

CSE 564
VISUALIZATION & VISUAL ANALYTICS

VISUAL BIAS

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Lecture	Topic	Projects
1	Intro, schedule, and logistics	
2	Applications of visual analytics, basic tasks, data types	
3	Introduction to D3, basic vis techniques for non-spatial data	
4	Data assimilation and preparation	Project #1 out
5	Bias in visualization	
6	Data reduction and dimension reduction	
7	Visual perception and cognition	
8	Visual design and aesthetics	Project #1 due/Project #2 out
9	Python/Flask hands-on	
10	Cluster analysis: numerical data	
11	Cluster analysis: categorical data	
12	Foundations of scientific and medical visualization	
13	Computer graphics and volume rendering	Project #2 due / Project #3 out
14	Scientific and medical visualization	
15	Illustrative rendering	Project #3 due
16	High-dimensional data, dimensionality reduction	Final project proposal call out
17	Correlation visualization	
18	Principles of interaction	
19	Midterm #1	
20	Visual analytics and the visual sense making process	Final project proposal due
21	Evaluation and user studies	
22	Visualization of time-varying and time-series data	
23	Visualization of streaming data	
24	Visualization of graph data	Final Project preliminary report due
25	Visualization of text data	
26	Midterm #2	
27	Data journalism	
	Final project presentations	Final Project slides and final report due

WHAT IS BIAS?

Cause to feel or show inclination or prejudice for or against someone or something



"I trust this site to tell the truth."

CONFIRMATION BIAS

Persistence of mindset

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



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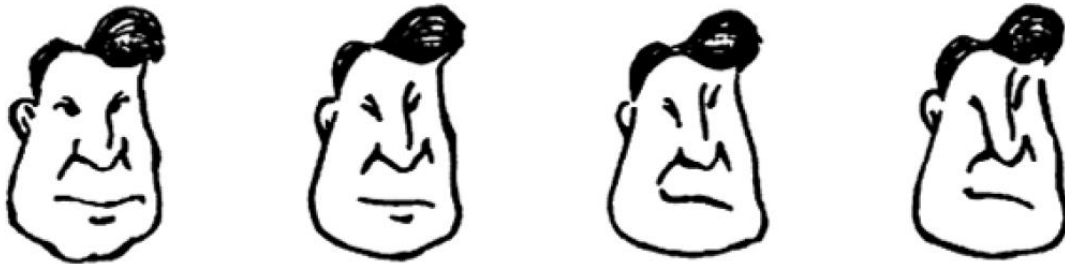
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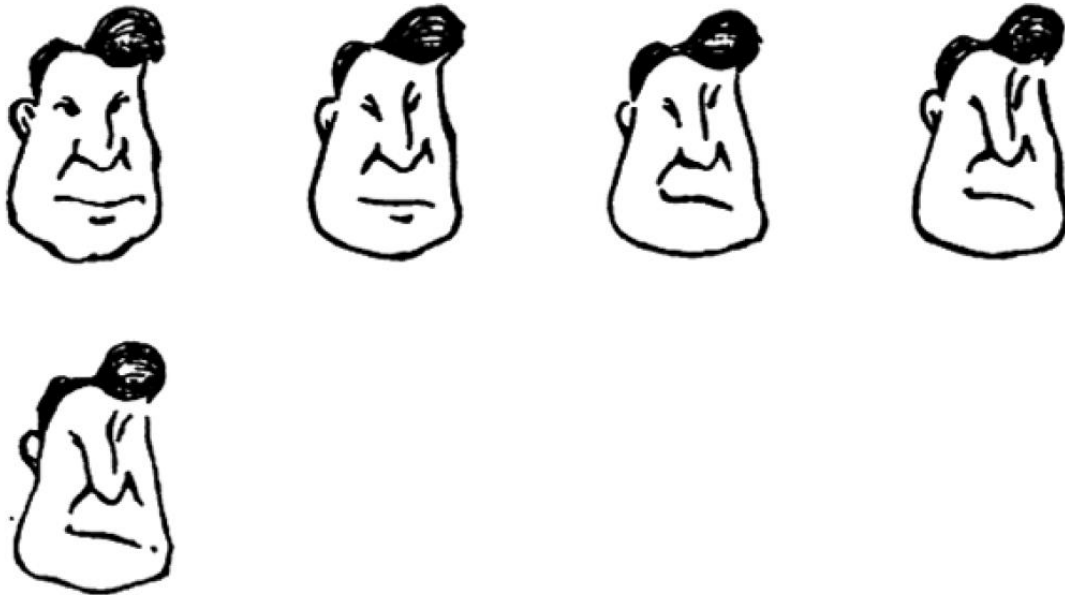
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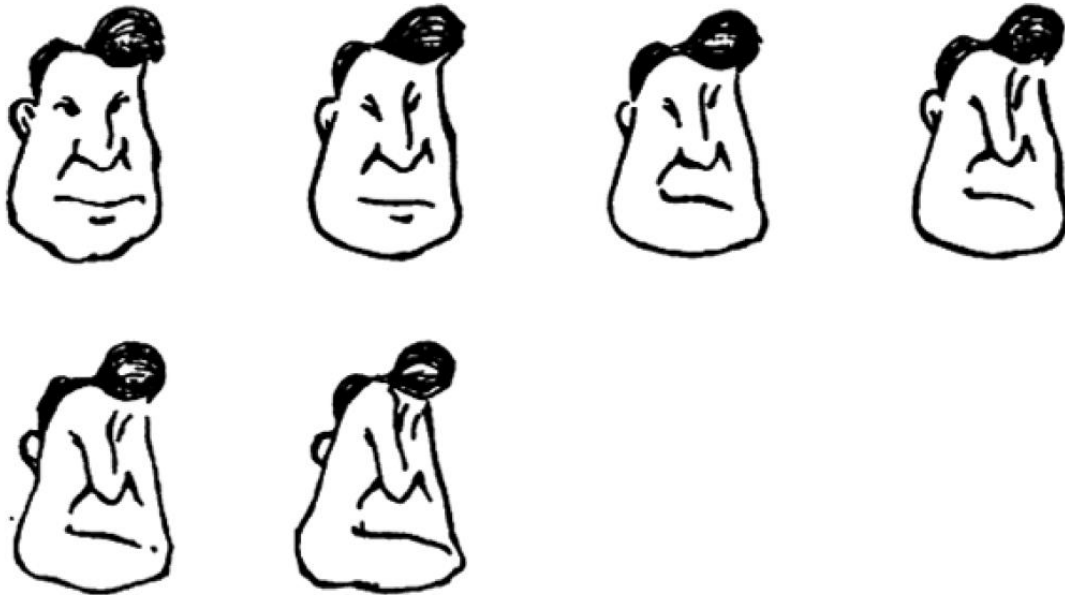
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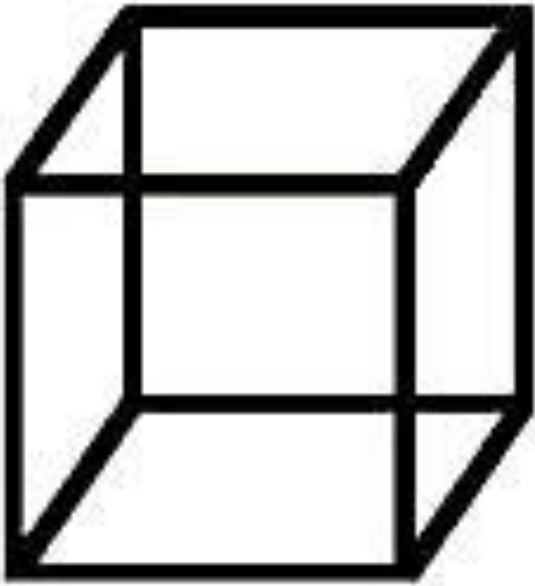


man/woman

Young/old woman

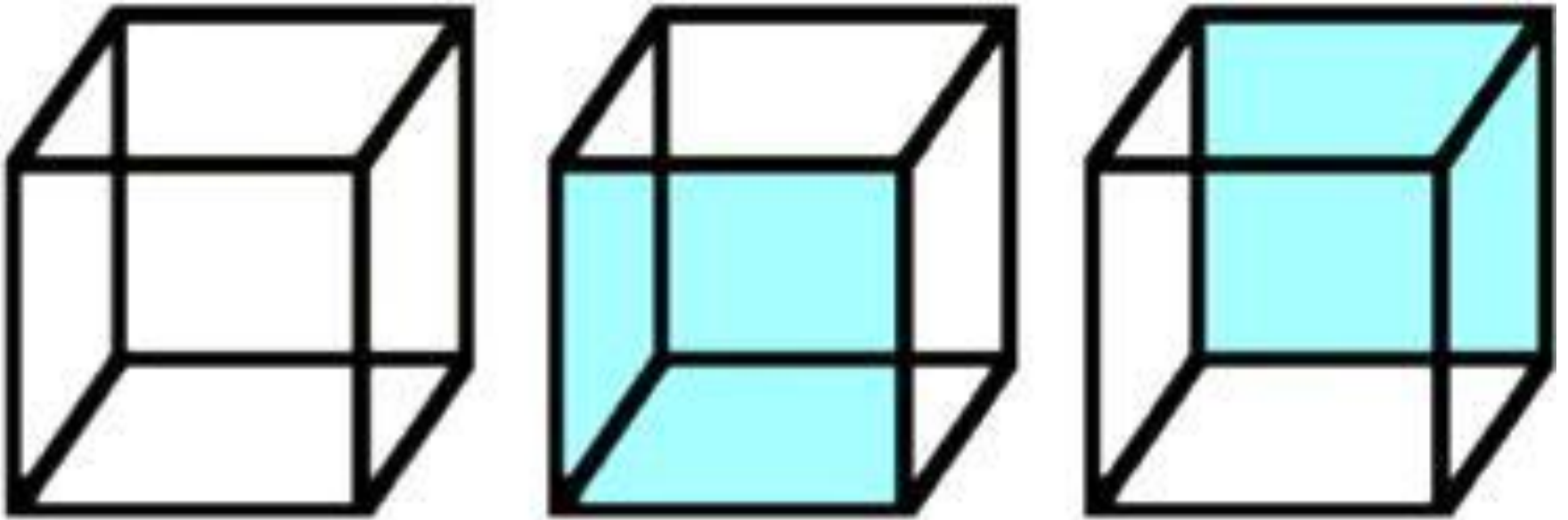


NECKER CUBE



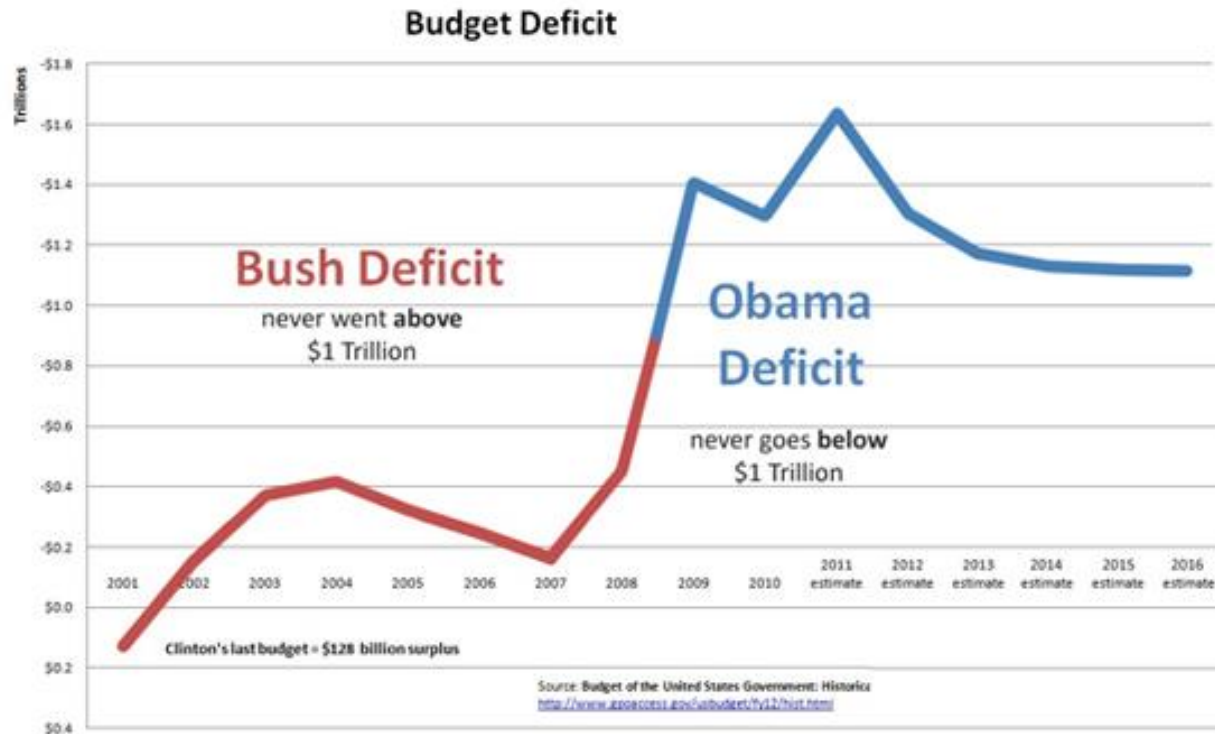
Which is face facing the front?

NECKER CUBE



Which is face facing the front?

VISUALIZATION CAN SUPPORT BIAS !!



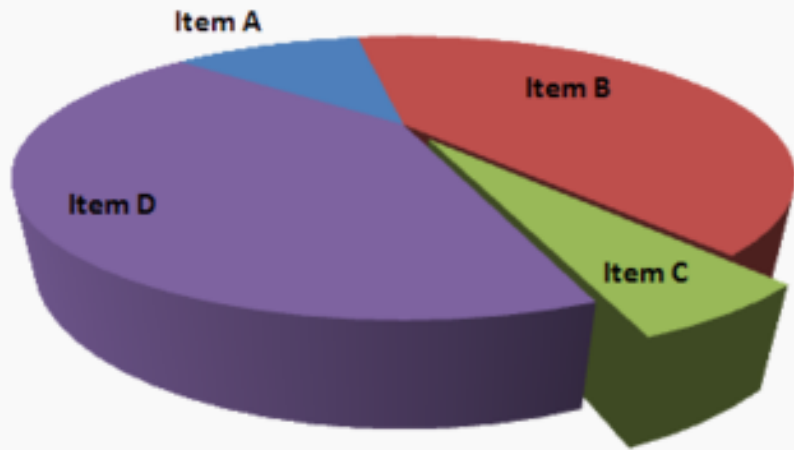
Signal value issues. The red line feels more negative. From <http://www.politicalmathblog.com>

Appeals to **cultural bias**

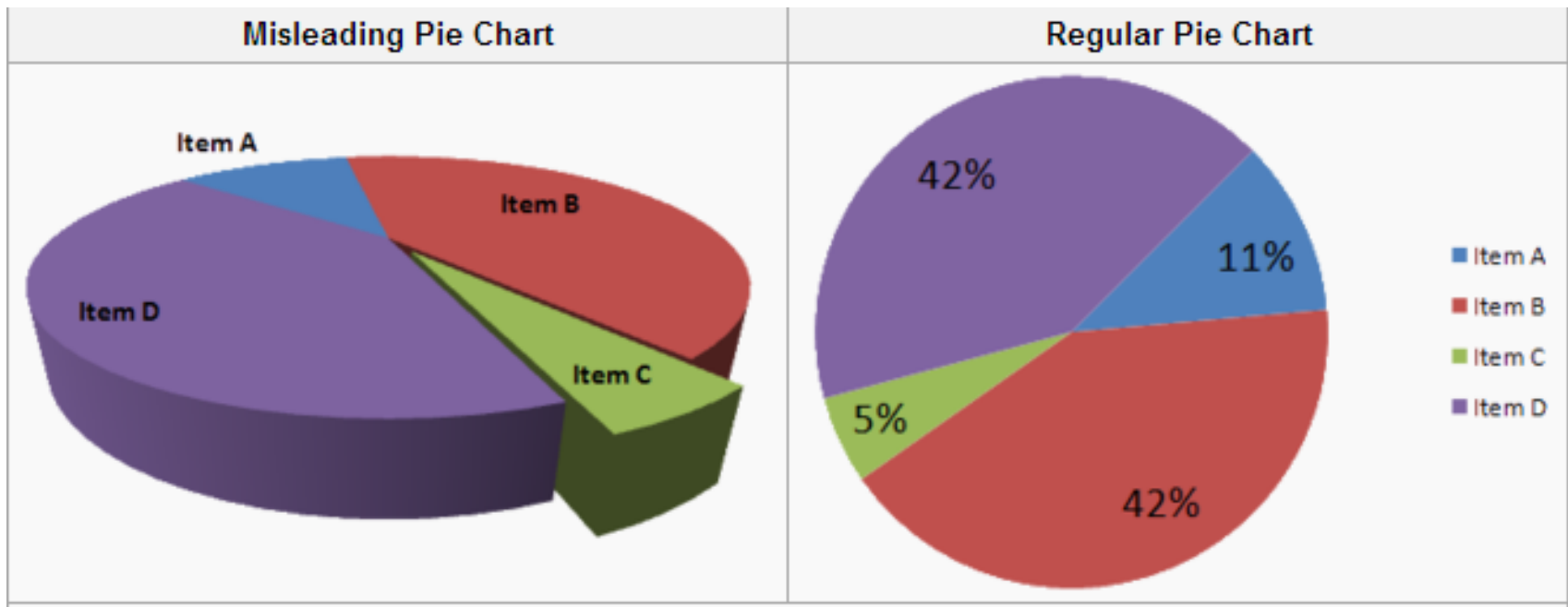
- although Obama's deficit was larger, the color red implies that Bush's deficit was more "negative"

GRAPHICAL BIAS

Misleading Pie Chart



GRAPHICAL BIAS



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.

COGNITIVE BIASES

Impede proper decision making

Comes in many guises

THE CONFIRMATION BIAS

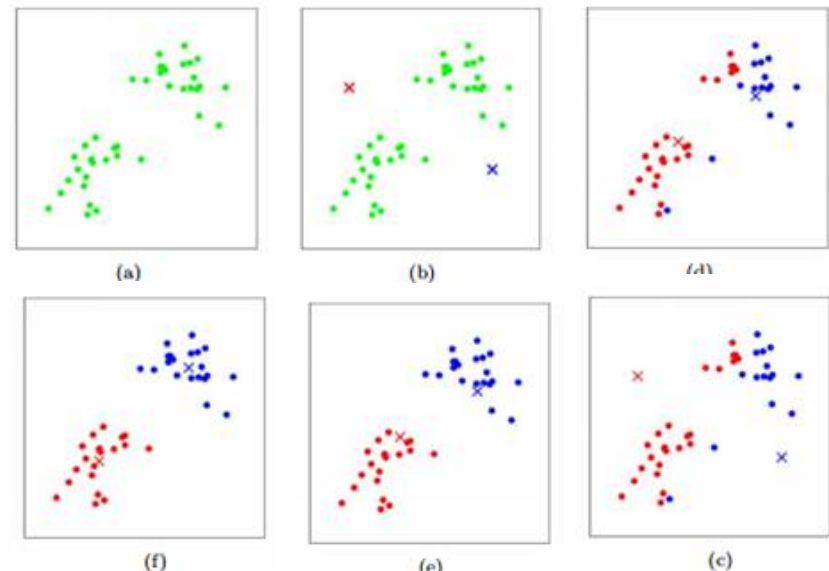
Favor information that confirms previously held beliefs

Which clustering is correct?

- the one you did first?
- the one you saw before?

There are many different clusterings

- all are good (or bad)
- depends on task
- or additional knowledge
- visualize and check plausibility



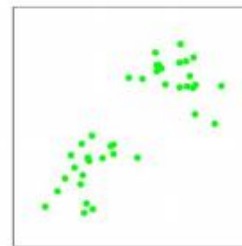
THE HINDSIGHT BIAS

See events, even random ones, as more predictable than they are

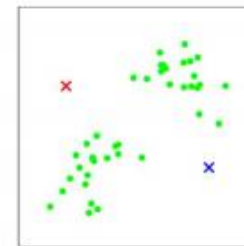
- look back on events and believe that we “knew it all along”

Which clustering is correct?

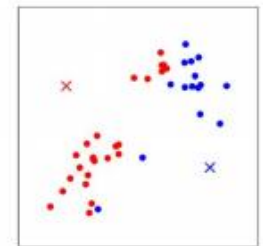
- of course (b) once you ran your favorite algorithm
- or is it (d)?



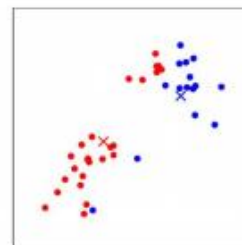
(a)



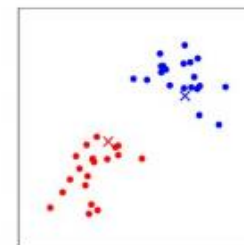
(b)



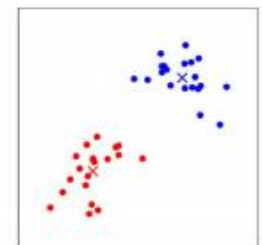
(c)



(d)



(e)

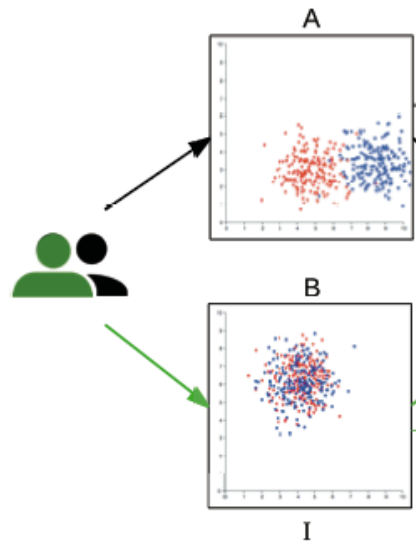


(f)

THE ANCHORING BIAS

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

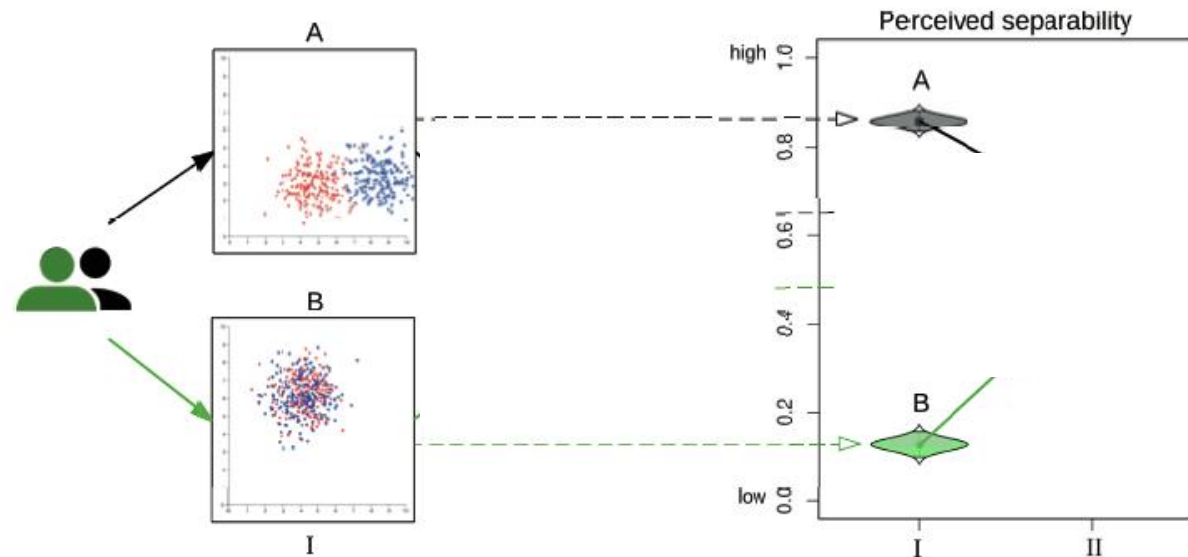
- also called priming
- example: first number heard in pricing negotiations
- example: separability study by Valdez et al.



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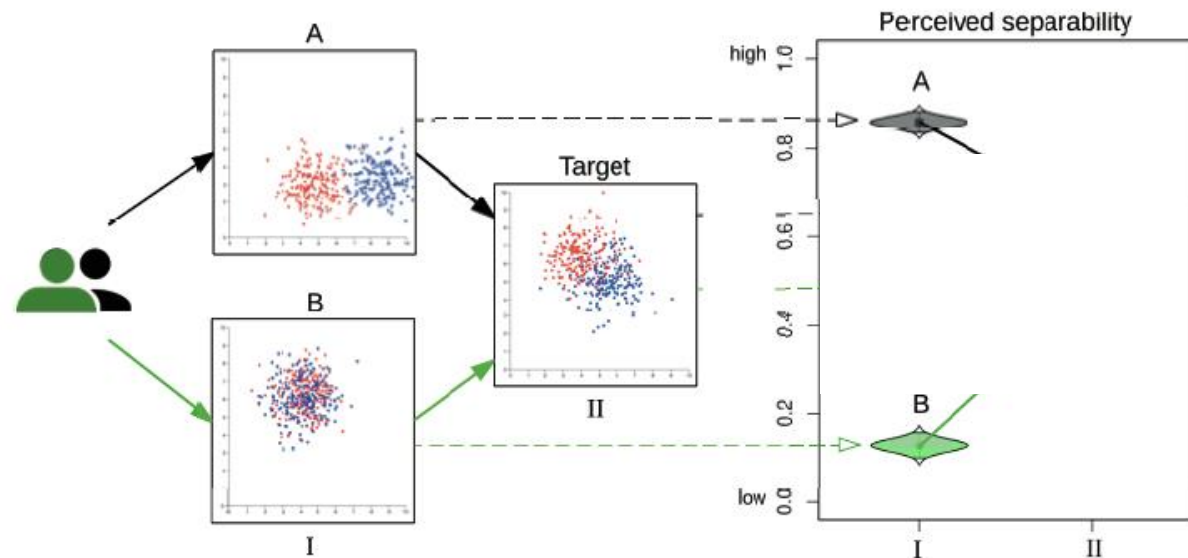
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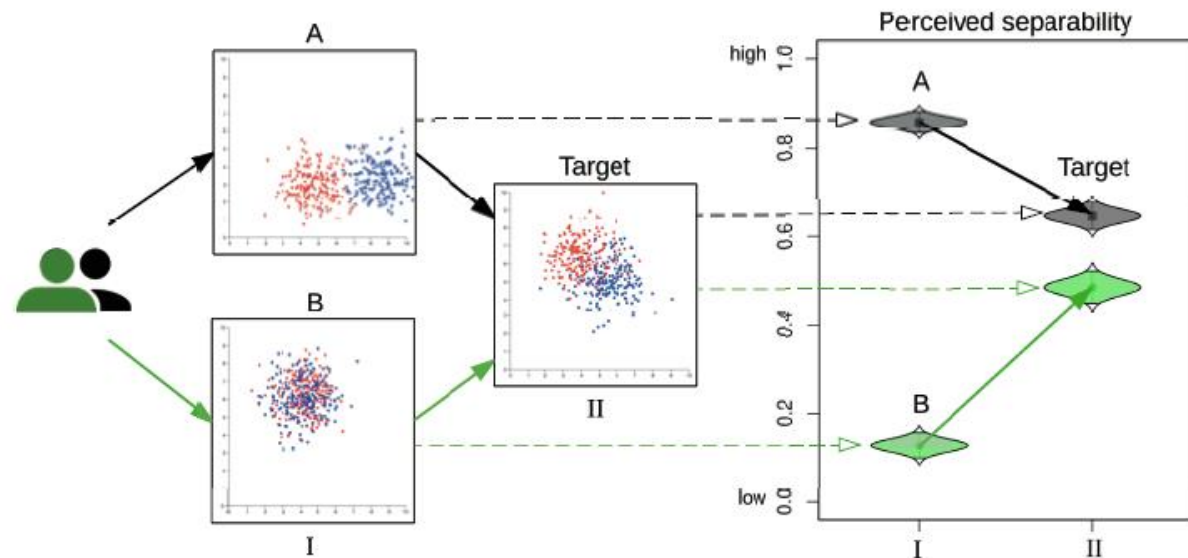
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THE AVAILABILITY HEURISTIC

A strategy that people use to make quick decisions

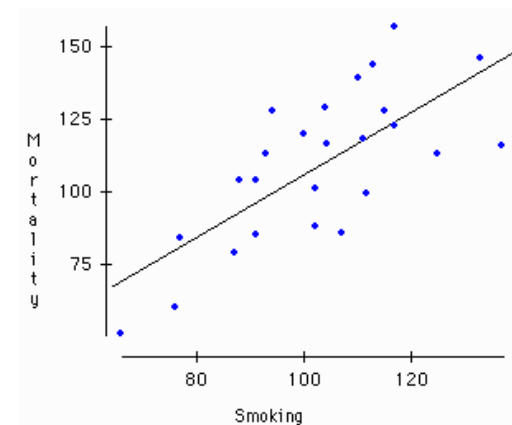
- this can lead to systematic errors, misconceptions, prejudices

Examples:

- smokers who have never known someone to die of a smoking-related illness, might underestimate the health risks of smoking
- death from COVID-19 (wear mask?)

Visualization can help overcome this problem

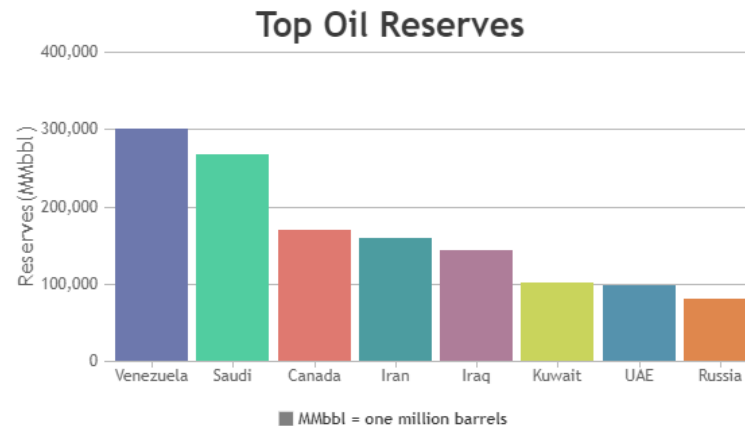
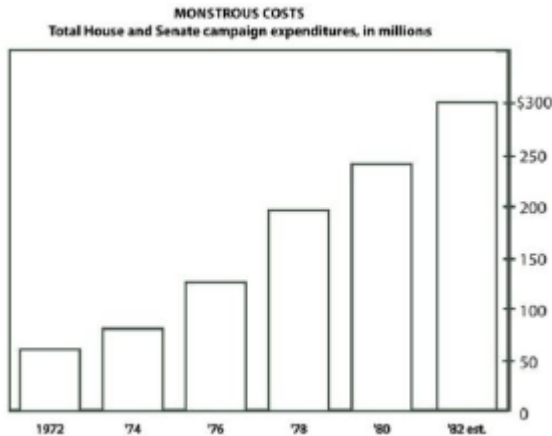
- it can alter the way our memory stores the events for later recall, so as to improve users' long-term intuitions



THE HALO EFFECT

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
- user studies often fall victim to that (don't only ask your friends)

Solution for all of these (in the context of data science & vis)

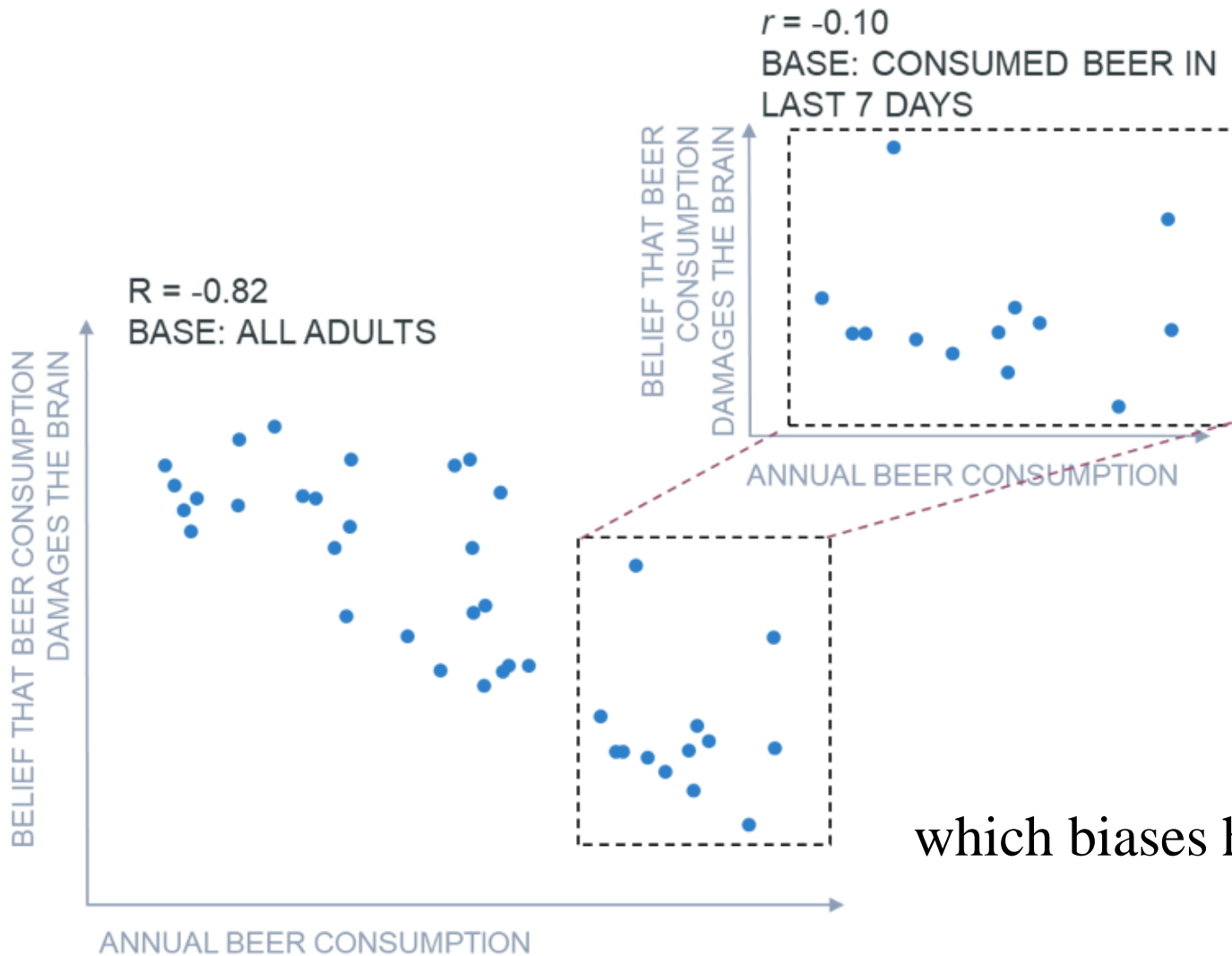
- look at data in several ways
- visualize different metrics computed from the data

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 one only uses the favored samples
- rejection of data considered bad (loss of objectivity)

SELECTION BIAS – EXAMPLE 1



which biases have occurred?

SELECTION BIAS – EXAMPLE 2



[video link](#)

ONE MORE

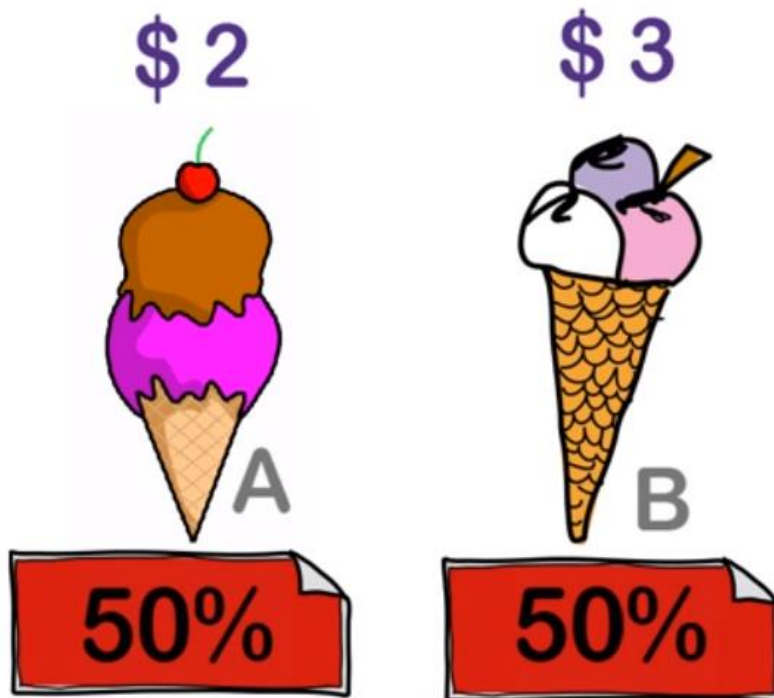
The attraction bias

- exploited in marketing
- can affect visualizations as well
- let's learn first about the attraction effect

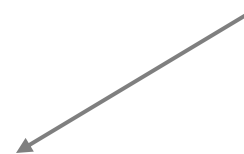
THE ATTRACTION EFFECT (1)

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

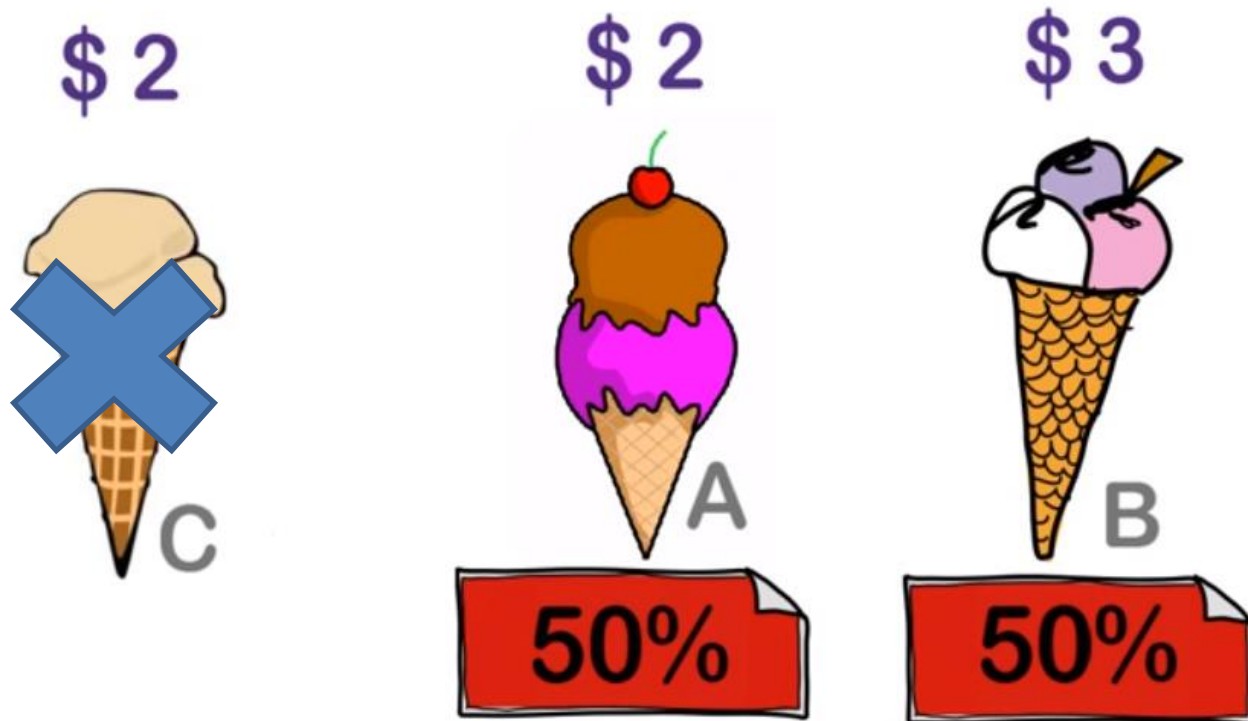


ice cream cone
A and B have the
same market share



THE ATTRACTION EFFECT (2)

Now suppose there was a third ice cream cone available



- nobody would pick it

THE ATTRACTION EFFECT (3)

ADDING A THIRD OPTION CAN INCREASE SALES!

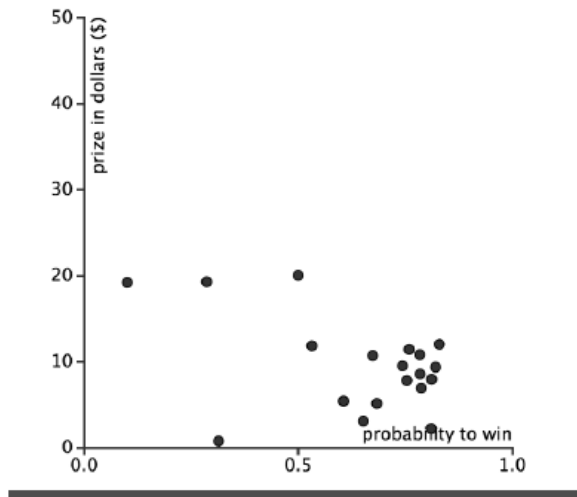


Adding the third (inferior) option stole $50\% - 33\% = 17\%$ market share from ice cream cone B and gave it to A

APPLICATION TO VISUALIZATION

Decision making with conflicting goals

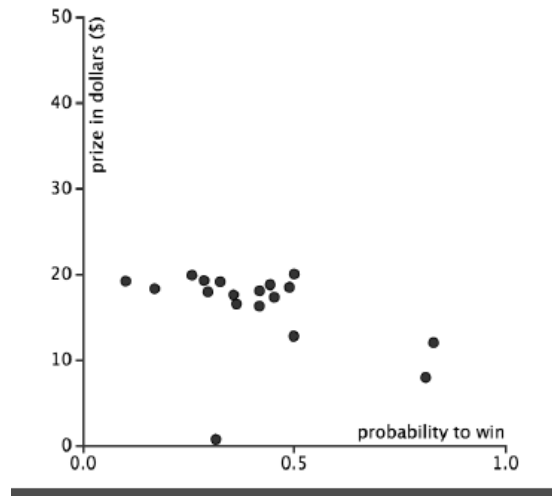
- here: lottery prize vs probability of winning – which ticket will you buy?



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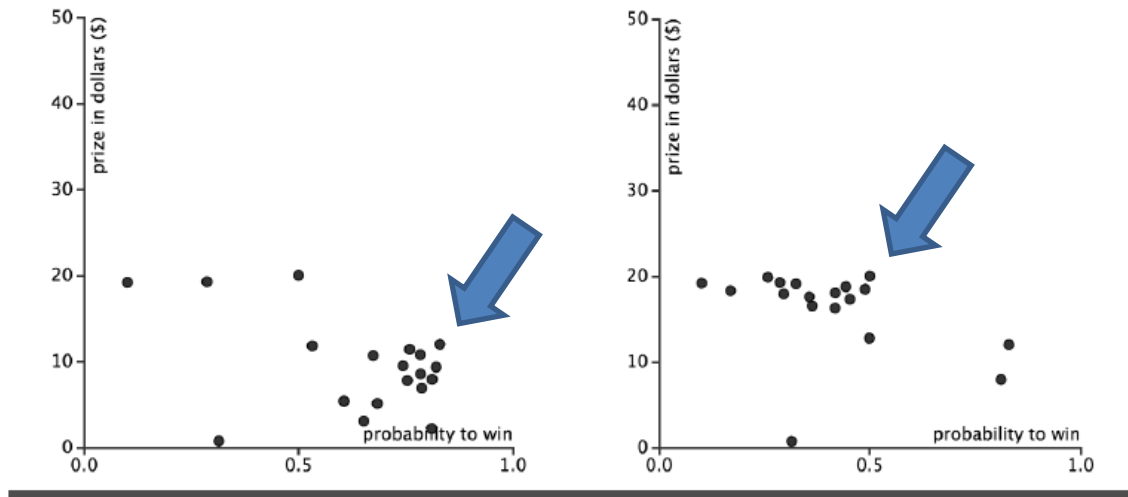
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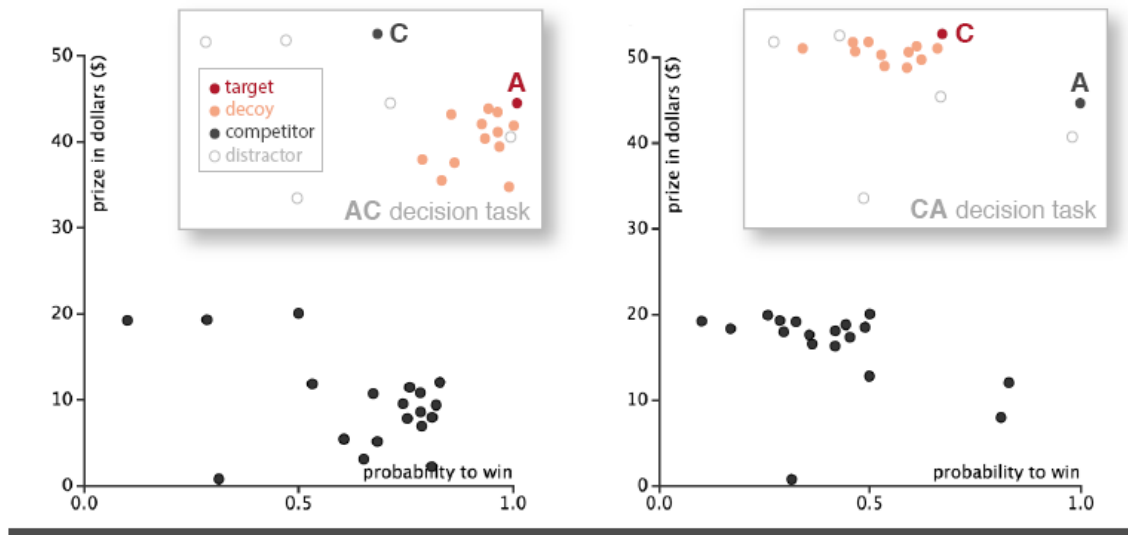
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APPLICATION TO VISUALIZATION

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

A MITIGATION TECHNIQUE

Allow user to delete data points

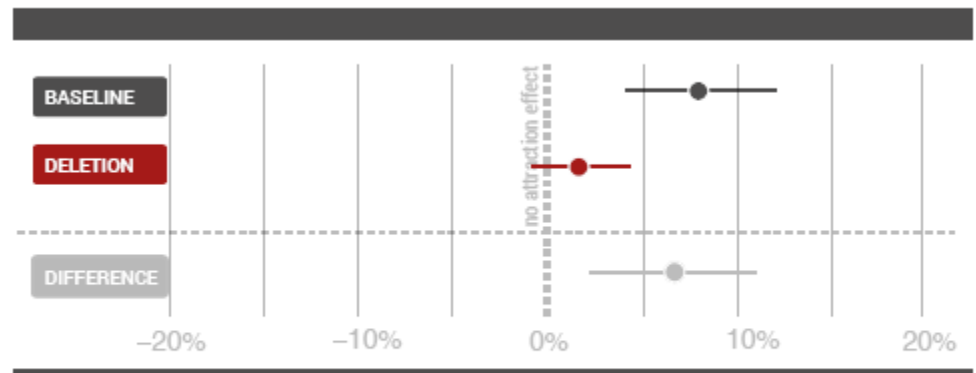
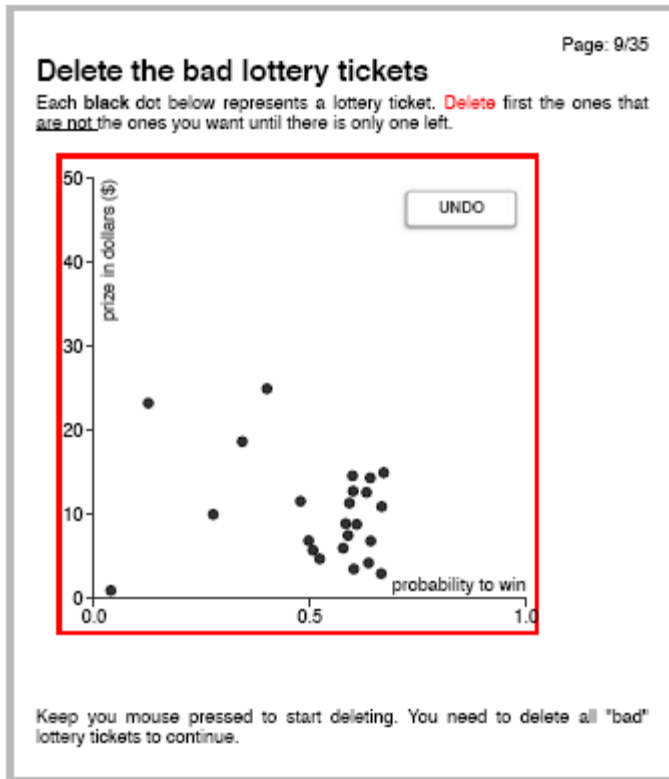


Fig. 8. Point estimates and 95% confidence intervals for the attraction effects in *baseline* and *deletion* conditions.

indeed allowed users to overcome the bias

SUMMARY

Today we discussed different kinds of biases that consumers of visualizations can fall victim to

Some of the more prominent ones are

- selection bias
- confirmation bias
- anchoring bias
- graphical bias
- attraction effect
- halo effect

REFERENCES

Dimara E, Bailly G, Bezerianos A, Franconeri S. [Mitigating the attraction effect with visualizations](#). IEEE Transactions on Visualization and Computer Graphics. 2019 Jan;25(1):850-60.

Valdez AC, Ziefle M, Sedlmair M. [Priming and anchoring effects in visualization](#). IEEE Transactions on Visualization & Computer Graphics. 2018 Jan 1(1):584-94.

Borland, D, W Wang, J Zhang, J Shrestha, D Gotz. "[Selection bias tracking and detailed subset comparison for high-dimensional data](#)." IEEE Transactions on Visualization and Computer Graphics ,26(1): 429-439, 2019

The Attraction Effect Explained – [Whiteboard video](#)

20 Cognitive Biases That Screw Up Your Decisions – [weblink](#)

10 Cognitive Biases That Distort Your Thinking - [weblink](#)