

# Lecture 1: A/B testing

Lecturer: Ksenia Kasianova  
xeniakasianova@gmail.com

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# Plan

Sequential  
decision  
making

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Kasianova

Plan

What is  
market  
research all  
about?

Idea of the  
course

Course  
outline

A/B  
testing

## Plan

- 1) What is market research all about?
- 2) Idea of the course: integrate course to the needs of computer science student
- 3) Course outline
- 4) A/B testing

# What is market research all about?

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A market researcher's role is to support a firm's decision-makers (i.e. management) by collecting, analysing and interpreting information necessary to identify and solve various marketing problems. In order to understand market research, we must answer the following questions.

Taking a holistic view, market research is in practice a combination of:

- Demography - socio-economic characteristics
- Economics - trends, utility
- Psychology - perception and learning theories, group influences
- Social anthropology - environmental influences, cultural norms and values
- Sociology - social class, social mobility, diffusion of innovations, household behaviour, lifestyle
- Statistics - sampling, multivariate analysis, modelling.

However, given the emphasis on the collection, analysis and interpretation of information, the focus in this course will be on statistics, complemented in places with aspects of demography and economics.

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A firm's marketing decision-makers need to optimise the strategic market position, which takes into account:

- Customer targeting (for example, moving into new or overseas markets)
- Competitors' activities
- The company
- Customer research (factors affecting buying behaviour, attitudes etc.).

Positioning is then reflected in the right marketing mix giving rise to the four 'p's model:

- Product - a tangible good or an intangible service for which decisions about the design, development, testing of a new product, improvement of existing ones, packaging etc. are taken.
- Price - an indicator of quality, where pricing decisions will impact profits and the marketing strategy. Price discrimination (charging different prices to different consumers) could be applied, which would require information on different consumers' price elasticities of demand which quantifies price sensitivities.
- Placement - ensuring a firm positions its product in the right place, at the right time, at the right price. Even e-commerce firms need to engage potential customers with appropriate web placement
- Promotion - publicising the product to consumers and differentiating the product from any competitors (helped by a strong brand image), for example through advertising, social media marketing, search engine marketing etc.

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## Main goals:

- Understand the forces which shape different customer groups – this could help predict future customer behaviour.
- Test market variables to see whether they have the intended impact on dependent variables – casual research design will be introduced in the next chapter.
- Describe the nature and scope of customer groups – by having a clear ‘profile’ of each group it allows the firm to develop bespoke marketing strategies for each group.
- Monitor and reflect upon successes and failures – as will be emphasised, market research does not guarantee success. A statistical model may predict that a particular marketing mix will achieve an outcome (such as increased brand awareness, or higher sales) but there may be unintended consequences of the marketing action, hence we should monitor whether our response expectations are met (or exceeded!), and be prepared to u-turn if the outcome falls short of our expectations.

# Idea of the course

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- Learn statistical models needed to achieve these goals
  - We will start with relatively simple models and methodology but will try to look at it from different points of view
  - e.g. t-test vs Welch test in terms of their power given different properties of data
- Combine your existing knowledge about different statistical approaches and machine learning techniques and apply them to solving market research problems
  - e.g. PCA vs CFA; Logit vs LDA
- Integrate modern tasks related to doing business on-line
  - e.g. A/B testing, on-line surveys (instead of telephone calls)

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## Topics

- A/B testing  
Welch test, Mann-Whitney test, Sample size calculation
- Bootstrap  
Hypothesis testing, Bootstrap in regression, MDE
- Variance reduction  
Sampling, CUPED, Stratification
- Diff-in-diff  
The difference in Difference estimator, Matching
- Contingency tables  
Contingency tables, Chi-squared tests, Partial correlation
- ANOVA  
ANOVA, ANCOVA, Multiple comparison corrections
- LDA  
Discriminant analysis, Logit
- CFA  
PCA, Factor analysis, Multidimensional scaling
- Cluster analysis  
Cluster analysis, Dendrograms
- Conjoint Analysis  
Conjoint Analysis, Market Research design



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## Grading (2 module)

$$Fall\_Grade = 0.4 * Homework + 0.6 * Exam_1 + 0.1 * Bonus\_activities$$

- 1 Homework
- Bonus activities for Module 2 (for participating in discussions on seminars): no more than 10% of the Fall grade
- Written exam

## Grading (2 module)

$$Final\_Grade = 0.5 * Fall\_Grade + 0.2 * Homework + 0.3 * Exam_2 + 0.1 * Bonus\_activities$$

- 1 Homework
- Bonus activities for Module 3 (for participating in discussions on seminars): no more than 10% of the Final grade
- Written exam

**A/B testing**, also known as split testing, refers to a randomized experimentation process wherein two or more versions of a variable (web page, page element, etc.) are shown to different segments of website visitors at the same time to determine which version leaves the maximum impact and drives business metrics.

A lot of versions:

- **A/A testing** uses A/B testing to test two identical versions of a page against each other. Typically, this is done to check that the tool being used to run the experiment is statistically fair.
- **A/B/C** and
- **A/B/n testing** is an extension of A/B testing in which multiple variants of a page are compared against each other.

# A/B testing

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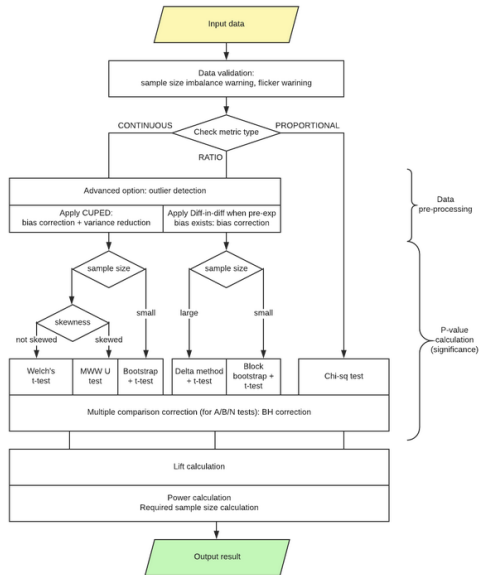
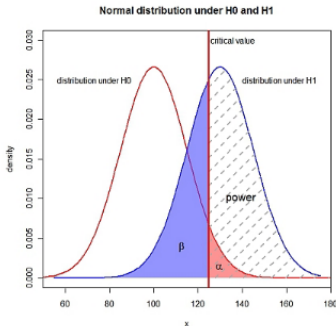


Figure: Uber's statistics engine is used for A/B/N experiments

## Hypothesis testing

		Null hypothesis ( $H_0$ ) is	
		True	False
Decision about null hypothesis ( $H_0$ )	Don't reject	True Negative Confidence: $P(S^{obs} \notin D^{crit}   H_0) = 1 - \alpha$	False Negative Type II error: $P(S^{obs} \notin D^{crit}   H_1) = \beta$
	Reject	False Positive Type I error: $P(S^{obs} \in D^{crit}   H_0) = \alpha$	True Positive Power: $P(S^{obs} \in D^{crit}   H_1) = 1 - \beta$

(!) Type I error and Type II errors are inversely related



4 pieces of a puzzle:

- Effect size
- Sample size
- Significance
- Statistical power

Goal: Compare t-test, Welch test t-test, Mann-Whitney U-test