Week 1: Introduction to Statistics

Unit 3: Use and Abuse of Numbers

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Use and Abuse of Numbers

Introduction

- Although numbers don’t lie, they can be used to mislead with half-truths. This is known as the “abuse (or misuse) of statistics”.
- To be able to interpret data, it is important that you are familiar with the basics of statistical misuse. In this presentation, you’ll review some of the most common forms.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2685008/

Cherry picking

- Often, when a company promotes a product, they will undertake studies to “prove” the product’s effectiveness.
- So the company could be very selective and cherry-pick the results.

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Loaded questions

- The manner in which questions are phrased can have a massive impact on the way an audience answers them.
- Specific wording patterns have a persuasive effect, and influence respondents to answer in a predictable manner.

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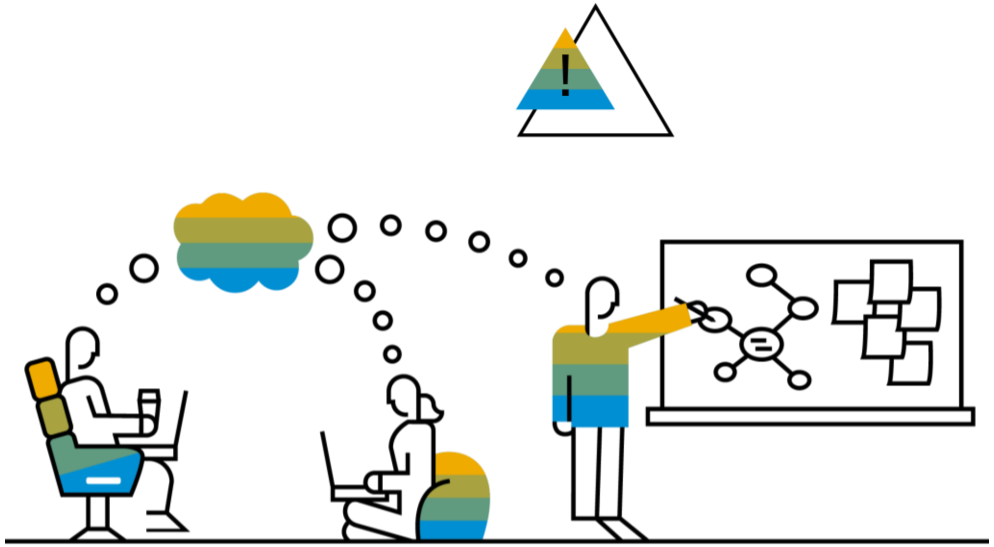
Overgeneralization

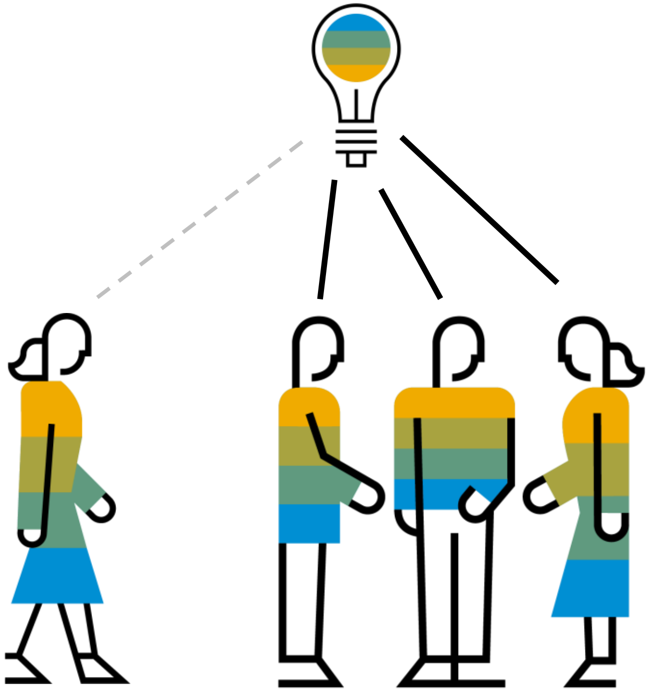
- **Overgeneralization** is a logical fallacy that occurs when a conclusion about a group is drawn from an unrepresentative sample, especially a sample that is too small or too narrow.



https://rampages.us/noelta/tag/overgeneralization/

Biased samples

- Sampling bias is a bias in which a sample is collected in such a way that some members of the intended population are less likely to be included than others.



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Classic example

- On election night of the 1948 presidential election, the Chicago Tribune printed the headline DEWEY DEFEATS TRUMAN. Truman won!
- In the morning, the grinning president-elect, Harry S. Truman, was photographed holding a newspaper bearing this headline.
- The reason the Tribune was mistaken was due to the results of a biased phone survey.

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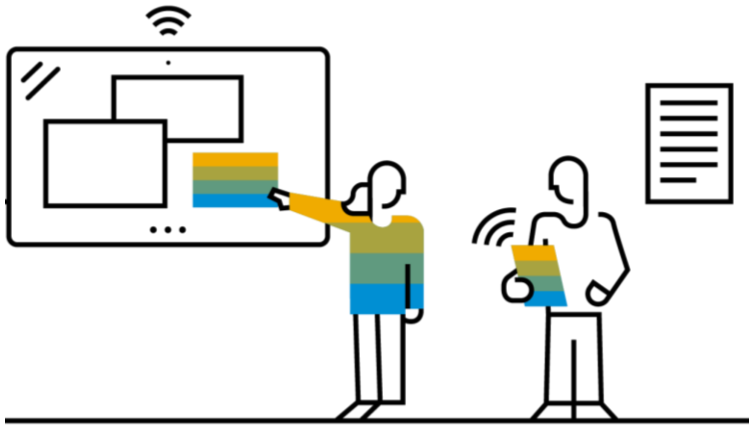
Misreporting estimated error

- If you want to know how 1 million people feel about a topic, it is impractical to ask all of them. Therefore, you choose a random sample.
- The confidence is the "plus or minus" figure often quoted for statistical surveys.
  - For example, a survey might have an estimated error of ±5% at 95% confidence.
- The smaller the estimated error, the larger the required sample, at a given confidence level.
- Many people might assume, that if the confidence figure is omitted, then there is a 100% certainty that the true result is within the estimated error. Of course, this is not mathematically correct.



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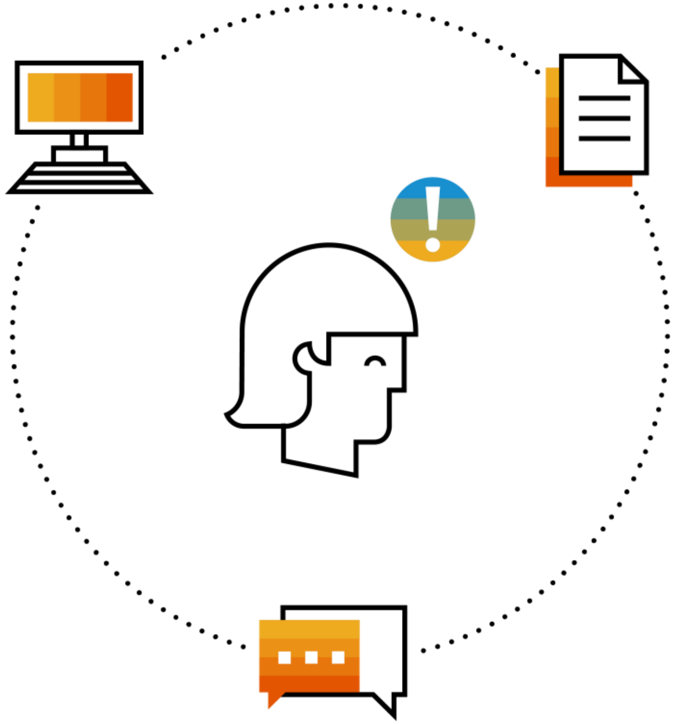
Correlation and causation

- In statistics, many statistical tests calculate the correlation between variables, and when two variables are found to be correlated, it is tempting to assume that this shows that one variable causes the other.
- However, correlation does not imply causation!!



https://www.quackwatch.org/01QuackeryRelatedTopics/emf.html

https://en.wikipedia.org/wiki/Correlation_does_not_imply_causation

Statistical vs. practical significance

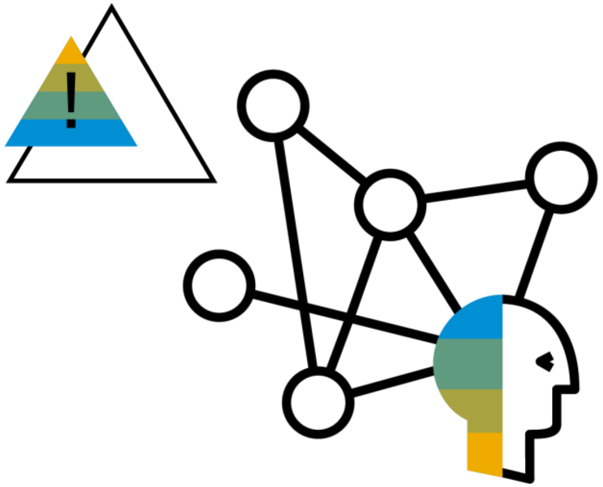
- **Statistical significance** is concerned with whether a research result is due to chance or sampling variability.
- **Practical significance** is concerned with whether the result is large enough to be of value in the real world.

Panel from a 2011 xkcd cartoon explaining p-hacking, in which scientists look for relationships between many colors of jelly beans and acne, and find a p value <0.05 only for green ones.

https://www.explainxkcd.com/wiki/index.php/882:_Significant

Data dredging

- Data dredging (sometimes called “data fishing”, “data snooping”, and “p-hacking”) is the misuse of data analysis to find patterns in data that can be presented as statistically significant when in fact there is no real underlying effect.
- “p-hacking” is when a data scientist analyses and presents the data in a way that supports pre-conceived answers.
  - They know that by selectively munging, binning, constraining, cleansing, and sub-segmenting data, they can get it to tell almost any story or validate almost any “fact”.



https://en.wikipedia.org/wiki/Data_dredging

https://infocus.dellemc.com/william_schmarzo/management-challenge-p-hacking/

https://www.nngroup.com/articles/understanding-statistical-significance/

https://www.nngroup.com/articles/probability-theory-and-fishing-significance/

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Summary

- We expect statistics should make data easier for us to understand.
- Unfortunately, it’s easy for statistics to be used in a misleading way to trick the casual observer into believing something other than what the data shows.
- This misuse of statistics occurs when a statistical argument asserts a falsehood.
- In some cases, the misuse may be accidental.
- In others, it is purposeful and is designed to trick us into believing a lie.
- This presentation will hopefully help you recognize the common forms of misuse.

Thank you.

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