/5000/1000/1) (major) CPT-RC (Set 5/bayses-p/5000/1000/1) (major) CPT-RC (Set 5/bayses-p/5000/1000/1) (major) CPT-RC (Set 5/bayses-p/5000/1000/1) (major) CPT-RC (Set 5/bayses-p/5000/1000/1) (major) CPT-RC (Set 5/bayses-p/5000/1000/1) (major)
Clear v	O Euclidean 0.5 Change Random preference:	File Load Options Save About	CPT+KT (Set 9/bayes=p/5000/1000/1) (major) CPT+KT (Set 9/bayes=p/5000/1000/1) (major) CPT+KT (Set 10/bayes=p/5000/1000/1) (major) CPT+KT (Set 11/bayes=p/5000/1000/1) (major) CPT+KT (Set 11/bayes=p/5000/1000/1) (major) CPT+KT (Set 10/bayes=p/5000/1000/1) (major)

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "OG" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

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	Home	Layout	Tables	Charts	Sinaru	art For	mulas		SVIEW										-
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	A1	: 0	🔘 (= f.	× Data set															
	А	В	C	D	E	F	G	Н		J	K	L	M	N	0	Р	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
4	Specificatio	n major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference 1	olume																	
6	Lambda	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7	U																		
8	N																		
9	Random se	e(1	1	1	1	. 1	. 1	1	1	1	1	1	. 1	1	1	. 1	1	1	1
10	Gibbs samp	le 5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17	v18
13	Vertex weig	ht																	
14	Vertex L/U																		
15	Likelihood ı	atio																	
16	p-value	0	0	0	0	0	0 0	0	0	0	0	0	0	0	0	0	0	0	0
17	Warning																		
18	DIC	106.457	130.663	171.063	138.798	260.11	276.25	397.558	397.55	518.875	567.52	98.4002	147.045	147.038	268.37	268.362	389.67	405.81	373.545
19	Prior volum	e 1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10
20	Posterior vi	9.60E-36	9.19E-42	7.90E-52	8.59E-44	4.20E-60	4.12E-64	2.01E-80	2.01E-80	9.85E-97	7.60E-109	9.68E-34	7.47E-46	7.47E-46	3.65E-62	3.65E-62	1.79E-78	1.75E-82	1.91E-74
21	Bayes facto	r 1																	
22	Bayes facto	r 2																	
23	Bayes facto	r 9.60E-26	9.19E-32	7.90E-42	8.59E-34	4.20E-50	4.12E-54	2.01E-70	2.01E-70	9.85E-87	7.60E-99	9.68E-24	7.47E-36	7.47E-36	3.65E-52	3.65E-52	1.79E-68	1.75E-72	1.91E-64
24	Weighted p	- 0	0	0	0	0	0 0	0	0	0	0	0	C	0	C	0	0	0	0
25	Weighted D	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584	99.584
26	Weighted B	a 4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25
27																			
28																			
29																			
30																			
1		4 5 51	PT KT 9 cm	. + .		1	1	1	1		_								
											-		_						
	Nor	mai view	Ready								Sum=0		-						

The weighted p-values are in row 24 of the spreadsheet. Notice the same pvalue repeats for all the columns "B" through "W" listed as "Set 1"—this is the Bayes p value for participant 1, listed under "0.90 Supermajority" and "KT" in Table 1 of QTBC2. Notice the same holds true for all the columns "X" through "AS" listed as "Set 2", for participant 2, and so on. From this file, column "KT" under "0.90 Supermajority" of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

The weighted DIC values are in row 25 of the spreadsheet. Again, notice the same DIC value repeats for all the columns "B" through "W" listed as "Set 1"—this is the DIC value for participant 1, listed under "0.90 Supermajority" and "KT" in Table 2 of QTBC2. Notice the same holds true for all the columns "X" through "AS" listed as "Set 2", for participant 2, and so on. From this file, column "KT" under "0.90 Supermajority" of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

This completes the analysis for Cash I data for the Bayes p & DIC test of CPT- $\mathcal{K}T$.90-supermajority probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes p & DIC test of CPT- $\mathcal{K}T$, but now with

a random preference probabilistic specification in the following two sections, L.2.7 and L.2.8.

<u>L.2.7 Probabilistic specification: Cash I, CPT-KT, Random</u> <u>Preference</u>

If continuing from section L.2.6, click "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes p & DIC test of CPT-KT.90-supermajority probabilistic specification from the QTEST interface.

nble pairs	Theories				Pafaranca valuma	Hypothesis testing		Multicore
Number of gambles: 5	CPT-KT	∧ Vert v1 (0.	ices:	Add		R	un test	Auto save
(C) (C) (C)	Set	√2 [0.9 √3 [0.9 √4 [0.9 √5 [0.9 √6 [0.9	9] 9] 9] 9] 9]	Remove	Weight	Theories Selected All	Specifications -	Data sets O Selecte O All
(,D) 10 (,E) 20 (,E) 2	All Dup	licate (A,B) (A,C): emove (A,D): (A,E): (A,E):	9]	Set	Determine volume from current settings: Set	Type of test Bayes Freque	Factor Bay entist All	yes p & DIC
~	s	ave (B,D): (B,E): (C,D):	0 0 0		Set volume manually	Gibbs sampli Sample	ng: size: 5000	Change
	Deckebilie					Burn-in s	size: 1000	Change
Sample size N: Observations 20 (A, B): 11,9	Aggrega	tion-based:	Supermajority level: 0.9 Change		Visualize Over last figure	Chi-bar squared simulation sam	l weights F ple size: s Change	Random number seed: 1 Se
(A,D): 2,10 (A,E): 2,18	Овог	la score			Color scheme:	Results:		
Enter (B,C): 10,10 (B,D): 8,12 (B,E): 2,18 (B,E): 2,18	Distanc	e-based:	Max-distance (U):		Default ~	CPT-KT (Set 1/ CPT-KT (Set 2/ CPT-KT (Set 3/	bayes-p/5000/1000/ bayes-p/5000/1000/ bayes-p/5000/1000/	1) (major) 1) (major) 1) (major)
(C,D): 14,6 (C,E): 5,15 (D,E): 7,13	⊖ City	/-block	0.5 Change		Close all figures	CPT-KT (Set 4/ CPT-KT (Set 5/ CPT-KT (Set 6/	bayes-p/5000/1000/ bayes-p/5000/1000/ bayes-p/5000/1000/	1) (major) 1) (major) 1) (major)
Clear	↓ O Euc	lidean	0.5 Change			CPT-KT (Set 7/ CPT-KT (Set 8/ CPT-KT (Set 9/	bayes-p/5000/1000/ bayes-p/5000/1000/ bayes-p/5000/1000/	1) (major) 1) (major) 1) (major)
Name Set 1	Random	preference:		Fil	e	CPT-KT (Set 10 CPT KT (Set 11)/bayes-p/5000/100	D/1) (major)
	O From	n file:	Load		Load Options	Table	Remove	Export

Whether the user is continuing from section L.2.2 or L.2.6, the QTEST interface should match the screenshot below.

QIEST							
Samble pairs	CPT-KT	Vertices:	Reference volur	ne	Hypothesis testing		Multicore
Number of gambles: 5 Chan	ge	1 [0.9]	Add Use referer	nce volume	R	un test	Auto save
(A,B) (A,C) (A,D) (A,D) (A,E)		4 [0.9] 5 [0.9]	Remove	ght	Selected	 Specifications Selected 	Data sets
(B,C) (B,D) None	Add				◯ All		All
(D,E) (C,D) (C,E) (D,E)	Duplicate (4 Remove (4 Load (5	A,B): 0 A A,C): 0 A,D): 0 A,E): 0 B,C): 0	Determine vo from current settings:	lume Set	Type of test Bayes Freque	Factor	yes p & DIC
~	Save (C	3,D): 0 3,E): 0 2,D): 0	Set volum	e manually	Gibbs samplin Sample s Burn-in s	ng: size: 5000 size: 1000	Change
Data	Probabilistic specifications		Figure		Chi-bar squared	weights F	Random number
Observations:	Aggregation-based:	Supermajority level:	Visual	ize	simulation samp	ole size:	eed:
20 (A,C): 4,16 (A,C): 4,16	Supermajority Barda score	0.9 Change	Over last	figure	1000	Change	1 Set
(A,E): 2,18 (A,E): 2,18	Dorda score		Color sche	me:	Results:		
(B,C): 10, 10 (B,D): 8,12 (B,E): 2,18	Distance-based:	Max-distance (U):	Default	~			^
Load (C,D): 14,6	⊖ Supremum	0.5 Change					
Save (C,E): 5,15 (D,E): 7,13	City-block	0.5 Change	Close all	figures			
Clear	✓ O Euclidean	0.5 Change					
Name Set 1	Random preference:		File				~
	O From file:	Load	Load	Options	Table	Remove	Export

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Mixture from vertices" under "Random preference:" is selected. \blacksquare \blacksquare \blacksquare \blacksquare \blacksquare \blacksquare \blacksquare

Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices:	Reference volume	Run test Auto save
(A,B) (A,C)	V2 V3	Remove Weight	Theories Specifications Data sets
(A,D) (A,E) (B,C)	V5 V6		Selected Selected Selected Selected Selected Selected
(B,D) None (B,E) (C,D) (C,E) (D,E) All	Add V7 Duplicate [A, B): 0 (A, C): 0 (A, C): 0 Remove (A, D): 0 (A, E): 0 (B, C): 0 Load (B, D): 0	Determine volume from current settings: Set	Type of test O Bayes Factor Bayes p & DIC Frequentist All
~	(0, 0), 0 (B, E); 0 (C, D); 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations: Sample size N: (A,B): 11,9 (A,C): 4,16 (A,C): 4,16	O Supermajority 0.9 Char	el: Visualize Ige Over last figure	simulation sample size: seed: 1000 Change 1 Set
(A, J): 2, 10 (A,E): 2,18 (B,C): 10,10	Distance-based:	Color scheme:	Results:
(B,D): 8,12 (B,E): 2,18 (C,D): 14,6 (C,D): 14,6	Max-distance (U) Supremum 0.5 Char	nge	
Clear	City-block 0.5 Char Euclidean 0.5 Char	nge Close all figures	
Name Set 1	Random preference:	File	v
	From file: Los Mixture from vertices Sa	Ad Options	Table Remove Export
		Save About	Details Clear

L.2.8 Hypothesis Testing: Cash I, CPT-KT, Random Preference

We are now ready for the Bayes p & DIC test of $CPT \ KT$ random preference probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



mble pairs	Theories				Hypothesis testing		
Number of cambles: 5 Change	CPT-KT	Vertices:		Reference volume		2	Multicore
Change		v1	Add.	Use reference volume		Run test	Auto save
		v2 v3	Remo	Weight	Theories	Specifications	Data sets
D) Set	~	v4	- Come	Weight	Selected	Selected	O Selecte
,C)	Add	v6					
D) None		V/ (A B): 0	•		Turn of text		
D) All	Duplicate	(A,C): 0	<u> </u>	from current	Type of test		0.010
.E)	Remove	(A,D): 0 (A,E): 0	Set.	settings: Set	O Baye	s Factor Bay	esp&DiC
	Load	(B,C): 0 (B,D): 0				ienust Co	`
	Save	(B,E): 0	~	Set volume manually	Gibbs samp	ling:	Change
~		(C,D): U			Sample	size: 5000	Change
ata	-Probabilistic specificati	005		- Figure	Dum-m	size. 1000	Change
ala	Aggregation-based:	0113		riguie	Chi-bar square	d weights R	andom number
					STOLEN SAL	111110 51210 51	
Observations: Sample size N: (A B): 11.9	O Suparmajority	Supermajority le	vel:	Visualize	sinulation sal	npre size. st	eeu.
Observations: Sample size N: (A,B): 11.9 20 (A,C): 4.16	⊖ Supermajority	Supermajority le	vel: inge	Visualize Over last figure	1000	Change	1 Set
Observations: Sample size N: (A, D): 11.9 20 (A, C): 4, 16 (A, D): 2, 18 (A, E): 2, 18	O Supermajority	Supermajority le	wel: inge	Visualize Over last figure Color scheme:	1000 Results:	Change	1 Set
Apple size N: (A, D): 11.9 20 (A, C): 4, 16 (A, D): 2, 18 (A, D): 2, 18 Enter (B, C): 10, 10 (B, C): 10, 10 (B, C): 2, 12	 Supermajority Borda score Distance-based: 	Supermajority le 0.9 Cha Max-distance (U	vel: inge	Visualize Over last figure Color scheme: Default	1000 Results:	Change	1 Set
Sample size N: (A. E): 41.6 20 (A. C): 4.16 (A. D): 2.18 (A. C): 4.16 (A. C): 4.16 (A. C): 2.18 Enter (B. D): 6.12 (B.D): 6.12 (B.D): 6.12 Load (C. D): 41.6	Supermajority Borda score Distance-based: Supremum	Supermajority le 0.9 Cha Max-distance (U 0.5 Cha	vel: inge J):	Visualize Visualize Visualize Over last figure Color scheme: Default V	1000 Results:	Change	1 Set
Sample size N: (A.B) 11.9 ^ 20 (A.C): 4.16 ^ (A.C): 4.16 (A.C): 4.16 ^ (A.D): 2.18 (B.C): 10.10 (B.D): 8.12 (B.D): 8.12 (B.D): 8.12 (B.D): 5.15 (C.D): 14.6 (C.D): 14.6 (C.D): 5.15	Supermajority Borda score Distance-based: Supremum	Supermajority le	vel: inge J): ange	Visualize Over last figure Color scheme: Default	1000 Results:	Change	1 Set
Sample size N: A.B. 11.9 A.C.: 4.16 20 (A.C.: 4.16 (A.C.: 4.16 (A.D.: 2.18 (B.C.: 10.10 (B.C.: 10.10 (B.D.): 6.12 (B.D.: 6.12 (B.C.: 10.10 (B.D.: 6.12 (B.D.: 5.15 (C.E.): 5.15 (D.E.; 7.13 (D.E.; 7.13) (D.E.; 7.13)	 Supermajority Borda score Distance-based: Supremum City-block 	Supermajority le 0.9 Cha Max-distance (U 0.5 Cha 0.5 Cha	vel: inge J): ange	Visualize Over last figure Color scheme: Default Close all figures	Results:	Change	1 Set
Sample size N: (A.B): 11.9 (A.C): 4.16 20 (A.C): 4.16 (A.C): 4.16 (A.D): 2.18 (B.C): 10.10 (B.D): 8.12 Load (B.D): 8.12 (C.D): 14.6 (C.D): 14.6 (C.E): 5.15 (D.E): 7.13 Clear (C.E): 7.13 (C.E): 7.13	Supermajority Borda score Distance-based: Supremum City-block Euclidean	Supermajority le 0.9 Cha Max-distance (U 0.5 Cha 0.5 Cha 0.5 Cha	vel: inge J): ange ange	Visualize Over last figure Color scheme: Default Visualize Close all figures	Results:	Change	1 Set
Sample size N: (A.E): 119 (A.C): 4.16 20 (A.C): 4.16 (A.C): 4.16 [A.E): 218 (A.E): 2.18 (B.C): 10.10 [B.D]: 8.12 (B.D): 8.12 (B.D): 8.12 Load (C.D): 14.6 (C.E): 5.15 [Clear (C.E): 7.13 (C.E): 7.13	Supermajority Borda score Distance-based: Supremum City-block Euclidean Random preference:	Supermajority le 0.9 Cha Max-distance (U 0.5 Cha 0.5 Cha 0.5 Cha	vel: inge J): ange ange	Visualize Over last figure Color scheme: Default Visualize	Results:	Change	1 Set
Sample size N: (A.B): 11.9 (A.C): 4.16 20 (A.C): 4.16 (A.C): 4.16 (A.D): 2.18 (B.C): 10.10 (B.C): 10.10 (B.D): 8.12 (B.D): 8.12 (C.D): 14.6 Clear (C.E): 7.13 (C.E): 7.13 Clear v v	Supermajority Borda score Distance-based: Supremum City-block Euclidean Random preference: From file:	Supermajority le	vel: inge J): ange ange bad	Visualize Over last figure Color scheme: Default Close all figures File Load Options	Results:	Change	1 Set

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".

Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test
	Please wait

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

Q TEST			- 🗆 X
- Comble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices: V1 Ad V2 V3 Part	d Reference volume	Run test Multicore Run test Auto save Theories Specifications Data sets
(A.D) (A.D) (B.C) (B.D) None		vveign	Selected Selected Selected All All All
(B,E) (C,D) (C,E) (D,E)	Duplicate (A, B): 0 A Remove (A, D): 0 (A, D): 0 Load (B, C): 0 Set	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	(b, D) : 0 (B, E): 0 (C, D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Bandom number
Observations: Sample size N: (A E): 11.9 (A C): 4.15 (A C): 4.15 (A D): 2.18 (A E): 2.18 Enter (B C): 10.10	Aggregation-based: Supermajority level: Borda score Distance-based:	Visualize Visualize Visualize Visualize Color scheme: Oxford	Clin-bar squareu weights seed: simulation sample size: seed: 1000 Change 1 Set Rooffs: IOPTEKT (Set 1/bayes-p/5000/1000/11 (moture)
(B D): 8.12 (B E): 2,18 (C D): 14.6 (C E): 5,15 (D E): 7,13	Max-distance (U): Supremum 0.5 Change City-block 0.5 Change	Close all figures	CPT-KT (Set 2/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 3/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 4/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 5/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 5/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 7/bayes-p/5000/1000/1) (mixture)
Clear	Euclidean 0.5 Change		CPT-KT (Set 8/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 9/bayes-p/5000/1000/1) (mixture)
Name Set 1 V	Random preference: O From file: Load	File Load Options	CPT-KT (Set 10/bayes-p/5000/1000/1) (mixture)
	Mixture from vertices Save	Save About	Details Clear

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.

QTEST			-
amble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices:	Add	Run test Auto save
(A,B) (A,C) (A,D) (A,E) (Set	V2 V3 V4 V5	Remove Weight	Theories Specifications Data sets Selected Selected Selected
B,C) (B,D) None	Add v6 v7 v		
B.E) (C.D) (C.E) D,E)	Duplicate (A, B): 0 A Remove (A, C): 0 (A, D): 0 (A, E): 0 Load (B, C): 0 (B, C): 0 (B, C): 0	Set Determine volume from current settings: Set	Type of test O Bayes Factor Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications	Figure	Obites and width Dedage and be
Observations:	Aggregation-based:	Visualize	simulation sample size: seed:
Sample size N: (A.B): 11,9	O Supermajority	Over last figure	1000 Change 1 Set.
20 (A,C): 4,16 (A,D): 2,18	O Borda score	Cales askesses	Paculte
Enter (A,E): 2,18 (B,C): 10,10	Distance-based:	Default	CPT-KT (Set 1/baves-p/5000/1000/1) (mixture)
(B,D): 8,12 (B,E): 2,18	Max-distance (U):	Delault	CPT-KT (Set 2/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 3/bayes-p/5000/1000/1) (mixture)
(C,D): 14,6 (C,D): 5,15	O Supremum 0.5 Change		CPT-KT (Set 4/bayes-p/5000/1000/1) (mixture)
(D,E): 7,13	O City-block 0.5 Change	Close all figures	CPT-KT (Set 5/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 6/bayes-p/5000/1000/1) (mixture)
Clear	O Euclidean 0.5 Change		CPT-KT (Set 7/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 8/bayes-p/5000/1000/1) (mixture)
¥	- Pandam proference:	File	CPT-KT (Set 9/bayes-p/5000/1000/1) (mixture) CPT-KT (Set 10/bayes-p/5000/1000/1) (mixture)
Name Set 1 ~	From file:	Land	CPT KT /Sot 11/bayos a/5000/1000/1) (mixturo)
		Load Options	Table Remove Export
	Carrow Ca		

The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

•	•								CP	T_KT_Mixe	d.csv								
2	1	8	🔏 🗗 🕷	👌 🎻 🞽	∩ • @ •	Σ • 🛃	• 🍸 • [🌆 🛅 🛓	100%	0						Q- (Se	arch in Shee	et	
	A Home	Layout	Tables	Charts	Smart/	Art For	mulas I	Data R	eview										~ \$·
	Edit			Font			Aligr	iment		N	umber		For	mat		Cells		Themes	
	3 - 💽	Fill * Cal	bri (Body)	v 12	• A• A	-	ab	- 📆 wr	ap Text 👻	General		•	- N	ormal] 🚬 🖉	💁	-	Aab-	-
Pa	aste 🥥	Clear * B	ΙU		<u>∕</u> • <u>A</u>	•	= = 4	÷	Merge -	🥞 🔻 %	°.0 .00	00 ↓.0 Condit Forma	ional B	əd	in U	sert Delet	e Format	Themes 4	Aa≁
	A1	: 0	🔿 (= f	x Data se	t								•						
1	I A	B	C	D	E	F	G	Н	1	J	K	L	M	N	0	P	Q	R	S =
	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
4	Specificatio	on mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture
5	Reference	volume																	
6	Lambda																		
7	U																		
8	N																	-	
9	Random se	1 5000	1	1	1	1	1	1	1	1	1	1	1	1	1		. 1	1	1
10	GIDDS sam	pic 5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-In siz	e 1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	apt .	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI I
10	Vertex Wel	Bur																	
10	Vertex L/O																		
15	Likelihood	0.0619	0.3599	0.360	0.0018	0 4094	0.0173	0.6933	0.2764	0 4193	0 2702	0.1463	0.0274	0.673	0.2154	0.3939	0.0356	0.225	0.517
17	Warning	0.0018	0.3366	0.309	0.0018	0.4364	0.0172	0.0622	0.3764	0.4102	0.3792	0.1402	0.0374	0.072	0.3134	0.3636	0.0250	0.335	0.517
18	DIC	24 0209	19 22/15	17 5649	42 2090	14 0973	31 4600	11 6613	17 5947	15 7006	16 7043	22 3079	27 41 35	11 91/6	16 6007	16 3914	32 150	17 0157	13 0951
10	Prior volum	24.5200	10.2245	17.5045	42.3003	14.5675	51.4055	11.0015	17.5647	15.7500	10.7543	22.3370	27.4155	11.0140	10.0337	10.3014	52.155	17.5157	13.5651
20	Posterior	olume																	
21	Bayes facto	or 1																	
22	Bayes facto	nr 2																	
23	Bayes facto	or exact																	
24	Weighted	o-value																	
25	Weighted	DIC																	
26	Weighted	Baves factor																	
27																			
28																			
29																			
30																			
31		_					1		1				1				1		
		C	PT_KT_Mixe	d.csv +															
	NO	rmal View	Ready								Sum=0		•						,

The p-values are in row 16 of the spreadsheet. The p-value in column "B" listed as "Set 1" is the Bayes p value for participant 1, listed under "Mixture" and "KT" in Table 1 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "KT" under "Mixture" of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

The DIC values are in row 18 of the spreadsheet. Again, the DIC value in column "B" listed as "Set 1" is the DIC value for participant 1, listed under "Mixture" and "KT" in Table 2 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "KT" under "Mixture" of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

This completes the analysis for Cash I data for the Bayes p & DIC test of CPT- $\mathcal{K}T$ random preference probabilistic specification.

L.3.1 Theory and Vertex: Cash I, CPT-GE

Under "Theories", select "Load...".

ble pairs	meones	Madiana	Reference volume	Hypothesis testing	Multicore
lumber of gambles: 5 Change	^	Venices:		Run test	Auto save
B) C) D) E) C) D) E) D) E) D) All	Add Duplicate	Add Removed and Add Removed	Ve Weight Determine volume from current	Theories Specifications Selected All Type of test	Data sets Selecter All
ta Sample size N. 20	Remove Load Save Probabilistic specification Aggregation-based: © Supermajority © Borda score	s Supermajority level: 0.5 Change	Figure Figure Over last figure	Gibbs sampling: Sample size: 5000 Burn-in size: 1000 Chibas squared weights simulation sample size: 1000 Change	Change Change Random number seed: 1 Set
Enter	Distance-based:	Max-distance (U): 0.5 Change	Color scheme: Default v	Results:	^
Save Clear	City-block	0.5 Change 0.5 Change	Close all figures		
Name Default ~	Random preference:	Load	File Load Options	Table Remove	Export

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "TheoriesVertices" folder and open "Vertices_CPT_GE_Cash1.csv". In the dialog box, type "CPT-GE" and select "OK".

🛑 😑 🔘 Theory	
Entername for theory:	
CPT-GE	1
OK Cancel	

On the QTEST interface there should now be a list of 11 vertices for CPT-GE under "Theories". Verify your screen matches the screenshot below.

Great			
Samble pairs 5 Change (A, C) (A, C) (A, C) (A, C) (B, C) (B, C) (B, C) (C, C) (C, C) (C, C) (C, C) (C, E) (D, E) None	CPT-GE Vertices: V[0.5] Add V [0.5] V [0.5] <t< td=""><td>A Use reference volume Weight Determine volume from current settings: Set</td><td>Hypothesis testing Run test Theories Selected All Type of test Bayes Factor Bayes p & DIC Cibe requentist All Cibe sempling:</td></t<>	A Use reference volume Weight Determine volume from current settings: Set	Hypothesis testing Run test Theories Selected All Type of test Bayes Factor Bayes p & DIC Cibe requentist All Cibe sempling:
Data Descriptions: Description	Save (E, E): 0 (C, D): 0 (C, D): 0 Probabilistic specifications Aggregation-based: © Supermajority 0.5 Change	Figure Visualize Over last figure Color scheme:	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
Load Save	Distance-based: Max-distance (U): O Supremum 0.5 City-block 0.5 Change O Euclidean 0.5	Default ~	^
Name Default ~	Random preference: O From file: Load	File Options	Table Remove Export
	O Mixture from vertices Save	Save About	Dataila

nder "Data", se	elect "Load…".				
ITEST					- 🗆
mble pairs	Theories			Hypothesis testing	
Number of nambles: 5	CPT-GE	Vertices:	Reference volume	Durat	Multicore
	lange	v1 [0.5] ^ Ad	dd Use reference volume	Run u	Auto save
A,B) A,C)		v3 [0.5] Rei	move Weight	Theories	pecifications Data sets
A,D) Se	et 🗸	v4 [0.5] v5 [0.5]	rroigin	Selected	Selected
B,C)	Add	v6 [0.5]		⊖ All (
3,D) No 3,E) No	Durliaste	(A B): 0	Determine unlume	-Type of test	
C,D) A	All Duplicate	(A,C): 0	from current	Bayos Eas	
D,E)	Remove	(A,D): 0 Se	t settings: Set	Dayes r ac Erequentis	t OAll
	Load	(B,C): 0 (B,D): 0		Griedania	. 0/1
	Save	(B,E): 0	Set volume manually	Gibbs sampling:	E000 Change
*		(C,D): U		Sample size	: 5000 Change
	Drehebilistis sessificati			Bum-in size:	1000 Change
Jata	Aggregation-based	uns	Figure	Chi-bar squared wei	ghts Random number
Observations: Sample size N		Supermajority level:	Visualize	simulation sample s	IZE: SEED:
Oumple Size IV.	 Supermajority 	0.5 Change	Over last figure	1000 Cł	nange 1 Set
20	O Borda score		Color scheme:	Results:	
Enter	Distance-based:		Default		^
Land		Max-distance (U):	2 onder		
Ludu	 Supremum 	0.5 Change			
Save	City-block	0.5 Change	Close all figures		
Clear	O Euclidean	0.5 Change			
News	Random preference:		File		~
Delaut	From file:	Load	Load Options	Table	Remove Export

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "DataSets" folder and open "Cash1.txt".

承 QTEST			- 🗆 X
Gamble pairs Number of gambles: 5 (A. B) (A. C) (A. D) (A. E) (B. C) Set	Vertices: Add Vertices: Vertices: V2 (0.5) Add V2 (0.5) Rem V2 (0.5) Vertices: V3 (0.5) Vertices: V4 (0.5) Vertices: V3 (0.5) Vertices: V4 (0.5) Vertices: V5 (0.5) Vertices:	Reference volume Use reference volume Weight	Hypothesis testing Run test Theories Selected All All Hypothesis testing Data sets Selected All All All
(B.D) (B.E) (C.D) (C.E) (D.E) (D.E)	Duplicate (A (2): 0 Remove (A (2): 0 (A (2): 0 (A (2): 0 (A (2): 0 (B (2): 0 (B (2): 0 (B (2): 0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling:
Data Data Sample size N (A B) 119 (A C) 4 16	Save (C.D): 0 Probabilistic specifications Aggregation based: Supermajority level: Supermajority 0.5 Channe	Figure Visualize Over last figure	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1
20 (A, D) 2, 18 Enter (B, C) 10, 10 (B, C) 10, 10 (B) 8, 12 (B, C) 10, 10 (B) 8, 12 (B, C) 10, 10 (B) 8, 12 (B, C) 10, 10 (B, C) 10, 10 (B, C) 10, 14, 6 (C, D) 14, 6 (C, E) 5, 15 (D, E): 7, 13	Borda score Distance-based. Max-distance (U): Supremum 0.5 Change O City-block 0.5 Change	Color scherne: Default ✓	Results:
Clear Name Set 1	Euclidean 0.5 Change Random preference:	File Load Options Save About	Table Remove Export Details Clear

Under "Data" notice the "Observations:" list has now been populated:

Under "Data", select the dropdown menu next to "Name..." to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

L.3.3 Probabilistic specification: Cash I, CPT-GE, 0.50-Majority/modal choice

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected and that the "Supermajority level:" is set to "0.5".

able pairs	Theories		Hypothesis testing
	CPT-GE Vertices:	Reference volume	Multicore
Change	v1 [0.5]	Add Use reference volume	Run test Auto save
.8) ^	v2 [0.5] v3 [0.5]	Pamova Wainht	Theories Specifications Data sets
,D) Set	v4 [0.5]	veight	Selected Selected Selected
,E) ,C)	Add v6 [0.5]	v	
E)	Duplicate (A,B): 0	Determine volume	Type of test
,D) ,E)	(A,C): 0 (A,D): 0	from current	Bayes Factor Bayes p & DIC
,E)	(A,E): 0	Set Set	Frequentist All
	Load (B,D): 0		Gibbs sampling:
~	Save (B,E): 0 (C,D): 0	✓ Set volume manually	Sample size: 5000 Change
			Burn-in size: 1000 Change
ata	Probabilistic specifications	Figure	
		i iguio	Chi har aquarad waighta Dandam number
Observations:	Aggregation-based:	. Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Observations: Sample size N: (A,B): 11.9	Aggregation-based: Supermajority lev	vel: Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Observations: Sample size N: (A, B): 11.9 20 (A, C): 4,16 (A, D): 2,18 (A, C): 4,16	Aggregation-based: Supermajority levelose of the second s	el: Vísualize Inge Over last figure	Chi-bar squared weights simulation sample size: seed: 1000 Change 1 Se
Observations: Sample size N: (A, B): 11,9 20 (A, C): 4, 16 (A, C): 2, 18 (A, E): 2, 18 Enter (B, C): 10, 10	Aggregation-based: Supermajority le Supermajority 0.5 Cha	el: Visualize Ige Color scheme:	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Se Results:
Observations: Sample size N: (A.B) 11,9 (A.C) 4,16 (A.C) 2,18 (A.C) 2,18 (A.E) 2,18 (B.C) 10,10 (B.C) 10,10 (B.C) 8,12 (B.C) 12	Aggregation-based Supermajority le Supermajority 0.5 Cha Distance-baset Max-distance-baset	el: Visualize igge Color scheme: Default	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Se Results:
Sample size N: Observations: 20 (A,C): 4, 16 (A,D): 2, 18 (A,D): 2, 18 Enter (B,C): 10, 10 (B,D): 8, 12 (B,D): 8, 12 (C,D): 14, 6 (C,D): 14, 6	Aggregation-based: Supermajority B Supermajority 0.5 Cha Distance-based Supremum 0.5 Cha	el: Visualize Visualize Over last figure Color scheme: Default V	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Se Results: ^
Cobservations: Sample size N: (A.E): 11.9 (A.C): 4.16 (A.C): 2.18 (A.C): 2.18 (B.C): 2.18 (B.C): 0.10.10 (B.D): 8.12 Load (C.D): 14.6 Save (D): 7.13	Aggregation-based: Supermajority levelocity of the score 0.5 Chamber of the score 0.5 Chamber of the score 0.5 Chamber of the score of	el: Visualize gg Visualize Over last figure Color scheme: Default Close all figures	Chi-bar squared weights Random number simulation sample size: Seed: 1000 Change 1 Se Results: ^
Conservations: Sample size N: (A.B): 11:9 20 (A.C): 4:16 (A.C): 2:18 (A.C): 2:18 (B.C): 10:10 (B.C): 10:10 (B.D): 8:12 (B.C): 10:10 (B.C): 10:10 (B.C): 2:18 (C.C): 5:15 (C.C): 7:13	Aggregation-based: Supermajority levelocity of the score 0.5 Char Distance-based: Supremum 0.5 Char City-block 0.5 Char Euclidean 0.5 Char	el: Visualize Visualize Color scheme: Default v	Chi-bar squared weights Random number simulation sample size: seed.
Deservations: 20 (A, C); 4, 16 (A, C); 4, 16 (A, C); 4, 16 (A, C); 4, 16 (A, C); 2, 18 (B, C); 10, 10 (B, C); 10, 10 (B, C); 10, 10 (C, C); 12, 16 (C, C); 12, 16 (C, C); 12, 16 (C, C); 14, 16 (C, C); 14, 16 <t< td=""><td>Aggregation-based: Supermajority levelocity of the score 0.5 Char Distance-baset: Supremum 0.5 Char City-block 0.5 Char Euclidean 0.5 Char Random preference:</td><td>el: ige Visualize Visualize Over last figure Color scheme: Default Visualize Close all figures File</td><td>Chi-bar squared weights Random number simulation sample size: seed.</td></t<>	Aggregation-based: Supermajority levelocity of the score 0.5 Char Distance-baset: Supremum 0.5 Char City-block 0.5 Char Euclidean 0.5 Char Random preference:	el: ige Visualize Visualize Over last figure Color scheme: Default Visualize Close all figures File	Chi-bar squared weights Random number simulation sample size: seed.
Sample size N: Observations: 20 (A,C): 4,16 (A,C): 4,16 (A,C): 2,18 (B,C): 10,10 (B,C): 10,10 (B,C): 10,10 (B,C): 10,10 (C,C): 10,10 (B,C): 2,18 (C,C): 10,10 (B,C): 10,10 (C,D): 14,6 (C,C): 7,13 Clear V Name Set 1	Aggregation-based: Supermajority levelocity of the score 0.5 Char Distance-baset: Supremum 0.5 Char City-block 0.5 Char Euclidean 0.5 Char Random preference: From file:	el: ige Visualize Visualize Over last figure Color scheme: Default Close all figures File ad Options Options	Chi-bar squared weights saed: Simulation sample size: Seed: 1000 Change 1 Se Results: Table Remove Export

L.3.4 Hypothesis Testing: Cash I, CPT-GE, 0.50-Majority/modal choice

We are now ready for the Bayes p & DIC test of CPT-GE.50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

承 QTEST					- 🗆 ×
Gamble pairs Sector Sector Number of gambles: 5 Change (A, D) (A, D) (A, D) (A, D) (A, D) Set	Vertices: Vertices: v1 (0.5) v3 (0.5) v3 (0.5) v4 (0.5) v5 (0.5) v6 (0.5)	Add Remove	Reference volume	Hypothesis testing Run test Theories Selected Selected Selected	Multicore Auto save Data sets Selected
(B, C) (B, D) (B, E) (C, D) (C, E) (D, E) (D, E)	Add Vol [0:5] Duplicate (A.B): 0 (A.C): 0 (A.C): 0 Remove (A.D): 0 (A.E): 0 (B.C): 0 Load (B.D): 0	> Set	Determine volume from current settings: Set	Type of test Bayes Factor	Bayes p & DIC
	(B,E): 0 (C,D): 0	~	Set volume manually	Sample size: 5000 Burn-in size: 1000	Change
Data Observations: Sample size N: (A E): 41.9 20 (A D): 2.18 (A E): 2.18 (A E): 2.18 Enter (B C): 10.10 (B): 8.12 (B D): 8.12 Load (C D): 44.6 (C E): 5.15 (D E): 7.13 Clear (D E): 7.13	Probabilistic specifications Aggregation-based: Supermajority Ø Supermajority 0.5 Distance-based: Max-distance-based: Distance-based: Max-distance-based: O Supermum 0.5 O City-block 0.5 O Euclidean 0.5 Random preference: Random preference:	ty level: Change e (U): Change Change	Figure Visualize Vover last figure Color scheme: Default Volose all figures File	Chi-bar squared weights simulation sample size: 1000 Change Results:	Random number seed: 1 Set
Name Set 1	O From file:	Load	Load Options	Table Remove	Export
	O Mixture from vertices	Save	Save About	Details Clear	

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".

承 QTEST			- 🗆 X
Gamble pairs Gamble pairs 5 Change (A.B) (A.C) (A.D) (A.D) (A.D) (A.D) Set (B.C) (B.C) None None None	Vertices: V1 (0 5) V2 (0 5) V3 (0 5) V4 (0 5) V5 (0 5) V6 (0 5) V6 (0 5) V6 (0 5) V7 (0 5)	Add Reference volume Use reference volume Weight	Hypothesis testing Run test Auto save Theories Selected All All All All All
(B,E) (C,D) (C,E) (D,E)	Duplicate (A, B): 0 ^ (A, C): 0 (A, D): 0 (A, D): 0 (A, D): 0 (A, D): 0 (A, D): 0 (A, D): 0 (B, D): 0 (B, D): 0 (B, D): 0 (C, D): 0 V	Set Determine volume from current settings: Set Set Set volume manually	Type of test O Bayes Factor Frequentist Gibbs sampling: Sample size: 5000 Charge
Data Data Observations: Sample size N: (A, D): 11,9 20 (A, C): 4, 16 (A, D): 2, 18 (A, D): 2, 18	Probabilistic specifications Aggregation-based: Supermajority level: Dorda score O.5 Change	Figure Visualize Over last figure Color scheme:	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Results: Set
(B, C): 10, 10 (B, D): 8, 12 (B, E): 2, 18 (C, E): 5, 15 (C, E): 5, 15 (D, E): 7, 13 Clear	Distance-based: Max-distance (U): O Supremum 0.5 Change O City-block 0.5 Change O Euclidean 0.5 Change	Close all figures	^
Name Set 1	Random preference: Load From file: Load O Mixture from vertices Save	File Load Options Save About	Table Remove Export Details Clear

Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

▲ QTEST			- 🗆 X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-GE Vertices:	Add	Run test Auto save
(A,B) (A,C) (A,D) (A,E) (B,C)	V2 [0.5] v3 [0.5] v4 [0.5] v5 [0.5] v6 [0.5]	Remove Weight	Theories Specifications Data sets Selected Selected Selected All All All
(B.D) None (B.E) (C.D) All (C.E) (D.E)	Add V7 [0.5] V Duplicate (A.B): 0 A Remove (A.D): 0 (A.D): 0 (A.E): 0 (B.C): 0 (A.D): 0	Determine volume from current settings: Set	Type of test Bayes Factor
~	Load ((6,0): 0 (8,5): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications	Figure	Chi ba a successful wights
Observations:	Aggregation-based:	Visualize	simulation sample size: seed:
Sample size N: (A,B): 11.9 (A,C): 4.16	Supermajority 0.5 Change	Over last figure	1000 Change 1 Set
20 (A,D): 2,18 (A,E): 2,18	O Borda score	Color scheme:	Resulte
Enter (B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U)	Default ~	CPT-GE (Set 1/bayes-p/5000/1000/1) (major)
Load (B.E): 2,18 (C.D): 14.6	O Supremum 0.5 Change		CPT-GE (Set 2/bayes-p/5000/1000/1) (major) CPT-GE (Set 3/bayes-p/5000/1000/1) (major)
Save (C,E): 5,15 (D,E): 7,13	City-block 0.5 Change	Close all foures	CPT-GE (Set 4/bayes-p/5000/1000/1) (major) CPT-GE (Set 5/bayes-p/5000/1000/1) (major)
Clear	C Euclidean 0.5 Change		CPT-GE (Set 7/bayes-p/500/1000/1) (major) CPT-GE (Set 8/bayes-p/5000/1000/1) (major) CPT-GE (Set 8/bayes-p/5000/1000/1) (major)
Name Set 1	Random preference:	File	CPT-GE (Set 10/bayes-p/5000/1000/1) (major) CPT-GE (Set 11/bayes p/6000/1000/1) (major)
	O From file: Load	Load Options	Table
	O Mixture from vertices Save	Save About	Details Clear

Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "GQ" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected "Details..." for each participant. The layout is a little different, however.

-	•••									1_GE50.	CSV								
2	1	8 🔿 🖯	😹 🗗 🕷	1 💉 🖄) • 🖂 •	Σ • 🛃	• 🍸 • 🛛	£ 🖻 🛃	100% -							Q- Sea	arch in Shee	rt	
Г	A Home	Layout	Tables	Charts	SmartA	rt For	mulas I	Data Re	view										~ ¢
	Edit			Font			Align	ment		Nu	imber		For	mat		Cells		Themes	
f	N 🗸 💽 F	ill 🔻 Cali	bri (Body)	v 12	• A• A•		ab-	🔻 🗒 Wra	ap Text *	General		•	- N	ormal		🚳	•	Aab-	Ŧ
Pa	aste 🥥	lear • B	ΙU		3 ▼ <u>A</u>		E = (e	2	Merge 👻	S • %	°.00.	00 0.0 Condit Format	ional B tting	ad	Ins	sert Delete	Format	Themes 1	Aa∙
	A1	≑ ⊗	💿 (• f.	× Data set															
1	A	В	С	D	E	F	G	Н	1	J	К	L	M	N	0	Р	Q	R	S
	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specificatio	n major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference v	olume																	
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random see	8 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs samp	k 5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
13	Vertex weig	ht																	
14	Vertex L/U																		
15	Likelihood r	atio																	
16	p-value	0.3088	0.2048	0.0664	0.1546	0.0058	0.0048	0.0002	0	0	0	0	0	0	0	0	0	0	0
17	Warning																		
18	DIC	17.3199	19.6095	25.1156	21.5019	36.4965	37.816	52.7995	52.7848	67.8022	75.7134	75.121	123.66	122.345	111.265	91.2414	83.2574	75.3462	67.417
19	Prior volum	e 0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vo	0.00467512	0.00048861	6.59E-06	0.00016155	1.79E-08	4.24E-09	4.69E-13	4.69E-13	5.19E-17	1.87E-19	3.77E-19	7.23E-31	3.05E-30	4.09E-27	3.90E-22	1.08E-19	2.99E-17	8.28E-15
21	Bayes facto	r 1																	
22	Bayes facto	1 20700	0.500007	0.00074540	0.465.406	4 005 05	4.245.05	4 005 40	4 005 40		4 005 40	2.005.40	7.445.00	0.405.07	4 4 9 5 9 4	2 005 40		2.005 4.4	0.405.40
23	Bayes facto	4.78732	0.500337	0.00674513	0.165426	1.83E-05	4.34E-06	4.80E-10	4.80E-10	5.31E-14	1.92E-16	3.86E-16	7.41E-28	3.12E-27	4.19E-24	3.99E-19	1.11E-16	3.06E-14	8.48E-12
24	weighted p	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.294297	0.520016	0.520016	0.520016	0.520016	0.520016	0.520016	0.520016
25	weighted L	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	18.2705	14.9302	14.9302	14.9302	14.9302	14.9302	14.9302	14.9302
20	weighted B	a 0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	/1.4165	/1.4165	/1.4165	/1.4165	/1.4165	/1.4165	/1.4165
27	-																		
28																			
29																			
21																			
		< C	PT_GE50.cs	v + /															11
	Nor	mal View	Ready	~			_			_	Sum=0		•						1)

The weighted p-values are in row 24 of the spreadsheet. Notice the same pvalue repeats for all the columns "B" through "L" listed as "Set 1"—this is the Bayes p value for participant 1, listed under "0.50 Majority Choice" and "GE" in Table 1 of QTBC2. Notice the same holds true for all the columns "M" through "W" listed as "Set 2", for participant 2, and so on. From this file, column "GE" under "0.50 Majority Choice" of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

The weighted DIC values are in row 25 of the spreadsheet. Again, notice the same DIC value repeats for all the columns "B" through "L" listed as "Set 1"—this is the DIC value for participant 1, listed under "0.50 Majority Choice" and "GE" in Table 2 of QTBC2. Notice the same holds true for all the columns "M" through "W" listed as "Set 2", for participant 2, and so on. From this file, column "GE" under "0.50 Majority Choice" of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

This completes the analysis for Cash I data for the Bayes p & DIC test of CPT-GE.50-majority/modal choice probabilistic specification. We will, again, demonstrate the analysis for the Cash I data for the Bayes p & DIC test of CPT-GE, but now with a .90-supermajority probabilistic specification in the following two sections, L.3.5 and L.3.6.

L.3.5 Probabilistic specification: Cash I, CPT-GE, 0.90-Supermajority

If continuing from section L.3.4, select "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes p & DIC test of CPT-GE.50-majority/modal choice probabilistic specification from the QTEST interface.

nble pairs	Theories		Hypothesis testing
Vumber of gambles: 5 Change	CPT-GE Vertices:	Reference volume	Run test
B) (C) (D) (C) (C) (C) (C) (C) (C) (C) (C) (C) (C	V2 [0.5] V3 [0.5] V4 [0.5] V5 [0.5] V5 [0.5] V6 [0.5] V6 [0.5] V6 [0.5] V7 [0.5]	Add Use reference volume Remove Weight	Theories Specifications Data sets Selected All All
E) D) E) E) E)	Duplicate (A. B): 0 ^ Remove (A. C): 0 ^ (A. D): 0 (A. E): 0 (A. E): 0 Load (B. C): 0 0	Determine volume from current settings: Set	Type of test O Bayes Factor Bayes p & DIC Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
ata Observations: Sample size N: (A B): 11 9	Probabilistic specifications Aggregation-based: Supermajority level:	Figure	Chi-bar squared weights Random number simulation sample size: seed:
20 (A,C): 4,16 (A,D): 2,18 (A,E): 2,18	Borda score 0.5 Change	Over last figure	Results:
Enter (B,C): 10,10 (B,D): 8,12 (B,E): 2,18	Distance-based: Max-distance (U):	Default ~	CPT-GE (Set 1/bayes-p/5000/1000/1) (major) CPT-GE (Set 2/bayes-p/5000/1000/1) (major) CPT-GE (Set 3/bayes-p/5000/1000/1) (major)
(C,D): 14,6 (C,E): 5,15 (D,E): 7,13	City-block 0.5 Change	Close all figures	CPT-GE (Set 4/bayes-p/5000/1000/1) (major) CPT-GE (Set 5/bayes-p/5000/1000/1) (major) CPT-GE (Set 6/bayes-p/5000/1000/1) (major)
Clear	O Euclidean 0.5 Change		CP1-GE (Set //bayes-p/5000/1000/1) (major) CPT-GE (Set 8/bayes-p/5000/1000/1) (major) CPT-GE (Set 9/bayes-p/5000/1000/1) (major)
Name Set 1 ~	Random preference:	File	CP1-GE (Set 10/bayes-p/5000/1000/1) (major) CPT CE (Set 11/bayes p/5000/1000/1) (major)
		Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

	Theories		Hypothesis testing
Number of gambles: 5 Change XC)	CPT-GE Vertices: v1 (0.5) v2 (0.5) v4 (0.5) v5 (0.5) v6 (0.5)	Add Use reference volume Remove Weight	Imponents testing Multicore Run test Auto save Theories Specifications O Selected Selected All All
3.0) 3.E) 3.E) 3.C) 3.E) 3.E) 3.E) All All	Vr/10.51 Vr/10.51 Duplicate (A B) 0 ^ (A C) 0 (A C) 0 ^ (A D) 0 (A C) 0 ^ (B C) 0 (B C) 0 ^	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	Save (B,E): 0 (C,D): 0	Set volume manually	Sample size: 5000 Change Burn-in size: 1000 Change
observations:	Probabilistic specifications Aggregation-based:	Figure	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 11.9 (A,C): 4,16 (A,D): 2,18	Supermajority Supermajority O.5 Change	Over last figure	1000 Change 1 Set
(A,E): 2,18 (B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Color scheme: Default	Results:
Load (B,E): 2,18 (C,D): 14,6 (C,E): 5,15	O Supremum 0.5 Change		
(U,E): 7,13	O City-block 0.5 Change O Euclidean 0.5 Change	Close all figures	
	-Pandom proference:	File	- · · · · · · · · · · · · · · · · · · ·
Name Set 1	Random preference.		-

Whether the user is continuing from section L.3.2 or L.3.4, the QTEST interface should match the screenshot below.

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected. To set the "Supermajority level:" to "0.9", select "Change..." and enter "0.9", then select "OK."

••	Change	e Para
Superma	ajority Level (Lar	nbda):
0.9		
	ОК	Cancel

📣 QTEST			- 🗆 X
Gamble pairs Kumber of gambles: 5 Change (A, B) (A, C) (A, D) Set (A, D) Set Set Set	CPT-GE Vertices: v10.9 v v	Ad Remove Rem	Hypothesis testing Run test Theories Specifications Selected Selected Selected Selected
(E. C) (B. D) (B. E) (C. D) (C. E) (D. E) (D. E)	Add V ⁶ [0.9] Duplicate (A, B): 0 Remove (A, C): 0 (A, D): 0 (A, C): 0 Load (B, C): 0	Determine volume from current settings: Set	Type of test Bayes Factor ® Bayes p & DIC Frequentist All
~	(B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data	Probabilistic specifications Aggregation-based:	Figure	Chi-bar squared weights Random number
Sample size N: (A.B): 11.9	Supermajority level:	Visualize	1000 Change 1 Set
20 (A,C): 4,16 (A,D): 2,18	O Borda score		Deculte:
Enter (A,E): 2, 16 (B,C): 10,10 (B,D): 412	Distance-based: May distance (II)	Default V	
Load (B,E): 2,18 (C,D): 14.6	Supremum 0.5 Change		
Save (C,E): 5,15 (D,E): 7,13	O City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Set 1	Random preference:	File	
	O From file: Load	Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

The QTEST interface should now match the screenshot below.

L.3.6 Hypothesis Testing: Cash I, CPT-GE, 0.90-Supermajority

We are now ready for the Bayes p & DIC test of CPT-GE.90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

ble pairs	Theories	Defense indust	Hypothesis testing
Number of gambles: 5 Change	CPT-GE Vertices:	Reference volume	Run test Auto save
.B)	v2 [0.9]	Add Use reference volume	TheoriesSpecificationsData sets
,C) ,D) Set	v [0.9] v (4 [0.9]	Remove Weight	Selected Selected Selected
E) C)	V5 [0.9] V6 [0.9]		
D) None	(A,B): 0	Determine volume	Type of test
D) All	(A,C): 0 (A,D): 0	from current	Baves Factor Baves p & DIC
E)	(A,E): 0 (B,C): 0	Set Set	◯ Frequentist ◯ All
	(B,D): 0 (B,D): 0	Satualuma manuallu	Gibbs sampling:
~	Save (C,D): 0	Set volume manually	Sample size: 5000 Change
			Burn-in size: 1000 Change
ta	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations: Sample size N: (A D) 44.0	Supermajority level:	Visualize	simulation sample size: seed:
20 (A,C): 4,16	Supermajority 0.9 Change.	Over last figure	1000 Change 1 Set
(A,D): 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
(B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default ~	^
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Change.		
Save (C,E): 5,15 (D,E): 7,13	City-block 0.5 Change.	Close all figures	
Clear	Cuclidean 0.5 Change.		
Nume Cat 1	Random preference:	File	~ ~
set i	O From file: Load	Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Detaile

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".

ble pairs	Theories	57	Hypothesis testing
umber of gambles: 5 Change	CPT-GE Vertices:	Reference volume	Run test
B)	v2 [0.9]	Add Use reference volume	Theories Specifications Data sets
C) D) Set	v3 [0.9] v4 [0.9]	Remove Weight	Selected Selected Selected
E)	v5 [0.9] v6 [0.9]		
D) None	Add v7 [0.9]		
E) D) All	Duplicate (A.B): 0 (A.C): 0	Determine volume from ourrout	Type of test
E)	Remove (A,D): 0	Set Set	O Bayes Factor Bayes p & DIC
-,	Load (B,C): 0		O Frequentist
	(B,D): 0 (B,E): 0	Set volume manually	Gibbs sampling:
~	(C,D): 0		Sample size: 5000 Change
	Deskahilistis seesifisations		Burn-in size: 1000 Change
ta	Aggregation-based:	Figure	Chi-bar squared weights Random number
Observations: Sample size N: (A R) 41.0	Supermajority level:	Visualize	simulation sample size: seed:
20 (A,C): 4,16	Supermajority 0.9 Change	Over last figure	1000 Change 1 Set.
(A,D): 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
Enter (B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default ~	^
Load (B,E): 2,18	Supremum 0.5 Change		
Save (C,E): 5,15			
(U,E): 7,13	City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Cat 1	Random preference:	File	~
Name Set I	O From file: Load.	· Load Options	Table Remove Export
	Mixture from vertices Save		
Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

000	Running Hypothesis Test		
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

QTEST			- 🗆 X
Gamble pairs Gamble pairs 5 Change (A, B) (A, C) (A, D) (A, D) (A, E) (B, C) (B, C) (B, C) None	Vertices: V2 [0:9] V4 [0:9] V5 [0:9] V6 [0:9] V7 [0:9]	Add Use reference volume Remove Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected All All All All All
(B,E) (C,D) (C,E) (D,E)	Duplicate (A, B): 0 (A, C): 0 (A, D): 0 (A, E): 0 (A, E): 0 Load (B, C): 0 Save (B, E): 0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling:
Data Observations: Sample size N: (A,D): 11.9 20 (A,O): 4,16	Probabilistic specifications Aggregation-based: Supermajority 0.9 Char	el: Visualize Ige	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1
(A, D): 2, 18 (A, D): 4, 18 (B, C): 10, 10 (B, C): 10, 10 (B, C): 2, 18 (B, C): 2, 18 (C, D): 4, 4, 6 (C, D): 4, 4, 6 (C, D): 4, 4, 6 (C, D): 4, 4, 6 (C, D): 5, 15 (D, E): 7, 13	O Borda score Distance-based: Max-distance (U) O Supremum 0.5 Chay-block 0.5	Color scheme: Default nge Close all figures	Results: <u>DFT-GE (Set 1/bayes-p/5000/1000/1) (major)</u> CPT-GE (Set 2/bayes-p/5000/1000/1) (major) CPT-GE (Set 3/bayes-p/5000/1000/1) (major) CPT-GE (Set 3/bayes-p/5000/1000/1) (major) CPT-GE (Set 5/bayes-p/5000/1000/1) (major) CPT-GE (Set 5/bayes-p/5000/1000/1) (major) CPT-GE (Set 5/bayes-p/5000/1000/1) (major)
Clear v	O Euclidean 0.5 Char Random preference: O From file: Lo O From file: Lo O Mixture from vertices Sa	rge File Load Options Save About	CPT-GE (Set 7/bayes-pisou0/100/1) (major) CPT-GE (Set 8/bayes-pi500/1000/1) (major) CPT-GE (Set 9/bayes-pi500/1000/1) (major) CPT-GE (Set 10/bayes-pi500/1000/1) (major) CPT-GE (Set 10/bayes-pi500/1000/1) (major) TGE-GE 10/bayes-pi500/1000/1) (major) TGE-GE 10/bayes-pi500/1000/1) (major) TGE-GE 10/bayes-pi500/1000/1) (major) Details Details

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "GQ" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

•	••									PI_GE90.	CSV								
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1	A Home	Layout	Tables	Charts	Smart	Art For	mulas	Data R	eview										_ ^ ☆
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	A1	¢ 6	3 🛇 (° J	fx Data set															
	A	В	C	D	E	F	G	H	1	J	K	L	M	N	0	P	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2					
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Ineory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specificatio	n major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
6	Lambda	olume	0 00	0.9	0.0	0.9		0.9	0.9	0.0	0.9	0.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7		0.	5 0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8	N																		
9	Random see	N	1 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs samp	ie 500	0 5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	100	0 1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
13	Vertex weig	ht																	
14	Vertex L/U																		
15	Likelihood r	atio																	
16	p-value		0 0	0	0	0	0 0	0	0	0	0	0	0	0	0	0	0	0	0
17	Warning																		
18	DIC	106.45	7 130.663	171.063	138.798	260.11	276.25	397.558	397.55	518.875	567.52	559.463	550.944	534.83	477.984	403.744	355.098	306.533	257.935
19	Prior volum	e 1.00E-1	0 1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10
20	Posterior vo	9.60E-3	6 9.19E-42	7.90E-52	8.59E-44	4.20E-60	4.12E-64	2.01E-80	2.01E-80	9.85E-97	7.60E-109	7.67E-107	3.35E-144	3.42E-140	5.26E-126	1.76E-107	2.28E-95	2.95E-83	3.83E-71
21	Bayes facto	r1																	
22	bayes facto	0.605.2	6 0 105 33	7 005 43	9 505 34	4 205 50	4 105 54	2.015.70	2 015 70	0.055.07	7 605 00	7 675 07	3 355 134	3 435 130	5 265 116	1 765 07	2 205 05	2 055 72	2 935 61
23	Moightod p	9.60E-2	0 9.19E-32	7.90E-42	0.59E-34	4.20E-5L	4.12E-54	2.01E-/0	2.01E-/0	9.65E-87	7.60E-99	7.6/E-9/	3.35E-134	3.42E-130	5.26E-116	1./6E-9/	2.285-85	2.35E-/3	3.63E-61
24	Weighted p	106.45	7 106 457	106 457	106 457	106 467	106 457	106 457	106 457	106 457	106 457	106 457	27 6025	27 6025	27 6026	27 6026	27 6025	27 6025	27 6025
26	Weighted B	a 8.73E-2	7 8 735-27	8 73E-27	8 73E-27	8 73E-27	8 73F-27	8 73E-27	8 73E-27	8 73E-27	8 73E-27	8 73E-27	27.0035 8.00E-05	27.0035 8.00E-05	27.0035 8.00E-05	27.0035 8.00E-05	27.0035 8.00E-05	27.0035 8.00E-05	8.005-05
27	The Brited D	0 0.756-2	., 0.756-27	0.736-27	0.730-27	0.736-27	5.73L-27	0.750-27	5.756-27	5.73E-27	0.73E-27	0.730-27	0.000-05	0.002-00	0.000-00	0.000-00	0.000-00	0.002-00	0.000-000
28																			
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30																			
31		_																	
		< > > 1	CPT_GE90.c	sv +															11
	Nor	mal View	Ready								Sum=0		-						

The weighted p-values are in row 24 of the spreadsheet. Notice the same pvalue repeats for all the columns "B" through "L" listed as "Set 1"—this is the Bayes p value for participant 1, listed under "0.90 Supermajority" and "GE" in Table 1 of QTBC2. Notice the same holds true for all the columns "M" through "W" listed as "Set 2", for participant 2, and so on. From this file, column "GE" under "0.90 Majority Choice" of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

The weighted DIC values are in row 25 of the spreadsheet. Again, notice the same DIC value repeats for all the columns "B" through "L" listed as "Set 1"—this is the DIC value for participant 1, listed under "0.90 Supermajority" and "GE" in Table 2 of QTBC2. Notice the same holds true for all the columns "M" through "W" listed as "Set 2", for participant 2, and so on. From this file, column "GE" under "0.90 Supermajority" of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

This completes the analysis for Cash I data for the Bayes p & DIC test of CPT-*GE*.90-supermajority probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes p & DIC test of CPT-*GE*, but now with a random preference probabilistic specification in the following two sections, L.3.7 and L.3.8.

L.3.7 Probabilistic specification: Cash I, CPT -GE, Random Preference

If continuing from section L.3.6, click "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes p & DIC test of CPT-GE.90-supermajority probabilistic specification from the QTEST interface.

mble pairs		Theories			-Deference velume	Hypothesis testing		Multicore
Number of gambles: 5	Change	CPT-GE	Vertices: /1 (0.9)	A Add		Rur	ı test	Auto save
A.B) A.C) A.D) A.E) 3.C)	Set		/2 [0.9] /3 [0.9] /4 [0.9] /5 [0.9] /6 [0.9]	Remo	ve Weight	Theories Selected All	Specifications — Selected All	Data sets O Selecte All
3,D) 3,E) 2,D) 2,E) 0,E)	All	Add Duplicate Remove	/7 (0.9) (A,B): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0	Set.	Determine volume from current settings: Set	Type of test O Bayes F O Frequent	actor	res p & DIC
~		Save	(B,D): 0 (B,E): 0 (C,D): 0	~	Set volume manually	Gibbs sampling Sample si Burn-in siz	: ze: 5000	Change
Data		Probabilistic specification	IS		Figure		1000	Change
Observat	ions:	Aggregation-based:			Visualize	simulation sample	veights R e size: s	andom number eed:
Sample size N: (A,B): 11,9 (A,C): 4,10	^	Supermajority	0.9	Change	Over last figure	1000	Change	1 Se
(A,D): 2,18 (A,E): 2,18		Borda score			Color scheme:	Results:		
Enter (B,C): 10,	0	Distance-based:	May distan	aa (II):	Default	CPT-GE (Set 1/b	ayes-p/5000/1000/	1) (major) 🛛 🗸
(b, b) : 6, 1 (B, E): 2, 18 (C, D): 14, 1 (C, E): 5, 14		O Supremum	0.5	Change		CPT-GE (Set 2/b CPT-GE (Set 3/b CPT-GE (Set 4/b CPT-GE (Set 5/b	ayes-p/5000/1000/ ayes-p/5000/1000/ ayes-p/5000/1000/ ayes-p/5000/1000/	1) (major) 1) (major) 1) (major) 1) (major)
(D,E): 7,1.	,	O Euclidean	0.5	Change	Close all figures	CPT-GE (Set 6/bi CPT-GE (Set 7/bi CPT-GE (Set 8/bi CPT-GE (Set 9/bi	ayes-p/5000/1000/ ayes-p/5000/1000/ ayes-p/5000/1000/ ayes-p/5000/1000/	1) (major) 1) (major) 1) (major) 1) (major)
Nama C-14		Random preference:			File	CPT-GE (Set 10/	bayes-p/5000/1000)/1) (major)
Ivanie Set	\sim	O From file:		Load	Load Options	Table	Remove	Export



Whether the user is continuing from section L.3.2 or L.3.6, the QTEST interface should match the screenshot below.

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Mixture from vertices" under "Random preference:" is selected.

QTEST			—
Gamble pairs Aumber of gambles: 5 Change [A C] A A [A C] A B (A D) A B (A E) B B	Theories CPT-GE Vertices: Vert	Add Verget	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected Selected Selected Selected
(B.C) (B.D) (B.E) (C.D) (C.E) (D.E) (D.E)	Add V6 Upplicate (A, B) 0 (A, C): 0 (A, C): 0 (A, D): 0 (A, C): 0 Load (B, C): 0	Determine volume from current seti Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burnin size: 1000 Change
Data Observations: Sample size N: (A(2):416 (A(2):416 (A(2):218 (A(2):218)	Probabilistic specifications Aggregation-based: Supermajority level O Supermajority 0.9 Chang	Figure Visualize Over last figure	Chi-bar squared weights simulation sample size: seed: 1000 Change 1 Set
Enter (P.E.) 2,10 (B,C): 10,10 (B,D): 8,12 Load (B,E): 2,18 (C,D): 14,6 (C,E): Save (D,E): 7,13	Distance-based: Supremum 0.5 Chang City-block 0.5 Chang	e Close all figures	
Clear	Cuclidean 0.5 Chang	E	
Name Set 1	From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

L.3.8 Hypothesis Testing: Cash I, CPT-GE, Random Preference

We are now ready for the Bayes p & DIC test of CPT-GE random preference probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".

T QTEST			- 🗆 ×
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-GE	Reference volume	Run test
(A.B)	V2 V2	Add Use reference volume	Theories Specifications Data sets
(A,C) (A,D) Set	v4 v4	Remove Weight	Selected Selected Selected
(A,E) (B,C) (B,D) None	Add v6	~	
(B,E) (C,D) All	Duplicate (A,B): 0 (A,C): 0	Determine volume form surrent	Type of test
(C,E) (D,E)	Remove (A,D): 0 (A,E): 0 (B,C): 0	Set Set	Bayes Factor Bayes p & DIC Frequentist
	Load (B,D): 0 (B,E): 0 (B,E): 0	Set volume manually	Gibbs sampling:
· · · · · · · · · · · · · · · · · · ·			Burn-in size: 1000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations: Sample size N:	Aggregation-based. Supermajorit	y level: Visualize	simulation sample size: seed:
20 (A,C): 4,16	O Supermajority 0.9	Change Over last figure	1000 Change 1 Set
(A, D): 2, 10 (A, E): 2, 18 (B, C): 10, 10	O Borda score	Color scheme:	Results:
(B,C). 10, 10 (B,D): 8, 12	Distance-based: Max-distance	e (U):	^
Load (C,D): 14,6 (C,D): 14,6	O Supremum 0.5	Change	
Save (D,E): 7,13	O City-block 0.5	Change Close all figures	
Clear	O Euclidean 0.5	Change	
Name	Random preference:	File	~ ·
	O From file:	Load Options	Table Remove Export
	Mixture from vertices	Save Save About	Details Clear

Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

$\Theta \circ \circ$	Running Hypothesis Test	
	Please wait	

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.



Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.

nble pairs	Theories		D.()	Hypothesis testing	Multicore
Number of gambles: 5 Char	nge CPT-GE Vertice	S:	Reference volume	Run test	Auto save
<u>,B)</u>	v2 v3	Remove	Weight	Theories Specifica	tions Data sets
,D) Set	······································			All All	Cted Selecte
(,D) None	Add	~			0,11
,E) ,D) All	Duplicate (A,B) 0 (A,C): 0 (A,C): 0	^^	from current	Type of test	Bayes p & DIC
,Ē)	Remove (A,E): 0 (A,E): 0 (B,C): 0	Set	settings: Set	O Frequentist	All
	(B,D): 0 (B,E): 0		Set volume manually	Gibbs sampling:	
~	(C.D): 0	v		Sample size: Burn.in size:	5000 Change
ata	Probabilistic specifications		Figure		Change
Observations:	Aggregation-based:	permajority level:	Visualize	simulation sample size:	seed:
Sample size N: (A,B): 11,9 (A,C): 4,16	Supermajority	.9 Change	Over last figure	1000 Change	. 1 Set
20 (A,D): 2,18 (A,E): 2,18	◯ Borda score		Color scheme:	Results:	
(B,C): 10,10 (B,D): 8,12	Distance-based: Ma	x-distance (U):	Default ~	CPT-GE (Set 1/bayes-p/50 CPT-GE (Set 2/bayes-p/50	00/1000/1) (mixture) 00/1000/1) (mixture)
Load (B,E): 2,18 (C,D): 14,6	◯ Supremum	0.5 Change		CPT-GE (Set 3/bayes-p/50 CPT-GE (Set 4/bayes-p/50	00/1000/1) (mixture) 00/1000/1) (mixture)
Save (C,E): 5,15 (D,E): 7,13	City-block	0.5 Change	Close all figures	CPT-GE (Set 5/bayes-p/50 CPT-GE (Set 6/bayes-p/50	00/1000/1) (mixture) 00/1000/1) (mixture)
Clear	CEuclidean	0.5 Change		CPT-GE (Set 7/bayes-p/50 CPT-GE (Set 8/bayes-p/50	00/1000/1) (mixture) 00/1000/1) (mixture)
Name Sat 1	Random preference:		File	CPT-GE (Set 9/bayes-p/50 CPT-GE (Set 10/bayes-p/5 CPT-GE (Set 11/bayes-p/5	000/1000/1) (mixture) 000/1000/1) (mixture)
Set 1	O From file:	Load	Load Options	Table Rem	ove Export
	Mixture from vertices	Save	Sava About	Detaile	

The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

Image:	•	••								CP I	_GE_MIXtu	re.csv								
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2 Testy yee bayes_p	1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
3 Theory CPT-GE CPT-GE CPT-GE CPT-GE	2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
4 Specification mixture mixtu	3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
Simplement volume Grand mask Grand	4	Specificatio	n mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture
6 Lambda	5	Reference	volume																	
7 0 0 0 0 0 1	6	Lambda																		
8 N 1	7	U																		
9 Radom seet 1	8	N																		
10 Gibbs sample 5000	9	Random se	e	1	1 1	1	1	. 1	1	. 1	1	1	1	. 1	. 1	1	1 1	1	1	1
11 BUT writes 1000	10	Gibbs samp	ole 50	00 500	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Unit of the view Vie	11	Burn-in size	10	00 100	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
13 Vertax Weight 14 Vertax Weight 15 Vertax Weight 15 Vertax Weight 15 Vertax Weight 16 Pvalue 10 0.0094 0.1648 0 0.0918 0 0.2844 0.0182 0.017 0.2714 0.0426 0 0.011 0.1986 0.0655 0.0012 0.0026 0.093 17 Warning 18 DC 45.9126 30.7138 20.8709 117.643 22.7844 76.9085 15.036 27.5292 26.4385 15.5257 25.4066 55.7053 24.8515 18.5424 20.9347 40.3339 28.3976 18.0112 19 Potrov Volume 20 Posterior volume 21 Bayes factor 2 22 Bayes factor 2 23 Bayes factor 2 23 Bayes factor 2 24 Weighted Bayes factor 2 25 Weighted Bayes factor 2 26 Weighted Bayes factor 2 27 Weighted Bayes factor 2 28 Weighted Bayes factor 2 29 Bayes factor 2 29 Bayes factor 2 20 Bayes factor 2	12	Vertex	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI	VI
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19 Prior volume	18	DIC	45.91	26 30.713	3 20.8709	117.643	22.7844	76.9085	15.036	27.5292	26.4385	15.5257	25,4066	55,7053	24.8515	18.5424	20.9347	40.3339	28.3976	18.0112
20 Postfor volume	19	Prior volum	ne																	
22 Bayes factor 1 1	20	Posterior v	olume																	
22 Bayes factor 2 23 Bayes factor 2 24 Weighted availue 25 Weighted Dvalue 26 Weighted Bayes factor 27 28 31 31 31 31 31 31 31 31 31 31 31 31 31	21	Bayes facto	r 1																	
23 Bayes factor sact Image: Sactor sact Image: Sactor sacto	22	Bayes facto	r 2																	
24 Weighted p-value 25 Weighted by all 26 Weighted by all 27 Weighted Bayes factor 27 Weighted Bayes factor 28 Weighted Bayes factor 29 Weighted Bayes factor 20 Weighted B	23	Bayes facto	r exact																	
25 Weighted DiC 27 Weighted Bayes factor 27 Ze 29 John Status (Status (Stat	24	Weighted p	-value																	
26. Weighted Bayes factor 27. Bayes factor 28. Bayes factor 29. Bayes factor 30. Bayes factor 31. Example a state of the state of	25	Weighted 0	DIC																	
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28 29 30 31 11	27																			
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30 31 14 4 → ▶ CPT.GE.Mixture.csv +)	29																			
	30																			
			4 + +1	CPT_GE_Mix	ure.csv +															11
Normal view Ready		Nor	mal View	Ready							_	Sum=0		•						

The p-values are in row 16 of the spreadsheet. The p-value in column "B" listed as "Set 1" is the Bayes p value for participant 1, listed under "Mixture" and "GE" in Table 1 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "GE" under "Mixture" of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

The DIC values are in row 18 of the spreadsheet. Again, the DIC value in column "B" listed as "Set 1" is the DIC value for participant 1, listed under "Mixture" and "GE" in Table 2 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "GE" under "Mixture" of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

This completes the analysis for Cash I data for the Bayes p & DIC test of CPT-GE random preference probabilistic specification.

L.4.1 Theory and Vertex: Cash I, LH

EST				—
nble pairs Number of gambles: 5 Ch.	ange	Vertices:	Reference volume	Hypothesis testing Multicore Run test Auto save
.B) ,C) ,D) ,E) ,C) Set	£		Add Use reference volume Remove Weight	Theories Specifications Data sets Selected Selected Selected All
Nor D) Nor D) Al E) Al E) Al	e Add Duplicate Remove	^	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC
~	Save	, ·	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
ata Observations:	Probabilistic specifica Aggregation-based	ations	Figure	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N:	Supermajority Borda score	0.5 Change	Over last figure	1000 Change 1 Set
Enter	Distance-based:		Color scheme:	Results:
Load	⊖ Supremum	0.5 Change		
Save	O City-block	0.5 Change	Close all figures	
Clear	✓ O Euclidean	0.5 Change		
Name Default	Random preference O From file:	Load	File Load Options	Table Remove Export

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "TheoriesVertices" folder and open "Vertices_LH_Cash1.csv". In the dialog box, type "LH" and select "OK".

• •	Theory	
Enterna	nefortheory:	
LH		
	OK Cance	

On the QTEST interface there should now be a list of 1 vertex for \mathcal{LH} under "Theories". Verify your screen matches the screenshot below.



<u>L.4.2 Data: Cash I, LH</u>

Under "Data", select "Load...".

QTEST			-
Gamble pairs Number of gambles: 5 Change (A.B) (A.C) (A.D)	Theories Vertices: UH 0.5 F	Add Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets © Selected © Selected
(A E) Set (B C) (B D) None (C D) (C D) (C E) All	Add Duplicate (A, C): 0 (A, C): 0 (A, E): 0 (A, E): 0 (B, C): 1 (B, D): 0 (B, D): 0	Determine volume from current settings: Set	All All Type of test Bayes Factor Bayes Factor Bayes p & DIC
Data Observations:	Save (C.D): 1	Set volume manually	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: 20 Enter	Supermajority evel: Supermajority evel: Borda score Distance-based: Max distance (II):	Over last figure Color scheme: Default	1000 Change 1 Set Results: ^
Load Save	Supremum 0.5 Change City-block 0.5 Change	Close all figures	
Clear V Name Default	Change Random preference: From file: Load	File Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "DataSets" folder and open "Cash1.txt".

承 QTEST			- 🗆 X
Gamble pairs Number of gambles: 5 Change (A, D) (A, D) (A, D) (A, D) (A, E) Set	IH Vertices: IH IH Vertices: IH	Add Use reference volume Remove Weight	Hypothesis testing Run test Theories Selected Selected Selected Auto save Data sets Selected Selected Selected
(B, C) (B, D) (B, E) (C, D) (C, E) (D, E) (D, E)	Add (A.D): 1 (A.C): 0 (B.C): 1 (B.C): 1 (B.C): 1 (C): 0 (C):	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Image: Construction of the sector of the sect
	Save (D.E): 0 (C.D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Sample size N: (A.B): 11.9	Aggregation-based: Supermajority level:	Visualize	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set
20 (A,C), 4, 16 (A,D): 2,18 (A,E): 2,18 (B,C): 10,10	Borda score	Color scheme:	Results:
(B,D): 8,12 (B,E): 2,18 (C,D): 14,6	Supremum Oscillation Max-distance (U): Oscillation Change	Default	^
Save (C.E): 5,15 (D,E): 7,13	City-block 0.5 Change	Close all figures	
Name Set 1	Random preference:	File	~
	From file: Load Mixture from vertices Save	Load Options	Table Remove Export
\smile		About	Crear

Under "Data" notice the "Observations:" list has now been populated:

Under "Data", select the dropdown menu next to "Name..." to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

L.4.3 Probabilistic specification: Cash I, LH, 0.50-Majority/modal choice

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected and that the "Supermajority level:" is set to "0.5".



L.4.4 Hypothesis Testing: Cash I, LH, 0.50-Majority/modal choice

We are now ready for the Bayes p & DIC test of LH .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5. Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

	Theories			
hble pairs Number of gambles: 5 Change Change Change Change Change Change	LH Vertice	s: Ac Rer	Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
LE) None LD) All LE) LE) All	Add Duplicate (A.B) 1 (A.C): 0 (A.D): 0 (A.D): 0 (A.D): 0 (A.E): 0 (B.C): 1 (B	> Se	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC © Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 1	~	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
				Toto onange
ata	Probabilistic specifications		Figure	Chi-bar squared weights Random number
Observations:	Probabilistic specifications Aggregation-based:	permajority level:	Figure Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 11.9 20 (A,C): 4,16	Probabilistic specifications Aggregation-based: Supermajority	permajority level:	Figure Visualize Over last figure	Chi-bar squared weights Random number simulation sample size: seed:
Ata Observations: (A, 5); 11,9 (A, C); 4, 16 (A, C); 2, 18	Probabilistic specifications Aggregation-based: Supermajority Borda score	permajority level:	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights Random number simulation sample size: seed. 1000 Change 1 Set Results:
ata Observations: (A_D): 11.9 (A_C): 4.16 (A_D): 2.18 (A_D): 2.18 (A_D): 2.18 (B_D): 10.10 (B_D): 8.12	Probabilistic specifications Aggregation-based:	permajority level: .5 Change	Figure Visualize Over last figure Color scheme: Default	Chi-bar squared weights seed 1 Set Results:
Ata Obsenations: Sample size N: (A, C): 4, 16 (A, C): 4, 16 (A, C): 2, 18 (A, C): 2, 18 (B, C): 10, 10 (B, C): 10, 10 (B, E): 2, 18 (B, C): 10, 10 (B, E): 2, 18 (B, C): 14, 6 (C): 14, 6	Probabilistic specifications Aggregation-based:	permajority level: .5 Change ux-distance (U): 0.5 Change	Figure Visualize Over last figure Color scheme: Default v	Chi-bar squared weights seed simulation sample size: seed 1000 Change 1 Set Results:
Ata Observations: Observations: (A_D) 11 9 (A_C) 4 16 (A_C) 2 18 (A_C) 2 18 (A_C) 2 18 (B_C) 10 10 (B_C) 2 18 (B_C) 2 18 (C_C) 14 6 (C_C) 5 15 (D_C) 7, 13 (B_C) 2 18	Probabilistic specifications Aggregation-based Borda score Distance-based: City-block	permajority level: 1.5 Change w-distance (U): 0.5 Change 0.6 Change	Figure Visualize Over last figure Color scheme: Default V Close all figures	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
Ata Observations: Observations: (A E): 11.9 (A C): 4.16 (B C): 10.10 (B C): 2.18 (C C): 5.15 (C C): 5.15 (C C): 5.15 (C C): 7.13 (C C): 4.1 (C C): 7.13 (C C): 7.1	Probabilistic specifications Aggregation-based Borda score Distance-based: City-block Euclidean	permajority level: .5 Change bx-distance (U): 0.5 Change 0.5 Change 0.5 Change	Figure Visualize Over last figure Color scheme: Default V Close all figures	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
Ata Observations: Observations: (A D) 419 (A C) 4.16 (B C) 8.12 (B C) 8.12 (C C) 5.15 (C	Probabilistic specifications Aggregation-based Borda score Distance-based: City-block City-block Random preference:	permajority level: .5 Change xx-distance (U): 2.5 Change 2.5 Change 2.5 Change	Figure Visualize Over last figure Color scheme: Default Visualize Close all figures File	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
ata Sample size N: Observations: 20 (A,C): 4.16 20 (A,C): 4.16 (A,C): 4.16 (A,C): 4.16 Enter (B,C): 10.10 (B,C): 10.10 (B,C): 10.10 (B,C): 10.10 (B,C): 12.16 Save (C,C): 5.15 (D,C): 7.13 V	Probabilistic specifications Aggregation-based: Borda score Distance-based: City-block City-block Random preference: From file:	permajority level: 1.5 Change 2.5 Change 2.5 Change 3.5 Change 3.5 Change	Figure Visualize Over last figure Color scheme: Default Close all figures File Load Options	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results: Table Remove Exort

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".

mble pairs		Theories				Hypothesis	s testing		
Number of gambles:	Change	LH ^	Vertices:		Reference volume		Run test		.ore
.,B)]		LH [0.5]	^ Add	Use reference volur	ne Theories	Specific	ations Data se	ets -
,C)	Cat	~		Remove	Weight	Sele	ected Sel	ected O Sele	lecte
(E)	Set						O All	() All	
,D)	None	Add		~			0.1		
i,E) i,D)	All	Duplicate	(A,B): 1 (A,C): 0	^	Determine volume	Type of	test		
;,E) .E)		Remove	(A,D): 0 (A,E): 0	Set	settings:	Set	Bayes Factor	Bayes p & DIC	
		Load	(B,C): 1				Frequentist	O AU	
		Save	(B,E): 0	5	Set volume manua	Illy Gibb	s sampling:	5000	
~			(C,D): 1	•			Sample size:	5000 Cna	1e
ata		Probabilistic specificatio	ne		Figure		Bum-in size:	1000 Chang	ge
ala		Aggregation-based:	13		rigule .	Chi-ba simula	r squared weights	Random numl	iber
Sample size N: (A.	3): 11,9	Supermajority	Supermajority lev	el:	Visualize	10	00 Oherer		0.0
20 (A,C	C): 4,16	Barda score	0.5 Char	ige	Over last figure		Change.		Sei
Enter (A,E	E): 2,18	- Dolda Scole			Color scheme:	Result	ts:		
(B,C): 8,12	Distance-based:	Max-distance (U)		Default	~			^
Load (B,E	E): 2,18 D): 14,6	O Supremum	0.5 Cha	nge					
Save (C,E	E): 5,15 E): 7,13	O City-block	0.5 Cha	1ge	Close all figures				
		O Euslidean			ciuse all lightes				
Close		Cucildean	0.5 Cha	nge					
Clear	~				File				~
Clear Name Se	× 1 ×	Random preference:							
Clear Name Se	× 1 ×	Random preference:	Lo	ad	Load Opt	tions Ta	able Ren	nove Export	

Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		Ū
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

ble pairs	Theories		Hypothesis testing
umber of gambles: 5 Change	LH Vertices:	Reference volume	Run test Auto save
B) ^ C) D) Set		Add Use reterence volume Remove Weight	Theories Specifications Data sets Selected Selected Selected
C) D) None	Add V		
2) E) E)	Duplicate (A,C): 0 Remove (A,D): 0 (A,E): 0 (A,E): 0 (A,C): 0 (A,D): 0	Set Set	Bayes Factor Bayes p & DIC Frequentist All
~	(6,0): 0 (8,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change
12	Probabilistic specifications	Figure	Burn-in size: 1000 Change
Observations	Aggregation-based:	Visuelies	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 11,9	Supermajority	Visualize	
20 (A,C): 4,16 (A,D): 2,18	0.5 Change	Over last figure	Change
(A,D). 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
(B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default ~	LH (Set 1/bayes-p/5000/1000/1) (major)
Load (B,E): 2,18 (C,D): 14.6	O Supremum 0.5 Change		LH (Set 3/bayes-p/5000/1000/1) (major)
Save (C,E): 5,15 (D,E): 7,13	O City-block 0.5 Change	Close all figures	LH (Set 4/bayes-p/5000/1000/1) (major) LH (Set 5/bayes-p/5000/1000/1) (major) LH (Set 6/bayes-p/5000/1000/1) (major)
Clear	O Euclidean 0.5 Change		LH (Set 7/bayes-p/5000/1000/1) (major) LH (Set 8/bayes-p/5000/1000/1) (major) LH (Set 9/bayes-p/5000/1000/1) (major)
	Random preference:	File	LH (Set 10/bayes-p/5000/1000/1) (major)
Name Set 1	O From file: Load	Load Options	the Remove Example

Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected "Details..." for each participant. The layout is a little different, however.

•										LH50.cs	v								
9	🛅 🗊	8	🔏 🖧 🕻	è 💰 🛙	<u>∩ • ⊘ •</u>	Σ • 🛃	• 🍸 • [痃 🖭 🛓	100%	•						Q- (Se	arch in Shee	ət	
1	Home	Layout	Tables	Charts	Smart/	Art For	mulas	Data Re	eview										_ ^ ¢
	Edit			Font			Alig	nment		N	umber		For	mat		Cells		Themes	i :
	E E	III 🔻 Cal	ibri (Bodv)	× 12	• A• A	- = =	= ab	c 🔻 🔜 wr	ap Text 👻	General		- -	-	lormal	1 🖫	L			
			[= [==]														·		
Pa	ste 🥥 C	lear • B	$I \cup$	inini▼	🆄 🔻 🚣			2	Merge -	🧐 🔻 %	9	Condit	ional B tting	ad	In	sert Delet	e Format	Themes 1	Aa-
	A1	: 8) 🔘 (= j	x Data se	t														
4	А	В	C	D	E	F	G	Н	I	J	K	L	M	N	0	Р	Q	R	S
	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3	Theory	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
4	Specification	n major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference w	olume																	
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random see	H 1	. 1	1	1	1	1	1	1	1	1	1	1	1	1	1	. 1	1	1
10	Gibbs sampl	6 5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	LH	LH	un	LH	LH	un	LH	LH	un	LH	LH	LH	un	LH	LH	LH	LH	LH
13	Vertex Weigi	m																	
15	Vertex L/O	atio																	
16	n value	0 4642			0.022	0	0 2096	0		0.0272	0		0.6074	0 1676		0.1159		0 1726	0.2679
17	Warning	0.4042			0.032	0	0.2380	0		0.0372	0		0.0074	0.1070		0.1156	0	0.1730	0.3078
18	DIC	15.3887	87.5899	111.521	27,9357	98.51	18,1292	70,7866	102,634	27,8163	69.2457	90.498	12,8378	20.5272	178.428	23,7273	101.119	18,0907	16.5472
19	Prior volume	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vo	0.0241314	9.57E-21	2.50E-23	4.67E-05	5.80E-21	0.0124058	1.01E-15	1.78E-21	2.26E-06	4.33E-15	4.12E-19	0.159926	8.77E-05	1.18E-38	5.11E-05	1.64E-21	0.00091795	0.00156076
21	Bayes factor	1																	
22	Bayes factor	2																	
23	Bayes factor	24.7106	9.80E-18	2.56E-20	0.0477941	5.94E-18	12.7036	1.03E-12	1.82E-18	0.00231701	4.44E-12	4.22E-16	163.764	0.0897581	1.20E-35	0.0522793	1.68E-18	0.939978	1.59822
24	Weighted p-	-value																	
25	Weighted DI	IC																	
26	Weighted Ba	ayes factor																	
27																			
28																			
29																			_
30																			
31		4 5 5 1	H SO CSV	+						_									
			In_ISOICSV	-															111
	Norn	nal View	Ready								Sum=0		-						

The p-values are in row 16 of the spreadsheet. The p-value in column "B" listed as "Set 1" is the Bayes p value for participant 1, listed under "0.50 Majority Choice" and "LH" in Table 1 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "0.50 Majority Choice" under "LH" of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

The DIC values are in row 18 of the spreadsheet. Again, the DIC value in column "B" listed as "Set 1" is the DIC value for participant 1, listed under "0.50 Majority Choice" and "LH" in Table 2 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "LH" under "0.50 Majority Choice" of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

This completes the analysis for Cash I data for the Bayes p & DIC test of LH .50-majority/modal choice probabilistic specification. We will, again, demonstrate the analysis for the Cash I data for the Bayes p & DIC test of LH, but now with a .90-

supermajority probabilistic specification in the following two sections, L.4.5 and L.4.6.

L.4.5 Probabilistic specification: Cash I, LH, 0.90-Supermajority

If continuing from section L.4.4, select "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes p & DIC test of LH .50-majority/modal choice probabilistic specification from the QTEST interface.



Whether the user is continuing from section L.4.2 or L.4.4, the QTEST interface should match the screenshot below.

nble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Reference volume	Run test Auto save
.C) ,D) ,E) ,C)		Ada Use reference volume Remove Weight	Theories Specifications Data sets Selected All All All All All
ID None LE	Audu (A.B): 1 ^ Duplicate (A.C): 0 ^ (A.D): 0 (A.E): 0 ^ (B.C): 1 (B.C): 1 ^	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist
~	(B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change
ata Observations: Sample size N: (A.B): 11.9 (A.C): 4.16 (A.C): 4.16	Probabilistic specifications Aggregation-based: Supermajority level: 0.5 Chance	Figure Visualize Over last figure	Chi-bar squared weights Random number simulation sample size: seed:
(A,D): 2,18 (A,E): 2,18 (B,C): 10,10 (B,D): 8,12	O Borda score Distance-based: Max dictance (II):	Color scheme:	Results:
Load (C.D): 14,6 (C.D): 14,6 (C.E): 5,15 (D.E): 7,13	Supremum 0.5 Change City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Set 1 V	Random preference: O From file: Load	File Load Options	Table Remove Export
	Mixture from vertices Save	Sam Ahaut	

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected. To set the "Supermajority level:" to "0.9", select "Change…" and enter "0.9", then select "OK."

	Change	e Para
Supermaj	ority Level (Lar	nbda):
0.9		
	ОК	Cancel

The QTEST interface should now match the screenshot below.

A QTEST			- 🗆 🗙
Gamble pairs Gamble pairs 5 Change (A, B) (A, C) (A, D) (A, D) (A, E) Set (A, E) Set	Theories Utices:	Add Use reference volume Weight	Hypothesis testing Run test Theories Selected Selected Hypothesis testing Multicore Auto save Data sets Selected Selected Multicore Auto save Data sets Selected
(B, C) (B, D) (B, E) (C, D) (C, E) (D, E) (D, E)	Add v Duplicate (A. E): 1 (A. C): 0 (A. C): 0 (A. D): 0 (A. E): 0 (B. C): 1 (B. C): 0 (B. C): 0 (B. C): 0	Set Determine volume from current settings: Set Set Set volume manually	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling:
Data Data Observations: (A,E): 119 (A,C): 4.16 (A,C): 2.18 Fater (A,E): 2.18 (Probabilistic specifications Aggregation-based: Supermajority Used: Derivation of the section	Figure Visualize Over last figure Color scheme:	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Results: Set
(B.C): U, 10 (B.D): 8,12 (B.E): 2,18 (C.E): 5,15 (D.E): 7,13 (Clear	Distance-based: Max-distance (U): Supremum 0.5 City-block 0.5 Change Euclidean 0.5	Default ~	
Name Set 1 v	Random preference: Load From file: Load Mixture from vertices Save	File Options Options	Table Remove Export Details Clear

L.4.6 Hypothesis Testing: Cash I, LH, 0.90-Supermajority

We are now ready for the Bayes p & DIC test of LH .90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

ble pairs	Theories				Hypothesis testing
Number of gambles: 5 Change	LH ^	Vertices:	L L L	Reference volume	Run test Auto save
B) ^ ,C) _ ,D) Set	~		Add Remove	Use reference volume	Theories Specifications Data sets Selected Selected Selected
C) D) E) D)	Add Duplicate	(A,B): 1]	Determine volume	Type of test
E)	Remove Load	(A,D): 0 (A,E): 0 (B,C): 1 (B,D): 0	Set	settings: Set	Bayes Factor Bayes p & DIC Frequentist All
~	Save	(B,E): 0 (C,D): 1		Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change.
ata	Probabilistic specification	ns	[figure	Chi-bar squared weights Random number
Observations: Sample size N: (A.B): 11.9	Supermainrity	Supermajority level:		Visualize	simulation sample size: seed:
20 (A,C): 4,16 (A,D): 2,18	Borda score	0.9 Change		Over last figure	Change
(A,E): 2,18 (B C): 10,10	-Distance based:			Color scheme:	Results:
(B,D): 8,12 (B,E): 2,18	Supremum	Max-distance (U):		Default ~	í í
(C, D): 14,6 (C, E): 5,15 (D, E): 7,13	O City-block	0.5 Change		Close all figures	
Clear	OEuclidean	0.5 Change			
Name	Random preference:		F	ile	
	O From file:	Load		Load Options	Table Remove Export
		0			

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".



Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

nble pairs		Theories			Deferrer		Hypothesis testing		Multicore
Number of gambles:	5 Change		Vertices: H [0.9]		Reference	volume	F	lun test	Auto save
.B)	^				Add Use n	eterence volume	Theories	Specifications	Data sets
,C) ,D)	Set	~		R	emove	Weight	Selected	Selected	O Selecte
E) C)	Need	Add		~					All
) =)	None	Duplicate	A,B): 1	^	Determi	ne volume	Type of test		
D) E)	All	Remove	4,C): 0 4,D): 0		from cur	rent	Bayes	Factor 💿 Bay	es p & DIC
E)		(A	A,E): 0 3,C): 1	5	set	Set	⊖ Frequ	entist 🔿 All	
		Ebau (E	B,D): 0 B,E): 0		Satu	olumo manually	Gibbs sampli	ng:	
	~	Save	C(D): 1	~	Gerv	olume manually	Sample	size: 5000	Change
							Burn-in	size: 1000	Change
ta		Probabilistic specifications	3		Figure		Chi-bar square	d weights R	andom number
Sample cize N:	Observations:	Aggregation-based.	Supermajo	rity level:	V	/isualize	simulation sam	iple size: s	eed:
00	(A,B): 11,9 (A,C): 4,16	 Supermajority 	0.9	Change	Over	last figure	1000	Change	1 Se
20	(A,D): 2,18 (A,E): 2,18	O Borda score		-	Color	scheme:	Results.		
Enter	(B,C): 10,10	Distance-based:	May distan	aa (10)	Default	~	LH (Set 1/baye	s-p/5000/1000/1) (m	ajor)
Load	(B,E): 2,18	0.0	0.5	Oberes			LH (Set 2/baye LH (Set 3/baye	s-p/5000/1000/1) (m: s-p/5000/1000/1) (m:	ajor) ajor)
Sava	(C,D): 14,6 (C,E): 5,15	Supremum	0.5	Change			LH (Set 4/baye	s-p/5000/1000/1) (m s-p/5000/1000/1) (m	ajor) ajor)
ouro	(D,E): 7,13	O City-block	0.5	Change	Clos	e all figures	LH (Set 6/baye	s-p/5000/1000/1) (m	ajor)
Clear		OEuclidean	0.5	Change			LH (Set 8/baye	s-p/5000/1000/1) (m s-p/5000/1000/1) (m	ajor) ajor)
	×	- Dandam professional			File		LH (Set 9/baye LH (Set 10/bay	s-p/5000/1000/1) (m: es-p/5000/1000/1) (n	ajor) najor)
Name	Set 1 V	From file:		Load	Land	Ortions	N (Cot 11/hou	oc p/5000/1000/1) /r	naiori
					Load	Options	Table	Remove	Export
		Mixture from vertices	5	Save	Save	About	Details	Clear	

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

•••										LH90.cs	v								
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	1	A 6		fr Data co								Porma	itting						
	A	R			F	F	G	н		1	K	1	M	N	0	P	0	R	s
1 Data	set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2 Test t	ype	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p
3 Theor	ry	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
4 Speci	fication	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5 Refer	ence vo	lume																	
6 Lamb	da	0.9	0.9	0.9	0.9	0.9	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	/ 0.9	0.9	0.9	0.9
7 U																			
9 Randi	om seer	1	1	1		1			1	1	1		1	1		1 1	1	1	1
10 Gibbs	sample	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11 Burn-	in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12 Verte	x	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH	LH
13 Verte	x weigh	t																	
14 Verte	x L/U																		
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17 Warn	IIIR	90 3342	371 457	573 231	117.022	544 113	85 0314	428 706	501.15	101 728	324 306	473.05	77 6122	165 708	517.647	7 143 301	508 879	143 639	137.018
19 Prior	volume	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10
20 Poste	rior vol	1.01E-31	1.92E-99	1.80E-80	4.97E-35	8.72E-77	1.49E-27	2.42E-68	9.35E-77	6.81E-58	1.83E-65	1.61E-72	4.63E-29	3.07E-52	3.20E-127	7 1.14E-44	9.01E-82	7.77E-47	1.26E-44
21 Bayes	s factor	1																	
22 Bayes	s factor	2																	
23 Bayes	s factor	1.01E-21	1.92E-89	1.80E-70	4.97E-25	8.72E-67	1.49E-17	2.42E-58	9.35E-67	6.81E-48	1.83E-55	1.61E-62	4.63E-19	3.07E-42	3.20E-117	/ 1.14E-34	9.01E-72	7.77E-37	1.26E-34
24 Weig	hted p-v	alue																	
25 Weig 26 Weig	hted Dit	Jos factor																	
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The p-values are in row 16 of the spreadsheet. The p-value in column "B" listed as "Set 1" is the Bayes p value for participant 1, listed under "0.90 Supermajority" and "LH" in Table 1 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "0.90 Supermajority" under "LH" of Table 1 can be replicated. Note, however, that the Bayes p values vary slightly if the test is replicated with different random seeds for each replicate. The Bayes p values tend to vary by .03 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

The DIC values are in row 18 of the spreadsheet. Again, the DIC value in column "B" listed as "Set 1" is the DIC value for participant 1, listed under "0.90 Supermajority" and "LH" in Table 2 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "LH" under "0.90 Supermajority" of Table 2 can be replicated. Note, however, that the DIC values vary slightly if the test is replicated with different random seeds for each replicate. The DIC values tend to vary by .2 when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

This completes the analysis for Cash I data for the Bayes p & DIC test of LH .90-supermajority probabilistic specification.

L.5.1 Theory and Vertex: Cash I, Unconstrained Model

Under "Theories", select "Add...". 承 QTEST _ × Theories Hypothesis testing Gamble pairs Multicore Reference volume Vertices: Number of gambles: 5 Change... ~ Run test Auto save ^ Add... Use reference volume Theories Specifications Data sets (A,B (A,C Remove Weight... Selected Selected Selected (A,D) (A,E) (B,C) (B,D) (B,E) (C,D) (C,E) (D,E) Set... Add. ~ None Duplicate ^ Determine volume from current settings: Type of test All O Bayes Factor O Bayes p & DIC Remove Set Set... Frequentist Load. Gibbs sampling: Set volume manually... Save. Sample size: 5000 Change... Burn-in size: Change... 1000 Probabilistic specifications Data Figure Chi-bar squared weights simulation sample size: Random number Aggregation-based: Visualize Observations: Supermajority level: Sample size N: Supermajority Change... Set... 1000 1 Over last figure 0.5 Change... 20 O Borda score Color scheme: Results Enter... Distance-based: Default Max-distance (U): Load. O Supremum 0.5 Change... Save. O City-block Change.. 0.5 Close all figures Clear Euclidean 0.5 Change... Random preference File Name... Default \sim O From file: Load... Load... Options... Table... Remove Export... O Mixture from vertices Save.. Save. Details... Clear About...

In the dialog box, type "Unconstrained" and select "OK".

e intervention of the org
Entername for the ory:
Unconstrained
OK Cancel

Under "Vertices:" under "Theories", select "Add...".

A QTEST			- X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	Unconstrained Vertices:	Reference volume	Run test Auto save
(A.B)		Use reference volume	Theories Specifications Data sets
(A,C) (A,D) Set		Weight	Selected Selected Selected
(B,C) (B,D)	Add V		
	Duplicate	Determine volume	Type of test
(C.E) (D.E)	Remove	settings: Set	Bayes Factor Bayes p & DIC DIC
	Load		Prequentist All
~	Save V	Set volume manually	Gibbs sampling: Sample size: 5000 Change
			Burn-in size: 1000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations: Sample size N:	Supermajority level:	Visualize	simulation sample size: seed:
20	O Borda score	Over last figure	Change
Enter	Distance-based:	Color scheme:	Results:
Load	Max-distance (U):	Deladit	
Save	U.S Change		
	City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Default ~	Random preference:	File	· · · · · · · · · · · · · · · · · · ·
	Load	Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

In the dialog box, type "V1" if not already entered and select "OK".

	Vertex	
Enternar	me for vertex:	
V1		
	ОК	Cancel

On the QTEST interface there should now be a list of 1 vertex for the unconstrained model under "Theories". Verify your screen matches the screenshot below.

▲ QTEST			- X
Gamble pairs Number of gambles: 5 Change (A.B) (A.C) (A.C) (A.D) Cot	Theories Unconstrained Vertices: V1 [0.5] Add	Reference volume Use reference volume ove Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets © Selected © Selected
(AE) (BC) (BD) (BD) (CD) (CD) (CD) (CD) (CD) (CD) (CD) (C	Add Duplicate (A, C): 0 (A, C): 0 (A, C): 0 (B, C): 0 (B, C): 0 (B, C): 0 (B, C): 0 Save (C, D): 0	Determine volume from current settings. Set	O All O All Type of test O Bayes Factor Bayes Factor O Bayes p & DIC © Frequentist O All Gibbs sampling: Sample size: Sample size: 5000
Data Observations: 20 Enter Load Save Clear	Probabilistic specifications Aggregation-based: Supermajority level: Borda score Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change City-block 0.5 Change	Figure Visualize Over last figure Color scheme: Default V Close all figures	Burn-in size: 1000 Change Chi-bar squared weights Sendom number simulation sample size: seed: 1000 Change 1 Set Results:
Name Default v	Random preference: Load From file: Load Mixture from vertices Save	File Load Options Save About	Table Remove Export Details Clear

L.5.2 Data: Cash I, Unconstrained Model

Under "Data", select "Load...".

QTEST			
Gamble pairs Set Set (A, C) (A, C) (A, C) (A, C) (A, C) (A, C) (B, C) (B, C) (B, C) (C, C) (C, D) (C, C) (D, E) (D, E)	Add (A): 0 Ad Duplicate (A): 0 (A): 0 (A): 0 Remove (A): 0 (A): 0 (A): 0 Load (B: D): 0 (B: D): 0 (B: D): 0 Save (B: D): 0 (C): 0 (C): 0	Reference volume Use reference volume Weight Determine volume from current settings: Set Set volume manually	Hypothesis testing Run test Theories Selected All Type of test Bayes Factor Bayes Frequentist Gibbs sampling: Sample size: 5000 Change
Data Observations:	Probabilistic specifications Aggregation-based: Supermajority level: Borda score Distance-based: Supermum O.5 Change City-block O.5 Change Euclidean O.5 Change Change Change	Figure Visualize Over last figure Color scheme: Default V Close all figures	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Results: ^
Name Vofault v	Random preference: O From file: Load Mixture from vertices Save	File Load Options Save About	Table Remove Export Details Clear

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "DataSets" folder and open "Cash1.txt".

🔊 QTEST			
Gamble pairs	Theories Vartices:	Reference volume	Hypothesis testing Multicore
Number of gambles: 5 Change	V1 [0.5]	Add Use reference volume	Run test Auto save
(A.B) (A.C) (A.D) (A.E)	~	Remove Weight	Theories Specifications Data sets Selected Selected Selected
(B,C) (B,D) None	Add	✓	
(B,E) (C,D) (C,E) (D,E)	Duplicate (A, E): 0 (A, C): 0 (A, C): 0 (A, C): 0 (A, E): 0 (A, E): 0 (B, C): 0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC © Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 0	✓ Set volume manually	Gibbs sampling: Sample size: 5000 Change
2	Deskehilistis soorifistises		Burn-in size: 1000 Change
Uata Observations:	Aggregation-based:	Figure Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 11,9 (A,C): 4,16	Supermajority 0.5 Chai	nge Over last figure	1000 Change 1 Set
20 (A,D): 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
Enter (B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U	Default ~	^
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Cha	nge	
Save (C,E): 5,15 (D,E): 7,13	City-block 0.5 Cha	nge Close all figures	
Clear	O Euclidean 0.5 Cha	nge	
	Random preference:	File	~ ·
Ivanie	O From file:	ad Dotions	Table Remove Export
	O Mixture from vertices	ve Save About	Details Clear

Under "Data" notice the "Observations:" list has now been populated:

Under "Data", select the dropdown menu next to "Name..." to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

L.5.3 Probabilistic specification: Cash I, Unconstrained Model, Max-Distance (U) Supremum of 1

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supremum" is selected.



To set the "Max-distance (U):" to "1", select "Change..." and enter "1", then select "OK."

	•	\bigcirc	Chan	ge Para	
Max	-dista	ance	(V):		
1					
		(ок	Cancel)

Next, a warning dialog box will pop up, matching the one in the screenshot below. Select "OK".

	Warning
Warning:a.large distar	nce may result in overlapping regions
	ОК

The QTEST interface should now match the screenshot below.

nble pairs	Theories		Hypothesis testing	_
Number of gambles: 5 Change	Unconstrained Vertices:	Reference volume	Run test	Multicore
.B) ^ .C) .D) Set		emove Weight	Theories Specifications Selected Selected	Data sets Selected
.C) .D) .D	Add 🗸			◯ All
LE) D) All E) .E)	Duplicate (A.C): 0 Remove (A.C): 0 (A.E): 0 (A.E): 0 (B.C): 0 Load (B.C): 0	Determine volume from current settings: Set	Type of test ○ Bayes Factor ○ B ● Frequentist ○ A	ayes p & DIC II
~	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000	Change
ata Sample size N: (AB): 11.9 (AC): 4.16 (AC): 2.18 (AE): 2.18 (AE): 2.18 (AE): 2.18	Probabilistic specifications Aggregation-based: O Supermajority O Borda score U Supermajority level: O Softa score	Figure Visualize Over last figure Color scheme:	Chi-bar squared weights simulation sample size: 1000 Change Results:	Random number seed:
(B, C): 8,12 (B, E): 2,18 (C, D): 14,6 (C, E): 5,15 (D, E): 7,13	Distance-based: Max-distance (U): © Supremum 1 Change City-block 0.5 Change	Default ~		^
Clear	O Euclidean 0.5 Change			
Name Set 1 v	Random preference: O From file: Load	File Load Options	Table Remove	✓ Export

L.5.4 Hypothesis Testing: Cash I, Unconstrained Model, Max-Distance (U) Supremum of 1

We are now ready for the Bayes p & DIC test of the unconstrained model maxdistance (U) supremum of 1 probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5. Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

A QTEST			- 🗆 X
Gamble pairs Number of gambles: 5 (A, B) (A, C) (A, D) (A, C) (A, E) Set	Unconstrained Vertices:	Reference volume Add Remove Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
(B, C) (B, D) (B, E) (C, D) (C, E) (D, E) (D, E) (B, C) (C, E) (D, E)	Add Duplicate (A, B): 0 (A, C): 0 (A, D): 0 (A, E): 0 (A, E): 0 Load (B, C): 0 (B, D): 0	Determine volume from current settings: Set	Type of test Bayes Factor Frequentist All
~	(B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data Sample size N: (A.B) 11.9 (A.C): 4.16 (A.D): 2.18 (A.D): 2.18 (B.C): 10.10 (B.E): 2.18 (B.E): 2.18 (B.E): 2.18 (B.E): 2.18 (B.E): 2.18 (B.E): 2.18 (B.E): 2.18 (C.E): 14.6 (C.E): 5.15 (D.E): 7.13 Clear v Name Set 1	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (Supremum City-block 0.5 Ch Euclidean 0.5 Ch Random preference: Orrom fie: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	vel: nge): nge present the sector of the se	Chi-bar squared weights simulation sample size: Readom number seed: 1000 Change 1 Set Results:
	Mixture from vertices S	ave Load Options ave Save About	Table Remove Export Details Clear

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes p & DIC".



Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

QTEST			- 🗆 ×
Gamble pairs Gamble pairs 5 Change (A, B) (A, C) (A, D) (A, D) (A, D) (A, E) Set (A, E)	Unconstrained Vertices:	Add Use reference volume Weight	Hypothesis testing Run test Multicore Run test Auto save Theories Specifications Ø Selected Selected Ø Selected Selected
(B, C) (B, D) (B, E) (C, D) (C, E) (D, E) (D, E)	Add Duplicate (A.C) 0 (A.C) 0 (A.C) 0 Remove (A.E) 0 (A.E) 0 (A.C) 0 (A.D) 0 (A.C) 0 (A.D) 0 (A.C) 0 (A.D) 0 (A.C) 0 (A.D) 0 (A.C) 0 (A.C) 0 (A.C) 0 (A.C) 0 (A.C) 0 (B.C) 0 (B.C) 0 (B.C) 0 (B.C) 0 (B.C) 0 (B.C) 0 (B.C) 0 (B.C) 0	Determine volume from current settings: Set Set volume manually	Type of test Image: State of test Image: State of test Image: State of test
Observations: 20 (A, B): 11.9 20 (A, D): 2.18 (A, D): 2.18 (A, D): 2.18 (B, C): 10, 10 (B, D): 8.12 (B, D): 8.12 (B, D): 8.12 Load (C, D): 14.6 (C, E): 5.15 (D, E): 7, 13	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (U): Supermum City-block 0.5 Change Cit	Figure Visualize Over last figure Color scheme: Default Close all figures	Sample size: 0000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: Random number sed: sed: 1000 Change 1 Set Destils: Unconstrained (Set. 1/bayes-p/5000/1000/1) (sup Unconstrained (Set. 2/bayes-p/5000/1000/1) (sup Unconstrained (Set. 4/bayes-p/5000/1000/1) (sup Unconstrained (Set. 4/bayes-p/5000/1000/1) (sup Unconstrained (Set. 6/bayes-p/5000/1000/1) (sup
Name Set 1 v	Random preference: Criange Prom file: Load Mixture from vertices Save	File Options Options Save About	Unconstrained (Set 90 by sep 5000 (1001)) (sup Unconstrained (Set 90 by sep 5000 (1001)) (sup Table. Remove Export Details Clear

Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected "Details..." for each participant. The layout is a little different, however.

•	•••								Unc	onstrained	.CSV									
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	A Home	Layout	Tables	Charts	Smart	Art For	mulas	Data Re	eview										A 4	£ -
	Edit			Font			Aligr	nment		N	umber		Forr	nat		Cells		Themer	5	
	- I	Fill T Cal	ibri (Body)	× 12	▼ A▲ A		= ab	c 🔻 🚍 wr	an Text +	General		v .		ormal	1 🖳	L				
				(man) -										orman			· ·	Ad - + 1		
P	aste 🥥	Clear • B	$I \ \underline{U}$		🔕 🔻 🔼			2	Merge -	🕞 🔻 %	°.00	Condit	ional B	əd	In	sert Delet	e Format	Themes 4	Aa•	
A1 4 3 0 fata set									F											
	í A	В	C	D	E	F	G	Н	1	J	K	L	M	N	0	Р	Q	R	S	Ē
	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18	
2	Test type	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	bayes_p	
3	Theory	Unconstrain	Unconstrain	 Unconstrain 	 Unconstrain 	 Unconstrain 	 Unconstrain 	Unconstrain	Unconstrain	Unconstrain	Unconstrain	 Unconstrain 	Unconstraine	Unconstrain	Unconstrain	 Unconstrain 	Unconstraine	Unconstraine	Unconstra	
4	Specificat	on sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	sup	
5	Reference	volume																		
6	Lambda																			
7	U	1	1 1	. 1	. 1	. 1	. 1	1	1	1	1	. 1	1	1	1	. 1	1	1		
8	N																			
9	Random s	ee 1	. 1	. 1	. 1	. 1	. 1	1	1	1	1	1	1	1	1	. 1	1	1		
10	Gibbs sam	pl(5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	50	1
11	Burn-In si	e 1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	10	
12	Vertex	V1	VI	V1	VI	V1	V1	VI	V1	VI	V1	V1	V1	V1	VI	V1	V1	V1	V1	
13	Vertex we	ignt																		
10	Vertex L/V																			
15	Likelinood	ratio	0.4570	0.0004	0.4070	0.4140	0.4024	0.5405	0.0000	0.534	0.4740	0.0574	0.527	0.5070	0.0110	0.5420	0.4022	0.500		
10	p-value	0.531	0.4576	0.3284	0.4976	0.4146	0.4824	0.5496	0.3256	0.524	0.4748	0.3574	0.527	0.5272	0.2112	0.5438	0.4032	0.509	0.5.	1
19	Nathing	10 0200	16 0743	19 0202	15 0272	16 7200	16 4052	14 7229	10 1112	16 4753	16 0524	17 7025	16 1049	16 4211	19 1504	15 9916	17 1900	16 4620	16.26	
10	Prior volu	15.5200	10.0743	18.0302	15.5272	10.7255	10.4055	14.7320	10.1112	10.4755	10.0534	17.7025	10.1040	10.4211	10.1304	13.8810	17.1033	10.4025	10.20	
20	Posterior	ine iolume																		
21	Bayes fact	or 1																		
22	Bayes fact	or 2																		
23	Bayes fact	or exact																		
24	Weighted	p-value																		
25	Weighted	DIC																		
26	Weighted	Bayes factor																		1
27																				1
28																				1
29																				1
30																				
			Unconstraine	d.csv +																
	N	rmal View	Ready								Sum=0		-							1

The DIC values are in row 18 of the spreadsheet. The DIC value in column "B" listed as "Set 1" is the DIC value for participant 1, listed under "Unconstr."—an abbreviation for the unconstrained model—in Table 2 of QTBC2. Notice the same holds true for the column "C" listed as "Set 2", for participant 2, and so on. From this file, column "Unconstr." of Table 2 can be replicated.

This completes the analysis for Cash I data for the Bayes p & DIC test of the unconstrained model max-distance (U) supremum of 1 probabilistic specification.

Now the user should have replicated all the Cash 1 Bayes p and DIC values of Tables 1 and 2 in QTBC2. To summarize, section L.2 demonstrated the steps in running the Bayes p & DIC test of CPT - KT for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications. Section L.3 demonstrated the steps in running the Bayes p & DIC test of CPT - GE for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications. Then, section L.4 demonstrated the steps in running the Bayes p & DIC test of LH for the .50-majority/modal choice and the .90-supermajority probabilistic specifications. Lastly, section L.5 demonstrated the steps in running the Bayes p & DIC test of LH for the unconstrained model.

M. Table 3 of QTBC2

This section of the tutorial allows a user of QTEST to replicate the Cash 1 Bayes factor values of Table 3 in QTBC2.

Section M.2 demonstrates to a user the steps in running the Bayes Factor test of CPT-KT for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications.

Section M.3 demonstrates to a user the steps in running the Bayes Factor test of CPT-GE for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications.

Then, section M.4 demonstrates to a user the steps in running the Bayes Factor test of \mathcal{LH} for the .50-majority/modal choice and the .90-supermajority probabilistic specifications.

M.1 Gamble pairs

Starting with a clear (or new) QTEST interface, under "Gamble pairs", "Change" the "Number of gambles:" to "5" and then select "All". QTEST should look like the following screenshot.



M.2.1 Theory and Vertex: Cash I, CPT-KT

Under "Theories", select "Load...".

▲ QTEST			- 🗆 X
Gamble pairs Number of gambles: 5 (A, B) (A, C) (A, D) (A, E) (B, C) (B, E) (B, D) (B, E) (C, D) (C, E) (C, E)	Theories Vertices: Add Duplicate Remove Load. Save	Reference volume Use reference volume Weight Determine volume from current settings: Set Set volume manually	Hypothesis testing Run test Run test Run test Run test Auto save Theories Selected All Type of test Bayes Factor Bayes p & DiC Frequentist Sampling: Sample size: 5000 Change
Data Observations: 20 Enter Load Sarve Clear Vame Default V	Probabilistic specifications Aggregation-based: Supermajority 0.5 Change Distance-based: Distance-based: City-block City-block Euclidean Construction Change Caty-block Construction Change	Figure Visualize Over last figure Color scheme: Default Close all figures File Load Options	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Results: Image: Chick of the seed: Image: Chick of the seed: Table. Remove Exont
	Mixture from vertices Save	Save About	I able Remove Export Details Clear

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "TheoriesVertices" folder and open "Vertices_CPT_KT_Cash1.csv". In the dialog box, type "CPT-KT" and select "OK".

• • •	Theory	
Entername	for the ory:	
CPT-KT		
	ОК	Cancel


On the QTEST interface there should now be a list of 22 vertices for CPT - KT under "Theories". Verify your screen matches the screenshot below.

<u>M.2.2 Data: Cash I, CPT-KT</u>

TEST				
mble pairs Number of gambles: 5 Chang AC	Add Remove Load	Vertices: v1 (0.5) v2 (0.5) v3 (0.5) v4 (0.5) v4 (0.5) v5 (0.5) v7 (0	Add Use reference volume Remove Weight Determine volume from current settings: Set	Hypothesis testing Hunce Run test Auto save Theories Selected All Type of test Bayes Factor Frequentist All Multicore Data sets Selected All Data sets Selected Sel
Data Observations:	Probabilistic specificati Aggregation-based: -	(B,E): 0 (C,D): 0	Figure Visualize Over last figure	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set
Enter Load Save	O Borda score	Max-distance (U): 0.5 Change 0.5 Change	Color scheme:	Results:
Clear Default	C Euclidean Random preference:	0.5 Change	File	·
Derault	O From file: O Mixture from verti	Load ces Save	Load Options	Table Remove Export

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "DataSets" folder and open "Cash1.txt".





Under "Data", select the dropdown menu next to "Name..." to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

M.2.3 Probabilistic Specification: Cash I, CPT-KT, .50-Majority/modal choice

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected and that the "Supermajority level:" is set to "0.5".



<u>M.2.4 Hypothesis Testing: Cash I, CPT-KT, .50-Majority/modal</u> <u>choice</u>

We are now ready for the Bayes Factor test of $CPT \ KT$.50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes Factor".



Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		Ū
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.



Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "OG" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

•	•••									PI_GE_BF.	csv								
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4	A	В	C	D	E	F	G	Н		J	K	L	M	N	0	P	Q	R	S
1	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1
2	Test type	bayes_facto	r bayes_facto	r bayes_factor	bayes_facto	r bayes_factor	bayes_factor	bayes_facto	r bayes_factor	bayes_factor	bayes_factor	bayes_facto	r bayes_facto	r bayes_factor	bayes_facto	r bayes_factor	bayes_facto	r bayes_factor	bayes_factor
3	Theory	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
4	Specificatio	n major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference v	oiume																0.5	
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0	U																		
0	N Random cou			1		1			1	1			1	1	1	1		1	
10	Gibbs comp	E 5000	E E000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17	v18
13	Vertex weig	ht																	
14	Vertex L/U																		
15	Likelihood r	atio																	
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volum	e 0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vo	0.0046751	0.00048861	6.59E-06	0.00016155	1.79E-08	4.24E-09	4.69E-13	4.69E-13	5.19E-17	1.87E-19	0.00941455	3.40E-05	3.40E-05	3.76E-09	3.76E-09	4.16E-13	9.87E-14	2.42E-12
21	Bayes facto	r1																	
22	bayes facto	4 7073	0.5000077	0.00074510	0.105.400	1 025 05	4 345 00	4 005 10	4 005 10	5 315 14	1 005 10	0.0405	0.0240105	0.0340105	2.055.05	2.055.05	4 205 10	1.015.10	2 405 00
23	Weighted p	4.7873. waluo	0.500337	0.00074513	0.165426	1.83E-05	4.34E-06	4.60E-10	4.80E-10	5.31E-14	1.925-16	9.6405	0.0348185	0.0348185	3.65E-06	3.852-06	4.265-10	1.01E-10	2.48E-09
24	Weighted D	-value																	
26	Weighted B	a 0.68954	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545	0.689545
27	weighted b	0.00554	0.000040	0.003040	0.003343	0.003040	0.003343	0.003343	0.003040	0.003343	0.003343	0.003343	0.005040	0.003040	0.003343	0.003040	0.003040	0.003343	0.033343
28																			
29																			
30																			
31	1																		
		<	CPT_GE_BF.cs	V +)															
	Non	mal View	Ready								Sum=0		-						

The weighted Bayes factor values are in row 26 of the spreadsheet. Notice the same Bayes factor repeats for all the columns "B" through "W" listed as "Set 1"—this is where the Bayes factor for participant 1 can be found, listed under "0.50 Majority Choice" and "KT" in Table 3 of QTBC2. Notice the same holds true for all the columns "X" through "AS" listed as "Set 2", for participant 2, and so on.

Note, however, that the weighted Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select "Change…" next to "Sample size:" under "Hypothesis testing" and "Gibbs sampling:". Then, in the "Gibbs sampling" dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column "KT" under "0.50 Majority Choice" of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of CPT- \mathcal{KT} .50-majority/modal choice probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes Factor test of CPT- \mathcal{KT} , but now with a .90-supermajority probabilistic specification in the following two sections, M.2.5 and M.2.6.

<u>M.2.5 Probabilistic Specification: Cash I, CPT-KT, .90-Supermajority</u>

If continuing from section M.2.4, select "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes Factor test of CPT-KT.50-majority/modal choice probabilistic specification from the QTEST interface.

12	QIEST			
	Gamble pairs	Theories		Hypothesis testing
	Number of gambles: 5 Change	CPT-KT Vertices:	Reference volume	Run test
		v1 [0.5] ^ Add	Use reference volume	Auto save
	(A,B)	v2 [0.5] v3 [0.5] Remr	Woight	Theories Specifications Data sets
	(A,D) Set	✓ v4 [0.5]	Weight	Selected Selected Selected
	(A,E) (B,C)	v5 [0.5] v6 [0.5]		
	(B,D) None	Add v7 i0.51		
	(B,E) (C,D) All	Duplicate (A,B): 0	Determine volume	Type of test
	(C,E)	Remove (A,D): 0	settings:	Bayes Factor Bayes p & DIC
	(D,E)	(A,E): 0 Used (B,C): 0	Jei	◯ Frequentist ◯ All
		(B,D): 0		Gibbs sampling:
	~	Save (C.D): 0	Set volume manually	Sample size: 5000 Change
				Burn-in size: 1000 Change
	Data	Probabilistic specifications	Figure	
	Observations:	Aggregation-based:	Vicualiza	Chi-bar squared weights Random number simulation sample size: seed:
	Sample size N: (A B): 119	Supermajority level:	VISUAIIZE	
	20 (A,C): 4,16	0.5 Change	Over last figure	1000 Change 1 Set
	(A,D). 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
	(B,C): 10,10 (B,D): 8.12	Distance-based: Max-distance (LI):	Default ~	CPT-KT (Set 1/bayes-f/5000/1) (major)
	(B,D): 0,12 (B,E): 2,18			CPT-KT (Set 2/bayes-t/5000/1) (major) CPT-KT (Set 3/bayes-t/5000/1) (major)
	(C,D): 14,6 (C,E): 5.15	O Supremum		CPT-KT (Set 4/bayes-f/5000/1) (major)
	(D,E): 7,13	Ocity-block 0.5 Change	Close all figures	CPT-KT (Set 5/bayes-f/5000/1) (major)
	Clear	Euclidean 0.5 Change		CPT-KT (Set 7/bayes-f/5000/1) (major) CPT-KT (Set 8/bayes-f/5000/1) (major)
	~	o.o onalige		CPT-KT (Set 9/bayes-f/5000/1) (major)
	Name Set 1 ~	Random preference:	File	CP1-K1 (Set 10/bayes-t/5000/1) (major)
		C From file: Load	Load Options	Table Remove Expos
		O Mixture from vertices Save	Save About	Details Clear
			A A A A A A A A A A A A A A A A A A A	Cristil

Whether the user is continuing from section M.2.2 or M.2.4, the QTEST interface should match the screenshot below.

Samble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices:	Reference volume	Run test Auto save
(A,B) (A,C) (A,D) (A,E) (B,C)	v2 [0.5] v3 [0.5] v4 [0.5] v6 [0.5] v6 [0.5]	move Weight	Theories Specifications Data sets • Selected • Selected • Selected • All • All • All • All
(B,D) None (B,E) (C,D) All (C,E) (D,E)	Aud vZ10.51 v Duplicate (A.B).0 (A.C):0 Remove (A.D):0 (A.E):0 Load (B.C):0 (A.E):0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn in size: constant
Data	Probabilistic specifications	Figure	Chi.bar squared weights Random number
Observations: Sample size N:	Aggregation-based: Supermajority level:	Visualize	simulation sample size: seed:
(A, B), 11.9 (A, C): 4,16 (A, D): 2,18 (A, D): 2,18	Supermajority O.5 Change	Over last figure	1000 Change 1 Set
Enter (A,E). 2, 10 (B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default ~	^
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Change		
Save (C,E): 5,15 (D,E): 7,13	O City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name. Set 1 ×	Random preference:	File	~
	O From file: Load	Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected. To set the "Supermajority level:" to "0.9", select "Change…" and enter "0.9", then select "OK."

• •	Change Para							
Supermajority Level (Lambda):								
0.9								
	OK Cancel							

The QTEST interface should now match the screenshot below.

A QTEST			– 🗆 ×
Gamble pairs	Theories	Reference volume	Hypothesis testing Multicore
Number of gambles: 5 Change (A,B) (A,C)	Venuces: v1 (0.9) v2 (0.9) v2 (0.9) Rem	1 Use reference volume	Run test Auto save Theories Specifications Data sets
(A,D) Set (A,E) (B,C) (B,D) None	✓ V4 [0.9] V5 [0.9] v5 [0.9] Add v6 [0.9] v7 [0.9] v7 [0.9]	Thogen	Selected All All All All
(B,E) (C,D) All (C,E) (D,E)	Duplicate (A, B): 0 (A, C): 0 (A, C): 0 Remove (A, D): 0 (A, E): 0 Set Load (B, C): 0	Determine volume from current settings: Set	Type of test • Bayes Factor • Bayes p & DIC • Frequentist • All
	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data Observations: Sample size N: (A BV 11.9	Probabilistic specifications Aggregation-based: Supermajority level:	Figure Visualize	Chi-bar squared weights Random number simulation sample size: seed:
20 (A,C): 4,16 (A,D): 2,18 (A,E): 2,18	O Borda score 0.9 Change	Over last figure Color scheme:	1000 Change 1 Set Results:
(B,C): 10,10 (B,D): 8,12 (B,E): 2,18 (C,D): 14.6	Distance-based: Max-distance (U): O Supremum 0.5 Change	Default ~	^
Save (C,E): 5,15 (D,E): 7,13	City-block 0.5 Change	Close all figures	
Name Set 1	Change	File	~
TRUTC	From file: Load Mixture from vertices Save	Load Options	Table Remove Export
		Jave ADOUL	Details Olean

M.2.6 Hypothesis Testing: Cash I, CPT - KT, .90-Supermajority

We are now ready for the Bayes Factor test of CPT - KT.90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

▲ QTEST		- 🗆 X
Gamble pairs	Theories	Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices: Reference volume	Run test Auto save
(A,B) (A,C)	V2 [0.9] V3 [0.9] V3 [0.9] V3 [0.9]	Theories Specifications Data sets
(A,D) (A,E) (B,C)	v5 [0.9]	
(B,D) None (B,E)		Tune of test
(C,D) All (C,E) (D,E)	Duplicate (A, C): 0 Determine volume Remove (A, D): 0 From current Set Load (B, C): 0 Set Set	Bayes Factor Bayes p & DIC Frequentist All
~	(B,D) 0 (B,E) 0 (C,D) 0 (C,D) 0	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications	1000 Change
Observations:	Aggregation-based: Visualize Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 11.9 (A,C): 4,16	Supermajority O.9 Change Over last figure	1000 Change 1 Set
(A,D): 2,18 (A,E): 2,18	O Borda score Color scheme:	Results:
(B,C): 10,10 (B,D): 8,12	Distance-based: Default V	^
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Change	
(D,E): 7,13	City-block 0.5 Change Close all figures	
Clear	Change	
Name Set 1	Random preference:	~
	O From file: Load Options	Table Remove Export
	Mixture from vertices Save Save About	Details Clear

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes Factor".



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Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		U
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

Gamble pairs			Theories					Hypothesis testing		
Number of gamb	es: 5	Change	CPT-KT	Vertices:		Reference	volume	F	tun test	Auto save
(A,B) (A,C) (A,D) (A,E) (B,C)	^	Set	V	v2 [0.9] v2 [0.9] v3 [0.9] v4 [0.9] v5 [0.9] v6 [0.9]	Re	Add Use r	eference volume Weight	Theories Selected All	Specifications -	Data sets Selected All
(B,D) (B,E) (C,D) (C,E) (D,E)		All	Duplicate Remove Load	v7 (0.9) (A,B): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0 (B,C): 0		Determ from cu settings	ine volume rrent Set	Type of test Bayes Frequences	s Factor O Ba ventist O All	yes p & DIC
	~		Save	(B,E): 0 (C,D): 0	~	Setv	volume manually	Gibbs samp Sample Burn-in	ling: size: 5000 size: 1000	Change
Data Sample size N 20 Enter Load Save Clear	Obser (A,B) 1 (A,C): 4 (A,C): 2 (B,C): 1 (B,D): 8 (B,E): 2 (C,D): 1 (C,E): 5 (D,E): 7	vations: 1.0 16 18 18 18 0,10 12 18 4,6 15 13 V	Probabilistic specifics Aggregation-based Supermajority Borda score Distance-based Supremum City-block Euclidean	titions Supermajo 0.9 Max-distan 0.5 0.5 0.5	change Change Change Change Change	Figure Ove Color Defau Clos	risualize r last figure scheme: t e all figures	Chi-bar square simulation san Results: CPT-KT (Set 2 CPT-KT (Set 2 CPT-KT (Set 2 CPT-KT (Set 2 CPT-KT (Set 6 CPT-KT (Set 6 CPT-KT (Set 6 CPT-KT (Set 6 CPT-KT (Set 6) CPT-KT (Set 6) CPT-KT (Set 6)	Ad weights F pipe size: s Change Daves.//5000/1) (n 2/bayes.//5000/1) (n 3/bayes.//5000/1) (n 3/bayes.//5000/1) (n 3/bayes.//5000/1) (n 3/bayes.//5000/1) (n 3/bayes.//5000/1) (n	Random number eeed: Set. Najor) najor) najor) najor) najor) najor) najor) najor) najor)
Name	Set 1	~	Random preference	1	Load	File Load	Options	Table	Remove	Export
			O Mixture from ver	rtices	Save	Save	About	Dotaile	Cloar	

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "OG" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

•	••									PI_KI_BF.	CSV								
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3	Theory	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT	CPT-KT
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11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17	v18
13	Vertex weig	ght																	
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20	Posterior w	ol 9.60E-36	5 9.19E-42	7.90E-52	8.59E-44	4.20E-60	4.12E-64	2.01E-80	2.01E-80	9.85E-97	7.60E-109	9.68E-34	7.47E-46	7.47E-46	3.65E-62	3.65E-62	1.79E-78	1.75E-82	1.91E-74
21	Bayes facto	r1																	
22	Bayes facto	r 2 0.605.34	0.105.33	7 005 43	9 505 34	4 305 50	4 1 25 54	2.015.70	2.015.70	0.055.07	7 605 00	0.695.34	7 475 36	7 475 26	2 655 52	2 655 52	1 705 69	1 755 70	1.015.64
23	Moightod g	1 9.00E-20	9.190-32	7.906-42	0.395-34	4.202-30	4.120-34	2.010-70	2.010-70	9.032-07	7.602-99	9.000-24	7.476-30	7.472-30	3.036-52	3.050-52	1.792-08	1.750-72	1.910-04
24	Weighted F																		
26	Weighted B	a 4.44E-25	5 4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25	4.44E-25
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		<>>>	CPT_KT_BF.cs	v +							_								1
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The weighted Bayes factor values are in row 26 of the spreadsheet. Notice the same Bayes factor repeats for all the columns "B" through "W" listed as "Set 1"— this is where the Bayes factor for participant 1 can be found, listed under "0.90 Supermajority" and "KT" in Table 3 of QTBC2. Notice the same holds true for all the columns "X" through "AS" listed as "Set 2", for participant 2, and so on.

Note, however, that the weighted Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select "Change…" next to "Sample size:" under "Hypothesis testing" and "Gibbs sampling:". Then, in the "Gibbs sampling" dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column "KT" under "0.90 Supermajority" of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of CPT- \mathcal{KT} .90-supermajority probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes Factor test of CPT- \mathcal{KT} , but now with a random preference probabilistic specification in the following two sections, M.2.7 and M.2.8.

M.2.7 Probabilistic Specification: Cash I, CPT-KT, Random Preference

If continuing from section M.2.6, click "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes Factor test of CPT-KT.90-supermajority probabilistic specification from the QTEST interface.

A QTEST			- X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices:	Reference volume	Run test Auto save
(A,B)	V10.9 V2[0.9] V3[0.9]	Use reference volume	Theories Specifications Data sets
(A,D) Set	v (4 [0.9] v5 [0.9]	vveignt	Selected Selected Selected
(B,C) (B,D) None	Add v6 [0.9] v7 [0.9]		
(B,E) (C,D) All	Duplicate (A,B): 0 A	Determine volume from current	Type of test
(D,E)	(A,D): 0 (A,E): 0	et Set	Frequentist All
	(B,D): 0 (B,E): 0	Set volume manually	Gibbs sampling:
`	((C.D): 0		Sample size: 5000 Change
Data	Probabilistic specifications	Figure	Title
Observations:	Aggregation-based:	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 11,9	Supermajority	Over last figure	1000 Change 1 Set
20 (A,C). 4, 10 (A,D): 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
Enter (B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default ~	CPT-KT (Set 1/bayes-f/5000/1) (major)
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Change		CPT-KT (Set 3/bayes-f/5000/1) (major) CPT-KT (Set 4/bayes-f/5000/1) (major)
Save (C,E): 5,15 (D,E): 7,13	City-block 0.5 Change	Close all figures	CPT-KT (Set 5/bayes-f/5000/1) (major) CPT-KT (Set 6/bayes-f/5000/1) (major)
Clear	O Euclidean 0.5 Change		CPT-KT (Set 7/bayes-f/5000/1) (major) CPT-KT (Set 8/bayes-f/5000/1) (major) CPT-KT (Set 9/bayes-f/5000/1) (major)
Name Set 1 V	Random preference:	File	CPT-KT (Set 10/bayes-f/5000/1) (major)
	From file: Load	Load Options	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

Whether the user is continuing from section M.2.2 or M.2.6, the QTEST interface should match the screenshot below.

Gamble pairs		Theories			Hypothesis testing
Number of gambles:	5 Change	CPT-KT Vertices:	A Add	Reference volume	Run test Auto sav
(A,B) (A,C)	^	v2 [0.9] v3 [0.9]	Remov	Use reference volume Weight	Theories Specifications Data sets
(A,D) (A,E) (B,C)	Set	V4 [0.9] V5 [0.9] V6 [0.9]			Selected Selected Selected Selected All All All
(B,D)	None	Add v7 [0.9]	~		
(C,D)	All	Duplicate (A,B): 0 (A,C): 0	^	Determine volume from current	Iype of test Bayes Eactor Bayes n & DIC
(D,E)		Remove (A,D). 0 (A,E): 0 (B,C): 0	Set	settings: Set	C Frequentist All
		Load (B,D): 0 (B,D): 0		Set volume manually	Gibbs sampling:
	~	Save (C D): 0	~	Oct volume manually	Sample size: 5000 Change.
Data		Probabilistic specifications		Figure	Burn-In size: 1000 Change.
	Observations:	Aggregation-based:	in the levels	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N:	(A,B): 11,9	Supermajority	Change	Over last figure	1000 Change 1 S
20	(A,D): 2,18 (A,E): 2,18	O Borda score	onunge	Color scheme:	Results:
Enter	(B,C): 10,10 (B,D): 8,12	Distance-based: Max-dis	ance (U):	Default ~	
Load	(B,E): 2,18 (C,D): 14,6	O Supremum 0.5	Change		
Save	(C,E): 5,15 (D,E): 7,13	O City-block 0.5	Change	Close all figures	
Clear		O Euclidean 0.5	Change		
Name	Set 1	Random preference:		File	
		O From file:	Load	Load Options	Table Remove Export
		O Mixture from vertices	Save	Save About	Details Clear

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Mixture from vertices" under "Random preference:" is selected.

QTEST			- ×
Gamble pairs	Theories		-Hypothesis testing
Number of gambles: 5 Change	CPT-KT Vertices:	Reference volume	Run test Auto save
(A,B) (A,C) (A,D)	V2 V3 V4	emove Weight	Theories Specifications Data sets Operation Operation Operation Operation
(A,E) (B,C) (B,D) None	V5 V6 V7		
(B,E) (C,D) All (C,E) (D,E)	Duplicate (A, B): 0 (A, C): 0 (A, C): 0 (A, D): 0 (A, E): 0	Determine volume from current settings: Set	Type of test Bayes Factor Frequentist All
~	Load (B,C): 0 (B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	- Drehabilistia anasificationa	,,	Burn-in size: 1000 Change
Observations:	Aggregation-based:	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
20 (A, C): 4,16 (A, D): 2 18	O Supermajority 0.9 Change	Over last figure	1000 Change 1 Set
(A,E): 2,18 (B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Color scheme: Default	Results:
Load (B,E): 2,18 (C,D): 14,6 (C,D): 515	O Supremum 0.5 Change		
Save (D,E): 7,13	City-block 0.5 Change	Close all figures	
Clear	Euclidean 0.5 Change		
Name Set 1 ~	Random preference:	File	
		Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

M.2.8 Hypothesis Testing: Cash I, CPT-KT, Random Preference

We are now ready for the Bayes Factor test of CPT - KT random preference probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

QTEST		– 🗆 X
Gamble pairs Number of gambles: 5 Change (A,D) (A,C)	CPT-KT Vertices: Vertices: V2 V3 Reference volume Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets
(A,C) (A,E) (B,C) (B,D) (C,D) (C,C) (C,C) (D,E) (D,E) (All (All (A,E) (B,C) (B,C) (B,C) (B,C) (B,C) (B,C) (B,C) (B,C) (B,C) (B,C) (B,C) (B,C) (B,C) (C,C) (B,C) (C,C	Vois Vois Vois Vois Vois Vois Upplicate (A, B) 0 Remove (A, D) 0 (A, E) 0 Set Load (B, C) 0 (B, D) 0 Set	Selected Selected Selected Al Al Type of test • Bayes Factor Frequentist Al Gibbs sampling:
Data	Probabilistic specifications	Sample size: 5000 Change Burn-in size: 1000 Change
Observations: Sample size N: (A, C): 4,16 20 (A, C): 2,18 (A, E): 2,18 (A, E): 2,18	Aggregation-based: Supermajority level: Borda score Distance-based: Visualize Visualize Over last figure Color scheme: Distance-based: Visualize	Chi-bar squared weights seet: Random number seet. 1000 Change 1 Set Results:
(B, D): 8,12 (B, E): 2,18 (C, D): 14,6 (C, E): 5,15 (D, E): 7,13 Clear	Max-distance (U): O Supremum 0.5 Change O City-block 0.5 Change Euclidean 0.5 Change	
Name Set 1	Random preference: File File Load Options Options	Table Remove Export
	Mixture from vertices Save Save About	Details Clear

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes Factor".



Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

[📣 QTEST										-	- 🗆 ×
	Gamble pairs			Theories						Hypothesis testing		
i.	Number of gambles:	5	Change	CPT-KT	Vertices:		Add	Reference volum	ne	R	un test	Auto save
	(A,B) (A,C) (A,D) (A,E)	^	Set	~	v2 v3 v4 v5	F	temove	Use referen	ht	Selected	Specifications Selected	Data sets
	(B,C) (B,D)		None	Add	vo v7	~					All	
	(B,E) (C,D) (C,E) (D,E)		All	Duplicate Remove	(A,B): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0		Set	Determine vo from current settings:	Set	Type of test Bayes Freque	s Factor O Bay ventist O All	res p & DIC
1		~		Save	(B,D): 0 (B,E): 0 (C.D): 0	~		Set volume	e manually	Gibbs sampl Sample	ing: size: 5000	Change
	Data			Probabilistic specifica	ations		F	igure		Durrent	1000	Change
	Sample size N:	Obser (A,B): 1 (A,C): 4	vations:	Aggregation-based	Supermaj	ority level: Change		Visualia	ze	Chi-bar square simulation sam	ed weights F nple size: s Change	tandom number eed:
	Enter	(A,D): 2 (A,E): 2	,18 ,18	Borda score				Color scher	me:	Results:		
	Load Save	(B,C): 1 (B,D): 8 (B,E): 2 (C,D): 1 (C,E): 5 (D,E): 7	0,10 ,12 ,18 4,6 ,15	Distance-based: -	Max-dista	Change		Default		CPT-KT (Set 1 CPT-KT (Set 2 CPT-KT (Set 3 CPT-KT (Set 4 CPT-KT (Set 5	/bayes-f/5000/1) (n //bayes-f/5000/1) (n //bayes-f/5000/1) (n //bayes-f/5000/1) (n //bayes-f/5000/1) (n	nixture) nixture) nixture) nixture) nixture)
	Clear	(D,L). /	,15 V		0.5	Change		Close all li	Igures	CPT-KT (Set 6 CPT-KT (Set 7 CPT-KT (Set 8 CPT-KT (Set 9	i/bayes-f/5000/1) (n 1/bayes-f/5000/1) (n 1/bayes-f/5000/1) (n 1/bayes-f/5000/1) (n	nixture) nixture) nixture) nixture)
	Name	Set 1	~	Random preference	¢		Fi	le		CRT-KT (Set 1	0/bayes-f/5000/1) (mixture)
				O From file:		Load		Load	Options	Table	Remove	Export
				Mixture from ver	tices	Save		Save	About	Details	Clear	
ĺ.												

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.

承 QTEST							- 🗆 :
Gamble pairs		Theories			Hypothesis testing		_
Number of gan	bles: 5 Change	CPT-KT	Add	Reference volume	F	tun test	Multicore
(A,B) (A,C) (A,D) (A,E)	Set	V2 V3 V4 V5	Remove	e Weight	Theories Selected	Specifications	Data sets
(B,C) (B,D) (B,E) (C,D) (C,E) (D,E)	None	Add Vo V7 (A B): 0 (A,C): 0 (A,C): 0 Remove (A,E): 0 (A,E): 0 (B,C): 0	V Set	Determine volume from current settings:	Set O Frequ	s Factor Bay	yes p & DIC
	~	(B,D): 0 (B,E): 0 (C,D): 0	~	Set volume man	Gibbs samp Sample	ing: size: 5000	Change
Data Sample size	Observations: N: (A,B): 11,9	Probabilistic specifications Aggregation-based: Supermajority	ajority level:	Figure Visualize	Chi-bar squar simulation san	ed weights F nple size: s	Change Random number seed:
20 Enter	(A,C): 4,16 (A,D): 2,18 (A,E): 2,18	O Borda score	Change	Color scheme:	Results:		
Load Save	(B,C): 10,10 (B,D): 8,12 (B,E): 2,18 (C,D): 14,6 (C,E): 5,15 (D,E): 7,13	Distance-based: Supremum 0.5 City-block 0.5	Change	Default Close all figures	CPT-KT (Set CPT-KT (Set CPT-KT (Set CPT-KT (Set CPT-KT (Set CPT-KT (Set	1/bayes-1/5000/1) (n 2/bayes-1/5000/1) (n 3/bayes-1/5000/1) (n 4/bayes-1/5000/1) (n 5/bayes-1/5000/1) (n 6/bayes-1/5000/1) (n	nixture) nixture) nixture) nixture) nixture) nixture)
Clear		O Euclidean 0.5	Change		CPT-KT (Set CPT-KT (Set CPT-KT (Set	7/bayes-f/5000/1) (n 8/bayes-f/5000/1) (n 9/bayes-f/5000/1) (n	nixture) nixture)
Name	Set 1 V	Random preference:		File	CPT-KT (Set	10/bayes-f/5000/1)	(mixture)
		O From file:	Load	Load Of	ptions Table	Remove	Export.
		Mixture from vertices	Save	Save A	About Details	Clear	

The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

		•								C	PT_KT_BF.	CSV								
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13 Vertex weight 14 <th14< th=""> <th14< th=""> 14</th14<></th14<>	12	Vertex	1000	y1	1000 v1	v1	v1	v1	1000	v1	v1	1000	1000 v1	v1	1000 v1	1000	v1	v1	1000	1000 v1
14 vertex 1/J 15 Markholaratio 15 Markholaratio 16 Priving 18 Markholaratio 19 Vertex 1/J 19 Vertex 1/J 19 Vertex 1/J 10 Vertex 1/J 19 Vertex 1/J 10 Vertex 1/J 11 Vertex 1/J 12 Vertex 1/J	13	Vertex weigh	ht	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1	*1
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17 Varing	16	p-value																		
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24 Weighted p-value 25 Weighted Bayes factor 26 Weighted Bayes factor 27 Particular State 28 Particular State 29 Particular State 29 Particular State 29 Particular State 29 Particular State 29 Particular State 29 Particular State 20 Particul	23	Bayes factor	exact																	
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IIII Normal View Rearby	31		+ + +	CPT_KT_BF.cs	v / + /															111
		UIII Norra	nal Maw	Ready	~							Sum-0		-						

The Bayes factor values are in row 22 of the spreadsheet. The Bayes factor in column "B" listed as "Set 1" is where the Bayes factor for participant 1 can be

found, listed under "Mixture" and "KT" in Table 3 of QTBC2. Notice the same holds true for column "C" listed as "Set 2", for participant 2, and so on.

Note, however, that the Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select "Change…" next to "Sample size:" under "Hypothesis testing" and "Gibbs sampling:". Then, in the "Gibbs sampling" dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column "KT" under "Mixture" of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of CPT - KT random preference probabilistic specification.

M.3.1 Theory and Vertex: Cash I, CPT-GE

Q TEST		- 0	×
Gamble pairs Number of gambles: 5 Change (A.B) (A.C) (A.D) (A.E) (B.C) (B.C) (B.C) (B.C) (B.C) (C.C) (C.C	Theories Vertices: Add Add	Reference volume Hypothesis testing Multicore Use reference volume Run test Auto save Weight Selected Selected All All All	d
(B,D) NOR (B,E) (C,D) (C,E) (D,E) V	Duplicate Remove Load Save	Determine volume from current settings: Type of test Image: Set wolume manually Image: Sample size:	
Data Observations: 20 Enter Load Clear	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Supremum 0.5 Change City-block 0.5 Change City-block 0.5 Change	Figure Burn-in size: 1000 Change Figure Chi-bar squared weights simulation sample size: Random number seed: Over last figure 1000 Change 1 Color scheme: Esuts: Close all figures ^	
Name Defaut V	Random preference. Cod	File v Load Options Table Remove Export Save About Details Clear	

Under "Theories", select "Load...".

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "TheoriesVertices" folder and open "Vertices_CPT_GE_Cash1.csv". In the dialog box, type "CPT-GE" and select "OK".

• • (Theory	
Enternam	efortheory:	
CPT-GE		
	ОК	Cancel

On the QTEST interface there should now be a list of 11 vertices for CPT-GE under "Theories". Verify your screen matches the screenshot below.

▲ QTEST			- 🗆 ×
Gamble pairs Number of gambles: 5 (A,B) (A,C) (A,D) (A,E)	Vertices: v2 0 5 v3 0 5 v4 0 5 v4 0 5 v5 0 5	Reference volume Use reference volume Weight	Auto save Run test Auto save Theories Secifications Data sets Selected Selected
(B,C) (B,D) (B,E) (C,D) (C,C) (C,E) (D,E)	Add Vo (0.5) V/ 10.51 Duplicate (A.C.):0 (A.C.):0 (A.C.):0 (A.C.):0 (A.C.):0 (A.C.):0 (B.C.):0 (B.C.):0 (B.D.):0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling:
~	Save ((B,E): 0 (D): 0	Set volume manually	Sample size: 5000 Change Burn-in size: 1000 Change
Data Observations: 20 Enter Load Giear	Probabilistic specifications Aggregation-based: Supermajority levet: Borda score Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Dodos parferemen	Figure Visualize Over last figure Color scheme: Default Close all figures	Chi-bar squared weights Random number size: Results:
Name Default ~	Random preterence:	lead Ontions	×
	Mixture from vertices Save	Save About	Details Clear

M.3.2 Data: Cash I, CPT-GE

TEST					
mble pairs	Theories			Hypothesis testing	
Number of gambles: 5 Change	CPT-GE	Vertices:	Reference volume	Run	test Auto sav
A,B) A,C) A,D) A,E) Set		V [0.5] V3 [0.5] V4 [0.5] V5 [0.5] V5 [0.5]	nove Weight	Theories Selected All	Specifications Data sets Selected All All All All All All All A
S(J) None 3(E) .0) 2(E) All 0(E)	Add Duplicate Remove	(A, B), 0 (A, C); 0 (A, C); 0 (B, C); 0 (B, C); 0	Determine volume from current settings: Set	Type of test Bayes F Frequen	actor OBayes p & DIC tist OAll
~	Save	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling Sample siz Burn-in siz	r: ze: 5000 Change. e: 1000 Change
ata Observations:	Probabilistic specificat Aggregation-based:	ions	Figure	Chi-bar squared simulation sample	weights Random numbe e size: seed:
Sample size N:	Supermajority Borda score	Supermajority level: 0.5 Change	Over last figure	1000 (Results:	Change 1 S
Enter	Distance-based:	Max-distance (U):	Default ~		,
Load Save	O Supremum	0.5 Change			
Clear	City-block	0.5 Change	Close all figures		
Name Default ~	Random preference:		File		
Delium	O From file:	Load	Load Options	Table	Remove Export
	Mixture from verti	ices Save	Course About	Deteile	Class

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "DataSets" folder and open "Cash1.txt".

Under "Data" notice the "Observations:" list has now been populated: 承 QTEST

	▲ QTEST				- 🗆 X
	Gamble pairs	Theories			Hypothesis testing
6	Number of gambles: 5 Change	CPT-GE Vertices:	A Add	Reference volume	Run test Auto save
	(A, C) (A, C) (A, D) (A, E) Set	v2 (0.5) v3 (0.5) v4 (0.5) v5 (0.5) v6 (0.5)	Remove	Use reterence volume Weight	Theories Specifications Data sets Selected Selected Selected All All All
	(B,C) (B,D) None	Add V0 [0.5] v7 [0.5]	~		
	(C, D) All (C, E) (D, E)	Duplicate (A, B): 0 (A, C): 0 (A, C): 0 Remove (A, D): 0 (A, E): 0 (B, C): 0	Set	Determine volume from current settings: Set	Iype of test Bayes Factor Bayes p & DIC Frequentist All
	~	(B,D): 0 (B,E): 0 (C,D): 0	~	Set volume manually	Gibbs sampling: Sample size: 5000 Change
		Desk skillstig og sillsstiger		·	Burn-in size: 1000 Change
	Data Observations:	Aggregation-based:	F	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
	Sample size N: (A,B): 11,9 20 (A,C): 4,16	Supermajority 0.5	Change	Over last figure	1000 Change 1 Set
	(A,D): 2,18 (A,E): 2,18	O Borda score		Color scheme:	Results:
	(B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance	ce (U):	Default ~	^
	Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5	Change		
	Save (C,E): 5,15 (D,E): 7,13	Ocity-block 0.5	Change	Close all figures	
	Clear	O Euclidean 0.5	Change		
	Name Set 1	Random preference:	Fi	ile	~
		O From file:	Load	Load Options	Table Remove Export
	Ú	O Mixture from vertices	Save	Save About	Details Clear

Under "Data", select the dropdown menu next to "Name..." to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

M.3.3 Probabilistic Specification: Cash I, CPT -GE, .50-Majority/modal choice

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected and that the "Supermajority level:" is set to "0.5".



M.3.4 Hypothesis Testing: Cash I, CPT~GE, .50-Majority/modal choice

We are now ready for the Bayes Factor test of CPT-GE .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

▲ QTEST		– 🗆 X
Gamble pairs Gamble pairs Number of gambles: 5 Change (A C) (A D) (A E) (A E)	Vertices: Reference volume Vertices: Vertices: Vertices: Vertices:	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets © Selected © Selected © Selected
(B,D) (B,E) (C,D) (C,C) (C,E) (D,E)	Add V7 (0.5) V Duplicate (A,B) 0 Add Remove (A,C) 0 From current Load (B,C) 0 Set Save (B,C) 0 Set volume manually	Type of test Bayes Factor Frequentist Gibbs sampling: Con
Data Data Data Dotevations: (AC) 4.16 (AC) 4.16 (AC) 2.18 (BC) 0.10 (BC) 8.12 Load (C.E) 5.15 (D.E) 7.13 Clear	Probabilistic specifications Aggregation-based: Supermajority Borda score Distance-based: Max-distance (U): Supermum 0.5 Change City-block 0.5 Change City-block 0.5 Change Close all figures	Sample size: 5000 Change Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed. 1000 Change 1 Set Results:
Name Set 1 V	Random preference. File From file: Load O Mixture from vertices Save	Table Remove Export Details Clear

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes Factor".



Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		U
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

Gamble pairs			Theories						Hypothesis testing		
Number of gam	oles: 5	Change	CPT-GE	Vertices: v1 (0.5)		Refere	ence volume		R	un test	Multicore
(A,B) (A,C) (A,D) (A,E) (B,C)	^	Set	-	v2 [0.5] v3 [0.5] v4 [0.5] v5 [0.5] v6 [0.5]	Re	move	weight.		Selected All	Specifications Selected All	Data sets
(B,D) (B,E) (C,D) (C,E) (D,E)		None	Add Duplicate Remove Load	X7 [0.5] (A,B): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0		Det from setti	ermine volum n current ings:	ne Set	Type of test Bayes Frequ	s Factor OBay	es p & DIC
	~		Save	(B,D): 0 (B,E): 0 (C.D): 0	~	S	Set volume m	anually	Gibbs sampl Sample	ing: size: 5000	Change
Data Sample size 20 Enter	Obser N: (A,B): 1 (A,C): 4 (A,D): 2 (A,E): 2	vations:	Probabilistic specifica Aggregation-based Supermajority Borda score	Supermaj	ority level: Change	Figure	Visualize Over last figu olor scheme:	ıre :	Chi-bar square simulation sam	ed weights R nple size: s Change	andom number eed:
Load Save	(B,C): 1 (B,D): 8 (B,E): 2 (C,D): 1 (C,E): 5 (D,E): 7	0,10 ,12 ,18 4,6 ,15 ,13	Oistance-based:	Max-dista 0.5 0.5	Change	De	efault Close all figu	res	CPT-GE (Set CPT-GE (Set CPT-GE (Set CPT-GE (Set CPT-GE (Set CPT-GE (Set CPT-GE (Set	1/bayes-f/5000/1) (n 2/bayes-f/5000/1) (n 3/bayes-f/5000/1) (n 4/bayes-f/5000/1) (n 5/bayes-f/5000/1) (n 6/bayes-f/5000/1) (n	najor)
Clear		~	OEuclidean	0.5	Change				CPT-GE (Set 8 CPT-GE (Set 8	B/bayes-f/5000/1) (n B/bayes-f/5000/1) (n B/bayes-f/5000/1) (n	najor) najor)
Name	Set 1	~	Random preference		Load	File	ıd	Options	Table	10/bayes-f/5000/1) Remove	Export
			O Mixture from ve	rtices	Save	Sa	ve	About	Details	Clear	

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "GQ" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

	••								CP1	[_GE_BF5	0.csv								
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	A Home	Layout	Tables	Charts	SmartA	Art For	mulas (Data Re	view										_ ^ ‡
	Edit			Font			Align	iment		N	mber		For	mat		Cells		Themes	
	🖲 🖕 💽 F	ill * Cali	bri (Body)	▼ 12	• A• A•	-	≡ 📰 ab	💌 🗒 Wra	ap Text *	General		•	- N	ormal] 🚬 🚪	🚳	-	Aa -	•
Pa	iste 🥥 🕻	Clear * B	ΙU		<u>∕</u> s - <u>A</u>	• = 3	E 🗏 🔄	2	Merge -	🥞 🔻 %	°,0,€,0	00 Condit	ional B	əd	In	sert Delet	e Format	Themes 4	Aa≁
	A1	: 😔	💿 (= f	Data set	1														
2		В	С	D	E	F	G	Н	1	J	K	L	M	N	0	Р	Q	R	S
	Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2
2	Test type	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_facto	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_facto	bayes_facto	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor	bayes_factor
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specificatio	n major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5	Reference v	olume																	
6	Lambda	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	U																		
8	N																		
9	Random see	H 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Gibbs samp	le 5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in size	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
13	Vertex weig	ht																	
14	Vertex L/U																		
15	Likelihood r	atio																	
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volum	e 0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656	0.00097656
20	Posterior vo	0.00467512	0.00048861	6.59E-06	0.00016155	1.79E-08	4.24E-09	4.69E-13	4.69E-13	5.19E-17	1.87E-19	3.77E-19	7.23E-31	3.05E-30	4.09E-27	3.90E-22	1.08E-19	2.99E-17	8.28E-15
21	Bayes facto	r 1																	
22	Bayes facto	r 2																	
23	Bayes facto	r 4.78732	0.500337	0.00674513	0.165426	1.83E-05	4.34E-06	4.80E-10	4.80E-10	5.31E-14	1.92E-16	3.86E-16	7.41E-28	3.12E-27	4.19E-24	3.99E-19	1.11E-16	3.06E-14	8.48E-12
24	Weighted p	-value																	
25	Weighted D	IC																	
26	Weighted B	a 0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	0.49635	71.4165	71.4165	71.4165	71.4165	71.4165	71.4165	71.4165
27																			
28																			
29	-																		
30	-																		
31	-	< C	PT_GE_BF .5	0.csv / + /															10
	HII Nor	mal View	Ready								Sum=0		-						

The weighted Bayes factor values are in row 26 of the spreadsheet. Notice the same Bayes factor repeats for all the columns "B" through "L" listed as "Set 1"—this is where the Bayes factor for participant 1 can be found, listed under "0.50 Majority Choice" and "GE" in Table 3 of QTBC2. Notice the same holds true for all the columns "M" through "W" listed as "Set 2", for participant 2, and so on.

Note, however, that the weighted Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select "Change…" next to "Sample size:" under "Hypothesis testing" and "Gibbs sampling:". Then, in the "Gibbs sampling" dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column "GE" under "0.50 Majority Choice" of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of CPT-*GE*.50-majority/modal choice probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes Factor test of CPT-*GE*, but now with a .90-supermajority probabilistic specification in the following two sections, M.3.5 and M.3.6.

M.3.5 Probabilistic Specification: Cash I, CPT-GE, .90-Supermajority

If continuing from section M.3.4, select "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes Factor test of CPT-GE .50-majority/modal choice probabilistic specification from the QTEST interface.

-	QIESI			
-	Gamble pairs	Theories	Reference volume	Hypothesis testing
	Number of gambles: 5 Change	CPT-GE Vertices:		Run test Auto save
	(A,B) (A,C)	V 0.5 V2 [0.5] V3 [0.5]	Add Use reference volume Remove Weight	Theories Specifications Data sets
	(A,D) Set	V4 [0.5]		Selected Selected Selected
	(B,C) (B,D) None	Add v6 [0.5] v7 [0.5]		
1	(B,E) (C,D) All	Duplicate (A,B): 0 (A,C): 0	Determine volume from current	Type of test
	(D,E)	Remove (A,D): 0 (A,E): 0 (B,C): 0	Set Set	Frequentist All
		(B,D): 0 (B,E): 0	Set volume manually	Gibbs sampling:
	~	((C.D): 0 *		Sample size: 5000 Change
				Burn-in size: 1000 Change
	Data	Probabilistic specifications	Figure	Chi-bar squared weights Random number
	Observations:	Aggregation-based:	Visualize	simulation sample size: seed:
	Sample size N: (A,B): 11,9	Supermajority		1000 Change 1 Set
	20 (A,C): 4,16 (A,D): 2,18	0.5 Change	Over last ligure	
	(A,E): 2,18 (B,C): 10.10	Distance based	Color scheme:	Results:
	(B,C): 10,10 (B,D): 8,12	Max-distance (U):	Default	CPT-GE (Set 1/bayes-f/5000/1) (major)
	Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Change		CPT-GE (Set 3/bayes-f/5000/1) (major) CPT-GE (Set 4/bayes-f/5000/1) (major)
	Save (C,E): 5,15 (D,E): 7,13	City-block 0.5 Change	Close all figures	CPT-GE (Set 5/bayes-f/5000/1) (major) CPT-GE (Set 6/bayes-f/5000/1) (major)
	Clear	O Euclidean 0.5 Change		CP1-GE (Set //bayes-t/5000/1) (major) CPT-GE (Set 8/bayes-t/5000/1) (major) CPT-GE (Set 9/bayes-t/5000/1) (major)
	Name Cat 1	Random preference:	File	CPT-GE (Set 10/bayes-f/5000/1) (major)
	Name Set 1	O From file: Load	Load Options	Table Remove Exerct
		O Mixture from vertices Save	Save About	Details Clear

Whether the user is continuing from section M.3.2 or M.3.4, the QTEST interface should match the screenshot below.

Samble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-GE Vertices: v1 [0.5] v2 [0.5]	Reference volume Id Use reference volume	Run test Auto save
(A,C) (A,D) (A,E) Set	v3 [0.5] v4 [0.5] v5 [0.5]	weight	Selected Selected Selected
(B,C) (B,D) None	Add v7.10.51		
(B,E) (C,D) Ali (C,E) (D,E)	Duplicate (A.B) 0 Remove (A.C): 0 (A.C): 0 (A.C): 0 (A.C): 0 (A.C): 0 Se	Determine volume from current settings: Set	Type of test
v	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling. Sample size: 5000 Change Burn-in size: 4000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Bandom number
Observations:	Aggregation-based: Supermajority level:	Visualize	simulation sample size: seed:
Sample size N: (A,B): 11.9 20 (A,C): 4,16 (A,D): 2,18	Supermajority O Borda score	Over last figure	1000 Change 1 Set
Enter (A,E): 2,18 (B,C): 10,10	Distance-based: Max distance (II):	Default ~	Results.
Load (B,E): 2,18 (C,D): 14.6	Supremum 0.5 Change		
Save (C,E): 5,15 (D,E): 7,13	O City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Set 1	Random preference:	File	~
Name Set 1	O From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save		

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected. To set the "Supermajority level:" to "0.9", select "Change…" and enter "0.9", then select "OK."

• •	Change Para
Superma	ajority Level (Lambda):
0.9	
	OK Cancel

The QTEST interface should now match the screenshot below.

▲ QIEST		- X
Gamble pairs	Theories	Hypothesis testing
Number of gambles: 5 Change	CPT-GE Vertices:	erence volume Run test Auto save
(A B) (A C) (A D) (A E) Set	v2 [0 9] v3 [0 9] Add v4 [0 9] K6 [0 9] Remove	Use reference volume Weight. Data sets Specifications Data sets Selected Selected Selected Selected
(B,C) (B,D) None	Add v6 [0.9]	
(B,E) (C,D) All (C,E) (D,E)	Duplicate (A,B):0 A Remove (A,D):0 Set Load (B,C):0 Set	etermine volume Type of test om current Image: Bayes Factor Bayes p & DIC Etlings: Set Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually Gibbs sampling. Sample size: 5000 Change Burnin size: 4000 Change
Data	Probabilistic specifications Figure	1000 Change
Observations:	Aggregation-based:	Chi-bar squared weights Random number Visualize simulation sample size: seed:
Sample size N: (A,B): 11,9 (A,C): 4 16	Supermajority O 9 Change	Over last figure 1000 Change 1 Set
20 (A,D): 2,18 (A,D): 2,18	O Borda score	Color scheme: Results:
Enter (B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Change	
Save (C,E): 5,15 (D,E): 7,13	City-block 0.5 Change	Close all figures
Clear	O Euclidean 0.5 Change	
Name Set 1	Random preference:	~ ~ ~
	O From file: Load	.oad Options Table Remove Export
	O Mixture from vertices Save	Save About Details Clear

M.3.6 Hypothesis Testing: Cash I, CPT-GE, .90-Supermajority

We are now ready for the Bayes Factor test of CPT-GE.90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

- direst									
Gamble pairs		Theories					Hypothesis testing		Multicoro
Number of gambles:	5 Change	CPT-GE	ertices:		Reference volum	e	F	tun test	Auto save
(A,B)	^	V2[[0.9]	Add	Use referen	ce volume	Theories	Specifications	Data sets
(A,C) (A,D)	Set	v3 v4[[0.9]	Remove	Weig	ht	 Selected 	 Selected 	OSelected
(A,E) (B,C)		Add V5	[0.9]						 All
(B,D) (B,E)	None		B): 0		Determine vel		Type of test		
(C,D) (C,E)	All	Dupilcate (A,C	C): 0		from current	une	Bave	s Factor OBa	ves p & DIC
(D,E)		(A,E	E): 0	Set	Settings.	Set	⊖ Frequ	uentist O All	
		Load (B,I	D): 0		Octurbury		Gibbs samp	ling:	
	~	Save (C.I	D): 0 ¥		Set volume	manually	Sample	size: 5000	Change
							Burn-in	size: 1000	Change
Data		Aggregation-based:	,	Fi	gure		Chi-bar square	ed weights F	Random number
Sample size N:	(A B): 11.9	Suparmajarity	Supermajority level:		Visualiz	e	Simulation Sal	ipic 5ize.	
20	(A,C): 4,16 (A,D): 2,18	Barda asoro	0.9 Change		Over last fi	gure	1000	Change	1 Set
Enter	(A,E): 2,18 (B,C): 10.10	Dida scole			Color schen	ne:	Results:		
	(B,D): 8,12	Distance-based:	Max-distance (U):		Default	~			^
Load	(C,D): 14,6	O Supremum	0.5 Change						
Save	(D,E): 5,15 (D,E): 7,13	City-block	0.5 Change		Close all fig	gures			
Clear		OEuclidean	0.5 Change						
Name	Set 1	Random preference:		File	e				~
Name	our	O From file:	Load		Load	Options	Table	Remove	Export
		Mixture from vertices	Save		Save	About	Details	Clear	

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes Factor".



Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		U
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

Gamble pairs Image: Source of gambles: Set: Source of gambles: Number of gambles: Number of gambles: Set: Source of gambles: Number of gambles: Number of gambles: Set: Source of gambles: Number of gambles: Number of gambles: Set: Source of gambles: Number of gambles: Number of gambles: Set: Source of gambles: Number of gambles: Number of gambles: Set: Source of gambles: Number of gambles: Numer of gambles: Number of gambles: Nu	- 🗆 X
Number of gambles: 5 Change Vertices: Reference volume (A,C) (A,C) (A,C) (A,C) (A,C) (A,C) (A,D) (A,E) (B,D) (B,D) (B,D) (B,D) (B,D) (B,D) None Add (A,C) (A,C) (A,C) (A,C) (B,D) None Add (A,C) (A,C) (A,C) (A,C) (B,D) None Add (A,C) (A,C) (A,C) (A,C) (B,D) None Add (A,C) (A,C) (A,C) (A,C) (A,C) (B,D) None Add (A,C) (A,C)<	
A3 V2 (0.9	Auto save
(B,D) None V.119.1 (B,D) Duplicate	Data sets O Selected All
Data Probabilistic specifications Sample size N: Figure Gibbs sampling: (G,D): 0 Set volume manually Gibbs sampling: Sample size: 5000 Burn-in size: 1000 1000 Set volume manually Figure Othear squared weights simulation sample size: 5000	yes p & DIC
Data Probabilistic specifications Figure Observations: Aggregation-based: Visualize	Change
20 (AC) 4.16 (A, D) 2.18 (A, D) 2.18 (B, D) 8.12 Supermajority 0.9 Change Load. (B, D) 8.12 (B, D) 8.12 Borda score Distance-based: Color scheme: Color scheme: Color scheme: CPT-GE (Set Thayes-ff:000/1)(CPT-GE (Set Zhayes-ff:000/1)(CPT-GE (Set Zhayes-ff:000/1)(CPT-GE (Set Shayes-ff:000/1)(CPT-GE (Set Shayes-ff:000/1)(CPT	Aandom number sed: Set major) major) major) major) major) major) major) major) major) major)
Name Set 1 V Random preference: File ONLOG: [Set 10bayes: \$1000/1] O From file: Load Dptions Table Remove	Export
Mixture from vertices Save Save About Details Clear	

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "GQ" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

								CP.	r_GE_BF9	0.csv								
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A Home	Layout	Tables	Charts	SmartA	Art For	mulas	Data Re	eview										^
Edit			Font			Aligi	nment		N	umber		For	mat		Cell	s	Themes	5
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Paste 🥥	Clear • B	ΙU		<u>м - А</u>	•		÷ 📄	Merge -	🥞 🔹 %)	↓00 ↓.0 Condit	ional B	ad	In In	sert Dele	te Format	Themes 4	Aa∙
A1	: 8	• • (• f	x Data se	t							Forma	ung					2	
A	B	C	D	E	F	G	н			K	L	M	N	0	Р	0	R	S
Data set	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 1	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2	Set 2
2 Test type	bayes_facto	r bayes_facto	bayes_facto	r bayes_factor	bayes_facto	bayes_facto	r bayes_factor	bayes_facto	bayes_factor	bayes_factor	r bayes_facto	bayes_facto	bayes_factor	bayes_facto	r bayes_facto	or bayes_facto	r bayes_factor	bayes_fact
3 Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4 Specificatio	on major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5 Reference	volume																	
6 Lambda	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	9 0.9	0.9	0.9
7 U																		
8 N																		
9 Random se	e 1	. 1	1	1	1	1	. 1	1	1	1	. 1	1	1	1		1 1	. 1	
.0 Gibbs samp	ole 5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	500
1 Burn-in size	e 1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	0 1000	1000	1000
.2 Vertex	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v1	v2	v3	v4	v5	v6	v7
.3 Vertex wei	ght																	
4 Vertex L/U																		
5 Likelihood	ratio																	
.6 p-value																		
.7 Warning																		
L8 DIC																		
9 Prior volum	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-1
Deves for v	01 9.00E-30	9.196-42	7.90E-52	8.596-44	4.206-00	4.126-64	2.016-80	2.016-80	9.855-97	7.60E-109	7.676-107	3.356-144	3.426-140	5.20E-120	1.766-10.	/ 2.286-95	2.955-83	3.83E-7
Bayes facto	97 I																	
2 Bayes facto	0 605 36	0 105 22	7 005 43	9 505 34	4 205 50	4 125 54	2 015 70	2 015 70	0.955.97	7 605 00	7 675 07	2 265 124	2 435 120	5 365 116	1 765 0	7 2 205 05	2 055 72	2 925 6
A Weighted		5.196-32	7.906-42	0.390-34	4.200-50	4.120-04	2.01E-70	2.01E-70	5.652-87	7.000-99	7.0/6-9/	5.55E-134	5.4ZE-130	5.200-110	1.702-9	2.285-83	2.355-73	3.835-0.
Weighted I																		
6 Weighted	3a 8 73E-27	8 73E-27	8 73E-27	8 73E-27	8 73E-27	8 735,27	8 73F-27	8 73E-27	8 73E-27	8 73E-27	8 73E-27	8 00E-05	8 00E-05	8 00E-05	8 00F-09	5 8 00E-05	8 00E-05	8 00F-0
27	0.735-27	0.736-27	0.736-27	0.736-27	0.736-27	0.736-27	0.736-27	0.736-27	0.736-27	0.736-27	0.736-27	0.002-03	0.002*03	0.002-03	0.002-0.	5 0.00E-03	0.002-03	0.000-0.
28																	-	
9																		
30																	-	
1																		
	(PT_GE_BF9	0.csv +															
	rmal View	Ready								Sum=0		-						

The weighted Bayes factor values are in row 26 of the spreadsheet. Notice the same Bayes factor repeats for all the columns "B" through "L" listed as "Set 1"— this is where the Bayes factor for participant 1 can be found, listed under "0.90 Supermajority" and "GE" in Table 3 of QTBC2. Notice the same holds true for all the columns "M" through "W" listed as "Set 2", for participant 2, and so on.

Note, however, that the weighted Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select "Change…" next to "Sample size:" under "Hypothesis testing" and "Gibbs sampling:". Then, in the "Gibbs sampling" dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column "GE" under "0.90 Supermajority" of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of CPT-GE.90-supermajority probabilistic specification. We will next demonstrate the analysis for the Cash I data for the Bayes Factor test of CPT-GE, but now with a random preference probabilistic specification in the following two sections, M.3.7 and M.3.8.

M.3.7 Probabilistic Specification: Cash I, CPT ~GE, Random Preference

If continuing from section M.3.6, click "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes Factor test of CPT-GE.90-supermajority probabilistic specification from the QTEST interface.

M QIESI			
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-GE Vertices:	Reference volume	Run test Auto save
(A,B) (A,C)	V2 [0.9] V3 [0.9]	Use reference volume Weight	Theories Specifications Data sets
(A,D) Set	✓ V4 [0.9] V5 [0.9]		Selected Selected Selected Selected
(B,C) (B,D) None	Add v7 [0.9]		
(C,D) (C,E) (D,E)	Duplicate (A,C): 0 Remove (A,C): 0 (A,C): 0 (A,C): 0 Load (B,C): 0	Determine volume from current settings: Set	Iype of test O Bayes Factor Bayes p & DIC Frequentist All
~	(B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications	Figure	Burn-in size: 1000 Change
Observations:	Aggregation-based: Supermajority level:	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
(A,B): 11,9 (A,C): 4,16 (A,D): 2,18	Supermajority O.9 Change	Over last figure	1000 Change 1 Set
Enter (A,E): 2,18 (B,C): 10,10	Distance-based:	Color scheme:	CPT-GE (Set 1/bayes-//5000/1) (major)
(B,D): 8,12 (B,E): 2,18 (C,D): 14,6	Max-distance (U):	Deraun	CPT-GE (Set 2/bayes-f/5000/1) (major) CPT-GE (Set 3/bayes-f/5000/1) (major) CPT-GE (Set 4/bayes-f/5000/1) (major)
Save (C,E): 5,15 (D,E): 7,13	O City-block 0.5 Change	Close all figures	CPT-GE (Set 5/bayes-f/5000/1) (major) CPT-GE (Set 6/bayes-f/5000/1) (major) CPT-GE (Set 6/bayes-f/5000/1) (major)
Clear	O Euclidean 0.5 Change		CPT-GE (Set 8/bayes-f/5000/1) (major) CPT-GE (Set 8/bayes-f/5000/1) (major) CPT-GE (Set 9/bayes-f/5000/1) (major)
Name Set 1 ~	Random preference:	File	CPT-GE (Set 10/bayes-f/5000/1) (major)
	From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

Whether the user is continuing from section M.3.2 or M.3.6, the QTEST interface should match the screenshot below.

QIEST			
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-GE Vertices:	Reference volume	Run test Auto save
(A,B) (A,C)	v2 [0.9] v3 [0.9]	Add Use reference volume Remove Weight	Theories Specifications Data sets
(A,D) (A,E) Set	v4 [0.9] v5 [0.9]	Trigit	Selected Selected Selected
(B,C) (B,D) None	Add v6 [0.9] v7 [0.9]		
(B,E) (C,D) All	Duplicate (A,B): 0 (A,C): 0	Determine volume from current	Type of test
(D,E)	Remove (A,D): 0 (A,E): 0 (B,C): 0	Set Set	Frequentist All
	Load (B,D): 0 (B,D): 0 (B,E): 0	Set volume manually	Gibbs sampling:
· · ·	(C.D): 0		Sample size: 5000 Change
Data	Probabilistic specifications	Figure	Chi.bar squared weights Random number
Observations:	Aggregation-based: Supermajority level:	Visualize	simulation sample size: seed:
20 (A,B): 11,9 (A,C): 4,16	Supermajority 0.9 Change	Over last figure	1000 Change 1 Set
(A,D): 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
(B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default ~	^
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Change		
Save (C,E): 5,15 (D,E): 7,13	Ocity-block 0.5 Change.	. Close all figures	
Clear	O Euclidean 0.5 Change		
Name Set 1	Random preference:	File	~ · · · ·
	O From file:	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Mixture from vertices" under "Random preference:" is selected.

Q TEST			- ×
Camble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	CPT-GE Vertices:	Add Use reference volume	Run test Auto save
(A,C) (A,D) Set	V3 V4 V5	Remove Weight	Selected Selected Selected
(B,C) (B,D) None	Add ¥0		
(B,E) (C,D) All (C,E) (D,E)	Duplicate (A, B): 0 A Remove (A, C): 0 (A, D): 0 (A, E): 0 Load (B, C): 0 (B, C): 0 (B, C): 0	Set Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications	- Figure	Burn-in size: 1000 Change
Observations:	Aggregation-based:	Visualize	Chi-bar squared weights Random number simulation sample size: seed:
(A,B): 11,9 (A,C): 4,16	O Supermajority 0.9 Change	Over last figure	1000 Change 1 Set
(A,D): 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
(B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default	^
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5 Change		
Save (C,E): 5,15 (D,E): 7,13	O City-block 0.5 Change	Close all figures	
Clear	O Euclidean 0.5 Change		
Name Set 1 ~	Random preference:	File	✓
	O From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

M.3.8 Hypothesis Testing: Cash I, CPT-GE, Random Preference

We are now ready for the Bayes Factor test of CPT-GE random preference probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".



amble pairs	Theories			Hypothesis testing
Number of gambles: 5 Change	CPT-GE	Vertices:	dd Use reference volume	Run test Auto sav
(A,C) (A,D) (A,E) (B,C)		V3 Ren v4 v5 v6	Nove Weight	Oselected Oselected All OAll OAll
(B,D) None (B,E) (C,D) All (C,E) (D,E)	Duplicate Remove	V7 (A, B): 0 (A, C): 0 (A, C): 0 (A, E): 0 (B, C): 0 (B, C): 0 (B, C): 0	Determine volume from current settings: Set	Type of test
*	Save	(B,D): 0 (B,E): 0 (C,D): 0	Set volume manually	Gibbs sampling: Sample size: 5000 Change. Burn-in size: 1000 Change.
Data Observations:	Probabilistic specifica Aggregation-based:	tions	Figure	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A, B): 11.9 20 (A, C): 4,16 (A, D): 2,18	Supermajority Borda score	0.9 Change	Over last figure	1000 Change 1 Si
(A,E): 2,18 (B,C): 10,10 (B,D): 8,12	Distance-based:	Max-distance (U):	Default ~	Results:
Load (B,E): 2,18 (C,D): 14,6	OSupremum	0.5 Change		
Save (C,E): 5,15 (D,E): 7,13	City-block	0.5 Change	Close all figures	
Clear	, O Euclidean	0.5 Change		
Name Set 1	Random preference:	Load	File Ontions	Table Domous Evont
				rabe Remote Export

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes Factor".

Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.


Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

承 QTEST											- 🗆 ×
Gamble pa	irs		Theories						Hypothesis testing		—
Number	of gambles: 5	Change	CPT-GE	Vertices:			Reference volun	ne	R	un test	Auto save
(A,B) (A,C) (A,D) (A,E)	^	Set	~	v2 v3 v4 v5		Remove	Use referer Weig	ght	Theories Selected	Specifications Selected Au	Data sets
(B,C) (B,D) (B,E) (C,D) (C,E) (D,E)		None	Add Duplicate Remove	V0 V7 (A,B): 0 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 0		Set	Determine vo from current settings:	Set	Type of test	s Factor OBa entist OAll	yes p & DIC
	~		Save	(B,D): 0 (B,E): 0 (C.D): 0	~		Set volume	e manually	Gibbs sampl Sample Burn-in	ing: size: 5000 size: 1000	Change
Data			Probabilistic specifica	tions		F	igure		Chi-bar square	ed weights	Random number
Sam	Obse ole size N: (A B):	ervations:	Supermaiority	Superma	jority level:		Visuali	ze	simulation sam	iple size:	seed:
	20 (A,C): (A,D):	4,16 2,18	Borda score	0.9	Change		Over last f	figure	1000	Change	1 Set
E	(A,E): (B,C):	2,18 10,10	Distance-based:				Color scher	me:	Results:	1/bayos (/5000/1)/	
	(B,D): (B,E):	8,12 2,18		Max-dista	ance (U):		Delault	(CPT-GE (Set 2	2/bayes-f/5000/1) (mixture)
5	ave (C,D): (C,E):	14,6 5,15	City black	0.5	Change				CPT-GE (Set 4 CPT-GE (Set 5	4/bayes-f/5000/1) (5/bayes-f/5000/1) (mixture) mixture)
	(D,E):	7,13	City-block	0.5	Change		Close all fi	igures	CPT-GE (Set 6 CPT-GE (Set 7	5/bayes-f/5000/1) (7/bayes-f/5000/1) (mixture) mixture)
		~	Euclidean	0.5	Change				CPT-GE (Set 8 CPT-GE (Set 9	3/bayes-f/5000/1) (9/bayes-f/5000/1) (mixture) mixture)
N	ame Set 1	~	Random preference:			F	ile		CPT-SE (Set 1	10/bayes-f/5000/1)	(mixtere)
			- From file:		Load		Load	Options	Table	Remove	Export
			Mixture from vert	ices	Save		Save	About	Details	Clear	

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.

	▲ QTEST						-	
	Gamble pairs	Theories				Hypothesis testing		
	Number of gambles: 5 Ch	ange CPT-GE	Vertices:	F	Reference volume	Run t	est	Multicore
	(A,B)		v2	Add	Use reference volume	Theories	Specifications	Data sets
	(A,C) (A,D) Se	t	v v v v v v v v v v v v v v v v v v v	Remove	Weight	Selected	Selected	Oselected
1	(A,C) (B,C) (B,D)	Add	v6 v7					 All
	(B,E) (C,D) A	Duplicate	(A,B): 0 (A,C): 0		Determine volume	Type of test		
	(C,E) (D,E)	Remove	(A,D): 0 (A,E): 0	Set	settings: Set	Bayes Fa Erequenti	ictor OBaye	sp&DIC
		Load	(B,C): 0 (B,D): 0			Gibbs sampling:		
	~	Save	(B,E): 0 (C,D): 0		Set volume manually	Sample size	e: 5000	Change
	Data	Probabilistic specif	fications	- Fig		Burn-in size	e: 1000	Change
ı	Observations:	Aggregation-bas	ed:	Fig	Visualize	Chi-bar squared w simulation sample	veights Ra size: se	ndom number ed:
:	Sample size N: (A,B): 11,9		y Change		Over last figure	1000 C	hange	1 Set
	20 (A,D): 2,18 (A,E): 2,18	O Borda score	0.5 Change.	·	Color scheme:	Results:		
	Enter (B,C): 10,10 (B,D): 8,12	Distance-based:	Max-distance (U):		Default ~	CPT-GE (Set 1/ba	yes-f/5000/1) (mi yes-f/5000/1) (mi	xture)
	Load (B,E): 2,18 (C,D): 14,6	◯ Supremum	0.5 Change.			CPT-GE (Set 3/ba CPT-GE (Set 4/ba	yes-f/5000/1) (mi yes-f/5000/1) (mi	xture) xture)
	Save (C,E): 5,15 (D,E): 7,13	O City-block	0.5 Change.		Close all figures	CPT-GE (Set 5/ba CPT-GE (Set 6/ba	yes-f/5000/1) (mi yes-f/5000/1) (mi	xture) xture)
	Clear	Euclidean	0.5 Change.			CPT-GE (Set 7/ba CPT-GE (Set 8/ba CPT-GE (Set 8/ba	iyes-1/5000/1) (mi iyes-f/5000/1) (mi	xture) xture)
	Name Set 1	 Random preferen 	ice:	File		CPT-GE (Set 10/b	ayes-f/5000/1) (m	nixture)
		O From file:	Load		Load Options	Table	Remove	Export
		Mixture from	vertices Save		Save About	Details	Clear	

The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

•	••								CPI_C	SE_RF_WIX	ure.csv								
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	- -		orr (body)	12			av	··· •• ••	op lext -	ouneral				vormai			• •		10.
Pa	ste 🥥	Clear • B	ΙU		🏇 🔻 🔼	·		2	Merge -	🧐 - %)	.00 \$.0 Condit	ional E	sad	in the second se	sert Delete	e Format	Themes A	\a-
	Δ1	• Ø	(a) (a) f	x Data set								Forma	tung						
-	A	B	6	Dutu sei	F	F	G	н	1	1	K		M	N	0	Р	0	R	S
1	Data set	Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18
2	Test type	bayes_facto	bayes_facto	bayes_factor	bayes_facto	r bayes_facto	r bayes_facto	bayes_facto	bayes_factor	bayes_factor	bayes_facto	r bayes_facto	r bayes_facto	r bayes_facto	bayes_facto	r bayes_factor	bayes_factor	bayes_factor	bayes_factor
3	Theory	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE	CPT-GE
4	Specification	on mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture	mixture
5	Reference	volume																	
6	Lambda																		
7	U																		
8	N																		
9	Random se	e 1	1	1	1	. 1	1	1	1	1	1	. 1	. 1	. 1	. 1	1	1	1	1
10	Gibbs sam	ple 5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
11	Burn-in siz	e 1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
12	Vertex	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1	v1
13	Vertex wei	ght																	
14	Vertex L/U																		
15	Likelihood	ratio																	
16	p-value																		
17	Warning																		
18	DIC																		
19	Prior volun	ne																	
20	Posterior v	olume																	
21	Bayes facto	1 1 1 5 6 09	1 205 07	2 705 00	7 765 20	1.045.03	2 925 15	0.0161074	6 025 10	2 505 06	0.0210970	1 625 07	E 09E 11	0.0007467	2 015 14	0.0640727	3 195 09	0.00050602	0.262527
22	Bayes facto	07 1.13E-08	1.200-07	3.792-09	7.702-25	1.046-07	2.020-13	0.0101074	0.032-10	2.396-00	0.0319879	1.032-07	0.060-11	0.0007407	2.010-14	0.0045727	3.100'00	0.00033032	0.202327
23	Moighted	or exact																	
24	Weighted	pivalue																	
25	Weighted	Bayer factor																	
27	**eigneeu	say as ractor																	
28																			
29							-					-				-			
30																			
31																			
		4 > > (CPT_GE_BF_M	ixture.csv	+/														11
	NO NO	rmal View	Ready								Sum=0		-						

The Bayes factor values are in row 22 of the spreadsheet. The Bayes factor in column "B" listed as "Set 1" is where the Bayes factor for participant 1 can be found, listed under "Mixture" and "GE" in Table 3 of QTBC2. Notice the same holds true for column "C" listed as "Set 2", for participant 2, and so on.

Note, however, that the Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select "Change…" next to "Sample size:" under "Hypothesis testing" and "Gibbs sampling:". Then, in the "Gibbs sampling" dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column "GE" under "Mixture" of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of CPT - GE random preference probabilistic specification.

M.4.1 Theory and Vertex: Cash I, LH

TEST								- 🗆
nble pairs	Theories					Hypothesis testing		_
lumber of gambles: 5 Change		Vertices:		Reference volu	ume		lun toct	Multicore
			Add	Use refere	ence volume	Therefore	Cassifications	Auto save
(,C)			Remove	We	ight	Theories	Specifications	Data sets
AD) Set	×					 Selected 	 Selected 	 Selecte
(C)	Add		~					
s,E)	Duplicate		^	Determine v	volume	Type of test		
;,D) All	Pomovo			from current settings:		Baye	s Factor OB	ayes p & DIC
),E)	Remove		Set	boungo.	Set	⊖ Freq	uentist O A	I
	Load					Gibbs same	lina:	
~	Save		~	Set volum	ne manually	Sample	e size: 5000	Change
						Burn-in	size: 1000	Change
ata	Probabilistic specificati	ons	Fi	gure		Chi har aquar	nd weighte	Dandom number
Observations:	Aggregation-based:	Concernationity Invest		Visua	lize	simulation sar	nple size:	seed:
Sample size N:	 Supermajority 	Supermajority level	-	Over last	tficure	1000	Change	1 Set
20	O Borda score	0.5 Change	<u></u>		riguio			
Enter	Distance based:			Color sche	eme:	Results:		
	Distance-Dased.	Max-distance (U):		Default	~			^
Load	◯ Supremum	0.5 Change	£					
Save	City-block	0.5 Change	.	Close all	lfigures			
Clear	CEuclidean	0.5 Change	.					
Namo	Random preference:		File	e				~
Delduit	O From file:	Load		Load	Options	Table	Remove	Export
	-							

Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "TheoriesVertices" folder and open "Vertices_LH_Cash1.csv". In the dialog box, type "LH" and select "OK".

• •	Theory	
Enterna	mefortheory:	
LH		
	ОК	Cancel



On the QTEST interface there should now be a list of 1 vertex for LH under "Theories". Verify your screen matches the screenshot below.

<u>M.4.2 Data: Cash I, LH</u>

Under "Data", select "Load...".



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Navigate to the "SectionJ_Table5" folder of the tutorial files, and then to the "DataSets" folder and open "Cash1.txt".

▲ QTEST			– 🗆 X
Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Reference volume	Run test Auto save
(A,B) (A,C) (A,D)		Remove Weight	Theories Specifications Data sets
(A,D) (A,E) (B,C)	Add		
(B,D) None (B,E)	Duplicate (A,B): 1	Determine volume	Type of test
(C,E) (D,E)	(A,C): 0 (A,D): 0 (A,E): 0 (A,E): 0	Set	Bayes Factor Bayes p & DIC Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change
	Derbehliste er eifertigen		Burn-in size: 1000 Change
Data	Aggregation-based:	Figure	Chi-bar squared weights Random number simulation sample size: seed:
Sample size N: (A,B): 11,9 (A,C): 4.16	Supermajority	Over last figure	1000 Change 1 Set
20 (A,D): 2,18 (A,E): 2,18	O Borda score	Color scheme:	Results:
(B,C): 10,10 (B,D): 8,12	Distance-based: Max-distance (U):	Default ~	^
Load (B,E): 2,18 (C,D): 14,6 (C,E): 5,15	O Supremum 0.5 Change		
(D,E): 7,13	City-block 0.5 Change	Close all figures	
Clear	Change		
Name Set 1	Random preference:	File	✓
	O From file:	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

Under "Data" notice the "Observations:" list has now been populated:

Under "Data", select the dropdown menu next to "Name..." to see all 18 data sets that have been loaded into the QTEST interface. We now have the Cash I data loaded into QTEST. Next, we create the probabilistic specification.

M.4.3 Probabilistic specification: Cash I, LH, 0.50-

Majority/modal choice

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected and that the "Supermajority level:" is set to "0.5".

amble pairs	Theories			Hypothesis testing	_
Number of gambles: 5 Change	LH Vertices:		Reference volume	Run test	Multicore
(A,B)	LH (0.5)	Add	Use reference volume	Theories Specifications	Data sets
(A,C) (A,D) Set	~	Remove	e Weight	Selected	Selecter
(A,E) (B,C)	Add				
B,D) None None	Duralizata (A.B); 1		Determine volume	Type of test	
C,D) All	(A,C): 0		from current	Bayes Factor Baye	es p & DIC
D,E)	(A,E): 0	Set	Seturigs. Set	◯ Frequentist ◯ All	
	Load (B,D): 0		Catural and an annually	Gibbs sampling:	
~	Save (C.D): 1	~	Set volume manually	Sample size: 5000	Change
				Burn-in size: 1000	Change
Data	Aggregation-based		Figure	Chi-bar squared weights Ra	ndom number
Observations: Sample size N:	Superm	ajority level:	Visualize	simulation sample size. Se	ea.
20 (A,C): 4,16	0.5	Change	Over last figure	1000 Change	1 Sel
(A,D): 2,18 (A,E): 2,18	O Borda so re		Color scheme:	Results:	
(B,C): 10,10 (B,D): 8,12	Distance-based: Max-dis	tance (U).	Default ~		^
Load (B,E): 2,18 (C,D): 14,6	O Supremum 0.5	Change			
(C,E): 5,15 (D,E): 7,13	City-block 0.5	Change	Close all figures		
Clear	O Euclidean 0.5	Change			
Name Set 1	Random preference:		File		~
our i	O From file:	Load	Load Options	Table Remove	Export

M.4.4 Hypothesis Testing: Cash I, LH, 0.50-Majority/modal choice

We are now ready for the Bayes Factor test of LH .50-majority/modal choice probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct. Under "Hypothesis testing", under the "Run test" button, there are 3 columns: "Theories", "Specifications" and "Data sets". For each of these, the user must choose the radio button next to either "Selected" or "All". For more information on these settings, as well as the inputs for "Chi-bar squared weights simulation sample size:" and "Random number seed:", see section G.5.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

▲ QTEST				- 🗆 ×
Gamble pairs	Theories			Hypothesis testing
Number of gambles: 5 Change	LH Vertices:		Reference volume	Run test
(A,B)	LH [0.5]	Add	Use reference volume	Theories Specifications Data sets
(A,C) (A,D) Set	~	Remo	Weight	Selected Selected Selected
(A,E) (B,C)	Add	~		
(B,E)	Duplicate (A,B): 1	^	Determine volume	Type of test
(C,E)	(A,C): 0 Remove (A,D): 0	Sat	from current settings:	Bayes Factor Bayes p & DIC
(D,E)	(A,E): 0 Load (B,C): 1	- Oet.		◯ Frequentist ◯ All
	(B,D): 0 (B,E): 0		Set volume manually	Gibbs sampling:
· · · · ·	(C.D): 1			Burn in size: 1000 Change
Data	Probabilistic specifications		Figure	Total Change
Observations:	Aggregation-based:	and a start store to	Visualize	Simulation sample size: seed:
Sample size N: (A,B): 11,9	Supermajority	najority level:	Over last figure	1000 Change 1 Set
20 ((A,D): 2,18 (A,D): 2,18	O Borda score	Change	Color scheme:	Results:
Enter (B,C): 10,10 (B,C): 10,10	Distance-based: Max-di	stance (U):	Default ~	
Load (B,E): 2,18 (C,D): 14.6	Supremum 0.5	Change		
Save (C,E): 5,15 (D,E): 7,13	City-block 0.5	Change	Close all figures	
Clear		Ohange	Close air ligures	
v		Change		
Name Set 1 ~	Random preference:	Level	File	
	O From the	Load	Load Options	Table Remove Export
	Mixture from vertices	Save	Save About	Details Clear

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes Factor".

mble pairs		Theories					Hypothesis testing		1 1 1 1 1
Number of gambles: 5	Change	LH ^	Vertices:		Reference vo	lume	Ru	ın test	Auto save
A,B) A,C) A,D) A,E) B,C)	Set	V		Re	nove W	eight	Theories • Selected • All	Specifications – Selected All	Data sets - O Selecte
B,D) B,E) C,D) C,E) D,E)	All	Duplicate Remove	(A,B): 1 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 1	S S	Determine from currer settings:	volume tt Set	Type of test Bayes Freque	Factor OBay	ves p & DIC
~		Save	(B,D): 0 (B,E): 0 (C,D): 1	~	Set volu	me manually	Gibbs samplin Sample :	ng: size: 5000	Change
Data		Probabilistic specificati	ions		Figure		Dutt-ins	1000	Change
Observat Sample size N: (A, B): 11.9 20 (A, C): 4,16	ions:	Aggregation-based:	Superma	jority level: Change	Visu	alize st figure	Chi-bar squared simulation samp	d weights R ble size: s Change	tandom number eed: 1 Set
(A,D). 2,18 (A,E): 2,18 (B,C): 10,1	0	Distance-based:	May diete	ance (LI):	Color sch Default	neme:	Results:		^
Load (B,E): 2,18 (C,D): 14,6 (C,E): 5,15	5	Osupremum	0.5	Change					
(D,E): 7,13		City-block	0.5	Change	Close a	ll figures			
Clear	~	Euclidean	0.5	Change					
Name Set 1	~	Random preference:		Load	File				~
		Mixture from verti	005	Save	Load	Options	Table	Remove	Export

Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.



Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

amble pairs		Theories					Hypothesis testing		
Number of gambles:	5 Change	LH ^	Vertices:		Reference	volume	R	lun test	Auto save
(A,B) (A,C) (A,D) (A,E) (B,C)	Set		LTT [0.3]	Rer	Id Use re	ference volume Weight	Theories Selected All	Specifications	Data sets
(0,0) (B,D) (C,D) (C,E) (D,E)	None	Add Duplicate Remove	(A,B): 1 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 1	Se	Determin from curr settings:	ne volume rent Set	Type of test Bayes Frequences	s Factor OBa	yes p & DIC
	~	Save	(B,D): 0 (B,E): 0 (C.D): 1	~	Set vo	blume manually	Gibbs sample	ling: size: 5000	Change
Data		Probabilistic specifica	tions		Figure		Burn-In	size: 1000	Change
Sample size N:	Observations:	Aggregation-based:	Superma	ijority level:	Vi	sualize	Chi-bar square simulation sam	ed weights F nple size: s	Random number seed:
20	(A,C): 4,16 (A,D): 2,18 (A,E): 2,18	Borda score	0.5	Change	Over	last figure scheme:	Results.	Change	
Enter	(B,C): 10,10 (B,D): 8,12	Distance-based:	Max-dist	ance (U):	Default	~	LH (Set 1/baye	es-f/5000/1) (major) es-f/5000/1) (major)	×
Load	(B,E): 2,18 (C,D): 14,6	◯ Supremum	0.5	Change		(LH (Set 3/baye LH (Set 4/baye	es-f/5000/1) (major) es-f/5000/1) (major)	
Save	(D,E): 5,15 (D,E): 7,13	O City-block	0.5	Change	Close	e all figures	LH (Set 5/baye LH (Set 6/baye	es-f/5000/1) (major) es-f/5000/1) (major)	
Clear	~	OEuclidean	0.5	Change			LH (Set 7/baye	es-f/5000/1) (major) es-f/5000/1) (major) es f/5000/1) (major)	
Name	Set 1 V	Random preference			File		H (Set 10/bay	yes-f/5000/1) (majo	0
		O From file:		Load	Load	Options	Table	Remove	Export
		O Mixture from ver	tices	Save	0.000	About		Class	

Of course, it would be quite tedious to look at each individual result, for each data set, for each vertex for each theory. Therefore, under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file. For more information on other ways a user can view the results, see section G.5.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on. All the information in this spreadsheet is identical to what one would see if they selected "Details..." for each participant. The layout is a little different, however.

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The Bayes factor values are in row 23 of the spreadsheet. The Bayes factor in column "B" listed as "Set 1" is where the Bayes factor for participant 1 can be found, listed under ".50 Majority Choice" and "LH" in Table 3 of QTBC2. Notice the same holds true for column "C" listed as "Set 2", for participant 2, and so on.

Note, however, that the Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select "Change…" next to "Sample size:" under "Hypothesis testing" and "Gibbs sampling:". Then, in the "Gibbs sampling" dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column "LH" under ".50 Majority Choice" of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of LH .50-majority/modal choice probabilistic specification. We will, again, demonstrate the analysis for the Cash I data for the Bayes Factor test of LH, but now with a .90-supermajority probabilistic specification in the following two sections, M.4.5 and M.4.6.

M.4.5 Probabilistic specification: Cash I, LH, 0.90-Supermajority

If continuing from section M.4.4, select "Clear" under "Hypothesis testing" and "Results:". This step clears the results of the Bayes Factor test of LH .50-majority/modal choice probabilistic specification from the QTEST interface.

Samble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices: LH [0.5]	dd Use reference volume	Run test Auto save Theories Specifications Data sets
(A,C) (A,D) Set (A,E) (B,C) None	Add V	Weight	Selected Selected Selected All All All
(B,E) (C,D) All (C,E) (D,E)	Duplicate (A,B): 1 A Remove (A,C): 0 (A,D): 0 (A,E): 0 Load (B,C): 1 St	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights chi-ba
Observations: Sample size N: (A, B): 11.9 20 (A, C): 4.16 (A, D): 2.18 (A, D): 2.18	Supermajority Supermajority level: Borda score 0.5	Visualize Over last figure Color scheme:	Simulation sample size seed. 1000 Change 1 Set Results: Set
Enter (B,C): 10,10 (B,D): 8,12 Load (B,E): 2,18	Distance-based: Max-distance (U):	Default	LH (Set 1/bayes-4/5000/1) (major) LH (Set 2/bayes-f/5000/1) (major) LH (Set 3/bayes-f/5000/1) (major)
(C,D): 14,6 (C,E): 5,15 (D,E): 7,13	O Supremum 0.5 Change O City-block 0.5 Change	Close all figures	LH (Set 4/bayes-f/5000/1) (major) LH (Set 5/bayes-f/5000/1) (major) LH (Set 6/bayes-f/5000/1) (major)
Clear	O Euclidean 0.5 Change		LH (Set //bayes-t/5000/1) (major) LH (Set 8/bayes-t/5000/1) (major) LH (Set 9/bayes-t/5000/1) (major)
Name Set 1 ~	Random preference:	File Options	Table Remove Fyeld
	Mixture from vertices Save	Courd Options	rabie Remove Ebolt

Whether the user is continuing from section M.4.2 or M.4.4, the QTEST interface should match the screenshot below.

Gamble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Reference volume	Dup test
	LH [0.5] Add		Auto save
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(A,D) Set	V	we weight	Selected Selected Selected
(A,E)			
(B,D) None	Add 🗸		
(B,E)	Duplicate (A,B): 1	Determine volume	Type of test
(C,E)	Remove (A,D): 0	settings:	Bayes Factor Bayes p & DIC
(D,E)	(A,E): 0 Set.	. Set	◯ Frequentist ◯ All
	Load (B,D): 0		Gibbs sampling
~	Save (B,E): 0 (C,D): 1	Set volume manually	Sample size: 5000 Change
			Burn-in size:
Data	Probabilistic specifications	Figure	1000 Charge
	Aggregation-based:	- iguio	Chi-bar squared weights Random number simulation sample size: seed
Sample size N: (A D) (4.0	Supermajority level:	Visualize	Similari Sampio Sicc. Socia.
(A,C): 4,16	Supermajority 0.5 Change	Over last figure	1000 Change 1 Set
20 (A,D): 2,18	O Borda score	Color scheme:	Results
Enter (A,E): 2,10 (B,C): 10,10	Distance-based:	Default	
(B,D): 8,12 (B,D): 2,12	Max-distance (U):	Deraut	
Load (C,D): 14,6	O Supremum 0.5 Change		
Save (C,E): 5,15	City block 0.5 Change		
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· · · · · · · · · · · · · · · · · · ·	Random preference:	File	
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	Load	Load Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

To set this specification, under "Probabilistic specifications", make sure the radio button left of "Supermajority" is selected. To set the "Supermajority level:" to "0.9", select "Change…" and enter "0.9", then select "OK."

• •	Change	e Para				
Supermajority Level (Lambda):						
0.9						
	ОК	Cancel				

The QTEST interface should now match the screenshot below.

QIESI			
Gamble pairs Number of gambles: 5 Change (A.B) (A.C) (A.D) (A.D) (A.D) Set (A.D)	Vertices:	Add Use reference volume Weight	Hypothesis testing Run test Run test Hypothesis testing Run test Auto save Theories Specifications Selected Selected Au
(B,C) None (B,D) (C,D) (C,D) (C,E) (D,E)	Add. Duplicate (A.D) 1 (A.C) 0 (A.D) 0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC Frequentist All
~	(B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data Observations: Sample size N (A.C): 4,16 20 (A.C): 2,18 (B.C): 2,18 (B.C): 2,18 (B.C): 2,18 (B.C): 2,18 (B.C): 2,18 (B.C): 2,18 (B.C): 2,18 (C.C): 10,10 (B.C): 2,18 (C.C): 10,10 (B.C): 2,18 (C.C): 14,16 (C.C): 14,6 (C.E): 5,15 (D.E): 7,13 (Clear	Probabilistic specifications Aggregation-based: Supermajority level: Borda score Distance-based: City-block City-block Euclidean Distance.	Figure Visualize Over last figure Color scheme: Defaut Visualize Close all figures	Chi-bar squared weights Random number simulation sample size: Seed: 1000 Change 1 Set Results:
Name Set 1	Random preference:	File Options	Table Remove Export
	Mixture from vertices Save	Save About	Details Clear

M.4.6 Hypothesis Testing: Cash I, LH, 0.90-Supermajority

We are now ready for the Bayes Factor test of LH .90-supermajority probabilistic specification for the Cash I data. Before executing this test, we need to verify that the settings are correct.

Under "Hypothesis testing", verify the radio button next to "Selected" is selected under "Theories", the radio button next to "Selected" is selected for "Specifications", and select the radio button next to "All" for "Data sets".

QTEST		- 🗆 X
Gamble pairs Number of gambles: 5 Change	Theories LH Vertices: Reference volume LH Add. Use reference wolume	Hypothesis testing Multicore Auto save
(A,B) (A,C) (A,D) (A,E) (B,C)	Remove Weight	Theories Specifications Data sets Selected Selected Selected All All All
(B,D) None (B,E) (C,D) (C,E) (D,E)	Duplicate (A,B) 1 A Remove (A,C) 0 from current settings: Set Set	Type of test
	(B,D): 0 (B,E): 0 (C,D): 1 (C,D): 1 (C,D): 1	y Gibbs sampling: Sample size: 5000 Change Burn-in size: 4000 Change
Data Observations: 20 (A,C):4,16 20 (A,C):2,18 Enter (B,C):10.10 (B,D):8,12 (B,D):8,12 Load (B,C):2,18 (C,D):14.6 (C,C):5,15 (D,E):7,13 (D,E):7,13	Probabilistic specifications Aggregation-based: Supermajority level: Borda score Distance-based: Max-distance (U) Supermum 0.5 Change Close all figures Elie Elie Elie Elie Elie Elie Elie Elie	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
Name Set 1 ~	C From file: Load Option	ns Table Remove Export
	Mixture from vertices Save Abo	ut Details Clear

Under "Hypothesis testing" and "Type of test", select the radio button next to "Bayes Factor".



Now that all the settings under "Hypothesis testing" are correct, select "Run test". The "Running Hypothesis Test" window will pop up. It starts with an empty, white, horizontal rectangle and fills with red as the analysis progresses.

00	Running Hypothesis Test		U
	Please wait		

Once the analysis is complete, QTEST will now look like the following screenshot. Under "Hypothesis testing", under "Results:", you will see a list of completed analyses.

▲ QTEST				-	
Gamble pairs	Theories			Hypothesis testing	7
Number of gambles: 5 Cl	hange	Vertices:	Add Lice reference volume	Run test	Auto save
(A,B) (A,C) (A,D) (A,E)	et ~		Remove Weight	Theories Specifications Selected Selected Sele	Data sets
(B,C) (B,D) No	Add	~			() All
(B,E) (C,D) (C,E) (D,E)	Duplicate Remove	(A,B): 1 (A,C): 0 (A,D): 0 (A,E): 0 (B,C): 1	Set Determine volume from current settings: Set	Type of test	p & DIC
~	Save	(B,D): 0 (B,E): 0 (C,D): 1	Set volume manually	Gibbs sampling: Sample size: 5000	Change
Data	Probabilistic specifica	ations	Figure	Burn-In size: 1000	Change
Sample size N: Observations: 20 (A, B): 11.9 (A, C): 4,16 (A, C): 2,18	Aggregation-based Aggregation-based Supermajority Borda score	Supermajority level:	Visualize Over last figure	Chi-bar squared weights Ran simulation sample size: see	iom number i: 1 Set
Enter (B,C): 10,10 (B,D): 8,12 Load (B,E): 2,18 (C,D): 14.6	Distance-based:	Max-distance (U): 0.5 Change	Default ~	LH (Set 1/bayes-//5000/1) (major) LH (Set 2/bayes-//5000/1) (major) LH (Set 3/bayes-//5000/1) (major) LH (Set 4/bayes-//5000/1) (major)	
Save (C,E): 5,15 (D,E): 7,13	City-block	0.5 Change	Close all figures	LH (Set 5/bayes-f/5000/1) (major) LH (Set 6/bayes-f/5000/1) (major) LH (Set 6/bayes-f/5000/1) (major)	
Clear	- Euclidean	0.5 Change		LH (Set 7/bayes-f/5000/1) (major) LH (Set 8/bayes-f/5000/1) (major) LH (Set 9/bayes-f/5000/1) (major)	
Name Set 1	Random preference		File	LN (Set 10/bayes f/5000/1) (major)	~
		Load	Load Options	Table Remove	Export
	O Mixture from ve	rtices Save	Save About	Details Clear	

Under "Hypothesis testing", under "Results:", select "Export...". An "Export Results As" window pops up. Navigate to the location to save the file and save it as a .csv file.



The following screenshot shows the .csv file that was just saved. The columns are labeled "Set 1" through "Set 18" in columns "B" through "S" of the spreadsheet. The columns represent different participants; "Set 1" refers to participant 1, "Set 2" refers to participant 2, and so on.

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2 Test ty	pe b	ayes_tacto	bayes_facto	r bayes_tacto	r bayes_tacto	bayes_facto	r bayes_facto	or bayes_tacto	r bayes_facto	r bayes_facto	r bayes_factor	r bayes_facto	r bayes_tacto	r bayes_facto	r bayes_facto	ir bayes_tacto	r bayes_facto	r bayes_factor	bayes_facto
4 Specifi	cation n	n	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major	major
5 Refere	nce volu	ime	major	major	major	major	major	major	major		major	major			major	major			major
6 Lambd	a	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	9.0	0.9	0.9	0.5
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17 Warnin	19																		
8 DIC	-0																-		
9 Prior v	olume	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	0 1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-10	1.00E-1(
0 Poster	ior vol	1.01E-31	1.92E-99	1.80E-80	4.97E-35	8.72E-77	1.49E-27	7 2.42E-68	9.35E-77	6.81E-58	1.83E-65	1.61E-72	4.63E-29	3.07E-52	3.20E-127	7 1.14E-44	\$ 9.01E-82	7.77E-47	1.26E-44
1 Bayes	factor 1																		
2 Bayes	factor 2																		
23 Bayes	factor	1.01E-21	1.92E-89	1.80E-70	4.97E-25	8.72E-67	1.49E-17	7 2.42E-58	9.35E-67	6.81E-48	1.83E-55	1.61E-62	4.63E-19	3.07E-42	3.20E-117	/ 1.14E-34	9.01E-72	7.77E-37	1.26E-34
4 Weigh	ted p-va	lue																	
S Weigh	ted DIC	e fastar																	
vveign	teu daye	IS Idutor																	
28																	+		
29																	-		
30																			
1	1															1	1		L
	14.4	P P L	.H_BF90.cs																
	Norma	View	Ready								Sum=0		-						

The Bayes factor values are in row 23 of the spreadsheet. The Bayes factor in column "B" listed as "Set 1" is where the Bayes factor for participant 1 can be found, listed under ".90 Supermajority" and "LH" in Table 3 of QTBC2. Notice the same holds true for column "C" listed as "Set 2", for participant 2, and so on.

Note, however, that the Bayes factor values vary if the test is replicated with different random seeds for each replicate. The Bayes factor values vary when setting a new seed each time the analysis is run under "Hypothesis testing" and "Random number seed:".

For tutorial demonstration, the default sample size of 5,000 was used. However, it is important to note that sample sizes larger than 5,000 were used to achieve converging Bayes factor values, given these data sets. To increase sample size, select "Change…" next to "Sample size:" under "Hypothesis testing" and "Gibbs sampling:". Then, in the "Gibbs sampling" dialog box, type in the sample size you wish to test. Once the Bayes factor values converge, column "LH" under ".90 Supermajority" of Table 3 can be replicated.

This completes the analysis for Cash I data for the Bayes Factor test of LH .90-supermajority probabilistic specification.

Now the user should have replicated all the Cash 1 Bayes factor values of Table 3 in QTBC2. To summarize, section M.2 demonstrated the steps in running the Bayes Factor test of CPT-KT for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications. Then,

section M.3 demonstrated the steps in running the Bayes Factor test of CPT-GE for the .50-majority/modal choice, the .90-supermajority, and the random preference probabilistic specifications. Lastly, section M.4 demonstrated the steps in running the Bayes Factor test of LH for the .50-majority/modal choice and the .90-supermajority probabilistic specifications.

PART IV: Online Supplements

In this part of the tutorial we recreate Figures 2, 3 and 4 of Online Supplement 1.

N. Figure 2 of online supplement 1

Figure 2 of online supplement 1 is the mixture model specification for the Linear Ordering Polytope.

N.1 Create the gamble pairs

Make sure the gamble pairs match the following screenshot.



N.2 Create the input file

The linear ordering polytope is based on the following system of facet-defining inequalities in 3-dimensional space. These inequalities are:

 $\theta_{AC} - \theta_{AD} + \theta_{AD} \le 1$ $-\theta_{AC} + \theta_{AD} - \theta_{AD} \le 0$

following input file.	
$\Theta \Theta \Theta$	OnlineSupplement_Figure2.txt ▼
2 3 1 -1 1 -1 1 -1	
1 0	
Vertices 1 0 0 "DAC" 0 0 1 "CDA" 1 1 0 "ADC" 0 0 0 "DCA" 1 1 1 "ACD" 0 1 1 "CAD"	

These inequalities, as well as prior literature about them, were also discussed in Regenwetter, Dana, and Davis-Stober (2010, 2011). These inequalities yield the following input file.

This is all the information QTEST needs to analyze this mixture model. Save this file as "OnlineSupplement_Figure2.txt". We now return to the QTEST interface to complete the analysis.

N.3 Mixture model analysis of the Linear Ordering Polytope

In the QTEST interface, under "Probabilistic specifications", under "Mixturebased", select the radio button next to "From file:". Then select "Load...".

	QIEST		
Gamble pairs Number of gambles: 5 Change (AC) (C,D) Set None AI	Theories Vertices: LH LH Add Add Remove Load Save Load Save CAC CDA (CD): 0 (CD): 0 Set. Sat	A	Hypothesis testina Run test Auto save Theories Seecifications Data sets Selected Selected All All Type of test Bayes Factor Bayes p & DIC Frequentist All Gibbs sampling: Sample size: 5000 Change
Data Observations: 20 Enter Load Save Clear Name Defaut	Probabilistic specifications Agregation-based: Supermajority Bords score P Distance-based: Max-distance (U): Supermum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Random preference: Imathematic from file: mix.txt Load Save	Figure Over last figure Color scheme: Default Close all figures File Load Options Save	Burn-in size: 1000 Change Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Results: 1 Set Table Remove Export Details Clear

In the "Load Specification" dialogue box that pops up, change the "Files of type:" to "Text files (*.txt)" and then navigate to the location of the

"OnlineSupplement_Figure2.txt" file. Then select "Open". Under "Figure", select "Visualize".



The figure that pops up is a version of Figure 2 of Online Supplement 1 of QTBC1.



This completes the 3-D example for the mixture model specification of the Linear Ordering Polytope.

O. Figure 3 of Online Supplement 1: CPT - KT with constant volumes vs. LH

Figure 3 of online supplement 1 is like Figure 8 of QTBC1, in that they both compare CPT-KT and LH in the same 3-D space. However, Figure 8 of QTBC1 created a 0.50-majority/modal choice specification (or a 0.90-supermajority specification) of these theories. In generating Figure 3 of online supplement 1, we start with a 0.50-majority/modal choice specification of the predictions for CPT-KT and LH. But then weight the volumes of each cube comprising the predictions of CPT-KT so that the total volume of all its cubes equals the volume of the cube for the single prediction of LH. The reason for this weight, as described in online supplement 1, is to place the theories on an equal footing geometrically, so that CPT-KT is not favored over LH simply because it has more predictions and occupies a larger volume in the geometric space. Here, volume serves as a measure of model complexity for an order-constrained probability model. After completing this section, we will have created Figure 3 of Online Supplement 1.

O.1 Create the gamble pairs



Set the gambles so QTEST matches the screenshot below.

O.2 Define two decision theories, CPT-KT and LH

To create theories "CPT-KT" and "LH", please see Section E above (or you can load the file 'OnlineSupplement_Figure3.mat').

$\Theta \circ \circ$	QTEST		
Gamble pairs Number of gambles: 5 Change (AC) (C,D) Set None All	Add Vertices: Duplicate IAC 0.5 ACD 0.5 ACD 0.5 Add IAC 0.5 ACD 0.5 Add IAC 0.5 ACD 0.5 Add IAC 0.5 ACD 0.5 Save Save	d Reference volume Use reference volume Weight 0.125 Determine volume from current settings: Set Set volume manually	Hypothesis testing Run test Auto save Theories Specifications Data sets Solected Selected All All All All Type of test Bayes Factor Bayes p & DIC Frequentist All All Gibbs samples;: 5000 Change Bayres rest 1000 Change
Data Sample size N: 20 Enter Load Save Clear Name Default	Probabilistic specifications Agregation-based: Supermajority Borda score Pistance-based: Max-distance (U): Supermum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Euclidean 0.5 Change Promotic Component of the state stat	Figure Over last figure Color scheme: Default Close all figures File Load Save About	Burn-n sze: 1000 Change Chi-bar squared weights sed: 1000 Change 1 Set 1000 Change 1 Set Results: Table Remove Export Details Clear

O.3 Specify the predictions of theories LH and CPT-KT

In Section E.3, we specified the predictions for LH and CPT. You may return to Section E.3 or create them as indicated below.

Gamble pairs Number of gambles: 5 Change (AC) (AD) (CD) Set None All	Add Implication Implication Add Duplicate Implicate Implicate Implicate Set.	Reference volume Use reference volume Weight 0.125 Determine volume from current settings:	Hypothesis testing Run test Auto save Theories Specifications Data sets Selected Selected Selected All All All Type of test Bayes Factor Bayes p & DIC © Frequentist All All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burp in size: 1000 Change
Data Sample size N: 20 Enter Load Save Clear	Probabilistic specifications Agregation-based: Supermajority Borda score P Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change	Figure Visualize Over last figure Color scheme: Default ¢ Close all figures	Chi-bar squared weights seed: 1000 Change 1 Set Results:
Name Default \$	Random preference: From file: Mixture from vertices Save	File Load Options Save About	Table Remove Export Details Clear

Under "Theories", under "Vertices:", verify the predictions "DAC", "DCA", "ADC" and "ACD" are listed in any order. The number contained in the square brackets following the prediction represents the probabilistic specification level.



Next, verify that LH has the correct prediction listed. Under "Theories", select "LH" and verify "LH" is listed under "Vertices:".

00	QTEST		
Gamble pairs Number of gambles: 5 (A,D) (C,D) Set	CPT-KT Vertices:	id Reference volume Use reference volume Weight	Hypothesis testing Run test Theories Selected Selected Selected Selected
None All	Add Dupicate Remove Load	0.125 Determine volume from current settings: Set	All All Type of test Bayes Factor Bayes Factor All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
Data Sample size N: 20 Enter Load Save Clear Name Default	Probabilistic specifications Agreation-based: Supermajority level: Bords score Change Distance-based: Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change Random preference: From file: Load Mixture from vertices Save	Figure Visualize Visualize Visualize Visualize Color scheme: Default Close all figures File Load Save About	Chi-bar squared weights simulation sample size: 1000 Change 1 Set Results: Table Remove Export Details Clear

O.4 CPT-KT with constant volumes vs. LH

First verify the "Supermajority level:" is set to "0.5" under "Probabilistic specifications".

Weighting $CPT \ \mathcal{K}T$ and LH is a two-step process. First, we will use the single prediction of LH as the reference volume. In the QTEST interface, under "Theories", select "LH" so that it is gray highlighted.

	Q	IESI	
Gamble pairs Number of gambles: 5 Change (A,C) (A,C	Theories LH Linear Orders CPT-KT	Add Reference volume Use reference volume Weight	Hypothesis testing Run test Auto sav Theories Specifications Data sets Specifications
None All	Add Duplicate (A,C):: (A,C):: (A,D):: (C,D):: Load Save	0.125 Determine volume from current settings: Set Set volume manually	All All All All Objected Selected Objected All Objected Selected Objected Selected <t< td=""></t<>
Data Description D	Probabilistic specifications Agregation-based: Supermajority level: Borda score P Distance-based: Distance-based: Max-distance (U): Supremum 0.5 Change City-block City-block C	Flaure Visualize Over last figure Color scheme: Default Close all figures File	Burn-In size: 1000 Change Chi-bar squared weights Sandom number simulation sample size: seed: 1000 Change 1 Se Results:
Ueraunt	From file: Load Mixture from vertices Save	Load Options Save About	Table Remove Export Details Clear

Under "Reference volume", next to "Determine the volume from current settings:", select "Set". Then select the box next to "Use reference volume".

	Q	1631	
amble pairs Number of gambles: 5 Change A.C) A.D C.D Set	Theories LH Under Orders CPT-KT Unit (0.5)	Add Reference volume Use reference volume Weight	Hypothesis testing Run test Auto save Theories Selected Selected Selected Selected
None	Add Duplicate (A,D): 0 Remove (C,D): 1	0.125 Determine volume from current settings: Set	All All All Type of test Bayes Factor Bayes p & DIC • Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Data Observations: Observations: Control of the servation	Probabilistic specifications Agaregation-based: Supermajority level: Supermajority 0.5 Change Distance-based:	Figure Visualize Over last figure Color scheme: Default *	Chi-bar squared weights Random number simulation sample size: seed: 1000 Change 1 Set Results:
Load Save Clear	Max-distance (U): Supremum 0.5 Change. City-block 0.5 Change. Euclidean 0.5 Change.	Close all figures	
Name Default 💠	Random preference: From file: Load Mixture from vertices Save	File Options	Table Remove Export

Select "Weight...", which is now clickable.



In the "Weight" dialogue box that pops up, enter "1". Select "OK".

0	0	0	Weight	
New	· weig	aht:		
1				
		(ок	Cancel

We now generate an intermediate figure. Under "Figure", change "Color scheme:" to "Blue" from the dropdown menu. (Deselect "Over last figure if it is checked.) Then select "Visualize".

	QIEST		
Gamble pairs Number of gambles: 5 Change (A.C) (A.D) (C,D) Set None All	Theories Vertices: LHear Orders LH (1) (0.5) Add If (A,D): 0 Duplicate If (A,D): 0 Remove (C,D): 1 Save Set	Reference volume Use reference volume Weight 0.125 Determine volume from current settings: Set Set volume manually	Hypothesis testing Run test Auto save Theories Specifications Data sets Selected Selected All All Tvpe of test Bayes Factor Bayes p & DIC o Frequentist All Gibbs sampling:
Data Sample size N: 20 Enter Load Save Clear Name Default	Probabilistic specifications Agaregation-based: Supermajority 0.5 Borda score ? Distance-based: Max-distance (U): Supermum 0.5 Change Change City-block 0.5 Change Euclidean Random preference: Load From file: Load Mixture from vertices Save	Figure Visualize Over last figure Color scheme: Blue Close all figures File Load Save About	Sample size: 0000 Change Burn-in size: 1000 Change Chi-bar guarde weights Random number simulation sample size: seed: 1000 Change 1 Set Results: Table Details Clear

A rotated version of the resulting figure is below. Do not close this figure window. We will visualize the weighted predictions for $CPT \ KT$ within this same window.



In the second step we weight CPT - KT so its total volume matches LH. Under "Theories" select "CPT-KT" so that it is gray highlighted. By default, under "Vertices:" the weights in parentheses have been set to "(1)".



Select "DAC (1) [0.68502]". Then select "Weight..." under "Reference volume".



In the "Weight" dialogue box that pops up, enter ".25" and then press "OK".

0	🖯 🔿 Weight	
Neww	eight:	
.25		
	ОККС	ancel

Under "Vertices" notice "DAC" has been updated to "DAC (0.25) [0.78735]".

	QIESI		
amble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices: Linear Orders DAC (0.25) [0.787355]	Reference volume	Run test Auto save
(A,C) (A,D) (C,D) Set	CPT-KT DCA (1) [0.662447] ADC (1) [0.662447] ACD (1) [0.662447] Remu	Weight	Theories Specifications Data sets O Selected Selected Selected
None	Add	0.125	
All	Duplicate (A,C): 1 (A,D): 0	Determine volume	Type of test
	Remove (C,D): 0 Set.	. settings: Set	• Frequentist All
	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change
			Burn-in size: 1000 Change
Data	Probabilistic specifications	Figure	Chi-bar squared weights Random number
Observations: Sample size N:	Supermajority level:	VISUAIIZE	simulation sample size: seed:
20	Supermajority O.9 Change	Over last figure	1000 Change 1 Set.
Enter		Color scheme:	Results:
Lood	Distance-based: Max-distance (U):	Blue	
Save	Supremum 0.5 Change		
	City-block 0.5 Change	Close all figures	
Clear	Euclidean 0.5 Change		
Name	Random preference:	File	
Detabli	From file: Load	Load Options	Table Remove Export
	Mixture from vertices Save	0	

Repeat this procedure for "DCA", "ADC" and "ACD". Set all weights to ".25". Once finished, the QTEST interface will look like the following screenshot.

• • •	1	QTEST	0
Gamble pairs 5 Change (A,D) (A,D) (C,D) Set None All All Image: All imag	Add Image: Control of the state of the s	Add West reference volume Remove Weight 0.125 Determine volume Set Set	Hypothesis testing Run test Theories Selected All Type of test Bayes Factor Frequentist Sample size: Brune size:
Data Sample size N: 20 Enter Load Save Clear Name Default \$	Probabilistic specifications Aggregation-based: Aggregation-based: Supermajority O.5 Change Distance-based: OS Change City-block OS Change Euclidean CS Change Random orderence: From file: Codd Maxture from vertices Save	Filure Visualize Ovor last figure Color scheme: Blue Close all figures File File Load Options About	Childra guarde weights Random number seed: 1000 Change 1 Set Results: Table Remove Export Details Clear

The 4 predictions of CPT-KT sum to the same volume as the 1 prediction of LH with a 0.50-majority/modal choice specification. We can visualize this weighted version of CPT-KT. Under "Figure", select "Default" from the "Color scheme:" and make sure the box next to "Over last figure" is checked. Then select "Visualize".



The resulting figure, which is a version of Figure 9 of QTBC1, is reproduced below. The coloring scheme is a little different in Figure 9 of QTBC1. But the goal of Section F, to place CPT - KT and LH on an equal footing by giving their predictions equal volumes, is now complete.



P. Figure 4 of Online Supplement 1: CPT-KT with proportional volumes vs. LH

In the previous section, M, each volume was weighted by .25 and the total volume of the 4 predictions of CPT-KT equaled the volume of the single prediction of LH under a 0.50-majority/modal choice specification. However, it is also possible to differentially weight each prediction. After completing this section, we will have created Figure 4 of Online Supplement 1, which gives different weights to each of the predictions of CPT-KT.

P.1 Create the gamble pairs

▲ QTEST			- 🗆 ×
Gamble pairs	United Orders Vertices: Linear Orders Linear Orders CPT-KT Re	Reference volume dd Use reference volume Weight	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Selected Selected
None All	Add Duplicate (A.C) 1 (A.D) 0 (C.D) 1 (C.D) 1 (S)	0.125 Determine volume from current settings: Set	All All Type of test Bayes Factor Bayes p & DIC ● Frequentist All
	Load Save Prohabilistic specifications	Set volume manually	Gibbs sampling: Sample size: 5000 Change Burn-in size: 1000 Change
Sample size N:	Aggregation-based © Supermajority Use Supermajority Level: 0.5 Change	Visualize Visualize Over last figure Color scheme:	Chi-bar squared weights simulation sample size: Seed:
Enter Load Save	Distance-based: Supremum 0.5 Change City-block 0.5 Change	Default ~	^
Clear V Name Default V	O Euclidean 0.5 Change Random preference: O From file: Load	File	Table Remove Export
	O Mixture from vertices Save	Save About	Details Clear

Verify the gamble pairs match the screenshot below.

P.2 Define two decision theories, CPT-KT and LH

Under "Theories", both "CPT-KT" and "LH" should be listed. (If you do not see "CPT-KT" and "LH" listed, return to Section C.2 to define these theories in QTEST, or load a saved session.)

承 QTEST		- 🗆 X
Gamble pairs	Theorise	Hypothesis testing
Number of gambles: 5 Change	LH Vertices:	Perence volume Run test Auto save
(A,C)	CPT-KT DCA [0.5]	Use reference volume Theories Specifications Data sets
(A,D) (C,D) Set	ADC [0.5] Remove	Weight Selected Selected Selected Selected
	Add	
None	Duplicate (A,C): 1	Determine volume Type of test
All	(A,D): 0 (C,D): 0	from current settings: Out OBayes Factor OBayes p & DIC
	Load	Set I Frequentist All
	Save	Gibbs sampling:
~		Burnain size: 5000 Change
Data	Probabilistic specifications Figure	
Observations:	Aggregation-based:	Visualize Simulation sample size: seed:
Sample size N:	Supermajority 0.5 Change	Over last figure 1000 Change 1 Set
20	Borda score ?	Color scheme: Results:
Enter	Distance-based: Max-distance (U);	Default
Load	O Supremum 0.5 Change	
Save	City-block 0.5 Change	Close all figures
Clear	Euclidean 0.5 Change	
×	- Pandam professore:	
Name Default ~	From file:	Load Options Table Remove Evont
	Mixture from vertices Save	Course About Dataile Class
		Save Details Clear

<u>P.3 Specify the predictions of theories LH and CPT - KT</u>

Under "Theories" select "CPT-KT" so it is gray highlighted. Under "Vertices:", verify that the following 4 predictions are listed in any order: "DCA", "DAC", "ADC" and "ACD". (If you need to specify these predictions, return to Section E.3.)

mble pairs	Theories				Hypothesis testing		
Number of gambles: 5 Char		Vertices:	R	eference volume		Puntost	Multicore
	Linear Orders	DAC [0.5]	^ Add	Use reference volume	Theories	Cresifications	Auto save
A,D) C,D) Set		ADC [0.5] ACD [0.5]	Remove	Weight	 Selected 	 Selected 	 Selecter
None	Add	\smile	~	0.125			
All	Duplicate Remove	(A,C): 1 (A,D): 0 (C,D): 0	Set	Determine volume from current settings: Set	Type of test Baye Frequences	s Factor OBay Juentist OAll	es p & DIC
~	Save		~	Set volume manually	Gibbs samp Sample	ling: e size: 5000	Change
					Burn-in	size: 1000	Change
Data	Probabilistic specific	ations I [.]	Figu	re	Chi-bar squar	ed weights R	andom numbe
Observations: Sample size N:		Supermajority level:		Visualize	Simulation sar	npie size. s	eed.
20	Supermajority	0.5 Change	e	Over last figure	1000	Change	1 Se
Entor	Borda score	?		Color scheme:	Results:		
Linei	Distance-based:	Max-distance (U):		Default ~			-
Load	◯ Supremum	0.5 Change	a				
Save	City-block	0.5 Change	è	Close all figures			
Clear	✓ O Euclidean	0.5 Change	.				
Name Default	 Random preference 	2:	File				~
	O From file:	Load		Load Options	Table	Remove	Export
	O Mixture from ve	rtices Save		Save About	Details	Clear	



imble pairs	meones	\sim		- Reference volume	Hypothesis testing		Multicore
Number of gambles: 5	Change	Vertices:			F	un test	Auto save
A.C) A.D) C,D)	CPT-KT		Remove	e Weight	Theories	Specifications Selected	Data sets
	None Add		~	0.125		All	All
	All Duplicate Remove	(A,C): 1 (A,D): 0 (C,D): 1	Set	Determine volume from current settings:	Type of test	s Factor O Ba lentist O All	yes p & DIC
~	Save	j	*	Set volume manual	y Gibbs samp Sample Burn-in	ing: size: 5000 size: 1000	Change.
Data Observation	Probabilistic spec Aggregation-ba	ifications sed: Supermajorit	y level:	Figure Visualize	Chi-bar square simulation san	ed weights F aple size: s	Random numbe seed:
20	O Borda score	? 0.5 0	Change	Color schomo:	Results:		
Enter	Distance-based	t Max dictano	o (LI):	Default	()		,
Load	◯ Supremum	0.5 (Change				
Save	City-block	0.5	Change	Close all figures			
Clear	OEuclidean	0.5	Change				
Name Default	Random prefere	nce:		File			
	O From file:		Load	Load Optio	ns Table	Remove	Export

<u>P.4 Giving CPT - KT proportional volumes (which sum to the total volume of LH)</u>

In the QTEST interface, under "Theories", select "LH" and under "Vertices:", select "LH (1) [0.5]". These will both be highlighted. Select "Use reference volume" if not already checked.



As an intermediate step, we will generate the current figure. Under "Figure", change "Color scheme:" to "Blue" from the dropdown menu and uncheck "Over last figure" if it is checked. Then select "Visualize".

Samble pairs	Theories Vertices		Reference volume	Hypothesis testing	Multicore
(A,C)	Linear Orders LH (1) [0.1 CPT-KT	Add	Use reference volume	Theories	Auto save
(A,D) (C,D) Set	~	Remove	Weight	Selected	 Selecter
None	Add	~	0.125		
All	Duplicate (A,C) 1 (A,D) 0 (C,D) 1 Load (C,D) 1	Set	Determine volume from current settings: Set	Type of test Bayes Factor Bayes Frequentist All	sp&DIC
~	Save	~	Set volume manually	Gibbs sampling: Sample size: 5000	Change
Data Observations:	Probabilistic specifications Aggregation-based:	rmaiority level:	Figure Visualize	Chi-bar squared weights Rar simulation sample size: see	Change Idom number
20	Supermajority Borda score	Change	Over last figure	1000 Change	1 Set
Enter	Distance-based: Max-	distance (U):	Blue V		^
Load	O Supremum 0.1	Change			
Save	City-block 0.	Change	Close all figures		
Clear	C Euclidean 0.1	Change			
Name Default	Random preference:	Load	File Load Options	Table Remove	✓
	Mixture from vertices	Saus		Table	Enport

A rotated version of the resulting figure is below. Do not close this figure window.



We now weight $CPT \ KT$ so its total volume matches that of LH. The weights of each prediction for $CPT \ KT$ are different, unlike Section F where the weights for each prediction of $CPT \ KT$ were the same. While those weights were constant,
these weights are proportional to the portion of the algebraic parameter space associated with each corresponding vertex.

Under "Theories" select "CPT-KT" so that it is gray highlighted. Notice that, under "Vertices" all the weights in parentheses have been set to "(0.25)". And the value in brackets is set to "[0.68502]".



In Figure 10 of QTBC1, DCA is weighted by .4. So, click on "DCA (.25) [0.68502]" so that it is gray highlighted. Then select "Weight…" under "Reference volume".

amble pairs	Theories		Hypothesis testing
Number of gambles: 5 Change	LH Vertices: Linear Orders DAC (0.25) I0 68502	Reference volume	Run test Auto save
(A,C) (A,D) (C,D) Set	CPT-KT DCA (0.25) [0.68502 ADC (0.25) [0.68502 ACD (0.25) [0.68502	Remove Weight	Theories Specifications Data sets • Selected • Selected • Selected
None	Add	✓ 0.125	
All	Duplicate (A, C): 0 Remove (A, D): 0 Load (C, D): 0	Determine volume from current settings: Set	Type of test Bayes Factor Bayes p & DIC • Frequentist All
*	Save	Set volume manually	Gibbs sampling: Sample size: 5000 Change. Burnin size: 1000 Change.
Data	Probabilistic specifications	Figure	Chi bar squared weights Pandom numbe
Observations:	Aggregation-based: Supermajority let	Visualize	simulation sample size: seed:
20	Supermajority 0.5 Cha	ge Over last figure	1000 Change 1 Se
Entor	Borda score ?	Color scheme:	Results:
	Distance-based: Max-distance (U	Blue	
Load	O Supremum 0.5 Cha	ige	
Save	City-block 0.5 Cha	Close all figures	
Clear	CEuclidean 0.5 Cha	ige	
Name Default	Random preference:	File	
	O From file:	Load Options	Table Remove Export
	O Mixture from vertices Sa	ve Save About	Details Clear

In the "Weight" dialogue box that pops up, enter ".4". Select "OK".



Under "Vertices" notice "DCA" has been updated to "DCA (0.4) [0.648366]".

mble pairs		Theories			Hypothesis testin	g	_
Number of gambles: 5	Change	LH	Vertices:	Reference volume		Run test	Multicore
		Linear Orders	DAC (0.25) [0.699357]	Add Vse reference v	volume	One if a fine	Auto save
A,D)			ADC (0.25) [0.699357]	Remove Weight	Ineones	Specifications	Data sets
;,D)	Set	· · · · ·	ACD (0.25) [0.699357]		Selected	Selected	Selecte
	None	Add	~	0.125			
	Hone	Duplicate	(A,C): 0	Determine volume	e Type of test		
	All	Remove	(A,D): 0 (C,D): 0	from current settings;	OBay	es Factor 🛛 🔘 Baye	es p & DIC
		Land		Set	Set Free	quentist OAII	
		Load			Gibbs sam	pling:	
~		Save	~	Set volume ma	Samp	le size: 5000	Change
					Burn-i	n size: 1000	Change
Data		Probabilistic specificati	ons	Figure	Chi-bar squa	red weights Ra	andom number
Obs	ervations:	Aggregation-based.	Supermaiority level:	Visualize	simulation sa	mple size: se	ed:
Sample size N.	^	 Supermajority 	0.5 Change	Over last figur	ie 1000	Change	1 Se
20		OBorda score ?	0.0 Onunge	Color scheme:	Results:		
Enter		Distance-based:		Blue	×		^
Load			Max-distance (U):				
Sava		Supremum	0.5 Change				
Save		O City-block	0.5 Change	Close all figure	es		
Clear		Euclidean	0.5 Change				
Nama		Random preference:		File			~
Dela	m -	O From file:	Load	Load	Options Table	Remove	Export
			Sava				

Repeat this procedure for the 3 remaining vertices, using the following weights:

"ADC" with weight ".02" "DAC" with weight ".01" "ACD" with weight ".57"

mble noire	Theories		Hypothesis testing
nible pars	Vorticos	Reference volume	Multicore
Number of gambles: 5 Change	Linear Orders DAC (0.01) [0.892278]		Run test Auto sav
A,C)	CPT-KT DCA (0.4) [0.631597]	Use reference volume	Theories Specifications Data sets
(,D) (,D) Set	ADC (0.02) [0.864279] ACD (0.57) [0.585433]	Remove Weight	Selected Selected Selected
None	Add	0.125	
All	Duplicate (A,C): 1 (A,D): 1	Determine volume from current	Type of test
	Remove (C,D): 1	Set Set	Bayes Factor Bayes p & DIC
	Load		Frequentist All
	Care	Set volume manually	Gibbs sampling:
~	Save		Sample size: 5000 Change.
			Burn-in size: 1000 Change.
ata	Probabilistic specifications	Figure	Chi-bar squared weights Random number
	ADDIED30005035E0		
Observations:	Supermajority leve	Visualize	simulation sample size: seed:
Observations:	Supermajority	I: Visualize	simulation sample size: seed:
Sample size N:	Supermajority Supermajority O.5 Change	I: Visualize I: Over last figure	simulation sample size: seed:
Observations: Sample size N: 20 Enter	Supermajority leve Supermajority Borda score Distance-based	t Visualize Visualize Color scheme:	simulation sample size: seed: 1000 Change 1 S Results:
Sample size N:	Supermajority Borda score Distance-based: Max-distance (U):	t Visualize Visualize Color scheme: Blue V	simulation sample size: seed: 1000 Change 1 S Results:
Sample size N: 20 Enter	Supermajority Supermajority Borda score 0.5 Distance-based Max-distance (U): Supermum 0.5	t Visualize Visualize Over last figure Color scheme: Blue Visualize	simulation sample size: seed: 1000 Change 1 S Results:
Sample size N: 20 Enter Save	Supermajority Supermajority Borda score 0.5 Distance-based: Max-distance (U): Supermum 0.5 Change City-block	k Visualize Visualize Color scheme: Blue Pe. Close all figures	simulation sample size: seed: 1000 Change 1 S Results:
Sample size N: 20 Enter Load Save	Supermajority 0.5 Change Borda score ? 0.5 Change Distance-based: Max-distance (U): Supermum 0.5 Change O Supermum 0.5 Change Change Change O Supermum 0.5 Change Change	k Visualize Visualize Visualize Color scheme: Blue Color scheme: Close all figures	simulation sample size: seed: 1000 Change 1 S Results:
Sample size N: 20 Enter Load Save Clear	Supermajority Supermajority Borda score ? Distance-based: Max-distance (U): Supermum 0.5 City-block 0.5 Chang Euclidean 0.5	k Visualize Visualize Vover last figure Color scheme: Blue Close all figures Pe	simulation sample size: seed: 1000 Change 1 S Results:
Sample size N: 20 Enter Load Save Clear Default	Supermajority 0.5 Chang Borda score ? 0.5 Chang Distance-based: Max-distance (U): Supermum 0.5 Chang City-block 0.5 Chang Euclidean 0.5 Chang Random preference:	t Visualize Visualize Visualize Color scheme: Blue Close all figures File	simulation sample size: seed: 1000 Change 1 S Results:
Sample Size N: 20 Enter Load Save Clear Name Default	Supermajority Supermajority Borda score 2 Distance-based: Max-distance (U): Supermum 0.5 City-block 0.5 City-block 0.5 Chang Period Random preference: From file: Load	t Visualize Visualize Visualize Color scheme: Blue Close all figures File Load Options	simulation sample size: seed: 1000 Change 1 S Results: Table Remove Export

Once these steps are completed "Vertices:" of the QTEST interface should look like the following screenshot.

Each of the 4 predictions has a different weight and volume. The weights sum to one. We can visualize this weighted version of CPT-KT and compare it to LH. Under "Figure", select "Default" from the "Color scheme:" and make sure the box next to "Over last figure" is checked. Then select "Visualize".

Gamble pairs Number of gambles: 5 Change (A, C) (A, D) (A, D)	LH Vertices: DAC (0.01) [0.892278] A CPT.KT DAC (0.01) [0.892278] A DCA (0.04) [0.631597] ADC (0.02) [0.894279] Ref	Reference volume	Hypothesis testing Multicore Run test Auto save Theories Specifications Data sets Selected Scienced
(C,D) Set	Add Duplicate (A.C):1 (A.C):1 (A.C):1 (C.D):1 (C.D):1 (Save	0.125 Determine volume from current settings: Set Set volume manually	Selected Selected All Type of test Bayes Factor Bayes Factor Gibbs sampling: Sample size: 5000 Change
Data Sample size N: 20 Enter	Probabilistic specifications Aggregation-based: Supermajority level: 0.5 Change Distance-based:	Figure Visualize Visualize Color scieme:	Burn-in size: 1000 Change Chi-bar squared weights simulation sample size: Random number seed: 1000 Change 1 Results:
Load Save Clear	Max-distance (U): Supremum 0.5 Change City-block 0.5 Change Euclidean 0.5 Change	Close all figures	
Name Default ~	Random preference: O From file: Load	File Load Options	Table Remove Export
	Mixture from vertices		

The resulting figure, which is a version of Figure 4 of Online Supplement 1, is reproduced below. The goal of placing CPT - KT and LH on an equal footing by giving their predictions equal total volumes while also setting the individual volumes proportional to the portion of the algebraic parameter space generating each prediction, is now complete.



PART V: QTEST Options

Q. Warnings, Options and Miscellaneous Items

Section O contains information about QTEST not covered elsewhere in the tutorial. These include warning messages one might encounter, different options and some other details.

Q.1 Options

The "Options..." button in the "File" section allows more control of QTEST behavior. Select "Options...".

hble pairs		Theories			- Deference vel	100.0	Hypothesis testing		Multicore
lumber of gambles:	0 Change	^	Vertices:	A	Reference volu	, inte	R	tun test	Auto save
	Set	~		Rer	nove We	ight	Theories Selected	Specifications Selected All	Data sets
	All	Add Duplicate Remove Load		Se	Determine v from current settings:	Set	Type of test Bayes Frequ	s Factor OBa lentist OAll	yes p & DIC
	~	Save		~	Set volun	ne manually	Gibbs sample Sample	size: 5000	Change
Sample size N:	Observations:	Probabilistic specificat Aggregation-based:	Supermajo	rity level: Change	Figure Visua Over las Color scho	lize t figure eme:	Chi-bar square simulation sam 1000 Results:	ed weights F nple size: s Change	Random number leed:
Load Save		Distance-based:	Max-distan 0.5 0.5	ce (U): Change Change	Default Close all	figures			^
Clear	~	C Euclidean Random preference:	0.5	Change	File		_		~
Name)efault	O From file:		Load	Load	Options	Table	Remove	Export
		Mixture from verti	ices	Save					

The following "Options" window pops up, the details of which are discussed after the screenshot.

●	Options		
Strict sample size when entering data			
- Volumes overlapping / outside the unit hypercub	00		
O Do not check			
 Check and warn only during hypothesis to 	esting		
Check and warn during both design and	test		
MLE optimality tolerance (Default: 1e-10):	1e-10	Change	ОК
MLE optimality iterations (Default: 100):	100	Change	Cancel

By default, in the "Data" section, QTEST does not restrict the total number of observations for each gamble pair to the stated sample size N. If indeed a fixed sample size per gamble pair is used, then checking "Strict sample size when entering data" can prevent mistakes in entering data.

QTEST can check and warn about overlapping volumes and volumes that fall outside the unit hypercube. However, this check can be computationally costly. Exactly when this check is performed can be set by choosing among the three options.

The last two pieces of the "Options" concern optimality. In running an analysis in QTEST, one might encounter the warning depicted in the following screenshot.

🛃 Convergence Warning	
Maximum likelihood estimator did not converge after 100 ite	erations
ок	

If this warning occurs, first note that the result may still be meaningful. One might want to inspect the data to see if the QTEST results seem reasonable based on where the data lies relative to the model. If one continues to get the same warning message, even after repeating the analysis and suspects the results may not be accurate, one can adjust the optimality parameter settings.

First, one can try to increase, or even decrease, the "MLE optimality tolerance".

Second, the default number of "MLE optimality iterations" is 100. This is the number of retries before gives up. Another strategy to deal with the "Convergence Warning" is to increase or decrease the number of iterations.

In very rare cases, when a data point is very close to the model, but yields a pvalue exactly equal to 0, redo the analysis in QTEST.

Q.2 Warning messages

When one is doing an analysis in QTEST and sets the reference volume manually, an error message might appear, indicating that at least two of the polytopes overlap. This does not mean the results are wrong but in these cases, one should not interpret the p-values as exactly correct. (One might also get this warning message if the distance-based specification is larger than 0.5.)

Another warning message one might see is the following: "WARNING: non-full rank polyhedral cone!". This message concerns the facet-defining inequalities near the maximum likelihood (ML) point. And it can be due to too many possible

facet-defining inequalities near the ML point. Proceed with caution; but usually such a warning is not problematic, especially if the polytope is full-dimensional.

Q.3 Data recommendation

We recommend that *at least* 20 observations per gamble pair, per person be used in any QTEST analysis. This ensures the assumptions of the asymptotic distributions are reasonably met. Of course, one may use more than 20 observations. But with less than 20 observations the results may be compromised. However, see Online Supplement 1 to QTBC1 for exceptions (i.e. mixture models) and further details.

Q.4 About

Selecting "About", under "File", will bring up a window with the following information regarding the release notes of QTEST.

About	_		\times
QTEST 2.1			
Programmed by Shiau Hong Lim			
QTEST uses PORTA by Thomas Christof a	and Andreas Loel	oel.	
This program was developed with support I grants SES 08-20009, SES 10-62045 and Regenwetter) and the Humboldt Foundation Regenwetter).	by the National S SES 14-59699 (P n (Co-PIs Jeff Ste	cience Fou 'I: Michel evens and I	ndation Michel
Special thanks to Daniel R. Cavagnaro, Yu Davis-Stober, Bryanna Fields, Ying Guo, M Anna Popova, Michel Regenwetter, Yixin Z	n-Shil Cha, Clinti lichael Lackner, V hang and Christo	n P. Villiam Mes opher E. Zw	ssner, /illing.
Developed with MATLAB. MATLAB is a registered trademark of The I	MathWorks, Inc.		