CSE 332
Introduction to Visualization

Visual Bias

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What is Bias?

Cause to feel or show inclination or prejudice for or against someone or something
Persistence of mindset

- humans tend to stick with an “opinion” for a long time
- how long does it take you to switch?
Persistence of mindset

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Confirmation Bias

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Which is face facing the front?
Necker Cube

Which is face facing the front?
Visualization can support bias!!

- Appeals to cultural bias
  - although Obama’s deficit was larger, the color red implies that Bush’s deficit was more “negative”
Which is bigger, A or C?
Perspective distortion in 3D rendering causes bias in the 3D chart. Item C appears to be at least as large as Item A whereas in actuality, it is less than half as large.

Which is bigger, A or C?
Cognitive Biases

Impede proper decision making

Comes in many guises
CONFIRMATION BIAS

THE CONFIRMATION BIAS CYCLE

1. Read the research.

Do I agree with the findings of the research?

No → Find a reason the research is flawed.

Yes → Ignore any flaws in the research.

2. Keep my worldview.

Confirmation Bias

Have you ever noticed... that squares are always blue?

Oh, I know! It's so weird!

Beatrice the Biologist
Confirmation Bias

Evidence we ignore

Facts and evidence

Evidence we believe

Our beliefs

previously learned
sub-conscious
A heavy smoker comes across a study that states smoking causes lung cancer. Yet they reject it stating that the study is flawed.

However, they later come across another study stating that smoking can cure lung cancer.

They state that this study is accurate, thereby aligning with their belief that smoking doesn’t cause harm.
Favor information that confirms previously held beliefs

Which clustering is correct?
- the one you did first?
- all clusters must look like that?
- many different clusterings
- all are good (or bad)
- depends on task

Overcome confirmation bias
- remain open
- apply healthy skepticism
- keep statistical metrics
- avoid generalization
3. THE HINDSIGHT BIAS

I knew that stock was going to rise!!!
See events, even random ones, as more predictable than they are
  ▪ look back on events and believe that we “knew it all along”

Which clustering is correct?
  ▪ of course (b) once you ran it
  ▪ or is it (d)?
Participants were given only 5 seconds to solve either of the following problem

- the estimates they made are very different

\[
\begin{align*}
1 \times 2 \times 3 \times 4 \ldots \times 8 &= 512 \\
8 \times 7 \times 6 \times 5 \ldots \times 1 &= 2,250
\end{align*}
\]

**Answer:** 40,320

The Anchoring Bias

Tendency to be overly influenced by the first piece of information that we hear or see

- also called priming
- example: first number heard in pricing negotiations
- example: separability study by Valdez et al.

Valdez et al. TVCG 2018
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Valdez et al. TVCG 2018
A strategy that people use to make quick decisions but often lead to systematic errors
- this can lead to misconceptions and prejudices

Examples:
- smokers who have never known someone to die of a smoking-related illness might underestimate the health risks of smoking

Visualization can help overcome this problem
- can alter the way our memory stores the events for later recall
- can improve a person’s long-term intuition
A strategy that people use to make quick decisions but often lead to systematic errors
  ▪ this can lead to misconceptions and prejudices

Examples:
  ▪ smokers who have never known someone to die of a COVID-19 related illness might underestimate the health risks of COVID-19

Visualization can help overcome this problem
  ▪ can alter the way our memory stores the events for later recall
  ▪ can improve a person’s long-term intuition
Also known as the "physical attractiveness stereotype" or the "what is beautiful is 'good' principle”

Plain chart vs fancy vs really fancy
Other Biases

The Optimism Bias
- overestimate the likelihood that good things will happen while underestimating the probability that negative events will occur

The Self-Serving Bias
- give yourself credit for successes but lay the blame for failures on outside causes

The False-Consensus Effect
- spend too much time with like-minded people (echo chamber bias)

Solution for all of these (in the context of data science & vis)
- look at data in several ways
- visualize different metrics computed from the data
Selection Bias

Occurs when the data sample is not an accurate representation of the population

- sampling bias – recall stratified sampling from last lecture as a good way to avoid this
- time bias – can occur when sampling is terminated too early
- attrition bias – loss of participants over time (sample hardening)
- cherry picking – when only uses the favored samples
- rejection of data considered bad (loss of objectivity)
- susceptibility bias – for example, when one disease predisposes for a second disease, and the treatment for the first disease erroneously appears to predispose to the second disease
Confound ing

Hot temperatures

Rate of ice cream consumption  Number of sunburns

Confounding Variable
Higher Temperature

Predictor
Ice Cream Sales

Spurious Correlation

Outcome
Shark Attacks
Selection Bias – Example 1

R = -0.82
BASE: ALL ADULTS

r = -0.10
BASE: CONSUMED BEER IN LAST 7 DAYS

which biases have occurred?
Selection Bias – Climate Change

Long-Term Warming and Short-Term Variation

Temperature Change (°F)

Year

Selection Bias – Example 2

video link
The attraction bias

- exploited in marketing
- can affect visualizations as well
- let’s learn first about the attraction effect
Assume you can choose among two ice cream cones

- one has a higher price but offers more scoops
- the other has fewer scoops but also a lower price
- depending on how you feel you will pick either one of them

ice cream cone A and B have the same market share
Now suppose there was a third ice cream cone available

- nobody would pick it
Adding the third (inferior) option stole 50%-33%=17% market share from ice cream cone B and gave it to A.
One More Example
Decision making with conflicting goals

- here: lottery prize vs probability of winning – which ticket will you buy?

Dimara et al. TVCG 2019
Decision making with conflicting goals
  - here: lottery prize vs probability of winning – which ticket will you buy?

Dimara et al. TVCG 2019
Decision making with conflicting goals
- lottery prize vs probability of winning – which ticket will you buy?
Decision making with conflicting goals

- here: lottery prize vs probability of winning – which ticket will you buy?

Placement of decoys will always make A or C most attractive in selection and attention tasks

- note, the bottom plots were used in the experiment
- the top plots are just for illustration

Dimara et al. TVCG 2019
Allow user to delete data points

indeed allowed users to overcome the bias

Dimara et al. TVCG 2019
REFERENCES


The Attraction Effect Explained – Whiteboard video

20 Cognitive Biases That Screw Up Your Decisions – weblink

10 Cognitive Biases That Distort Your Thinking - weblink