Maps

Data Visualization | Steven Bedrick & Jackie Wirz

Image from xkcd.com http://xkcd.com/503/
Ptolemy Geography (original ~150 AD) - The British Library Harley MS 7182, ff 58v-59.
Herman Moll  *A New Map of the Whole World* (1736). Image from Wikipedia.
Charles Joseph Minard map of Napoleon's disastrous Russian campaign of 1812 (1869)
Cholera Cases in London, 1854, drawn by Charles Cheffins.
Texas oil boom is visible from space

Lighting and natural gas flares from drilling on the 400-mile-long Eagle Ford shale formation can be seen from space in this image.

The new formation has helped make Texas the No. 1 oil-producing state in the nation.

**Oil production from different U.S. regions** (in thousands of barrels per day)

![Graph showing oil production from different U.S. regions](http://latdevelopers.com/graphics/bag/texas-oil-boom/texas-oil-boom.jpg)

Source: Energy Information Administration

SPREAD OF EBOLA
Outbreaks and scares as of August 6, 2014
Source: World Health Organization

International Business Times/Hanna Sender The Spread of Ebola (2014)
Maps 101
Overview and terminology
DMS: – Degrees, minutes, and seconds
Latitude: 40°26'47"N – Longitude: 79°58'36"W

Decimal Degree: – Only degrees (real number)
Latitude: 40.446195 – Longitude: -79.948862

3D Spheres do not flatten well...
Distortion Happens: Choose what you want to prioritize

• Distance between two points
• Direction between two points
• Shape of regions
• Area of regions
• Familiarity of projection...

Azimuthal
Preserves direction / distance
Equal-Area

Preserves area
Conformal
Preserves local angles
Tissot *Indicatrices*: http://en.wikipedia.org/wiki/Tissot%27s_indicatrix
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Comparing Map Projections

http://bl.ocks.org/syntagmatic/3711245
Comparing Map Projections

http://bl.ocks.org/syntagmatic/3711245
WHAT YOUR FAVORITE MAP PROJECTION SAYS ABOUT YOU

MERCATOR

YOU'RE NOT REALLY INTO MAPS.

http://xkcd.com/977/
What your favorite map projection says about you

Robinson

You have a comfortable pair of running shoes that you wear everywhere. You like coffee and enjoy the Beatles. You think the Robinson is the best-looking projection, hands down.

Dymaxion

You like Isaac Asimov, XML, and shoes with toes. You think the Segway got a bad rap. You own 3D goggles, which you use to view rotating models of better 3D goggles. You type in Dvorak.

http://xkcd.com/977/
WHAT YOUR FAVORITE MAP PROJECTION SAYS ABOUT YOU

PEIRCE QUINCUNCIAL

YOU THINK THAT WHEN WE LOOK AT A MAP, WHAT WE REALLY SEE IS OURSELVES. AFTER YOU FIRST SAW INCEPTION, YOU SAT SILENT IN THE THEATER FOR SIX HOURS. IT FREAKS YOU OUT TO REALIZE THAT EVERYONE AROUND YOU HAS A SKELETON INSIDE THEM. YOU HAVE REALLY LOOKED AT YOUR HANDS.

http://xkcd.com/977/
Maps Types

More than you’d think...
Physical Maps – Shows physical features (mountains, lakes)

Road Maps – Shows location and name of roads, other manmade features

Topographic Maps – Shows 3d topography in 2d map using contour lines

Thematic Maps – generally designed to depict a single theme (choropleth, proportional symbol, dot maps)

Other Maps – includes cartograms, flow maps, stylized
Thematic Maps

choropleth, proportional symbol, dot maps
Choropleth

Uses color and intensity to indicate data values
  • Use color *wisely*!

Data should be normalized
  • Good: Percentages, ratios
  • Bad: Counts, totals
Illiteracy in France

Charles Dupin, 1826

Slide modified from Hanspeter Pfister, Harvard
Slide modified from Hanspeter Pfister, Harvard
By Population Density

This map removes mostly uninhabited areas, revealing Mr. Bush’s suburban and rural support in the East and South.

* Areas with less than three people per square mile.
(Proportional) Symbol Maps

Use symbol size, color, or shape to code data in map overlays

Data sets be aggregated to points within an area
  • e.g. Cities
Killer circles threaten America

- No sides
- Area equal to $\pi r^2$
- Extremely round
- Often fatal
- North Dakota, New Mexico, Colorado remain circle-free

How are Americans reacting to the growing geometric menace?

<table>
<thead>
<tr>
<th>Don't care</th>
<th>Unsure</th>
<th>Scared of circles</th>
</tr>
</thead>
<tbody>
<tr>
<td>6%</td>
<td>14%</td>
<td>80%</td>
</tr>
</tbody>
</table>
Murder Rate in Large Cities: January-June 2011

Incidents Per 100,000
- 0.1
- 1
- 10

http://mattstil.es/images/murder.png
Murder Rate in Large Cities: January – June 2011
Slide from Matthew Erickson, NY Times
Isopleth

Color codes data according to values
Use contour lines to follow data at specific values
Use “heat maps” display gradient data

Data should be normalized and binned or smoothed
• Binning determines number & visual density of isopaths
• Smoothing involved with heat map
Lines of Equal Magnetic Declination
Edmond Halley, 1701

Slide modified from Hanspeter Pfister, Harvard
Cartogram

Use data attribute values to distort the area or shape of familiar maps

Only as useful as your target population is familiar with the baseline map!

Can scale by:

• *Distance*
• *Dorling Cartograms* – *scaled shape*; does not maintain region shape
• *Area*
Figure 1.8  Airlines’ view of the United States.
Maps can be scaled to units other than distance. In this case, airline fares are used instead of miles or other linear units.
(Map copyright by the author.)

Airlines’ View of the United States
from Atlanta, Georgia

Compiled from advertised one-way coach airfares in the Atlanta Journal Constitution from Atlanta to various American cities, American Airlines, September 24, 1987.

Dent, “Cartography” Based on slide from Hanrahan
Elvis Concerts

Attendance per State, 1970 - 1977


Note: NV, with an estimated concert attendance of over 600,000, is excluded because of space limitations.

Note: DE, DC, ID, MT, NH, ND, VT, WY, AK = 0 NJ data are unavailable.

Dent and Turnbull, “Elvis Concerts” Based on slide from Hanrahan
The following slides depict “The World” using different cartogram data distortions.

Images are originally from Mark Newman, University of Michigan.
GDP
Child Mortality
The following slides depict the 2012 Presidential Elections using different cartographical approaches.

Images are originally from Mark Newman, University of Michigan.
Election Results by State
Election Results by Population of State
Election Results by Electoral College Votes
Election Results by County Population
Election Results by County Population with Gradient Binning
”Tilegrams” address some limitations of cartograms:
Flow Maps

Reduce visual clutter by clustering edges

Encoding

• Edge between two locations indicates flow between those locations
• Width of edge proportional to flow
• Usually wider end of edge is source of flow

Limitations – Can get difficult to compare flows – Best flow maps are done by hand

Special types: Sankey Diagrams
Transportation of Passengers in Ireland
Henry Drury Harness, 1837
Charles Joseph Minard map of Napoleon's disastrous Russian campaign of 1812 (1869)
Where will a biology PhD take you?

A faculty job is an “alternative” career.

At this rate, <10% of entering PhD students will become tenure-track faculty. Yet, 53% rank research professorships as their most desired career.¹

86,000
current US biology PhD students

1,900 to 3,900
foreign-trained PhDs start postdocs

30% do more than one postdoc¹

17,000
current bio PhDs doing non-science jobs

720
leave the US

37-68,000
current postdocs

29,000
current tenured and tenure-track faculty

22,500
current industry researchers

9,000
receive PhDs

70% (5,800)
postdoc

? years
US PhDs spend an average of 4 years, but others must spend longer to account for number of postdocs.

18% of PhDs get non-tenure track academic jobs within 6 years post grad.²

25,000
current non-tenure track academic positions

24,000
current non-research, science related jobs

7,000
current gov’t researchers

37% drop out

30%
(2,500)
don’t postdoc

10% of former postdocs (up from 2% in 2010) consider themselves unemployed.²

Every year, ~16,000 students start biology PhD programs

7 years
average time to degree

Sources:
1 - Science Careers Annual Postdoc Survey (2012) http://geo.lrrnywCN
3 - Sauermann & Roach 2012 PLOS ONE; DOI: 10.1371/journal.pone.0036307

Unless otherwise noted, NIH Biomedical Workforce Working Group (2012)

Migration from California

Tobler 1987

Phan et al. 2005

Verbeek et al. 2011

Cui et al. 2008

Holten & van Wijk 2009

Slide modified from Jeffery Heer, University of Washington
For Fun…,

Extra entertaining thematic maps

Generalizations... and gross generalizations
Map of Online Communities

Size on map represents volume of daily social activity (more = more). Based on data gathered from the spring and summer of 2010.

通宵达旦

About This Map

Communities rise and fall, and total membership numbers are not a good measure of community. Current size and growth rates do not always reflect total social activity in a community. This map is not an accurate measure of the total number of users, IPv4 addresses, or server capacity. Some communities are more tightly integrated, while others may have overlapping or competing interests. Some rise and fall with the ebb and flow of the internet.

Sources: The map includes data from various online communities, including forums, social networking sites, and other websites. The data used to create this map is based on publically available information and is intended to provide a general overview of the online social landscape. For more detailed information, please refer to the sources listed below.

Disclaimer: The map is not intended to be a definitive source of information. It is a visual representation of the online social landscape and should be used for informational purposes only. The map may not be 100% accurate due to the rapidly changing nature of the internet and the limitations of the data used to create it.
From Memory (was: Maps from Memory): http://www.flickr.com/groups/46079190@N00/
Some conversations

Is it good? Is it bad? Is it... something else?
UNITED STATES ECONOMIC ACTIVITY, SPLIT IN HALF

Image From: http://i.imgur.com/9sI9TRJ.png (atrubetskoy)
UNITED STATES ECONOMIC ACTIVITY, SPLIT IN HALF

Image From: http://i.imgur.com/9slRTRJ.png (atrubetskoy)
“The reason this is getting any attention at all is because it’s a map. If it were a bar chart or similar, people would just ignore it. But no matter how simple or obvious your data, once it’s shown on a map, people find it interesting.”

http://www.reddit.com/r/MapPorn/comments/1y371s/us_gdp_split_in_half_oc_1770x1114/
“Where does the map say "hey, I'm showing you that population density is highly correlated to GDP production." It doesn't. Therefore, it's misleading if you don't know much about the U.S., which was one of my points above.

Simplicity is not a virtue. Clarity is. If by striving for simplicity you sacrifice data that are necessary to put the information into a proper context (and you point out what those data could be), you're doing it wrong.”

http://www.thefunctionalart.com/2014/02/the-incredible-gdp-map-that-shows-that.html
“The objective of visualization is not just to surprise, enlighten and reveal new things to all. If you can, wow, oh my god and the rest. But sometimes it just reinforces, maybe showing something we know but from a different angle. That’s ok. It is still legitimate to serve 'just' that objective.”

UNITED STATES ECONOMIC ACTIVITY, SPLIT IN HALF

http://junkcharts.typepad.com/numbersruleyourworld/2014/02/numbersense-and-true-lies.html
Pet Peeve #208:
Geographic profile maps which are basically just population maps.
Homework

Let’s get Political...
Who is going to win the election?
What 2016 would look like if just men voted
Based on the FiveThirtyEight polls-only forecast

ELECTORAL VOTES NEEDED TO WIN

188  Clinton

350  Trump

Nebraska's 5 electoral votes
STATEWIDE:  
DISTRICTS:  

Maine's 4 electoral votes
STATEWIDE:  
DISTRICTS:  

FIVETHIRTEYEIGHT
Find a map that predicts the election...

Chose an interesting set of circumstances (e.g. if only Men voted); detail what those circumstances are. How was the data gathered, cleaned and filtered? Was the data manipulation ethically sound?

Discuss how the data was visualized. Did they use a choropleth map? Symbolic map? Was the representation ethically sound?
http://www.thefunctionalart.com/2014/02/the-incredible-gdp-map-that-shows-that.html


http://junkcharts.typepad.com/numbersruleyourworld/2014/02/numbersense-and-true-lies.html