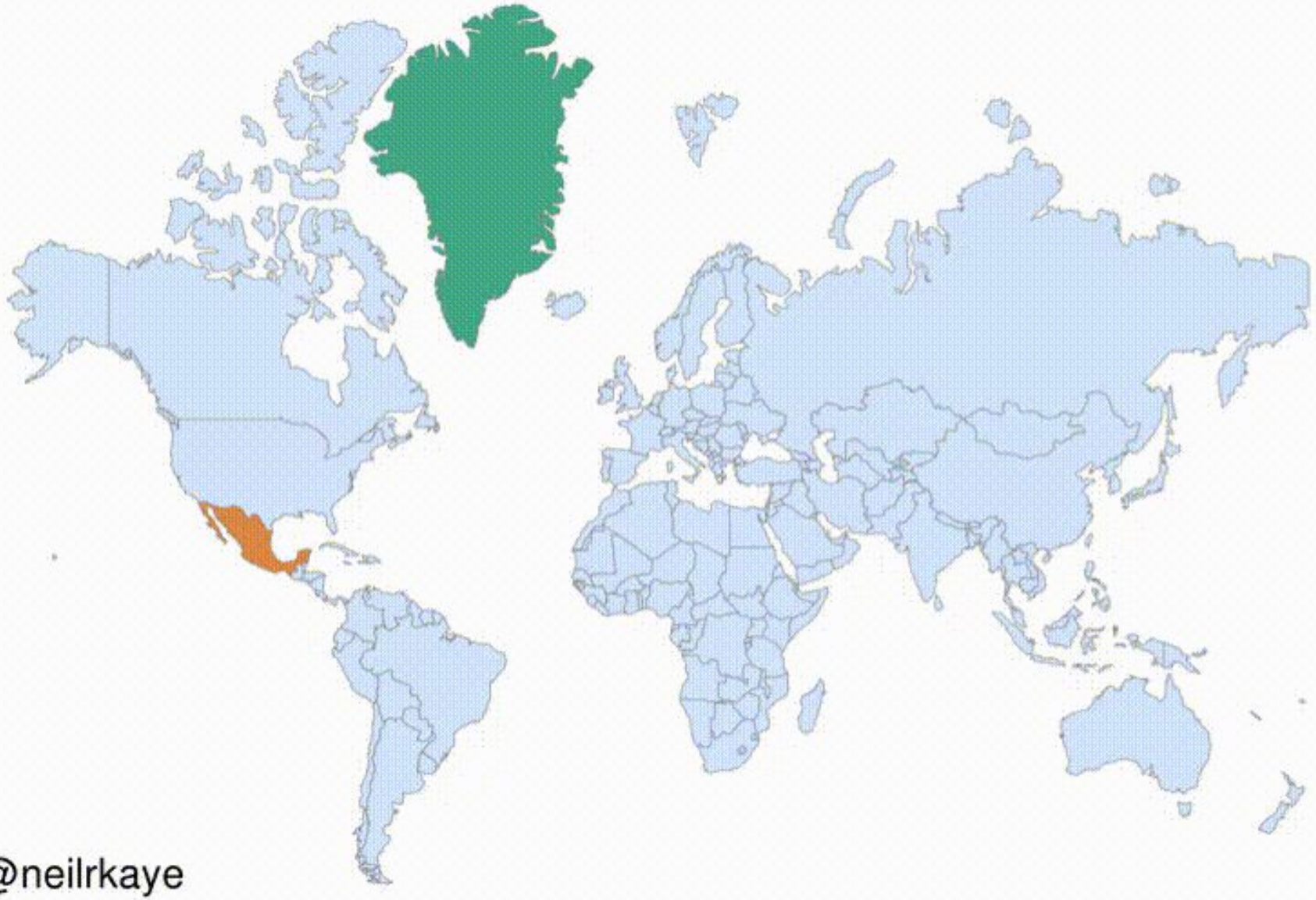
Creating effective figures for conference presentations and publications

Gaurav Kandlikar
Ecology and Evolutionary Biology
Graduate Writing Center Consultant

Trading places, Mexico and Greenland swap in the Mercator projection



@neilrkaye

Why do we make figures?

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How do we consume (read) figures?

Graphs and charts let you explore and learn about the structure of the information you collect.
Good data visualizations also make it easier to communicate your ideas and findings to other people.

"Data Visualization" , Kieran Healey, 2018

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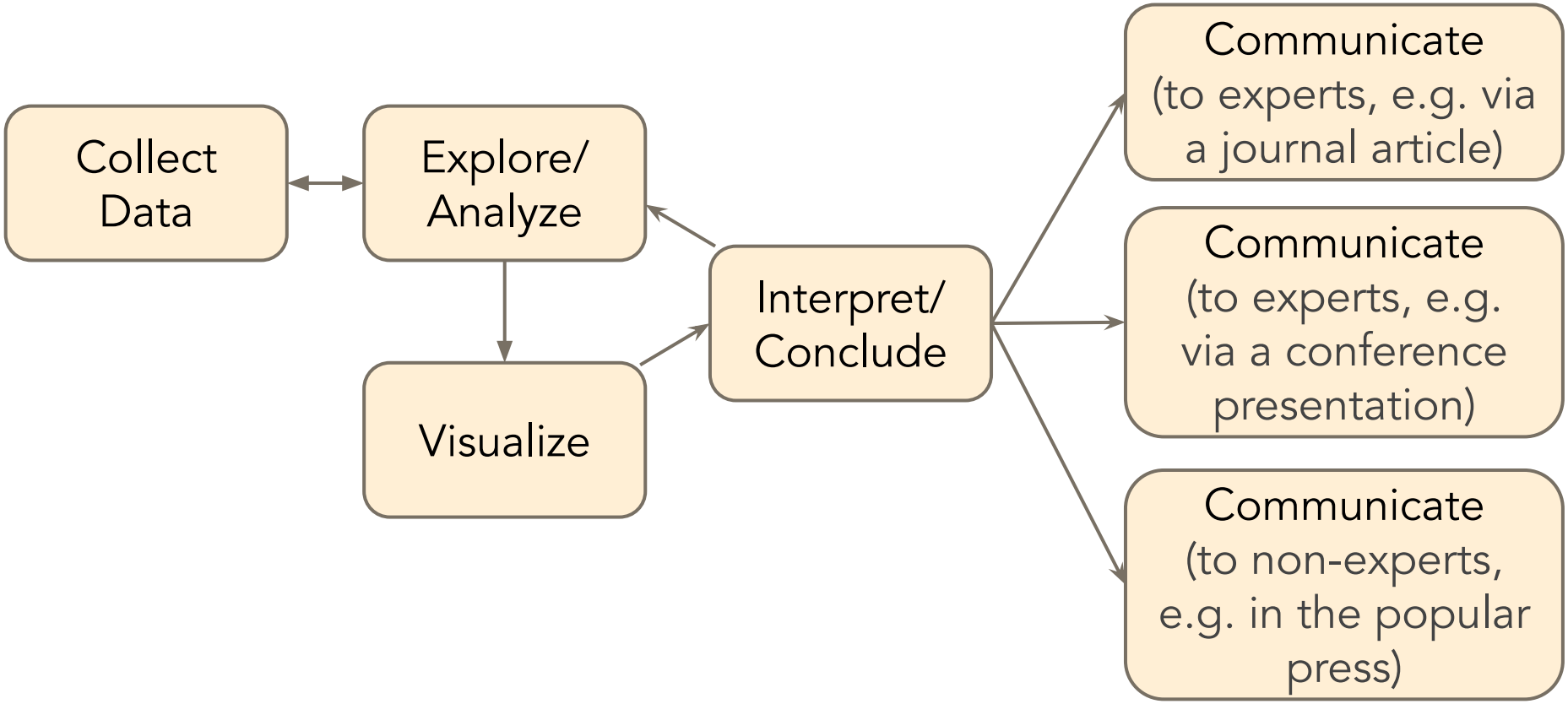
Data visualization is part art and part science. The challenge is to get the art right without getting the science wrong and vice versa.
A data visualization first and foremost has to accurately convey the data. It must not mislead or distort.
If one number is twice as large as another, but in the visualization they look to be about the same, then the visualization is wrong.

"Fundamentals of Data Visualization", Claus Wilke 2018


Collect Data
Explore/ Analyze
Visualize
Interpret/ Conclude
Communicate (to experts, e.g. via a journal article)
Communicate (to experts, e.g. via a conference presentation)
Communicate (to non-experts, e.g. in the popular press)

Outline of the workshop

1. "Theoretical" considerations
   - Types of figures
   - Mapping data onto figures
   - Encouraging accurate comparisons

2. "Practical" considerations
   - Color choice
   - Adapting figures for the audience
   - File formats

Types of figures

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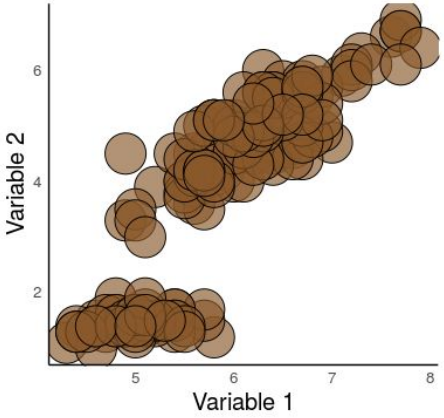
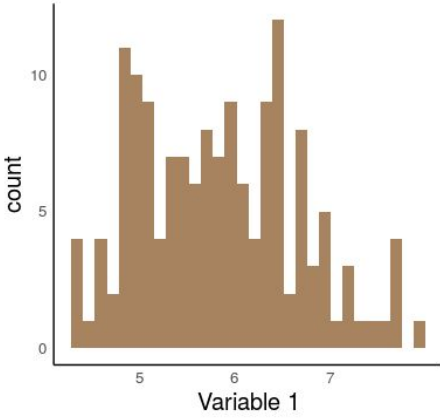
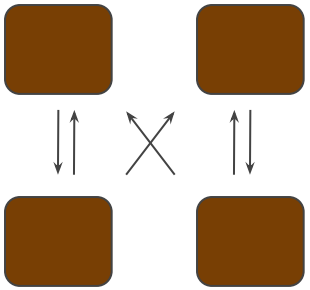
Relationships (among variables)



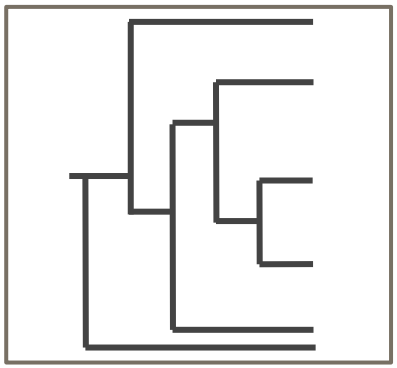
Distribution



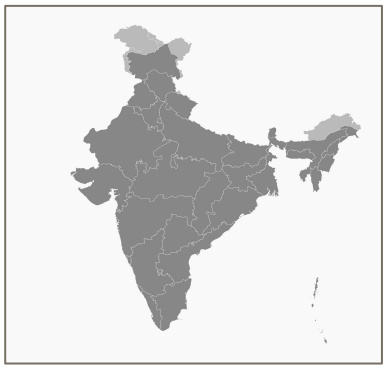
Concepts



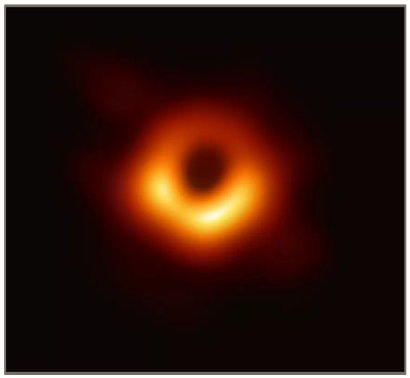
Relationships (among groups)



Geography

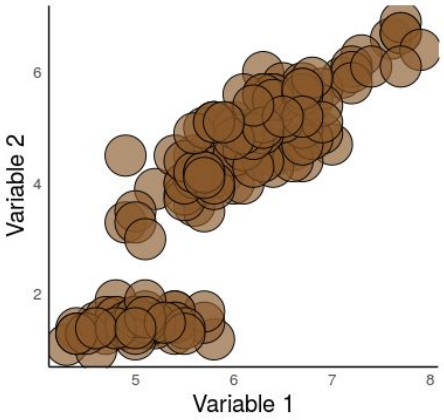


Pictures



Types of figures

Relationships (among variables)



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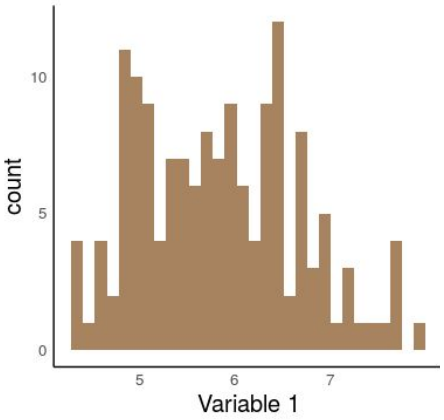
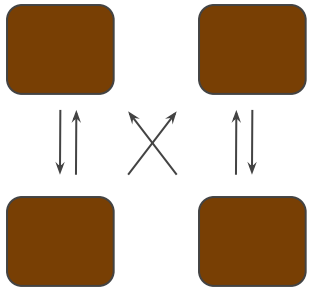


Concepts



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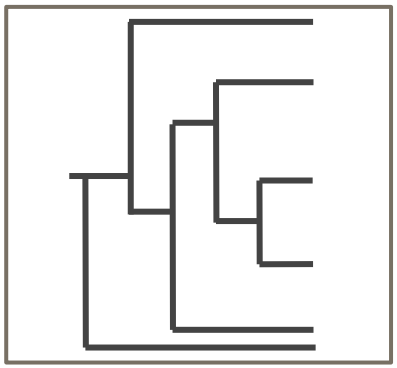

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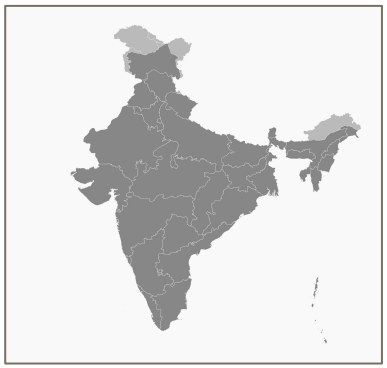

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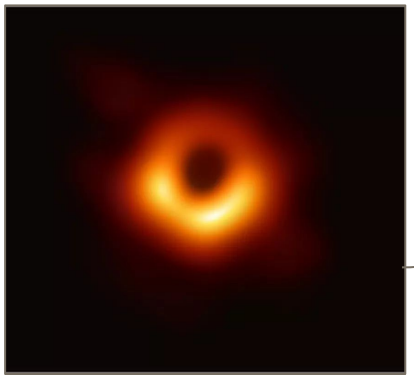

Combination (multipanel figures)

Elements of a good figure

A good figure is one that…

1. Shows the data
2. Tells the truth
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The Visual Display of Quantitative Information, Edward Tufte

What makes a figure bad?

Figures are often bad because of one of these three problems:

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   (e.g. ugly color combinations or fonts)

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Scientific figures are a blend of two disciplines: information design and graphic design

- Kelly Krause, Creative Director at Nature

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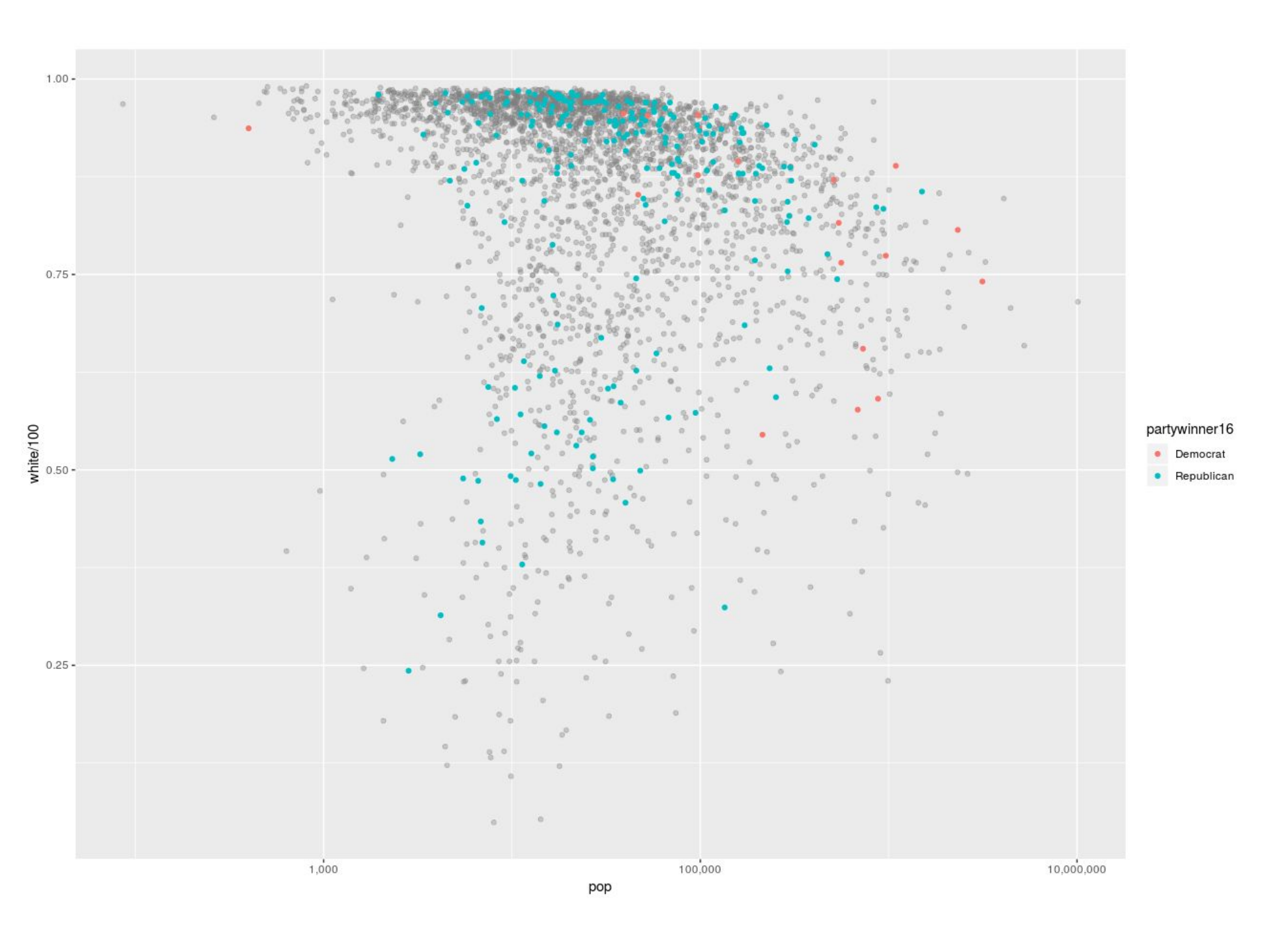
Scientific figures are a blend of ~~two~~ three disciplines: information design and graphic design, and the scientific domain

Transforming a figure:
An example from 2016 US elections

Example from "Data Visualization", Kieran Healey, 2018


1.00
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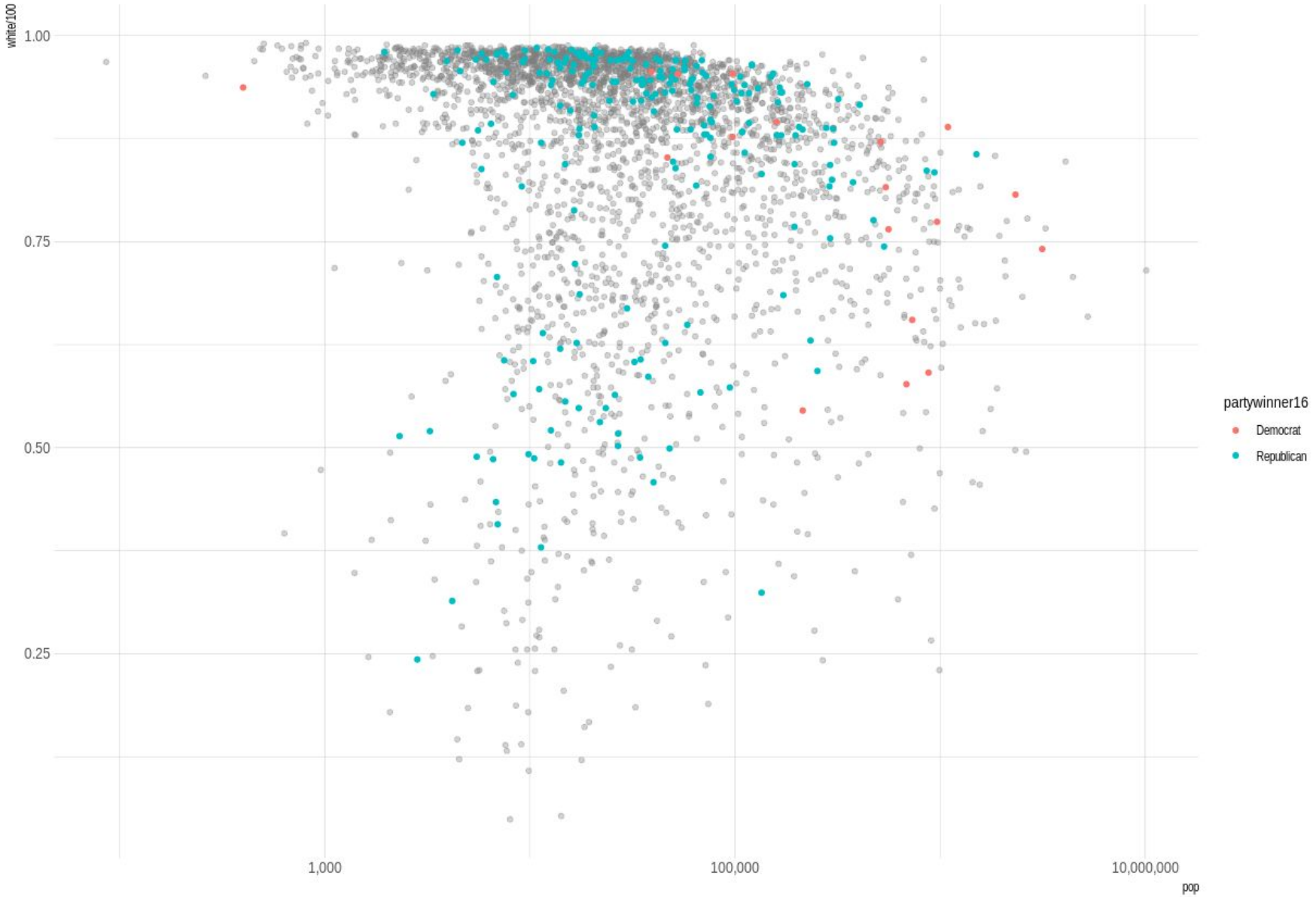
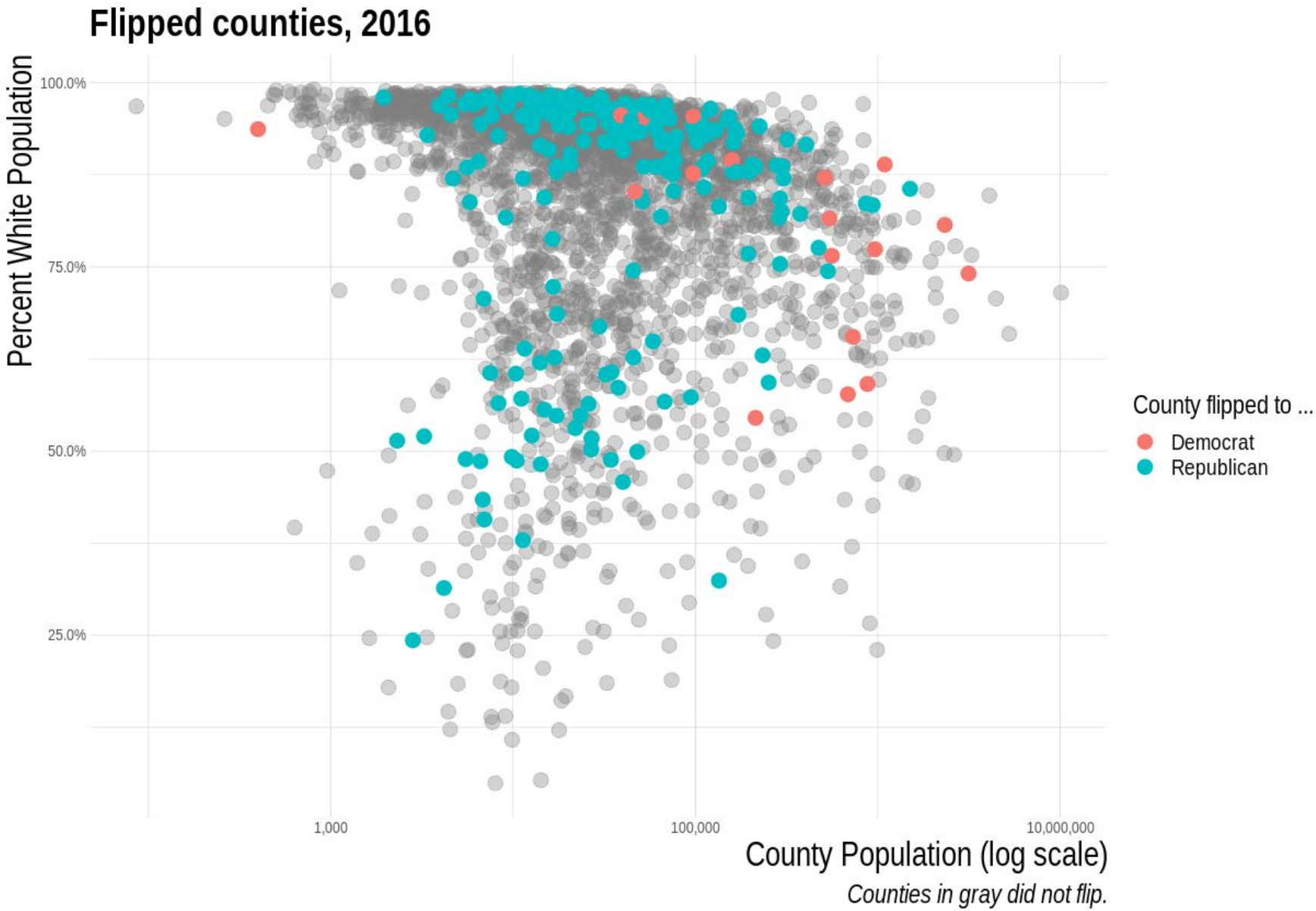
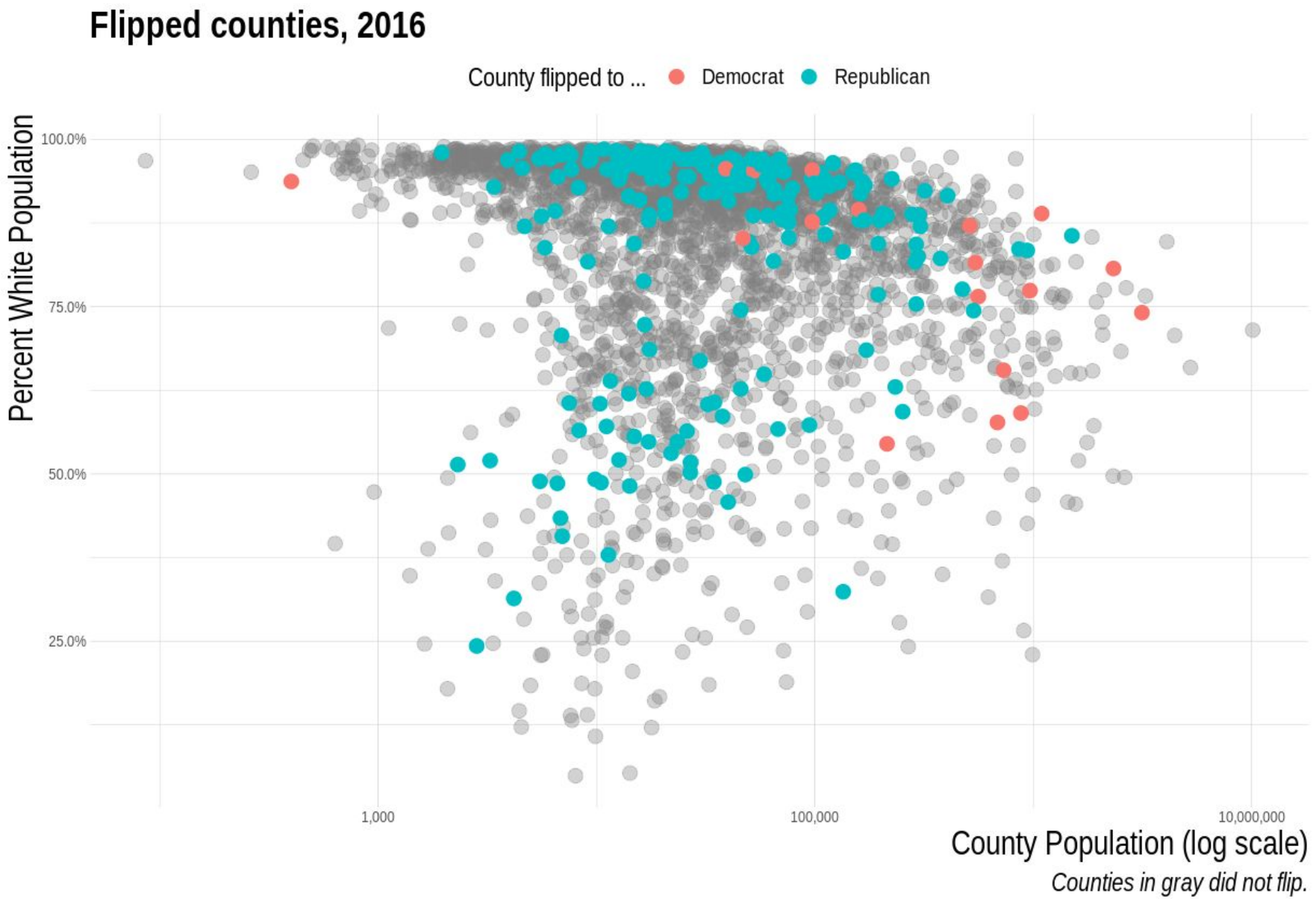
0.25
white/100
1,000
100,000
10,000,000
pop
partywinner16
Democrat
Republican



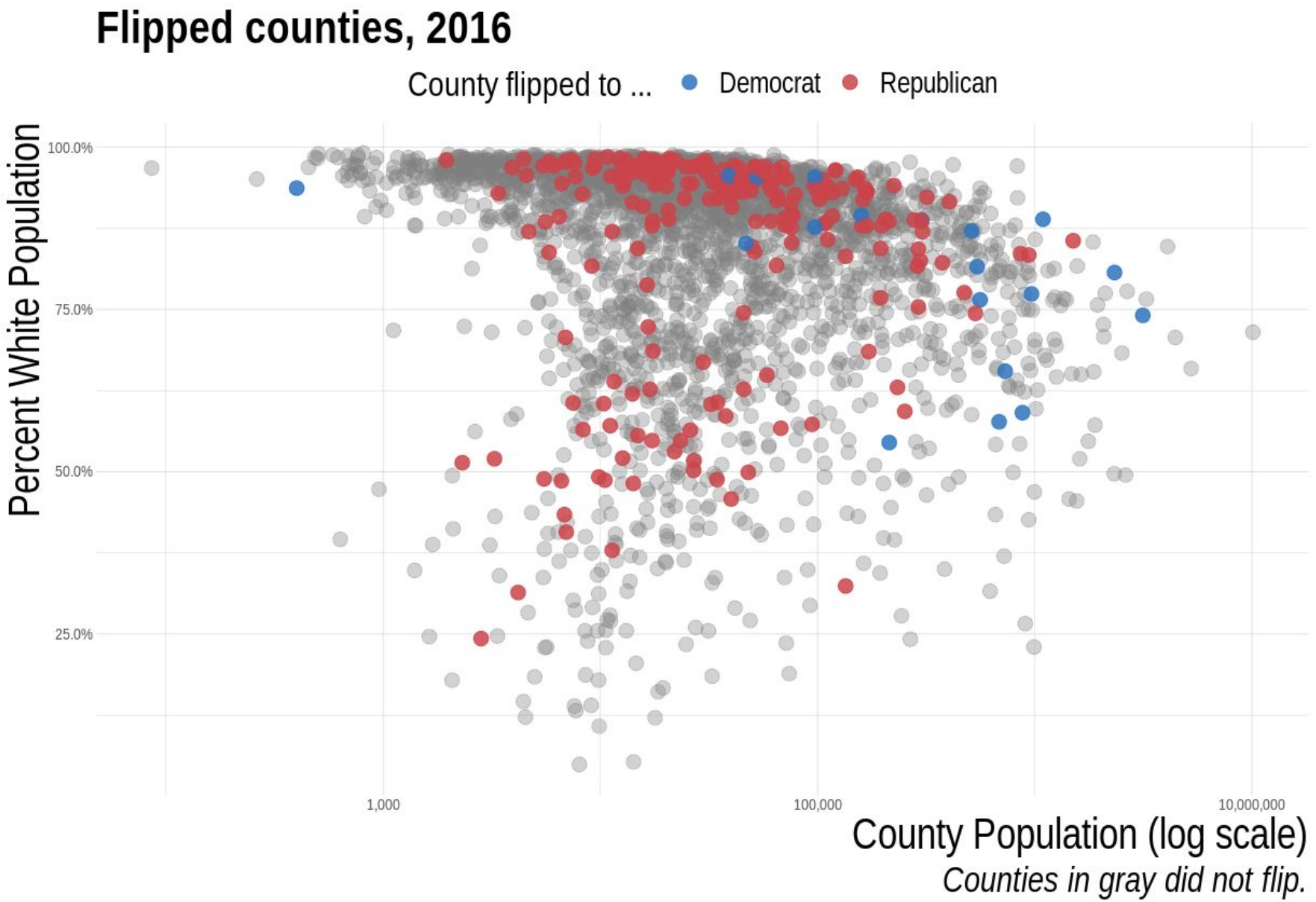
Eliminated grey background



Increased font and point sizes; added informative axis labels



Moved legend to the top to make better use of space



Changed color palette to align with viewer perceptions

Mapping data onto figures

The figure on the previous slide has three "dimensions" of information:

x position;
y position;
color.

Mapping data onto figures

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x position;
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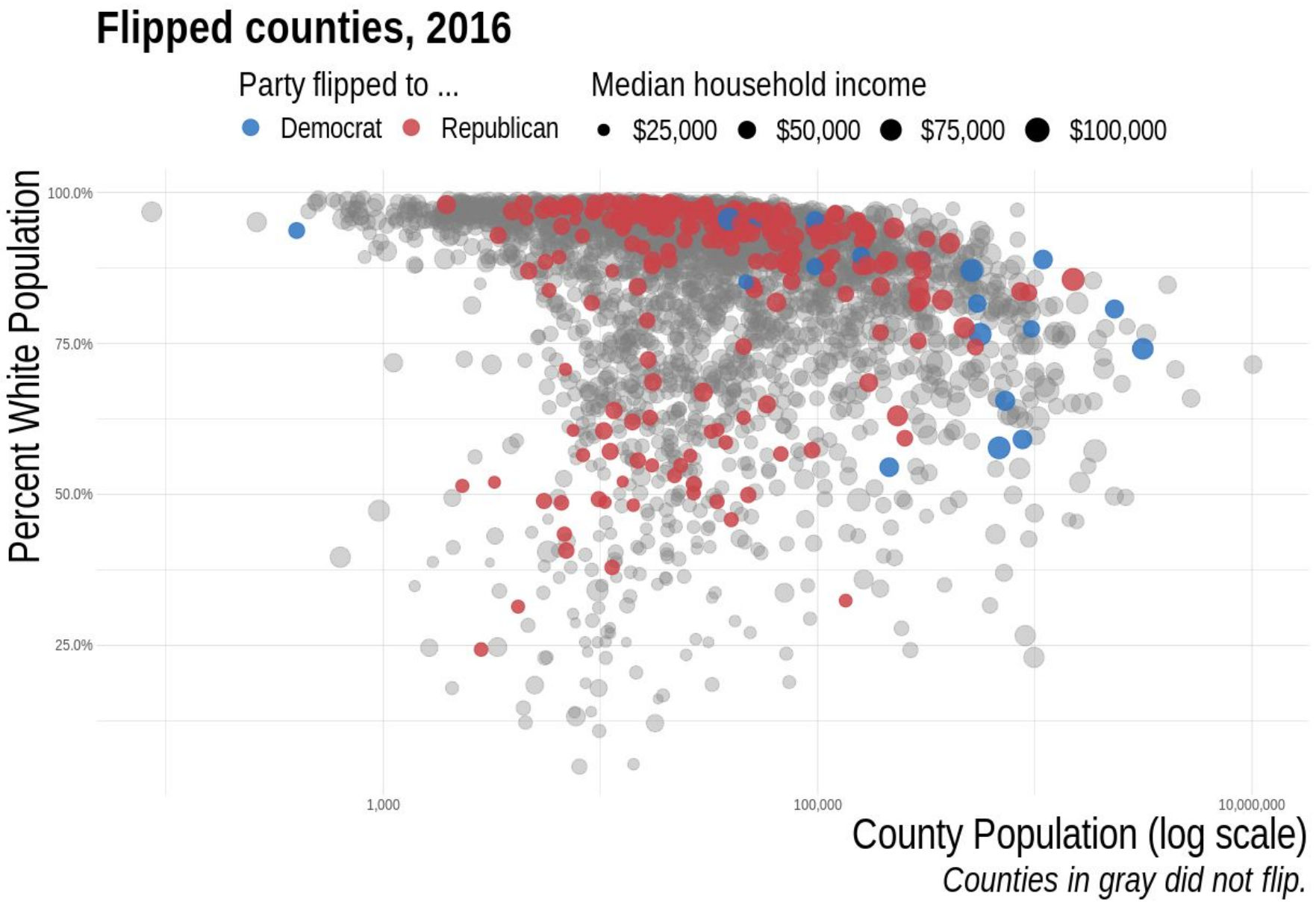
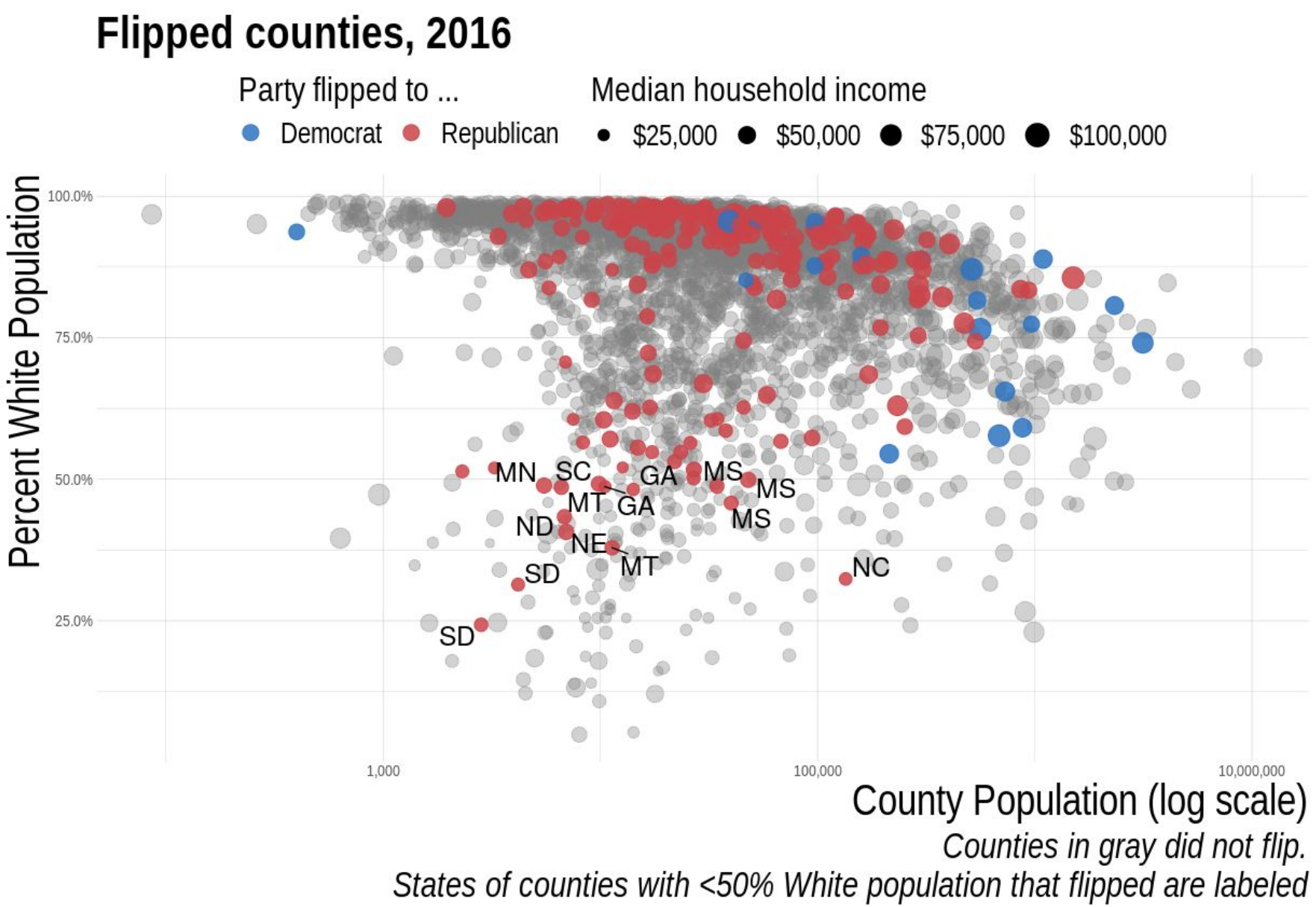
color.

If appropriate, we can *map* extra *dimensions of data* onto different *channels* single figure.



Sized points by household income

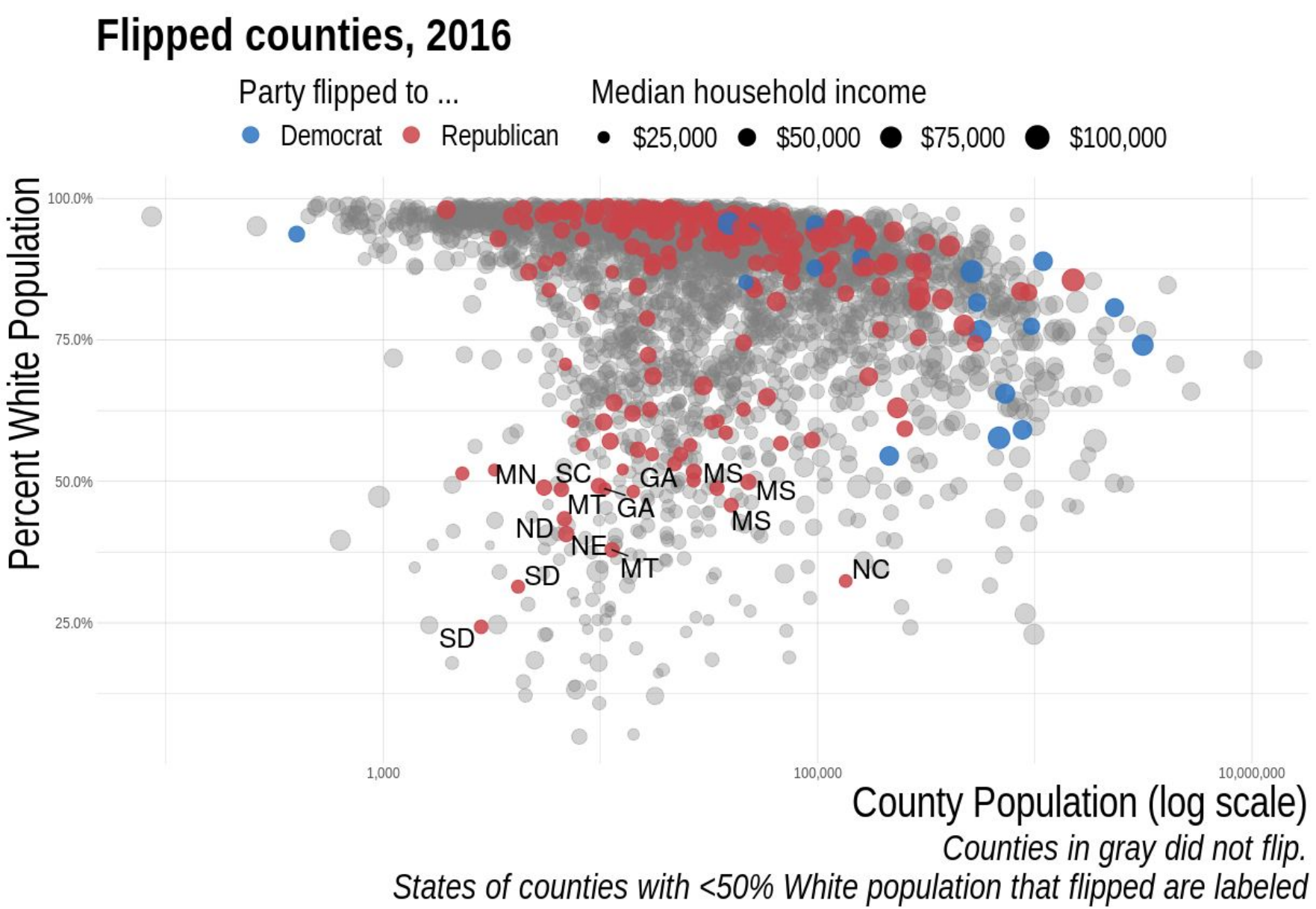


Labeled outlier points (and explained the labeling with text)

Figures are not data dumps.

They should help viewers make sense of information.

This means that in some cases, not all data points will be treated in the same way.



Note that not all points are labelled- that's OK!

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Multipanel figures

The same principles of good and bad figures apply to multipanel figures.

Some notes:

- Use consistent color schemes
- Follow reader expectations
  (e.g. organize information left to right, top to bottom)
- Clarify how the different elements relate to each other

Pay special attention to figure legends and axis labels.

A good figure (+ legend) should stand on its own.

Consider thinking about a figure legend as a mini-abstract for the figure.

1) Main takeaway;
2) Very brief methods overview;
3) Source of data.

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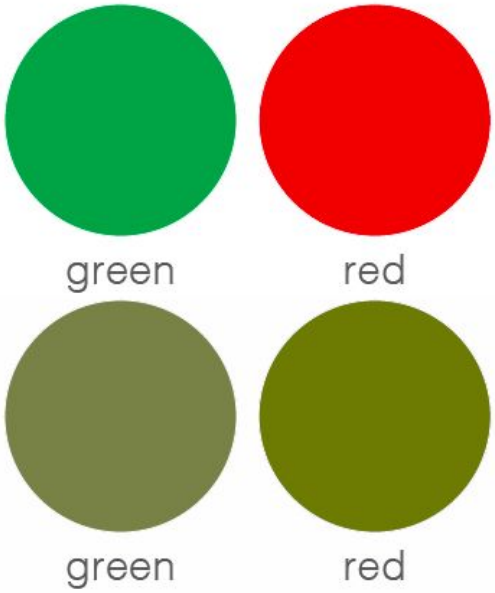
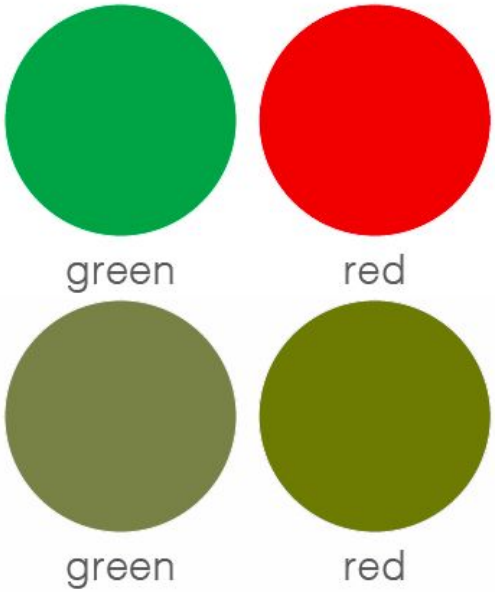
Color choice

Color choice 1: Design for colorblind viewers

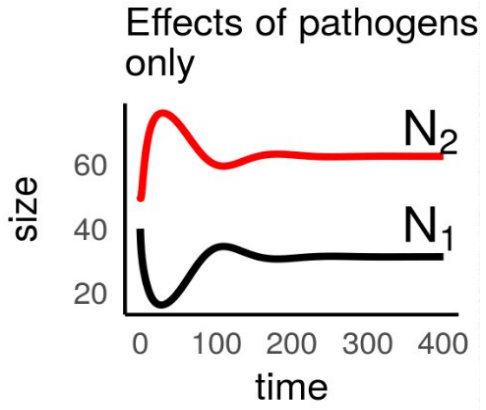


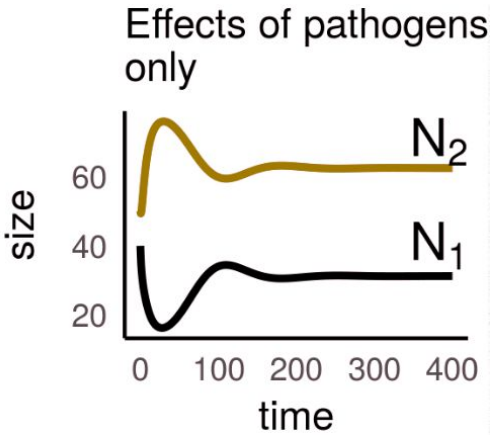
Color blindness simulated using Coblis;
More advice on designing for accessibility.

Color choice 1: Design for colorblind viewers



Color blindness





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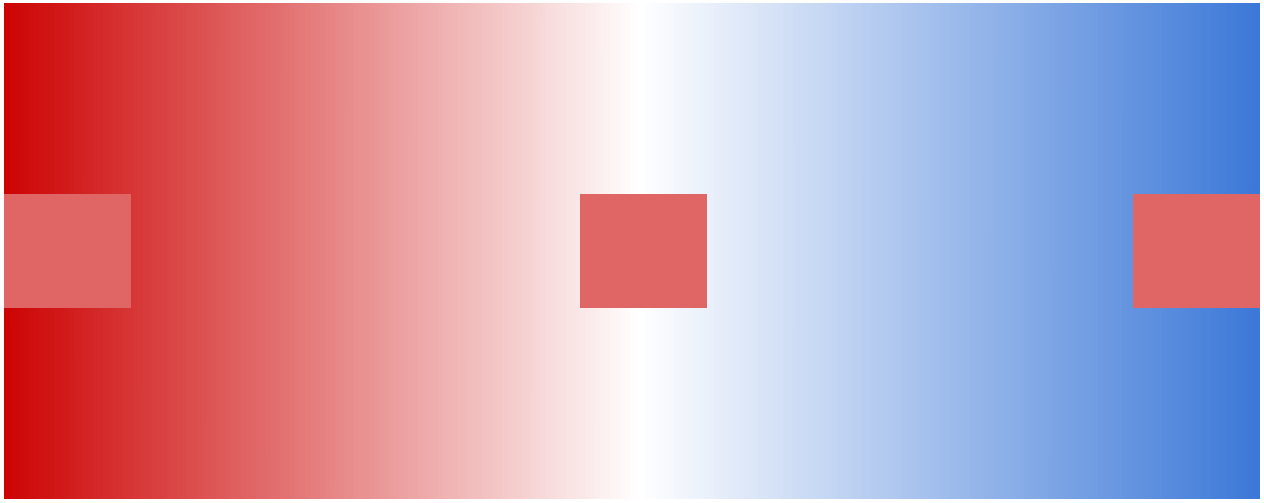
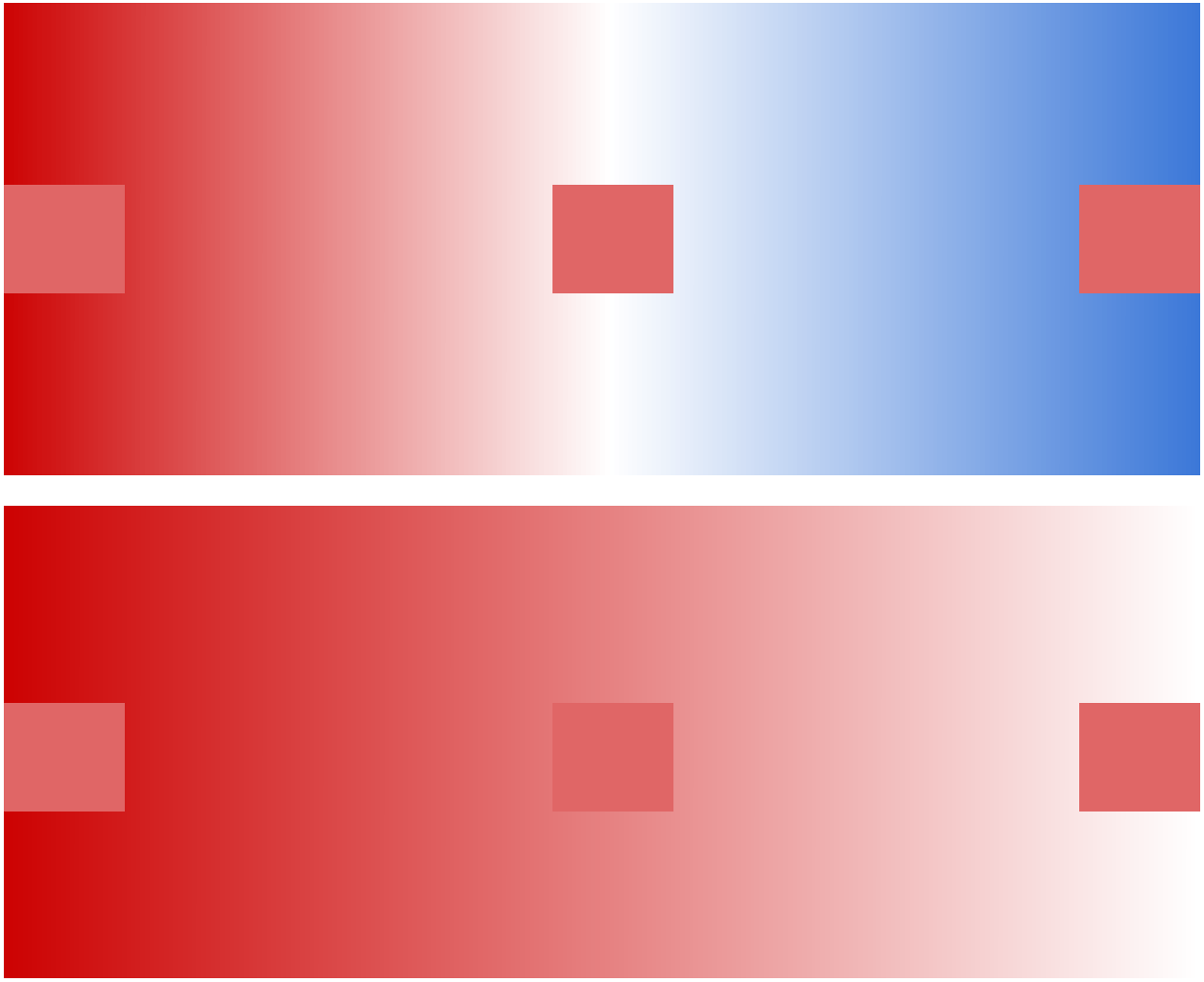
Color choice 2: Context changes color perception



Color choice 2: Context changes color perception

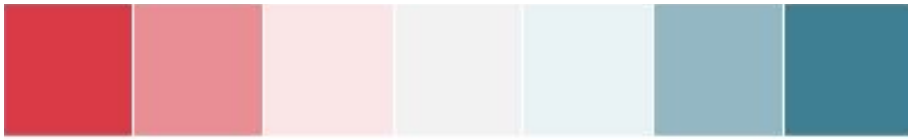


Color choice 3: Appropriate palettes

Decide whether *qualitative*, *sequential, or divergent* palettes are right for your figure.

Coloring by category; order is arbitrary

Highlight high (or low) values of a quantitative variable



Highlight high and low values of a quantitative variable

Some suggestions for choosing colors

1. Design colorblind-friendly figures
   use colorblind-friendly palettes to design your figures and verify on colorblindness simulators.

2. Use "natural" choices
   e.g. blue for Dems/red for Reps in the US;
   blue → red for cold → hot;
   map color onto natural differences between groups (e.g. between different species).

3. Use sequential/diverging/qualitative palettes as appropriate -- see colorbrewer palettes

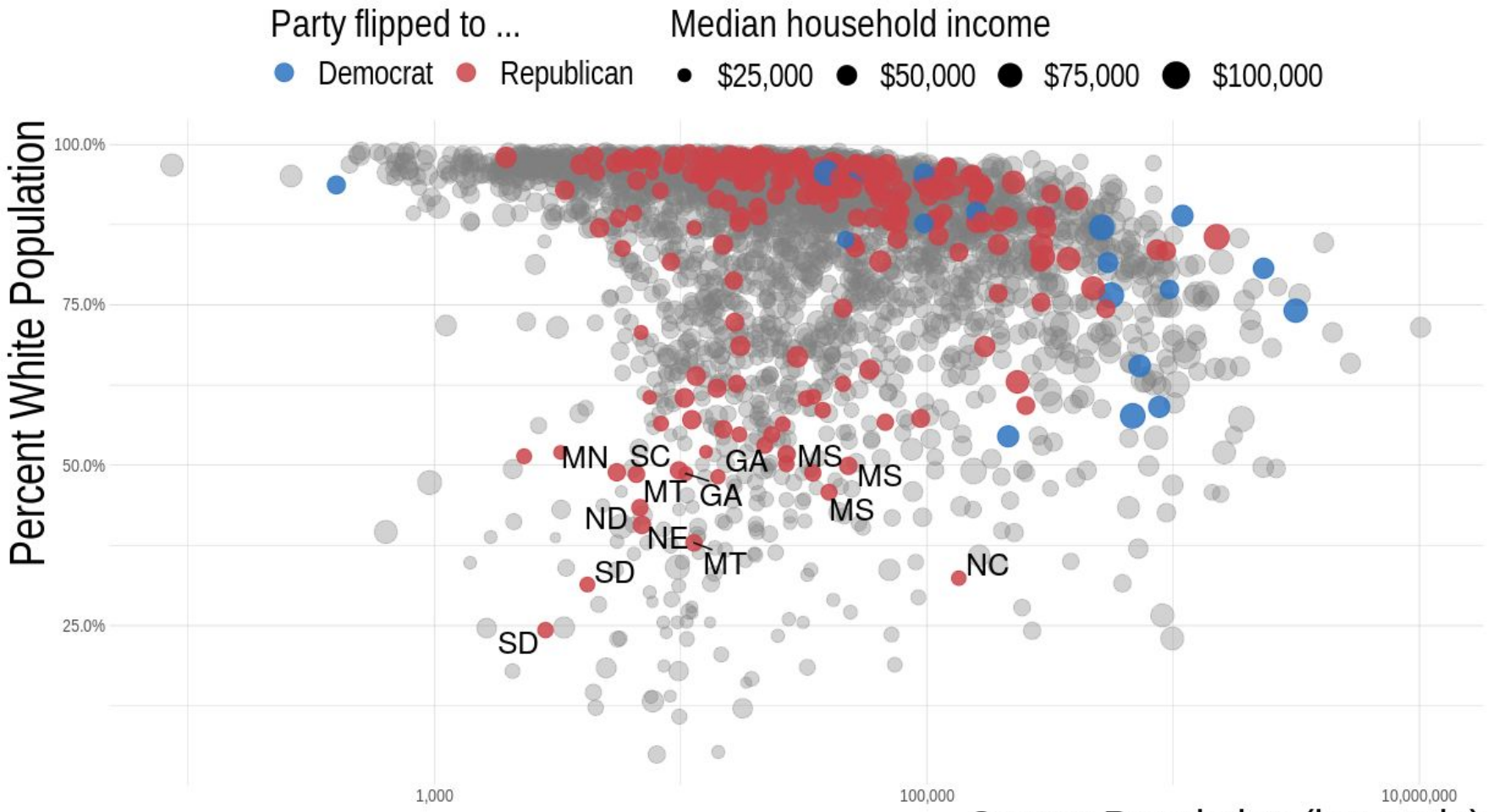
4. Consider the context.

Key reminder for working with colors

Try not to rely on color to encode any essential information.

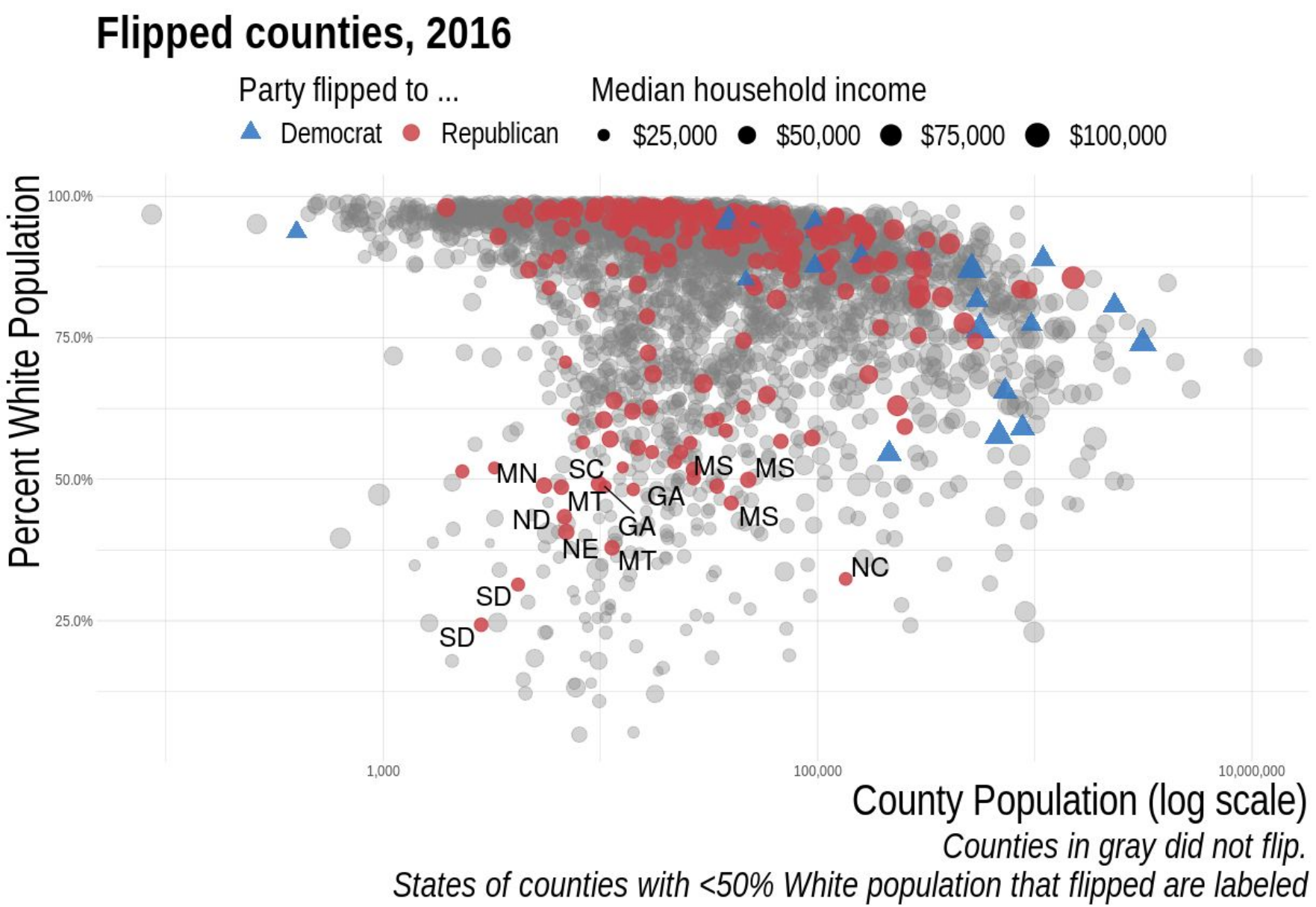
(It should only enhance information that is available without color.)

Flipped counties, 2016



Counties in gray did not flip.

States of counties with <50% White population that flipped are labeled



Converted blue circles into blue triangles

Adapting figures for the audience

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For a paper

How does this figure
render in black and white?

How does the figure scale
down to a smaller size?

Does the information in
this figure interact well
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For a presentation

Is the figure clearly visible for the audience?

Does the information in this figure interact well with the slides around it?

Will the audience have enough time to digest the information?

File formats

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"Raster" formats:

Based on coloring particular pixels at particular locations.

Each file is optimized at a particular resolution -- so, scaling up results in blurry images.

e.g. JPEG, PNG

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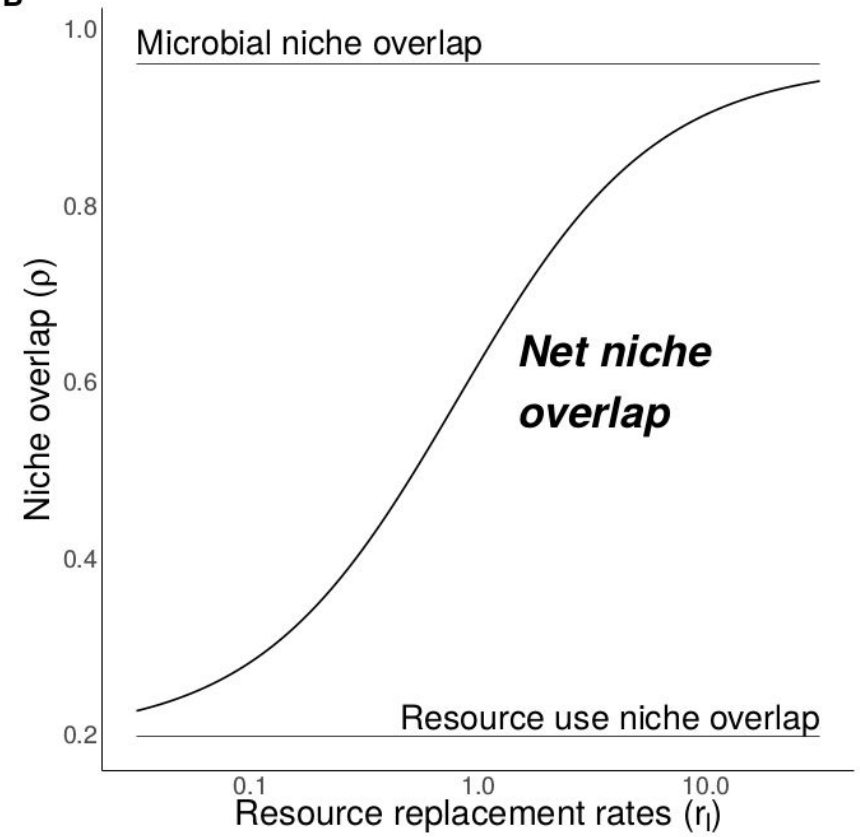
"Vector" formats:

Based on connecting points in a 2-D plane with lines and curves.

These files are scalable to any size, the figures are "crisper", and the file sizes are small

e.g. SVG, PDF

B


1.0
Microbial niche overlap
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Niche overlap (ρ)
Net niche overlap
Resource use niche overlap
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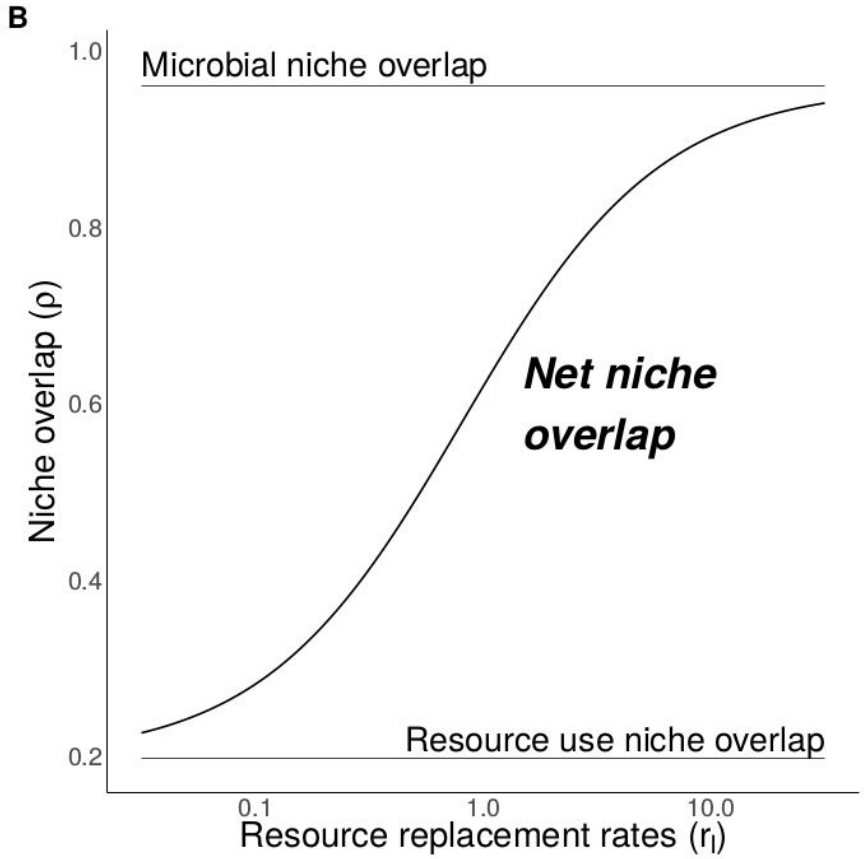
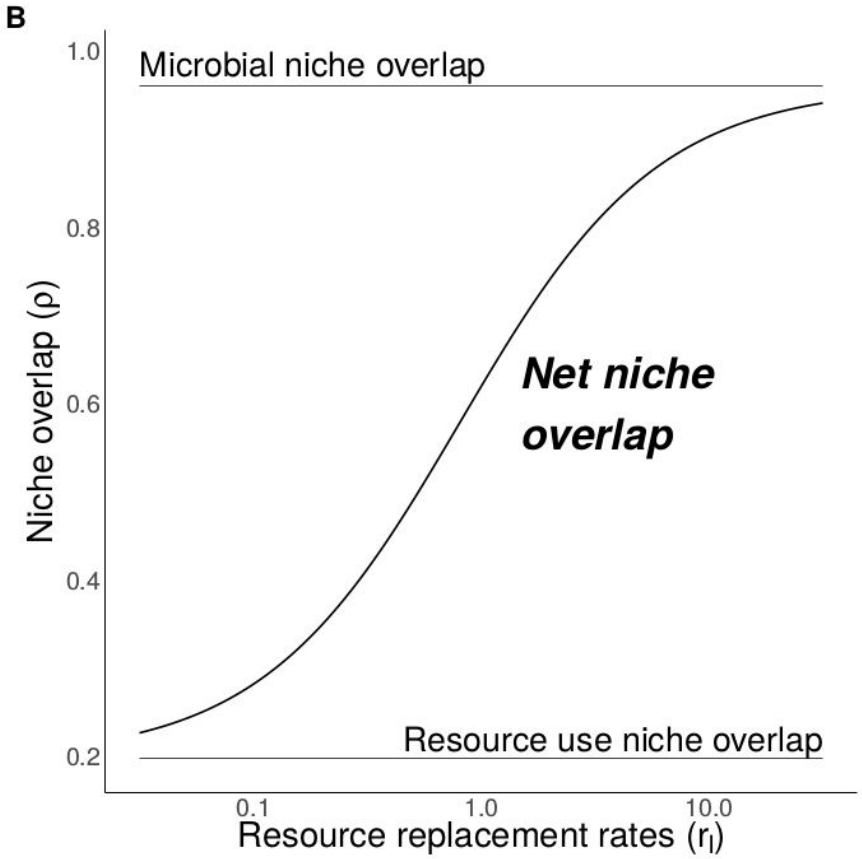
1.0
10.0
Resource replacement rates (r_l)



Net

File saved as PNG



Net

File saved as PNG

File saved as PDF

Net

(Free) tools for working with figures

For any figure that involves data, do it all in your favorite scripting language (e.g. Python, R).

1. Fully reproducible, easy to recreate.
2. Documents all data manipulations explicitly.
3. Easy to convert between file formats and resolutions

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Free graphics software:

Gimp (for rasterized images, e.g. PNGs, JPGs)
Inkscape (for vectorized images, e.g. SVGs)

Figures as an integral part of the writing process

Treat figures the same way as all other aspects of your writing: Make drafts, get comments, revise.

When creating a figure, think about how it will be consumed by the reader.

"Read" figures widely for inspiration.

R Graph Gallery; Edward Tufte's books; look through 'high-profile' figures in your field (but don't take them as gospel)

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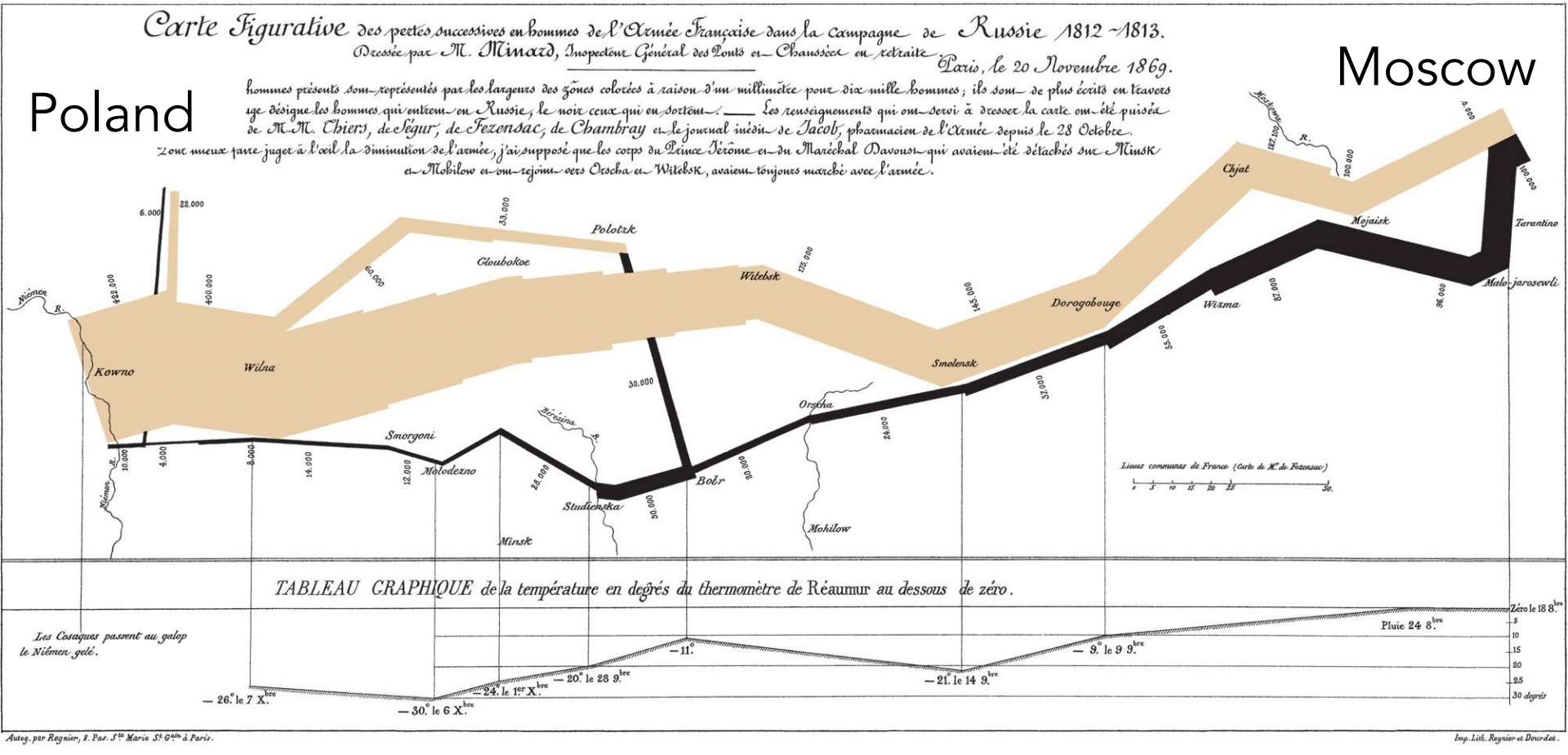
Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.
Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite.
Paris, le 20 Novembre 1869.
Poland
Moscow
Kowno
Wilna
Smorgoni
Molodezno
Minsk
Studienska
Bobr
Mohilow
Orscha
Smolensk
Dorogobouge
Wixma
Chjat
Mojaisk
Malo-jarosewli
Tarantino
Polotzk
Gloubokoe
Witebsk
Niemen R.
Beresina R.
Lieues communes de France (Carte de M.r de Fezensac)
TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.
Les Cosaques passent au galop le Niémen gelé.
— 26.° le 7 X.bre
— 30.° le 6 X.bre
— 24. le 1.er X.bre
— 20.° le 28 9.bre
— 11.°
— 21. le 14 9.bre
— 9.° le 9 9.bre
Pluie 24 8.bre
Zéro le 13 8.bre
30 degrés
Autog. par Regnier, 8. Pas. St.e Marie St Gain à Paris.
Imp. Lith. Regnier et Dourdet.

Resources

References

Fundamentals of data visualization (book);

Data Visualization: A practical introduction; (book)

Edward Tufte's website;

R Graphics cookbook (book);

Color Brewer (website);

Design for an Audience (slides from NYT graphics editor);

Basics of Information Design for Scientific Figures (talk by Nature figure editor);

Grammar of Graphics (book);

Coblis Color blindness simulator;

Making accessible visualizations.

Free graphics software

R (+ ggplot2)

Inkscape

Gimp

*Do **not** use Powerpoint to paste together panels for a multipanel figure.*