Lecture 5: Maps 1 of 2

February 24, 2025

Course Administration

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2. Beginning of a three lecture deviation from charts
    - maps 1
    - functions and stories
    - maps 2

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Lecture 5: Maps

Good, Bad, Ugly

Maps in general

1. What is a map?
2. Why maps?
3. What are the components of maps?
4. When do maps deceive?

Digital maps

1. What they are
2. What they can do

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Making Maps in R

1. `sf` package
2. Reading
3. Plotting
4. Projections
5. Spatially combining

Next Week's Assignment

Find a descriptive or choropleth map. Post link to google sheet by Wednesday noon.

Finder	Commenter
Emma C.	Caden S.
Caroline W.	Maddie S.

Katelyn on Raquel's Example

Flight Hours and General Aviation Accident Likelihood

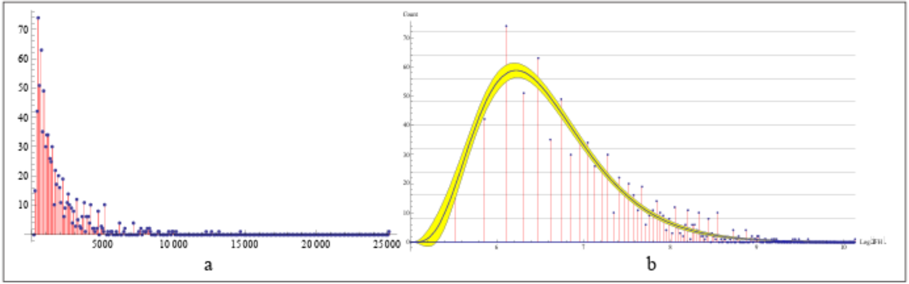

Figure 8. Frequency histograms of GA fatal accident count (y-axis) with a) untransformed, and b) natural log (ln)-transformed x-axis (which eventually proved essential to successful data-fitting).

From Federal Aviation Administration, "Predicting General Aviation Accident Frequency from Pilot Total Flight Hours," October 2012.

Why Do We Take Logs Sometimes?

$$\mathbf{y = x}$$

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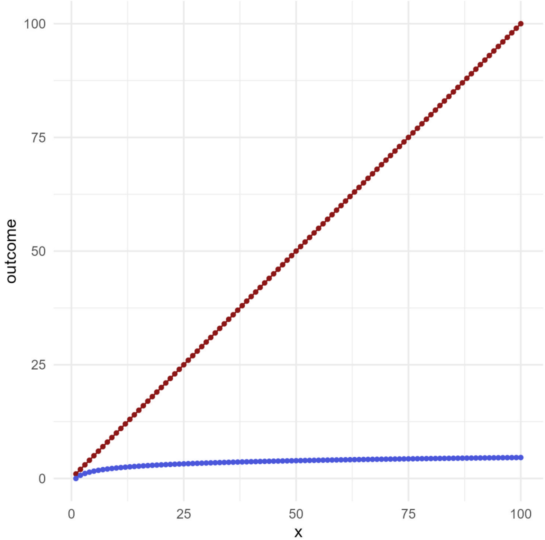
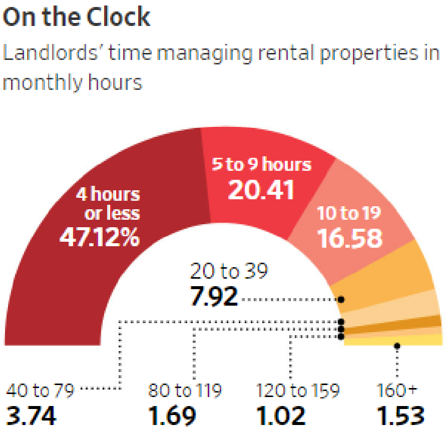


Past Student Sent This Graph

"Where New Landlords Go Wrong," *WSJ*, Feb. 17, 2023



From *WSJ*, Feb. 17, 2023.

On Maps, Today

- Maps in general
  1. What is a map?
  2. Why maps?
  3. What must you decide to make a map?
  4. Why avoid maps?
  5. When do maps deceive?
  6. Save for next map class: Choropleth maps and dot density maps
- Digital maps
  1. What they are
  2. What they can do (in person)

What and Why of Maps

1. What is a Map?

- Something that tries to describe two-dimensional space
- "scale model of reality" (Monmonier)
- "almost always smaller" than reality

Material in this section relies heavily on Mark Monmonier's *Mapping it Out*.

2. Why Maps?

- Use a map if you want to locate something in two-dimensional geographic space
- Use a map when you want to show a **spatial** relationship
- Don't use a map if you want to compare geographic units

When is Space Important?

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Don't use a map if you can do something simpler!

3. What Do You Have to Decide to Make a Map?

In distilling reality, there are three key choices

1. scale
2. projection
3. symbolization

Projection

- We want to show both
  - equivalence: size proportional to physical size
  - conformality: shape proportional to true shape

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Projection

- We want to show both
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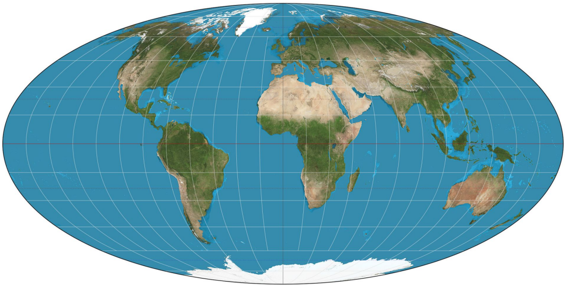
  - conformality: shape proportional to true shape
- But you cannot do both!
- When does this matter?
  - This matters for maps of the world
  - It is practically irrelevant for a map of DC
  - For small areas, we care about precision of distance
  - Frequently use a UTM (Universal Transverse Mercator) projection: units in meters

Rules of Thumb for Projections for Medium Areas

- Monmonier (p. 45) suggests for US either
  - Albers equal-area conic
  - Lambert conformal conic
- However, most maps you use should come with a projection defined

An Equal-Area Projection

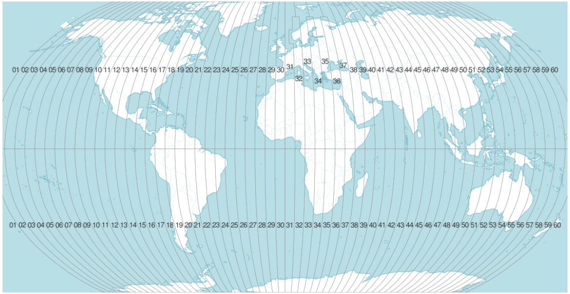


Thanks, Wikipedia.

The USA Four Ways

Thanks to Michael Corey.

UTM Zones

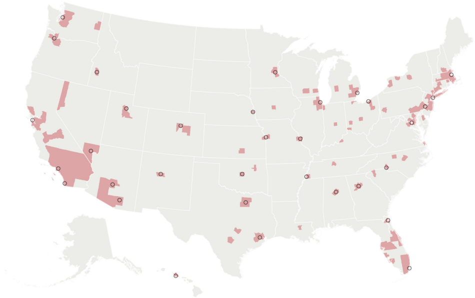


For small areas, use UTM projection if you need to calculate distances. Each number is a zone.
Thanks to Michael Corey.

4. Why Avoid Maps?

- They add complexity
- Geographic unit size infrequently related to importance
  - but remember that size indicates value
  - problematic!
- Examples?

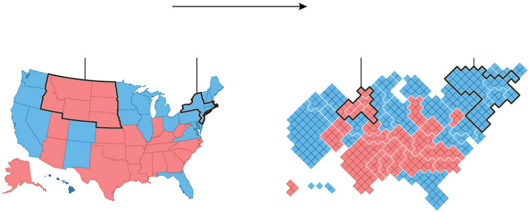
Red and Grey Areas Have About the Same Number of Votes Cast in 2012



With many thanks to the Washington Post

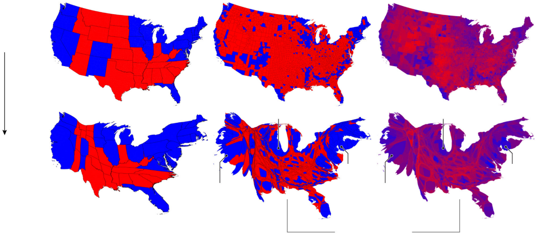
One Possible Solution

- A "cartogram" sizes locations by something: votes or people or electoral votes
- Five red midwestern states correspond to red block
- Mid-Atlantic corresponds to blue block

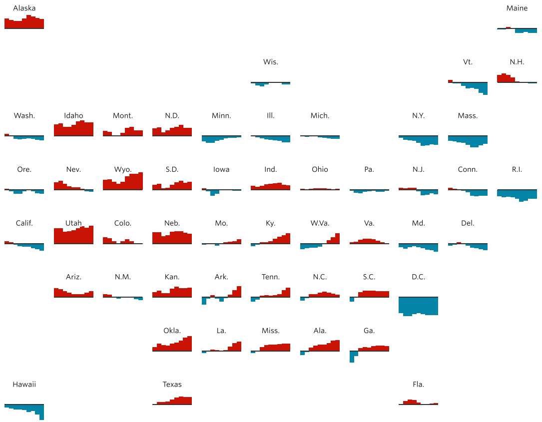


Another Possible Solution

- Thanks to U of Michigan physicist Newman
- Columns are state winner, county winner, county shaded by popular vote share
- Top is real map, bottom is cartogram
- Leftmost sized by electoral votes, others by votes cast



And a Quasi Map



Thanks to the Wall Street Journal, here.

When do Maps Deceive? 1 of 2

Modifiable Areal Unit Problem

- the value you calculate depends on the size of the geographic unit

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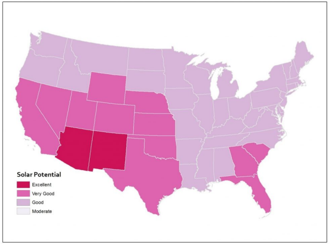
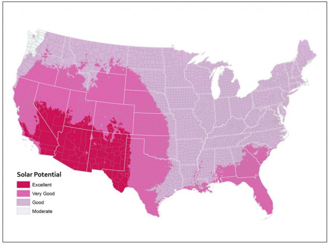




When do Maps Deceive? 2 of 2

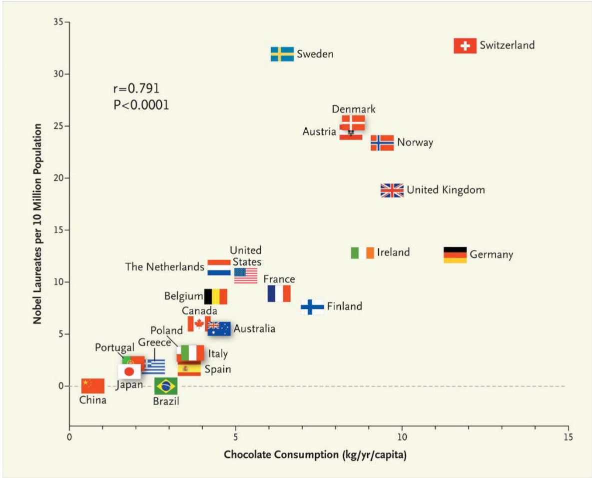
Ecological Fallacy

- not really the fault of the map
- reader attributes feature of average
- to those in group

When do Maps Deceive? 2 of 2

Ecological Fallacy

- not really the fault of the map
- reader attributes feature of average
- to those in group
- Here, chocolate consumption
- causes Nobel prizes



Thanks to data.europa.eu.

Digital Maps

1. Digital Maps Have

- Units defined by coordinates in space
- Data for each unit

Examples of a map unit of observation, please!

Digital Maps

- A map is a representation of space
- A digital map is a file that tells a computer how to do this
- There are many formats, but we'll focus on shapefiles
- Shapefiles are a proprietary ArcInfo format, but can be read in R

Three Major Types of Shapes for Maps

1. points
2. lines
3. polygons

Points in Space

- location 1: (x, y)
- location 2: (x, y)
- location 3: (x, y)

What would you represent with points?

A Points Dataframe Example

LibID	X	Y	Name	Books
Ana	38.866	-76.980	Anacostia	500
CV	38.889	-76.932	Capitol View	501
Gtn	38.913	-77.068	Georgetown	499

Lines in Space

- location 1: $(x_1, y_1), (x_2, y_2)$
- location 2: $(x_1, y_1), (x_2, y_2)$
- location 3: $(x_1, y_1), (x_2, y_2)$

What would you represent with lines?

A Lines Dataframe Example

Int	X1	Y1	X2	Y2	Name	Condition
495	45	-62	26	-62	I495W	good
695	23	-50	25	-50	I695S	poor
10	15	-23	18	-24	I10	excellent

Polygons in Space

- location 1: $(x_1, y_1), (x_2, y_2), (x_3, y_3), (x_4, y_4), (x_1, y_1)$
- location 2: $(x_1, y_1), (x_2, y_2), (x_3, y_3), (x_4, y_4), (x_5, y_5), (x_1, y_1)$
- location 3: $(x_1, y_1), (x_2, y_2), (x_3, y_3), (x_1, y_1)$

Note that last point is the same as the first point.[1]

What would you represent with polygons?

[1] Polygons can have holes; we can talk about this.

A Polygon Dataframe Example

Triangle	X1	Y1	X2	Y2	X3	Y3	X4	Y4
a	1	1	1	2	2	1	1	1
b	1	1	1	3	3	1	1	1

But Where Do the Points Go?

- A map file needs some instructions on what the points mean
- Map makers define coordinate systems so that everyone agrees on what $(x_1, y_1), (x_2, y_2)$ means
- Many maps have a geographic/global/spherical system: in latitude/longitude

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- Many maps have a geographic/global/spherical system: in latitude/longitude
- And to lay flat, if we are not drawing on a globe
    - we need a projected coordinate system
    - have a defined unit of measurement: meters, feet, decimal degrees
    - usually tell you meters/feet/miles from a specific point

Implications for Mapping

- You can't put maps with two different coordinate systems on top of each other
- Easier to calculate distances and areas with projected coordinate systems
- You can go from one projection to another, but **use the right command**
- Digital maps usually come with a projection defined

R, on Maps

Next Lecture

- Next class: come prepared to work on your policy brief storyline
- Read Knaflic, Chapters 7 and 8