

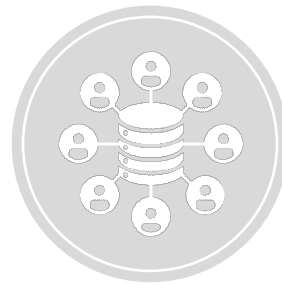
A guide to: Experimental design



Key concepts
& study plan



**Experimental
design**



Data collection
& processing



Model specification
& estimation



Interpretation
& application

A guide to: Experimental design

Steps in designing choice experiments

1. Determine design type
2. Determine design size
3. Generate design
4. Block design
5. Create choice tasks in survey instrument



Each study is different,
some steps may not apply
or in a different order

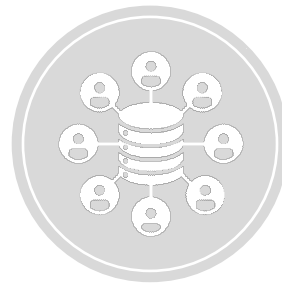
Design considerations



Key concepts
& study plan



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Design considerations

Experimental design

- Matrix with attribute level combinations, where
 - Each column represents an attribute of an alternative
 - Each row represents a choice task

Bike	Bus A		Bus B	
dist	time _A	cost _A	time _B	cost _B

10	10	1	20	3
2	20	2	30	1
5	30	3	10	2
5	10	2	20	1
5	20	3	30	2
5	30	1	10	3
5	10	2	20	1
5	20	1	10	2
10	30	3	30	3

Bike	Bus A	Bus B
5 km	20 min \$3	30 min \$2
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Design considerations

Realism

- ❑ A good design contains realistic attribute level combinations
- ❑ Non-sensible attribute level combinations should be avoided

Bike	Bus A		Bus B	
dist	time _A	cost _A	time _B	cost _B
10	10	1	20	3
2	20	2	30	1
5	30	3	10	2
5	10	2	20	1
5	20	3	30	2
5	30	1	10	3
5	10	2	20	1
5	20	1	10	2
10	30	3	30	3

Unrealistic attribute level combinations

Design considerations

Balance

- ❑ A good design contains a high degree of attribute level balance
- ❑ Highly unbalanced designs should be avoided

	Bike	Bus A		Bus B	
	dist	time _A	cost _A	time _B	cost _B
Unbalanced attribute levels	10	10	1	20	3
	2	20	2	30	1
	5	30	3	10	2
	5	10	2	20	1
	5	20	3	30	2
	5	30	1	10	3
	5	10	2	20	1
	5	20	1	10	2
	10	30	3	30	3

Design considerations

Variety

- ❑ A good design contains a variety of attribute level combinations
- ❑ Repeated or similar choice tasks should be avoided

Bike	Bus A		Bus B	
dist	time _A	cost _A	time _B	cost _B
10	10	1	20	3
2	20	2	30	1
5	30	3	10	2
5	10	2	20	1
5	20	3	30	2
5	30	1	10	3
5	10	2	20	1
5	20	1	10	2
10	30	3	30	3

Repeated choice tasks

Design considerations

Trade-offs

- ❑ A good design allows trade-offs between attributes
- ❑ Choice tasks with dominant alternatives should be avoided

Bike	Bus A		Bus B	
dist	time _A	cost _A	time _B	cost _B
10	10	1	20	3
2	20	2	30	1
5	30	3	10	2
5	10	2	20	1
5	20	3	30	2
5	30	1	10	3
5	10	2	20	1
5	20	1	10	2
10	30	3	30	3

No trade-off

Design considerations

Trade-offs

- ❑ A good design allows trade-offs between attributes
- ❑ Choice tasks with dominant alternatives should be avoided

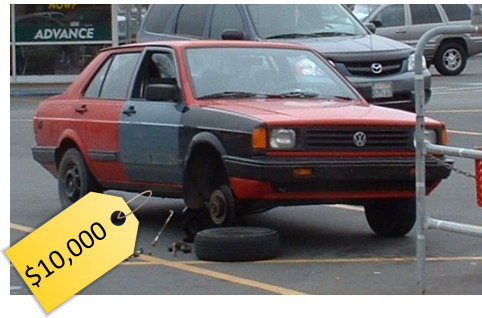
Bike	Bus A		Bus B	
dist	time _A	cost _A	time _B	cost _B
10	10	1	20	3
2	20	2	30	1
5	30	3	10	2
5	10	2	20	1
5	20	3	30	2
5	30	1	10	3
5	10	2	20	1
5	20	1	10	2
10	30	3	30	3

Bus B is dominant

Design considerations

Dominant alternative

- ❑ Alternative that is best across all attributes
- ❑ Often present in unlabelled experiments
- ❑ Choice task with dominant alternative provides no information, and should be detected and avoided



Design considerations

Dominant alternative

- Results in silly choice tasks



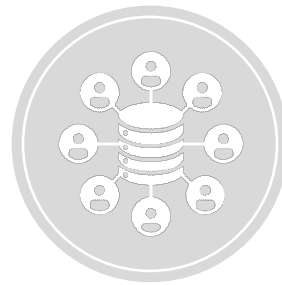
Step 1 – Determine design type



Key concepts
& study plan



**Experimental
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Data collection
& processing



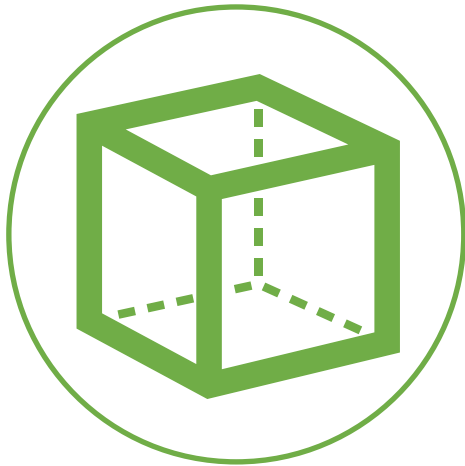
Model specification
& estimation



Interpretation
& application

Step 1 – Determine design type

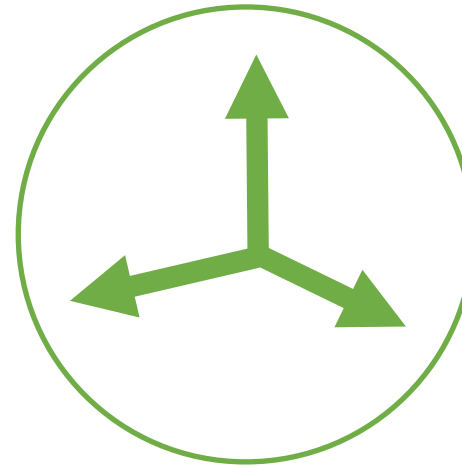
Design types



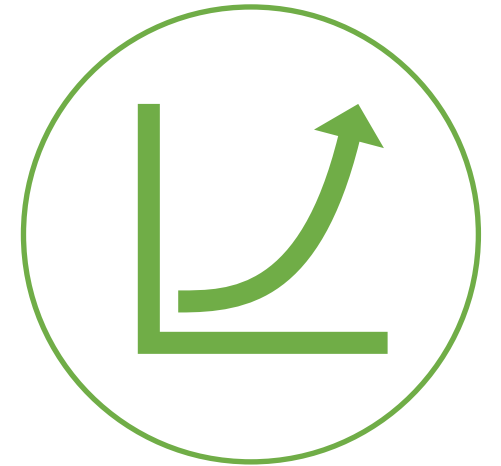
Full factorial design



Random design



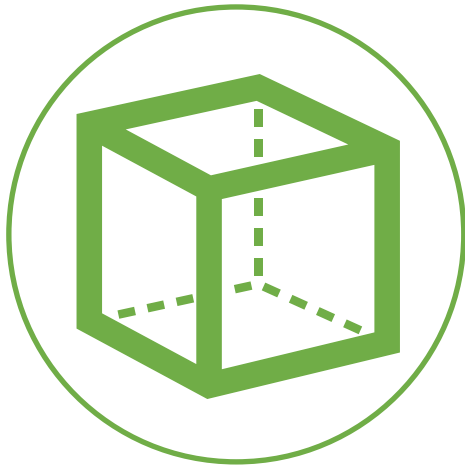
Orthogonal design



Efficient design

Step 1 – Determine design type

Design types



Full factorial design

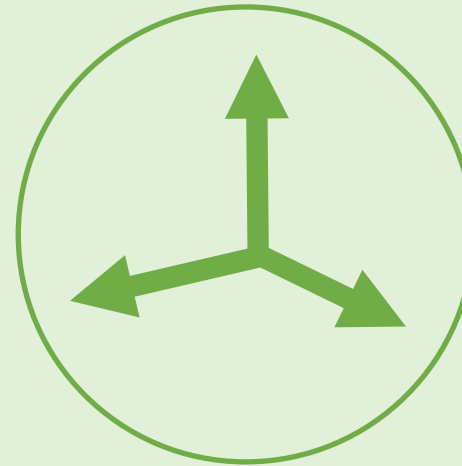
*all possible
attribute level
combinations*



Random design

*random
attribute level
combinations*

Fractional factorial designs



Orthogonal design

*balanced
attribute level
combinations*

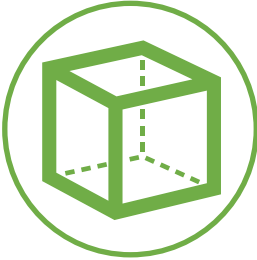

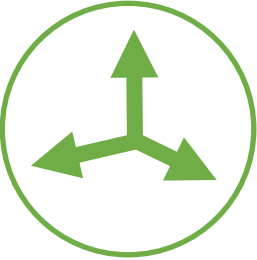
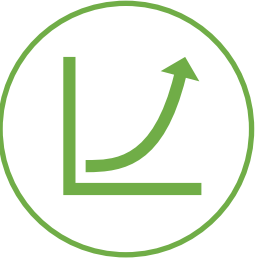


Efficient design

*trade-off maximising
attribute level
combinations*

Step 1 – Determine design type

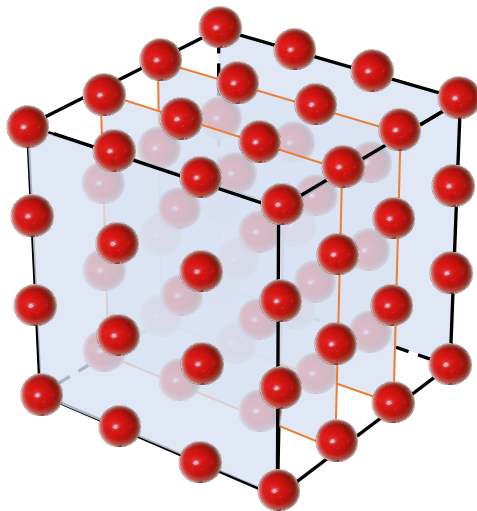
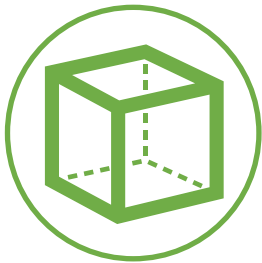
Each design type has different strengths and weaknesses

	Full factorial	Random	Orthogonal	Efficient
				
Realism	● ○ ○	● ● ○	● ○ ○	● ● ●
Trade-offs	● ○ ○	● ○ ○	● ● ○	● ● ●
Balance	● ● ●	● ○ ○	● ● ●	● ● ○
Variety	● ● ●	● ● ●	● ● ○	● ● ○

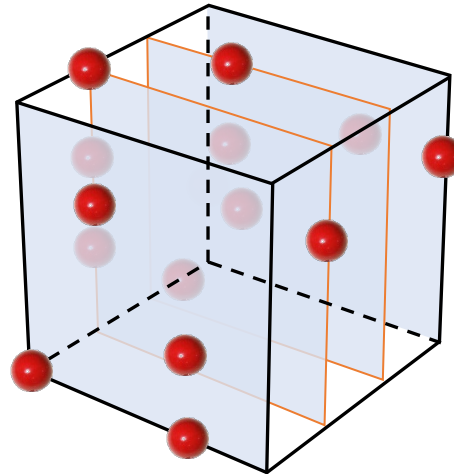
Step 1 – Determine design type

Each design type results in different attribute level combinations

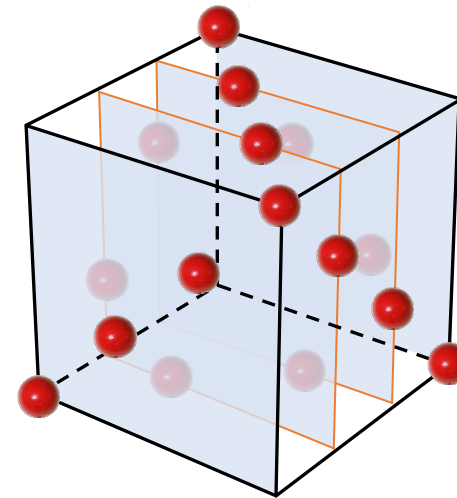
Full factorial



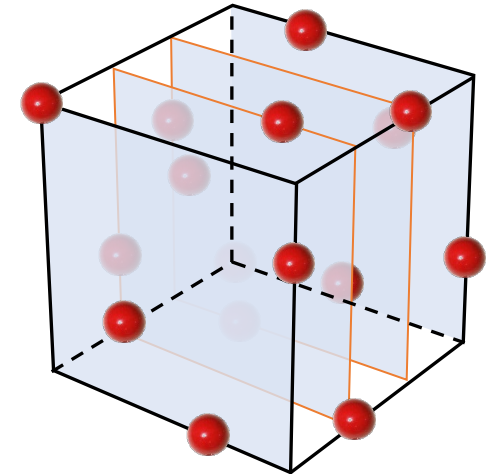
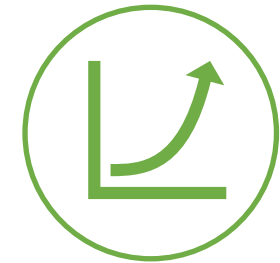
Random



Orthogonal

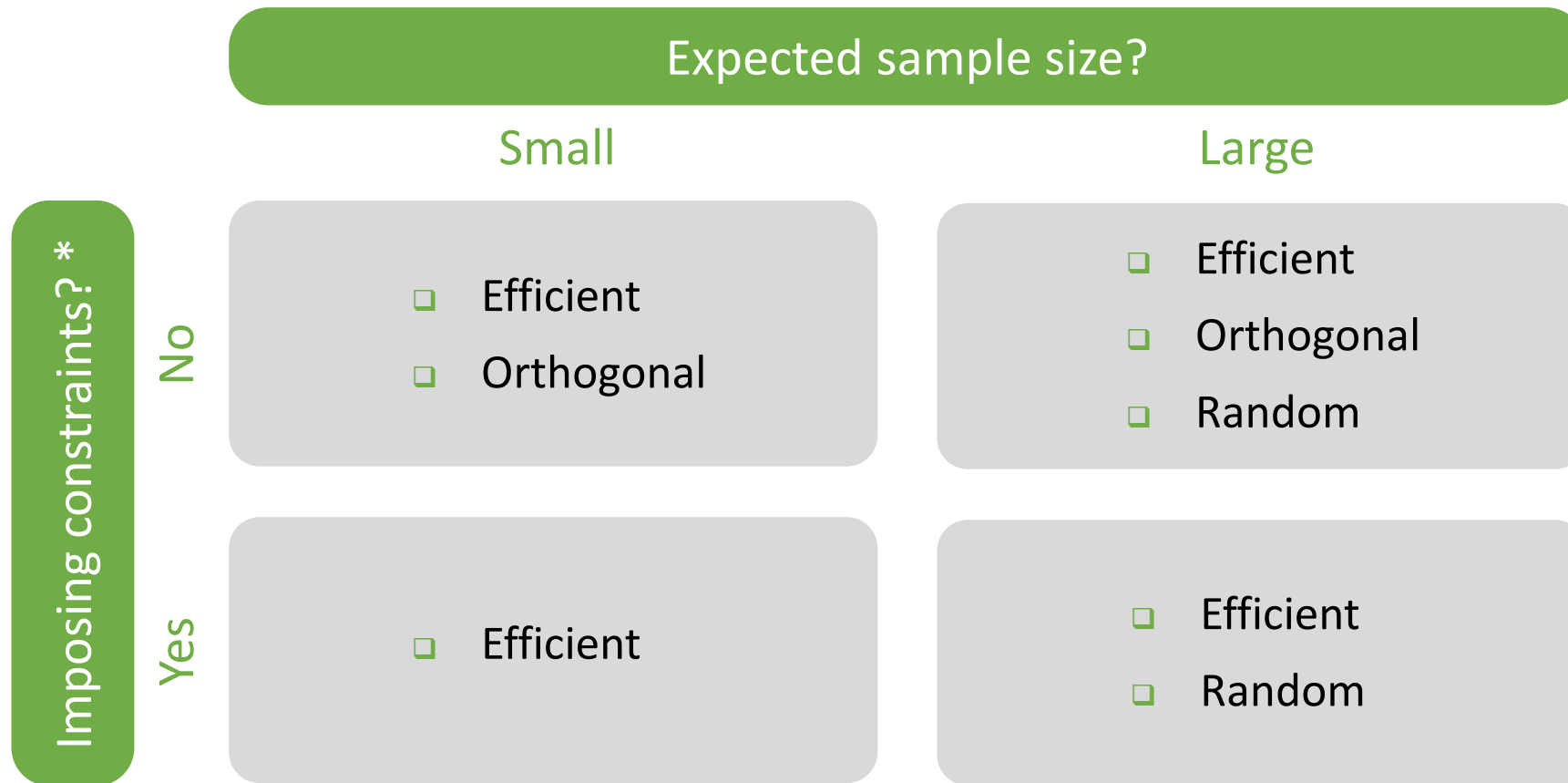


Efficient



Step 1 – Determine design type

Selecting best design type



* Prohibitions of certain attribute level combinations to ensure realism, non-dominance, etc.

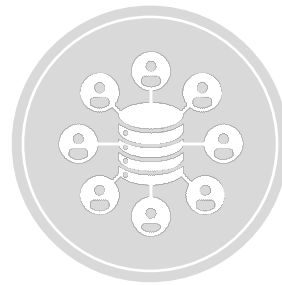
Step 2 – Determine design size



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Step 2 – Determine design size

Design size

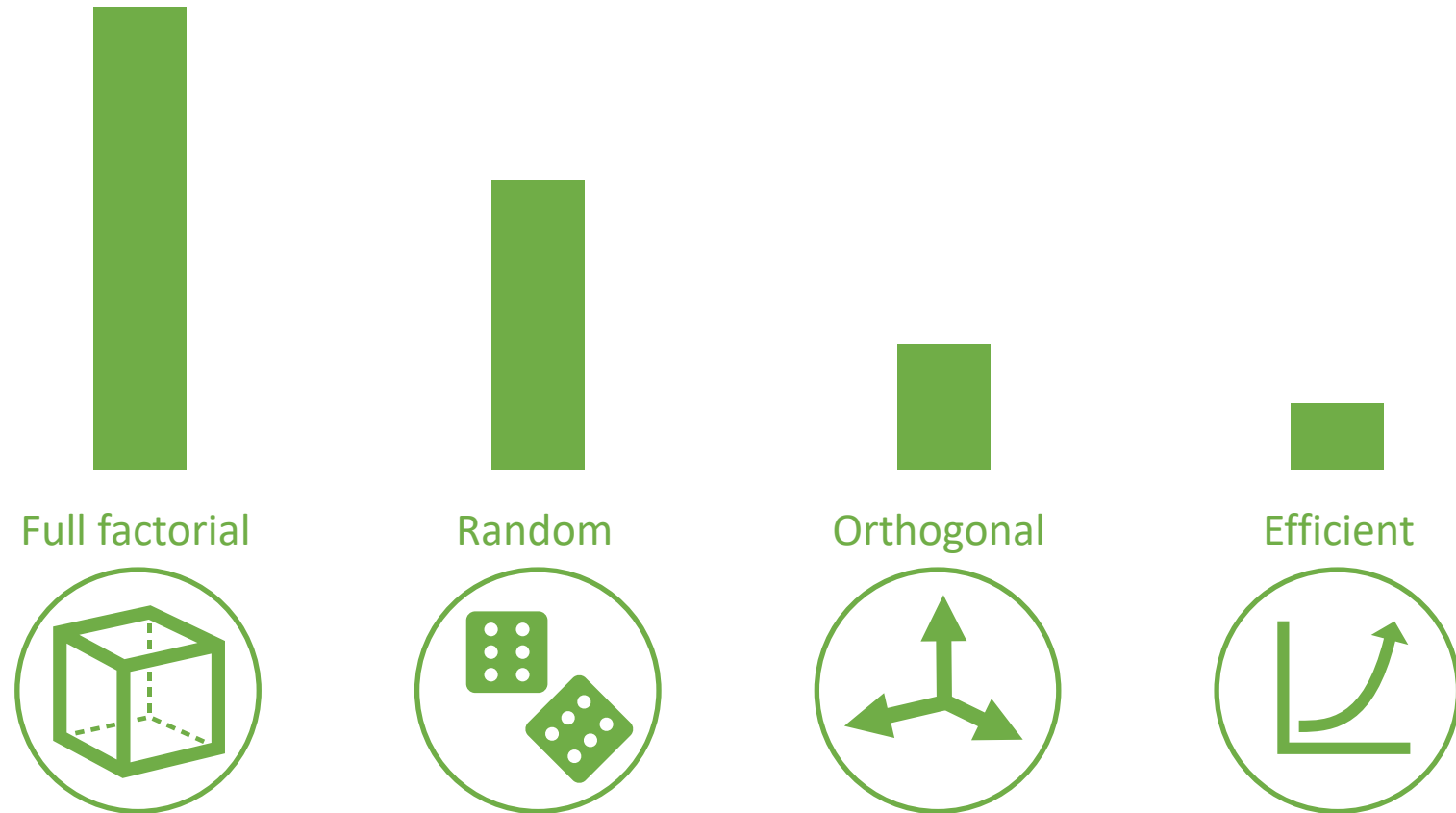
- Number of choice tasks (rows) in an experimental design

Bike		Bus A		Bus B	
dist	time _A	cost _A	time _B	cost _B	
2	10	1	20	3	} design size = 9
2	20	2	30	1	
2	30	3	10	2	
5	10	2	20	1	
5	20	3	30	2	
5	30	1	10	3	
10	10	3	20	2	
10	20	1	30	3	
10	30	2	10	1	

Step 2 – Determine design size

Appropriate design size varies by design type

□ Typical design size



Step 2 – Determine design size

Full factorial design is typically too large

- The full factorial design for this experiment contains 41,472 choice tasks!

Bike	Bus			Train			Tram		
dist	time	cost	wait	time	cost	wait	time	cost	wait
2	20	1	10	10	3	5	15	2	8
5	30	2	20	20	4	10	25	3	15
10	40	3		30	5		35	4	
		4			6			5	

3 × 3 × 4 × 2 × 3 × 4 × 2 × 3 × 4 × 2 = 41,472

levels



Step 2 – Determine design size

Minimum design size

- Theoretical minimum
 - Statistical requirement for any design

- Recommended
 - Multiplier $M > 1$
 - My rule of thumb:
 - Random design: $M = 10$
 - Efficient design: $M = 3$

$$\text{design size} > \frac{\text{number of parameters}}{\text{number of alternatives} - 1}$$

$$\text{design size} > M \cdot \frac{\text{number of parameters}}{\text{number of alternatives} - 1}$$

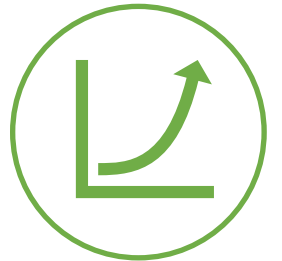
Step 2 – Determine design size

Minimum design size – Example efficient design

- Theoretical minimum
 - Statistical requirement for any design
- Recommended
 - Multiplier M = 3

$$\text{design size} > \frac{10}{3-1}$$

$$\text{design size} > 3 \cdot \frac{10}{3-1}$$



$$\text{Utility}(\text{Car}) = \beta_1 \cdot \text{TravelTime}_{\text{car}} + \beta_2 \cdot \text{FuelCost} + \beta_3 \cdot \text{TollCost}$$

$$\text{Utility}(\text{Bus}) = \beta_4 + \beta_5 \cdot \text{TravelTime}_{\text{bus}} + \beta_6 \cdot \text{WalkTime} + \beta_7 \cdot \text{NrTransfers} + \beta_2 \cdot \text{Fare}$$

$$\text{Utility}(\text{Bike}) = \beta_8 + \beta_9 \cdot \text{TravelTime}_{\text{bike}} + \beta_{10} \cdot \text{Rain}$$

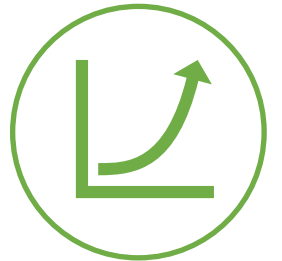
Step 2 – Determine design size

Minimum design size – Example efficient design

- Theoretical minimum
 - Statistical requirement for any design
- Recommended
 - Multiplier $M = 3$

design size > 5

design size > 15



$$\text{Utility}(\text{Car}) = \beta_1 \cdot \text{TravelTime}_{\text{car}} + \beta_2 \cdot \text{FuelCost} + \beta_3 \cdot \text{TollCost}$$

$$\text{Utility}(\text{Bus}) = \beta_4 + \beta_5 \cdot \text{TravelTime}_{\text{bus}} + \beta_6 \cdot \text{WalkTime} + \beta_7 \cdot \text{NrTransfers} + \beta_2 \cdot \text{Fare}$$

$$\text{Utility}(\text{Bike}) = \beta_8 + \beta_9 \cdot \text{TravelTime}_{\text{bike}} + \beta_{10} \cdot \text{Rain}$$

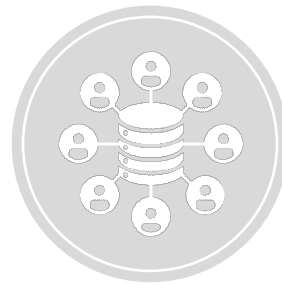
Step 3 – Generate design



Key concepts
& study plan



**Experimental
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Model specification
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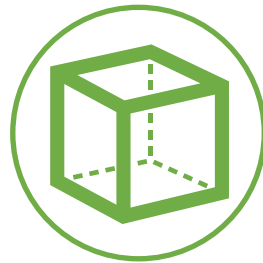


Interpretation
& application

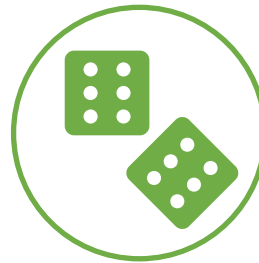
Step 3 – Generate design

Design generation tools

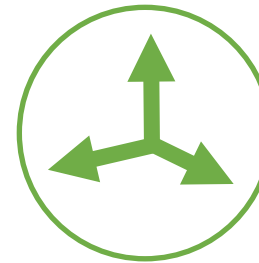
Full factorial



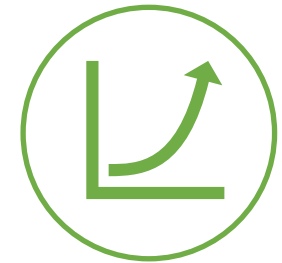
Random



Orthogonal



Efficient



☐ Spreadsheet



☐ Design library



☐ Design software



Step 3 – Generate design

Software for generating designs for choice experiments

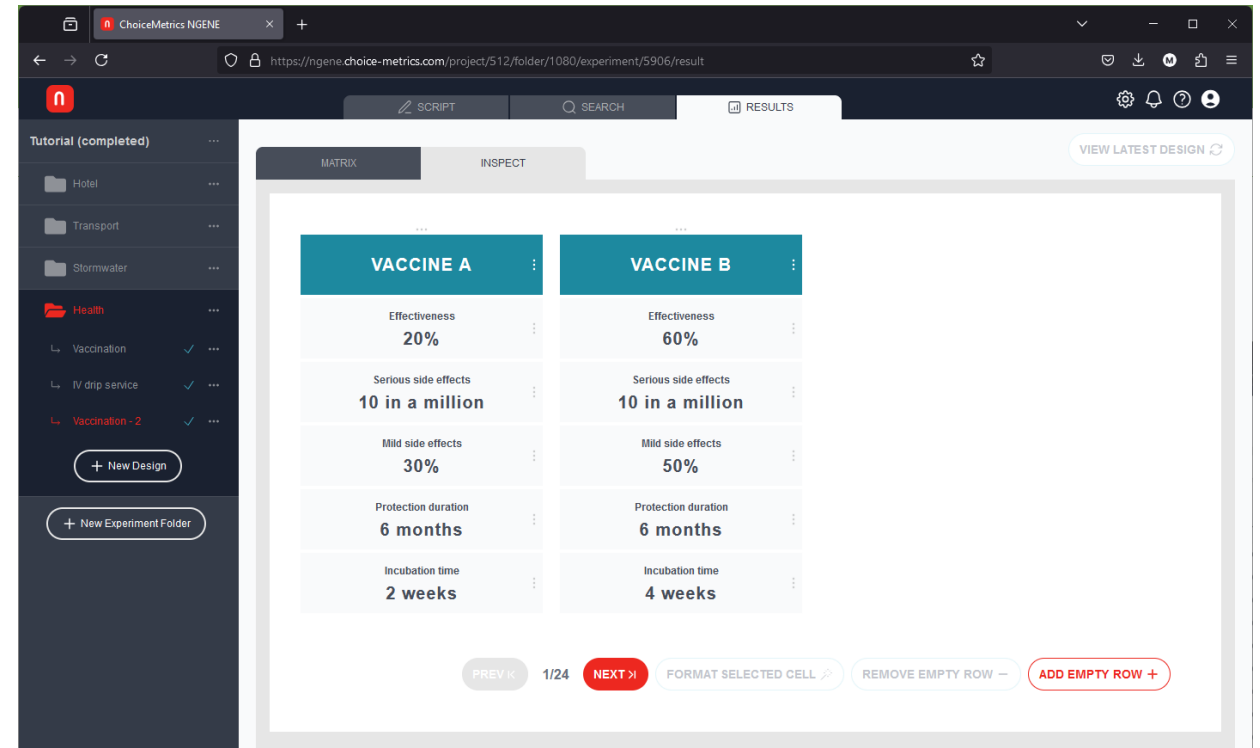
- ❑ Ngene
- ❑ SAS
- ❑ JMP
- ❑ Stata
- ❑ SPSS - orthogonal designs only
- ❑ Sawtooth
- ❑ Idefix in R - efficient designs only, free

Step 3 – Generate design

Ngene

- ❑ Used in this course
- ❑ Full factorial designs
- ❑ Random designs
- ❑ Orthogonal designs
- ❑ Efficient designs

www.choice-metrics.com



Step 3 – Generate design

Ngene

- ❑ Specify choice model and design properties in script
- ❑ Run script to generate design

The screenshot shows the Ngene script editor interface. The left sidebar contains a 'Tutorial (completed)' section with folders for 'Hotel', 'Transport', 'Stormwater', and 'Health'. The 'Health' folder is expanded, showing 'Vaccination', 'IV drip service', and 'Vaccination - 2'. The main editor area displays a script for generating a design. The script includes parameters for effectiveness, serious side effects, mild side effects, protection duration, and incubation time. The log at the bottom shows the simulation process, including the start and end times, the number of iterations, and the current evaluation.

```
1 design
2 ;alts = (vaccine1, vaccine2), optout
3 ;rows = 24
4 ;block = 3
5 ;eff = (mnl,d,mean)
6 ;bdraws = gauss(3)
7 ;model:
8 U(vaccine1, vaccine2)
9 = b1[(n, 0.0226, 0.00099)] * Effectiveness[20, 40, 60, 80] ? Effectiveness (%)
10 + b2[(n, -0.0009, 0.00053)] * Serious[1, 10, 100] ? Serious side effects (x in 1,000,000)
11 + b3[(n, -0.0409, 0.01255)] * Mild[10, 30, 50] ? Mild side effects (%)
12 + b4[(n, 0.0305, 0.00623)] * Protection[3, 6, 12] ? Protection duration (months)
13 + b5[(n, 0.0649, 0.02132)] * Incubation[2, 4] ? Incubation time (weeks)
14 /
15 U(optout) = asc[(n, 1.2027, 0.1038)]
16 $
```

Log

Note: Defaulting to assigning blocks with the 'minsum' method.
Beginning Gauss draws for simulation.
Started, at Wed Jan 15 2025 12:35:20 GMT+1100 (Australian Eastern Daylight Time)
Completed Gauss draws for simulation.
[Random] Finished initial seeding (0.001964)
[Swap] Start row swapping with initial seed. (10000 iterations of swapping)
Stopped, at Wed Jan 15 2025 12:36:39 GMT+1100 (Australian Eastern Daylight Time)

Current Evaluation: 354 Invalid Designs: 0

The screenshot shows the Ngene results interface. The left sidebar is the same as the previous screenshot. The main editor area displays the 'RESULTS' tab, which includes a 'Design' section with a table of choice tasks and a 'Model' section with various settings.

Choice situation	Block	vaccine1.effectiveness	vaccine1.serious	vaccine1.mild	vaccine1.protection	vaccine1.incubation	vaccine1.optout
1	1	20	10	30	6	2	
2	1	40	10	30	6	4	
3	1	60	100	50	6	4	
4	1	80	100	50	12	2	
5	1	80	1	10	3	4	
6	1	20	1	30	3	2	
7	1	40	10	50	6	4	
8	1	60	100	10	3	2	
9	2	20	10	10	12	4	
10	2	20	10	30	6	2	
11	2	40	100	30	6	2	

Design | Choice tasks

Model

- Design
- Choice tasks
- Correlations
- Model
- MNL
- Design properties
- Covariance matrix
- Fisher matrix
- Probabilities
- Utilities
- Covariance matrix (bayesian average)
- Fisher matrix (bayesian average)
- Efficiency measures by bayesian draws

Step 3 – Generate design

Ngene

- Active freely accessible forums for questions about
 - Ngene
 - Experimental design in general

choice-metrics.com • View forum

phpBB® choice-metrics.com
A forum for users of Ngene

Board index • Choice experiments - general

User Control Panel (0 new messages) • View your posts

Moderator Control Panel

Choice experiments - general
Moderators: Andrew Collins, Michel Blomer, John

NEW TOPIC • Search this forum... Search

Mark topics read • 139 topics • Page 1 of 6

ANNOUNCEMENTS	REPLIES	VIEWS	LAST POST
Choice experiments - general forum info - please read by admin • Wed Apr 30, 2024 8:21 am	0	5876	by admin • Wed Apr 30, 2024 8:21 am

TOPICS	REPLIES	VIEWS	LAST POST
Comparing GOF across two nearly identical experiments by Matteo Ciani • Fri May 10, 2024 5:13 pm	2	92	by Matteo Ciani • Mon May 13, 2024 10:58 am
Weak DCE results - seeking review by TopadstenB • Tue May 11, 2024 6:53 am	2	218	by TopadstenB • Fri May 14, 2024 1:07 am
Sample size limitation by sukanta • Mon Mar 03, 2021 2:38 am	4	260	by sukanta • Mon Mar 03, 2021 10:43 am
How many sample sizes do I need for a pilot study? by sukanta • Tue Apr 20, 2021 5:36 pm	4	325	by sukanta • Thu Apr 22, 2021 3:55 am
Status quo levels in discrete choice experiment by JvB • Mon Mar 22, 2021 6:13 pm	7	832	by Michel Blomer • Fri Mar 26, 2021 9:15 pm
Efficient fractional-factorial design for mixed logit model by Michael Blomer • Tue Mar 09, 2021 7:18 pm	3	626	by Michael Blomer • Mon Mar 22, 2021 11:28 pm
A way of checking the redesign after pilot studies by Kaito Aoki • Thu Mar 04, 2021 3:21 pm	4	599	by Kaito Aoki • Sat Mar 06, 2021 6:45 am
Setting Design Constraints and Criteria for Equal Att. Level by sb-yack • Wed Feb 03, 2021 11:13 am	2	578	by Michel Blomer • Mon Feb 22, 2021 10:47 pm
Multinomial Logit Model by fratis • Wed Jan 06, 2021 9:33 am	3	1258	by Michel Blomer • Mon Feb 22, 2021 10:36 pm
calculating WTA for a negative option by itakro • Fri Dec 11, 2020 10:57 pm	2	918	by itakro • Sat Dec 12, 2020 7:49 pm
A question about blocking by tomorobrian • Tue Nov 17, 2020 11:06 am	2	840	by tomorobrian • Tue Nov 17, 2020 8:29 pm
fixed levels within choice sets for some attributes by LauraWell • Tue Nov 10, 2020 5:33 am	6	1468	by LauraWell • Wed Nov 11, 2020 4:13 am
Generating a full factorial by mham997 • Thu Nov 05, 2020 6:26 am	1	764	by Michel Blomer • Thu Nov 05, 2020 6:56 am

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Choice experiments - Ngene
Moderators: Andrew Collins, Michel Blomer, John

NEW TOPIC • Search this forum... Search

Mark topics read • 536 topics • Page 1 of 23

ANNOUNCEMENTS	REPLIES	VIEWS	LAST POST
Short courses using Ngene by Michel Blomer • Tue Feb 11, 2020 5:53 am	2	4025	by Michel Blomer • Wed May 26, 2021 1:14 pm
Ngene installation deactivating/expiring by admin • Tue Feb 04, 2020 12:22 pm	0	5012	by admin • Tue Feb 04, 2020 12:22 pm
Ngene 1.2.1 now available by Andrew Collins • Fri Dec 21, 2018 9:18 am	0	3747	by Andrew Collins • Fri Dec 21, 2018 9:18 am
Choice experiments - Ngene forum information - please read by admin • Wed Apr 30, 2014 8:15 am	0	8723	by admin • Wed Apr 30, 2014 8:15 am

TOPICS	REPLIES	VIEWS	LAST POST
Online activation of Ngene gives internet connectivity error by Andrew Collins • Fri Dec 21, 2018 3:43 pm	0	3359	by Andrew Collins • Fri Dec 21, 2018 3:43 pm
OOD design by wxy008 • Wed Jun 09, 2021 8:58 pm	0	1	by wxy008 • Wed Jun 09, 2021 8:58 pm
uneven attribute levels and number of levels by sou15_2 • Wed Jun 09, 2021 7:00 pm	0	2	by sou15_2 • Wed Jun 09, 2021 7:00 pm
Patient profile by annet • Wed Jun 09, 2021 12:44 am	1	6	by Michel Blomer • Wed Jun 09, 2021 11:18 am
Number of choice sets by Pramita • Mon Apr 26, 2021 5:32 pm	6	247	by Michel Blomer • Mon May 31, 2021 10:42 pm
Ngene design with values for status quo by nyompi • Tue May 25, 2021 3:43 am	2	73	by nyompi • Mon May 24, 2021 5:41 am
Priors from pilot by sou15_2 • Mon May 17, 2021 7:13 pm	4	182	by sou15_2 • Thu May 20, 2021 6:09 pm
OOD optimality in efficient design by wxy008 • Fri May 14, 2021 10:30 pm	2	115	by wxy008 • Sat May 15, 2021 3:34 pm
S estimate by k24lewis • Thu Sep 22, 2016 8:47 pm	6	4100	by Michel Blomer • Fri May 14, 2021 5:13 am
A categorical model for continuous variable by sukanta • Wed May 12, 2021 5:40 pm	6	197	by sukanta • Thu May 13, 2021 9:58 am

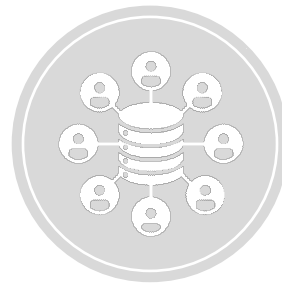
Step 4 – Block design



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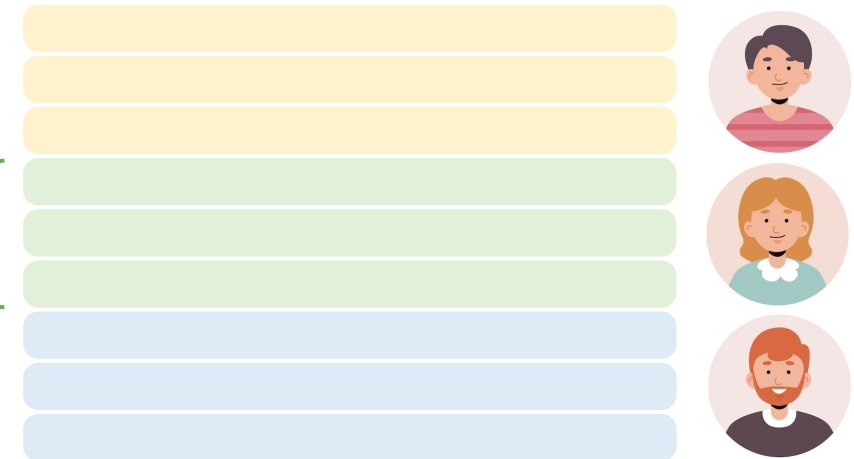
Step 4 – Block design

Block

- ❑ Subset of choice tasks given to a single decision-maker
- ❑ Block size depends on number of choice tasks that decision-makers can handle

Bike	Bus A		Bus B	
dist	time _A	cost _A	time _B	cost _B
2	10	1	20	3
2	20	2	30	1
2	30	3	10	2
5	10	2	20	1
5	20	3	30	2
5	30	1	10	3
10	10	3	20	2
10	20	1	30	3
10	30	2	10	1

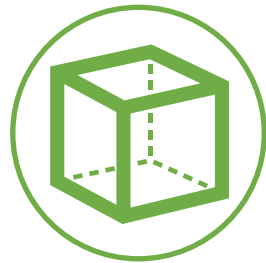
block size = 3



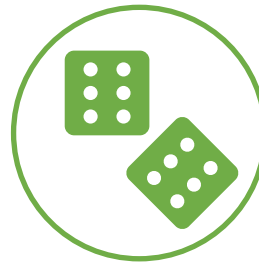
Step 4 – Block design

Blocking strategy

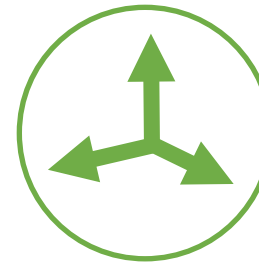
Full factorial



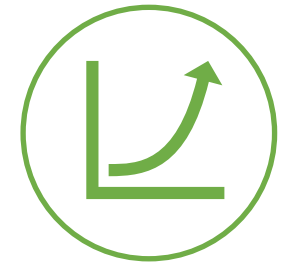
Random



Orthogonal



Efficient



☐ Random *



☐ Orthogonal



☐ Near-orthogonal






* Often default in survey software

Step 4 – Block design

Orthogonal blocking

- Attribute level balance within each block

Hotel A			Hotel B		
stars	distance	price	stars	distance	price
1	1	80	3	2	120
3	3	160	5	1	80
5	2	120	1	3	160
1	3	120	3	1	160
3	2	80	5	3	120
5	1	160	1	2	80
1	2	160	3	3	80
5	3	80	1	1	120
3	1	120	5	2	160



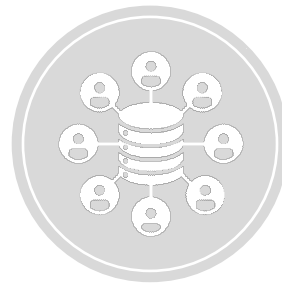
Step 5 – Create choice tasks in survey instrument



Key concepts
& study plan



Experimental
design



Data collection
& processing



Model specification
& estimation



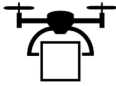


Interpretation
& application

Step 5 – Create choice tasks in survey instrument

The easy way

- Import design matrix into dedicated software for choice experiments

www.surveyengine.com

	Drone	Locker	Postie
			
Speed	2 business days	3 business days	5 business days
Delivery method	Leave in a safe place	Secure in locker	Leave at front door
Time window	9am - 5pm (30 minutes)	24/7 (kept for two days)	6pm - 9pm (no choice)
Cost	\$2	\$6	\$8
Which would you choose?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

www.qualtrics.com*

Please look over the **benefit packages** below and select the one you like most.

	Package 1	Package 2
Compensation Increases	2.5% per year	Based on promotion
Healthcare	50% of premium	100% of premium
401k Matching	50% matching	100% matching
PTO	10 days	20 days
Work from home	No	1 day a week
Free Lunch	Everyday	Never

* Requires purchasing additional conjoint analysis module

Step 5 – Create choice tasks in survey instrument

The hard way

- ❑ Create each choice task manually
- ❑ May require javascript coding
- ❑ May require screenshots of choice tasks

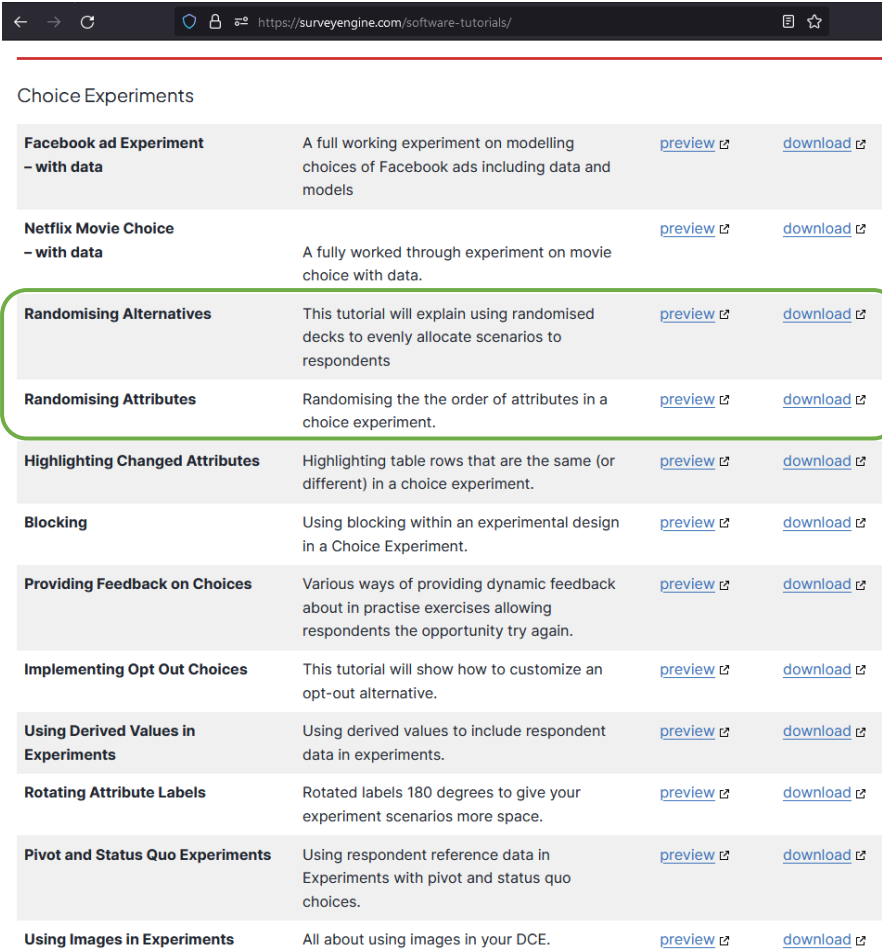
Motorway	Urban road
Speed limit of 90 km/h , no traffic lights .	Speed limit of 50 km/h , four traffic lights .
The travel time is 6 minutes every day. <div><div>6</div><div>6</div><div>6</div><div>6</div><div>6</div></div>	The travel time varies. You will experience one of the following travel times (in minutes) with equal probability: <div><div>4</div><div>6</div><div>12</div><div>12</div><div>12</div></div>
Toll cost: \$ 1.00	Toll cost: \$ 0.00

Step 5 – Create choice tasks in survey instrument

Randomise

- ❑ Order of **labelled alternatives** across respondents
- ❑ Order of **attributes** across respondents (optional)
- ❑ Order of **choice tasks** across respondents (optional)

- ❑ See tutorials on SurveyEngine website

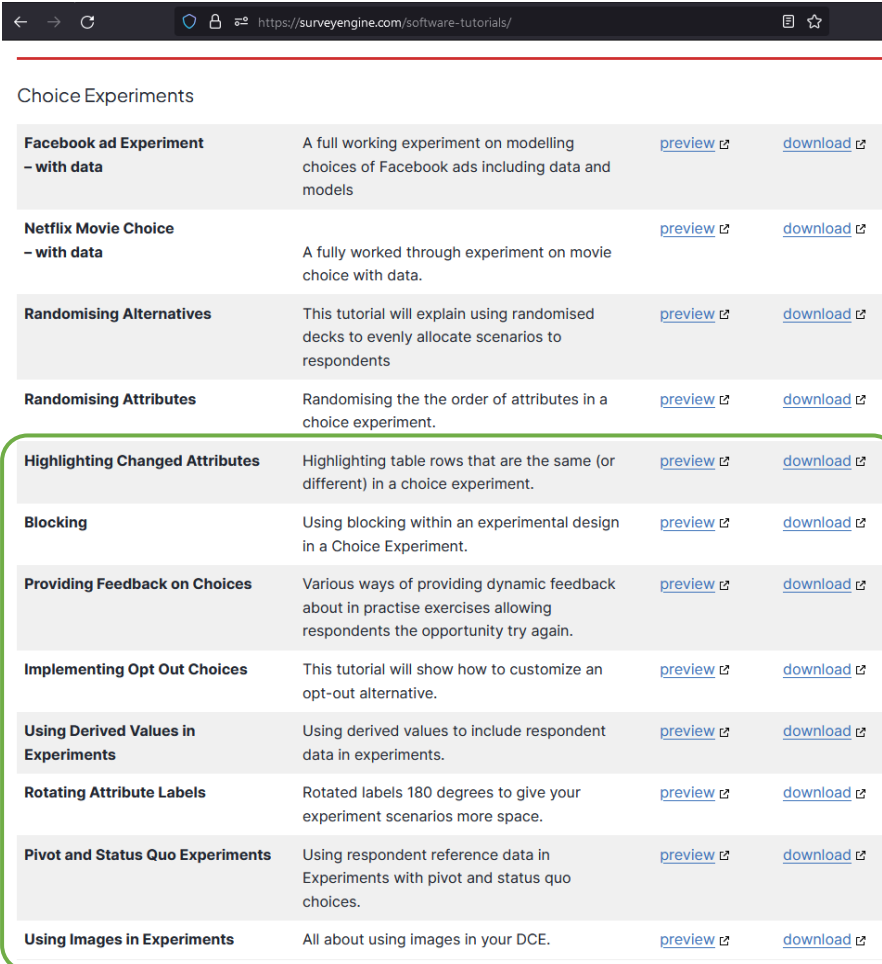


Choice Experiments			
Facebook ad Experiment – with data	A full working experiment on modelling choices of Facebook ads including data and models	preview	download
Netflix Movie Choice – with data	A fully worked through experiment on movie choice with data.	preview	download
Randomising Alternatives	This tutorial will explain using randomised decks to evenly allocate scenarios to respondents	preview	download
Randomising Attributes	Randomising the the order of attributes in a choice experiment.	preview	download
Highlighting Changed Attributes	Highlighting table rows that are the same (or different) in a choice experiment.	preview	download
Blocking	Using blocking within an experimental design in a Choice Experiment.	preview	download
Providing Feedback on Choices	Various ways of providing dynamic feedback about in practise exercises allowing respondents the opportunity try again.	preview	download
Implementing Opt Out Choices	This tutorial will show how to customize an opt-out alternative.	preview	download
Using Derived Values in Experiments	Using derived values to include respondent data in experiments.	preview	download
Rotating Attribute Labels	Rotated labels 180 degrees to give your experiment scenarios more space.	preview	download
Pivot and Status Quo Experiments	Using respondent reference data in Experiments with pivot and status quo choices.	preview	download
Using Images in Experiments	All about using images in your DCE.	preview	download

Step 5 – Create choice tasks in survey instrument

Other choice task considerations

- ❑ Highlighting attribute level overlap
 - ❑ Include respondent data in choice tasks
 - ❑ Status quo and opt-out alternatives
 - ❑ Using images in experiments
 - ❑ Etc.
-
- ❑ See tutorials on SurveyEngine website



Choice Experiments			
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