Introduction to experimental design

Session 1

MATH 80667A: Experimental Design and Statistical Methods
for Quantitative Research in Management
HEC Montréal

Outline

Class details

Motivation

Review

Key concepts in experimental designs

Class details

Learning objectives

Content

- Basics of experimental design
- Statistical inference
- Programming in **R**
- Analysis of variance
- Intro to causal inference
- Mediation analysis

Cross-disciplinary skills

- Scientific workflow
- Peer-review
- Reporting
- Statistical fallacies
- Reproducibility

Prerequisites

Math skills

Basic algebra

Computer science

None

Statistics

At the level of OpenIntro Statistics (Chapter 1)

Programming

We will use the **R** programming language and the **RStudio** IDE

- free (!)
- open-source
- large support community
- comprehensive

Learning R

Jesse Maegan
@kierisi

Following

My #rstats learning path:

1. Install R
2. Install RStudio
3. Google "How do I [THING I WANT TO DO] in R?"

Repeat step 3 ad infinitum.

7:19 AM - 18 Aug 2017

Motivation

Experiments as gold-standard

BJOG An International Journal of Obstetrics and Gynaecology

Royal College of Obstetricians & Gynaecologists

BJOG Research Methods Guides | Free Access

Randomised controlled trials – the gold standard for effectiveness research

Study design: randomised controlled trials

Eduardo Hariton, Joseph J Locascio

First published: 19 June 2018 | https://doi.org/10.1111/1471-0528.15199 | Citations: 121

> *Randomised controlled trials (RCTs) are the reference standard for studying causal relationships between interventions and outcomes as randomisation eliminates much of the bias inherent with other study designs.*

History

Experiments on agricultural trials in Rothamsted ongoing since 1841

ECN ROTHAMSTED

Rothamsted (Latitude 51° 48’ 34.44” N; Longitude 0° 21’ 22.76” W) is located about 35 km North of London, UK. It covers about 330 ha, all of which is included within the Rothamsted ECN site. The estate contains several ecosystems, including managed arable and grassland fields, naturally regenerated and ancient woodland, the river Ver and more recently energy crops e.g. short rotation coppice willow and miscanthus grass. The Park Grass Hay Experiment (est. 1856) is the principal target sample site (TSS) for the majority of the ECN protocols at Rothamsted. This experiment is widely acknowledged to be the oldest continuing agro-ecological experiment in the world; it is recognised internationally as an important site for long-term studies on biodiversity and ecology. The experimental plot on Park Grass of most interest to the ECN, in relation to physical and atmospheric inputs is Plot 3, Section d (Plot 3d). This plot receives no inorganic or organic inputs apart from atmospheric deposition.

Modern experiments: A/B testing

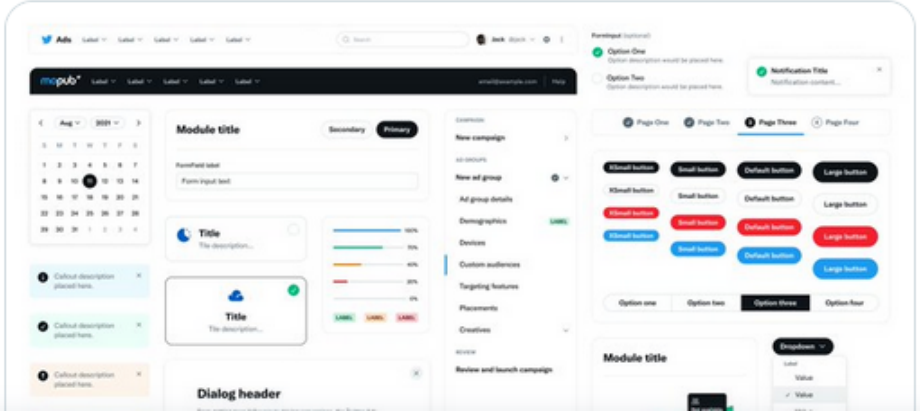
204 631 1,8 k

Afficher cette discussion

Twitter Design a retweeté

Joey Banks @joeyabanks · 11 août

I think one of the most exciting challenges in design system work is an opportunity to create alignment between platforms when it comes to shared patterns. With today's visual update, the components powering Twitter's revenue & developer products received a redesign, too! ✨



Vous pourriez aimer

Twitter API @TwitterAPI — Suivre

Twitter Live @TwitterLive — Suivre

Twitter TV @TwitterTV — Suivre

Voir plus

Ce qui se passe

Actualité internationale · Hier soir

Looking at the history of the Taliban in Afghanistan

Evidence-based policy

RAND health insurance study

Student Teacher Achievement Ratio (STAR)

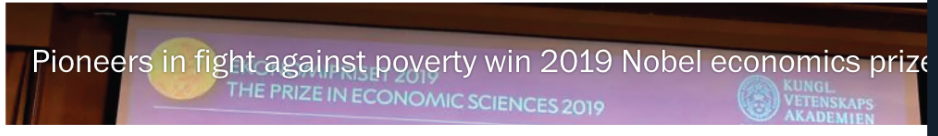
Nobel memorial prize

The Washington Post
Democracy Dies in Darkness

Business

3 share Nobel Prize in economics for ‘experimental approach’ to solving poverty

Esther Duflo, who at 46 is the award’s youngest winner, shares the hor
fellow MIT economist Abhijit Banerjee and Harvard’s Michael Kremer



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ABDUL LATIF JAMEEL POVERTY ACTION LAB

Review

Population and sampling

Defining a population

Sampling frame

Randomization

Convenience samples

Non-response bias

Sampling scheme

Simple random sampling

Stratified sampling

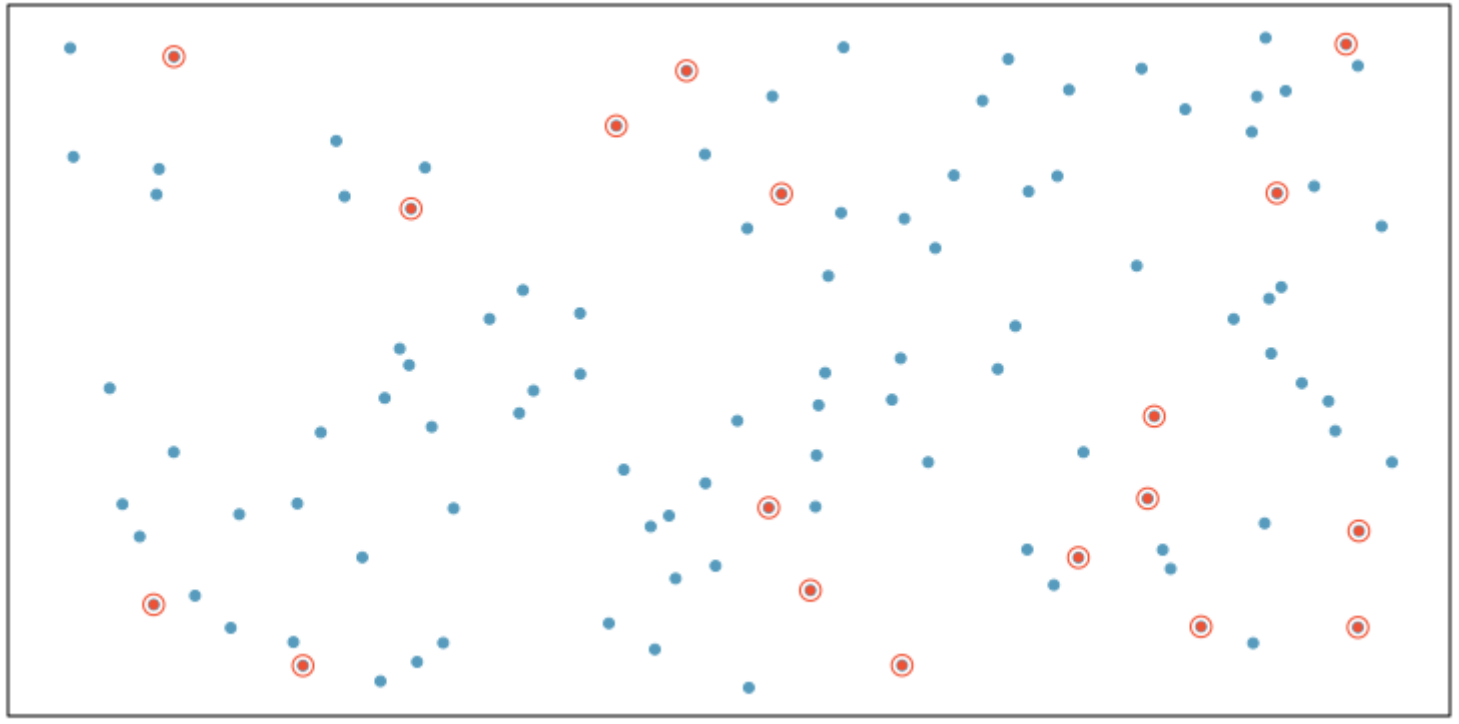
Gender, ethnicity, etc.

Cluster sampling

Villages, housing block, classrooms, etc.

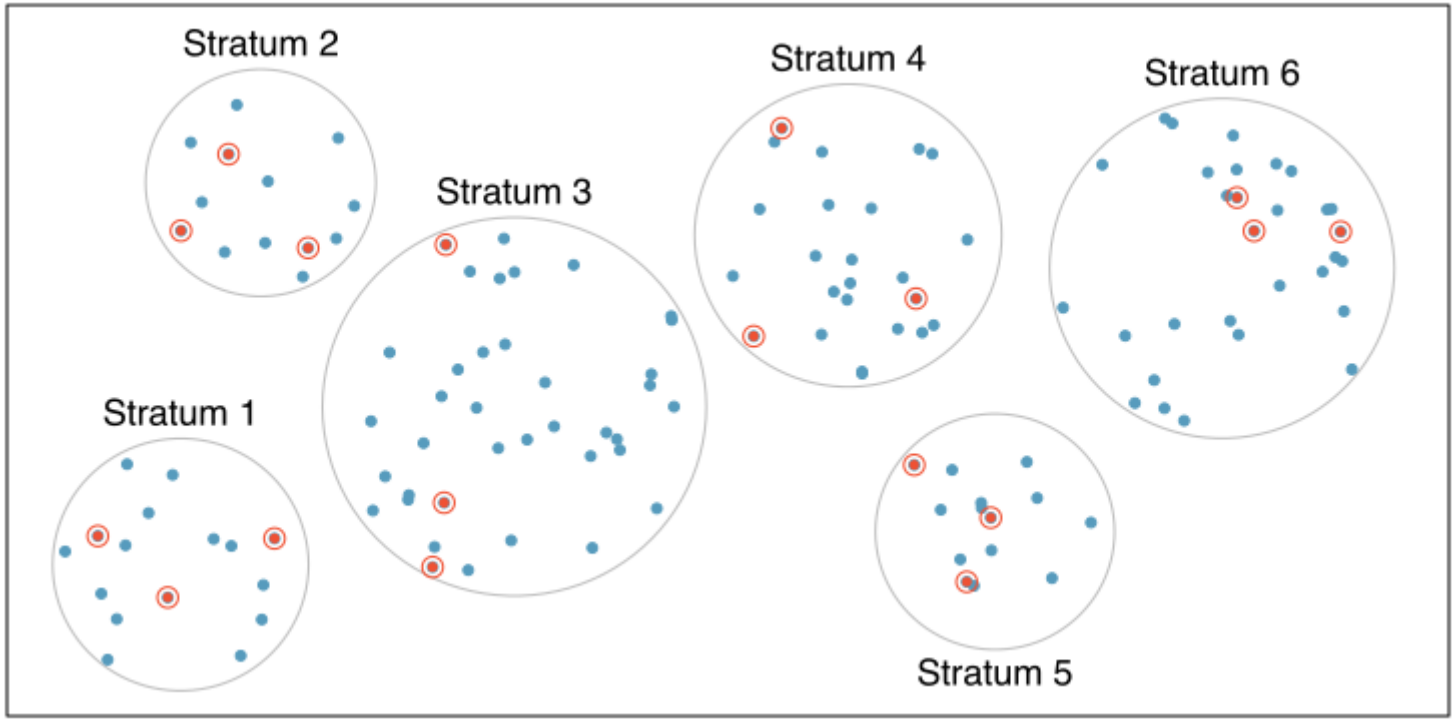
Multi-stage sampling

Simple random sampling

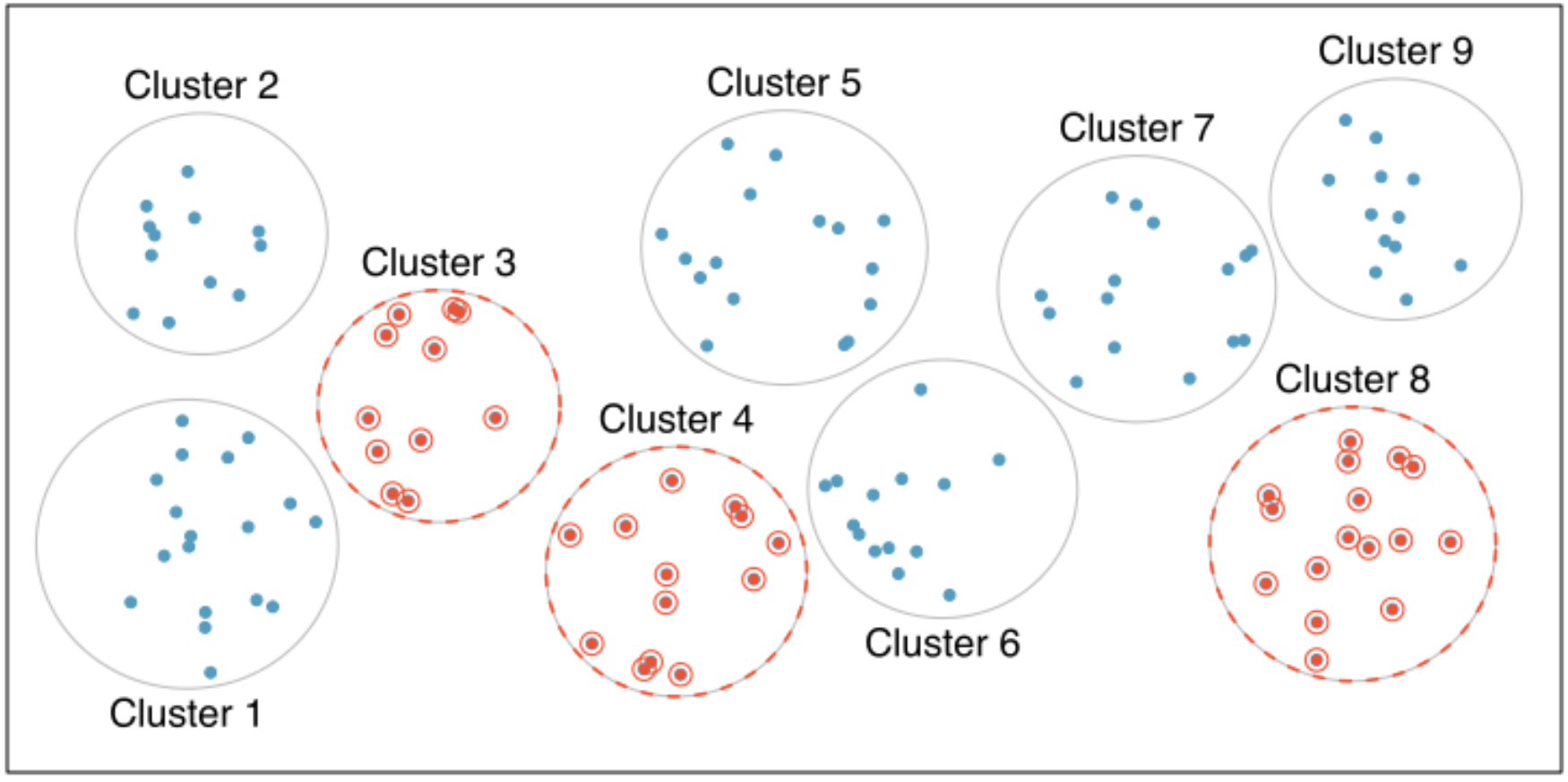


OpenIntro, CC BY-SA license

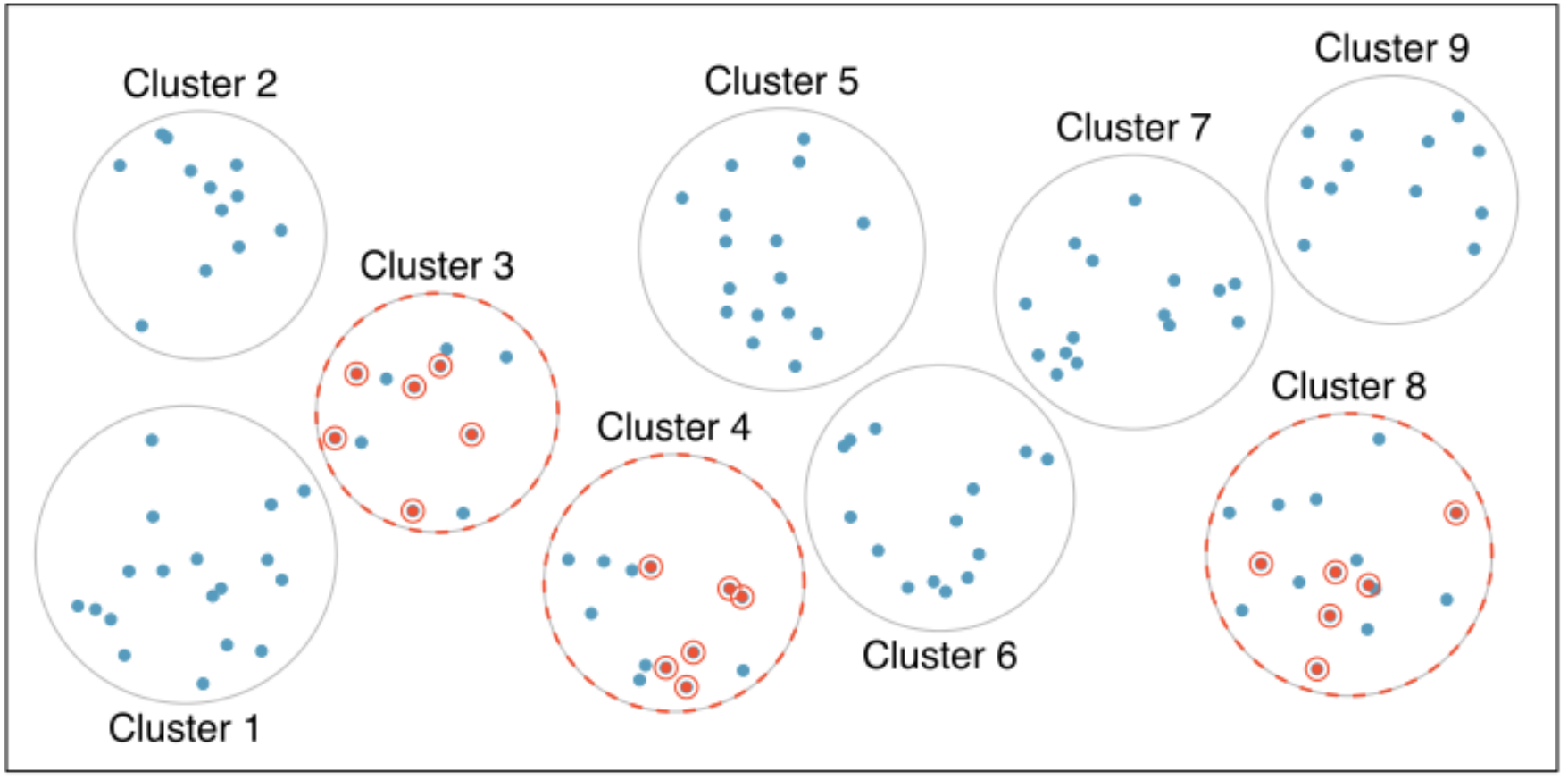
Stratified sampling



Cluster sampling



Multistage sampling



Judging the quality of a sample

Summary statistics

Reported to check representativeness of the sample relative to population.

Raw data

Used for reproducibility and to assess whether data is fraudulent.

Pre-testing

Check whether sampling allocation is sufficiently random.

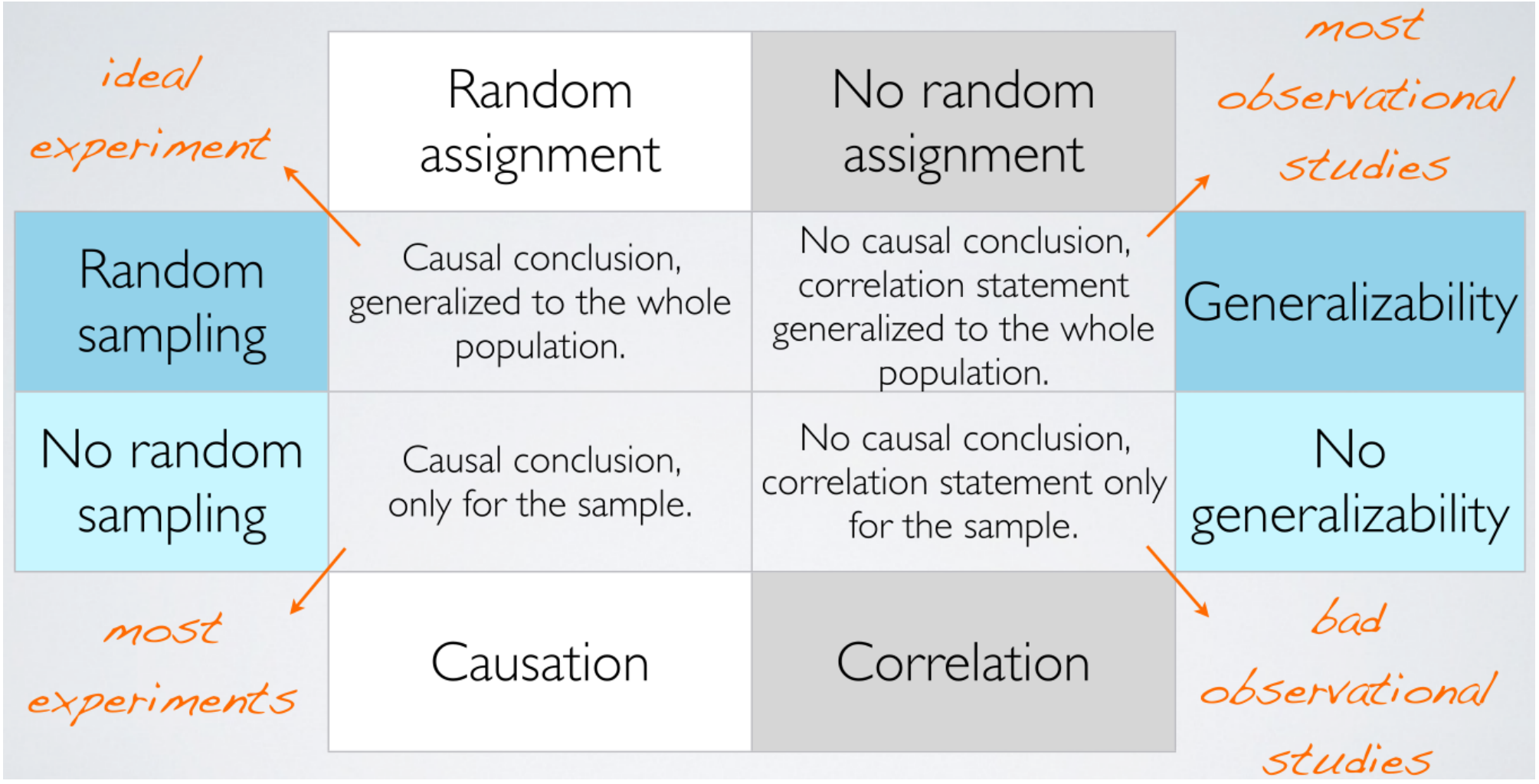
Experimental versus observational

Experiment controls allocation of treatment

Systematic vs random allocation

propensity score

Study type versus sampling



Key concepts in experimental design

Technical vocabulary

Experimental unit

Observational unit

Factor / treatment

Treatment group

Control group

Blocking factors

Confounder

Effect size

Placebo

(Double) blinding

Four pillars of experimental design

Control

Randomization

Blocking

Replication

Difference between stratification and blocking

Objective of the experiment

Compare multiple treatments

- Without treatment, **variability** in output from one observation to the next.
- Differences between treatment are **comparatively stable**.

Choices in experimental designs

treatments for comparison

observations to be made (number of repetitions, etc.)

experimental units

Requirements for good experiments (1/2)

Absence of systematic error

Achieved via randomization

Precision

- depends on the intrinsic variability
- function of
  1. accuracy of experimental work
  2. number of experimental units / repetitions per unit
  3. design and methods of analysis

Requirements for good experiments (2/2)

Range of validity

- What is population?
- Identify restrictions
- Extrapolation only if proper sampling scheme

Simplicity of the design

Leads to simple analysis