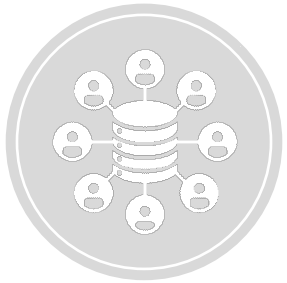
Formulating utility functions

Key concepts & study plan

Experimental design



Data collection & processing

Model specification & estimation

Interpretation & application

Formulating utility functions

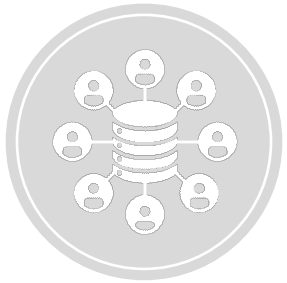
Outline

- Labelled versus unlabelled alternatives
- Variables in utility functions
- Adding attributes
- Adding socio-demographic/economic variables
- Adding scenario variables
- Alternative-specific constants

Labelled versus unlabelled alternatives

Key concepts & study plan

Experimental design



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Labelled versus unlabelled alternatives

Unlabelled alternatives

- Useful when study objective is
  - determining relative importance of attributes
  - determining willingness-to-pay

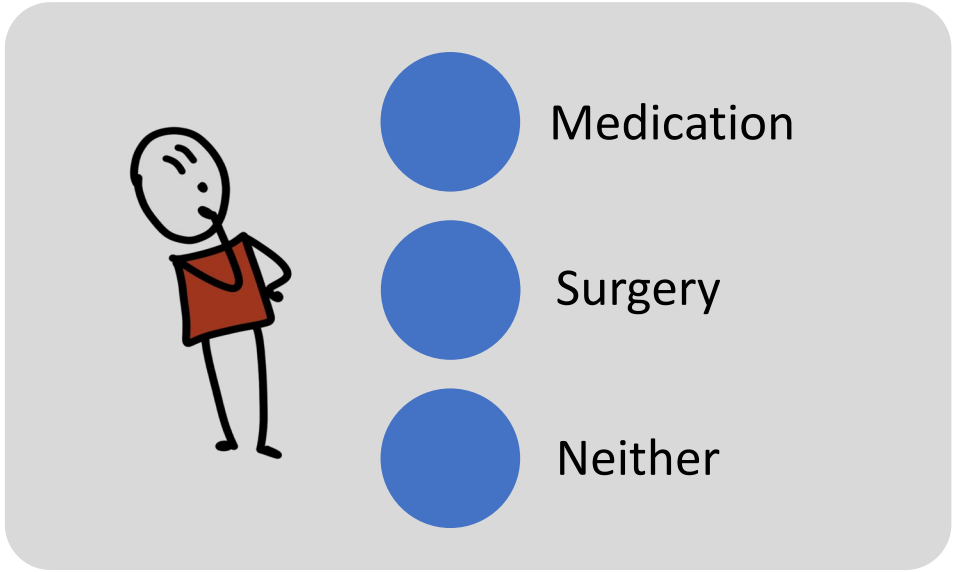
- Generic utility functions

$$U(\text{Treatment A}) = \beta_1 \cdot \text{Effectiveness}_A + \beta_2 \cdot \text{SideEffects}_A \cdot \text{Age} + \beta_3 \cdot \text{Cost}_A$$
$$U(\text{Treatment B}) = \beta_1 \cdot \text{Effectiveness}_B + \beta_2 \cdot \text{SideEffects}_B \cdot \text{Age} + \beta_3 \cdot \text{Cost}_B$$
$$U(\text{Treatment C}) = \beta_1 \cdot \text{Effectiveness}_C + \beta_2 \cdot \text{SideEffects}_C \cdot \text{Age} + \beta_3 \cdot \text{Cost}_C$$

Labelled versus unlabelled alternatives

Labelled alternatives

- Useful when study objective is
  - determining relative importance of attributes
  - determining willingness-to-pay
  - determining elasticities
  - forecasting market shares and demand



- Alternative-specific utility functions

$$U(\text{Medication}) = \beta_1 + \beta_2 \cdot \text{Effectiveness} + \beta_3 \cdot \text{SideEffects}_A \cdot \text{Age} + \beta_4 \cdot \text{Cost}_{\text{Medication}}$$

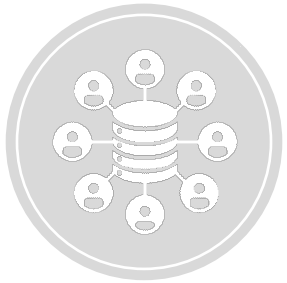
$$U(\text{Surgery}) = \beta_5 + \beta_6 \cdot \text{Risk} \cdot \text{Gender} + \beta_7 \cdot \text{RecoveryTime} + \beta_4 \cdot \text{Cost}_{\text{Surgery}}$$

$$U(\text{Neither}) = 0$$

Variables in utility functions

Key concepts & study plan

Experimental design



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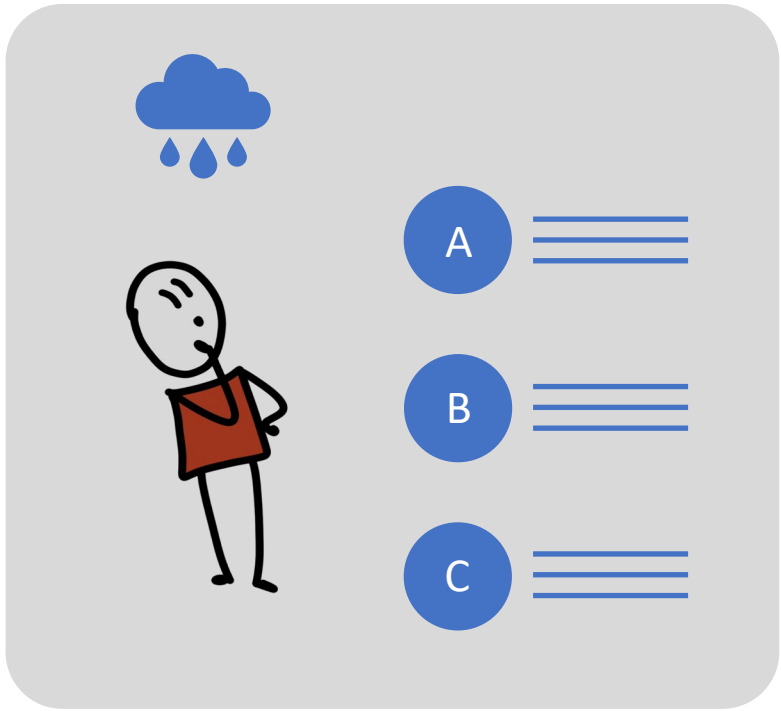
Variables in utility functions

Variables to include in utility functions

- Attributes (**x**)
  - Characteristics of the alternative
- Socio-demographic/economic variables (**z**)
  - Characteristics of the decision-maker
- Scenario variables (**w**)
  - Characteristics of the choice context
- Other variables
  - Characteristics of the data collection
    - SP or RP
    - Pilot study or main study
    - Laboratory or questionnaire



Variables in utility functions

Measurement of variables

CATEGORICAL VARIABLE

- Use dummy or effects coded values in utility function
  - blue, red, green, yellow colour
  - mild, moderate, severe side effects
  - male, female, other

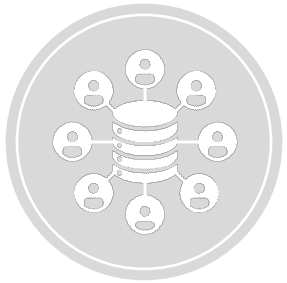
NUMERICAL VARIABLE

- Use numerical values directly in utility function
  - 10.99, 15.99, 21.99 dollars
  - 10, 20, 30, 40 percent risk of side-effects
  - 18, 19, 20, 21, … , 65 years

Adding attributes

Key concepts & study plan

Experimental design



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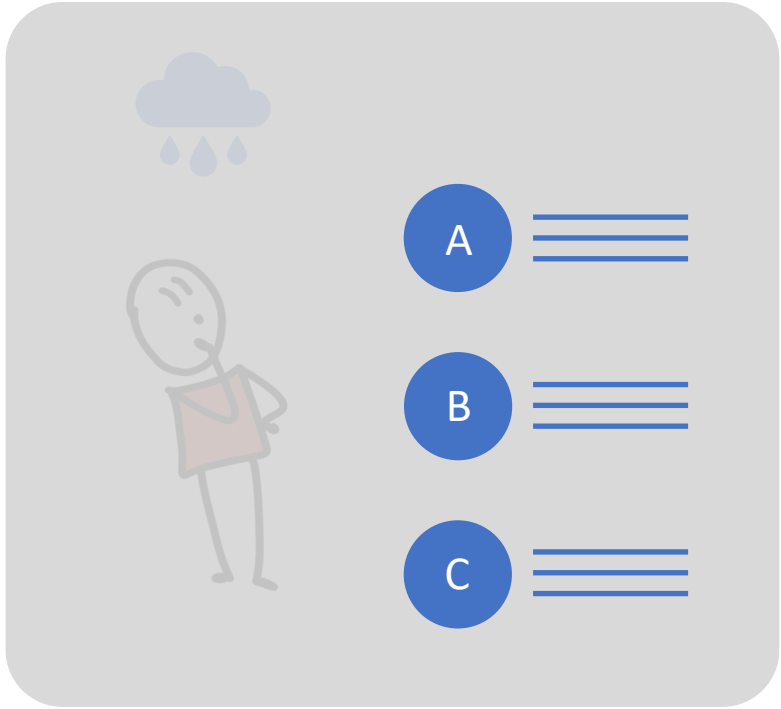
Interpretation & application

Adding attributes

Attributes

- Characteristics of the alternatives
- Main effects and/or interaction effects



Adding attributes

Linear main effects

- Example: Choice of treatment by patients
  - Higher effectiveness means more utility
  - Presence of side-effects means less utility
  - Higher cost means less utility

$$U(\text{Treatment}) = 0.5 \cdot \text{Effectiveness} - 0.2 \cdot \text{SideEffects} - 0.1 \cdot \text{Cost}$$

Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

Side effects	Value
Yes	1
No	0

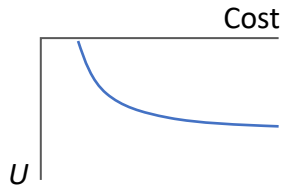
Cost	Value
$10	10
$20	20
$30	30

Adding attributes

Nonlinear main effects

- Example: Choice of treatment by patients
  - Diminishing effect of cost

$$U(\text{Treatment}) = 0.5 \cdot \text{Effectiveness} - 0.2 \cdot \text{SideEffects} - \underline{0.3 \cdot \log(\text{Cost})}$$



Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

Side effects	Value
Yes	1
No	0

Cost	Value
$10	10
$20	20
$30	30

Adding attributes

Interaction effects

- Example: Choice of treatment by patients
  - More effective treatment reduces cost sensitivity

$$U(\text{Treatment}) = 0.5 \cdot \text{Effectiveness} - 0.2 \cdot \text{SideEffects} - 0.10 \cdot \text{Cost} + \underline{0.06 \cdot \text{Effectiveness} \cdot \text{Cost}}$$

Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

Side effects	Value
Yes	1
No	0

Cost	Value
$10	10
$20	20
$30	30

Adding attributes

Interaction effects

- Example: Choice of treatment by patients
  - More effective treatment reduces cost sensitivity

$$U(\text{Treatment}) = 0.5 \cdot \text{Effectiveness} - 0.2 \cdot \text{SideEffects} - 0.10 \cdot \text{Cost} + \underline{0.06 \cdot \text{Effectiveness} \cdot \text{Cost}}$$

$$\left(-0.10 + 0.06 \cdot \text{Effectiveness}\right) \cdot \text{Cost}$$

Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

Side effects	Value
Yes	1
No	0

Cost	Value
$10	10
$20	20
$30	30

Adding attributes

Interaction effects

- Example: Choice of treatment by patients
  - More effective treatment reduces cost sensitivity

$$U(\text{Treatment}) = 0.5 \cdot \text{Effectiveness} - 0.2 \cdot \text{SideEffects} - 0.10 \cdot \text{Cost} + 0.06 \cdot \text{Effectiveness} \cdot \text{Cost}$$

$$\left(-0.10 + 0.06 \cdot 0.5\right) \cdot \text{Cost} = -0.07 \cdot \text{Cost}$$

Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

Side effects	Value
Yes	1
No	0

Cost	Value
$10	10
$20	20
$30	30

Adding socio-demographic/economic variables

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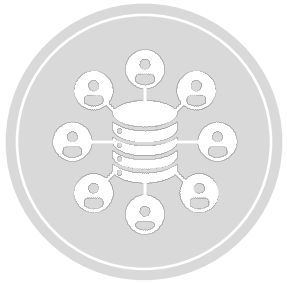
Experimental design



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Adding socio-demographic/economic variables

Socio-demographic/economic variables

- Characteristics of the decision-maker
- Has same value across all alternatives,
  hence can only be included as interaction effect

Adding socio-demographic/economic variables

Interaction with alternative-specific constant

- Example: Choice of treatment by patients
  - Older patients prefer medication less

$$U(\text{Medication}) = 0.3 - 0.01 \cdot \text{Age} + 0.5 \cdot \text{Effectiveness} - 0.02 \cdot \text{SideEffects} \cdot \text{Age} - 0.1 \cdot \text{Cost}$$

$$U(\text{Surgery}) = \ldots$$

$$U(\text{Neither}) = 0$$

Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

Side effects	Value
Yes	1
No	0

Cost	Value
$10	10
$20	20
$30	30

Adding socio-demographic/economic variables

Interaction with attribute

- Example: Choice of treatment by patients
  - Older patients have a stronger aversion to side effects of medication

$$U(\text{Medication}) = 0.3 - 0.01 \cdot \text{Age} + 0.5 \cdot \text{Effectiveness} - 0.02 \cdot \text{SideEffects} \cdot \text{Age} - 0.1 \cdot \text{Cost}$$

$$U(\text{Surgery}) = \ldots$$

$$U(\text{Neither}) = 0$$

Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

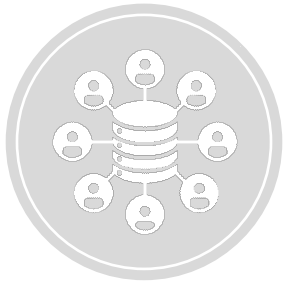
Side effects	Value
Yes	1
No	0

Cost	Value
$10	10
$20	20
$30	30

Adding scenario variables

Key concepts & study plan

Experimental design



Data collection & processing

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Adding scenario variables

Scenario variables

- Characteristics of the choice context
- Has same value across all alternatives,
  hence can only be included as interaction effect

Adding scenario variables

Interaction with alternative-specific constants

- Example: Choice of treatment by physicians
  - Physician is less likely to prescribe medication to skin cancer patients, relative to patients with hernia

Disease	Value
Skin cancer	1
Hernia	0

Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

$$U(\text{Medication}) = 0.3 - 0.6 \cdot \text{Disease} + 0.5 \cdot \text{Effectiveness} + 0.2 \cdot \text{Effectiveness} \cdot \text{Disease}$$

$$U(\text{Surgery}) = \ldots$$

$$U(\text{Neither}) = 0$$

Adding scenario variables

Interaction with attributes

- Example: Choice of treatment by physicians
  - Physician takes effectiveness of a drug more into account for skin cancer patients, relative to patients with hernia

$$U(\text{Medication}) = 0.3 - 0.6 \cdot \text{Disease} + 0.5 \cdot \text{Effectiveness} + \underline{0.2 \cdot \text{Effectiveness} \cdot \text{Disease}}$$

$$U(\text{Surgery}) = \ldots$$

$$U(\text{Neither}) = 0$$

Disease	Value
Skin cancer	1
Hernia	0

Effectiveness	Value
30%	0.3
50%	0.5
70%	0.7
90%	0.9

Alternative-specific constants

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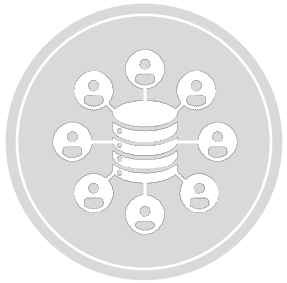

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Alternative-specific constants

Capture the mean of unobserved effects

- Label effect
  - Car vs Train
  - Apple vs Samsung
  - Status quo vs Hypothetical option
  - Opt-out vs Choosing an option

- Order/presentation effect
  - Left vs Right
  - Top vs Bottom