Module 1. Basic concepts and sampling

Data Science & AI

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Contents

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Learning Goals

- Variables and measurement levels
- Samples
- Basic concepts

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Basic Concepts in Data Science

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Variables and Values

Variable General property of an object, allows to distinguish objects

Value Specific property, interpretation for that variable

Variable: gender
Value: male

Variable: height
Value: 180cm

Variable: funny
Value: no

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Measurement Levels

- = Variable types
- Determine most suitable method for analysis
  - visualization methods
  - central tendency and dispersion
  - examine the relationship between variables

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Measurement Levels

Qualitative vs quantitative

Qualitative	Quantitative
Not necessarily numeric	Number + unit of measurement
Limited number of values	Many values, often unique

Quantitative variables often contain the result of a **measurement**

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Measurement Levels

Qualitative scales

Nominal Categories.
e.g. gender, race, country, shape, ...

Ordinal Order, rank.
e.g. military rank, level of education, ...

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Measurement Levels

Quantitative scales

Interval No fixed zero point ⇒ no proportions
e.g. °C, °F

Ratio Absolute zero point ⇒ proportions
e.g. distance (m), energy (J), weight (kg) …

Proportions:

- 20 m is 1/3th or ~ 33% longer than 15 m
- 20 °C is **NOT** 1/3th warmer than 15 °C (convert to °F)

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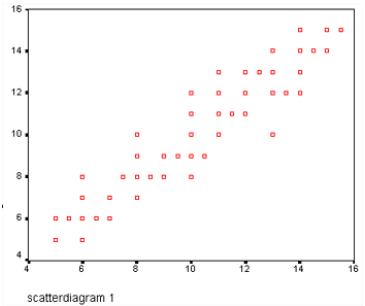
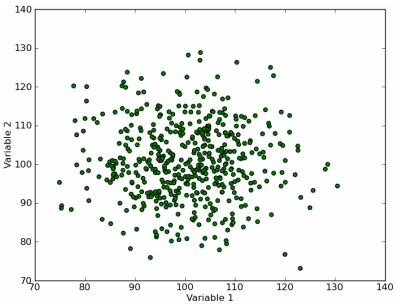
Relations between variables

Variables are related if their values change **systematically**.





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Relations between variables: example

Is there a relationship between type of cola and taste appreciation?

	Pepsi	Coca Cola	Total
Like	56	24	80
Dislike	14	6	20
Total	70	30	100

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Relations between variables: example

Is there a relationship between type of cola and taste appreciation?

	Pepsi	Coca Cola	Total
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Marginal totals

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Causal Relationships

Researchers are often looking for **causal relationships**, e.g.

- Frustration leads to agression
- Alcohol leads to decreased alertness
- ...

Cause Independent variable

Consequence Dependent variable

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Causal Relationships

Fake correlations or “Spurious correlations”

Warning!

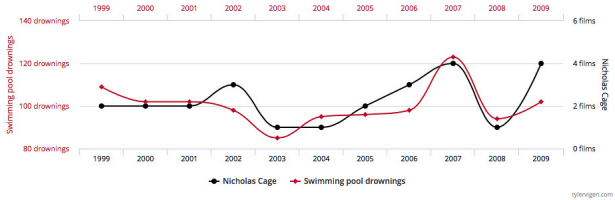
A relationship between variables does not necessarily indicate a *causal* relation!

Examples:

- Violent video games lead to violent behaviour
- Vaccines can cause autism
- Relationship between drinking cola light and obesitas
- …

Number of people who drowned by falling into a pool
correlates with
Films Nicolas Cage appeared in

Correlation: 66.6% (r=0.666004)

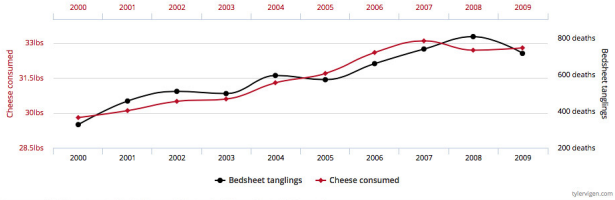


tylervigen.com

Data sources: Centers for Disease Control & Prevention and Internet Movie Database

Per capita cheese consumption
correlates with
Number of people who died by becoming tangled in their bedsheets

Correlation: 94.71% (r=0.947091)



tylervigen.com

Data sources: U.S. Department of Agriculture and Centers for Disease Control & Prevention

Sample Testing

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USA Today has come out with a new survey. Apparently, three out of every four people make up 75% of the population

—David Letterman

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Suppose you want to analyze a group of friends

Questions you can ask:

- How tall are my friends?
- What are their weights?
- How safe is their living environment?
- Do they have family?
- ...

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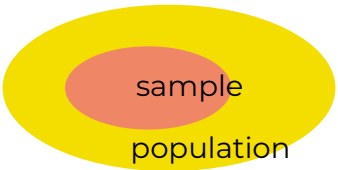
Population

Sample and Population

Population the collection of all objects/people/...that you want to investigate

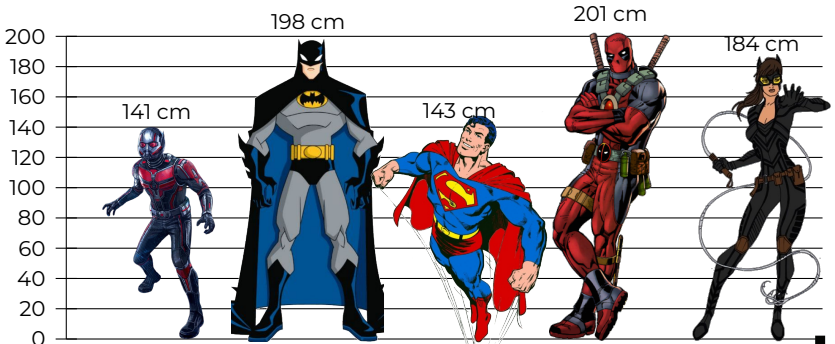
Sample a *subset* of the population from which measurements will be taken



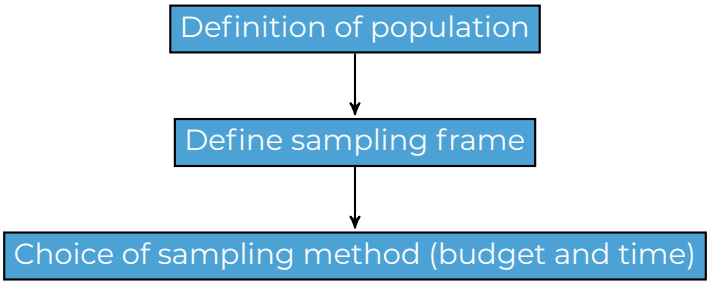
Under certain circumstances, the results for a sample are representative for the population.

Sample and Population

A sample is easier to analyze than the entire population



Sampling Method



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How to pick elements for a sample?

Random sample : every element from the population has an equal chance of being included in the sample.

Non-random sample : the elements for the sample are *not* randomly selected. Objects that can be collected *easily* are more likely to be included (convenience sampling).

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Stratified to variables

	Age				
Gender	≤ 18	]18, 25]	]25, 40]	> 40	Total
Woman	500	1500	1000	250	3250
Man	400	1200	800	160	2560
Total	900	2700	1800	410	5810

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Stratified to variables

	Age				
Gender	≤ 18	]18, 25]	]25, 40]	> 40	Total
Woman	500	1500	1000	250	3250
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Total	900	2700	1800	410	5810

	Age				
Gender	≤ 18	]18, 25]	]25, 40]	> 40	Total
Woman	50	150	100	25	325
Man	40	120	80	16	256
Total	90	270	180	41	581

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Possible Errors

Measurements in a sample will typically deviate from the value in the entire population ⇒ Errors!

- Accidental ↔ Systematic
- Sampling error ↔ Non-sampling error

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Sampling Errors

- Accidental sampling errors
  - Pure coincidence

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Sampling Errors

- Accidental sampling errors
  - Pure coincidence
- Systematic sampling errors
  - Online survey: people without internet are excluded
  - Street survey: only who is currently walking there
  - Voluntary survey: only interested parties participate

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Non-sampling Errors

- Accidental non-sampling errors
  - Incorrectly ticked answers

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Non-sampling Errors

- Accidental non-sampling errors
  - Incorrectly ticked answers
- Systematic non-sampling errors
  - Poor or non-calibrated measuring equipment
  - Value can be influenced by the fact that you measure
  - Respondents lie (number of cigarettes a day)

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