

Causes & impacts of data bias

Version: 1.0



Learning intentions

We will be looking at the **data bias**, specifically

- What is data bias
- What can cause data bias
- How to mitigate against data bias

Background

When analysing any dataset it is important to understand whether the way the data has been collected or how it is being analysed will influence the results.

The impact of these may not always be clear.

In this lesson, we will look at **different types of data bias**, what can **cause them** and how to **mitigate against them**.



Definition



Bias

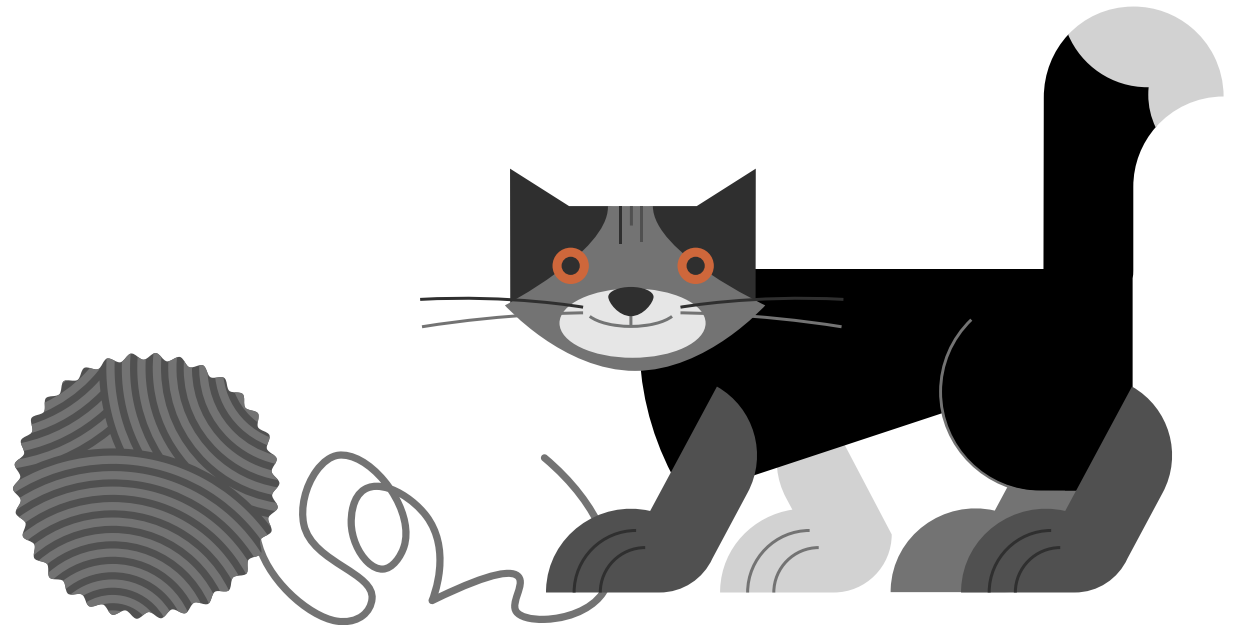
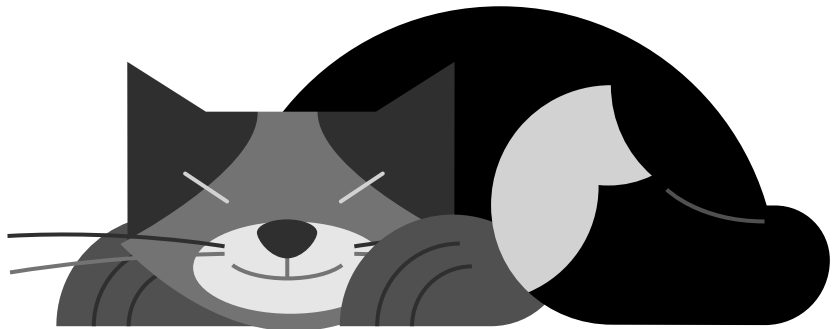
To prejudice for or against
one person or group

Show me...



There is a family where the parents don't like cats. They tell their children that cats are mean and will scratch them.

Without ever being near a cat, the children will think cats are mean and therefore will be biased against them.



Definition



Data bias

When data is used to
prejudice for or against one
person or group

Data bias

Data bias is when **data is used** consciously or unconsciously in a way that is **prejudiced for or against one person or group**.

When data is biased, it leads to ethical challenges, in particular fairness and equality risks.



Why identifying data bias is important?



The **wrong conclusions could be made** if using biased data



Groups or individuals could be harmed as the result of using biased data



Valuable data could be excluded from the analysis if you use biased data

When can data bias occur?

Data bias can occur at multiple stages of a data science project.

When the data is **collected**



When the data is **being analysed**



When the **outputs of the analysis** are used



Show me...



When people are asked how much they have slept each night, they tend to over/under estimate.

If the estimated data is used in the analysis rather than actual (or recorded) sleep time this may cause inaccuracies in the results.

This **bias occurs when collecting the data.**

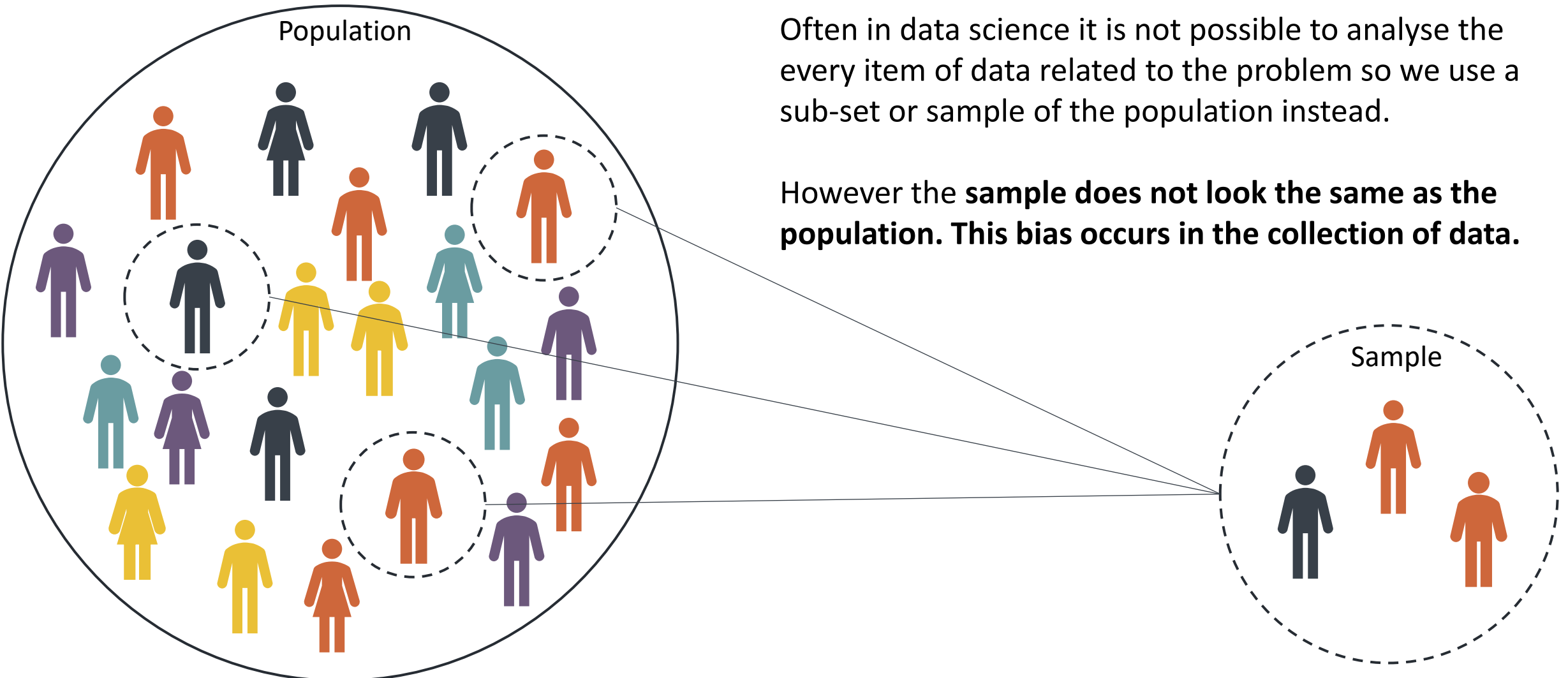
Sleep (hours)	Mon	Tue	Wed	Thu	Fri	Total sleep
Estimated	7.5	8.5	5.5	6.5	8.0	36.0
Actual	7.7	9.1	7.5	7.8	7.8	40.0
Difference	-0.2	-0.7	-2.0	-1.3	+0.2	-4.0



Population vs. sample

Often in data science it is not possible to analyse the every item of data related to the problem so we use a sub-set or sample of the population instead.

However the **sample does not look the same as the population. This bias occurs in the collection of data.**

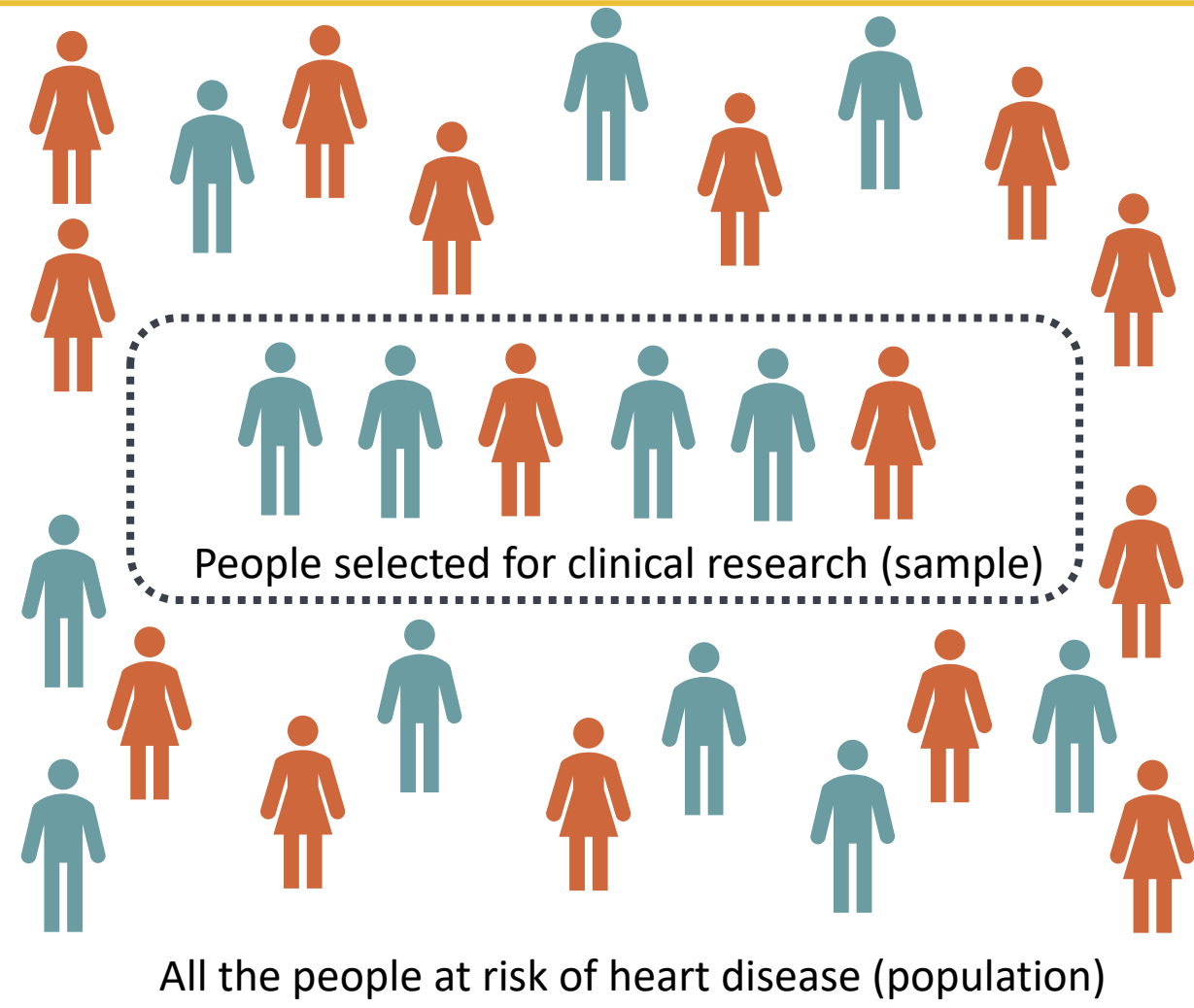


Show me...



The 2018 Heart & Stroke Report highlighted an issue with the research into heart disease which **often over looks women, caused by a bias when collecting the data.**

- Two-thirds of heart disease clinical research still focuses on men
- However, women are more likely than men to die or have a second heart attack within 6 months of a cardiac event.



Your turn....



You have been asked to find out **how people travel to your local supermarket** (e.g. walk, drive, cycle, bus)

You are going to ask people as they enter the store. The survey is voluntary.

Can you think of **any issues that might bias the data when you are collecting it?**



Your turn....



Here are some issues that might bias your dataset, you might have more,



The weather when you survey people may impact how they travel. Therefore your results might not be representative of how people travel at different times of the year.

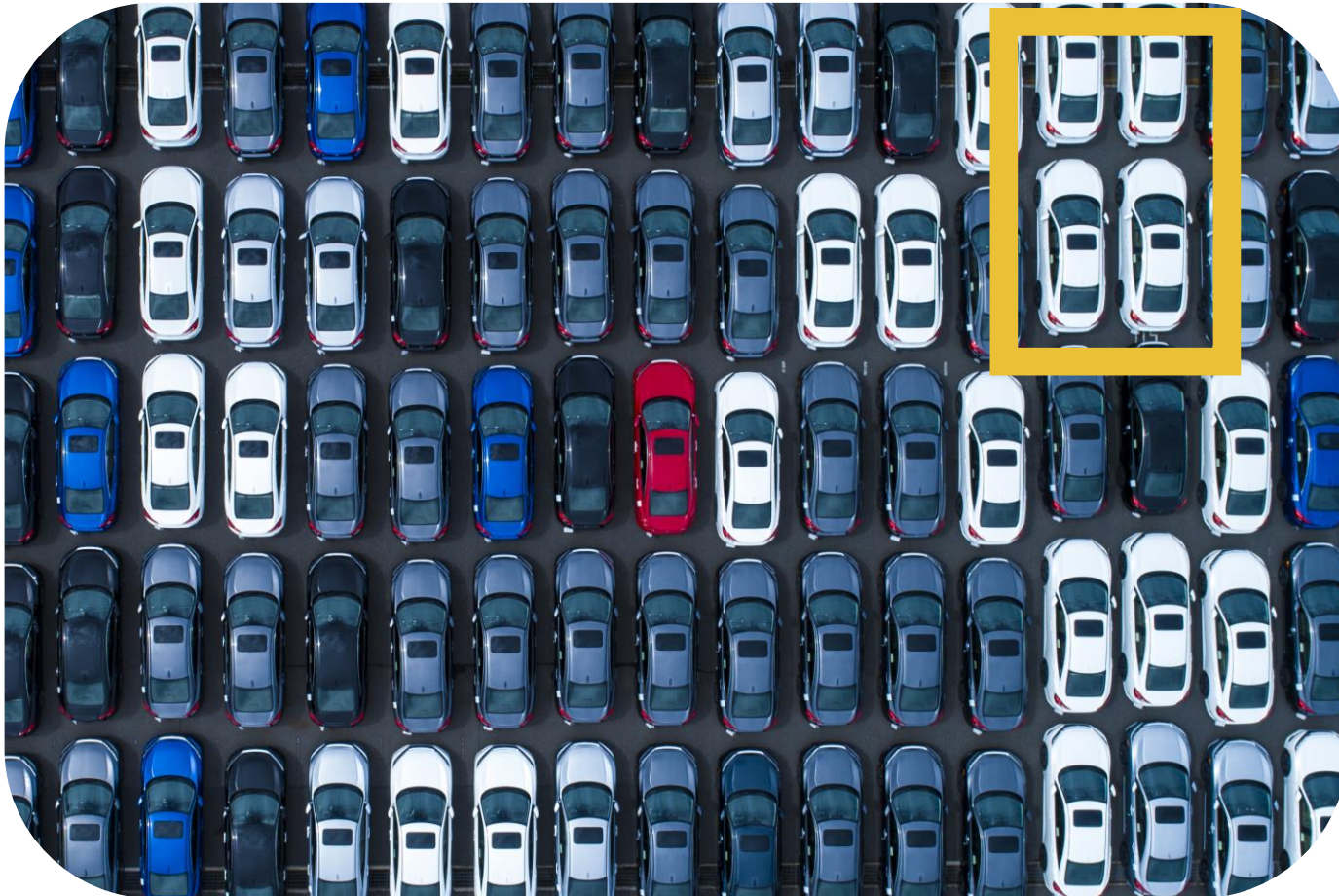


The **time of day**, there may not be any buses early morning or late at night. Again this would cause selection bias in your data.



People in a rush will not stop to answer. Do they travel to the supermarket in the same way as those people who answered?

Show me...



You need to find out **the colours of cars in the car park.**

Rather than looking at all the cars (the population) you select a sample to check, in this case those in the gold rectangle.

Based on **the data you have selected to analyse you believe all the cars are white.**

The data you are reviewing is **not representative of all the cars in the car park**, so the data is biased.

Algorithmic bias

Even if the data is collected and analysed in a way that doesn't introduce bias, **computer systems can make decisions that are unfair to certain individuals or groups.**

The way computer systems are designed to look for patterns and similarities in data may output results that are impacted by the values and unconscious biases of the people that designed them.

When the **outputs of the analysis** are used



Definition



Algorithmic bias

A computer system that makes decisions that are unfair to certain individuals or groups

Show me...



Search engines such as Google, make decisions on what information to display as a result of rules created through data analysis.

This means, if you search for results such as 'Professor style', Google will use its sets of rules to decide what to display.

For this example, the rules result in photos of men wearing tweed, which is not what all professors look like.

This is an **example of algorithmic bias**.

Images are from a Google Search for 'Professor style' in July 2022



Dressing The Professor: What To Wear ...
gentlemansgazette.com



How to Nail Professor St...
gq.com



Making the College Pro...
offthecuffdc.com



mens outfits, men dre...
pinterest.com



Making the College Professor Look your ...
offthecuffdc.com



Mastering the College ...
mensflair.com



How to Nail Professor ...
gq.com

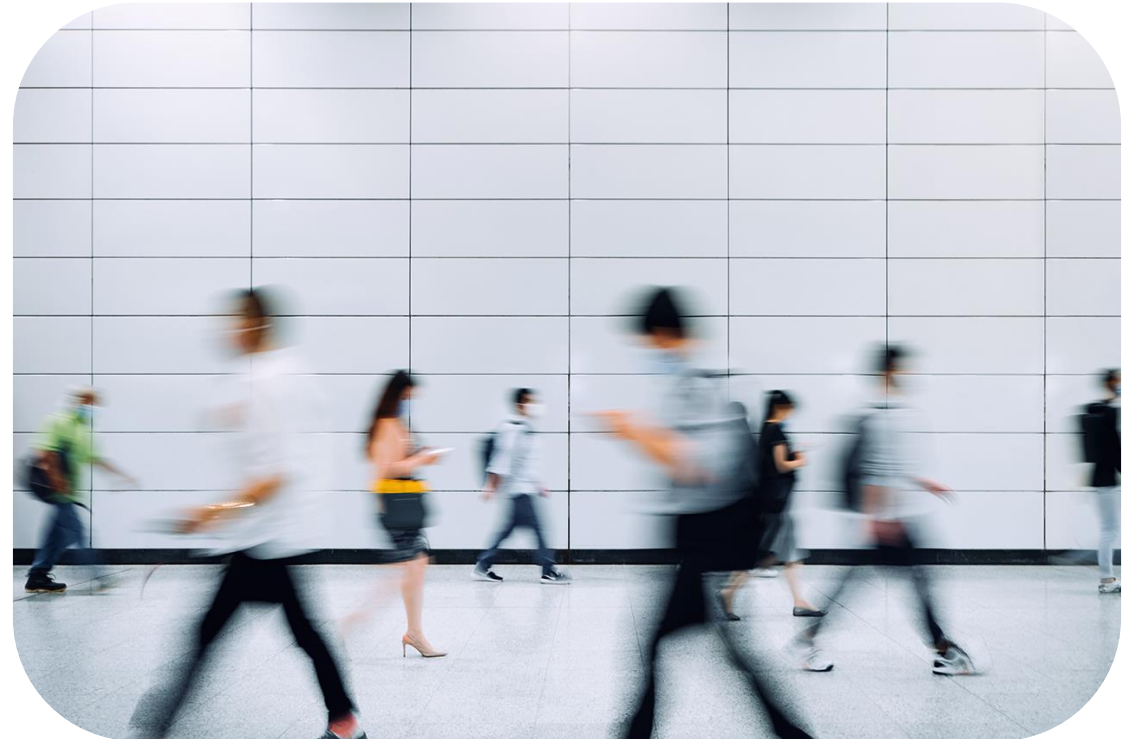


Dressing The Professor...
gentlemansgazette.com

Algorithmic bias in face recognition

Next we are going to watch a video called gender shades.

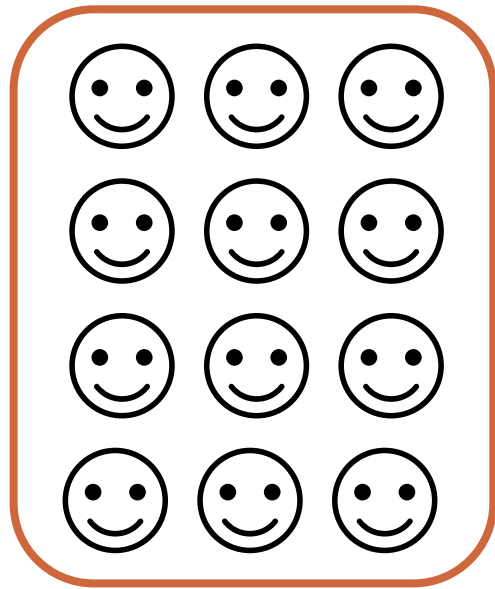
While watching this think about **how the computer system that is making the decision is unfair to certain groups.**



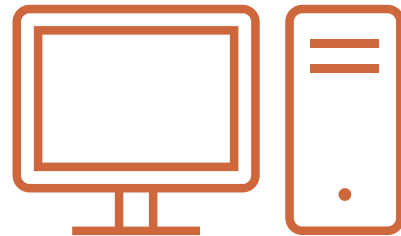
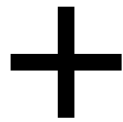


How facial recognition software is created

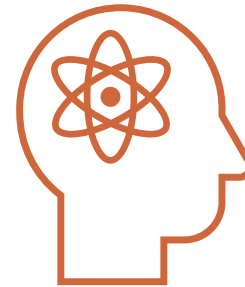
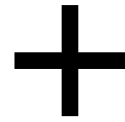
To create the facial recognition software it needs a lot of data to learn from (the training dataset) to allow it to recognise faces in the future.



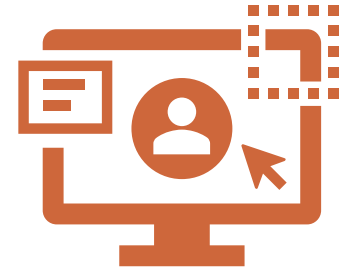
Training dataset



Computer software



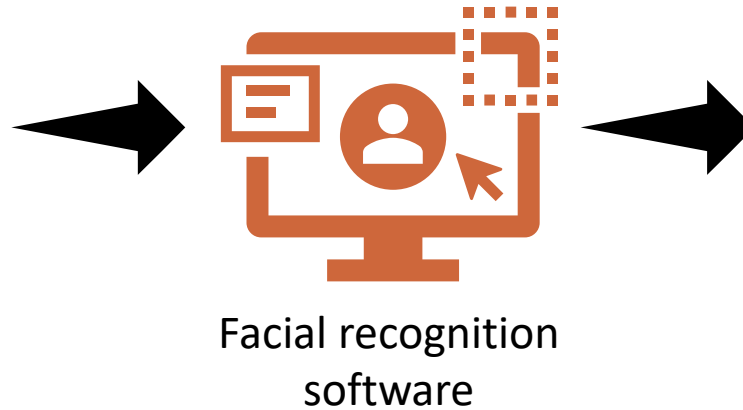
Values of people
creating it



Facial recognition
software

Gender shades video

The Gender Shades video looks at how computer software detects, recognises and then classifies faces. It found that the **systems work better on lighter, male faces**.



Your turn...



Thinking about the gender shades video,

1. Do you think **your face would be recognised** by these systems? How does that **make you feel**?
2. How has **algorithmic bias caused problems** in these systems?
3. Can you think of **any systems you use that might have algorithmic bias**? (e.g. voice recognition software)

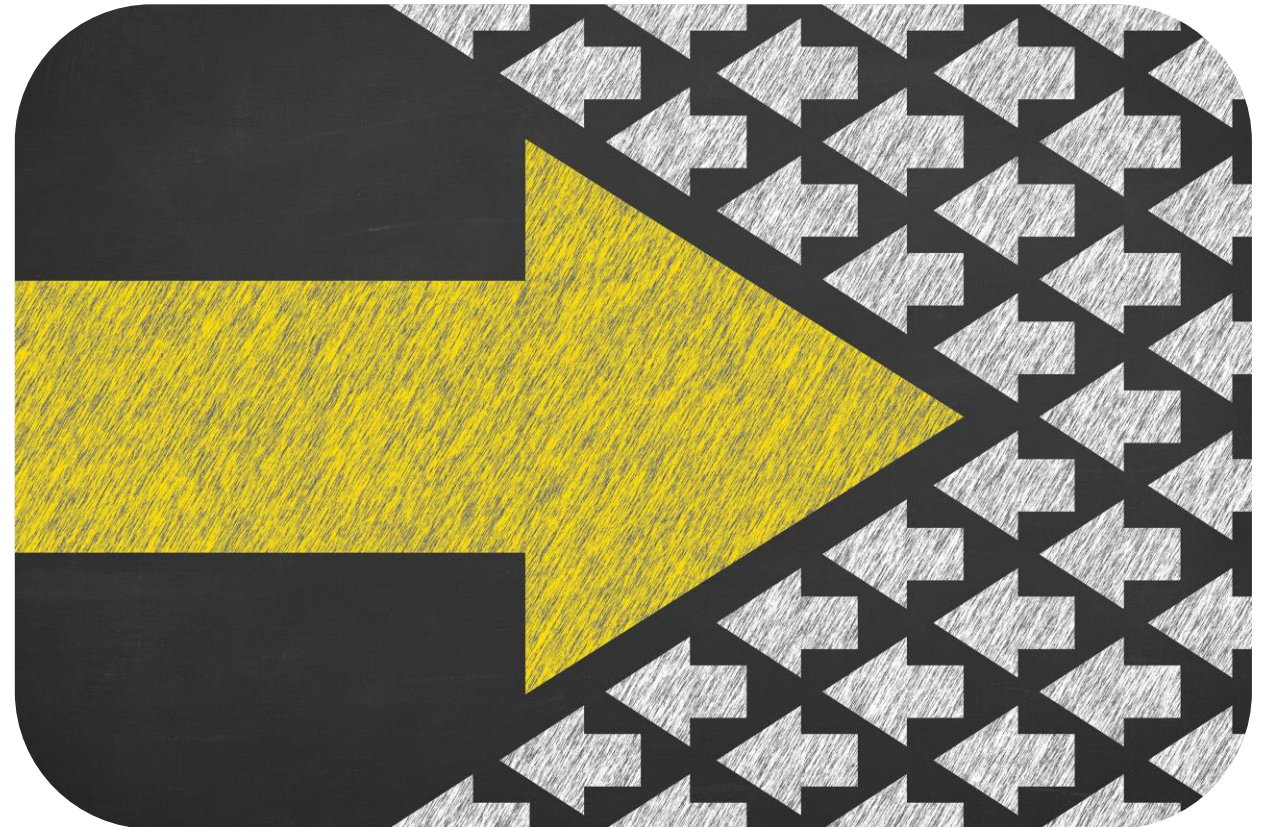
Next steps

Complete **questions 1 to xx**
in **section x** of the
'Causes & impacts of bias' workbook.

Causes of bias

Now we have looked when data can be biased and the impact of data bias.

We are now going to look at **causes of data bias**.



Causes of bias



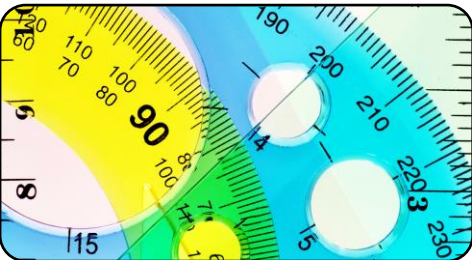
Sample bias

The dataset used for data analysis does not represent the population.



Exclusion bias

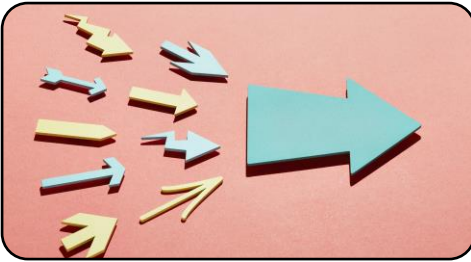
Predictive variables are removed prior to the data analysis



Measurement/detection bias

Arises from a systematic issue with the collection of the data, often through calibration or faulty detectors.

Causes of bias



Confirmation bias

Arises from cherry-picking data or variables that confirms a human's existing beliefs and expectations.



Stereotype/prejudice bias

Cultural or gender stereotypes may lead to an uneven distribution of modelling data.



Survivorship bias

Arises from concentrating on the successful output of the process and ignoring those that don't survive.

Show me... measurement bias



A shop has scales to measure and record the weight of the fruit it sells.

However the scales have not been set up correctly, so they record the weight 10g heavier than the actually are.

This means there is a **measurement bias in the recorded weight of the fruit sold.**

Fruit	RecordedWeight	ActualWeight
Apples	100g	90g
Pears	120g	110g



Show me... sample bias



Databases available for psychology studies are made up mostly from people of Western, Educated, Industrialised, Rich, Democratic (WEIRD) countries.

People from WEIRD countries make up 80% participants but only 12% of world's population.

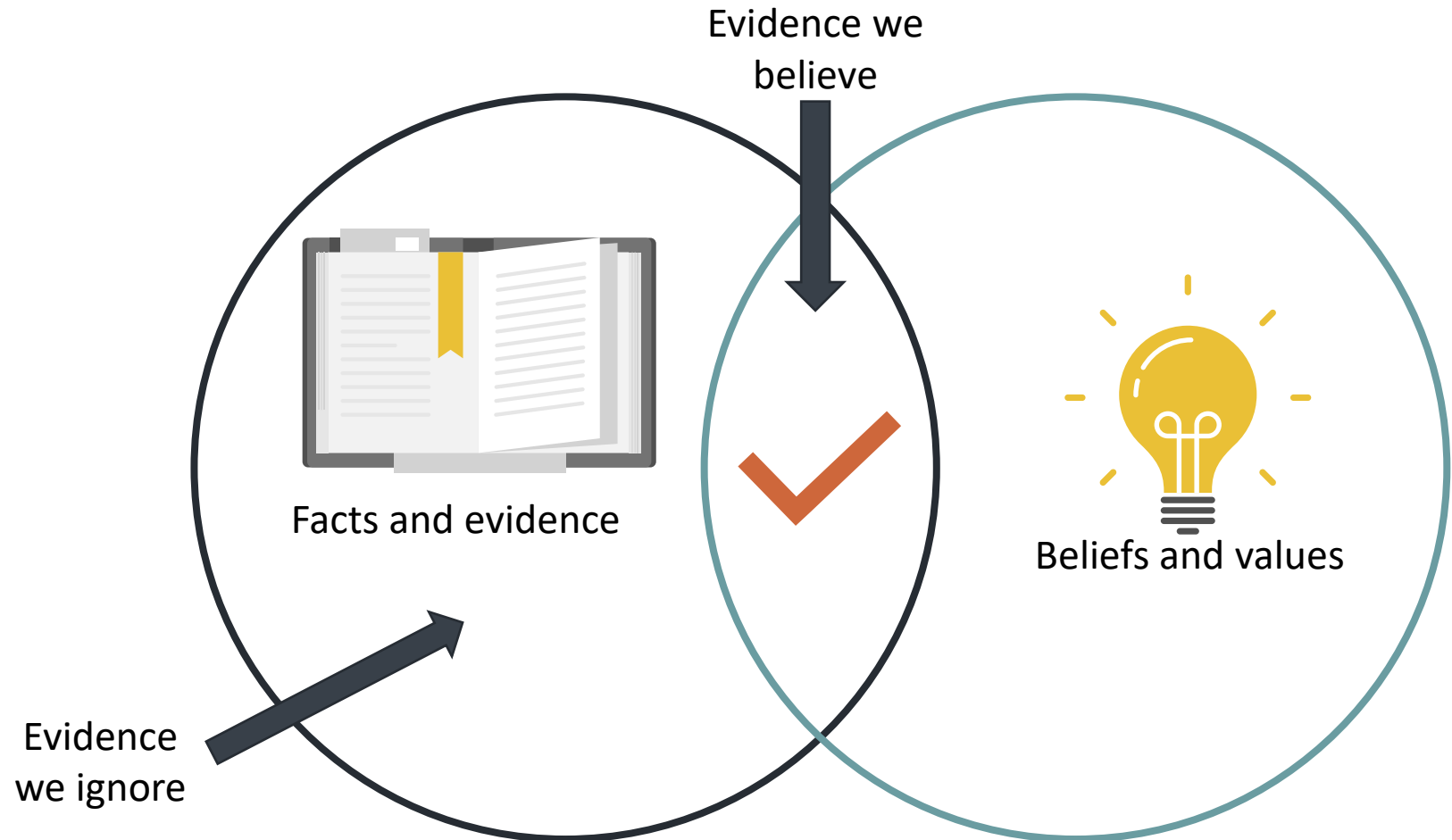
By focusing on the **data of only 12% of the world population** the sample datasets are not representative of everyone in the world.

Western
Educated
Industrialised
Rich
Democratic

Show me... confirmation bias



Confirmation bias is where people **only believe facts and evidence when it matches up with their beliefs and values.**



Your turn... survivorship bias

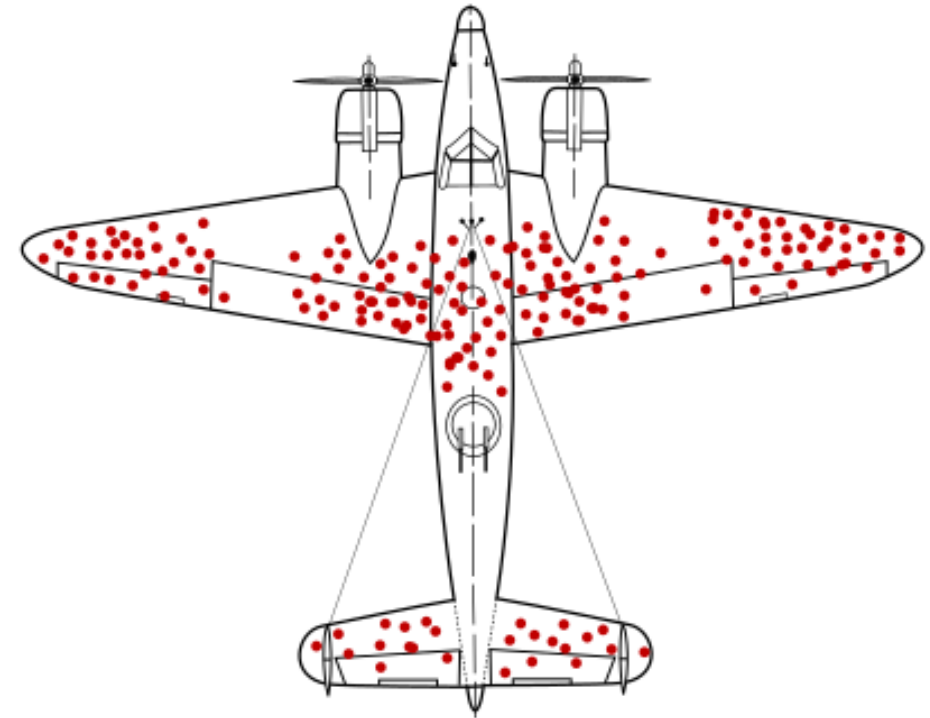


In World War II, people were looking at the pattern of bullet holes on planes that were returning.

Initially the military planned to reinforce the areas of the planes where they had seen lots of bullet holes.

Thinking about survivorship bias, **where do you think they should strengthen the planes?**

Reminder: Survivorship bias arises from concentrating on the successful output of the process and *ignoring those that don't survive*.



This hypothetical pattern of damage of returning aircraft shows locations where they can sustain damage and still return home

Image created by:

<https://commons.wikimedia.org/wiki/File:Survivorship-bias.svg>

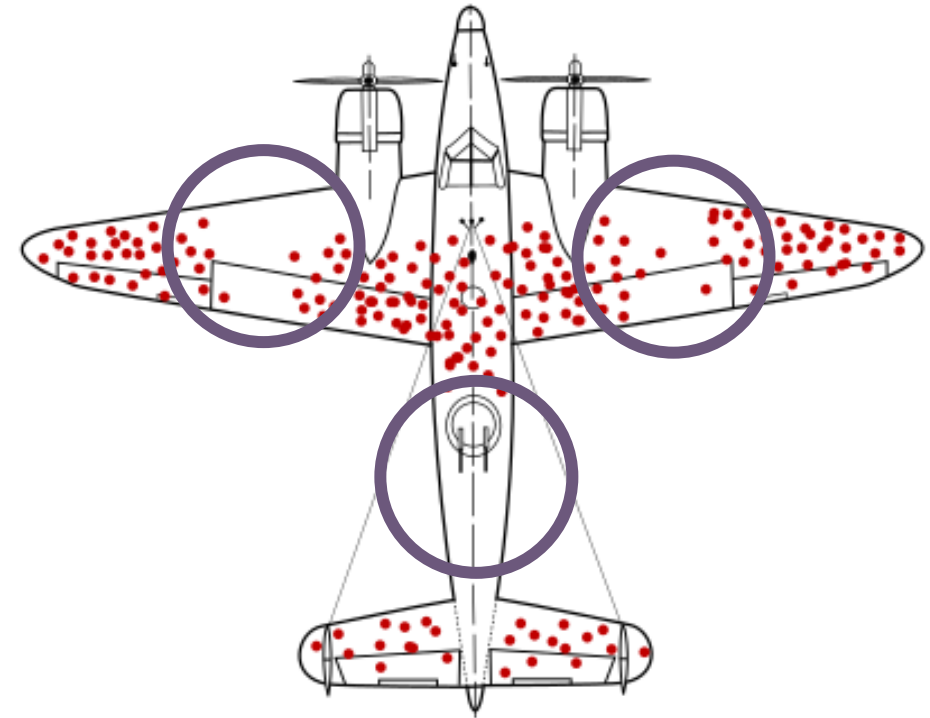
Your turn... survivorship bias



Planes that returned were able to survive being hit in these areas.

So you can **assume the planes that didn't return where hit in the other areas.**

Therefore they should reinforce the areas where they were the least number of bullet holes.



This hypothetical pattern of damage of returning aircraft shows locations where they can sustain damage and still return home

Image created by:

<https://commons.wikimedia.org/wiki/File:Survivorship-bias.svg>

Correlation bias

Another form of bias is **correlation bias**.

This is where there appears to be a **relationship between two data items but they are not actually linked**.

This example shows the divorce rate in Maine (USA) correlates with the amount of margarine eaten.

There is no link between divorce rates and amount of margarine eaten, there just happen to show the same pattern over this time period.

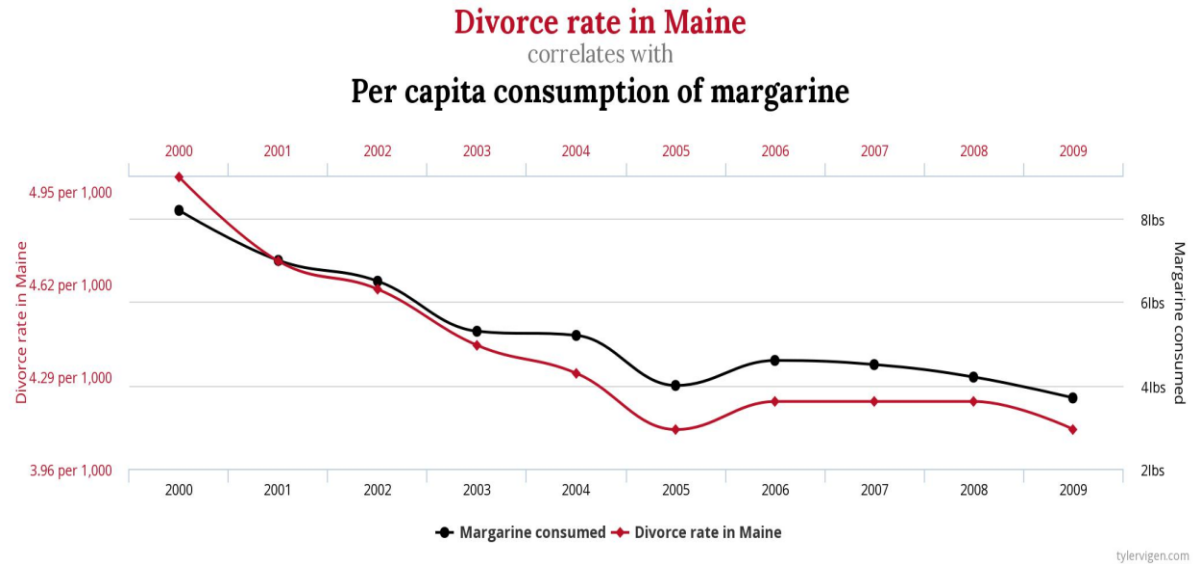


Image created by:

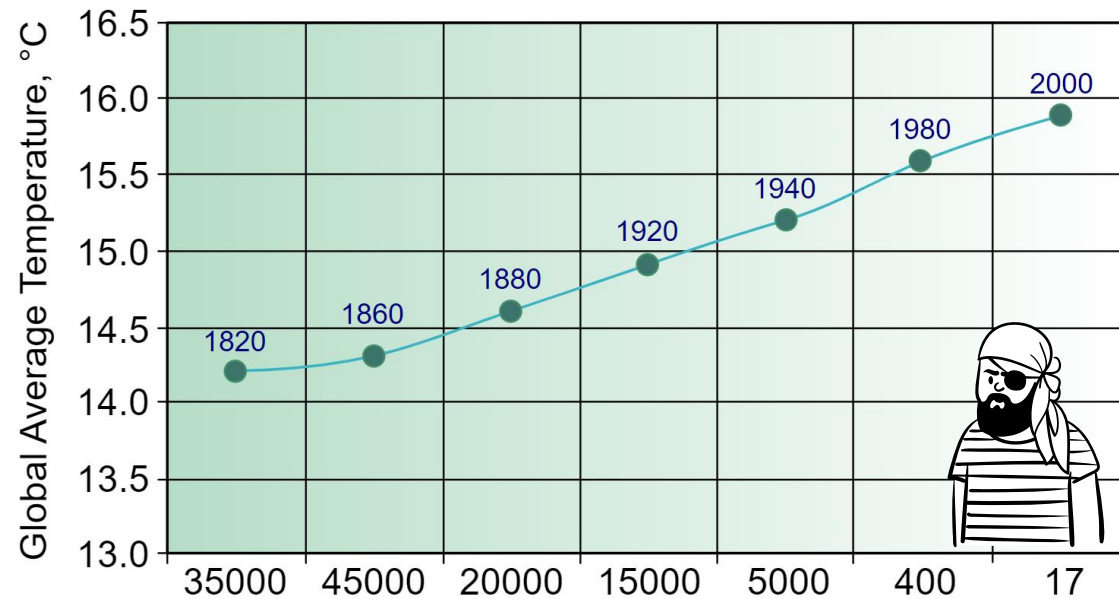
<https://www.tylervigen.com/spurious-correlations>

Show me...



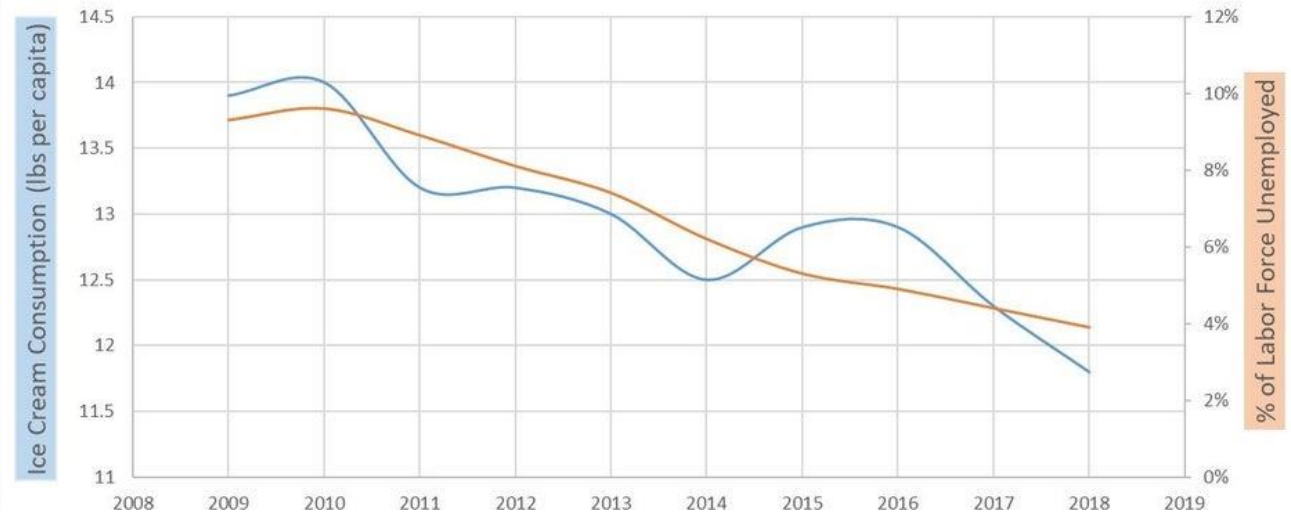
Here are more examples of correlation bias

Global Average Temperature vs. Number of Pirates



[https://commons.wikimedia.org/wiki/File:PiratesVsTemp\(en\).svg](https://commons.wikimedia.org/wiki/File:PiratesVsTemp(en).svg)

Ice Cream vs Unemployment



<https://coincidentalcorrels.wixsite.com/scotw/post/the-quarantine-fifteen>

How to mitigate bias

One of the best ways to avoid bias is to **make data science a team sport** and to have a diverse team. Also, you should,



Review findings with team members and subject matter experts



Include **multiple data sources** from as many providers as possible



Have **multiple people with differing backgrounds** involved in the project

Ethics vs. bias

Data ethics and bias can cause similar issues but are not the same thing.

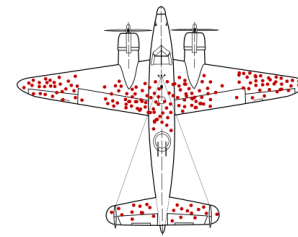
Data Ethics

“Branch of ethics that looks at the moral questions related to data”



Data Bias

“To prejudice for or against one person or group when using data”



Next steps

Complete **questions 1 to xx**
in **section x** of the
'Causes & impacts of bias' workbook.

Learning checklist

I can *explain* what is meant by data bias

I can *explain* what can cause and impact data bias

I can *explain* how to mitigate against data bias

How you can use this lesson



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