

# Product Design Via Conjoint Analysis

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# Agenda

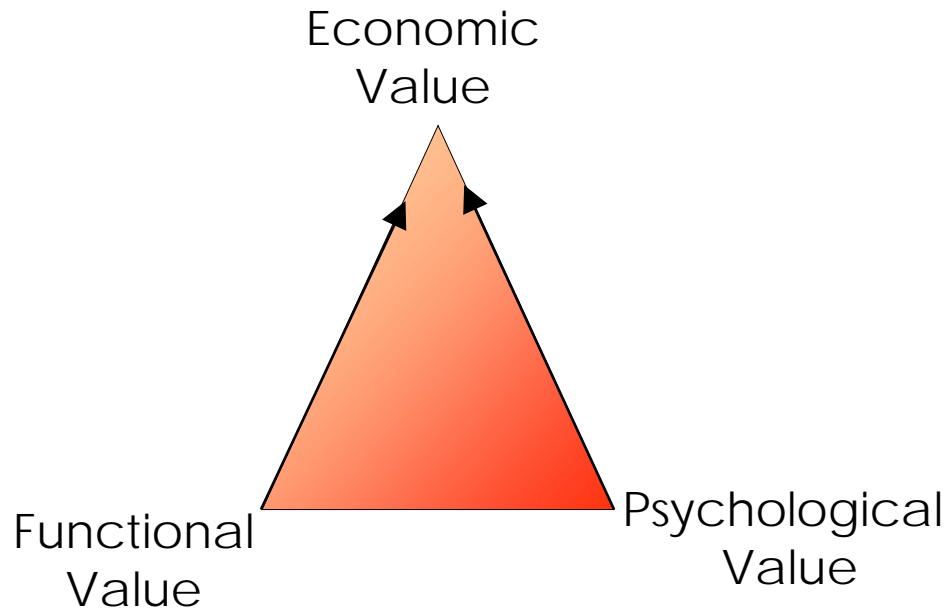
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- Product design task
  - What product features?
    - What Price?
- What is conjoint analysis?
- How does conjoint work?
- A conjoint application

# Product Design

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- A product can be considered as a bundle of **attribute levels** or features.
- Product Features provide **value** to consumers



# Product Design

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- A notebook computer can be described as

## Attribute

## Levels

Processor

2.4 Ghz, 3.2 Ghz

RAM

16GB, or 32 GB

Hard Disk

500 GB or 1 TB

Price

\$1500 or \$2000

Color



# Product Design

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- Optimal design involves choosing attribute levels of a product to maximize objectives
- Typical objectives
  - Market Share
  - Profitability
- Optimal design is based on an analysis of consumer preferences

# Analyzing Preferences: Conjoint Analysis

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- Conjoint analysis is an approach to
  - Understand how consumers make **trade-offs** among product attributes and features
  - Measure the importance of product attributes to consumers
- Why do consumers need to make tradeoffs?

# Conceptual Underpinnings of Conjoint

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- Consumers differ in their utilities for attribute levels
- Utility for a product = sum of utilities of its attribute levels

$$U = u(\text{ProcessorLevel}) + u(\text{RamLevel}) + u(\text{HardDiskLevel}) + u(\text{PriceLevel}) + \dots u(\text{ProcessorLevel}) \times u(\text{RamLevel})$$

- Utilities can be measured by consumer evaluation of product profiles
- Utility estimates can be used to predict market share of new products

# Conceptual Underpinnings

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- Conjoint relies on a compensatory model of preferences
- It uses a de-compositional approach to model preferences



# Stages in Conjoint Analysis

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1. Identify a set of relevant product attributes
2. Define reasonable levels for these attributes
3. Create product profiles
4. Obtain consumer preferences for profiles
5. Analyze the data
6. Simulate market level outcomes

# Application: Identify Attributes and Levels

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- Career : a) Business b) Fine Arts c) Science
- Fitness: a) Not Fit b) Somewhat Fit and c) Very Fit
- Sense of Humor: a) Serious b) Somewhat Funny and c) Very Funny
- Religiosity: a) Not religious b) Somewhat religious and c) Very religious
- Match with Interests: a) Identical b) Share some interests and c) Very Different

# Select Product Profiles

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- Five attributes with three levels means total number of possible product profiles is ---
- Data collection needs simplification, why?
- Theory of experimental designs can be used to choose a subset of products for the questionnaire

# Preference Data

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- Many Response formats can be used
  - Rating scales
  - Ranking
  - Paired comparisons
  - Multiple choice

# Collect Data

	Career	Fitness	Humor	Religious	Match with your Hobbies	Rating
1)	Fine Arts	Not fit	Serious	Some. religious	Share some	1 2 3 4 5 6 7
2)	Business	Very fit	Serious	Very religious	Very different	1 2 3 4 5 6 7
3)	Business	Not fit	Some. funny	Not religious	Very different	1 2 3 4 5 6 7
4)	Science	Not fit	Some. funny	Very religious	Identical	1 2 3 4 5 6 7
5)	Business	Some. fit	Very funny	Very religious	Share some	1 2 3 4 5 6 7
6)	Fine Arts	Not fit	Very funny	Very religious	Very different	1 2 3 4 5 6 7
7)	Science	Very fit	Serious	Some. religious	Share some	1 2 3 4 5 6 7
8)	Fine Arts	Very fit	Very funny	Some. religious	Very different	1 2 3 4 5 6 7
9)	Science	Mod fit	Serious	Not religious	Very different	1 2 3 4 5 6 7
10)	Fine Arts	Very fit	Some. funny	Not religious	Identical	1 2 3 4 5 6 7
11)	Fine Arts	Some. fit	Some. funny	Very religious	Share some	1 2 3 4 5 6 7
12)	Fine Arts	Some. fit	Serious	Not religious	Identical	1 2 3 4 5 6 7
13)	Business	Not fit	Serious	Some. religious	Identical	1 2 3 4 5 6 7
14)	Business	Some. fit	Very funny	Some. religious	Identical	1 2 3 4 5 6 7
15)	Business	Very fit	Some. funny	Not religious	Share some	1 2 3 4 5 6 7
16)	Science	Not fit	Very funny	Not religious	Share some	1 2 3 4 5 6 7
17)	Science	Some. fit	Some. funny	Some. religious	Very different	1 2 3 4 5 6 7
18)	Science	Very Fit	Very funny	Very religious	Identical	1 2 3 4 5 6 7

# Data Analysis

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- For ratings data, regression can be used to compute the part-worths for the attribute levels
- Attribute levels are specified in terms of dummy variables and the rating score is used as the dependent variable

# Data

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Rating	Career	Fitness	Humor	Religiosity	Interests
1	FineArts	NotFit	Serious	SomRel	ShareSome
1	Business	VeryFit	Serious	VeryRel	VeryDiff
1	Business	NotFit	SomeFunny	NotRel	VeryDiff
2	Science	VeryFit	Serious	SomRel	ShareSome
2	Business	SomeFit	VeryFunny	VeryRel	ShareSome
1	FineArts	NotFit	VeryFunny	VeryRel	VeryDiff
1	Science	NotFit	SomeFunny	VeryRel	Identical
6	Business	SomeFit	VeryFunny	SomRel	Identical
2	Science	SomeFit	Serious	NotRel	VeryDiff
5	FineArts	VeryFit	SomeFunny	NotRel	Identical
2	FineArts	SomeFit	SomeFunny	VeryRel	ShareSome
2	Science	NotFit	VeryFunny	NotRel	ShareSome
1	Business	NotFit	Serious	SomRel	Identical
5	FineArts	VeryFit	VeryFunny	SomRel	VeryDiff
2	Business	VeryFit	SomeFunny	NotRel	ShareSome
4	FineArts	SomeFit	Serious	NotRel	Identical
5	Science	SomeFit	SomeFunny	SomRel	VeryDiff
2	Science	VeryFit	VeryFunny	VeryRel	Identical

# Dummy Variable Coding

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- Career : a) **Business** b) Fine Arts c) Science
- Fitness: a) **Not Fit** b) Somewhat Fit and c) Very Fit
- Sense of Humor: a) **Serious** b) Somewhat Funny and c) Very Funny
- Religiosity: a) **Not religious** b) Somewhat religious and c) Very religious
- Match with Interests: a) **Identical** b) Share some interests and c) Very Different



# Dummy Variable Coding of Attributes

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FineArts	Science	SomeFit	VeryFit	SomeFunny	VeryFunny	SomRel	VeryRel	VeryDiff	ShareSome
1	0	0	0	0	0	1	0	0	1
0	0	0	1	0	0	0	1	1	0
0	0	0	0	1	0	0	0	1	0
0	1	0	1	0	0	1	0	0	1
0	0	1	0	0	1	0	1	0	1
1	0	0	0	0	1	0	1	1	0
0	1	0	0	1	0	0	1	0	0
0	0	1	0	0	1	1	0	0	0
0	1	1	0	0	0	0	0	1	0
1	0	0	1	1	0	0	0	0	0
1	0	1	0	1	0	0	1	0	1
0	1	0	0	0	1	0	0	0	1
0	0	0	0	0	0	1	0	0	0
1	0	0	1	0	1	1	0	1	0
0	0	0	1	1	0	0	0	0	1
1	0	1	0	0	0	0	0	0	0
0	1	1	0	1	0	1	0	1	0
0	1	0	1	0	1	0	1	0	0

# Regression Output

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	0.6818	0.5470	1.246	0.252721	
CareerFineArts	0.8333	0.3975	2.096	0.074263	.
CareerScience	0.1667	0.3975	0.419	0.687576	
FitnessSomeFit	2.3333	0.3975	5.870	0.000618	***
FitnessVeryFit	1.6667	0.3975	4.193	0.004072	**
HumorSomeFunny	1.3636	0.4152	3.284	0.013404	*
HumorVeryFunny	1.8182	0.4152	4.379	0.003237	**
ReligiositySomRel	0.8182	0.4152	1.971	0.089402	.
ReligiosityVeryRel	-1.5455	0.4152	-3.722	0.007433	**
InterestsShareSome	-1.3333	0.3975	-3.354	0.012179	*
InterestsVeryDiff	-0.6667	0.3975	-1.677	0.137417	

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

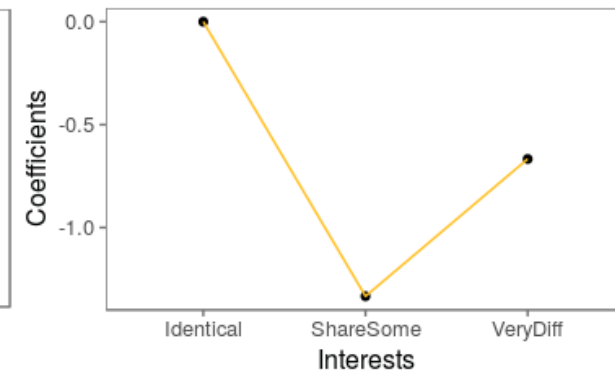
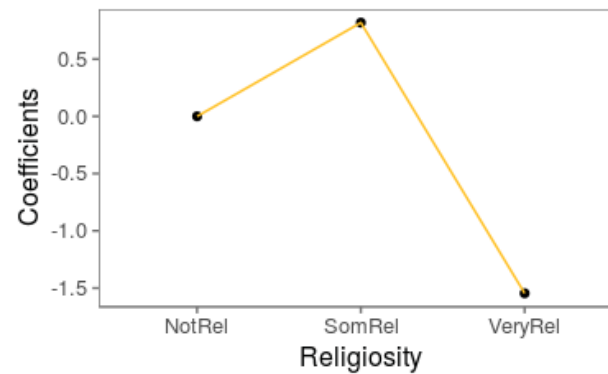
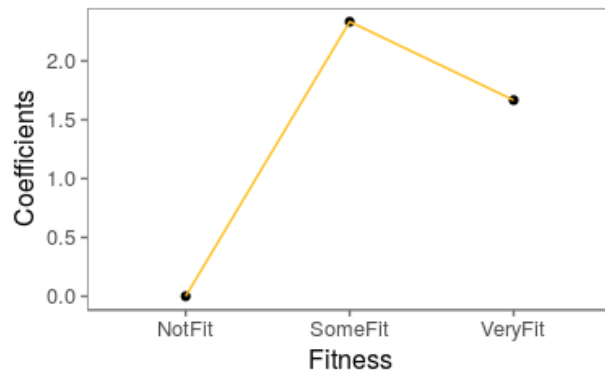
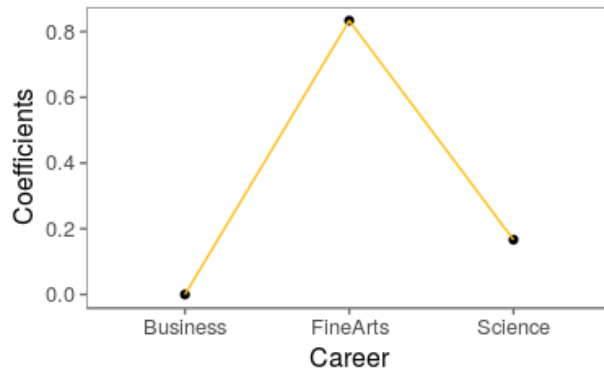
Residual standard error: 0.6885 on 7 degrees of freedom

Multiple R-squared: 0.9316, Adjusted R-squared: 0.8338

F-statistic: 9.532 on 10 and 7 DF, p-value: 0.003387

# Part-Worth Plots

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# Relative Importance of Attributes

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- Range of attribute  
= Maximum Partworth – Minimum Partworth
- Relative Importance  
= Range / (Sum of Ranges across all attributes)

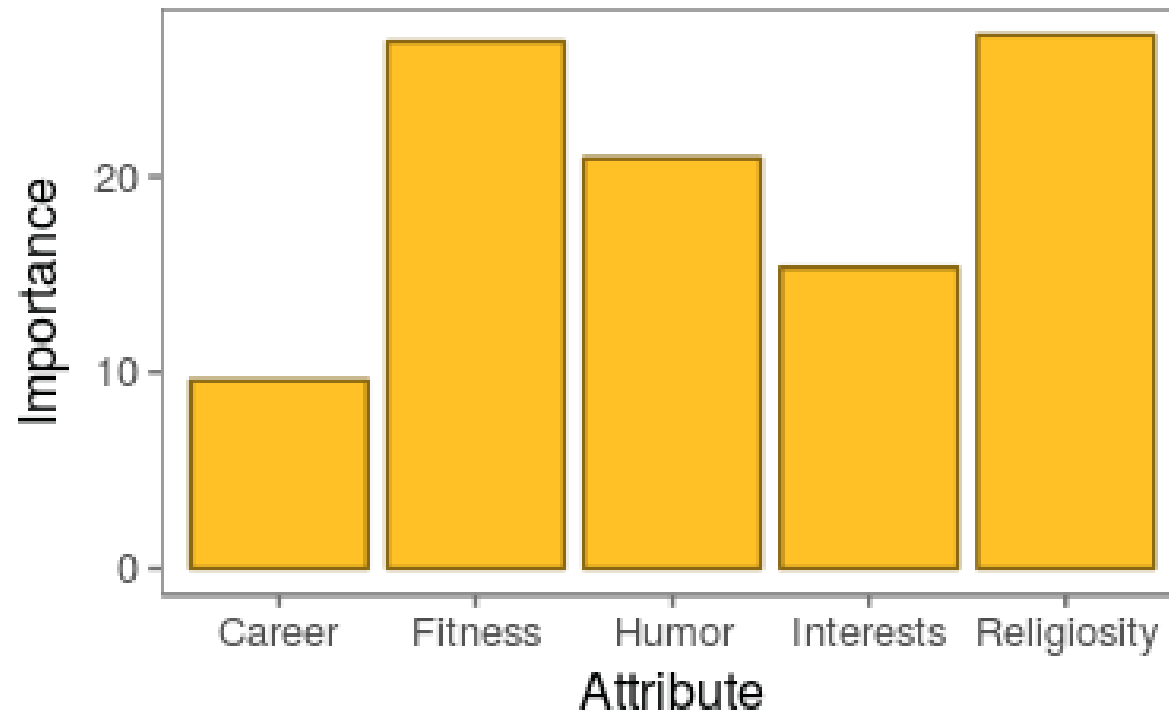
# Calculating Attribute Importances

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Attribute	Range	Importance (%)
Career	0.83	9.60
Fitness	2.33	26.88
Sense of Humor	1.82	20.94
Religiosity	2.36	27.23
Match with Interests	1.33	15.36
Total	8.67	

# Attribute Importance Weights

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# Ideal Product

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- The ideal product for this consumer has the following attribute levels

Attribute	Ideal Level
Career	Fine Arts
Fitness	Some. Fit
Sense of Humor	Very Funny
Religiosity	Some. Religious
Match with Interests	Identical

# Predictions and Market Share

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- Imagine two “new products” with the following profiles
- Product 1 = {Fine Arts, Not Fit, Some. Funny, Not Religious, Share some}
- Product 2 = {Business, Very Fit, Serious, Very Religious, Identical Interests}
- $Utility_1$  is  $0.68 + 0.83 + 0 + 1.36 + 0 - 1.33 = 1.54$
- $Utility_2$  is  $0.68 + 0.0 + 1.67 + 0.0 - 1.54 + 0.0 = 0.81$



# Market Share Calculations

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- Predictions are made for each member in the sample, for each of the products in the market.
- Customers are assumed to choose brand with the highest utility.
- Market share for a product is the proportion of the market who choose that product.

# Market Share Predictions

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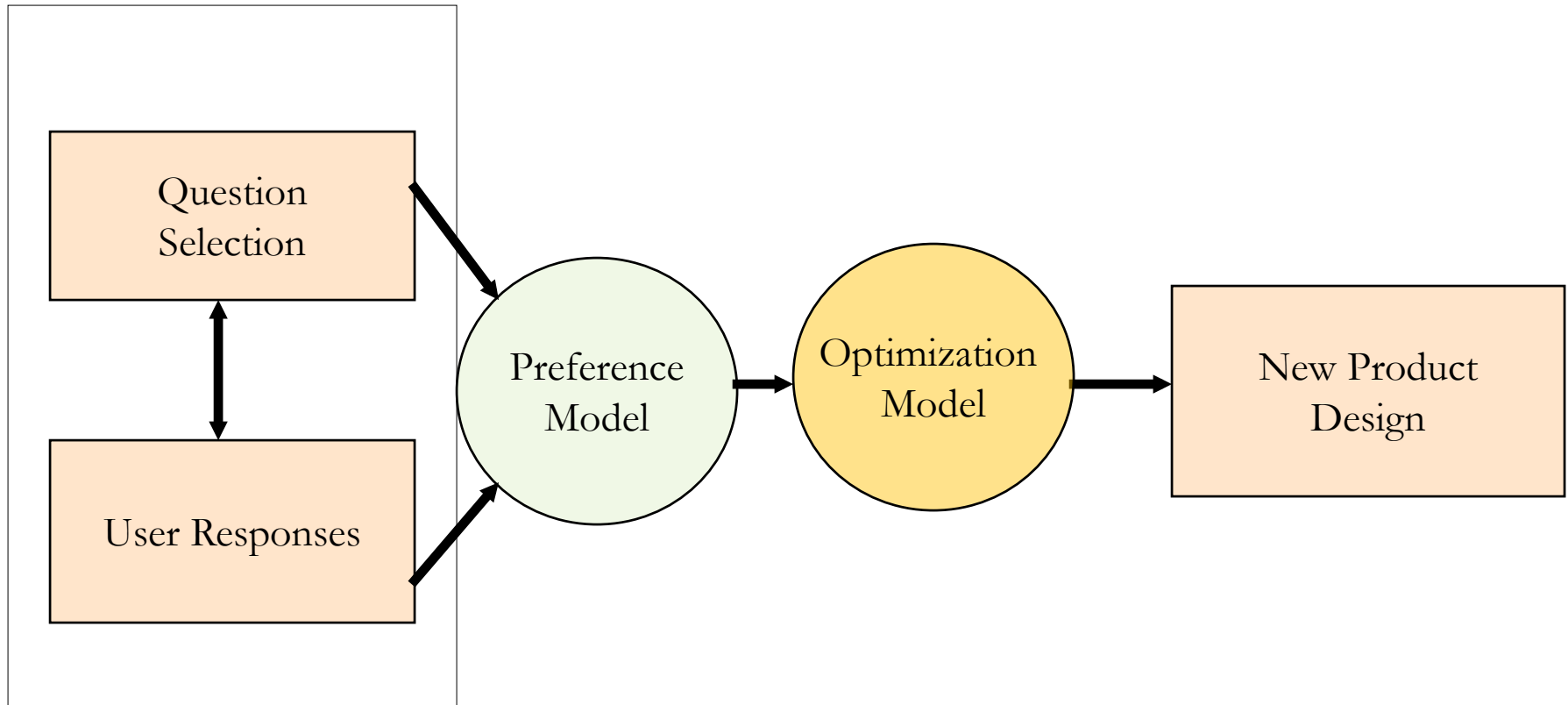
- Consider two products A and B and suppose market has 5 people
- We can compute predicted utilities for each person

Person	Utility of A	Utility of B	Choice
1	5.76	3.5	A
2	4.07	2.62	A
3	1.13	3.1	B
4	4.8	3.2	A
5	0.4	3.1	B

- Market Share for A is  $3/5$

# Conjoint Summary

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# Additional Readings and Links

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- Louviere, Hensher and Swait, (2000) *Stated Choice Methods: Analysis and Application*, Cambridge University Press
- Rao, Vithala R. (2014) *Applied Conjoint Analysis*, Springer-Verlag, Berlin Heidelberg
- Sawtooth Software