Foundations 2
Visualization Design

DataVis 2020

http://datavis2020.github.io

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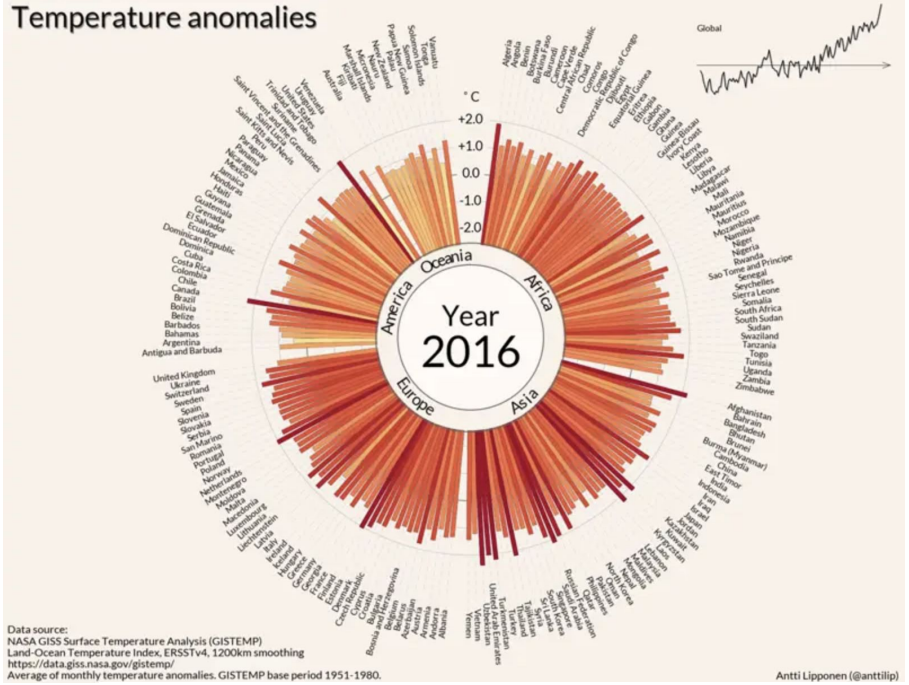
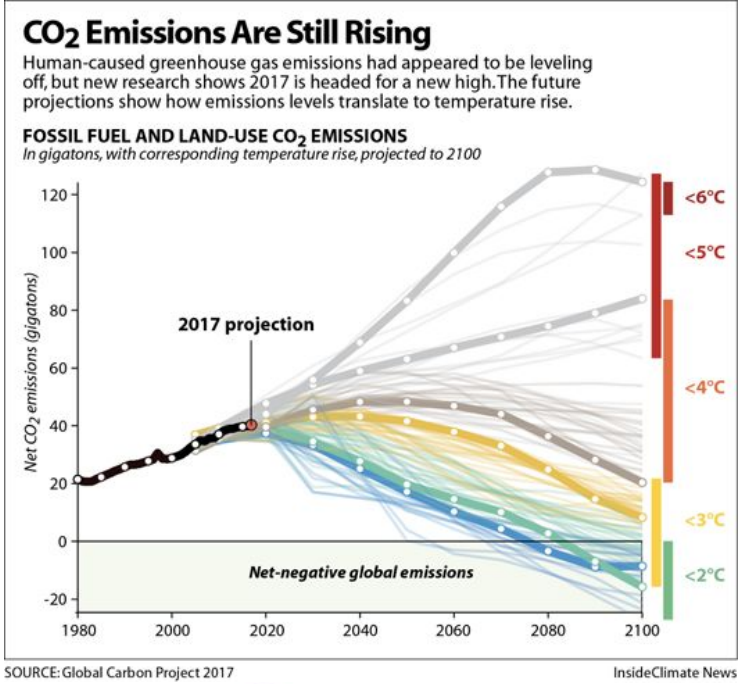
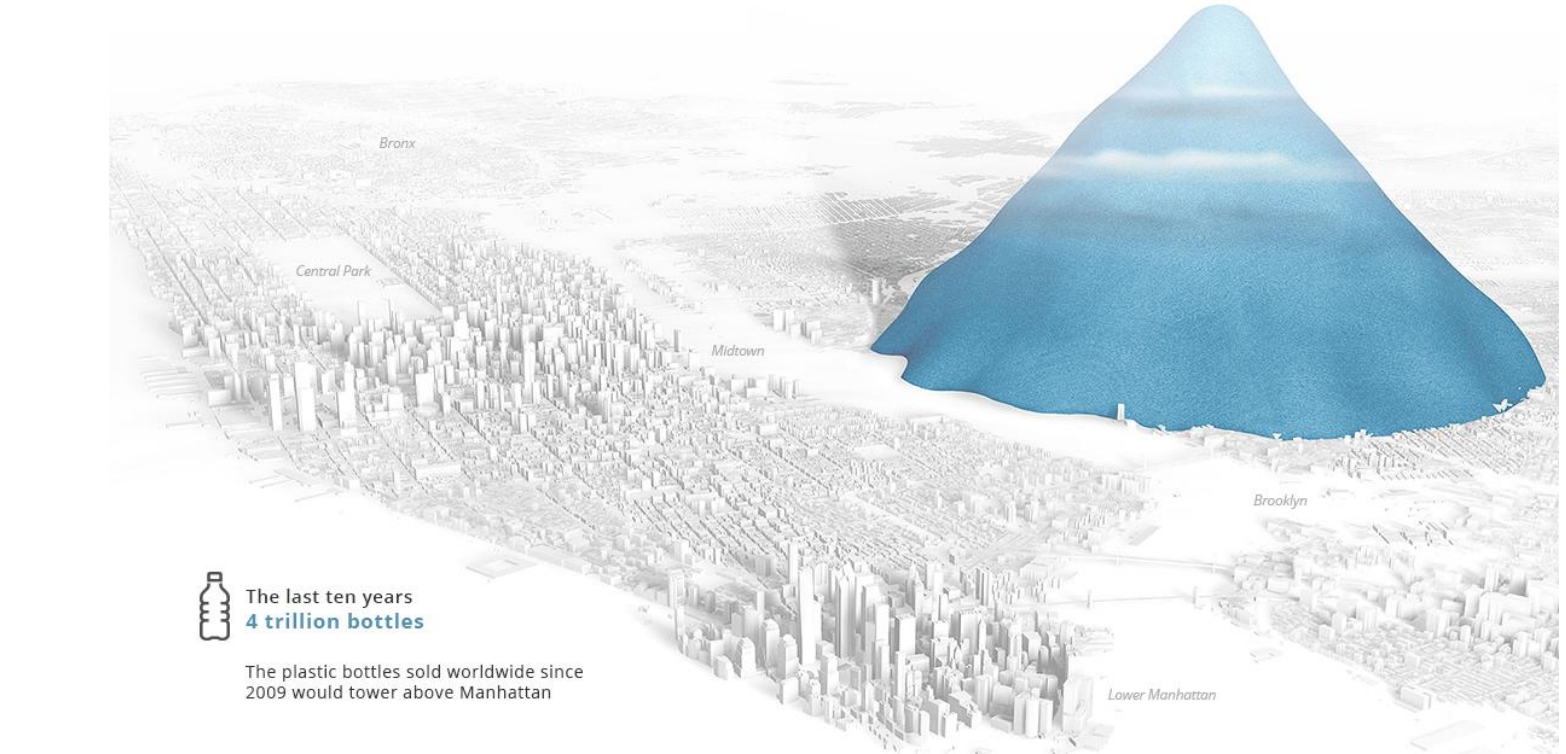
THE UNIVERSITY *of* EDINBURGH

How to make
climate action
understandable?


Temperature anomalies
Global
°C
+2.0
+1.0
0.0
-1.0
-2.0
Oceania
Africa
America
Europe
Asia
Year
2016
Data source:
NASA GISS Surface Temperature Analysis (GISTEMP)
Land-Ocean Temperature Index, ERSSTv4, 1200km smoothing
https://data.giss.nasa.gov/gistemp/
Average of monthly temperature anomalies. GISTEMP base period 1951-1980.
Antti Lipponen (@anttilip)


CO2 Emissions Are Still Rising
Human-caused greenhouse gas emissions had appeared to be leveling off, but new research shows 2017 is headed for a new high. The future projections show how emissions levels translate to temperature rise.
FOSSIL FUEL AND LAND-USE CO2 EMISSIONS
In gigatons, with corresponding temperature rise, projected to 2100
Net CO2 emissions (gigatons)
120
100
80
60
40
20
0
-20
1980
2000
2020
2040
2060
2080
2100
2017 projection
Net-negative global emissions
<6°C
<5°C
<4°C
<3°C
<2°C
SOURCE: Global Carbon Project 2017
InsideClimate News


Bronx
Central Park
Midtown
Brooklyn
Lower Manhattan
The last ten years
4 trillion bottles
The plastic bottles sold worldwide since 2009 would tower above Manhattan

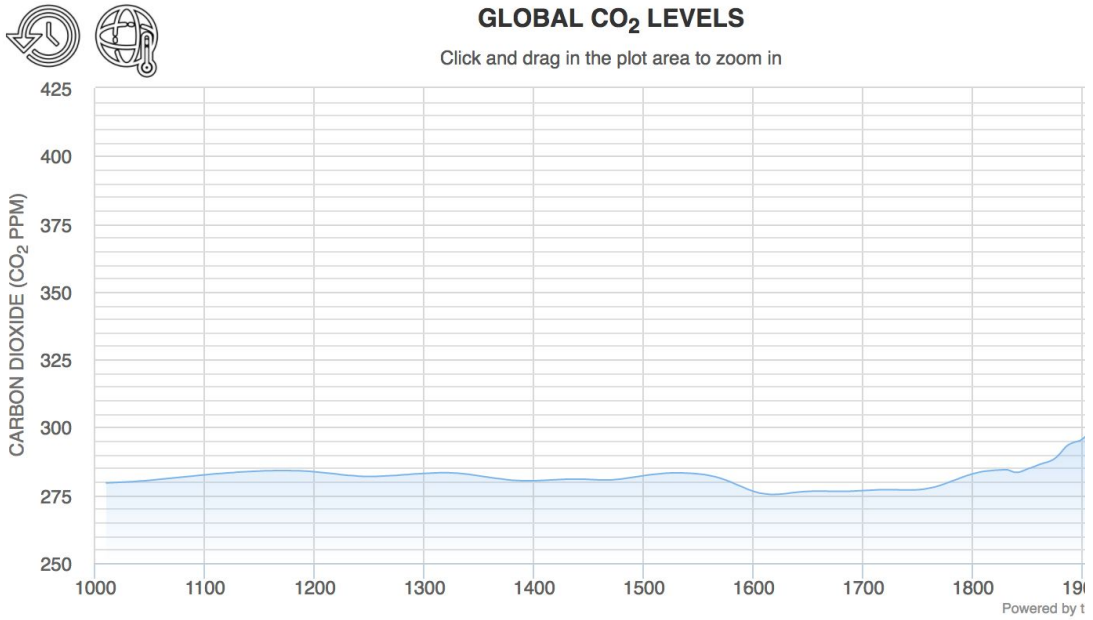
Assignment 1

1. Find **two different visualizations** (on the internet, in newspapers, TV, etc.). Different means, e.g., a line chart, a node-link diagram.
2. For each visualization, **describe three faults** and why they are problematic. Make sure to report different faults for each visualization, i.e., in total you should report six faults.
3. For each visualization, propose (sketch) one or two visualizations that solve the identified faults.
4. For each solution you find, argue with a more general visualization guidelines.
5.

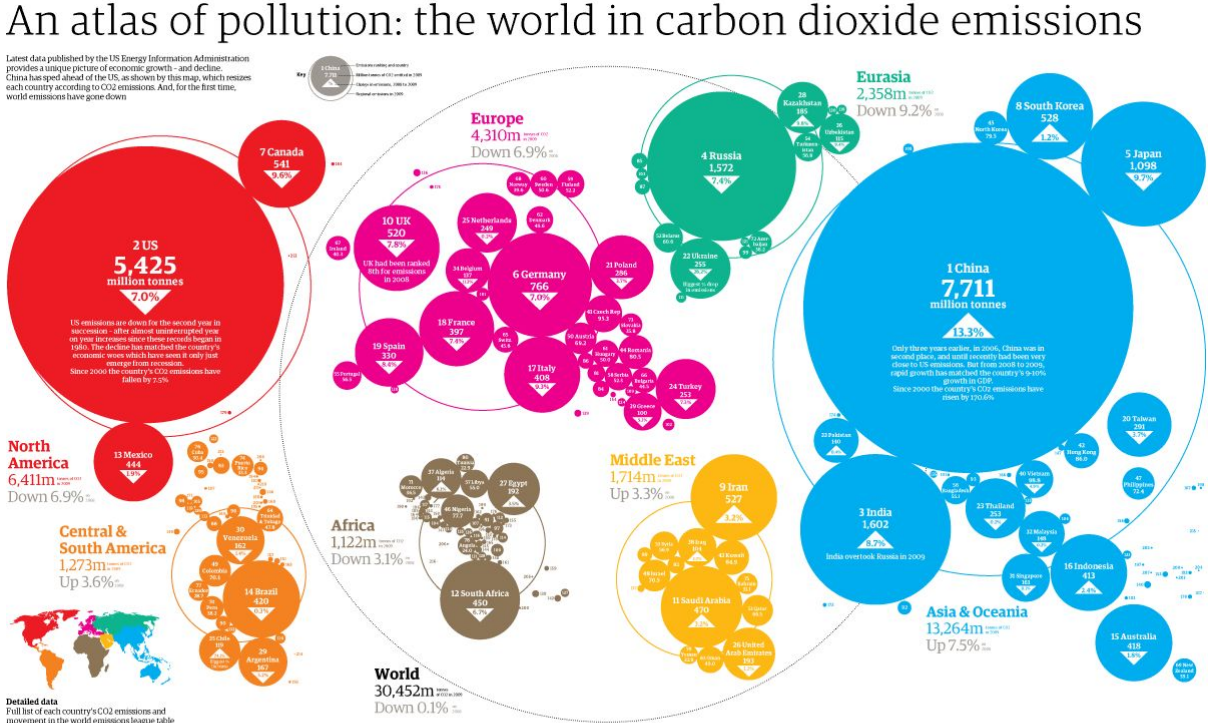
Tips

- Collect many visualizations
- Chose the most challenging one
- Create several solution
- **Don't rely on Google Images!!!**
  - https://informationisbeautiful.net/

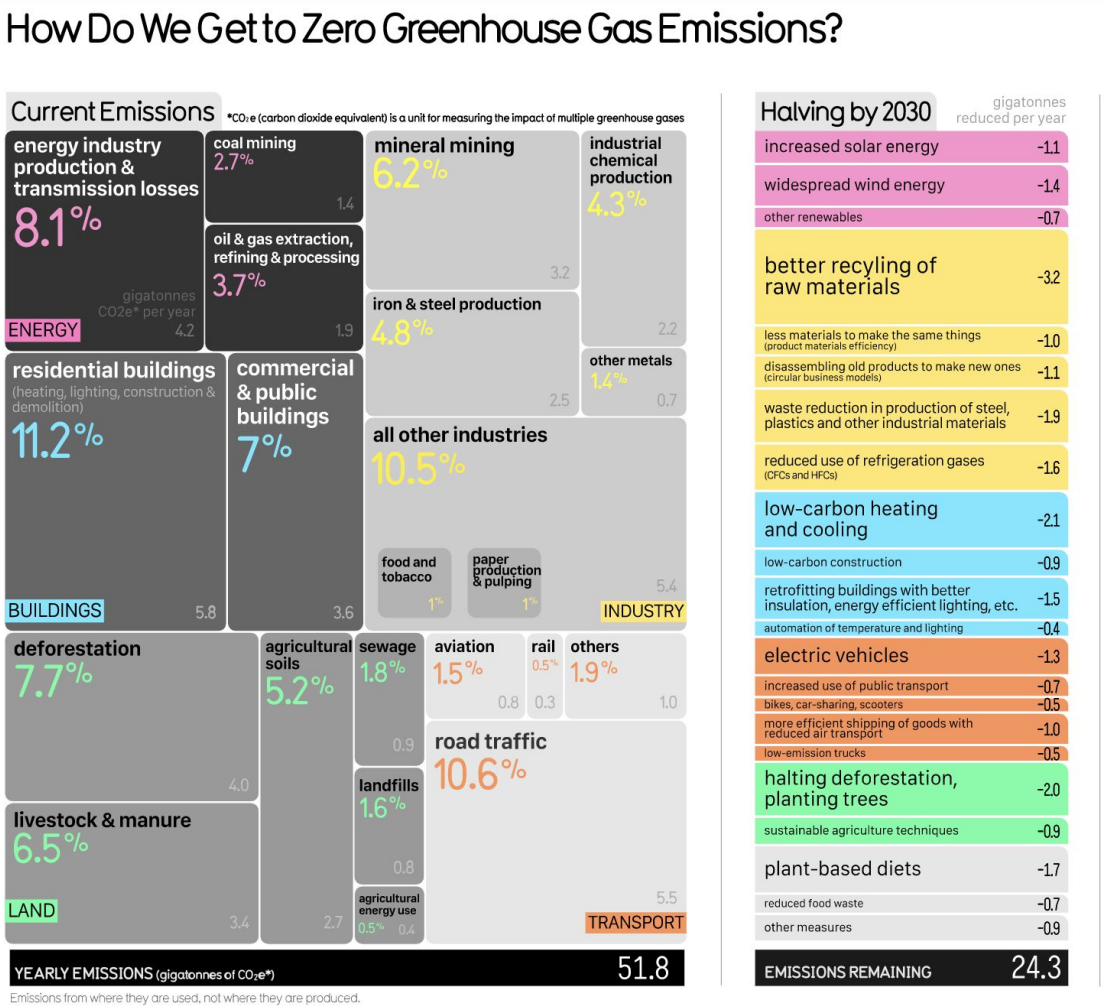
Too simple:



Too complex:



Good:


How Do We Get to Zero Greenhouse Gas Emissions?
Current Emissions
*CO₂e (carbon dioxide equivalent) is a unit for measuring the impact of multiple greenhouse gases
energy industry production & transmission losses
8.1%
gigatonnes CO2e* per year
4.2
ENERGY
coal mining
2.7%
1.4
oil & gas extraction, refining & processing
3.7%
1.9
mineral mining
6.2%
3.2
industrial chemical production
4.3%
2.2
iron & steel production
4.8%
2.5
other metals
1.4%
0.7
residential buildings
(heating, lighting, construction & demolition)
11.2%
BUILDINGS
5.8
commercial & public buildings
7%
3.6
all other industries
10.5%
food and tobacco
1%
paper production & pulping
1%
5.4
INDUSTRY
deforestation
7.7%
4.0
livestock & manure
6.5%
LAND
3.4
agricultural soils
5.2%
2.7
sewage
1.8%
0.9
landfills
1.6%
0.8
agricultural energy use
0.5%
0.4
aviation
1.5%
0.8
rail
0.5%
0.3
others
1.9%
1.0
road traffic
10.6%
5.5
TRANSPORT
YEARLY EMISSIONS (gigatonnes of CO₂e*)
51.8
Emissions from where they are used, not where they are produced.
Halving by 2030
gigatonnes reduced per year
increased solar energy -1.1
widespread wind energy -1.4
other renewables -0.7
better recyling of raw materials -3.2
less materials to make the same things (product materials efficiency) -1.0
disassembling old products to make new ones (circular business models) -1.1
waste reduction in production of steel, plastics and other industrial materials -1.9
reduced use of refrigeration gases (CFCs and HFCs) -1.6
low-carbon heating and cooling -2.1
low-carbon construction -0.9
retrofitting buildings with better insulation, energy efficient lighting, etc. -1.5
automation of temperature and lighting -0.4
electric vehicles -1.3
increased use of public transport -0.7
bikes, car-sharing, scooters -0.5
more efficient shipping of goods with reduced air transport -1.0
low-emission trucks -0.5
halting deforestation, planting trees -2.0
sustainable agriculture techniques -0.9
plant-based diets -1.7
reduced food waste -0.7
other measures -0.9
EMISSIONS REMAINING
24.3

Tutorial 2: Data Collection

- Collect yourself
- Gather from the internet
- Obtain from agency..

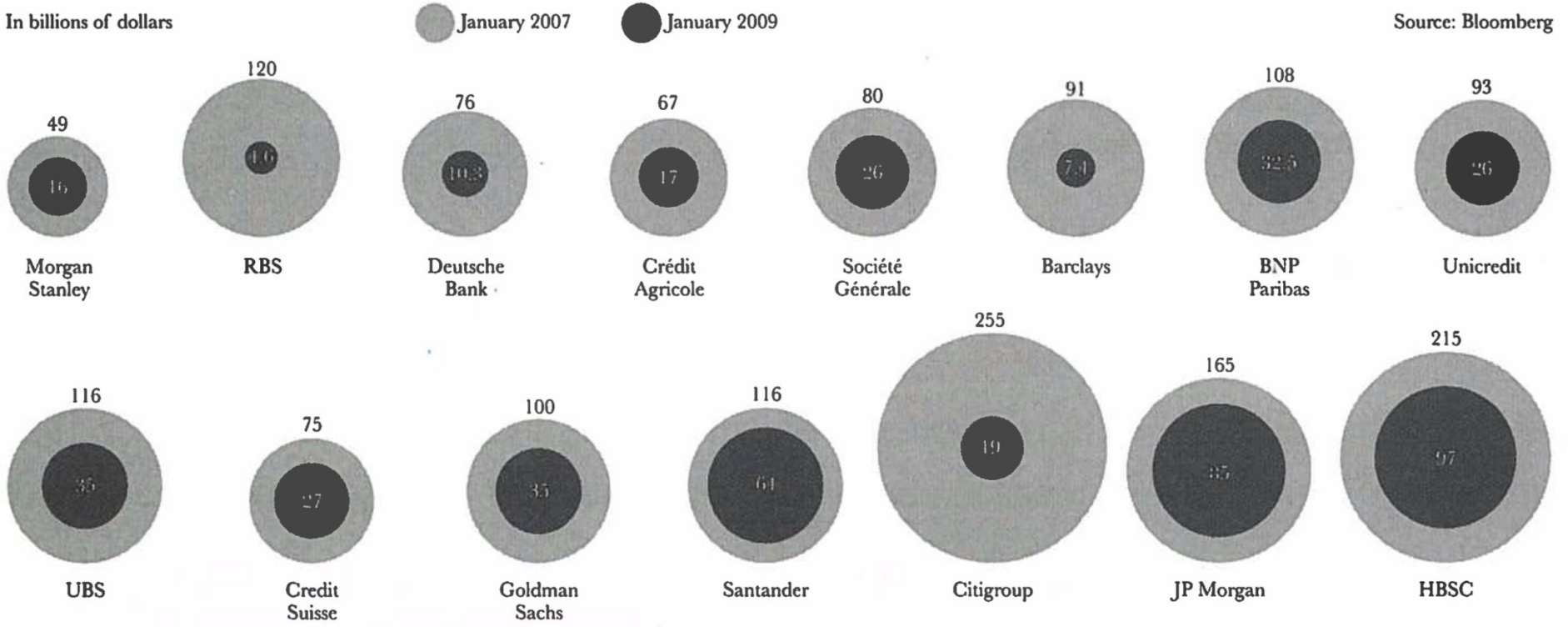
- Waste / weather / climate
- Deforestation
- News events
- Personal usage
- Positive action

What makes a **good** visualization?

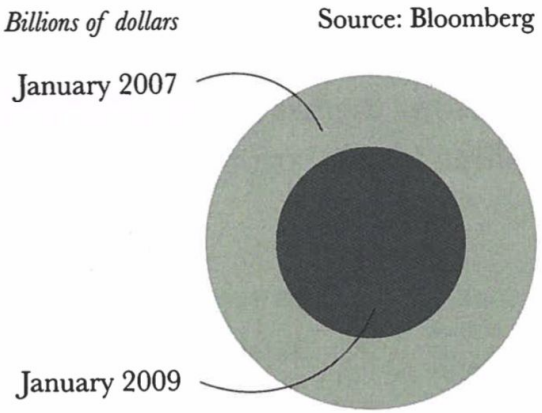
17 32

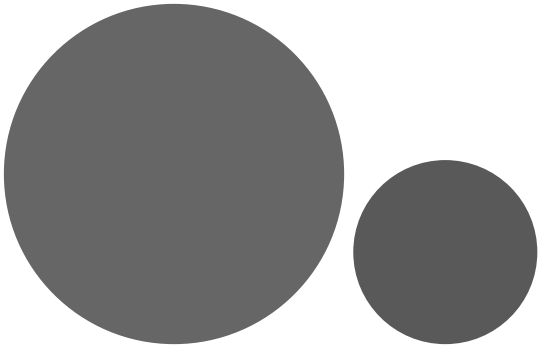
Visualization **Guidelines**

Market Capitalization of the World's Biggest Banks



How to decode bubbles?



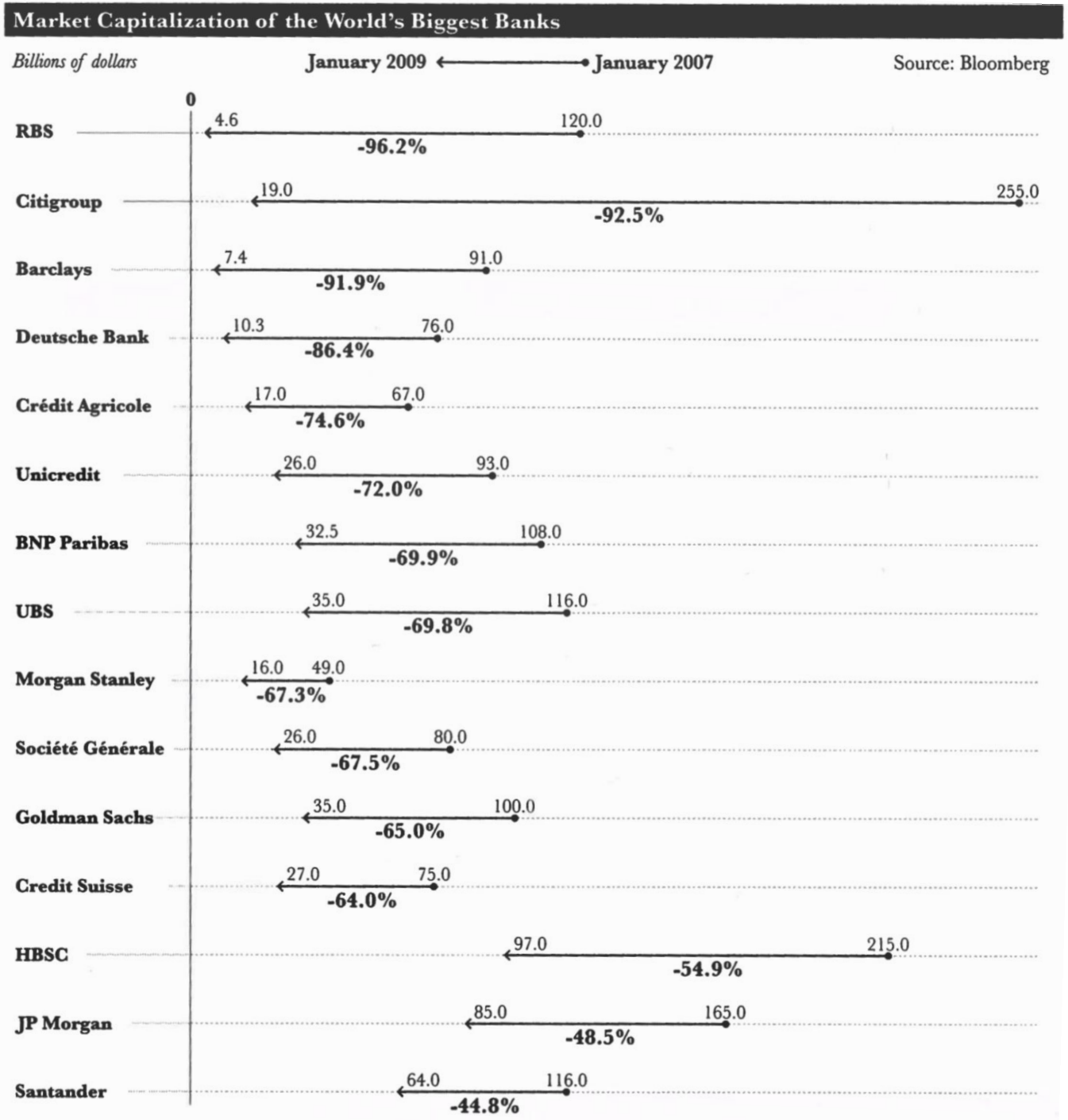


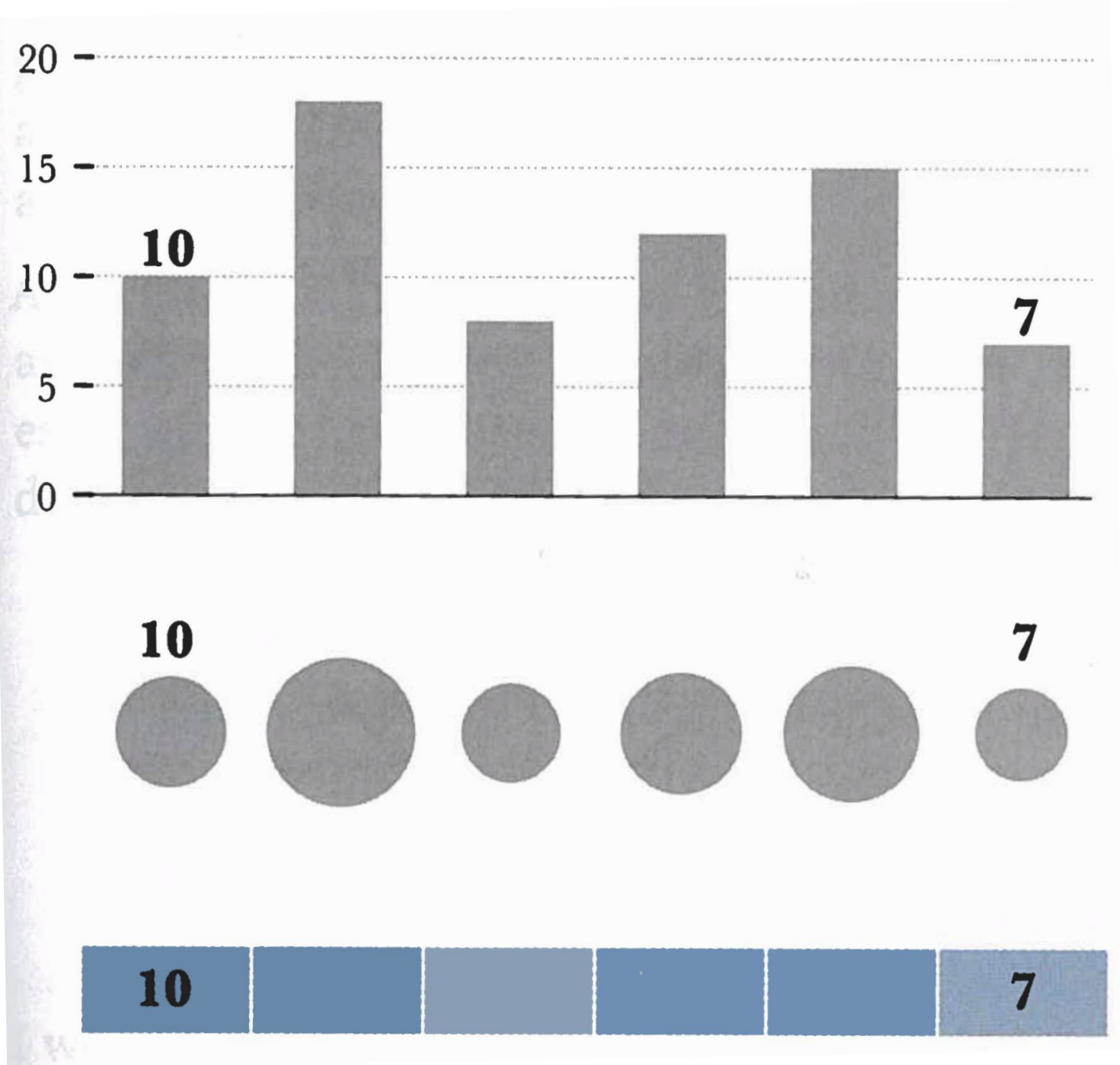
a)

b)

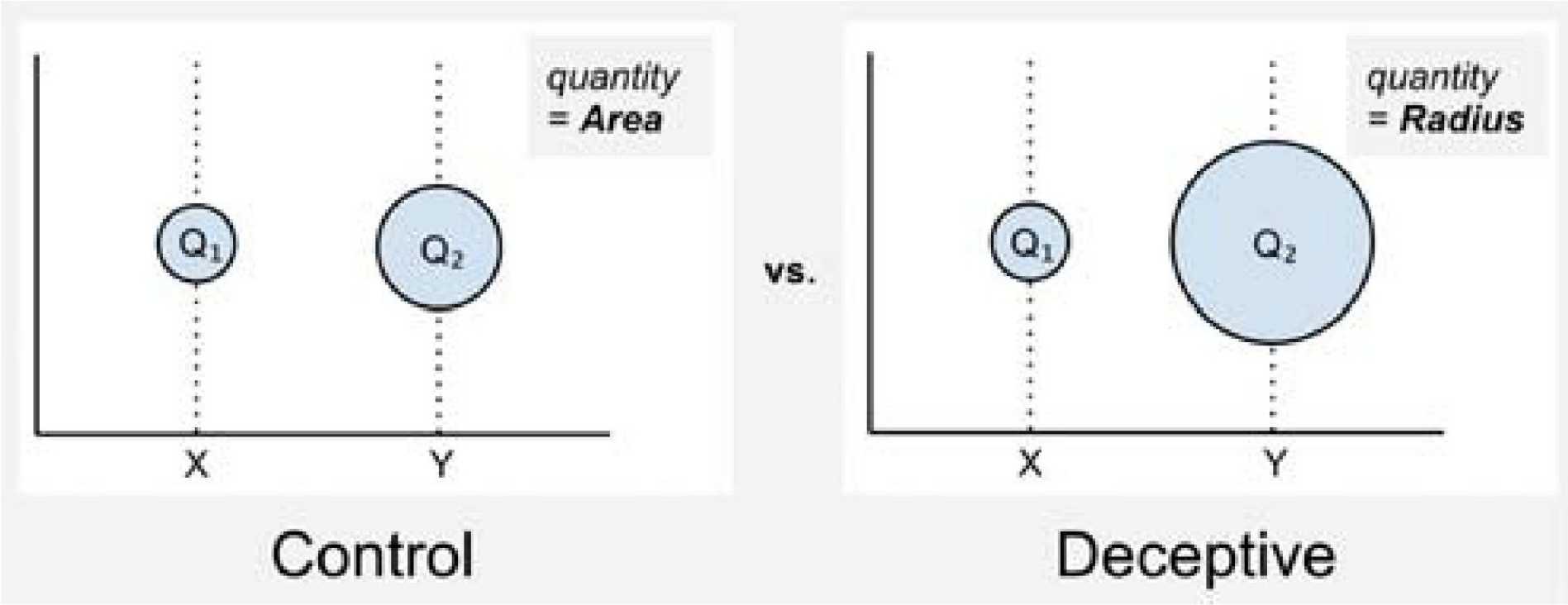
c)

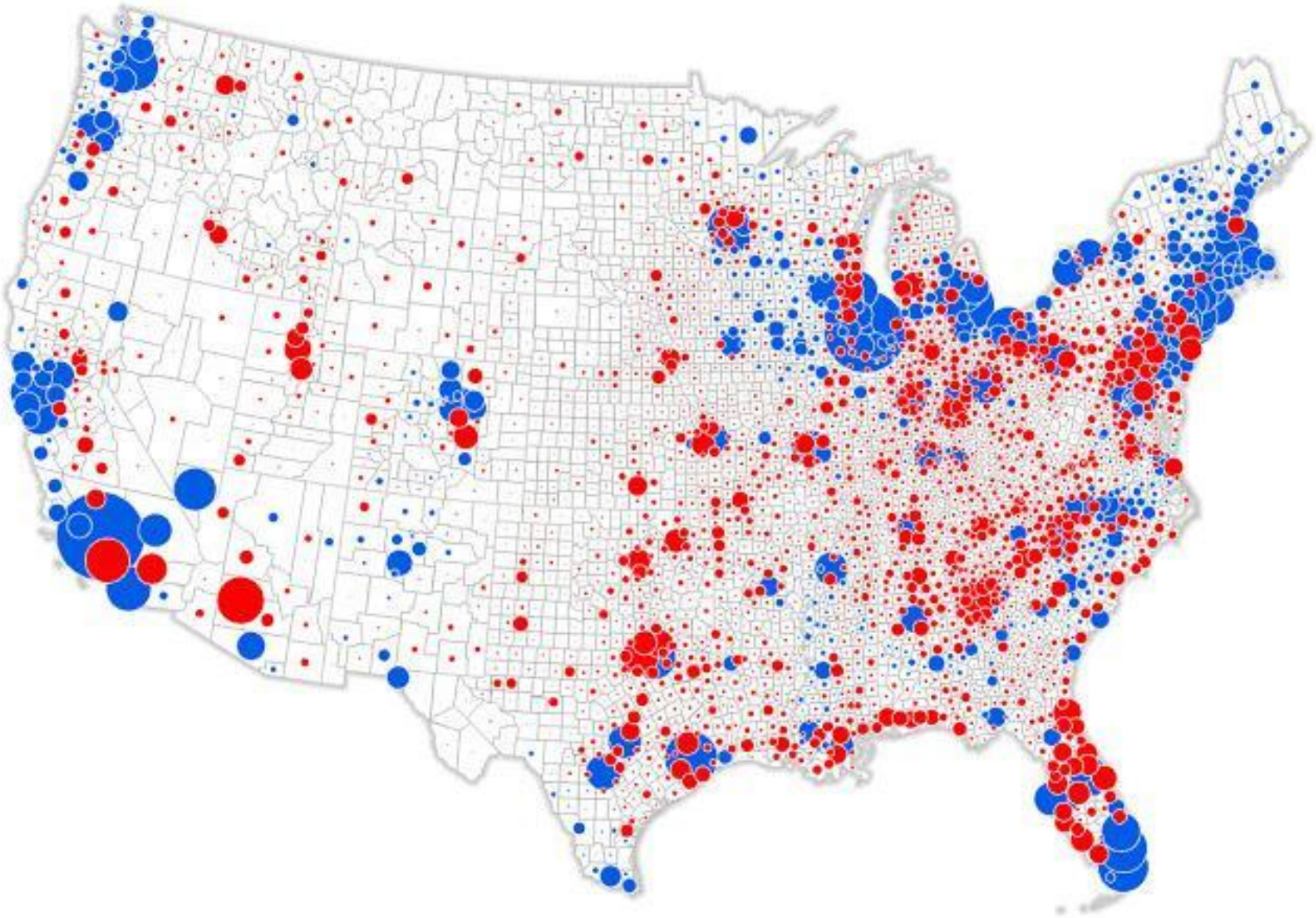
Market Capitalization of the World's Biggest Banks




20
15
10
5
0
10
7
10
7
10
7

Wrong sizes


quantity
= Area
Q1
Q2
X
Y
vs.
quantity
= Radius
Q1
Q2
X
Y
Control
Deceptive

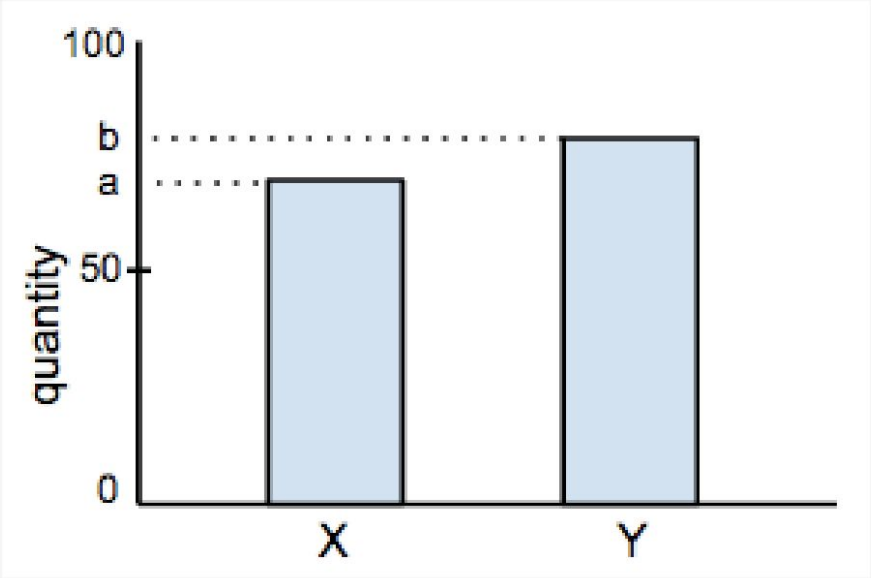


Guideline #1

"Don't use area size to compare quantities."

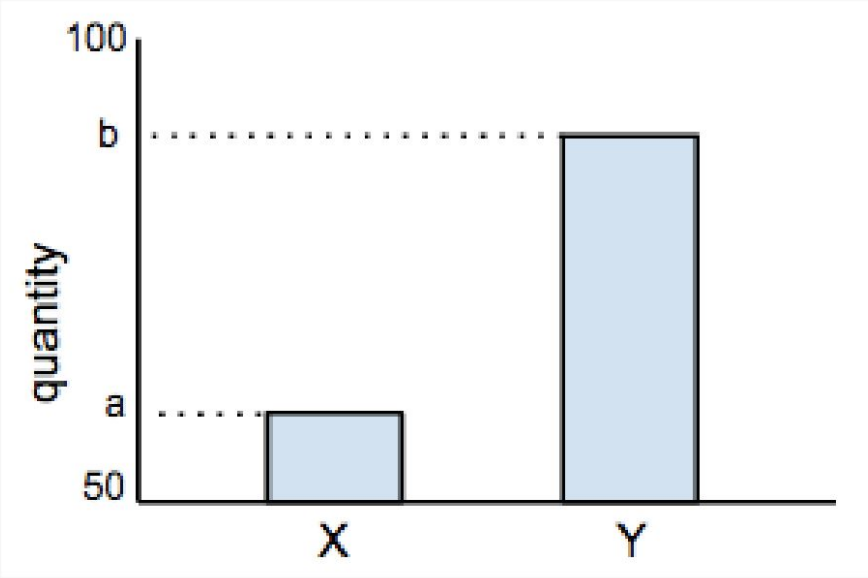
Exception: *It can work on maps.*

Truncated Axes



Control

vs.



Deceptive

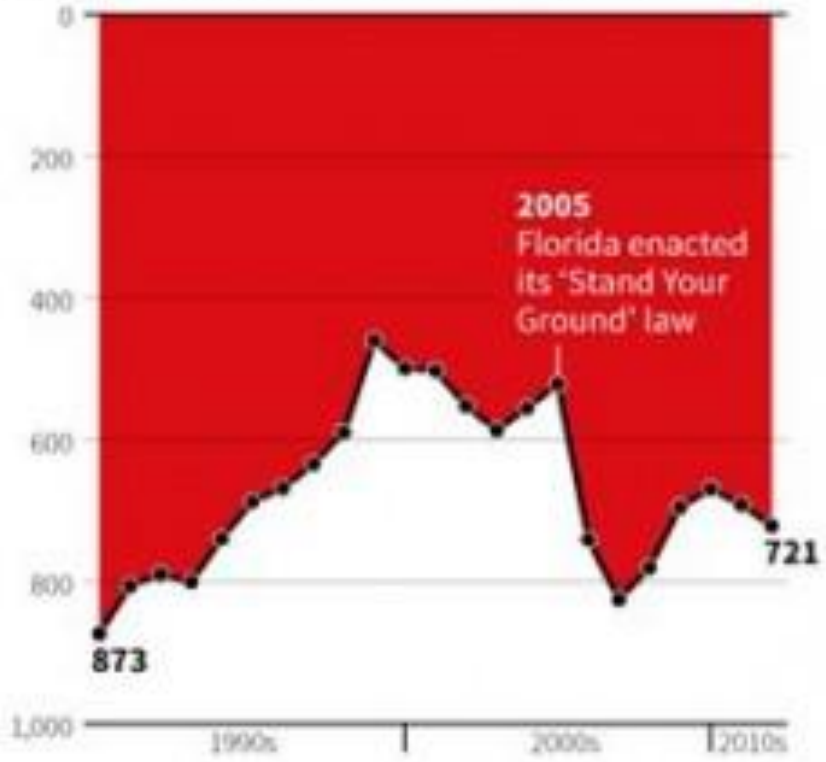
Guideline #2

"Don't truncate chart axes."

Exception: *Except you tell the reader.*

Gun deaths in Florida

Number of murders committed using firearms



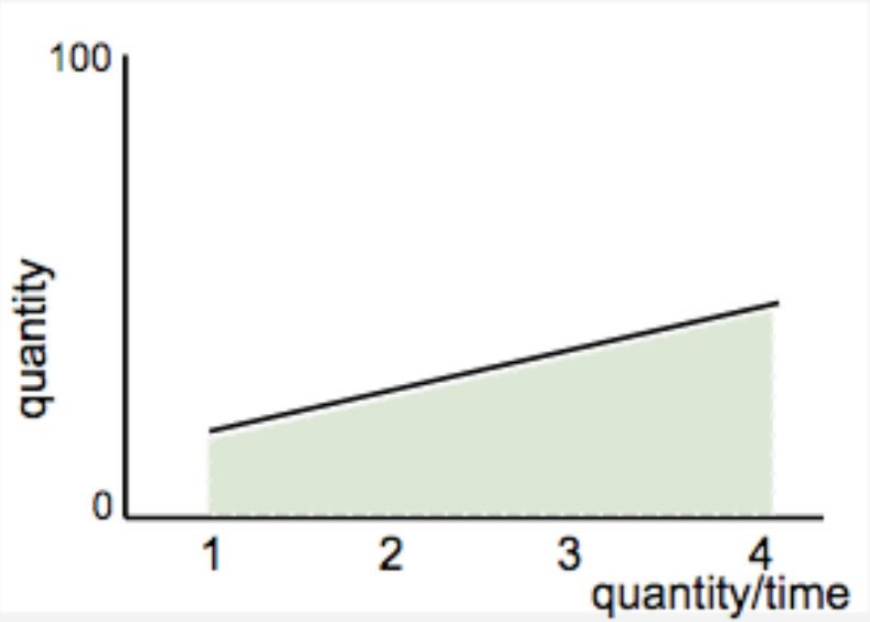
Source: Florida Department of Law Enforcement

C. Chan 16/02/2014

REUTERS

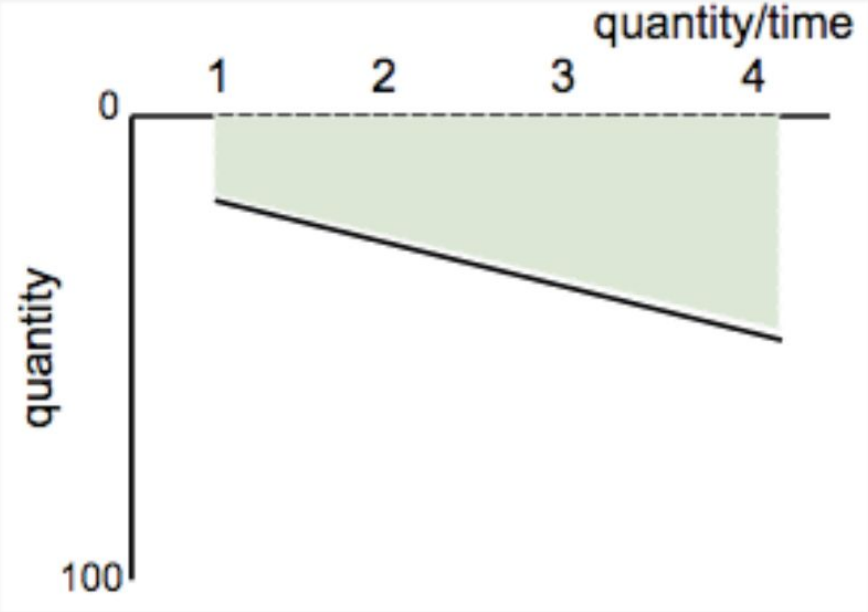
10,000,000
0
-10,000,000
-20,000,000
-30,000,000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

Inverse charts



Control

vs.



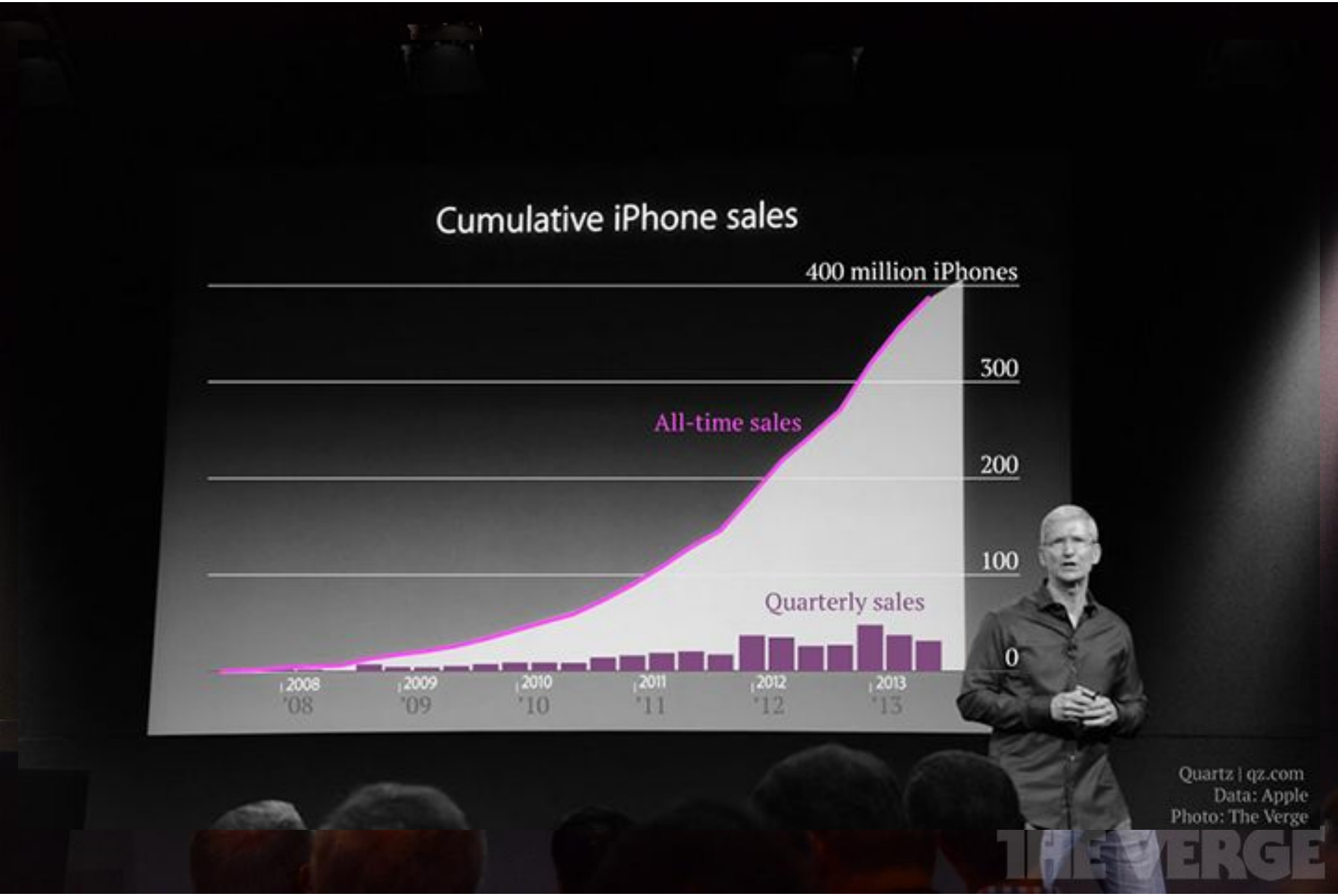
Deceptive

Guideline #3

"Don't inverse charts—it is deceiving."

Exception: *Except you tell the reader and it serves your purpose.*

Cumulative iPhone sales
2008
2009
2010
2011
2012
2013
THE VERGE


Cumulative iPhone sales
400 million iPhones
300
200
100
0
All-time sales
Quarterly sales
2008
'08
2009
'09
2010
'10
2011
'11
2012
'12
2013
'13
Quartz | qz.com
Data: Apple
Photo: The Verge
THE VERGE

Guideline #4

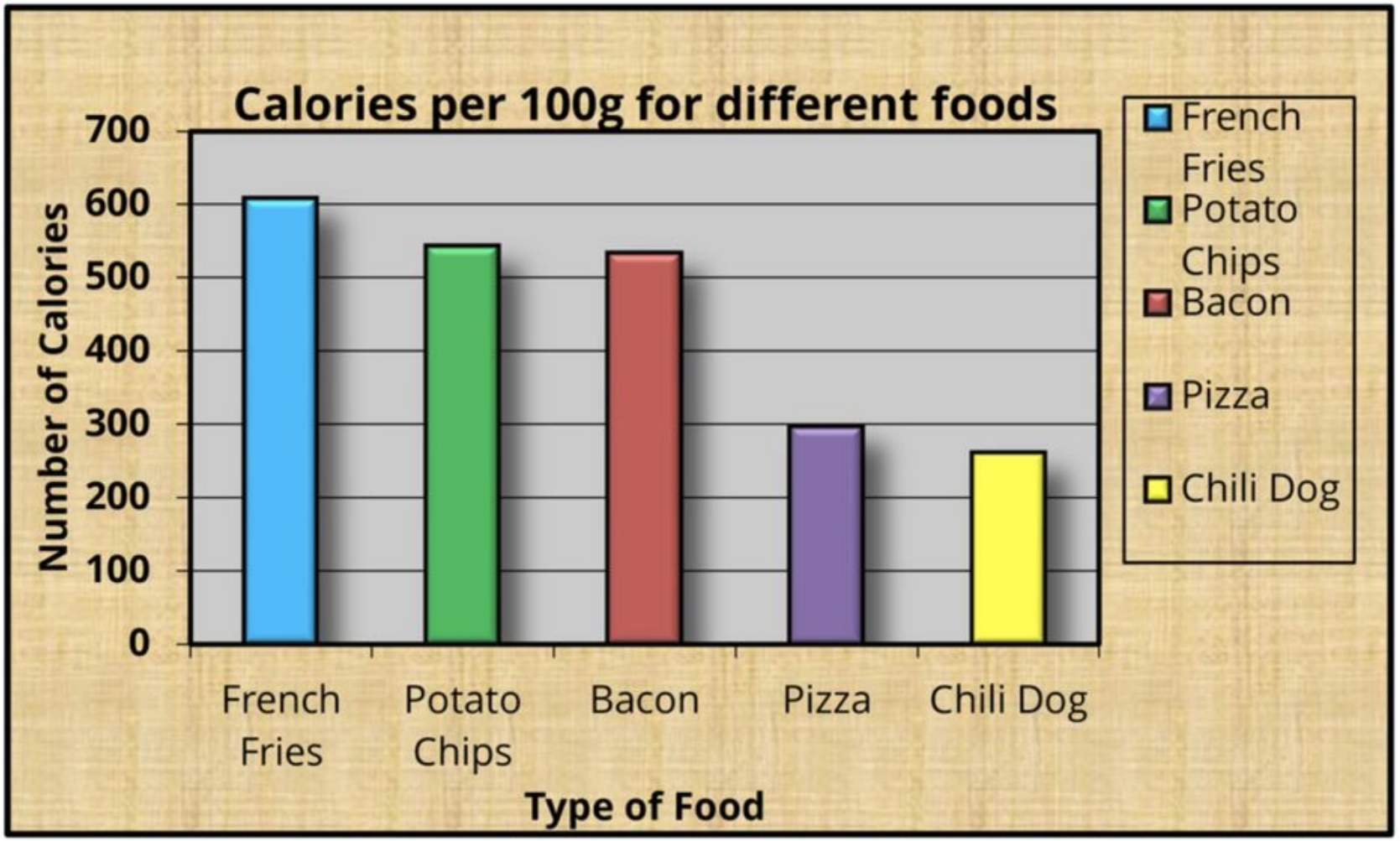
"Be true about your intention."

Exception: none

Common flaws (from 8 graphics only..)

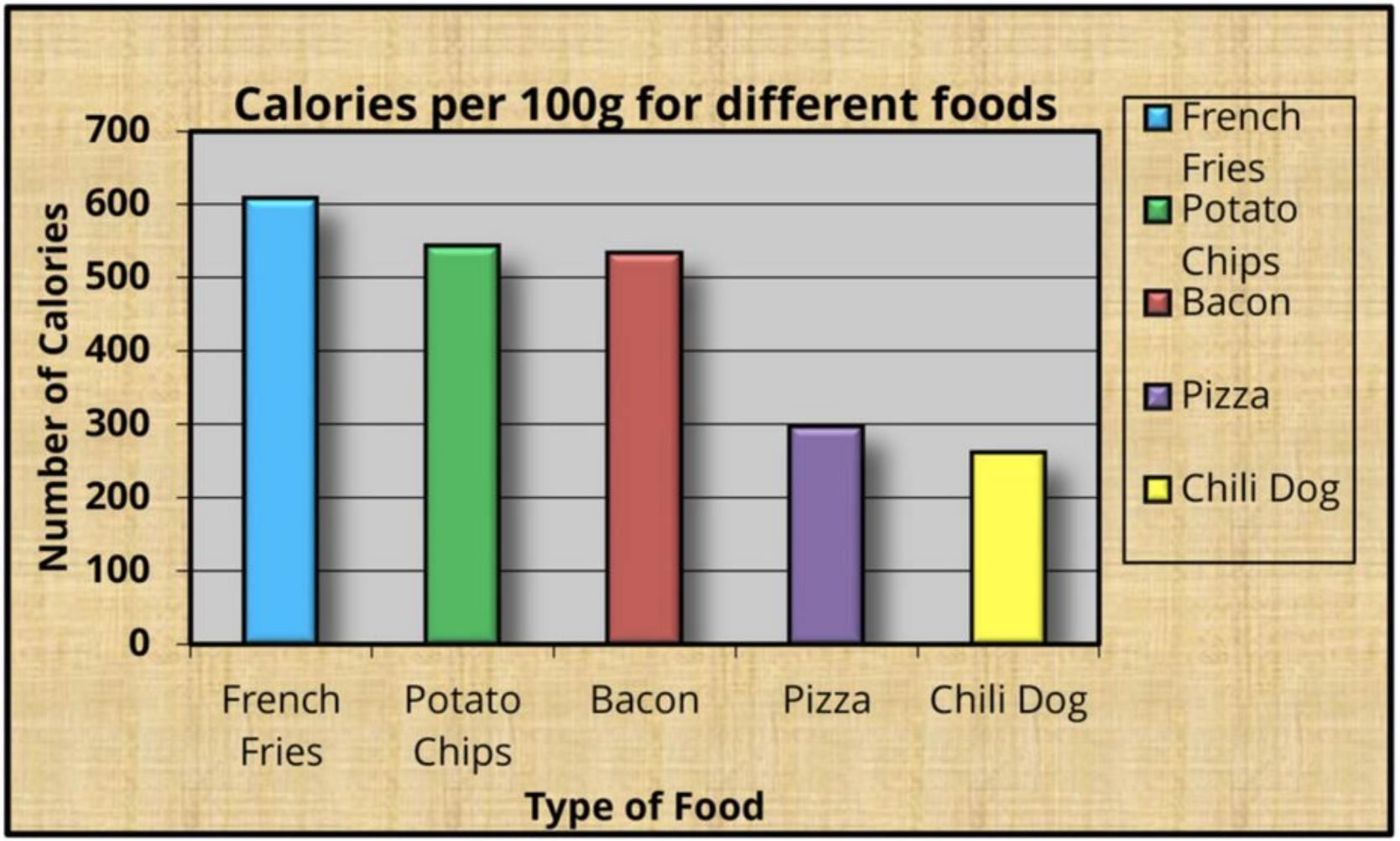
1. Missing **scales**
2. **3D** distortion
3. **3D** occlusion
4. Missing **color** contrast
5. **Colors** are too similar
6. Not B/W safe
7. overuse of **texture**
8. **Volume** as visual variable
9. Un-proportional **mappings**
10. Truncated **axes**
11. Missing **titles**
12. Missing axis **labels**
13. Unnecessary shapes/**ink**
14. Incomplete **data**

1. Wrong **legends**
2. Bad visual **mappings**
3. **Uncommon** / unknown design choices
4. Too much **clutter**
5. **Misplaced** data points
6. Long lines, which are hard to follow
7. Missing **legends**
8. **Too much** information in one graphic
9. **Missing** descriptions
10. **Overlapping** graphical elements
11. **Too many** charts in one

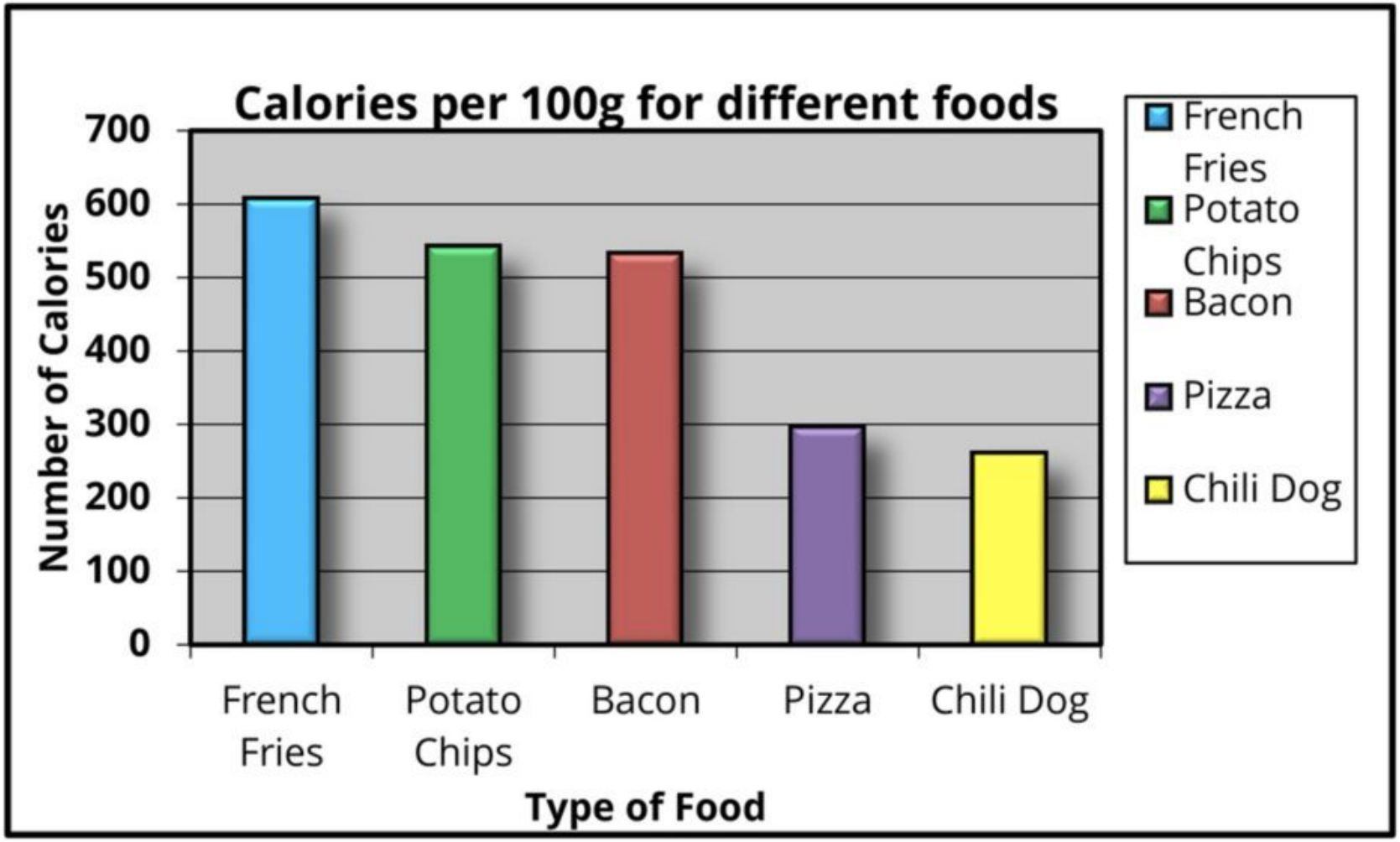

Calories per 100g for different foods
Number of Calories
700
600
500
400
300
200
100
0
French Fries
Potato Chips
Bacon
Pizza
Chili Dog
Type of Food
French Fries
Potato Chips
Bacon
Pizza
Chili Dog

$$\text{Data-Ink Ratio} = \frac{\text{Data-Ink}}{\text{Total Ink used to represent the graphic}}$$

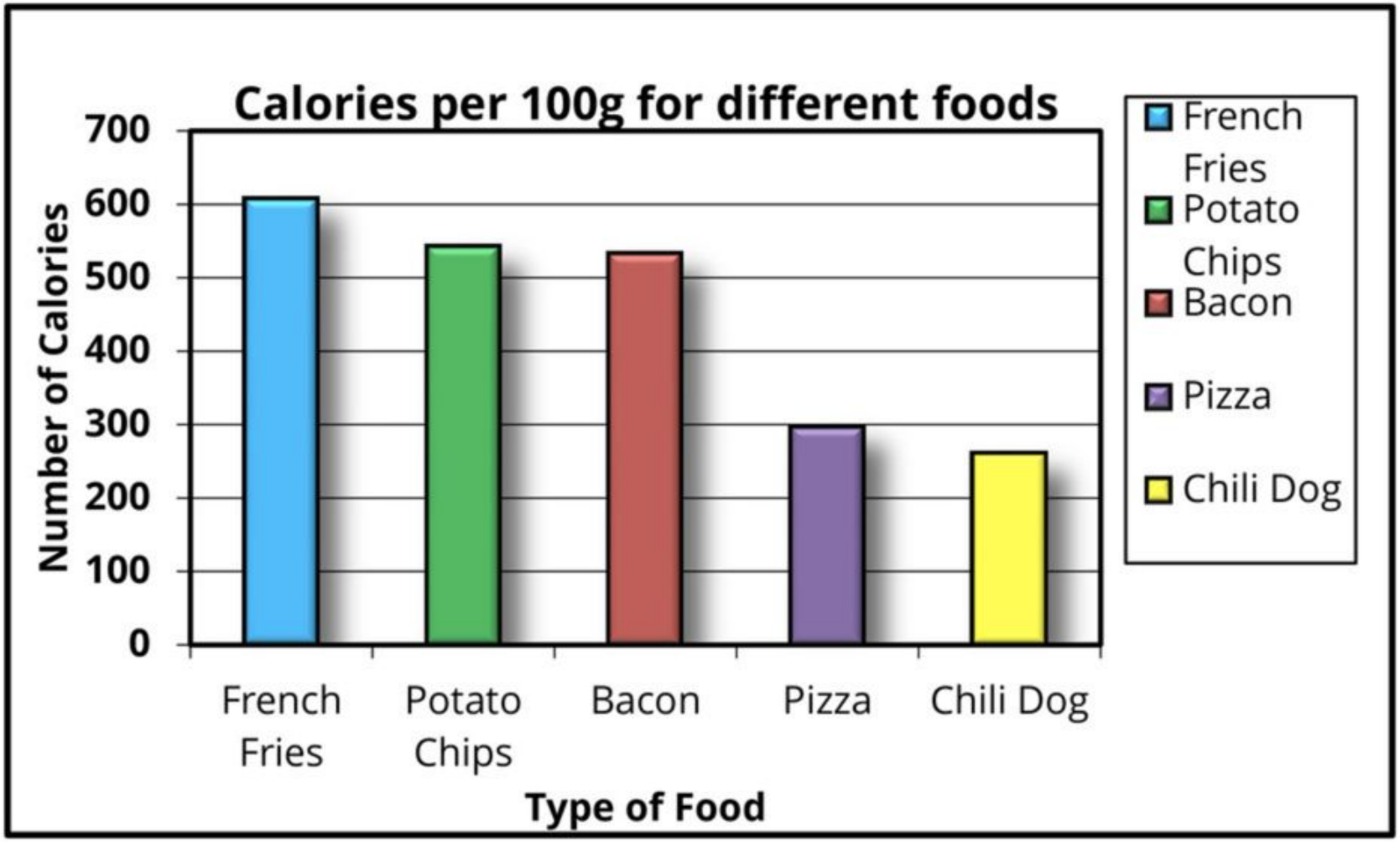
Remove backgrounds



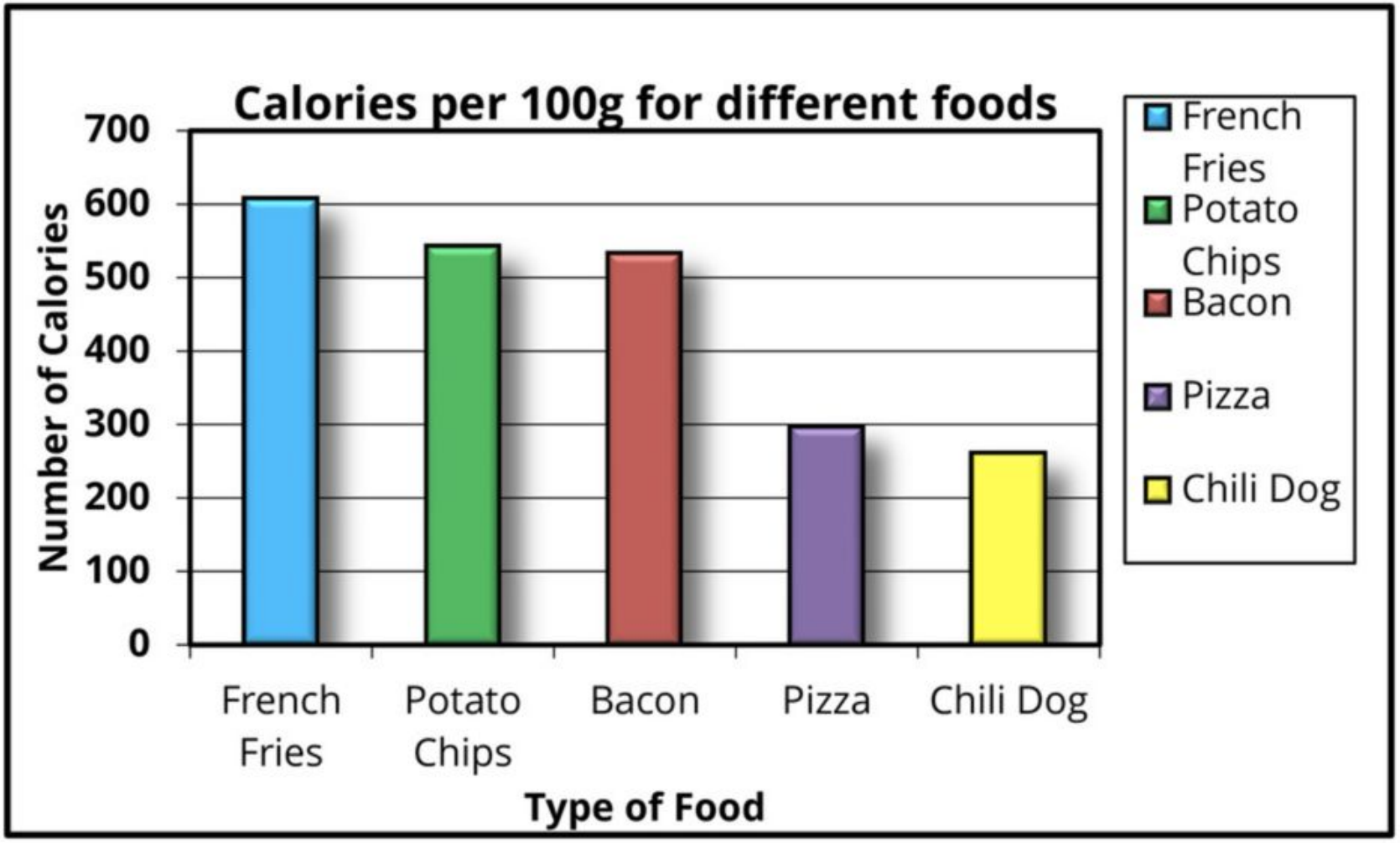
Remove backgrounds



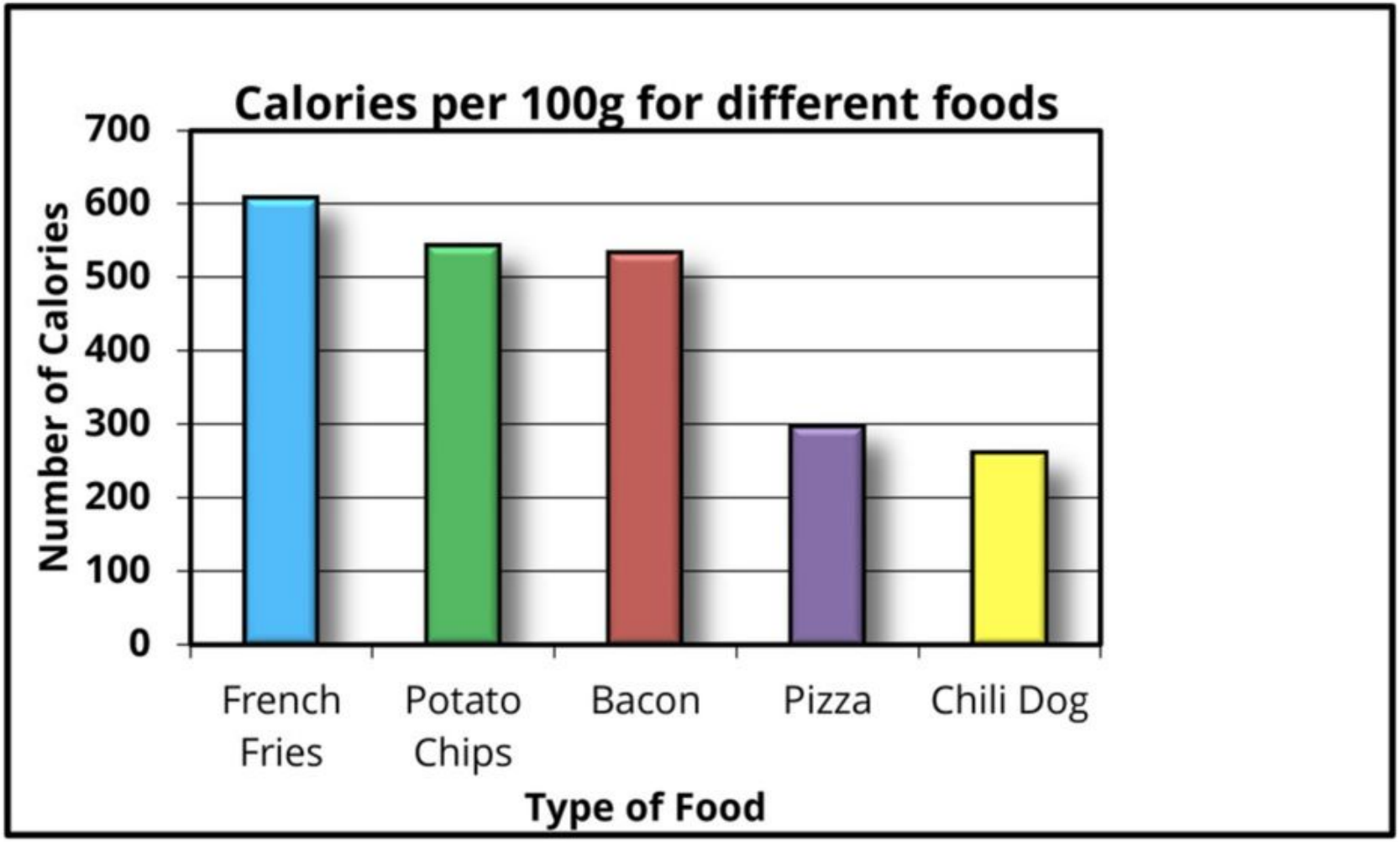
Remove backgrounds



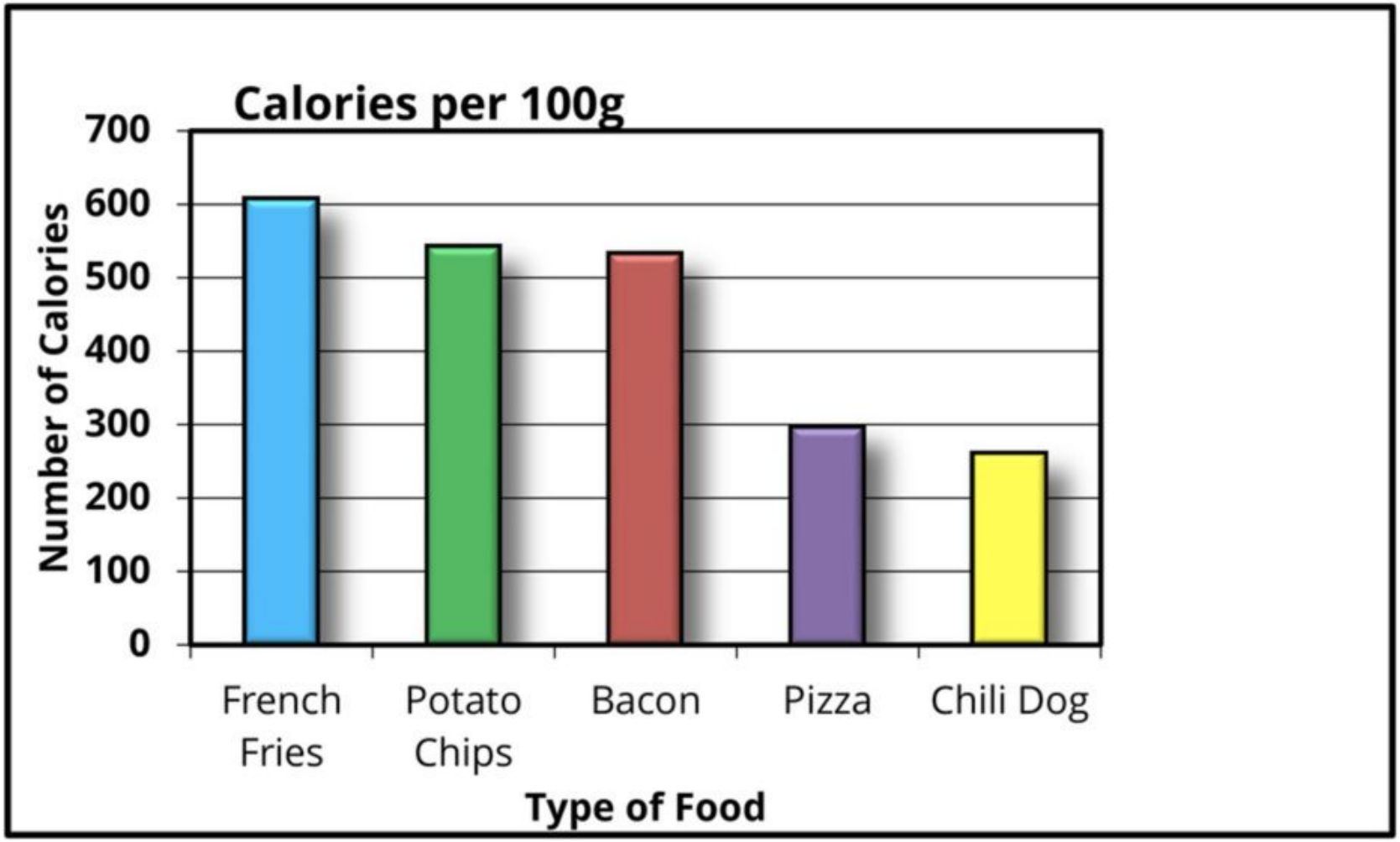
Remove redundant labels



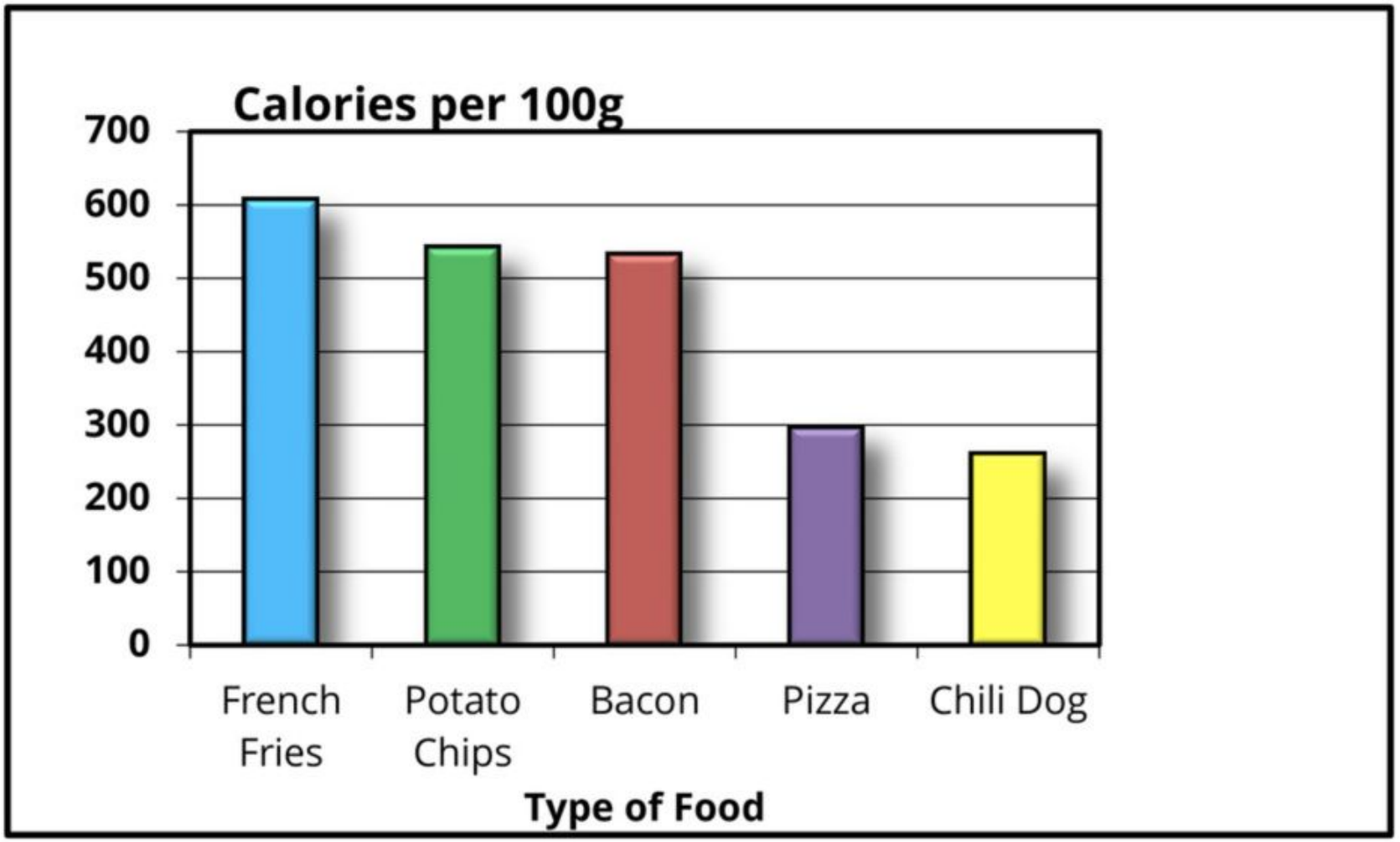
Remove redundant labels



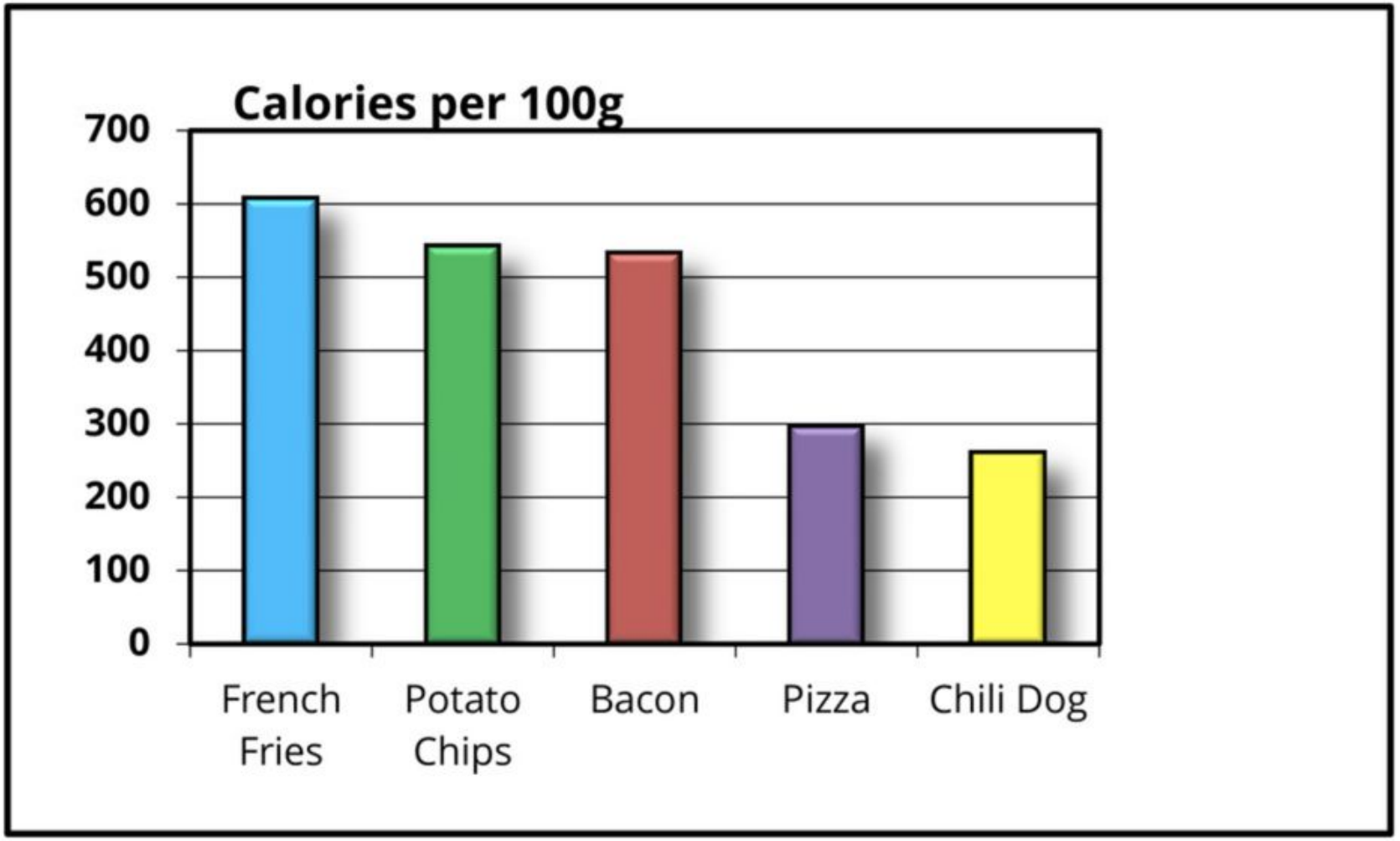
Remove redundant labels



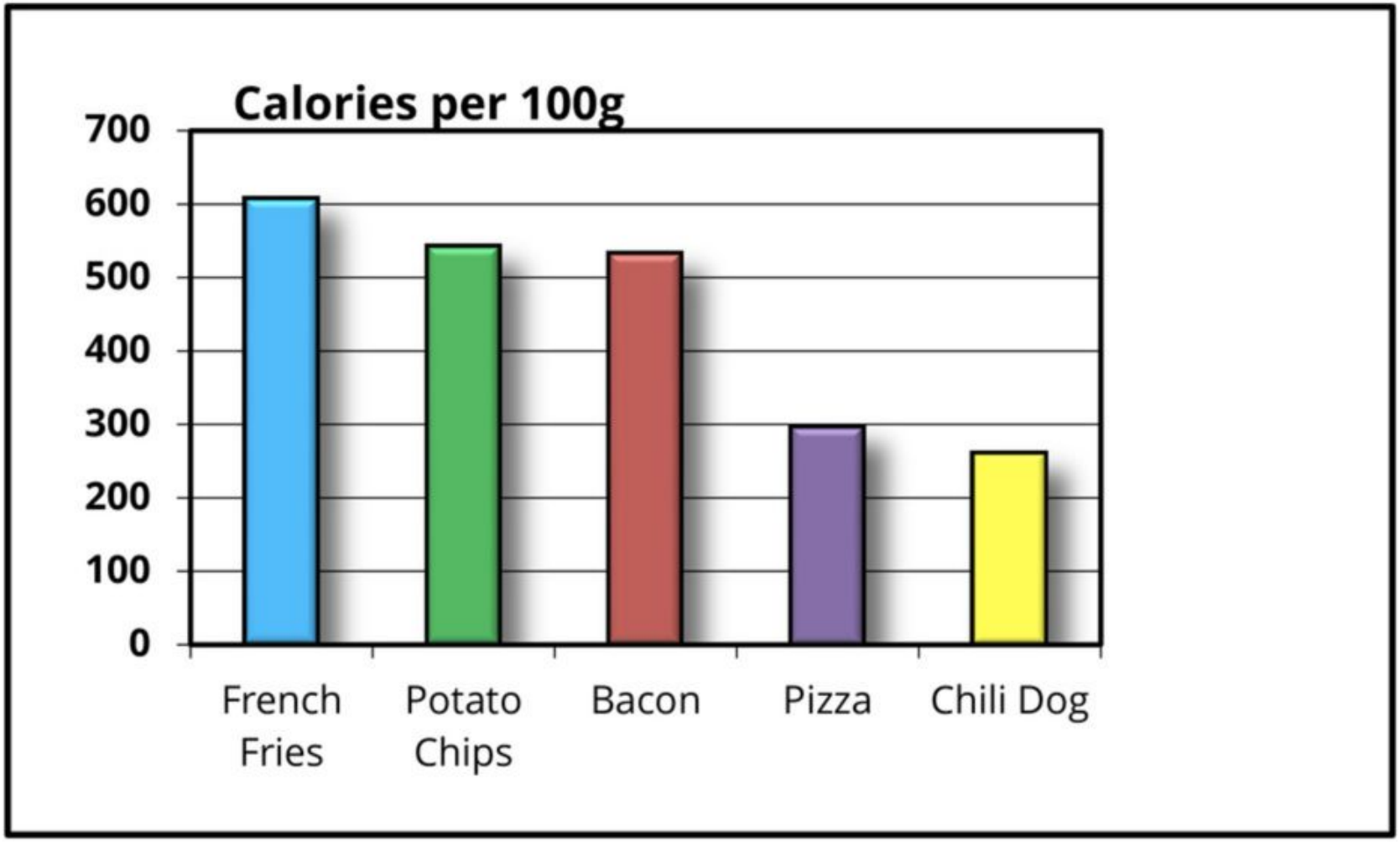
Remove redundant labels



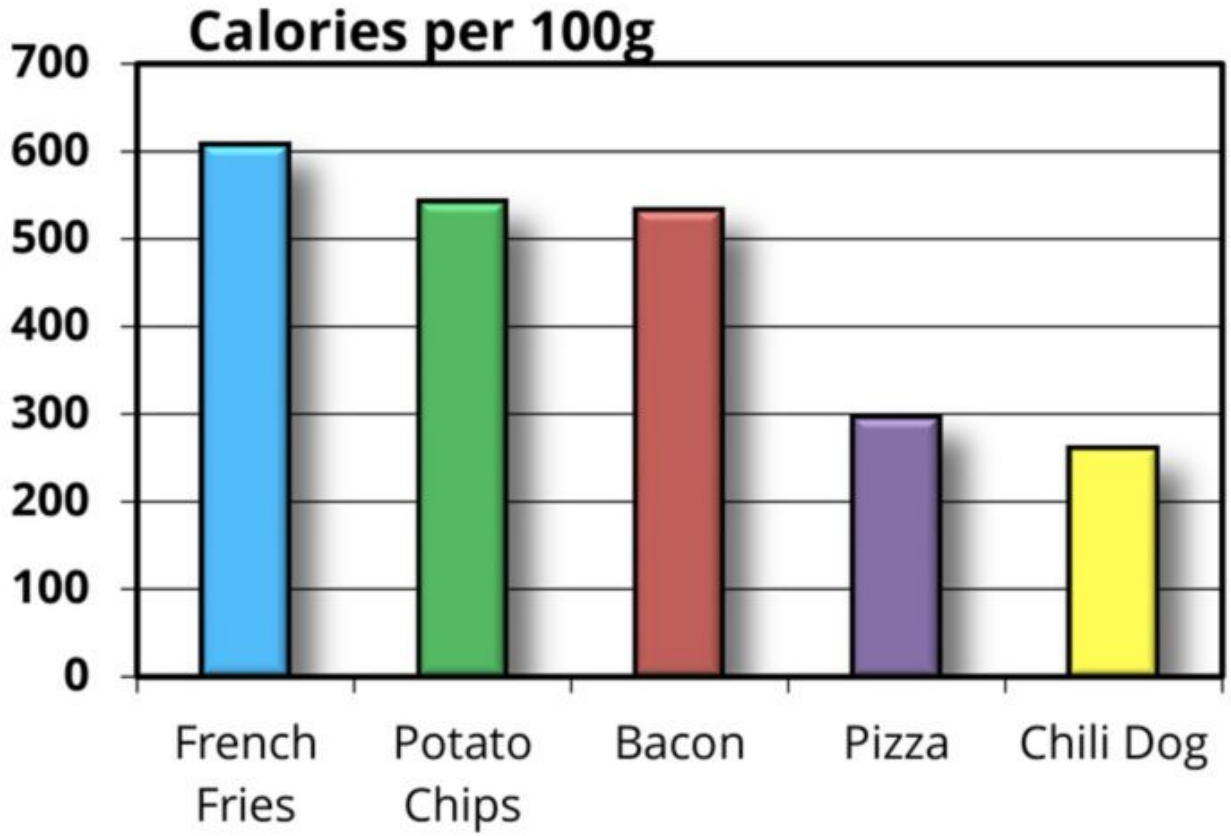
Remove redundant labels



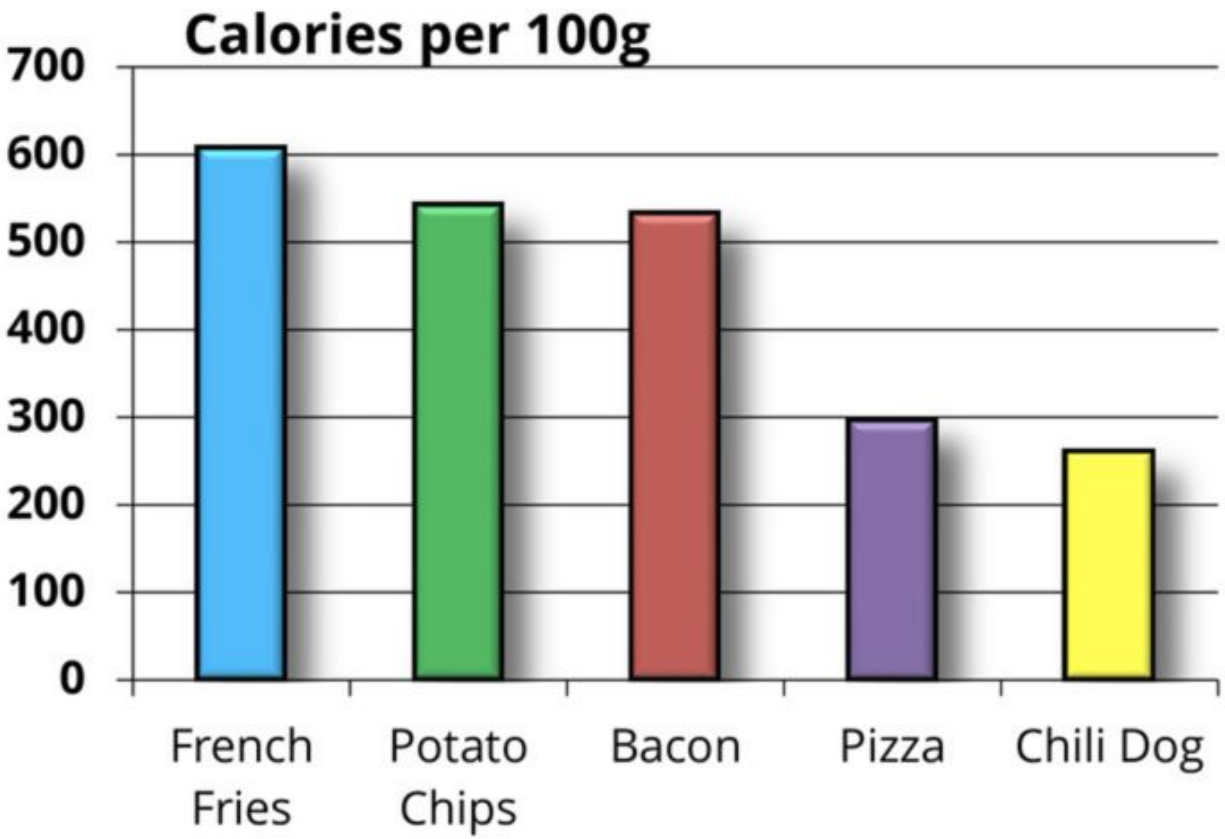
Remove borders



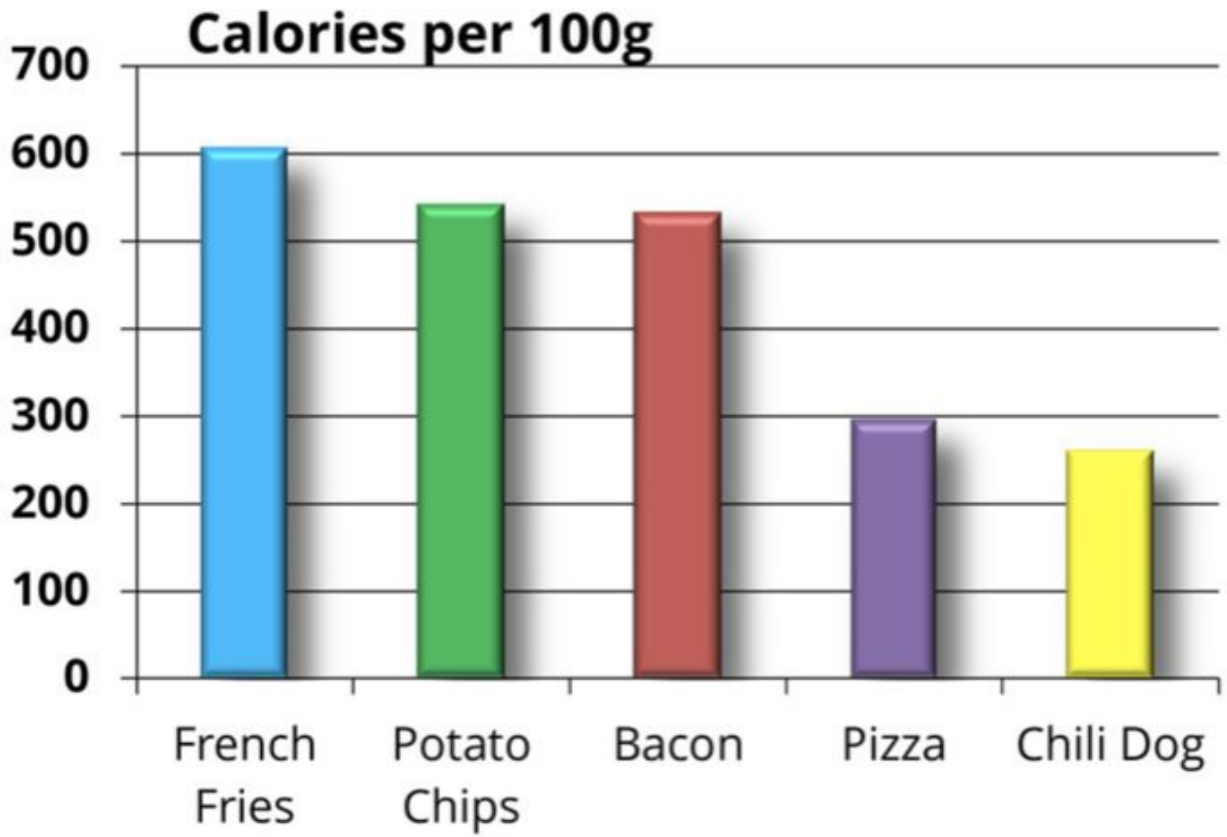
Remove borders



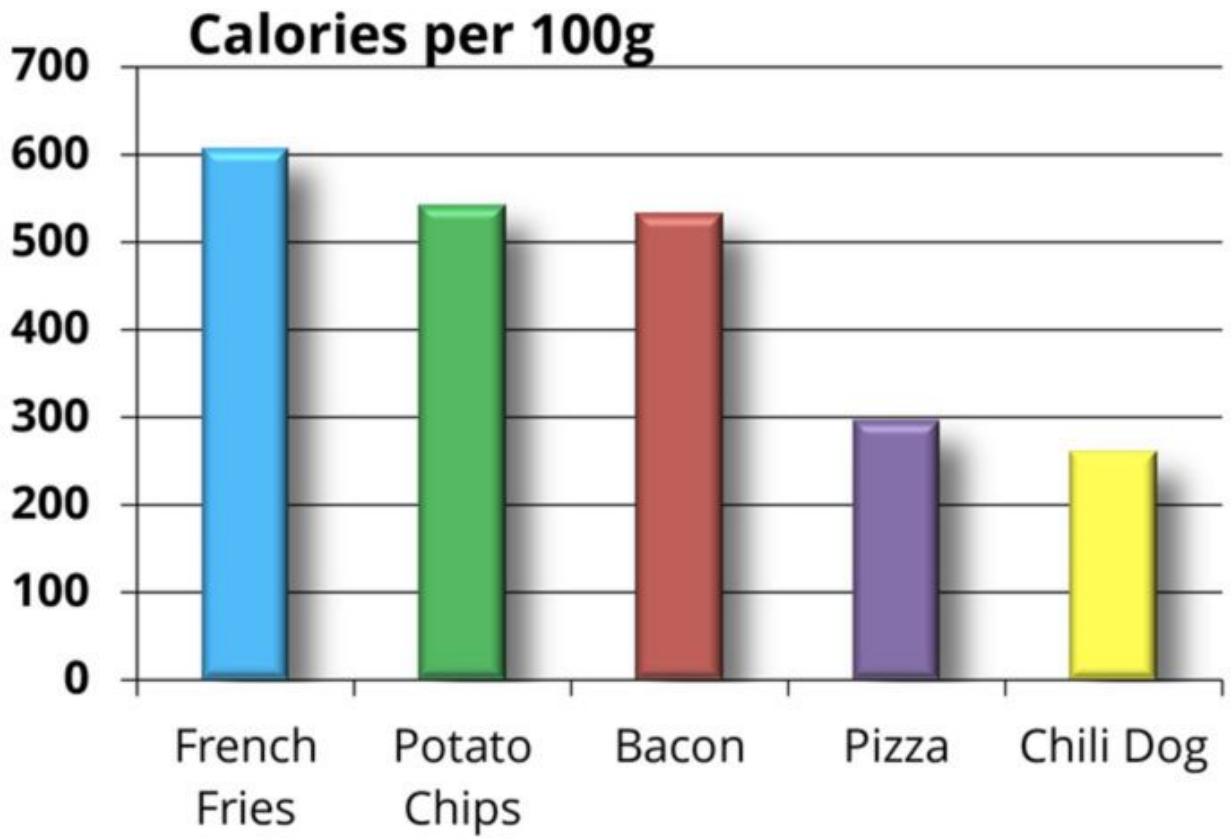
Remove borders



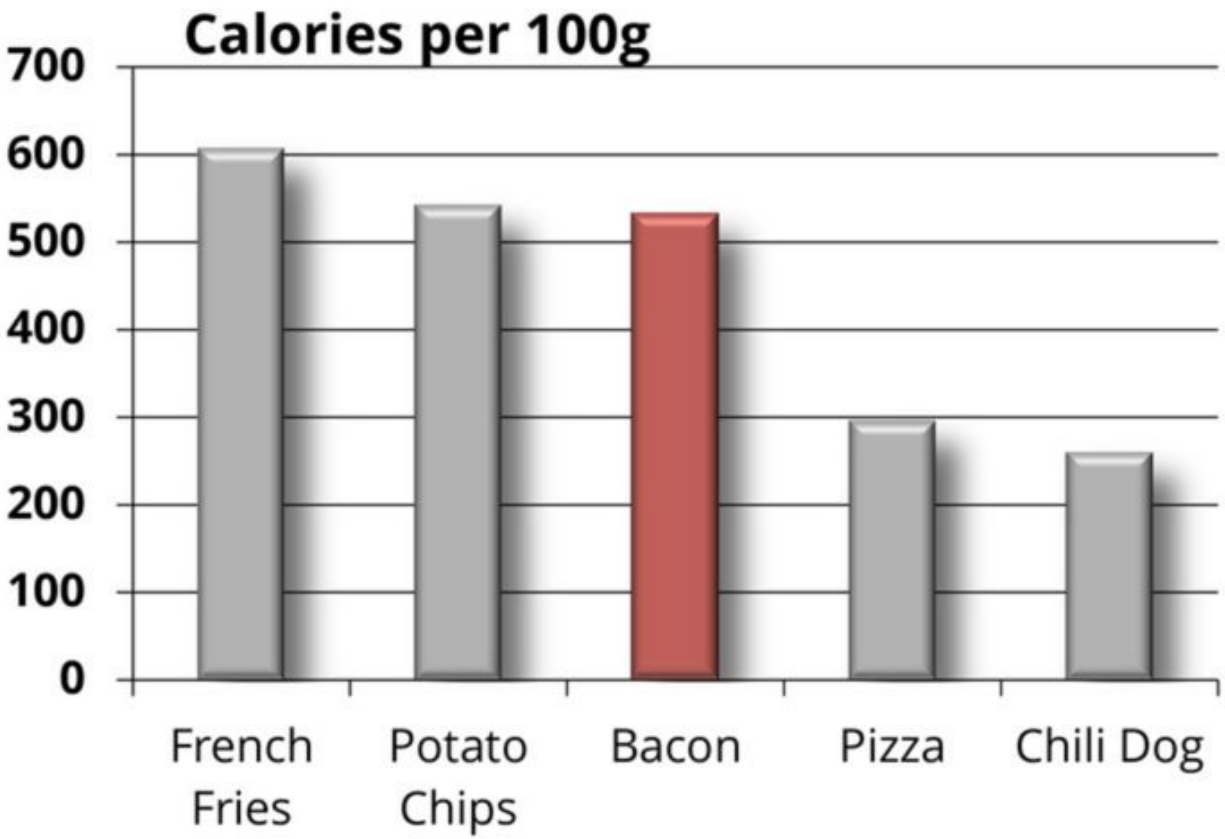
Remove borders



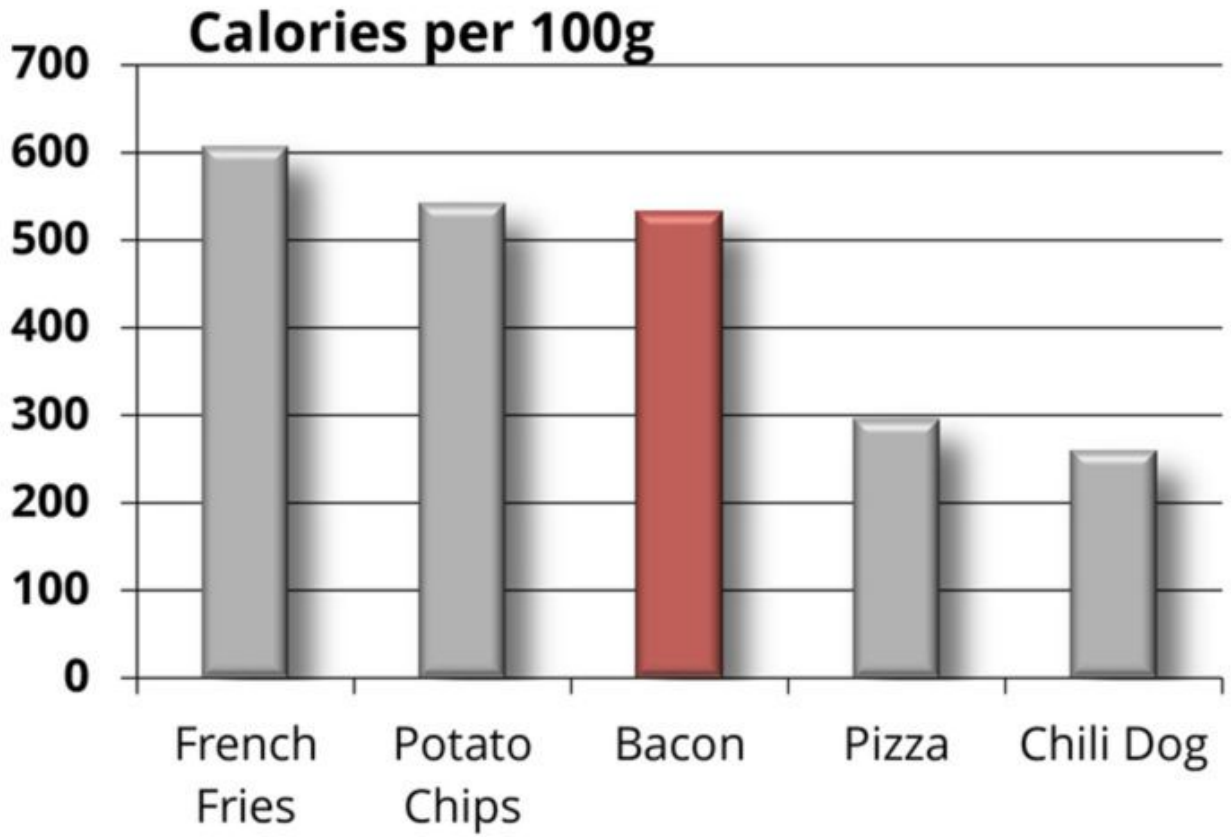
Reduce colors



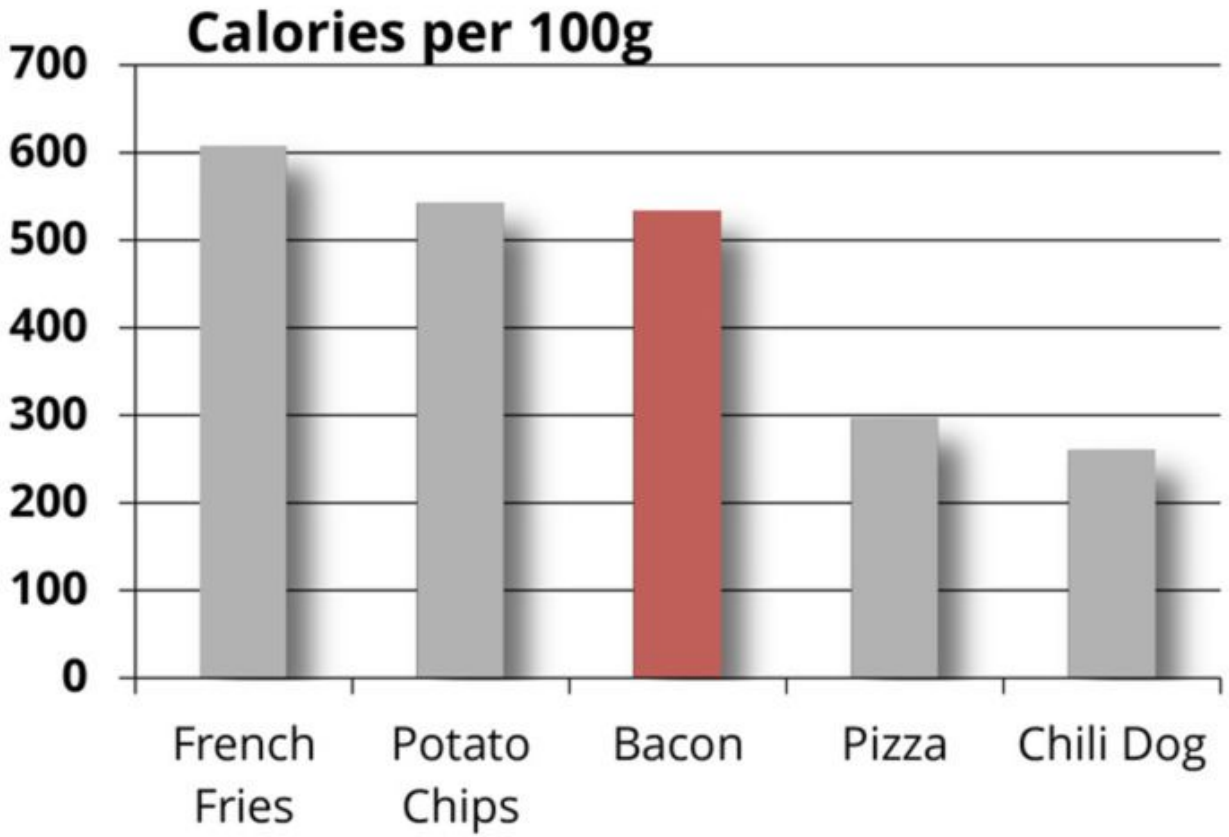
Reduce colors



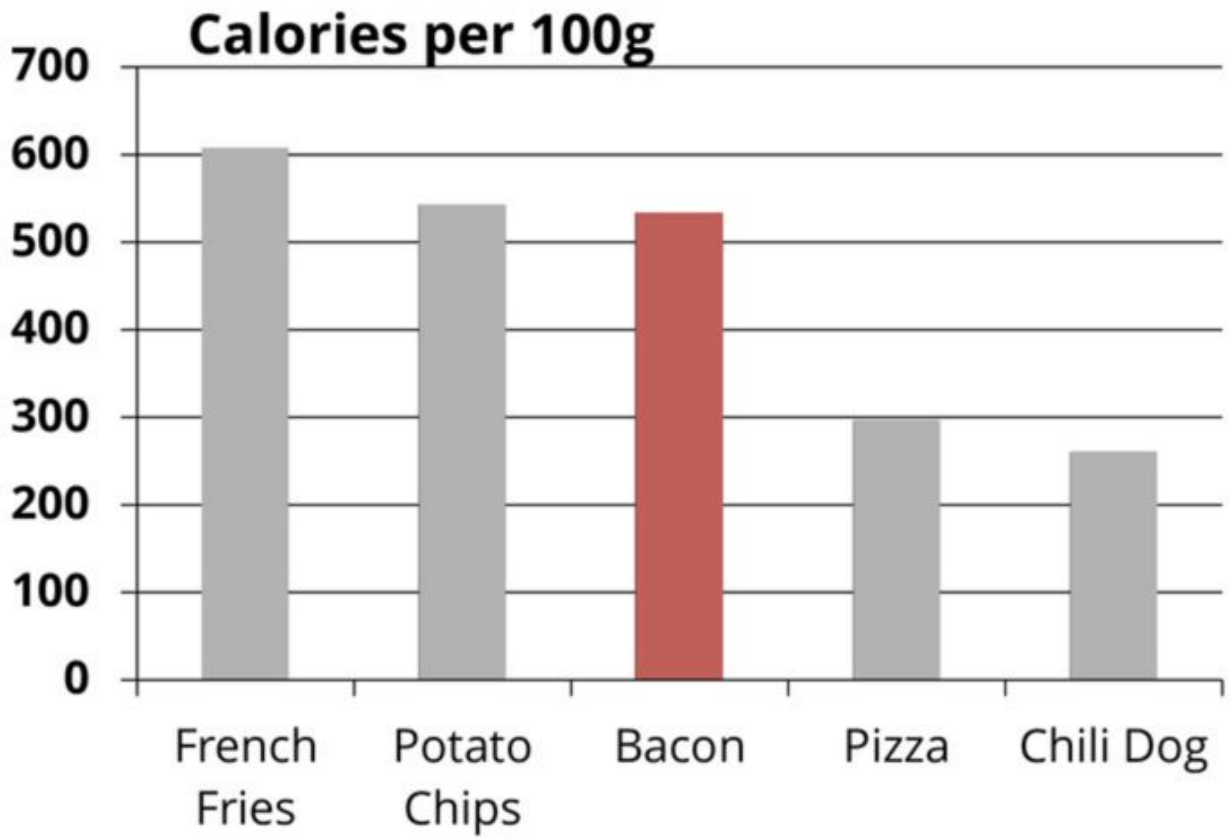
Remove special effects



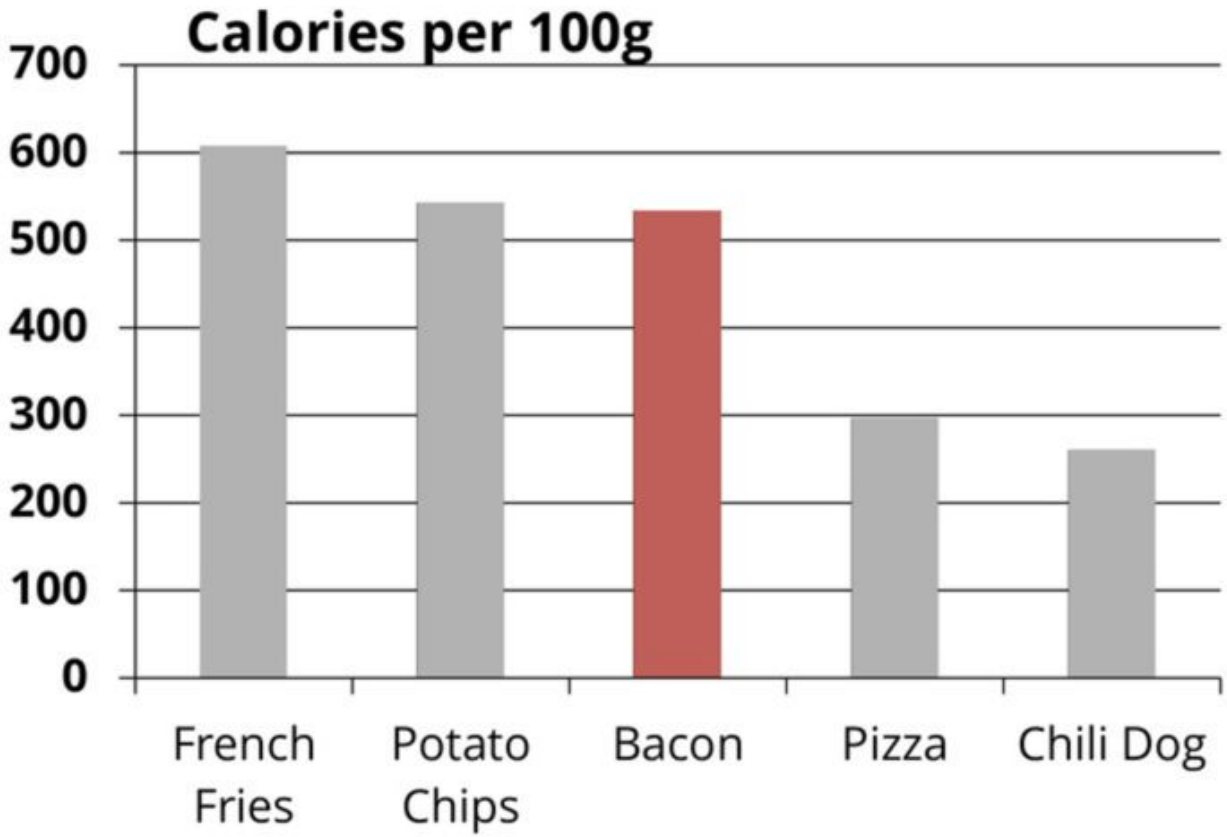
Remove special effects



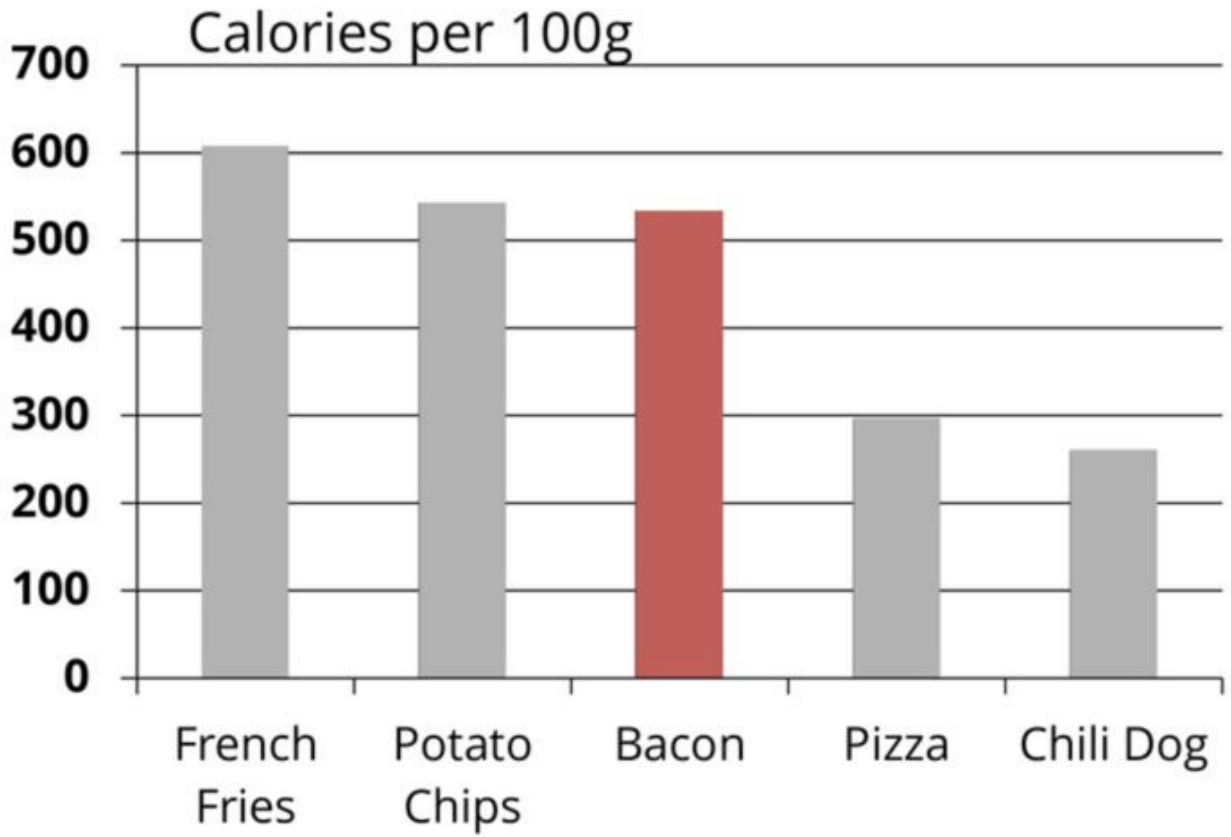
Remove special effects



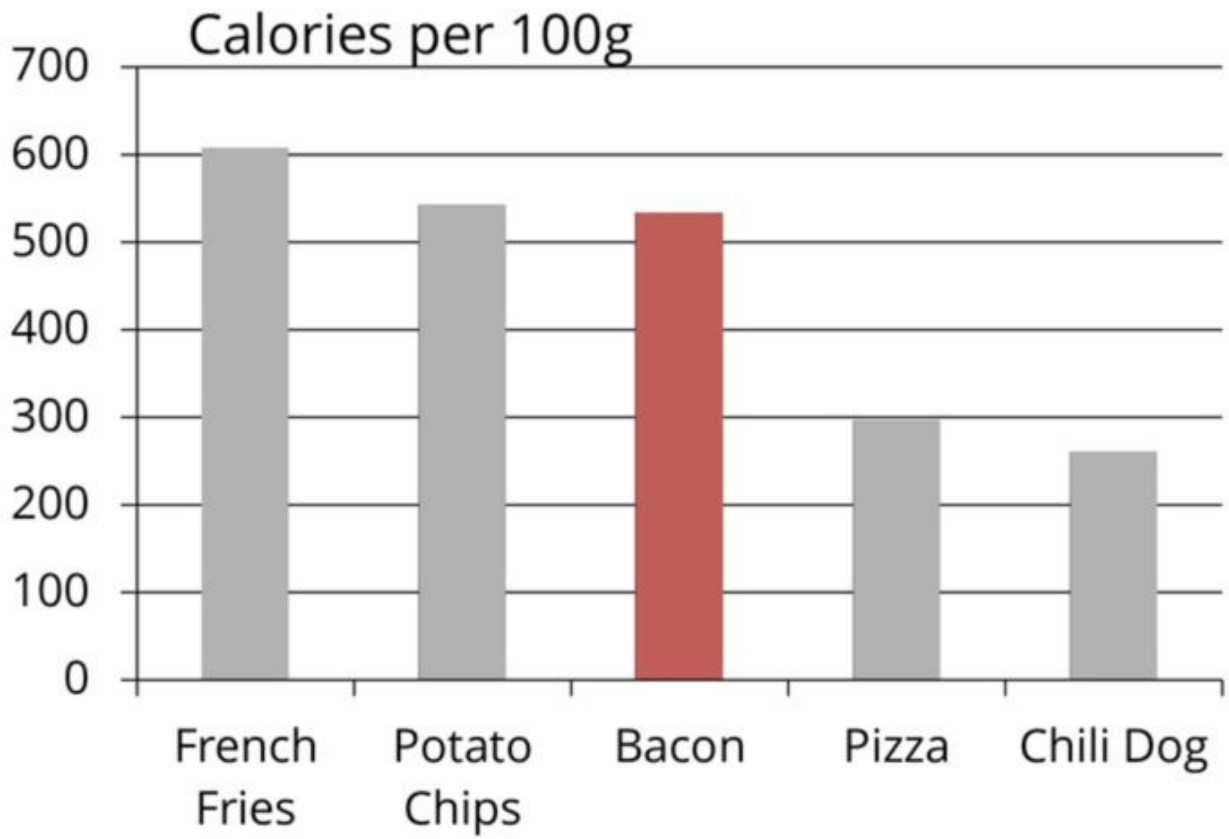
Remove bolding



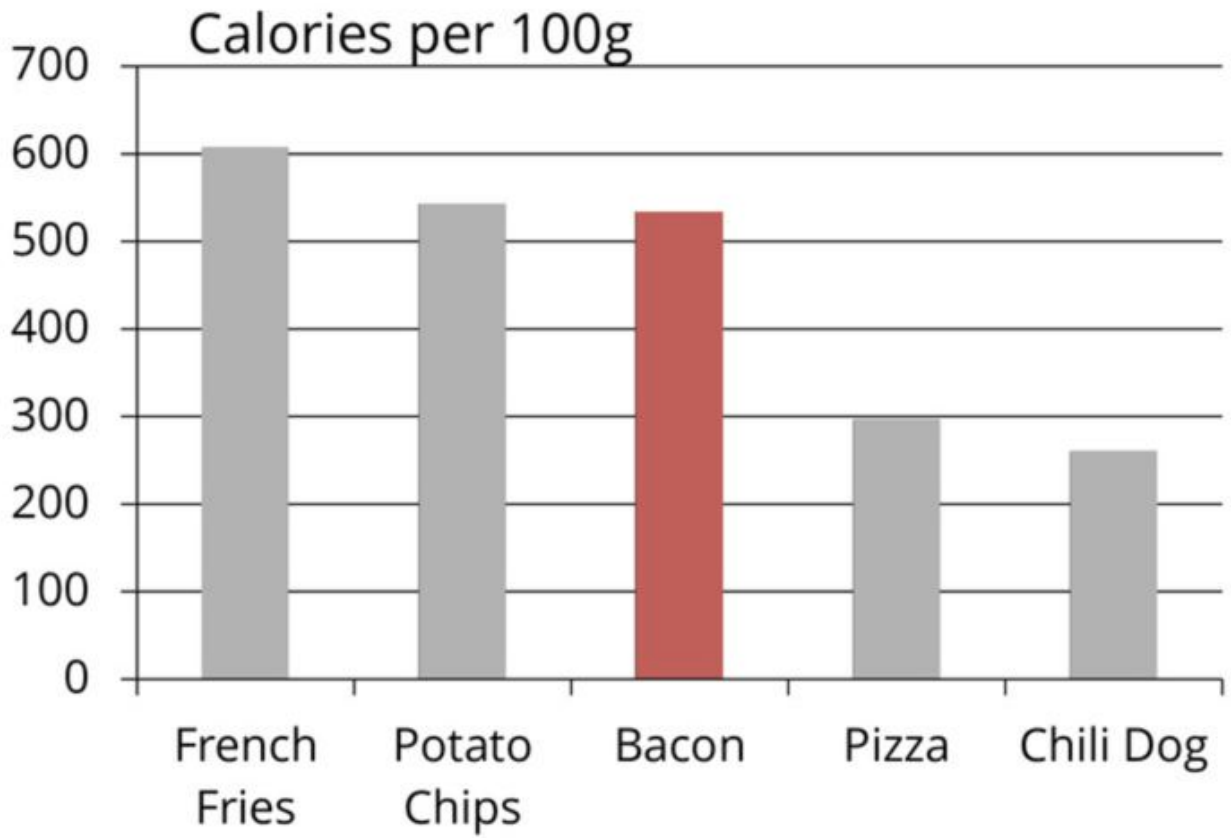
Remove bolding



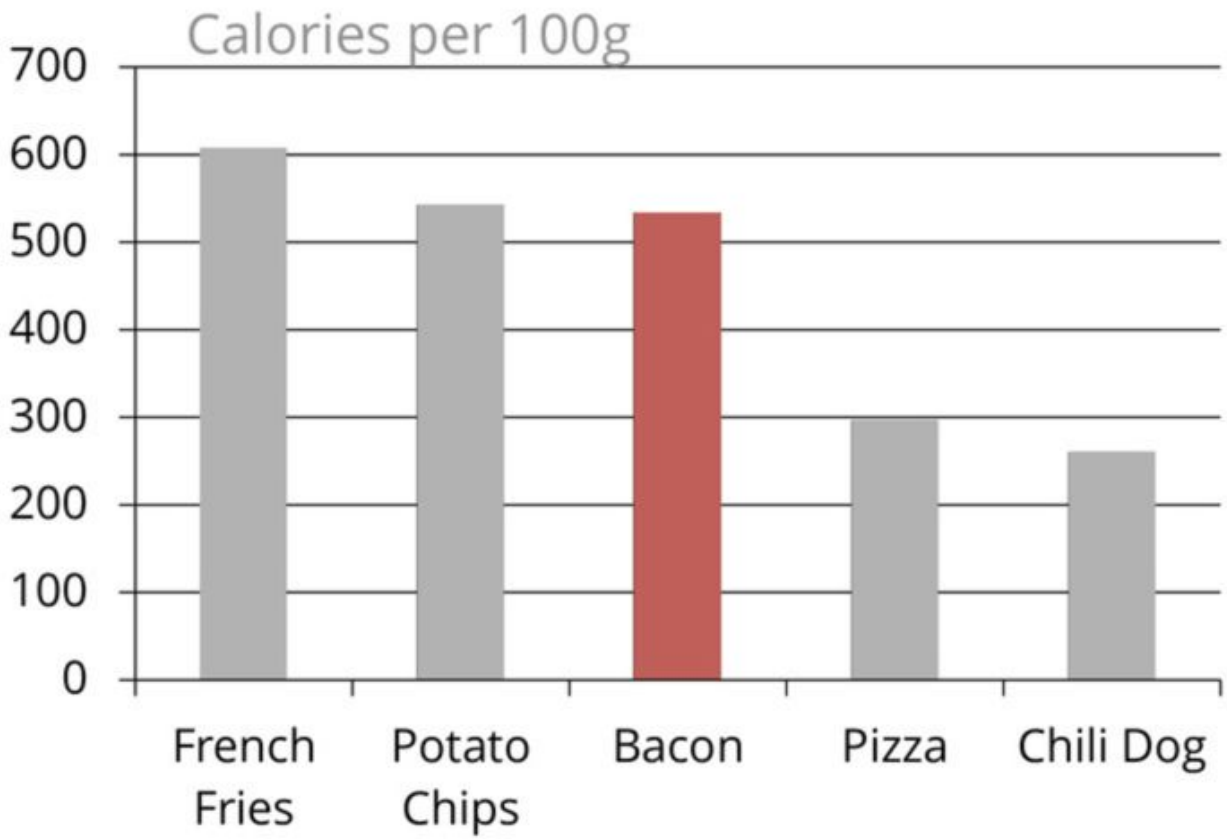
Remove bolding



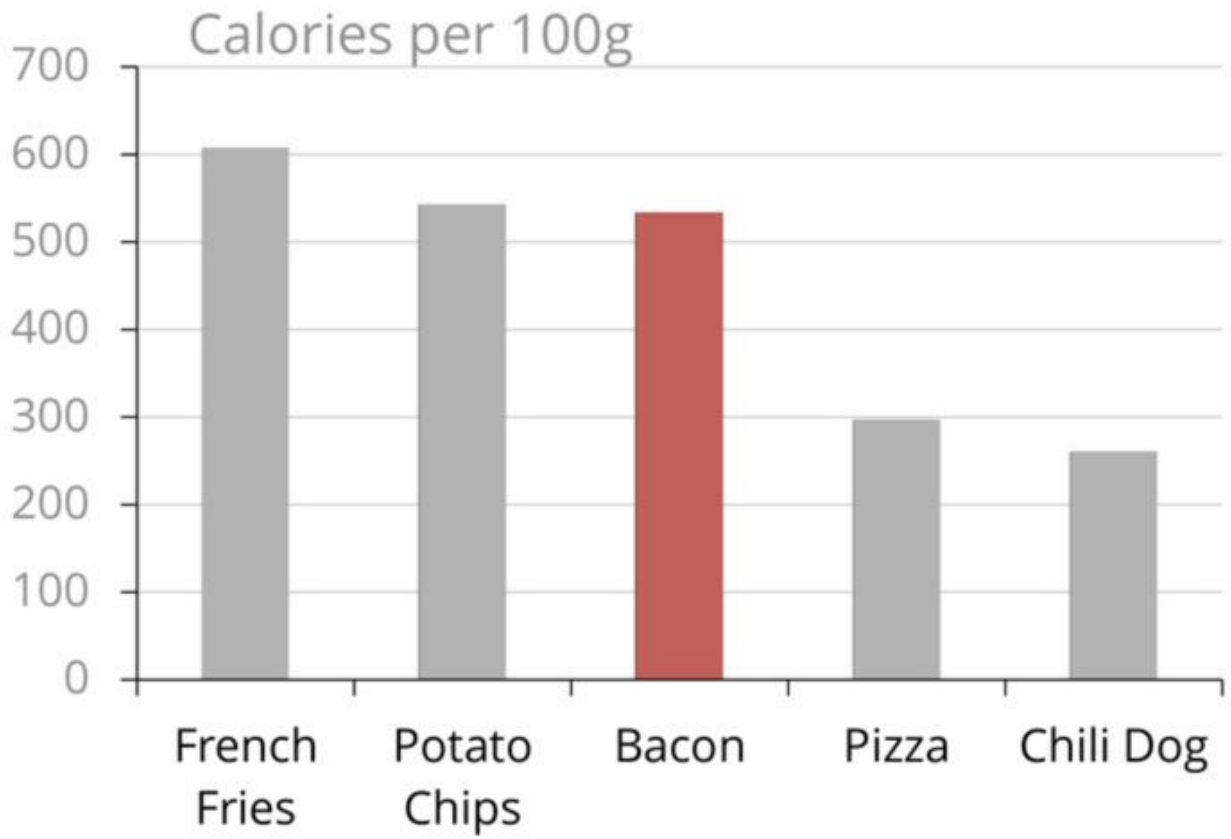
Lighten labels



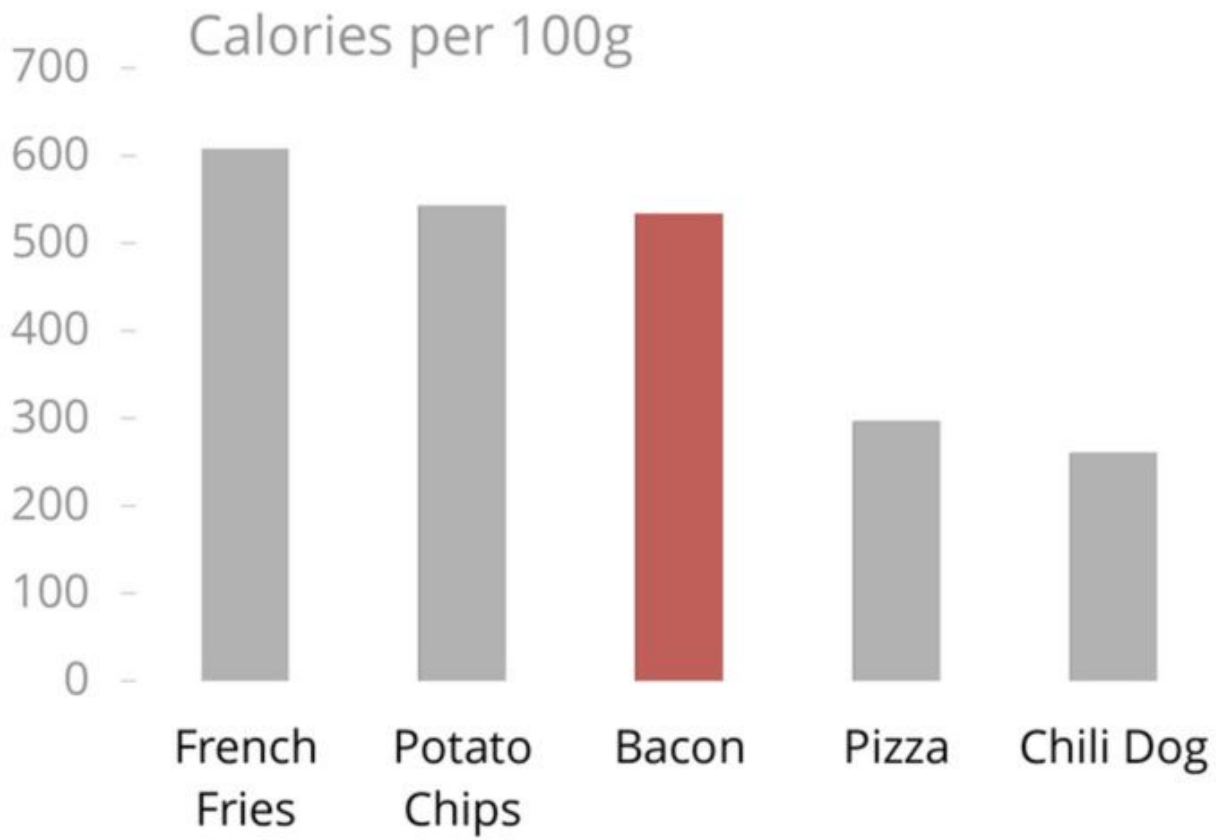
Lighten labels



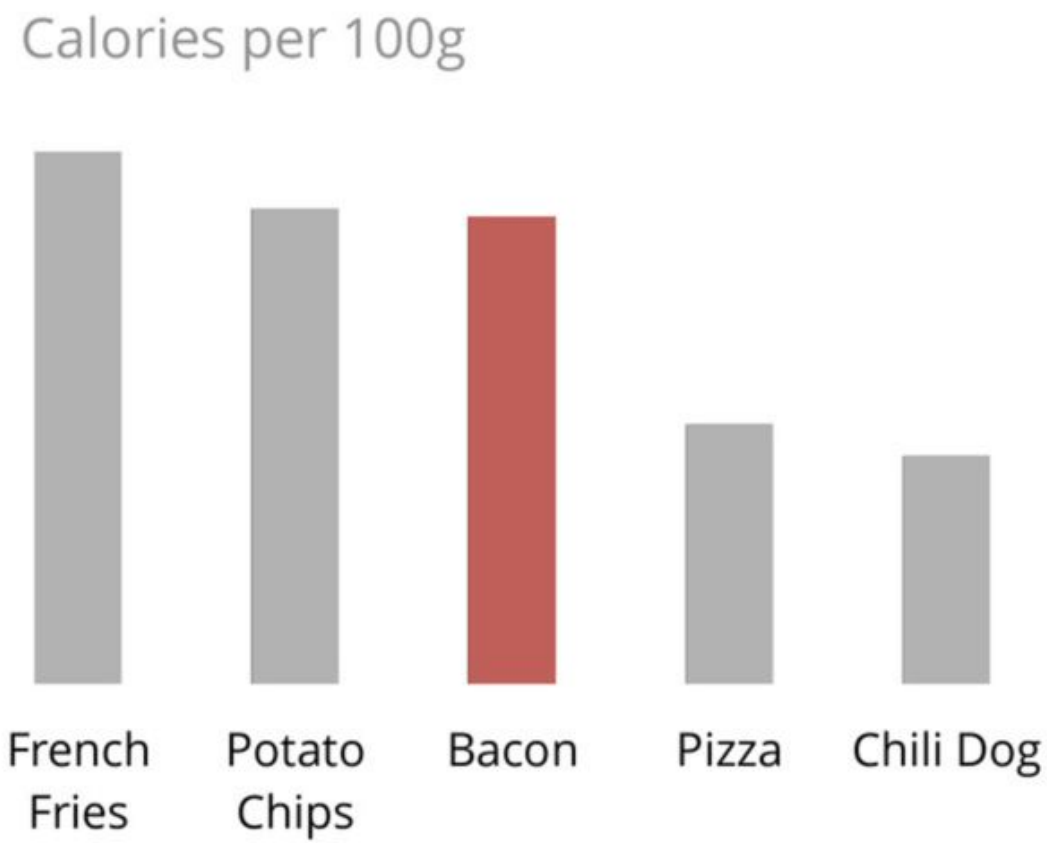
Lighten lines



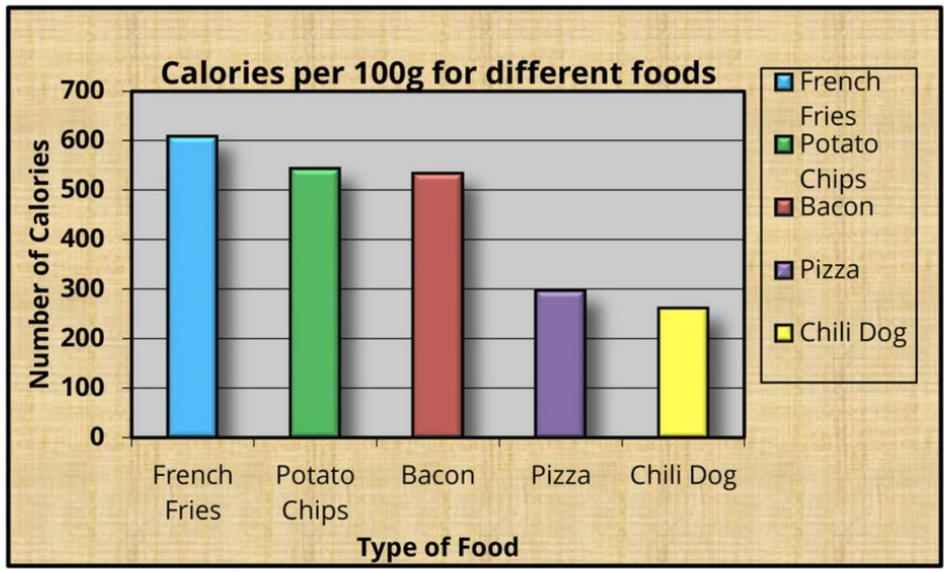
Direct label

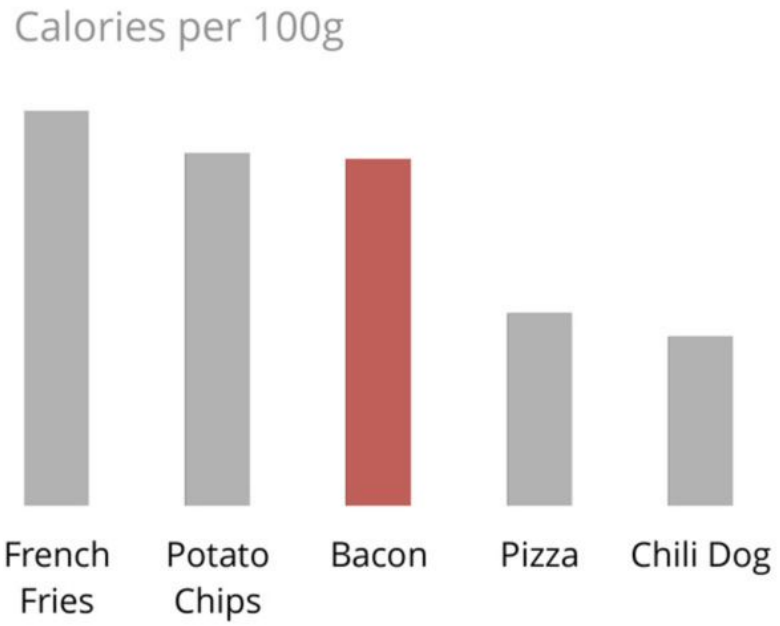


Direct label



Data-ink ratio



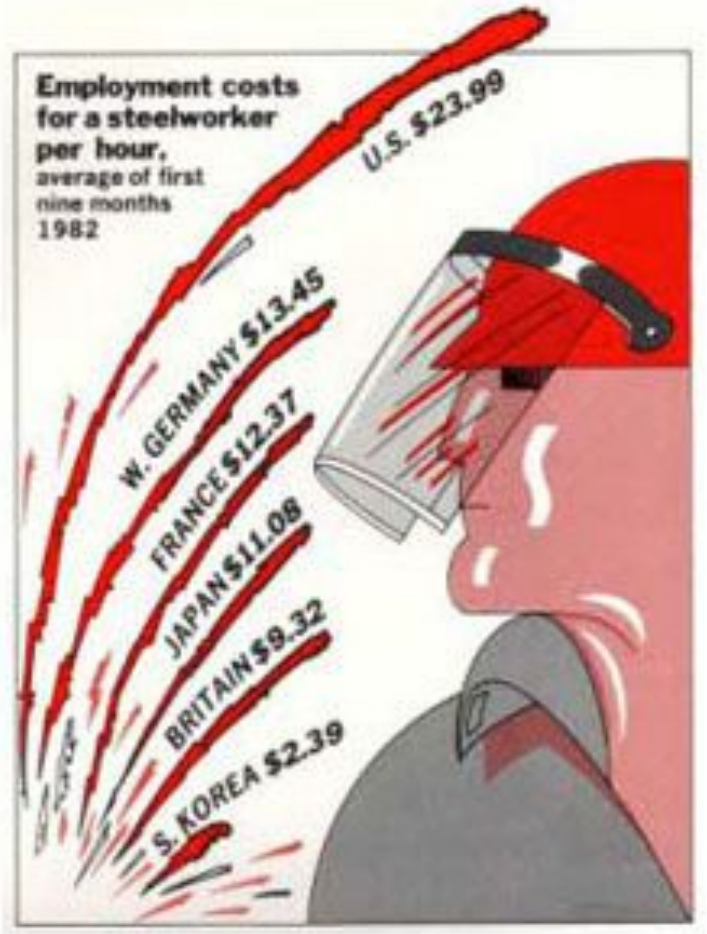


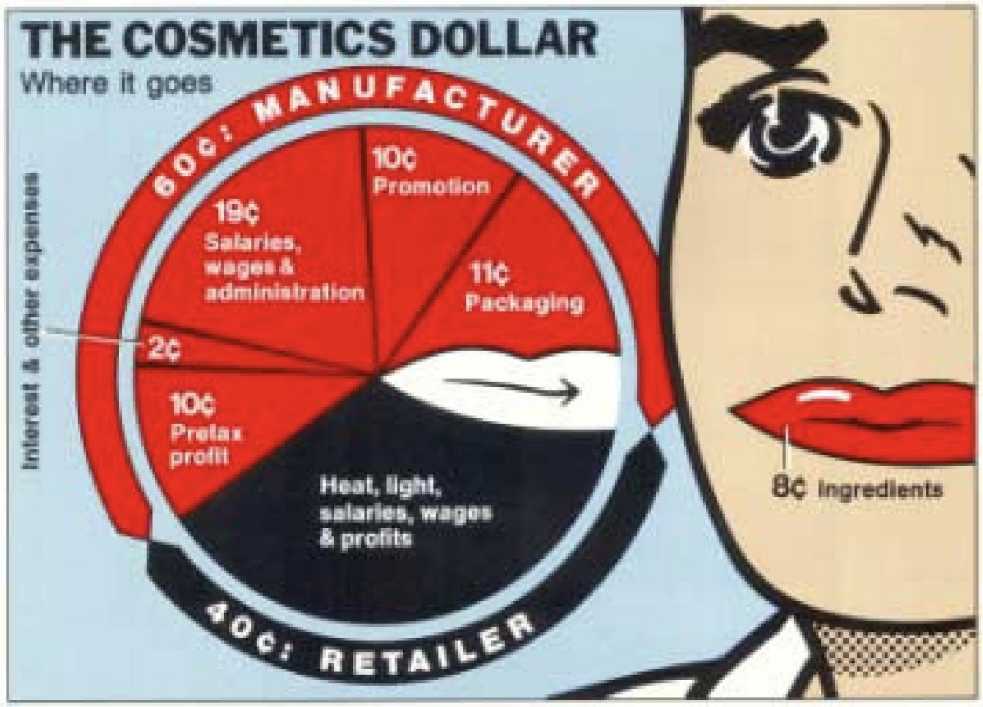
Guideline #5

"Try to optimize your data-ink ratio"

Exception: ...

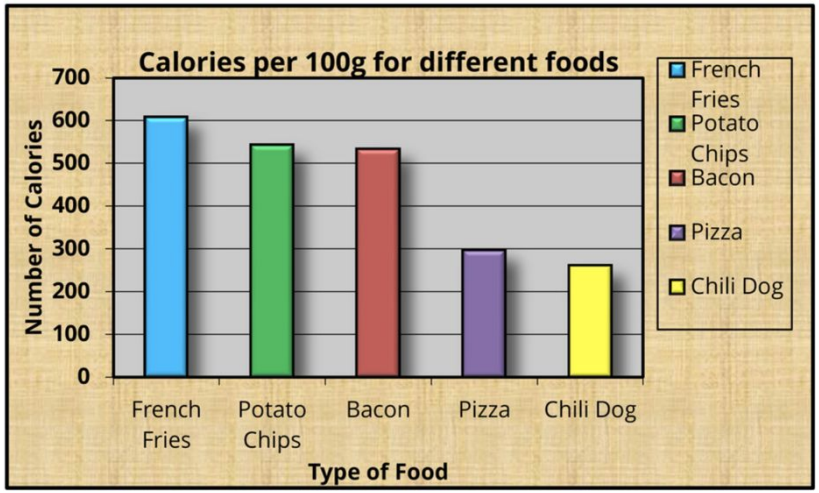
Embellishment: Metaphors





Embellishment

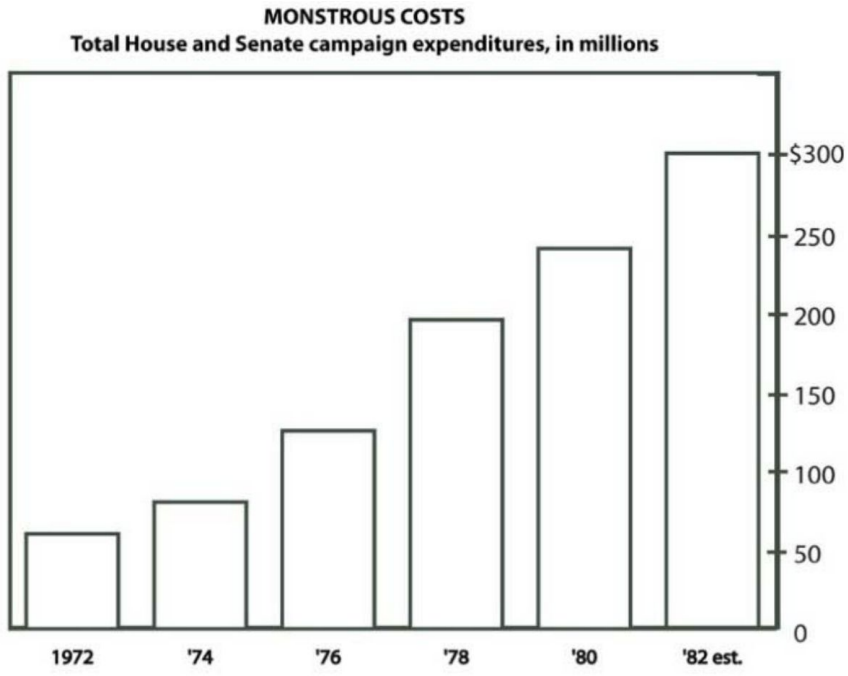
≠



Metaphor

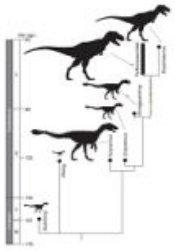
Distractors

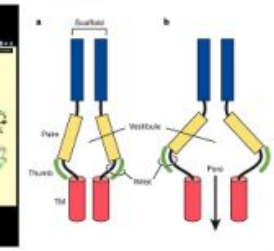
Embellishment

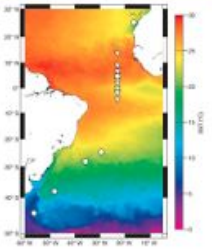


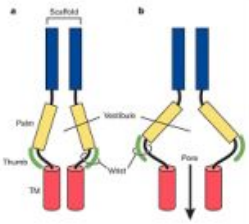
Understanding of embellished charts not worse, but recall after some weeks, much higher.

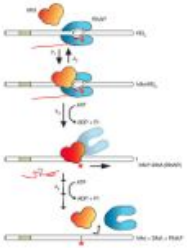
What makes a chart memorable?

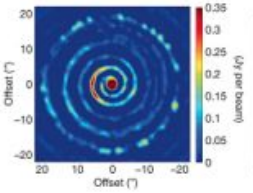


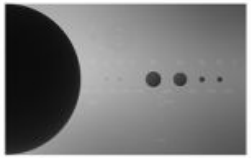


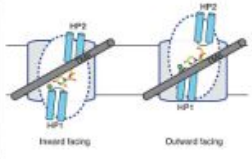


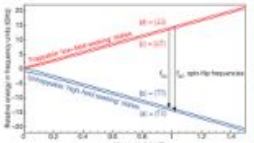


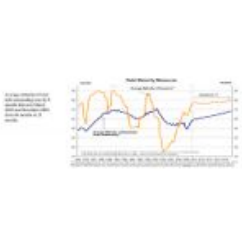


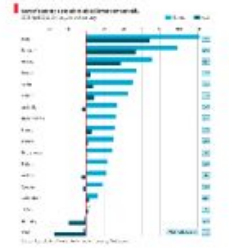


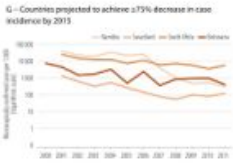


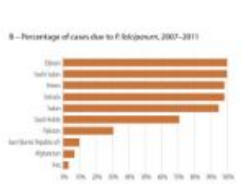


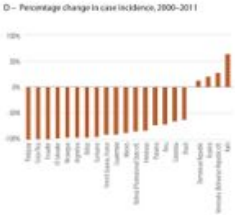


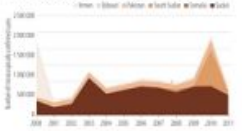


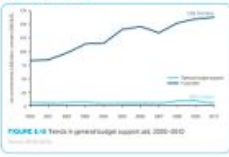




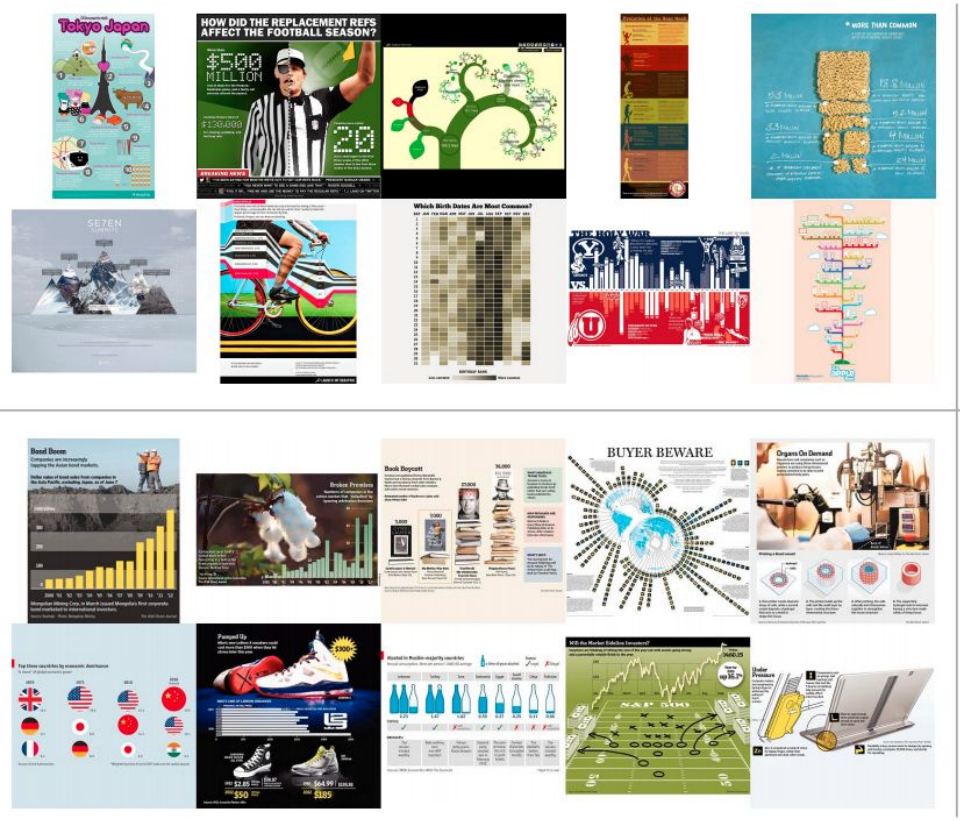


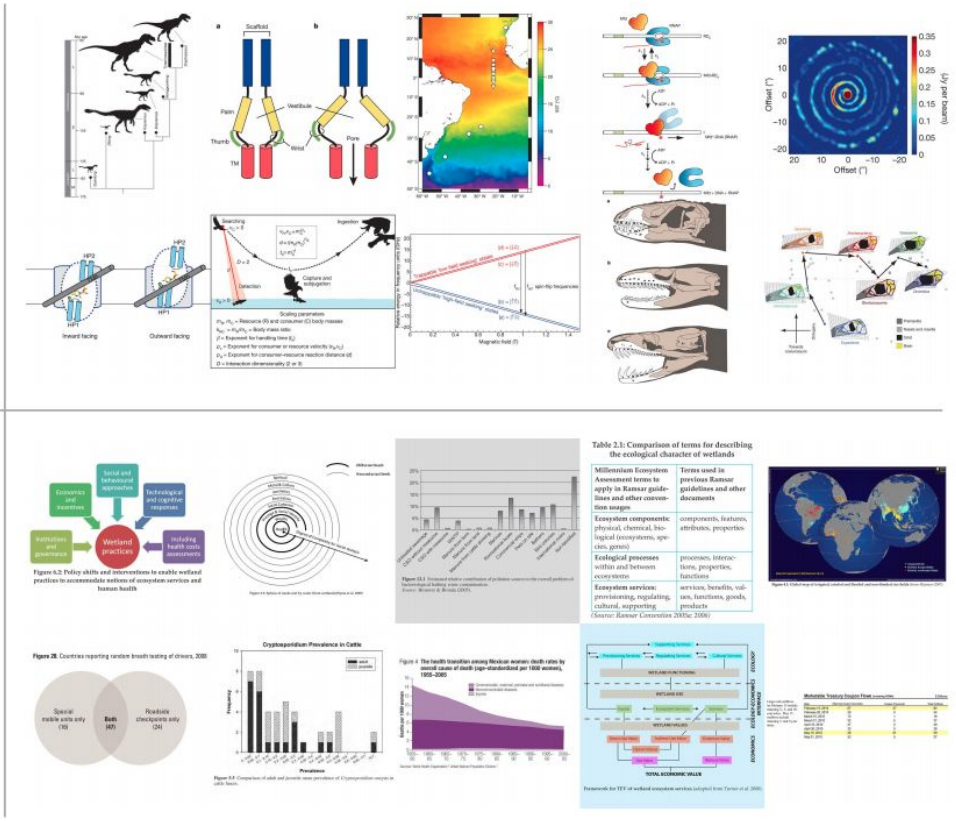






What makes a chart memorable?





Top 10 most memorable: top-left to bottom right for each category.

What makes a chart memorable?

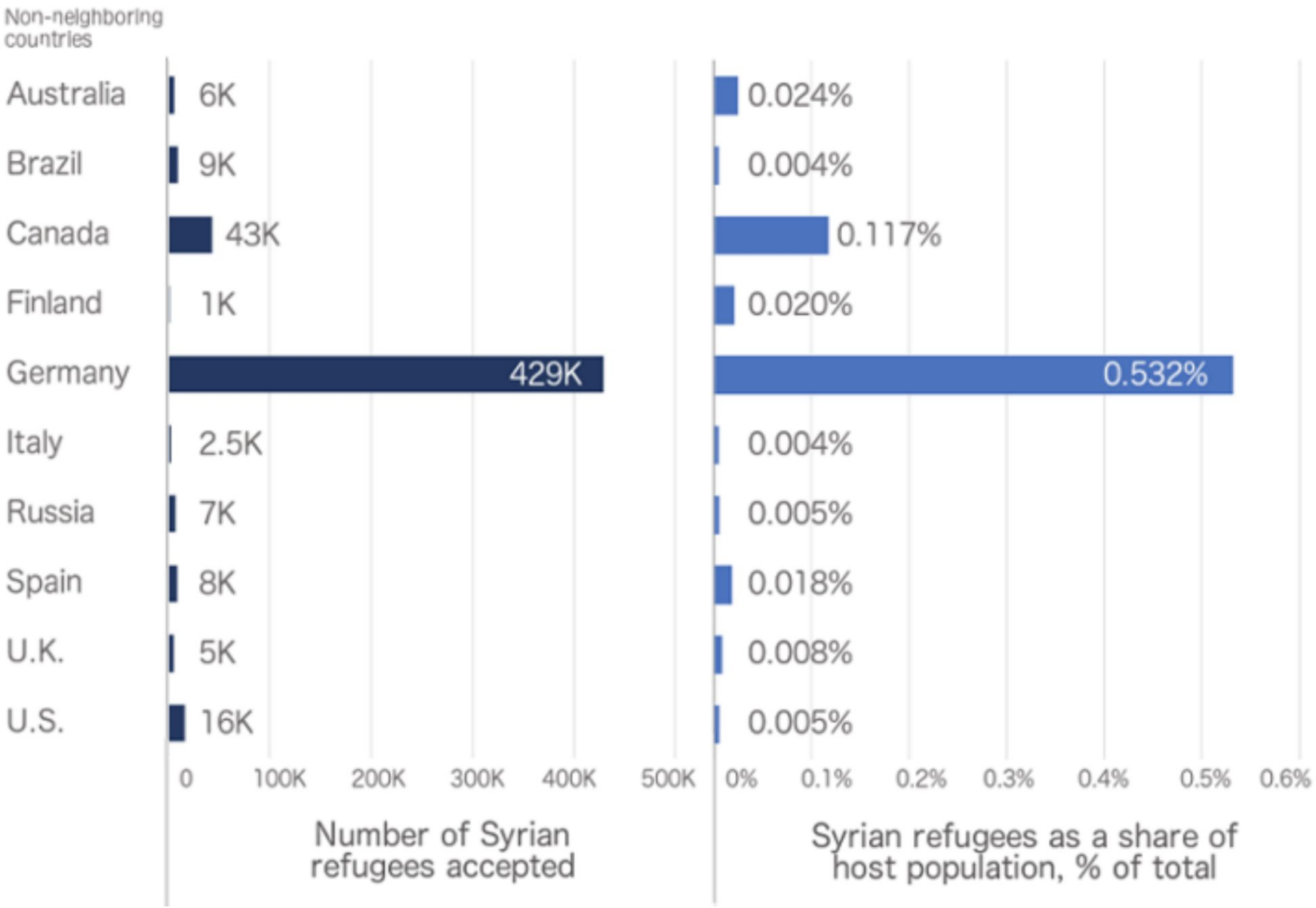
- Color
- Human recognizable objects
- Low data-ink ratio
- Unique visualization types < common graphs

Guideline #6

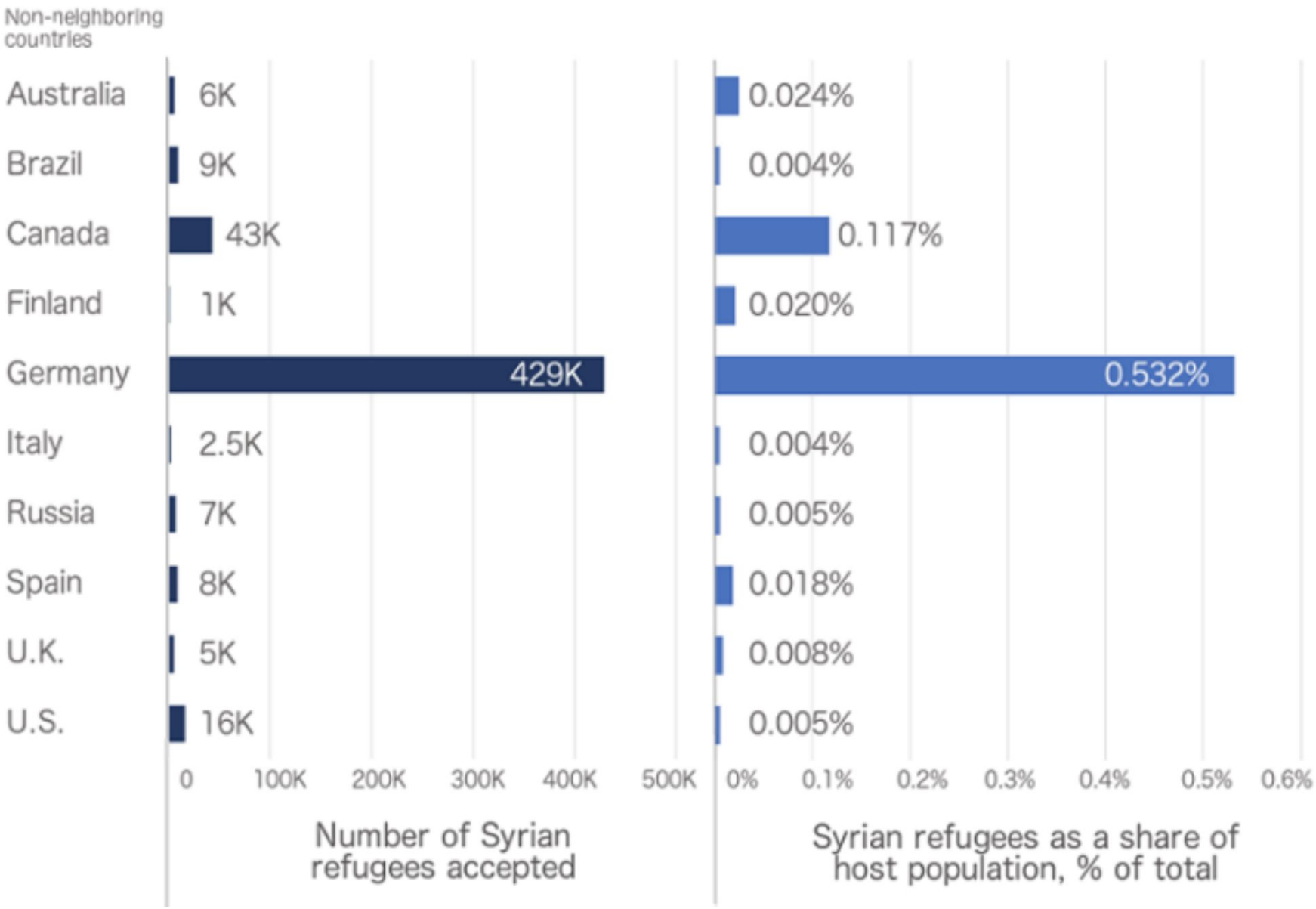
"Add embellishment carefully to make your graphic memorable and enjoyable"

Exceptions: Unless it clutters your visualization and obstructs the message.

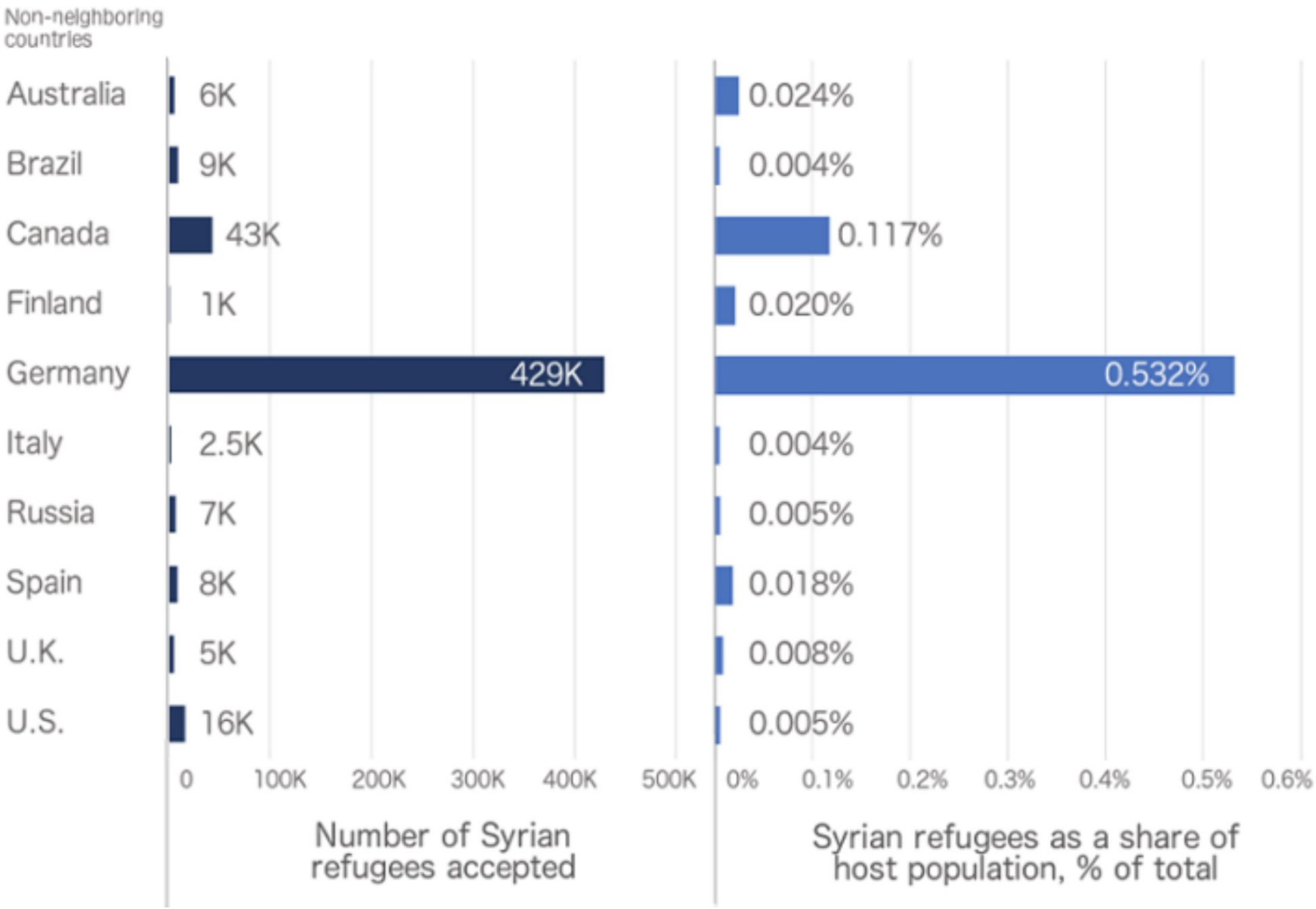
Letting in Potential Killers?



We must do our share!



Syrian Refugee Distribution:

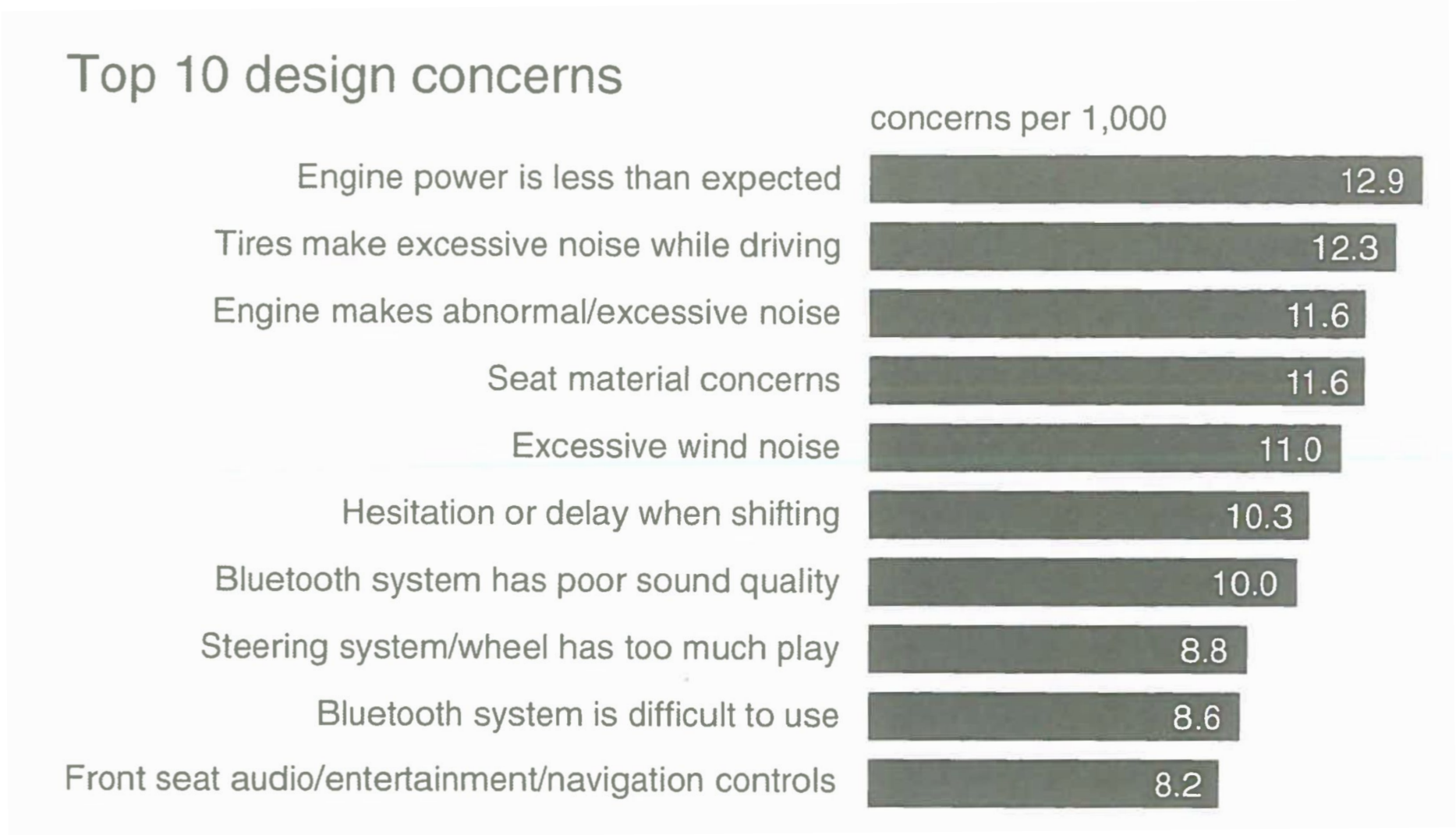


Guideline #7

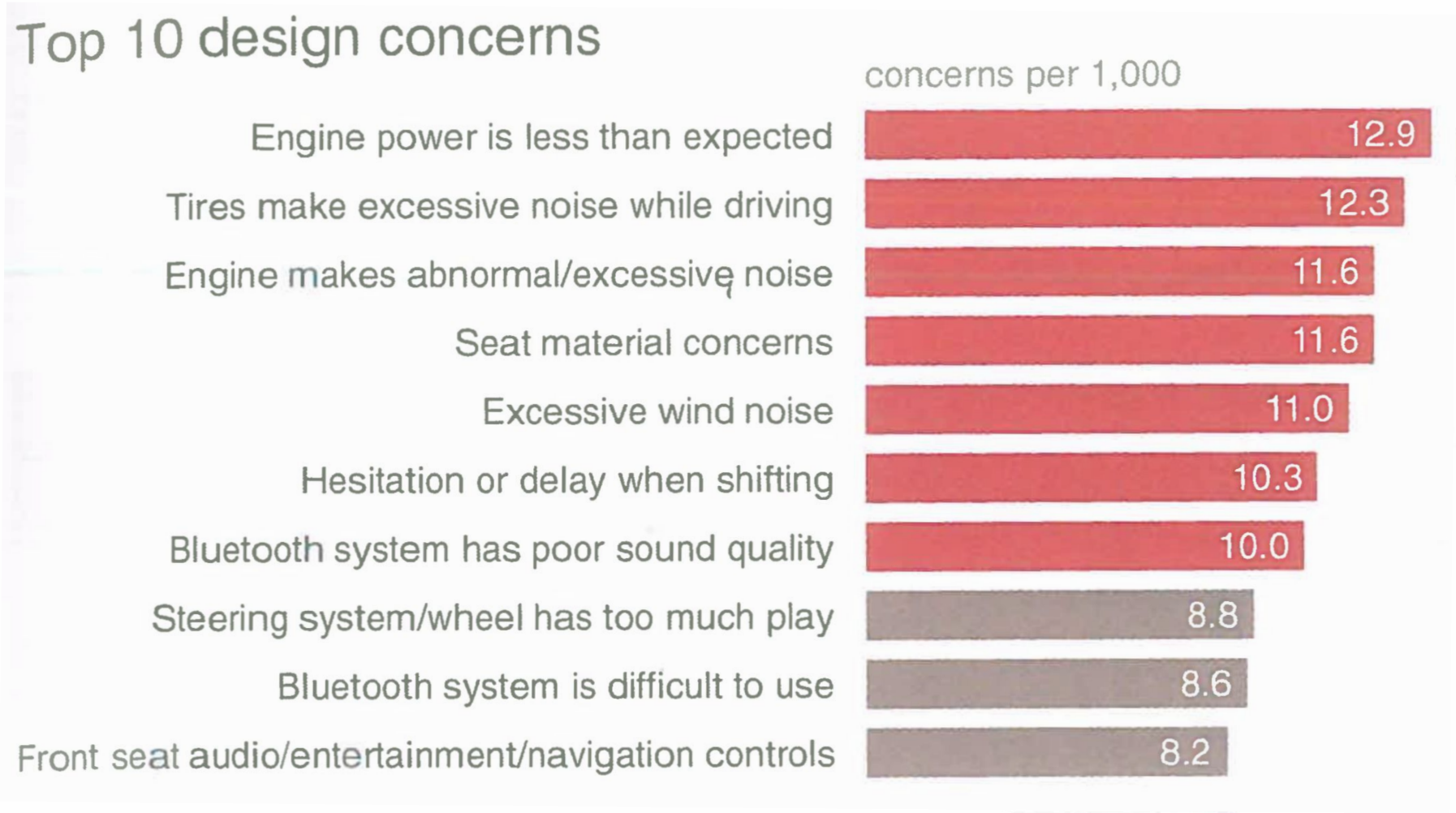
"Chose a title appropriate to your message or data — it will prime your reader."

Exceptions: none

Highlight


Top 10 design concerns
concerns per 1,000
Engine power is less than expected
12.9
Tires make excessive noise while driving
12.3
Engine makes abnormal/excessive noise
11.6
Seat material concerns
11.6
Excessive wind noise
11.0
Hesitation or delay when shifting
10.3
Bluetooth system has poor sound quality
10.0
Steering system/wheel has too much play
8.8
Bluetooth system is difficult to use
8.6
Front seat audio/entertainment/navigation controls
8.2

Highlight


Top 10 design concerns
concerns per 1,000
Engine power is less than expected
12.9
Tires make excessive noise while driving
12.3
Engine makes abnormal/excessive noise
11.6
Seat material concerns
11.6
Excessive wind noise
11.0
Hesitation or delay when shifting
10.3
Bluetooth system has poor sound quality
10.0
Steering system/wheel has too much play
8.8
Bluetooth system is difficult to use
8.6
Front seat audio/entertainment/navigation controls
8.2

Highlight

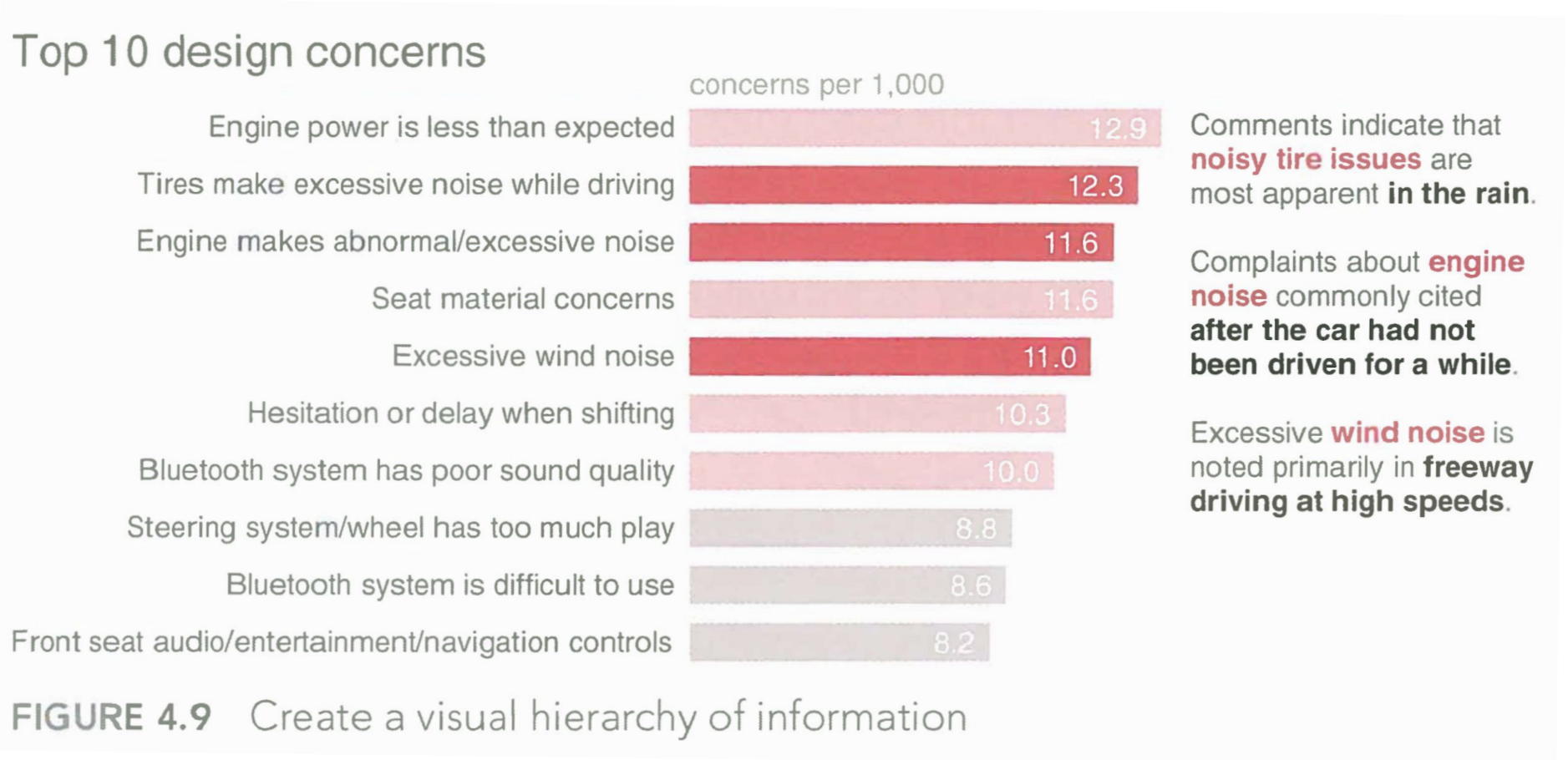
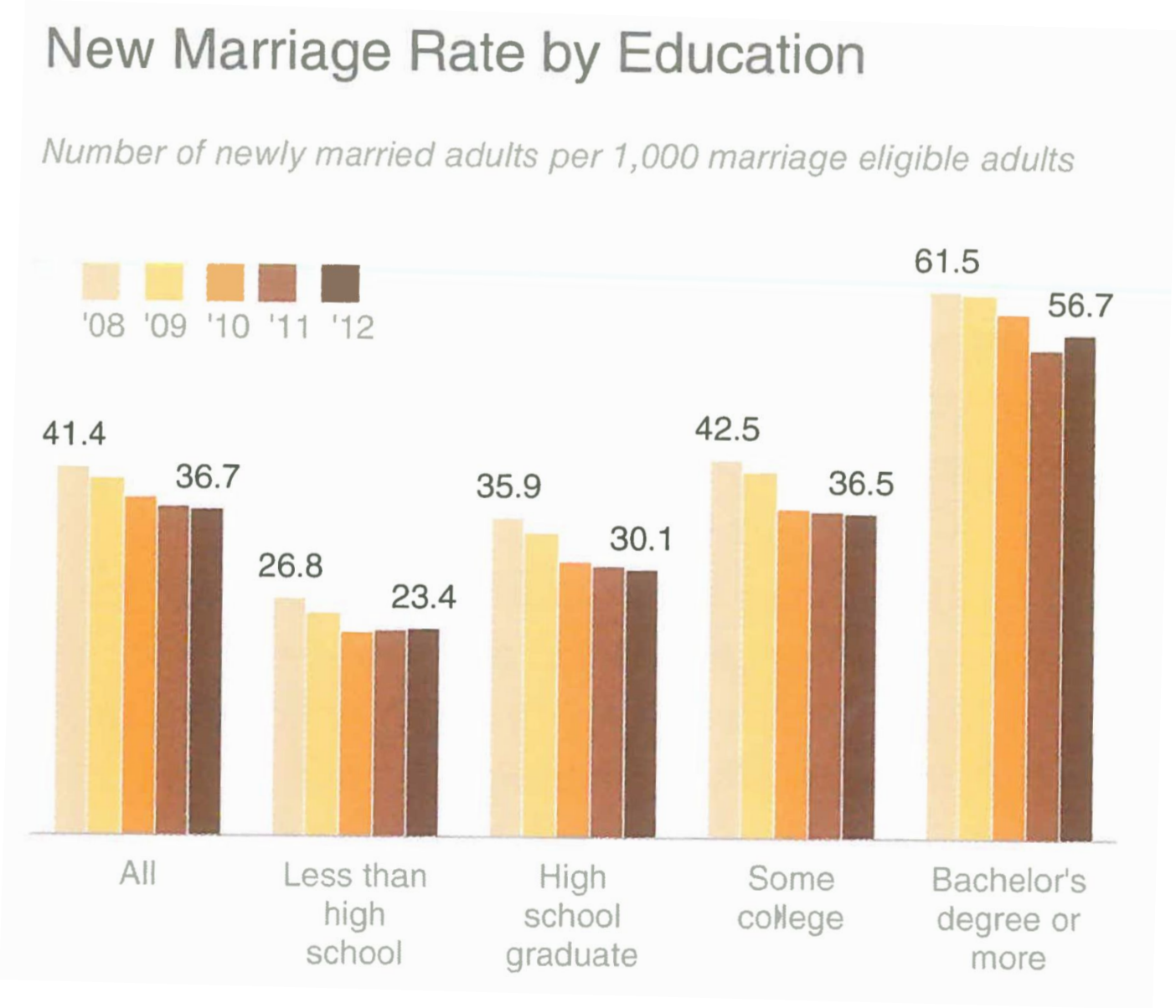
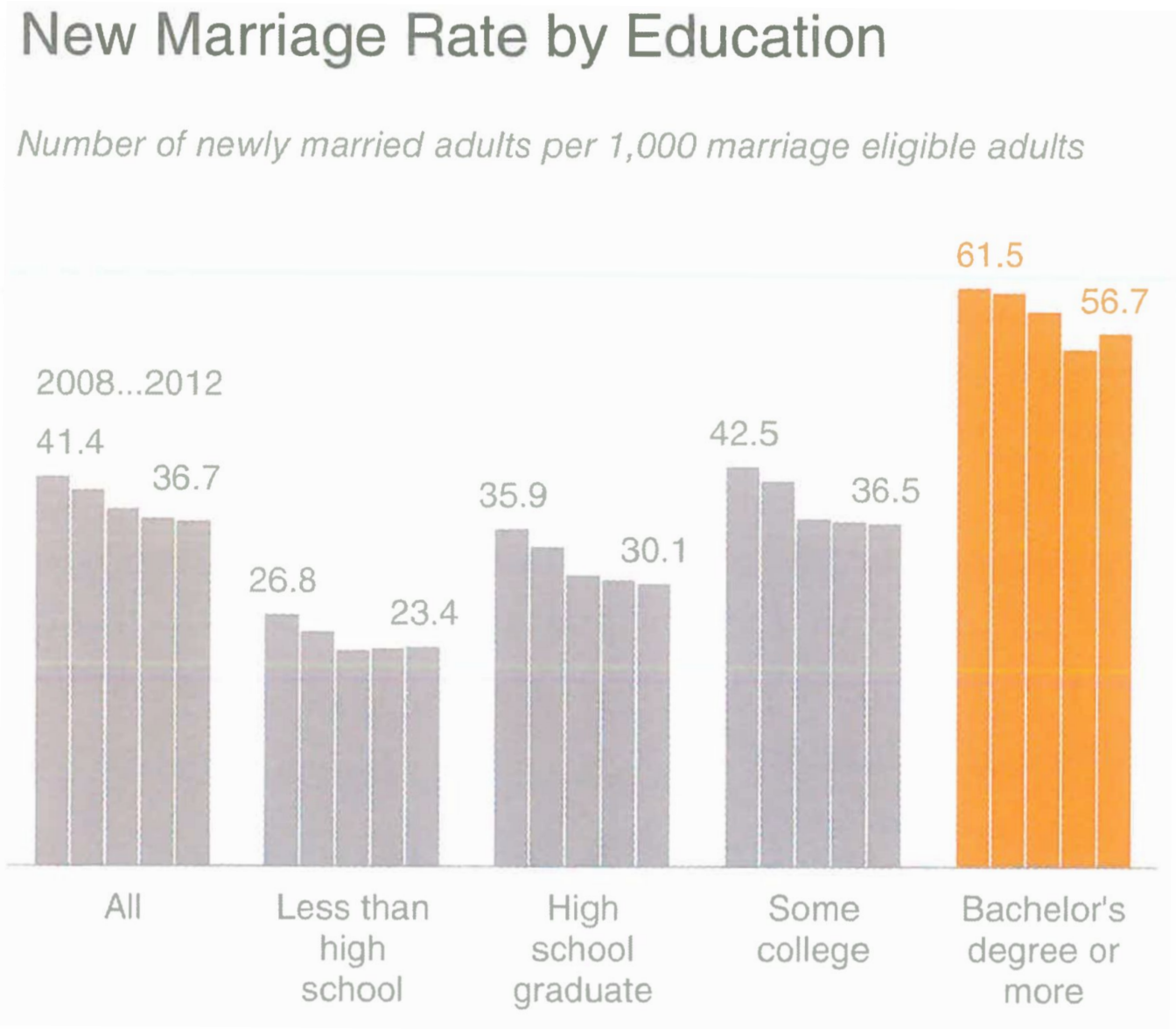


FIGURE 4.9 Create a visual hierarchy of information

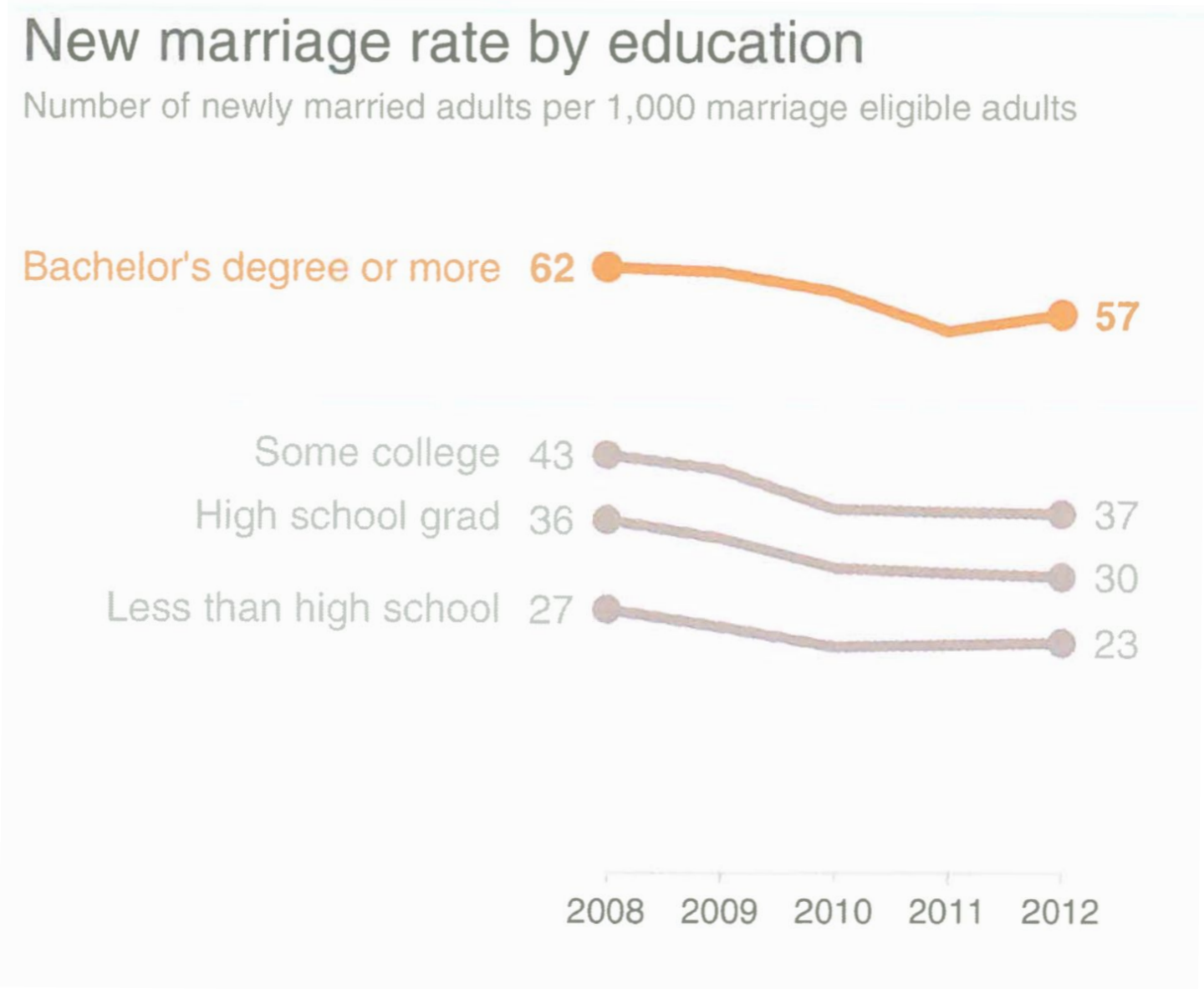
Message


New Marriage Rate by Education
Number of newly married adults per 1,000 marriage eligible adults
'08 '09 '10 '11 '12
41.4
36.7
26.8
23.4
35.9
30.1
42.5
36.5
61.5
56.7
All
Less than high school
High school graduate
Some college
Bachelor's degree or more

Message


New Marriage Rate by Education
Number of newly married adults per 1,000 marriage eligible adults
2008...2012
41.4
36.7
26.8
23.4
35.9
30.1
42.5
36.5
61.5
56.7
All
Less than high school
High school graduate
Some college
Bachelor's degree or more

Message


New marriage rate by education
Number of newly married adults per 1,000 marriage eligible adults
Bachelor's degree or more
62
57
Some college
43
37
High school grad
36
30
Less than high school
27
23
2008
2009
2010
2011
2012

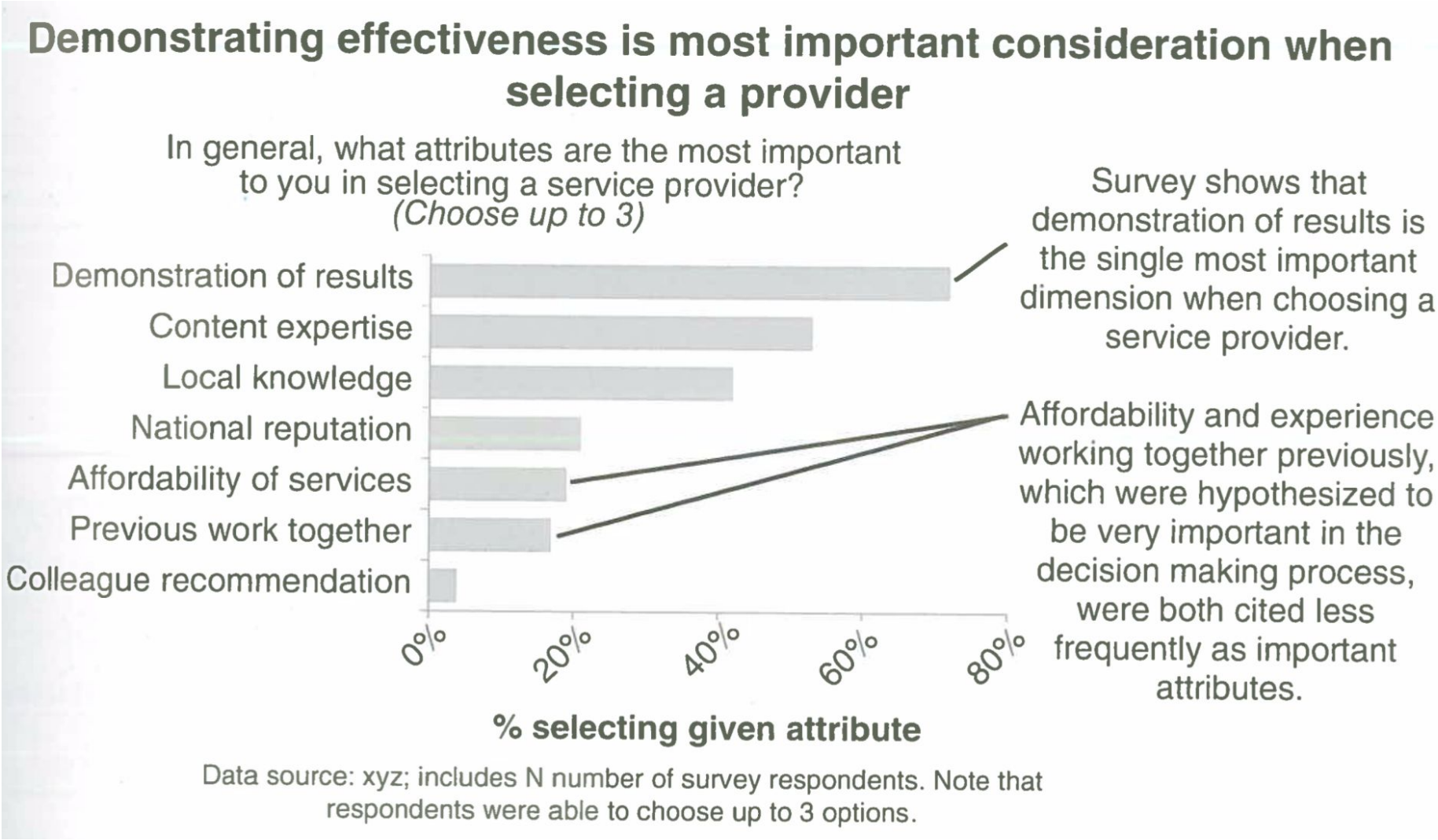
Guideline #8

"Highlight what is important "

Exceptions: except you have too many important things to say:

Solution: show another chart (can be the same)

Layout

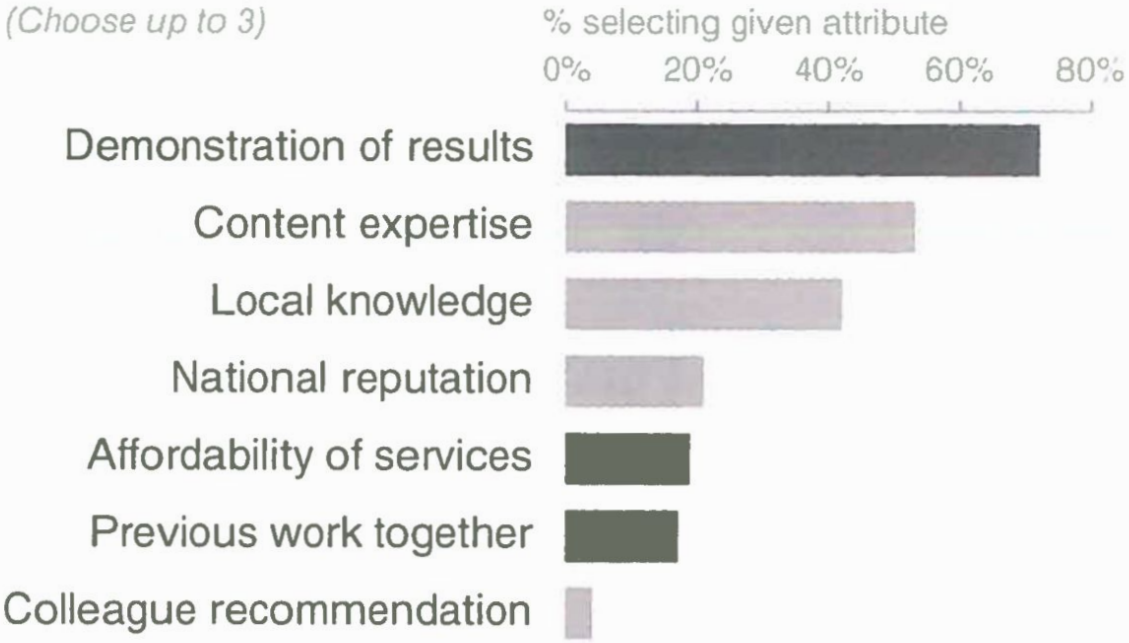

Demonstrating effectiveness is most important consideration when selecting a provider
In general, what attributes are the most important to you in selecting a service provider? (Choose up to 3)
Demonstration of results
Content expertise
Local knowledge
National reputation
Affordability of services
Previous work together
Colleague recommendation
0%
20%
40%
60%
80%
% selecting given attribute
Survey shows that demonstration of results is the single most important dimension when choosing a service provider.
Affordability and experience working together previously, which were hypothesized to be very important in the decision making process, were both cited less frequently as important attributes.
Data source: xyz; includes N number of survey respondents. Note that respondents were able to choose up to 3 options.

Layout

Demonstrating effectiveness is most important consideration when selecting a provider

In general, **what attributes are the most important** to you in selecting a service provider?

(Choose up to 3)



Survey shows that **demonstration of results** is the single most important dimension when choosing a service provider.

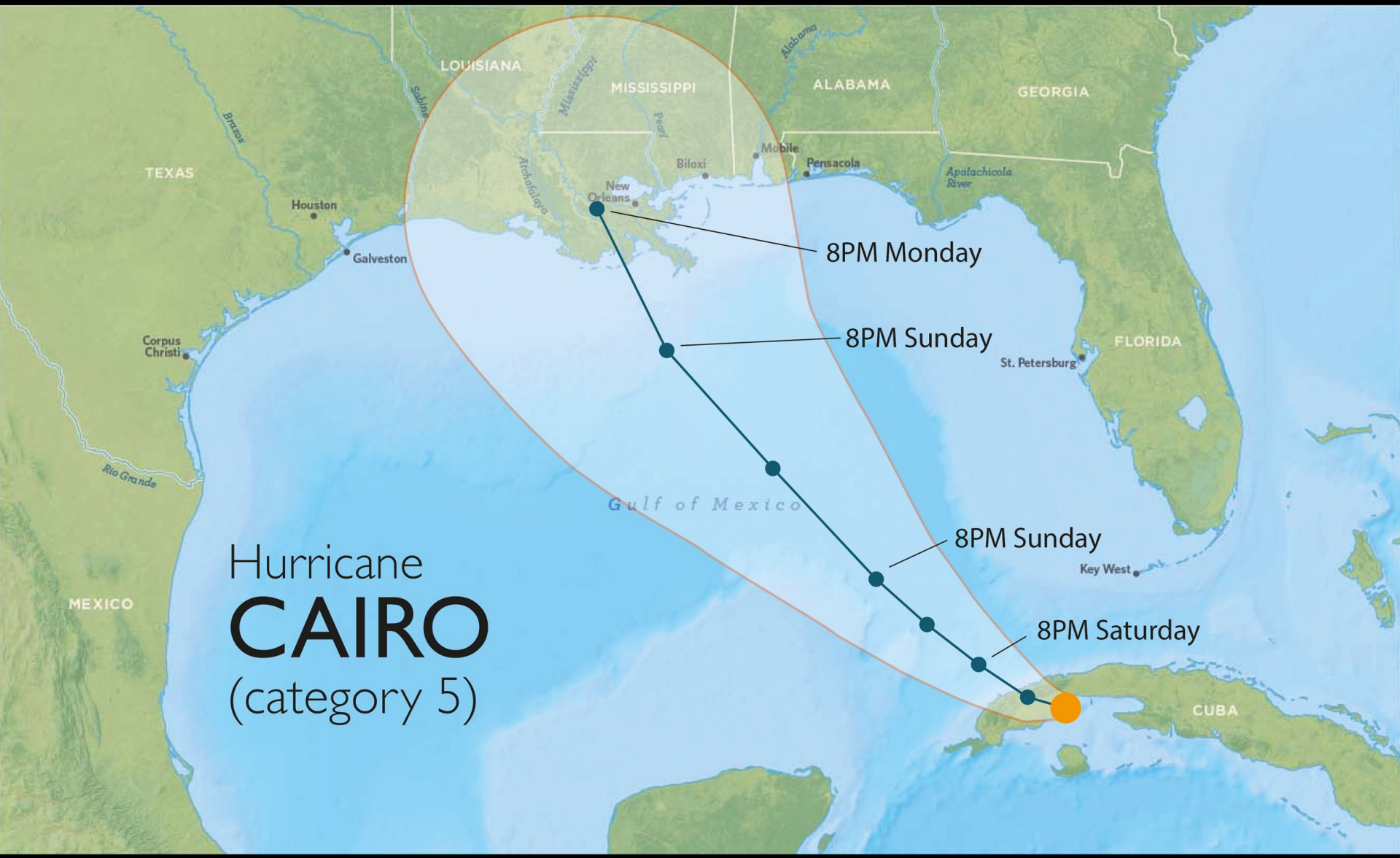
Affordability and **experience working together previously**, which were hypothesized to be very important in the decision making process, were both cited less frequently as important attributes.

Data source: xyz; includes N number of survey respondents.
Note that respondents were able to choose up to 3 options.

Guideline #9

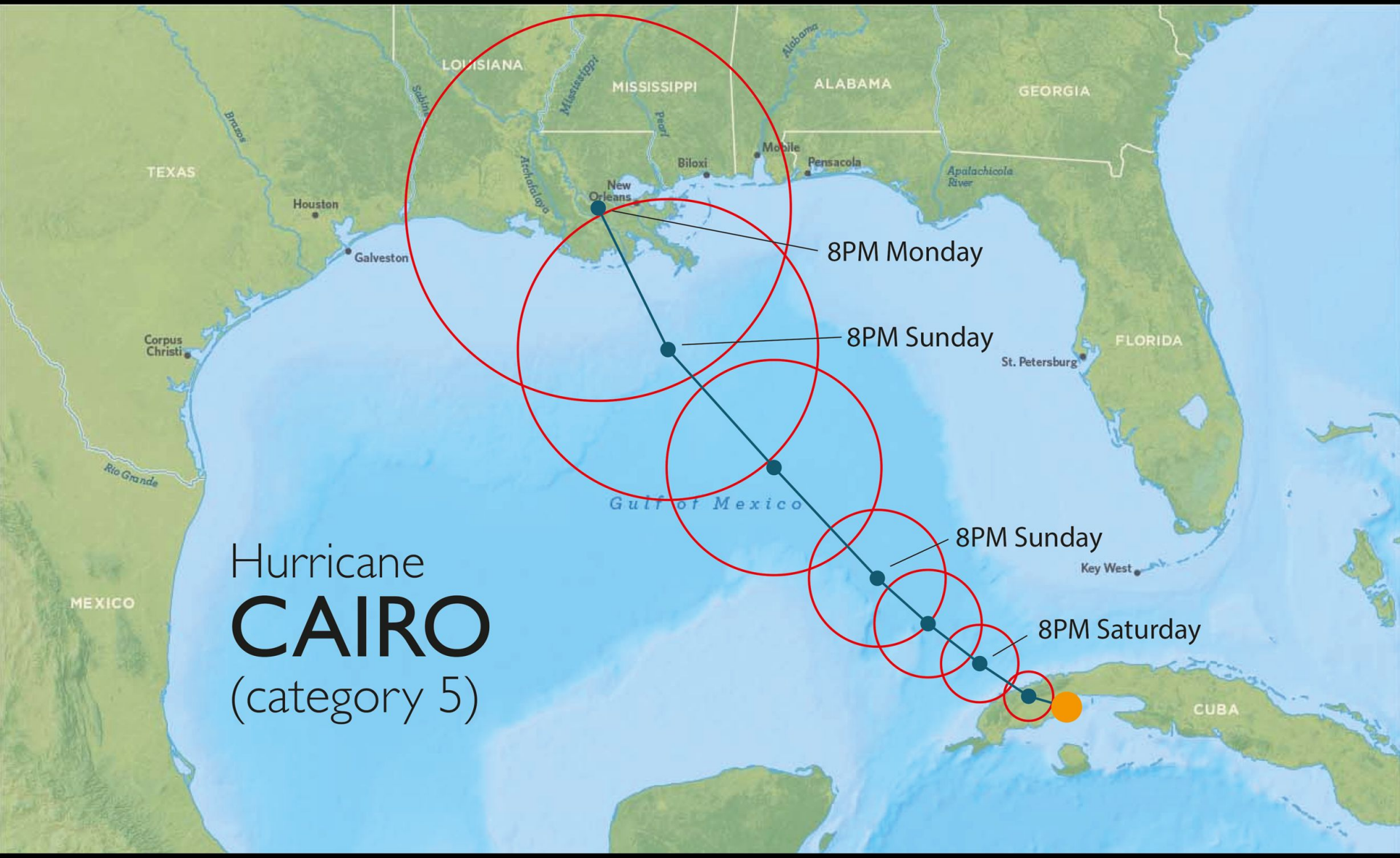
"Annotate what is important "

Exceptions: ?

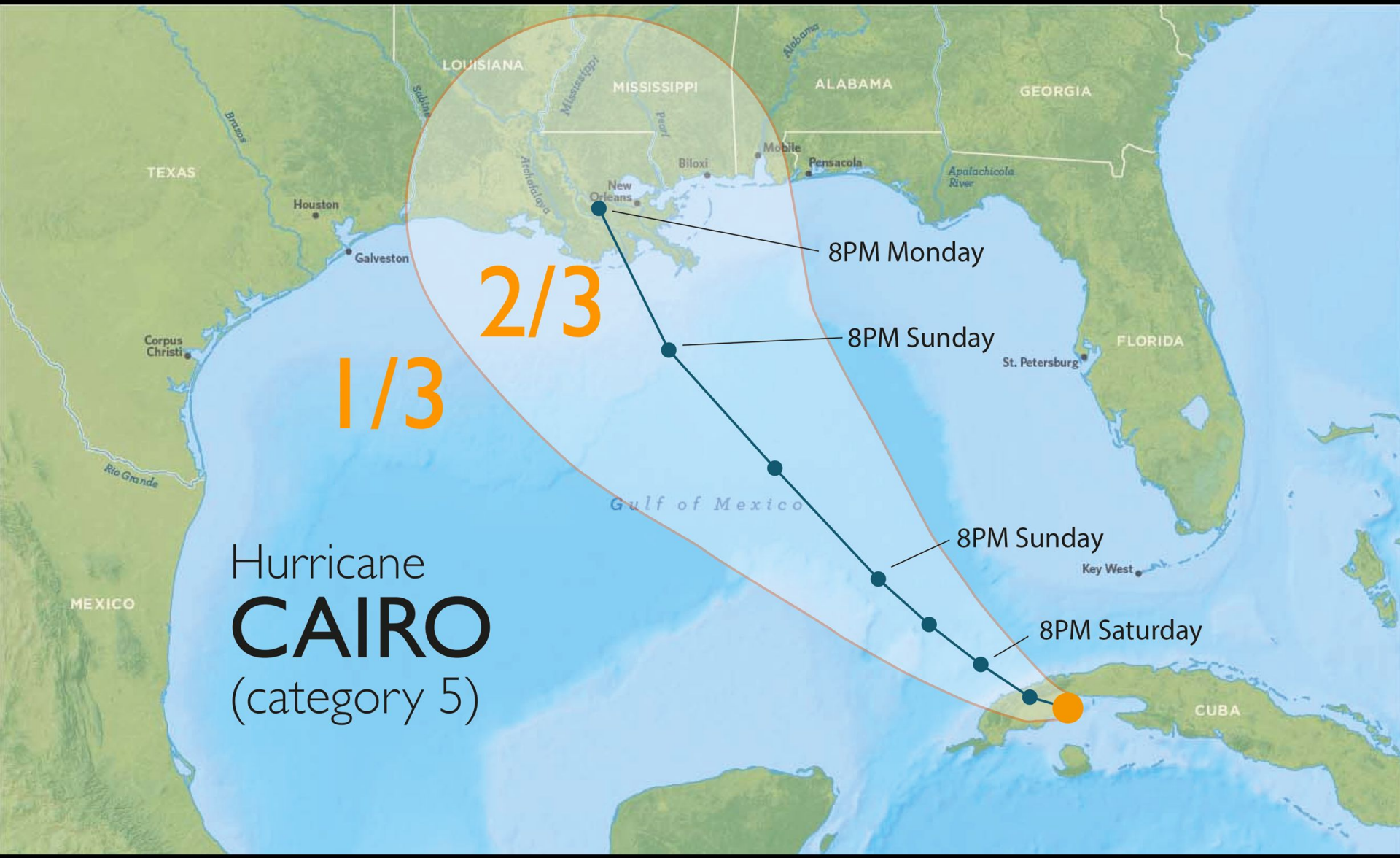


What you show

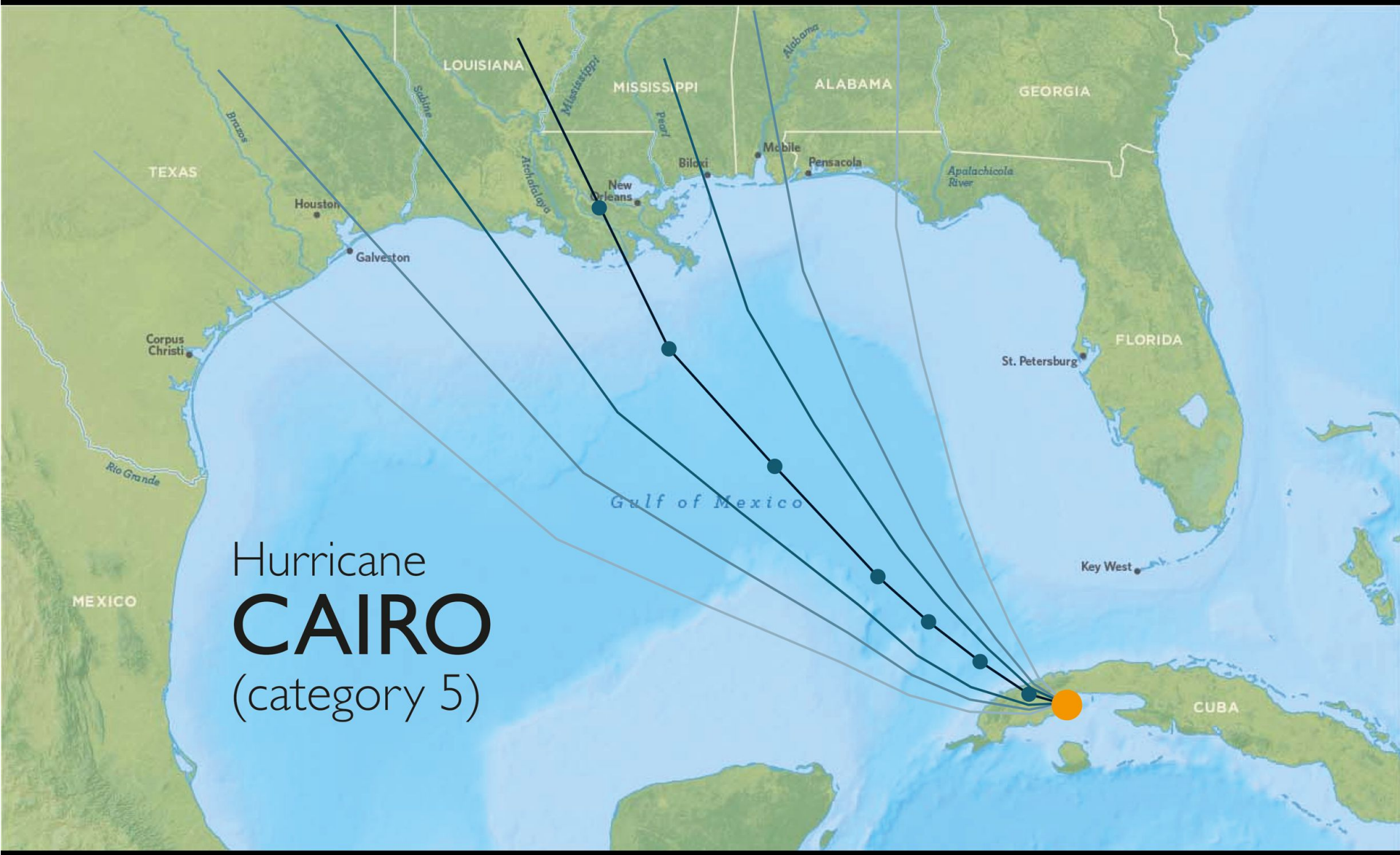
What I think some people see



What the cone is based on



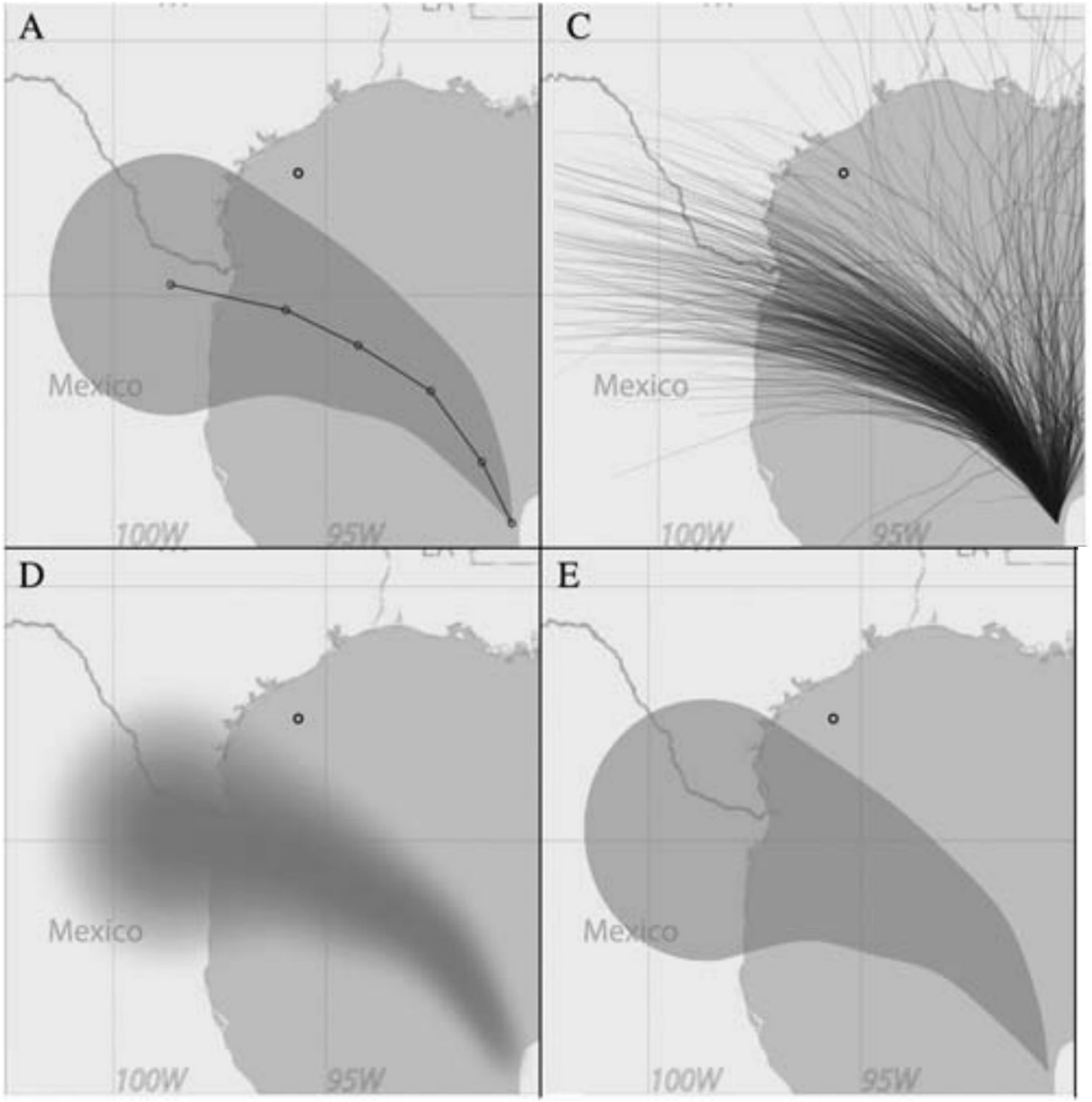
What non-scientists are not aware of (cone is just 66% probability)



What we could be showing instead

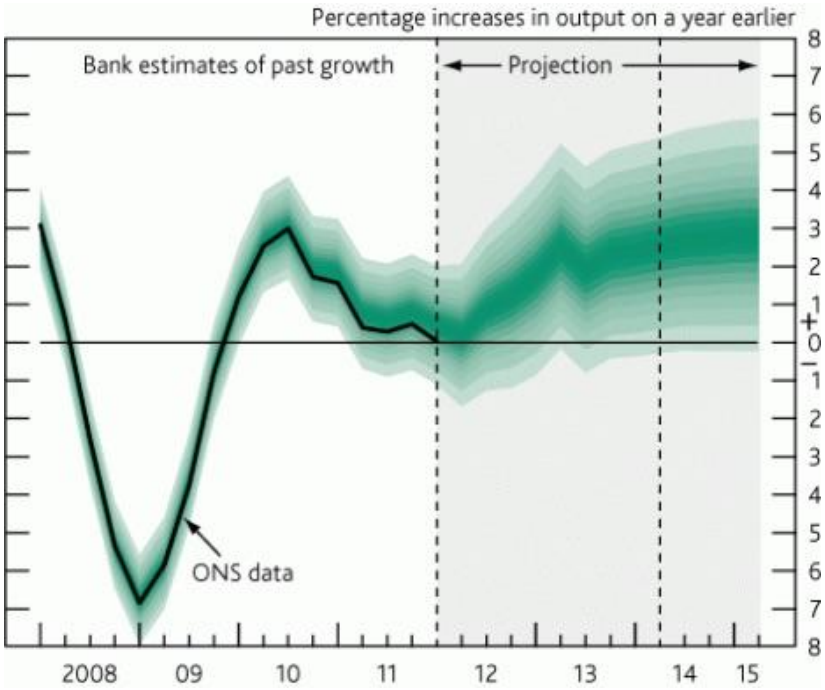
What all this may mean!

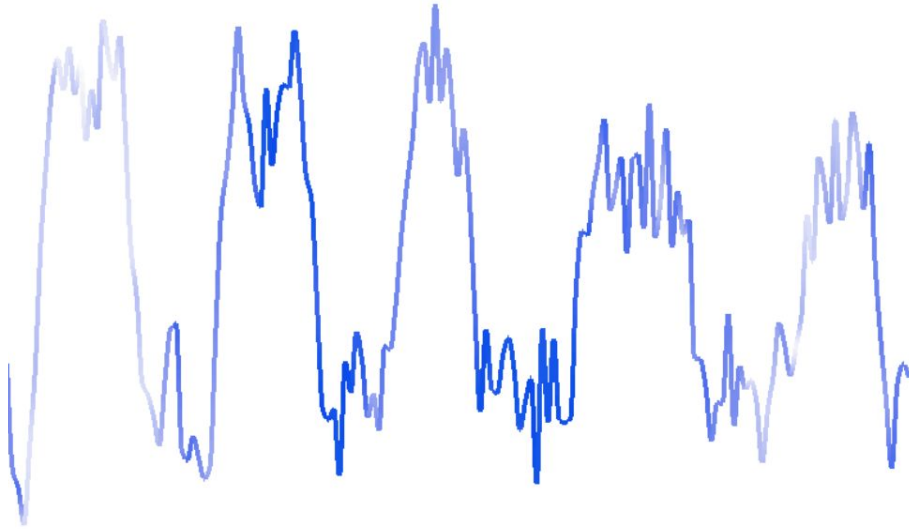
Uncertainty

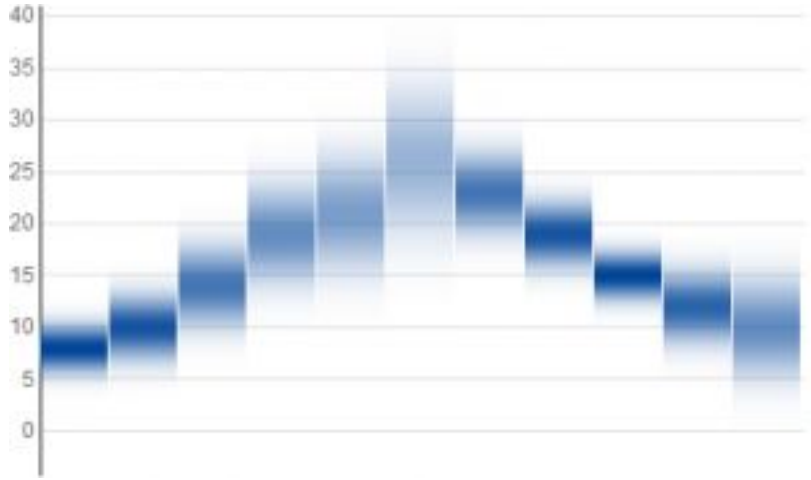


Ruginski et al,: Non-expert interpretations of hurricane forecast uncertainty visualizations, 2012

Uncertainty







Guideline #10

"Be clear about uncertaitny "

Exceptions: you are sure about it.

Balancing design

Familiarity vs. unfamiliarity

Clarity vs. Memorability

Novelty vs. Tradition

Facts vs. Uncertainty

Reader-driven vs. Author-driven

...

Closing Quotes

Nigel Holmes states: "*As long as the artist understands that the primary function is to convey statistics and respects that duty, then you can have fun (or be serious) with the image; that is, the form in which these statistics appear.*"

Alberto Cairo calls a Functional Art: "*something that achieves beauty not through the subjective, freely wandering self-expression of the painter or sculptor, but through the careful and restrained tinkering of the engineer.*"

Edinburgh Data Visualization Meetup

Edinburgh, United Kingdom
705 members · Public group
Organized by **Brendan Hill** and **2 others**

Share:

What we're about

Anyone interested in the process and product of more effectively and ingeniously communicating the meanings inherent in data by visual or other...

Read more

Upcoming events (1)

See all

THU, JAN 30, 6:00 PM

Edinburgh Data Visualization Meetup 12

Cirrus Logic

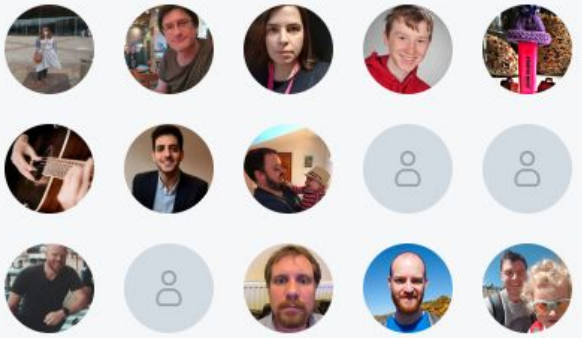
I See What You Mean - two ways vision helps us understand speech Gordon McLeod & Ben Hopson of Cirrus Logic (www.cirrus.com) Speaker identification

Organizers

Brendan Hill and **2 others**
Message

Members (705)

See all



Further readings

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- Edward Tufte. *The Visual Display of Quantitative Information, 1983*
- *Stephen Few: Sometimes we must raise our voices:* http://www.perceptualedge.com/articles/visual_business_intelligence/sometimes_we_must_raise_our_voices.pdf
- *Knafflic: Storyelling with data*
  - *Chapter 2: Choosing an effective visual*
  - *Chapter 3: Visual clutter is your enemy*
  - *Chapter 4: Focus on your audiences' attention*
- Bateman, Scott, et al. "Useful junk? The effects of visual embellishment on comprehension and memorability of charts." *Proceedings of the SIGCHI conference on human factors in computing systems*. 2010.
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- Borkin, Michelle A., et al. "What makes a visualization memorable?." *IEEE Transactions on Visualization and Computer Graphics* 19.12 (2013): 2306-2315.