

# **A Beginner's Guide to Choice-Based Conjoint**



# Agenda

- ▶ What is Conjoint Analysis?
- ▶ What is Choice Based Conjoint Analysis?
- ▶ Creating a CBC Exercise in Discover
- ▶ Analyzing CBC Data in Discover

## Section 1

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# WHAT IS CONJOINT ANALYSIS?

# Different Perspectives / Different Goals

- ▶ Buyers want all of the most desirable features at lowest possible price.
- ▶ Sellers want to maximize profits by:
  - Minimizing the costs of providing features
  - Providing products that offer greater overall value than the competition

# Breaking Down the Problem

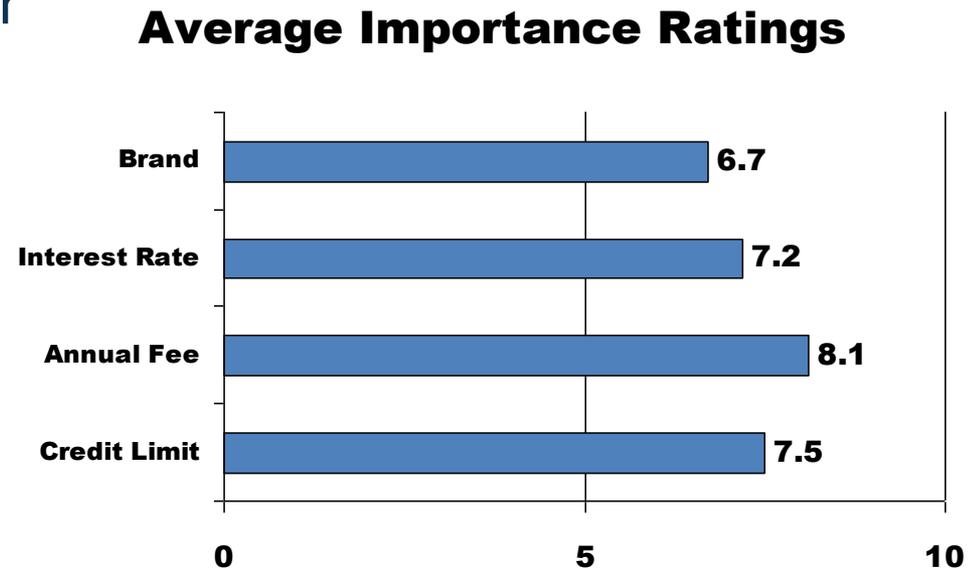
- ▶ If we learn how buyers **VALUE** the components of a product, we are in a better position to design those that improve profitability.
- ▶ BUT, how do we learn what the buyer wants?

# Age Old Approaches

- ▶ Ask Direct Questions about preference:
  - What brand do you prefer?
  - How much would you pay for it?
  - What color/flavor do you prefer?
- ▶ Answers often trivial and unenlightening (e.g. respondents prefer low prices to high prices, etc.)

# So What's the Problem?

- ▶ Answers often have low discrimination, with most answers falling in “very important” categories.
  - If they weren't important, we probably wouldn't have included them in the research!
- ▶ Answers sometimes useful for segmenting market, but still not very actionable.
  - We still don't know exactly what product they want.



# Insert – Conjoint Analysis!

- ▶ Research technique developed in early 70s
- ▶ Measures how buyers value individual components of a product/service bundle
- ▶ Dictionary definition -- “Conjoint: Joined together, combined”

# How Does Conjoint Analysis Work?

- ▶ We vary the product features (*independent variables*) to build many product concepts.
- ▶ We ask respondents to rate, rank or **choose** among a subset of those product concepts (*dependent variable*).
- ▶ Based on the respondents' evaluations of the product concepts, we figure out how much unique value (*utility*) each of the features added.

# Give Me an Example...

- ▶ How important are each of the following?

|            | Not at all Important  | Not very important    | Somewhat important    | Very important        | Extremely important   |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Horsepower | <input type="radio"/> |
| MPG        | <input type="radio"/> |

- ▶ Which of the following would you prefer...

210 Horsepower  
17 MPG

OR

120 Horsepower  
35 MPG

If you choose left,  
you prefer *Power*.

If you choose right, you  
prefer *Fuel Economy*.

- ▶ In conjoint analysis, rather than ask directly whether you prefer Power over Fuel Economy, we present realistic tradeoff scenarios and infer preferences from your product choices.

You can't have the **highest** fuel efficiency *and* the **best** performance



When respondents are  
**forced to make**  
**difficult tradeoffs,**  
we learn what they  
**truly value**

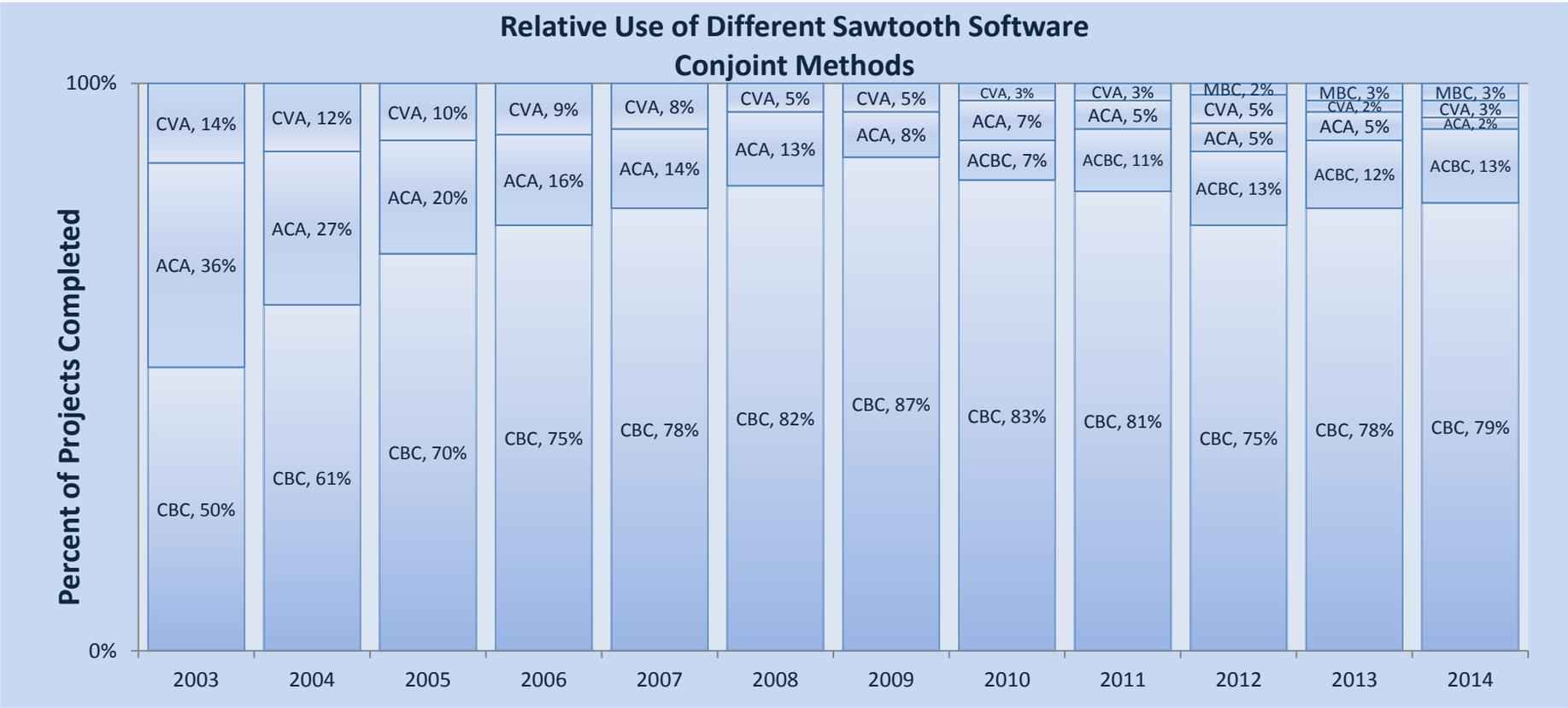
## Section 2

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# WHAT IS CBC?

# Choice Based Conjoint (CBC)

- ▶ Becoming popular in the early 90's, CBC now makes up about 75% of our users' conjoint-type research.



# What Does a CBC Experiment Look Like?

- ▶ Rather than rate options, respondents are simply asked to choose which they prefer.

Which would you rather be in 20 years?

(Task 1 of 12)

|            |                      |                       |                             |                            |                                                                |
|------------|----------------------|-----------------------|-----------------------------|----------------------------|----------------------------------------------------------------|
| Attributes | <b>Income Status</b> | Rich                  | Poor                        | Middle Class               | None: I would rather die than end up like any of these people. |
|            | <b>Hair Status</b>   | Bald                  | Full head of hair           | Receding hair line         |                                                                |
|            | <b>Family</b>        | No family             | Large family (10+ children) | One ex, but two great kids |                                                                |
|            |                      | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/>      |                                                                |
|            |                      | Concept 1             | Concept 2                   | Concept 3                  | "None" Option (Concept 4)                                      |

# Why Do Sawtooth Software Users Like It?

- ▶ **Simpler for respondents because it is more like what they typically do in real life**
  - We get better data if our data-gathering technique more closely matches reality
  - Less respondent fatigue caused by unfamiliar scales
- ▶ **Probabilities In : Probabilities Out**
- ▶ **Flexible Design and Analysis**
  - Different design algorithms (balanced overlap, complete enumeration; alternative specific; conditional pricing)
  - Different analysis techniques (logit, latent class, hierarchical Bayes)

# Additional Examples

Which of the following do you prefer?

(Task 1 of 10)

**Provider**



**Interest Rate**

12%

9.5%

7.5%

11.5%

**Annual Fee**

No Fee

No Fee

\$75

\$50

**Credit Limit**

\$5,000

\$3,000

\$9,000

\$7,000



<http://www.sawtoothsoftware.com/baseball>

### Interactive CBC Illustration

If these prices and wait times were involved, which option would you choose? (Task 1 of 9)

|                                                                                   |                                                                                   |                                                                                   |                                                                                    |                                                                                     |                                                                                     |                                       |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------|
|  |  |  |  |  |  |                                       |
| Dungeness Crab Sandwich                                                           | Garden Salad                                                                      | Garlic Fries                                                                      | Pizza Slice                                                                        | Clam Chowder                                                                        | Hot Dog                                                                             | NONE: I wouldn't choose any of these. |
| 3 people in line (approx. 3 minute wait)                                          | 5 people in line (approx. 5 minute wait)                                          | 1 person in line (approx. 1 minute wait)                                          | 1 person in line (approx. 1 minute wait)                                           | 5 people in line (approx. 5 minute wait)                                            | 3 people in line (approx. 3 minute wait)                                            |                                       |
| \$6.50                                                                            | \$3.50                                                                            | \$6.50                                                                            | \$3.50                                                                             | \$5.00                                                                              | \$5.00                                                                              |                                       |
| <input type="radio"/>                                                             | <input type="radio"/>                                                             | <input type="radio"/>                                                             | <input type="radio"/>                                                              | <input type="radio"/>                                                               | <input type="radio"/>                                                               | <input type="radio"/>                 |

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## Section 3

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# **CREATING A CBC EXERCISE**

# What Goes Into a CBC Exercise?

- ▶ # of Attributes
  - Precision decreases with more attributes
- ▶ # of Levels per Attribute
  - Precision decreases with more levels
- ▶ # of Tasks
  - Precision increases with more tasks
- ▶ # of Concepts
  - Precision increases with more concepts per task
- ▶ # of Versions
  - Precision increases with more versions, but strongly diminishing returns (typically very little gain beyond 6-10 versions)
- ▶ Design method
- ▶ Prohibitions
  - Precision decreases with more prohibitions

# Cell Phone Demo

| Brand                    | Battery Life  | Screen Size | Camera         | Price |
|--------------------------|---------------|-------------|----------------|-------|
| Apple iPhone             | 1 day battery | 4" screen   | 5 mega pixels  | \$200 |
| Microsoft Windows Phone  | 2 day battery | 5" screen   | 8 mega pixels  | \$300 |
| Google Nexus (Android)   | 3 day battery | 6" screen   | 15 mega pixels | \$400 |
| Samsung Galaxy (Android) |               |             |                | \$500 |
|                          |               |             |                | \$600 |

# Creating a CBC Exercise in Discover

 **Sawtooth Software** | Discover
megan@sawtoothsoftware.com 

**CBC Example**

[My Surveys](#) | [+ Create New Survey](#) | [? Help](#) | [Contact Us](#)

**Questions**

Settings

Survey Data

Publish

Invite

**+ ADD QUESTION** 
**✓ TEST SURVEY**

**If these were your only options, which would you choose?**

1 / 12

|       |                       |                       |                       |
|-------|-----------------------|-----------------------|-----------------------|
| Brand | Brand A               | Brand C               | Brand C               |
| Color | Blue                  | Yellow                | Orange                |
| Price | \$1.00                | \$5.00                | \$3.00                |
|       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

**Choice-Based Conjoint**

# Adding Attributes & Denoting Level Preference Order in Discover-CBC

**Attribute #5**

Attribute Text

Price

Levels

|   |       |  |  |
|---|-------|--|--|
| 1 | \$200 |  |  |
| 2 | \$300 |  |  |
| 3 | \$400 |  |  |
| 4 | \$500 |  |  |
| 5 | \$600 |  |  |

Click here to add items

Level Preference Order

Best to Worst ▼

Respondents would not agree on which levels are best and worst. Rating question will be asked for this attribute.

Upfront, you must specify which attributes have known (*a priori*) utility order (such as higher speeds always being preferred to lower speeds or lower prices always preferred to higher prices).

Level Preference Order

Best to Worst ▼

Respondents would not agree on which levels are best and worst. Rating question will be asked for this attribute.

# Adding Attributes & Denoting Level Preference Order in Discover-CBC

The screenshot shows the Sawtooth Software Discover interface for a survey titled "Example Cell Phone Survey". The user is logged in as "megan@sawtoothsoftware.com". The interface includes a navigation menu on the left with options like "Questions", "Settings", "CBC Settings", "Survey Data", "Publish", and "Invite". The main content area is titled "Attribute #1" and shows the configuration for an attribute named "Brand". The "Attribute Text" field contains "Brand". The "Levels" section lists four items: "1 Apple iPhone", "2 Microsoft Windows Phone", "3 Google Nexus (Android)", and "4 Samsung Galaxy (Android)". The "Level Preference Order" dropdown menu is set to "Not Ordered". A note below the dropdown states: "Respondents would not agree on which levels are best and worst. Rating question will be asked for this attribute."

Attributes without known utility order (brand, color, style, flavor) are denoted as “Not Ordered” and the software adds ratings questions prior the CBC tasks.

## Level Preference Order

Not Ordered ▼

Respondents would not agree on which levels are best and worst. Rating question will be asked for this attribute.

# Why Does Discover Do That?

- ▶ We use a rating scale with only a few scale points so respondents can differentiate among the levels. It also offers a “no opinion” rating, so we don’t force respondents to rate levels they have no opinion about.

- ▶ What are the benefits?

- Serve as utility constraints (monotonicity constraints) to permit robust individual utility estimation.
- Provide individual-level preference information so we can avoid dominated concepts within the on-the-fly experimental design.

Please rate the following phones in terms of how desirable they are.

|                          | Undesirable           | Somewhat Desirable    | Very Desirable        | No Opinion            |
|--------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Apple iPhone             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Microsoft Windows Phone  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Google Nexus (Android)   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Samsung Galaxy (Android) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

# Option to Remove Rating Questions

← → ↻ <https://discover.sawtoothsoftware.com/Questions/4612>

Sawtooth Software | Discover

Example Cell Phone Survey

Questions  
Settings  
**CBC Settings**  
Survey Data  
Publish  
Invite

✓ TEST SURVEY

Attributes None Option Design Settings Prohibitions

Number of CBC Questions

Use recommended value (14)  
 Use custom value

Number of Concepts per Question

Use recommended value (4)  
 Use custom value

Minimize level repeating within CBC questions (level overlap) for these attributes:

Attribute #1  
 Attribute #2  
 Attribute #3  
 Attribute #4  
 Attribute #5

Remove rating questions for these attributes:

Attribute #1  
 Attribute #2  
 Attribute #3  
 Attribute #4  
 Attribute #5

Remove rating questions for these attributes:

- Attribute #1
- Attribute #2
- Attribute #3
- Attribute #4
- Attribute #5

# Including a “None” Option

The screenshot shows the Sawtooth Software interface for editing a survey. The top navigation bar includes the Sawtooth Software logo, the word 'Discover', and the email address 'megan@sawtoothsoftware.com'. Below this is a secondary navigation bar with 'Example Cell Phone Survey', 'My Surveys', 'Create New Survey', 'Help', and 'Contact Us'. The main content area is titled 'Phone' and has a 'TEST SURVEY' button. Underneath, there are tabs for 'Attributes', 'None Option', 'Design Settings', and 'Prohibitions'. The 'None Option' tab is active, showing a checkbox labeled 'Include a "None of these" option as the last choice.' which is currently unchecked. Below the checkbox is a text input field containing the text: 'NONE: I wouldn't choose any of these.'

- ▶ By default, a “None” concept is added to each choice task. The questionnaire author may remove the None option if desired.

# Why Include a “None”?

- ▶ We may not want to assume that the respondent **MUST** choose an alternative. Therefore, we can include a “None” choice for respondents to tell us they would **NOT** choose any concepts in the task.
  
- ▶ **Why include a none option?**
  - Allows respondents to avoid making uncomfortable choices
  - May provide usable information about whether our concepts are acceptable, how acceptable they need to be
  - Remove respondents for whom product category does not apply
    - Earlier screening also helps!
  - Estimate utility for “None”

# How Many Tasks? How Many Concepts?

Sawtooth Software | Discover

Example Cell Phone Survey

Questions  
Settings  
**CBC Settings**  
Survey Data  
Publish  
Invite

TEST SURVEY

Attributes   None Option   **Design Settings**   Prohibitions

Number of CBC Questions  
 Use recommended value (14)  
 Use custom value

Number of Concepts per Question  
 Use recommended value (4)  
 Use custom value

Minimize level repeating within CBC questions (level overlap) for these attributes:  
 Attribute #1  
 Attribute #2  
 Attribute #3  
 Attribute #4  
 Attribute #5

Remove rating questions for these attributes:  
 Attribute #1  
 Attribute #2  
 Attribute #3  
 Attribute #4  
 Attribute #5

Attributes   None Option   **Design Settings**

Number of CBC Questions  
 Use recommended value (14)  
 Use custom value

Number of Concepts per Question  
 Use recommended value (4)  
 Use custom value

# Discover-CBC's recommendation wizard will help you with that!

- ▶ Discover-CBC's recommendation wizard will suggest an appropriate number of tasks and concepts per to ask, given the specific attribute and levels of your exercise.
  - We also warn the user if too few tasks are specified. Essentially, we make it nearly impossible for users to field a study that would yield poor quality utility estimates.
- ▶ The recommendations are based on Logit theory but the author may override the suggestions.

# Additional Recommendations

- ▶ Generally, 3 or more concepts are used. Showing just 2 concepts is typically considered sub-optimal.
  - It doesn't take respondents twice as much time to respond to four concepts per task than two.
- ▶ Attribute text length, graphical representation affect the decision
  - Notable exception: highly emotional decisions such as cancer treatment, where patients are unfamiliar with attributes and must make extremely difficult choices.
- ▶ As a rule of thumb, for individual-level estimation, we recommend that each level occur approximately 6x or more for each respondent.

$$\frac{(\# \text{ of Tasks} \times \# \text{ of Concepts})}{(\# \text{ of levels in largest attribute})} \geq 6$$

# Specifying Level Overlap per Attribute

**Example Cell Phone Survey**

Questions  
Settings  
**CBC Settings**  
Survey Data  
Publish  
Invite

Attributes   None Option   Design Settings   Prohibitions

Number of CBC Questions  
 Use recommended value (14)  
 Use custom value

Number of Concepts per Question  
 Use recommended value (4)  
 Use custom value

Minimize level repeating within CBC questions (level overlap) for these attributes:

- Attribute #1
- Attribute #2
- Attribute #3
- Attribute #4
- Attribute #5

Remove rating questions for these attributes:

- Attribute #1
- Attribute #2
- Attribute #3
- Attribute #4
- Attribute #5

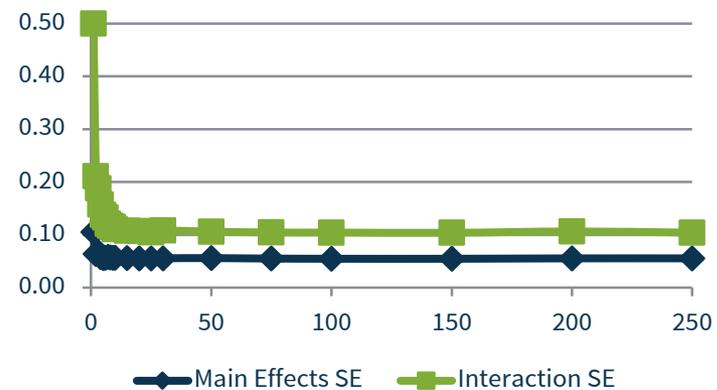
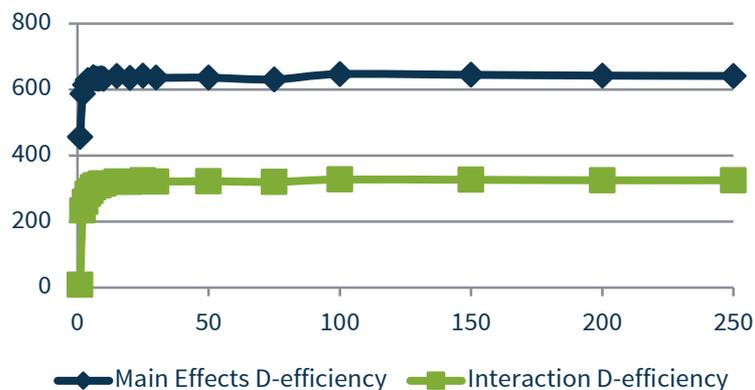
By default, in the design, all attributes have a modest degree of level overlap (level repeating within a task).

Minimize level repeating within CBC questions (level overlap) for these attributes:

- Attribute #1
- Attribute #2
- Attribute #3
- Attribute #4
- Attribute #5

# Number of Versions

- ▶ In Discover, you don't need to specify the number of versions as each design is generated on the fly reducing context and order bias.
- ▶ With computerized interviewing, it is easy to administer hundreds of versions to respondents
  - Avoids multicollinearity
  - Control for context effects, order effects
- ▶ Outside of Discover, our recommendations are:



# Adding Prohibitions

Attributes

None Option

Design Settings

Prohibitions

## Prohibition #1

The following attributes/levels will never be displayed together in a CBC concept:

Attribute #1 - Brand ▼

Apple iPhone ▼

Attribute #5 - Price ▼

\$200 ▼

[Add](#)

[+ ADD PROHIBITION](#)

# Should You Choose to Add Prohibitions...

- ▶ Discover-CBC supports prohibitions between attributes. But, we place limits on the number and pattern of prohibitions that may be specified so that design efficiency is not overly compromised.
  - If prohibitions are specified, the software will recommend a few additional choice tasks be asked to counteract the loss in statistical efficiency.
  - We will display a warning if the user tries to specify too many prohibitions or a particularly damaging pattern of prohibitions.

# So, What Does the Final CBC Exercise Look Like?

## Cell Phones

Please rate the following phone screen sizes in terms of how desirable they are.

|                | Undesirable           | Somewhat Desirable               | Very Desirable                   | No Opinion            |
|----------------|-----------------------|----------------------------------|----------------------------------|-----------------------|
| 4" screen size | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/>            | <input type="radio"/> |
| 5" screen size | <input type="radio"/> | <input type="radio"/>            | <input checked="" type="radio"/> | <input type="radio"/> |
| 6" screen size | <input type="radio"/> | <input checked="" type="radio"/> | <input type="radio"/>            | <input type="radio"/> |

0% 100%

## Cell Phones

If these were your only options, which would you choose?

1 / 14

|                     |                          |                        |                          |
|---------------------|--------------------------|------------------------|--------------------------|
| <b>Brand</b>        | Samsung Galaxy (Android) | Google Nexus (Android) | Samsung Galaxy (Android) |
| <b>Battery Life</b> | 3 day battery            | 1 day battery          | 2 day battery            |
| <b>Size</b>         | 5" screen size           | 6" screen size         | 4" screen size           |
| <b>Main Camera</b>  | 5 Mega Pixel Camera      | 15 Mega Pixel Camera   | 8 Mega Pixel Camera      |
| <b>Price</b>        | \$300                    | \$300                  | \$500                    |

0% 100%

## Section 4

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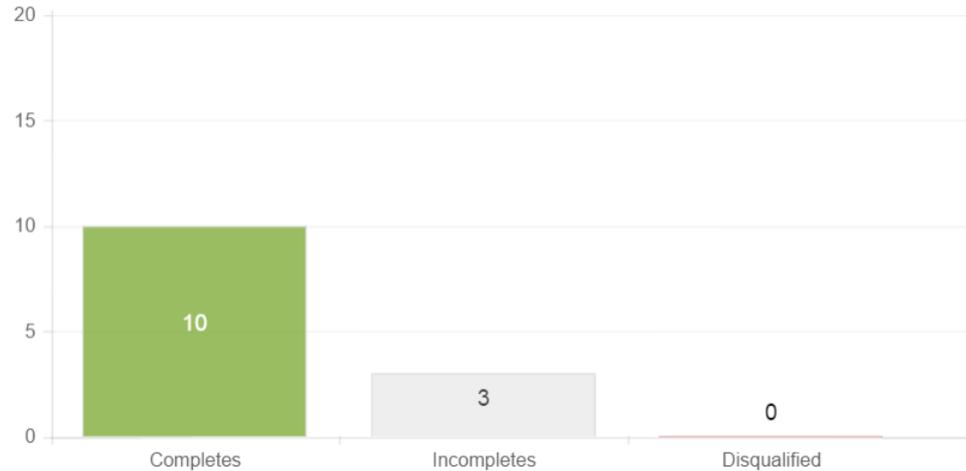
# **ANALYZING CBC DATA**

# Discover-CBC's Empirical Bayes Model

Cell Phone Survey - AMA

- Questions
- Settings
- CBC Settings
- Survey Data**
- Publish
- Invite

Data Source Live Data ▼



[DOWNLOAD DATA](#)

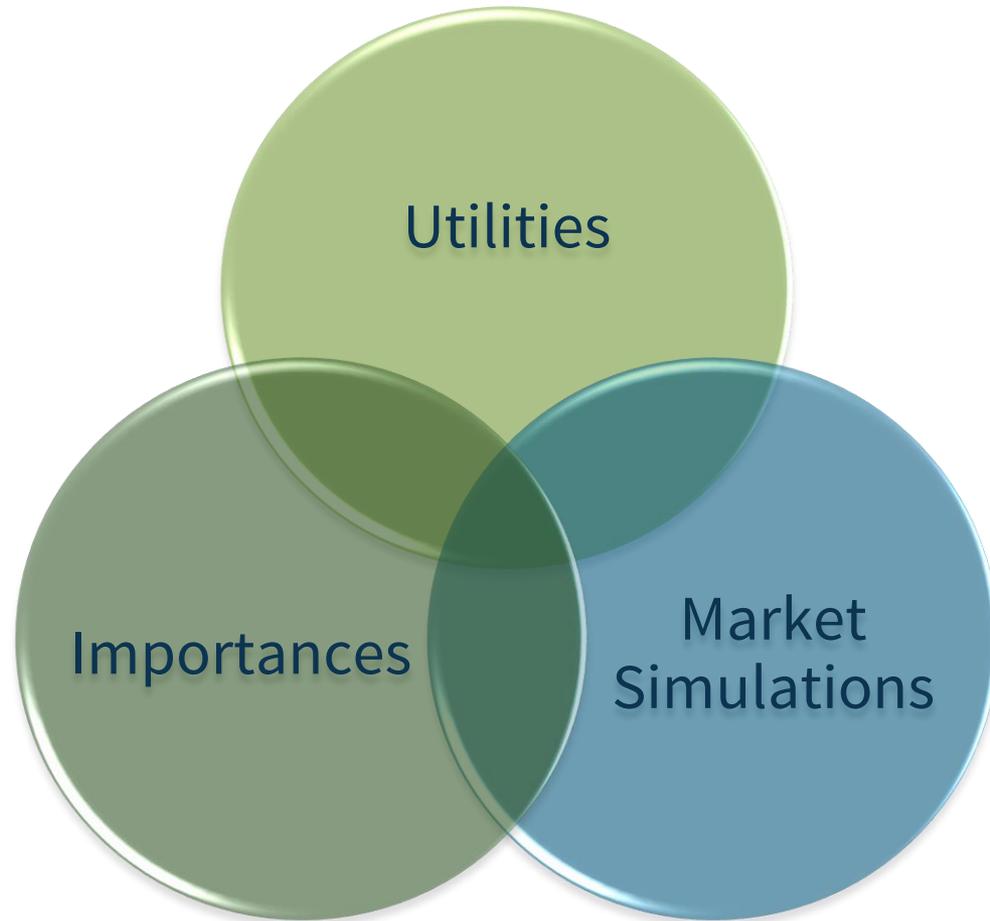
**[CBC ANALYSIS](#)**

- [VIEW DATA](#)
- [DATA REPORTS](#)
- [SURVEY ADMIN](#)
- [ADVANCED](#)
- [DELETE DATA](#)

# Why not Hierarchical Bayes?

- ▶ The main reasons against using HB for this particular software application were:
  - HB places a much larger computational requirement on the servers than our method of empirical Bayes. If hundreds of students submitted HB jobs simultaneously at midnight on the night before a project was due, the entire system could potentially grind to a crawl.
  - Purely individual-level estimation via logit (when leveraging within-attribute ranking information of levels via monotonicity constraints and employing empirical Bayes) can be nearly as accurate as HB models.

# Three Conjoint Analysis Outputs



# Utility Estimation

- ▶ “Utilities” are developed for each level such that the following model produces “maximum likelihood fit” to the actual choices.
- ▶ Consider three product alternatives (A, B, C) in a choice set:

$$P_A = \exp(U_A) / [\exp(U_A) + \exp(U_B) + \exp(U_C)]$$

where:

$P_A$  = “Probability of choosing alternative A”

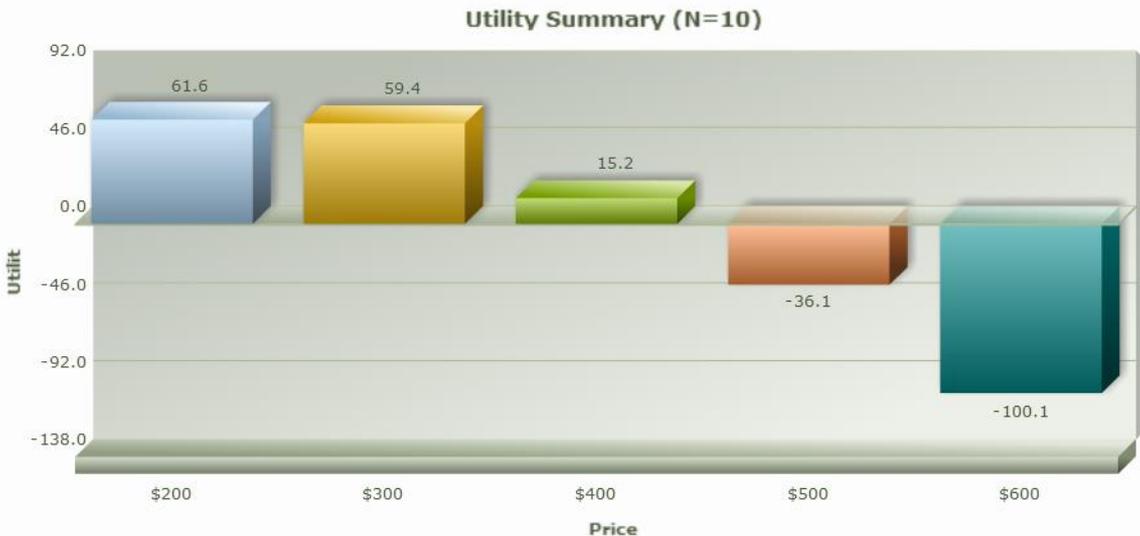
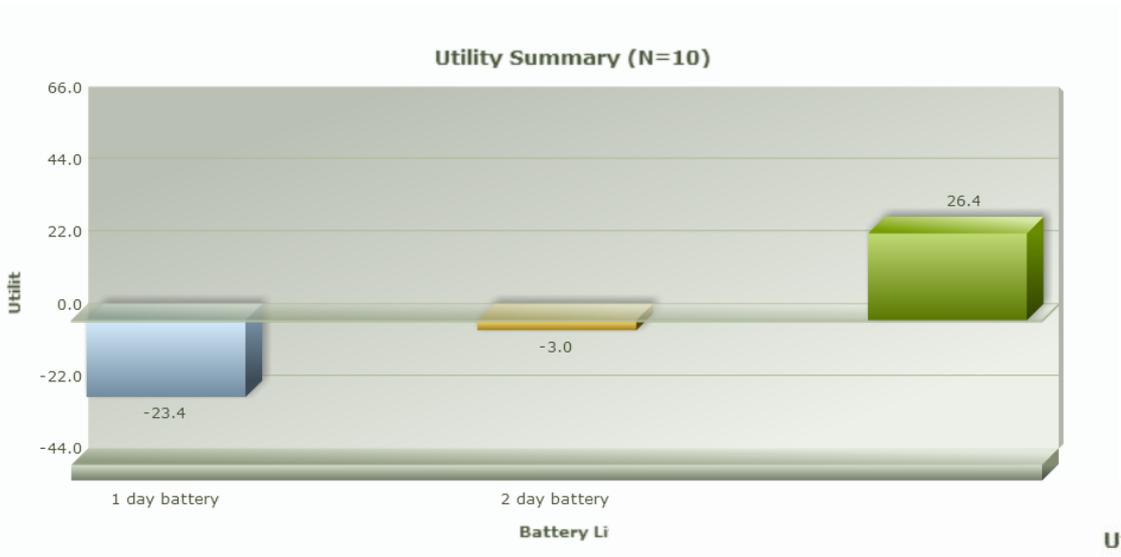
*exp* means “exponentiate” or raising **e** to the power of the total utility

$U_A$  = Total utility for alternative A, etc.

# Interpreting Conjoint Utilities

- ▶ Interval scaled data (no ratio operations!)
- ▶ You CANNOT compare one level from one attribute with one level from another attribute, since conjoint utilities are scaled to an arbitrary constant within each attribute (often zero-centered)
- ▶ You CAN compare differences between two levels of one attribute versus two levels of another attribute (an addition operation)

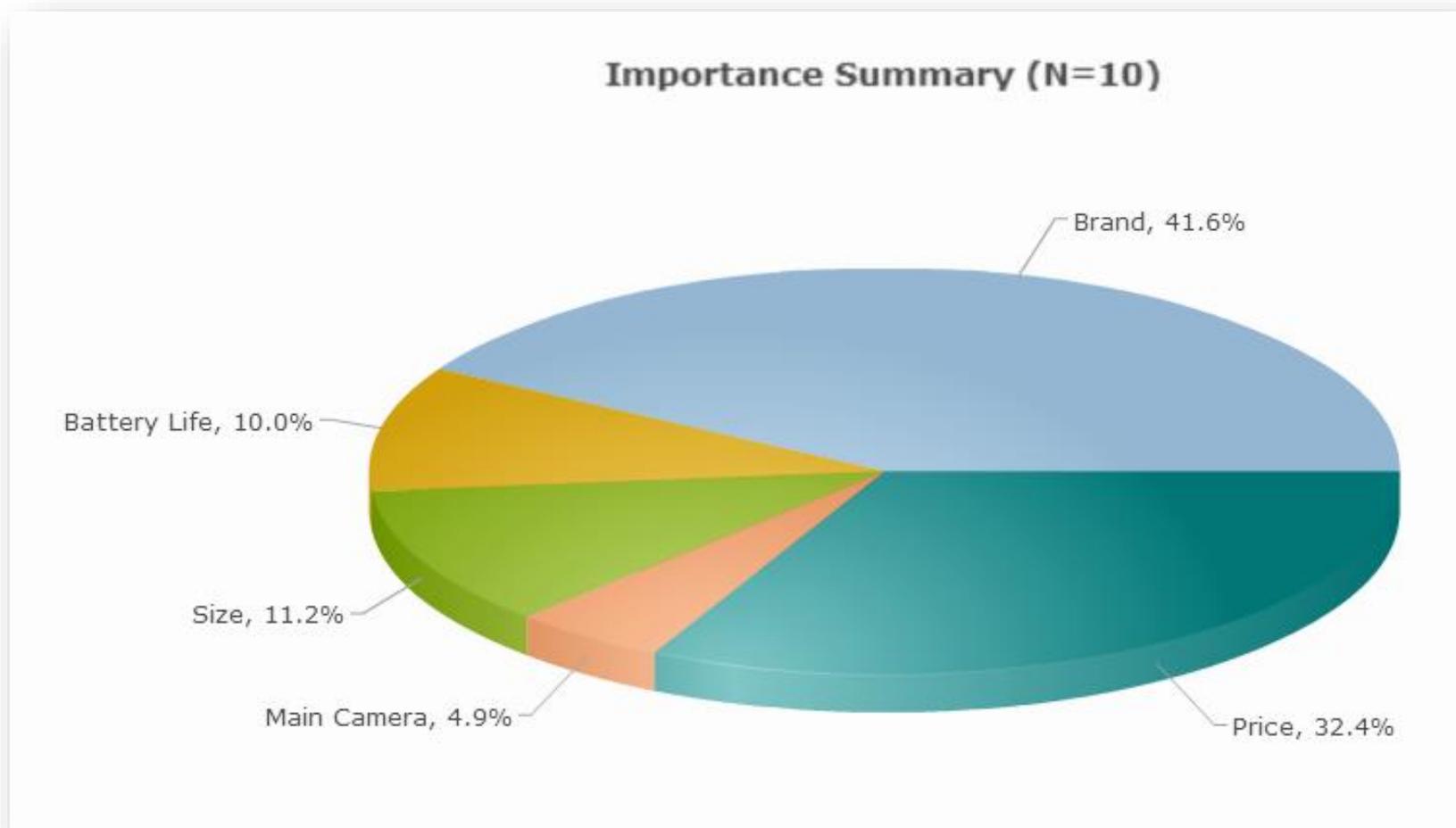
# Utility Examples



# Conjoint Importances

- ▶ Ratio scaled data
- ▶ Measure of how much influence each attribute has on people's choices
- ▶ Best minus worst level of each attribute, percentaged
- ▶ Importances are directly affected by the range of levels you choose for each attribute

# Importances Example

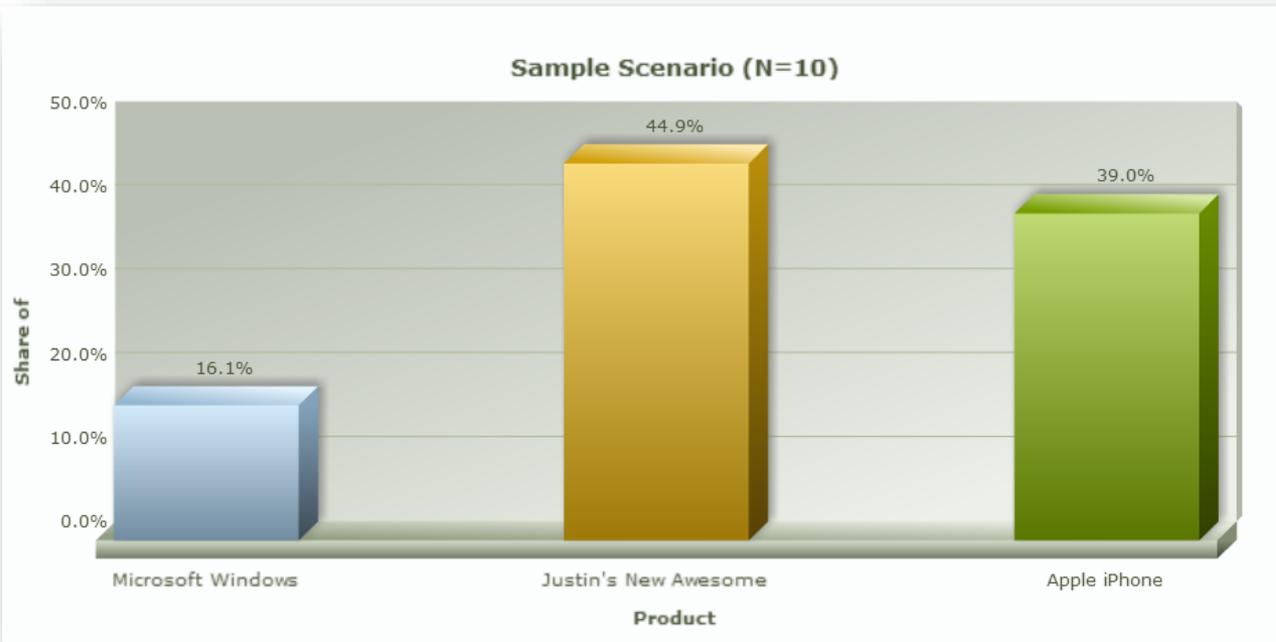


# Conjoint Analysis is an Additive Model

- ▶ How much a respondent likes a total product is simply the total of the utility values for that product.

# Market Simulation Example

- ▶ Create competitive market scenarios to predict which products respondents would choose.



**Microsoft Windows Phone**

Brand: Microsoft Windows Phone ▼

Battery Life: 1 day battery ▼

Size: 5" screen size ▼

Main Camera: 8 Mega Pixel Camera ▼

Price: \$400 ▼

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**Justin's New Awesome P**

Brand: Samsung Galaxy (Android) ▼

Battery Life: 2 day battery ▼

Size: 5" screen size ▼

Main Camera: 8 Mega Pixel Camera ▼

Price: \$200 ▼

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**Apple iPhone**

Brand: Apple iPhone ▼

Battery Life: 1 day battery ▼

Size: 6" screen size ▼

Main Camera: 5 Mega Pixel Camera ▼

Price: \$400 ▼

## Section 5

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## ▶ Discover includes:

- Standard survey question types: select (radio or multi-check), numeric, grid, ranking, constant sum, open-ends
- Skip patterns, styles, progress bar options
- CBC designer up to 8 attributes and 15 levels per attribute; No more than 8 concepts per task; No more than 30 tasks per respondent
- Near orthogonal CBC plans, avoiding dominated concepts and adjustable level overlap
- Individual-level utility estimation with empirical Bayes
- Online Market Simulator

## ▶ Discover-CBC: How and Why It Differs from Lighthouse Studio's CBC Software

# QUESTIONS?

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# Appendix

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# **CBC EXAMPLES**



# Marketing

- ▶ Set pricing
- ▶ Evaluate the impact of a product redesign
- ▶ Estimate brand equity
- ▶ Predict effect of line extensions
- ▶ Identify market segments



# Health Care

- ▶ Evaluate doctor to patent interactions
- ▶ Understand doctor prescription preferences
- ▶ Design effective treatment strategies
- ▶ Develop new drugs
- ▶ Identify ideal benefit programs



# Economics

- ▶ Evaluate transportation alternatives
- ▶ Compare energy alternatives
- ▶ Measure environmental impact



## Law

- ▶ Measure effects of litigation
- ▶ Damage assessment
- ▶ Identify boundaries between firms
- ▶ Evaluate punishment alternatives
- ▶ Select jury members



# Human Resources

- ▶ Screen potential employees
- ▶ Design compensation packages
- ▶ Select health care plans
- ▶ Evaluate performance
- ▶ Predict employee responses