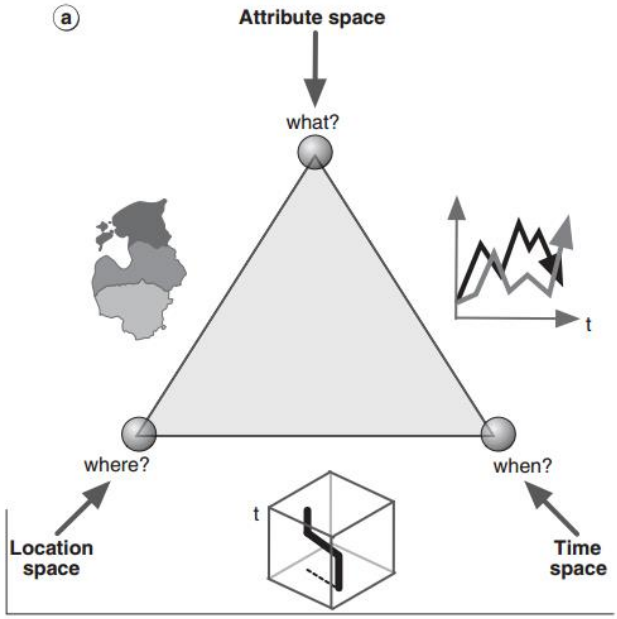
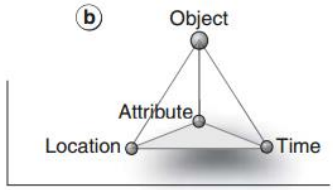
Geospatial Data Visualization

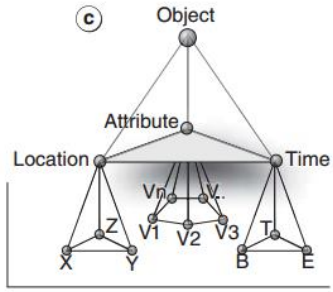
CS 7450 - Information Visualization
October 19, 2016
John Stasko
Guest speaker: Alex Godwin

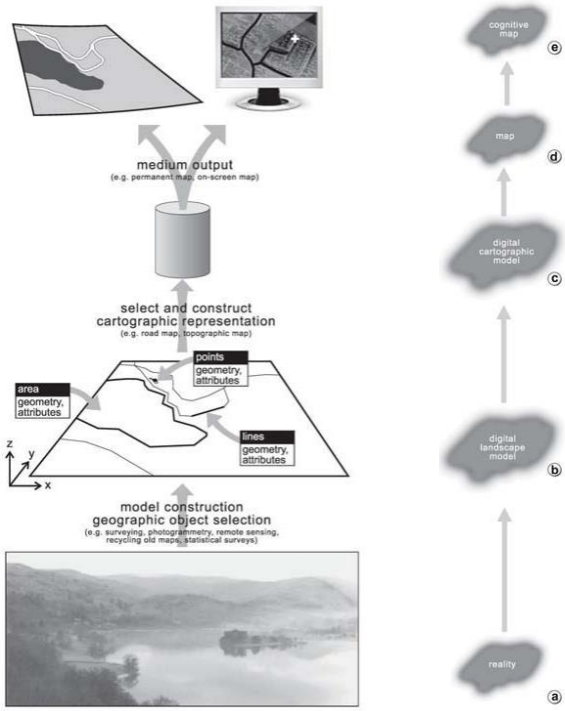
Learning Objectives

- Process of encoding Geospatial Visualization
- Common Geospatial Visualizations
- Benefits and tradeoffs of map types









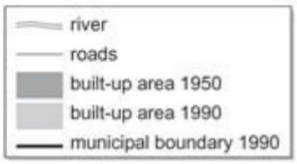
Cognitive map: interpretation of reality by map reader / analyst

Map: physical or on-screen

Digital cartographic model: translation of landscape to visual parameters

Digital Landscape Model: captured representation of the important aspects of reality as data

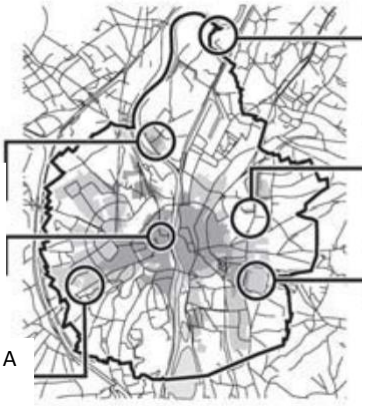
Reality: confusing and often subjective



what is the name of this village?
Identification: Borgharen

where is the city hall?
location: x,y = 1764,3180

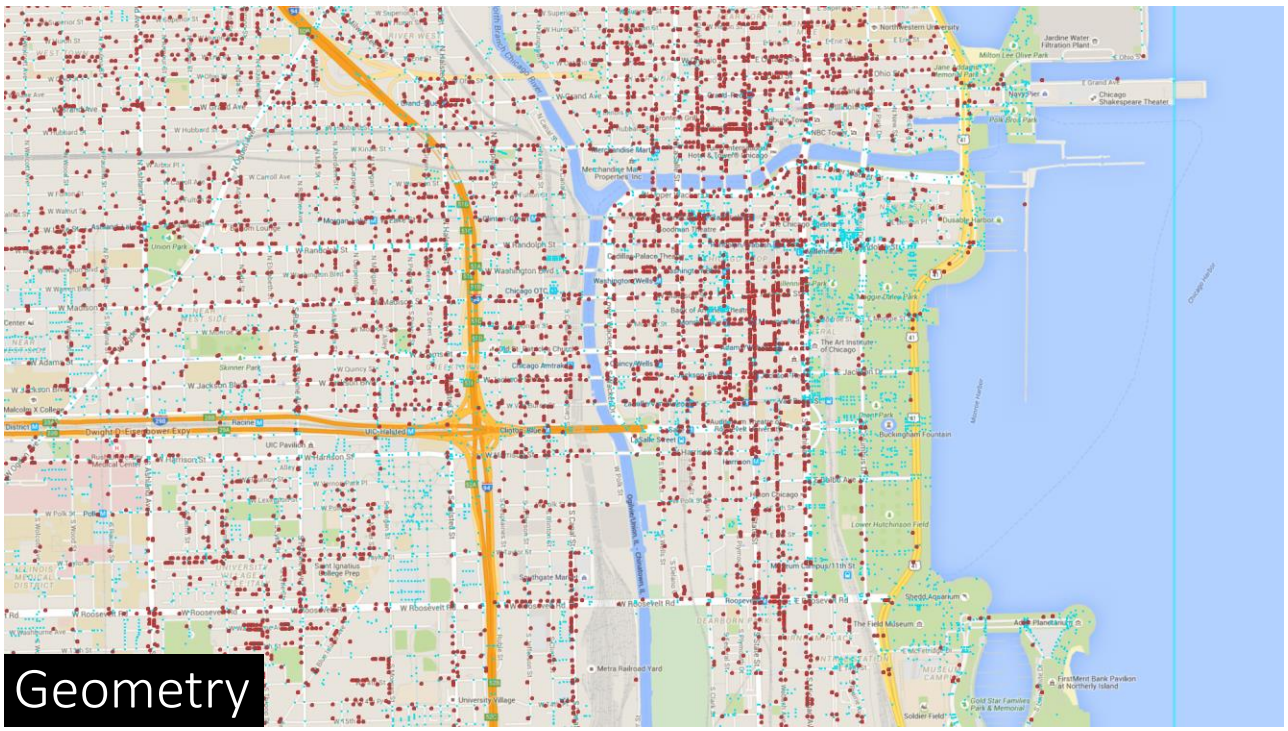
What is the shortest route between A and B?
optimal path: start at A, go left at …

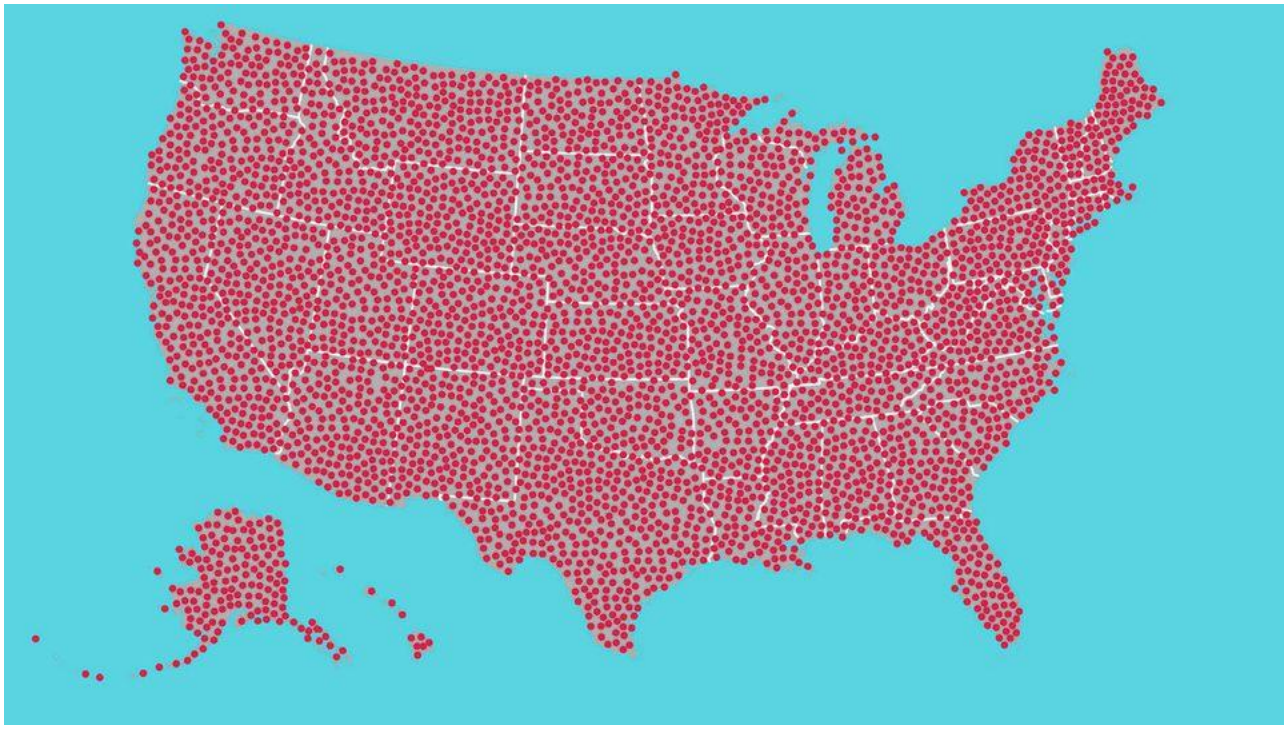


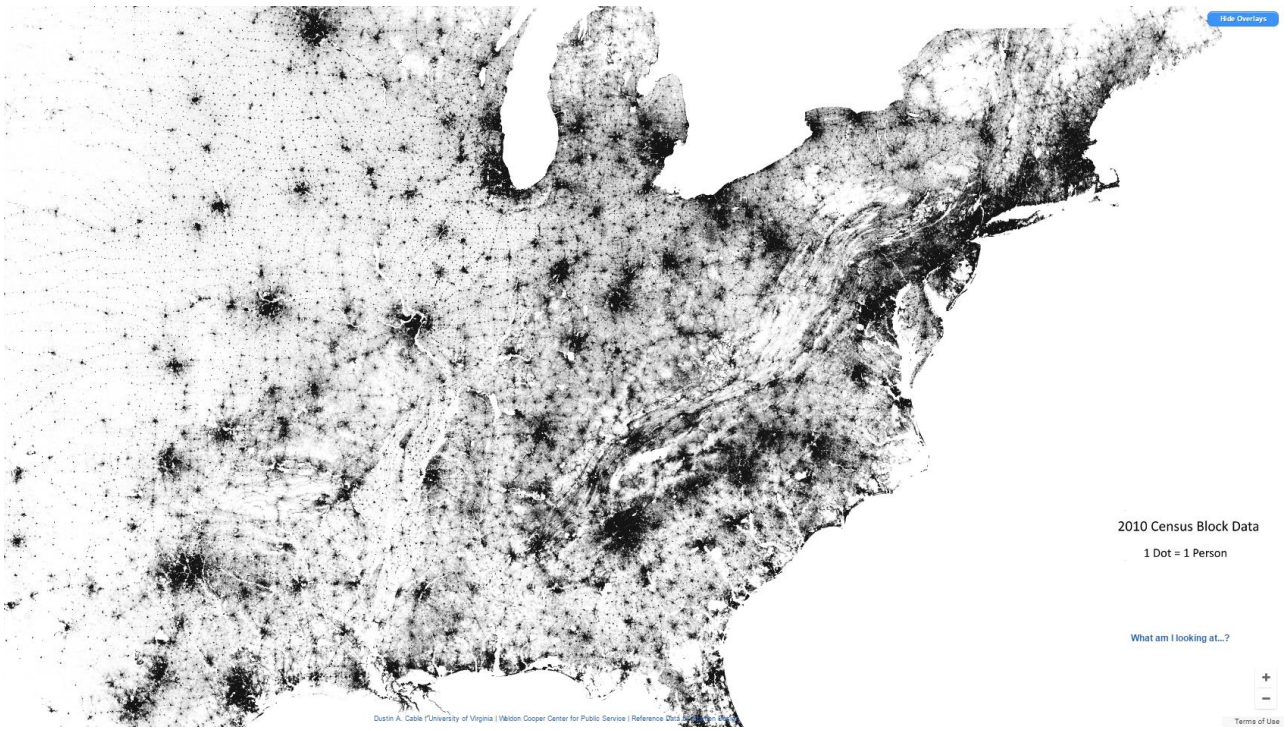
What relation exists between road network and river?
Pattern: river interrupts road network

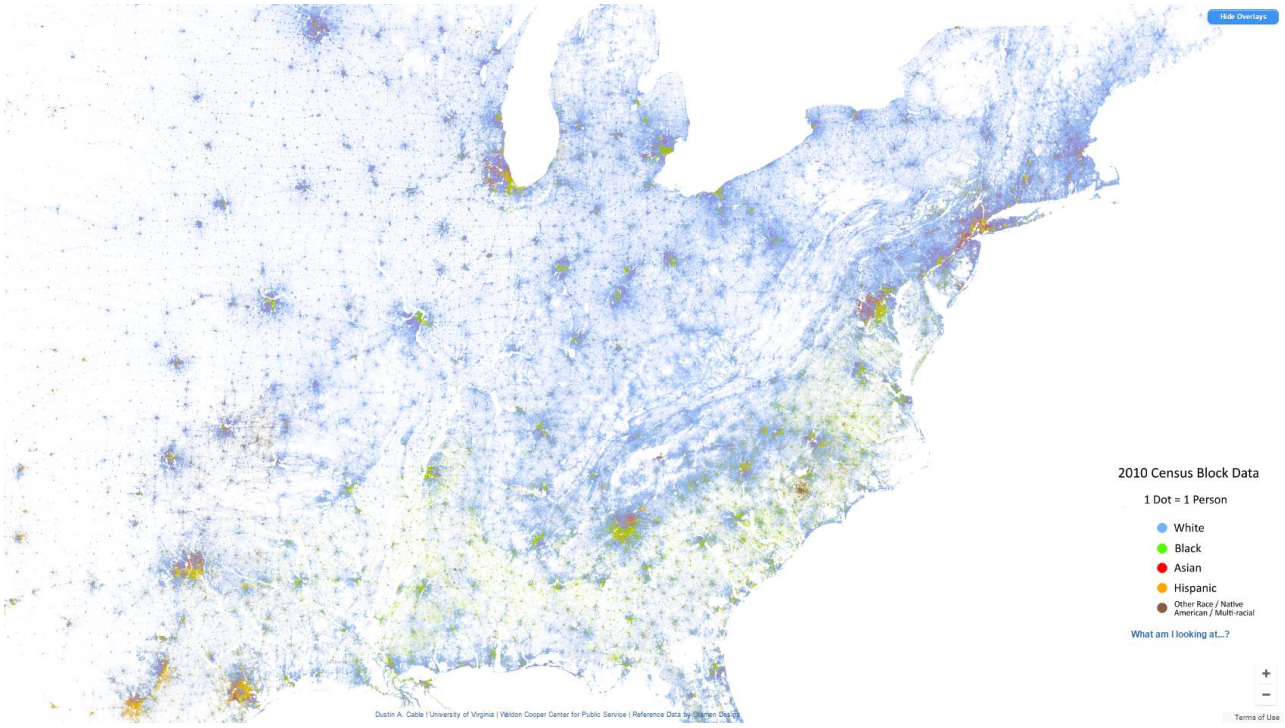
What if: a new built-up area is created here?
models: will affect traffic intensity

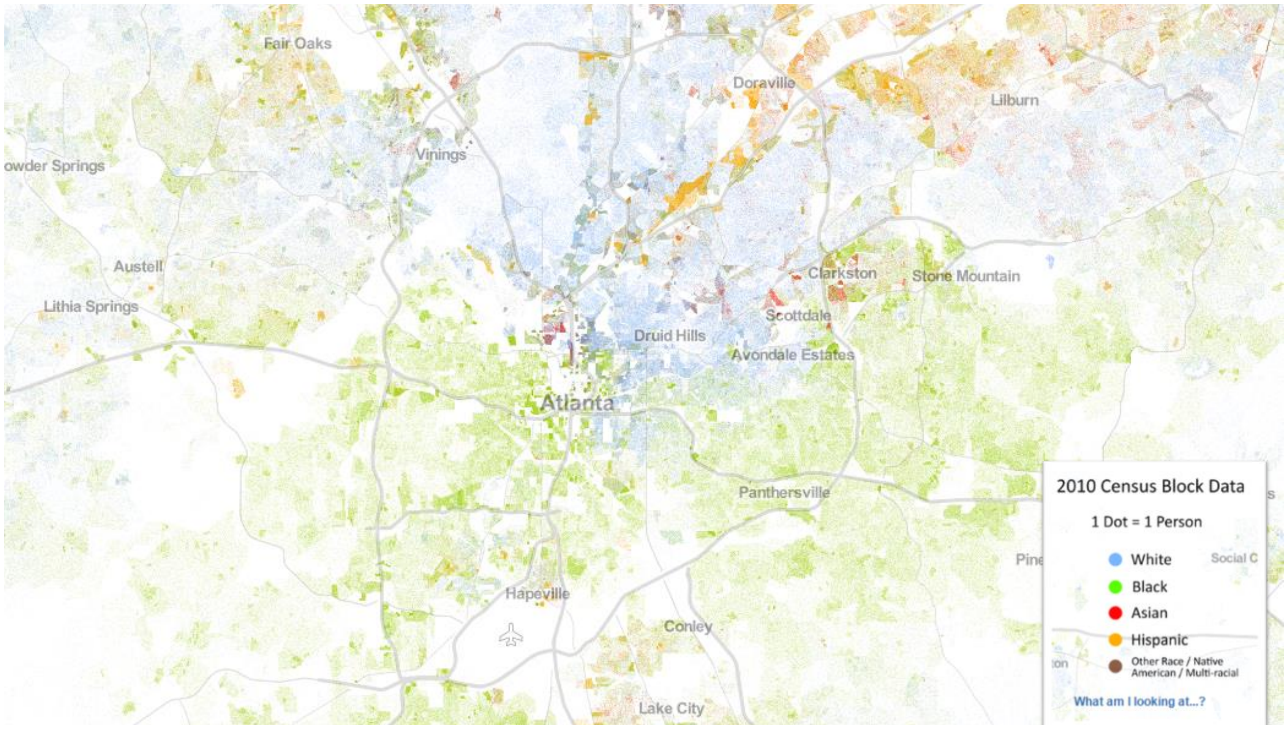
What has changed?
trends: growth urban area

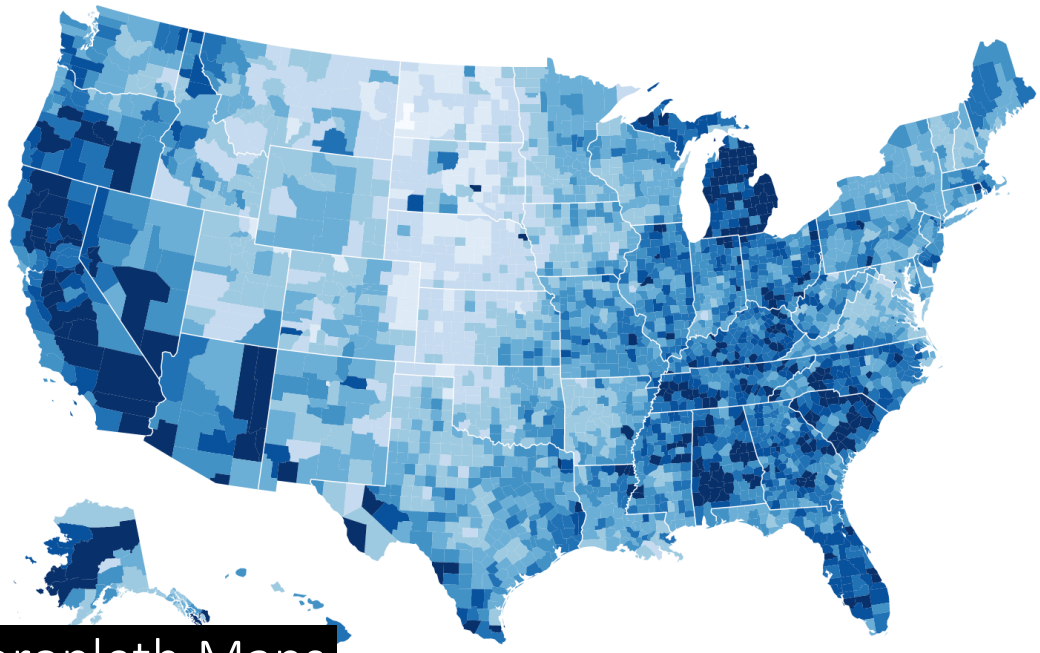




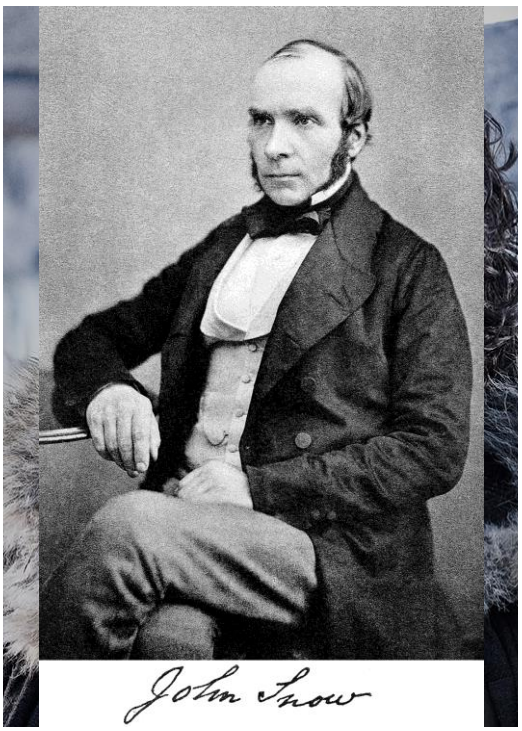

Hide Overlays
2010 Census Block Data
1 Dot = 1 Person
What am I looking at...?
Terms of Use


Hide Overlays
2010 Census Block Data
1 Dot = 1 Person
White
Black
Asian
Hispanic
Other Race / Native American / Multi-racial
What am I looking at...?
Terms of Use


Fair Oaks
Doraville
Lilburn
Vinings
Austell
Lithia Springs
Clarkston
Stone Mountain
Scottdale
Druid Hills
Avondale Estates
Atlanta
Panthersville
Hapeville
Conley
Lake City
2010 Census Block Data
1 Dot = 1 Person
White
Black
Asian
Hispanic
Other Race / Native American / Multi-racial
What am I looking at...?

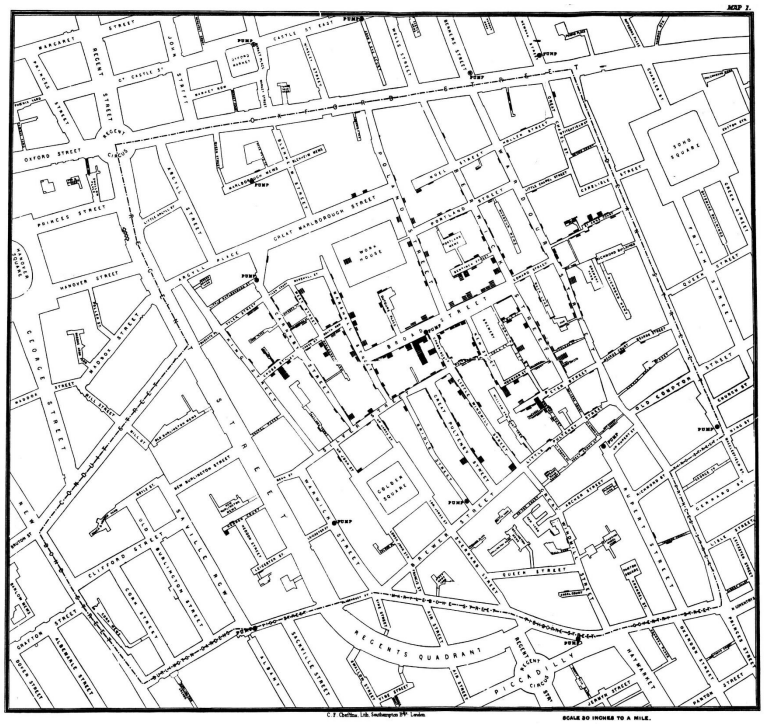


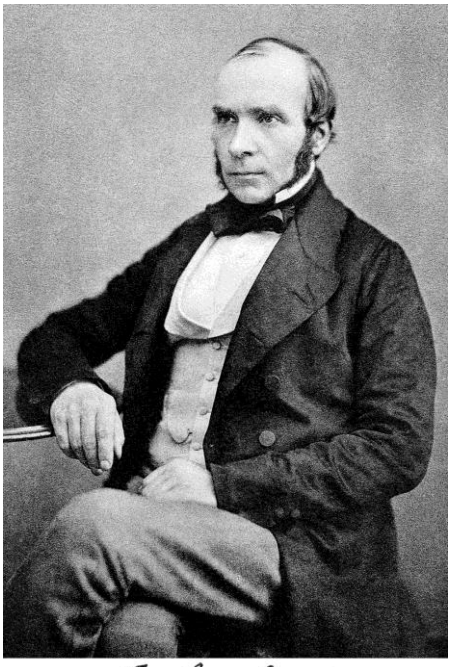
Choropleth Maps



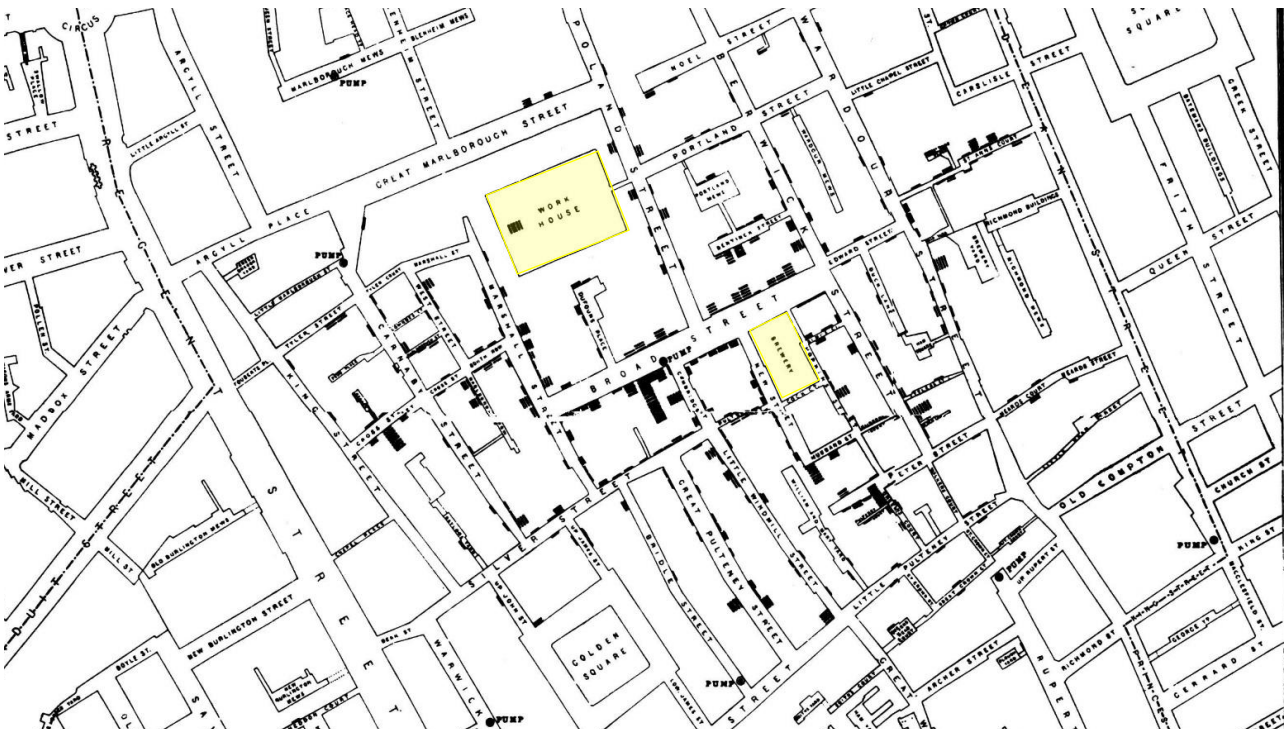
John Snow

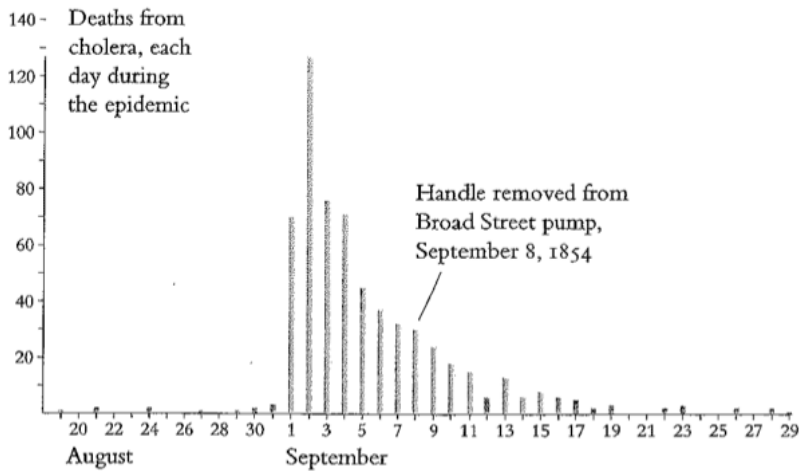
The Cholera Epidemic of London, 1854


MAP 1.
OXFORD STREET
PRINCES STREET
GEORGE STREET
GREAT MARLBOROUGH STREET
BROAD STREET
REGENT'S QUADRANT
PICCADILLY
SCALE 80 INCHES TO A MILE.

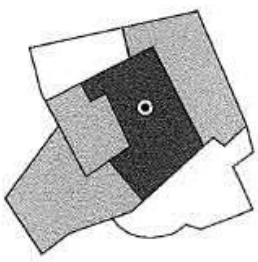


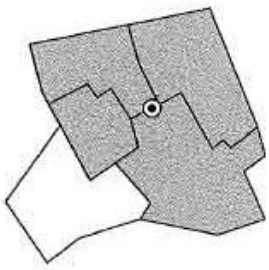
John Snow

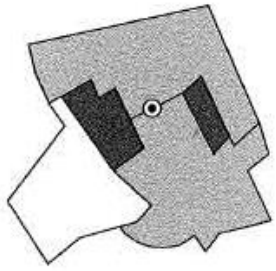

GREAT MARLBOROUGH STREET
ARGYLL PLACE
WORK HOUSE
BROAD STREET
BROWERY
PORTLAND STREET
GOLDEN SQUARE
NEW BURLINGTON STREET
OLD COMPTON
PUMP

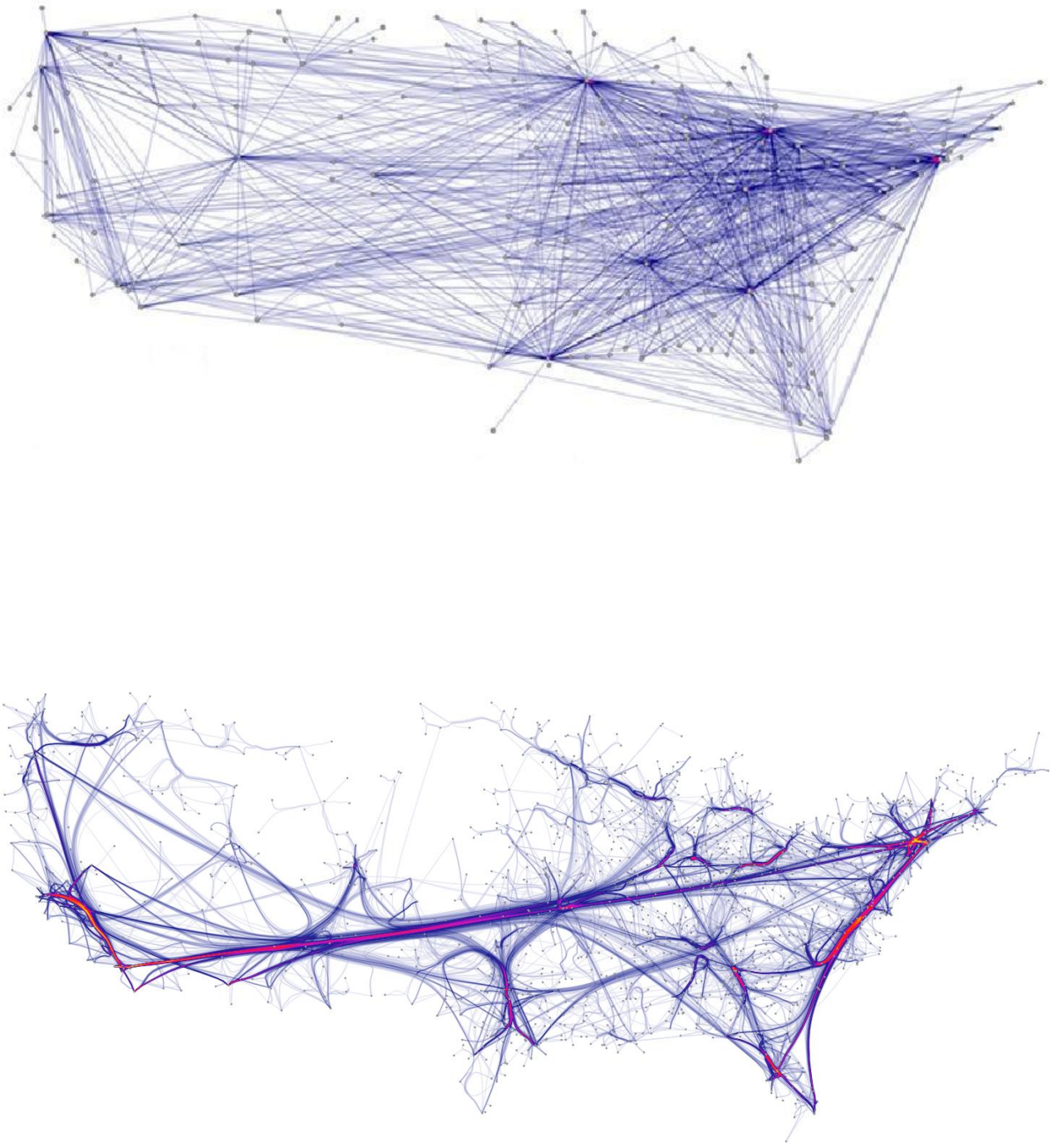


Data source: plotted from the table in Snow, *Cholera*, p. 49.

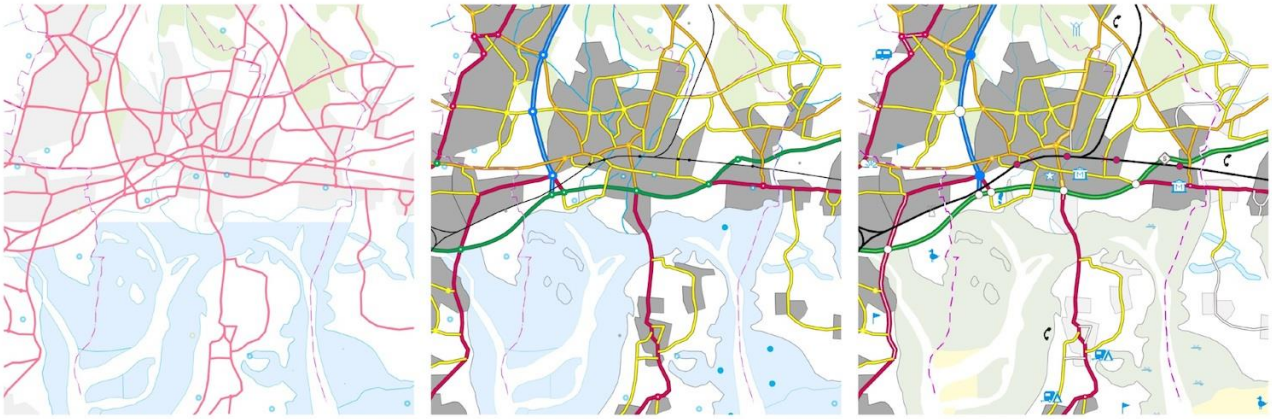




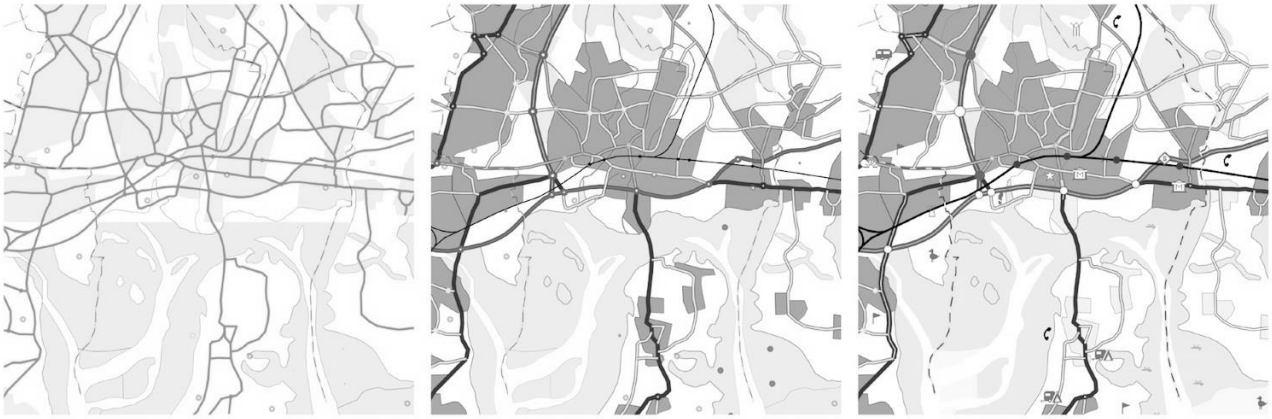




Holten, D., & Van Wijk, J. J. (2009, June). **Force-Directed Edge Bundling for Graph Visualization**. In Computer graphics forum (Vol. 28, No. 3, pp. 983-990). Blackwell Publishing Ltd.



Dykes, J., Wood, J. & Slingsby, A. (2010). **Rethinking map legends with visualization**. IEEE Transactions on Visualization and Computer Graphics, 16(6), pp. 890-899.



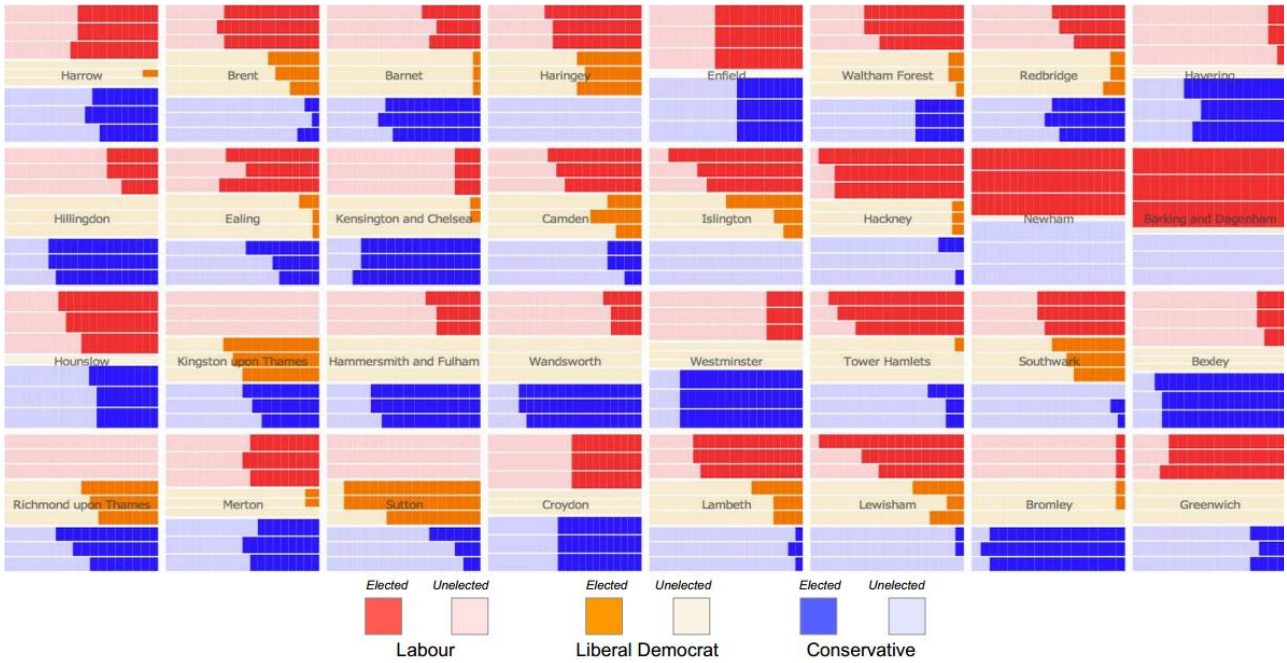
Dykes, J., Wood, J. & Slingsby, A. (2010). **Rethinking map legends with visualization**. IEEE Transactions on Visualization and Computer Graphics, 16(6), pp. 890-899.

BallotMaps

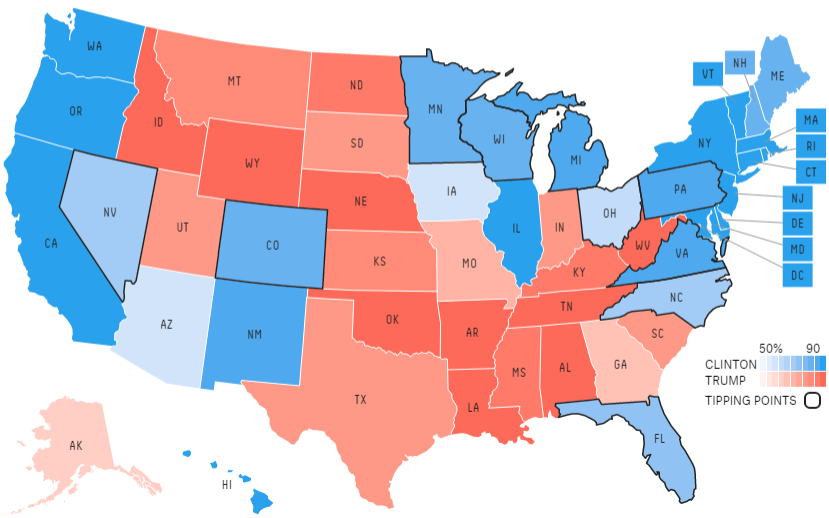
BallotMaps: Detecting name bias in alphabetically ordered ballot papers. Wood, J., Badawood, D., Dykes, J. & Slingsby, A. (2011). IEEE Transactions on Visualization and Computer Graphics, 17(12), pp. 2384-2391.

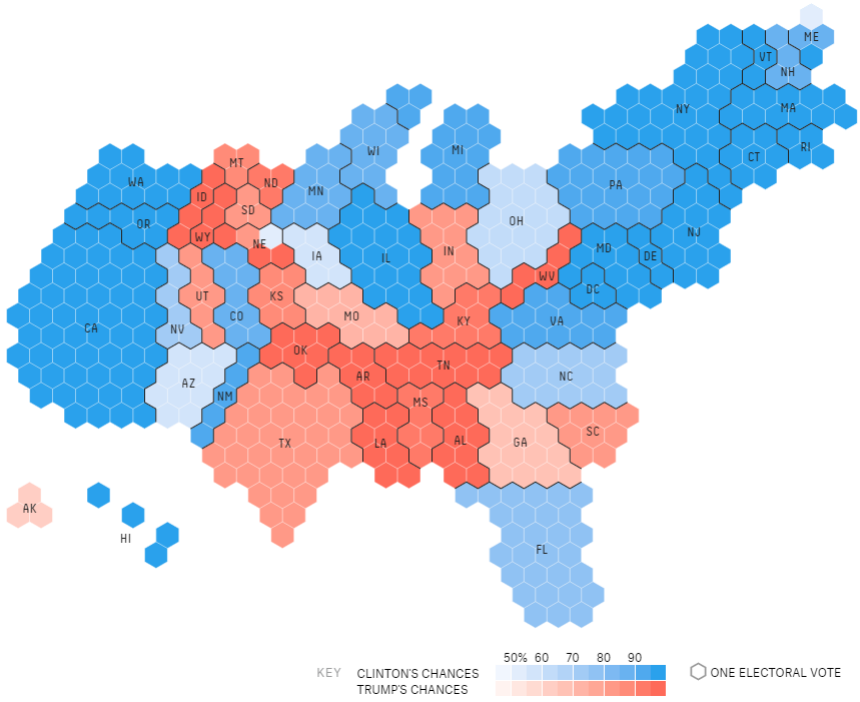
VOTE FOR NO MORE THAN THREE CANDIDATES

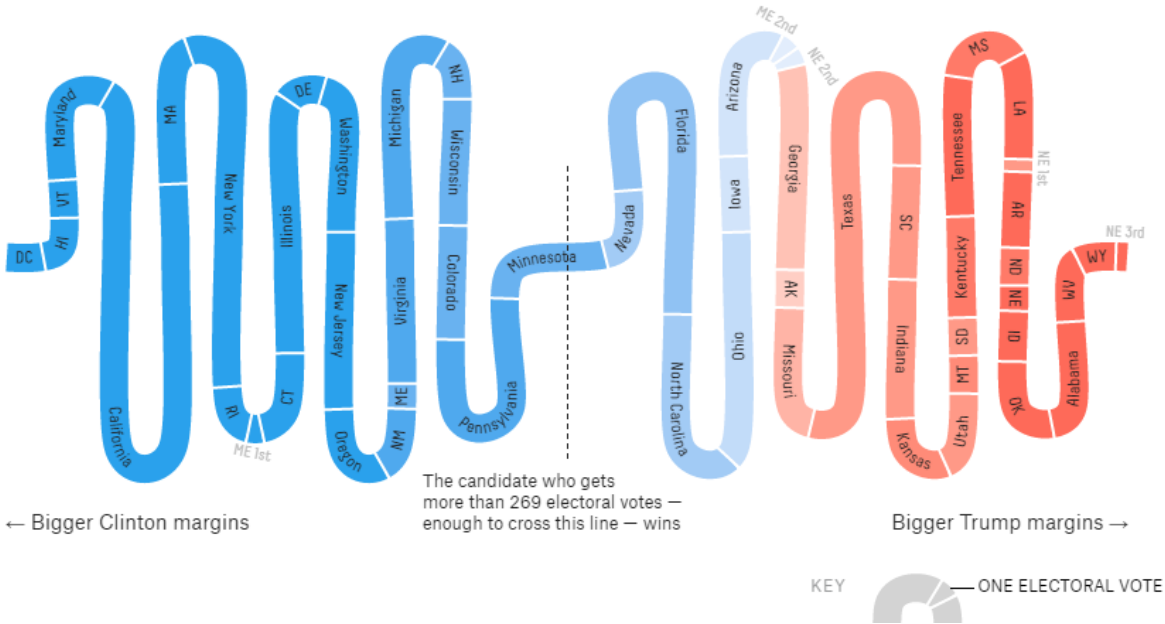
1	**AARON** Lawrence Aaron 17 Newington Road, London N1 6FG Liberal Democrats	Liberal Democrats
2	**CHADWELL** Gertrude Chadwell 22 Some St, London N1 2AB UK Independence Party	UKIP
3	**CROUSE** Justin Crouse (Address in constituency) The Labour Party Candidate	Labour
4	**DEBOSE** Joanne Debose 16 Acer Avenue, London NW4 8XT Green Party	Green Party
5	**HANDY** William Handy (Address in constituency) The Labour Party Candidate	Labour
6	**HOOPER** Malcolm Hooper (Address in constituency) The Conservative Party Candidate	Conservatives
7	**KOZLOWSKI** Michael Kozlowski (Address in constituency) The Conservative Party Candidate	Conservatives
8	**NOOR** Anjit Noor (Address in constituency) The Labour Party Candidate	Labour
9	**PFEIFFER** Dale Pfeiffer 103 Elephant Way, London NW1 8RH Liberal Democrats	Liberal Democrats
10	**TALLY** Deborah Tally (Address in constituency) The Conservative Party Candidate	Conservatives
11	**WHITFIELD** Sarah Whitfield 45 Kingham Place, London N1 6SL Liberal Democrats	Liberal Democrats
12	**YILMAZ** Shaquil Yilmaz 4 Pocklington Walk, London N1 5DS Independent Candidate	



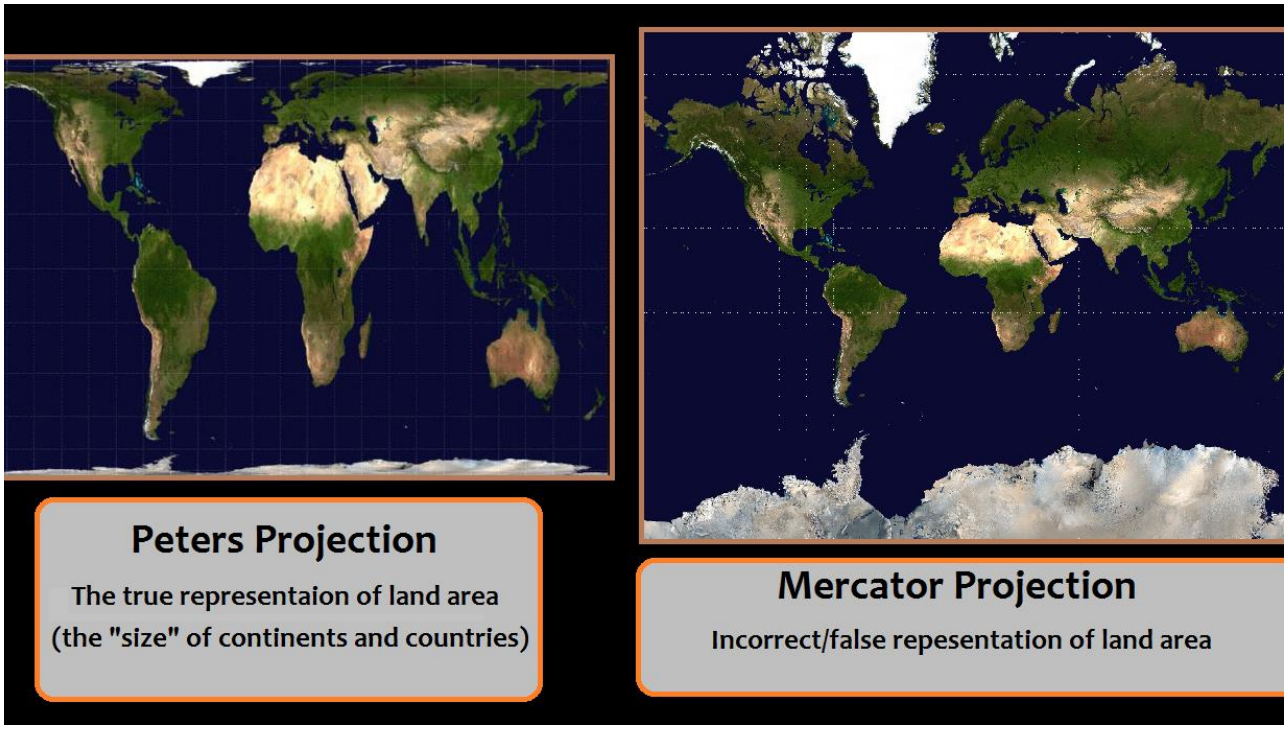
Chance of winning




ME
VT
NH
NY
MA
RI
CT
WA
MT
ND
MN
WI
MI
PA
NJ
ID
SD
OR
WY
NE
IA
IL
IN
OH
MD
DE
WV
DC
UT
KS
MO
KY
VA
CA
NV
CO
OK
TN
NC
AZ
NM
AR
MS
SC
TX
LA
AL
GA
AK
HI
FL
KEY
CLINTON'S CHANCES
TRUMP'S CHANCES
50%
60
70
80
90
ONE ELECTORAL VOTE


DC
HI
VT
Maryland
MA
New York
RI
CT
Illinois
DE
Washington
New Jersey
Oregon
California
ME 1st
NM
ME
Virginia
Michigan
NH
Wisconsin
Colorado
Pennsylvania
Minnesota
Nevada
Florida
North Carolina
Arizona
Iowa
Ohio
ME 2nd
NE 2nd
Georgia
AK
Missouri
Texas
SC
Indiana
Kansas
MS
LA
Tennessee
AR
Kentucky
ND
NE
SD
ID
MT
Utah
OK
NE 1st
Alabama
WV
NE 3rd
WY
The candidate who gets more than 269 electoral votes — enough to cross this line — wins
← Bigger Clinton margins
Bigger Trump margins →
KEY
ONE ELECTORAL VOTE

Map Projections

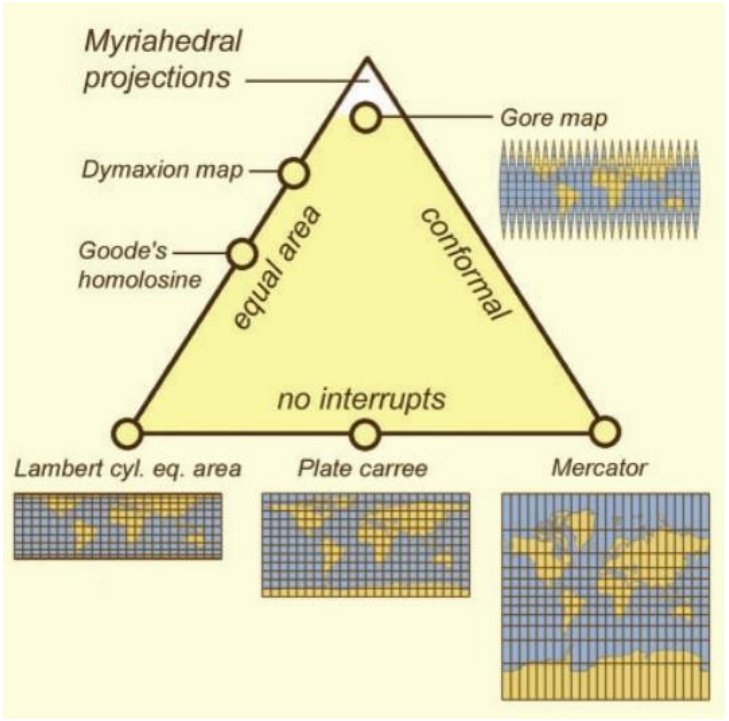


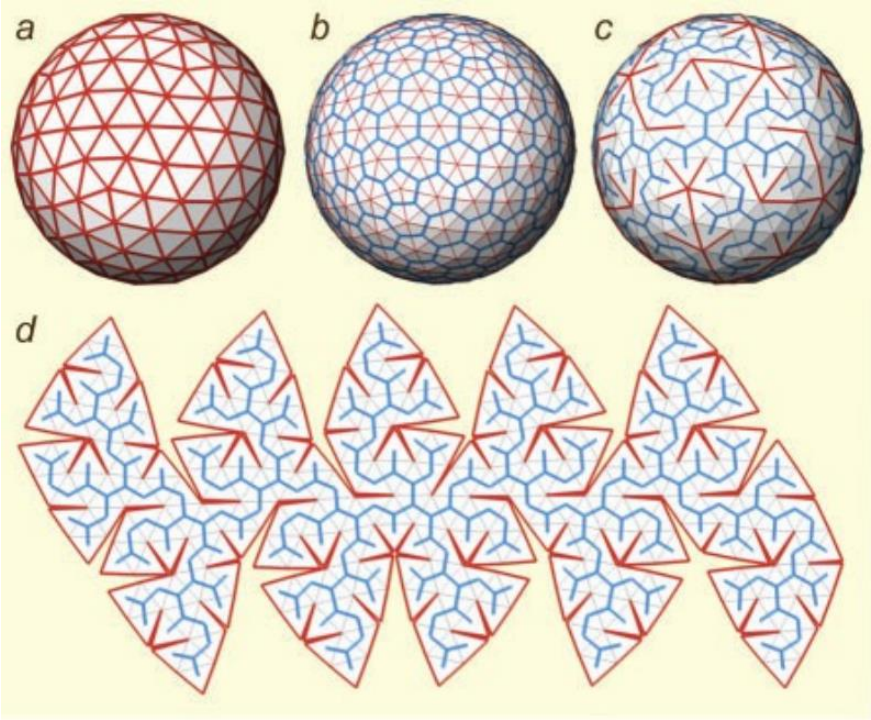
Peters Projection

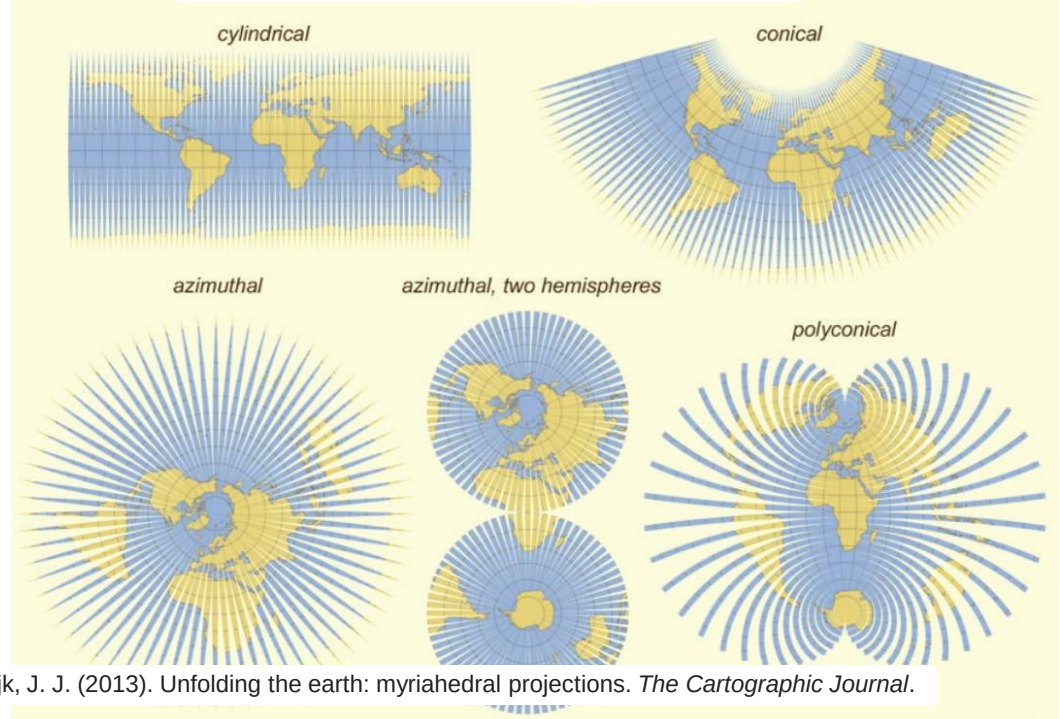
The true representaion of land area
(the "size" of continents and countries)

Mercator Projection

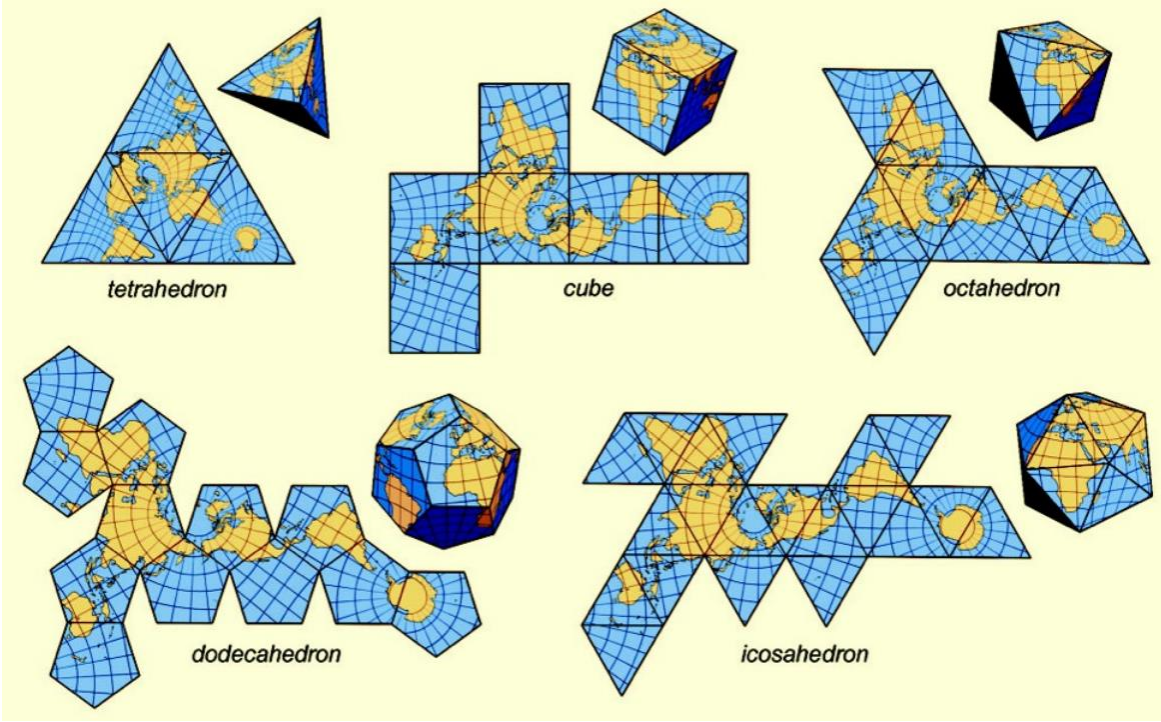
Incorrect/false repesentation of land area

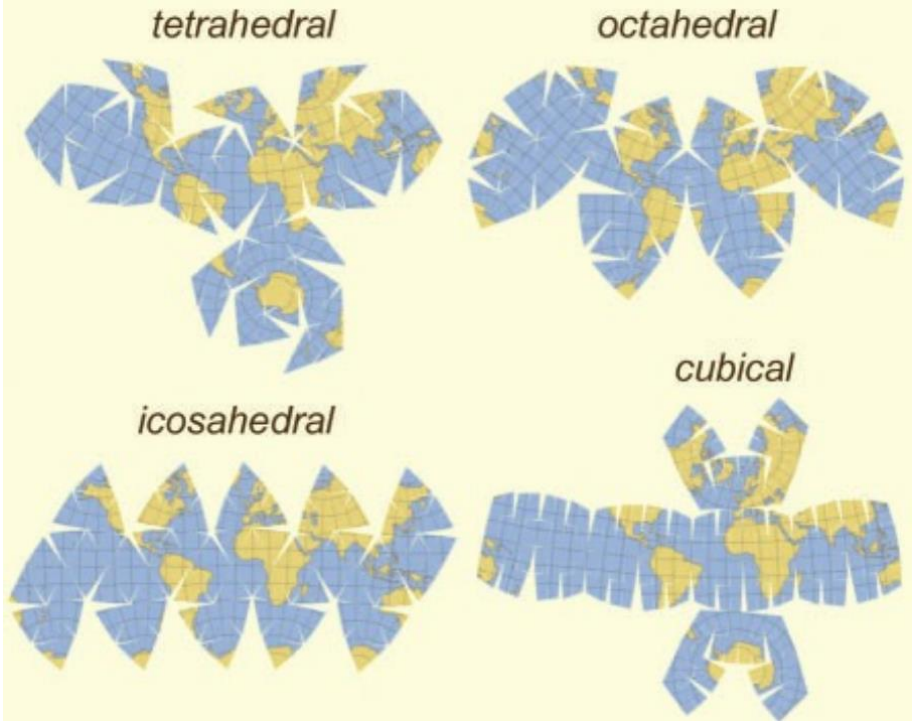


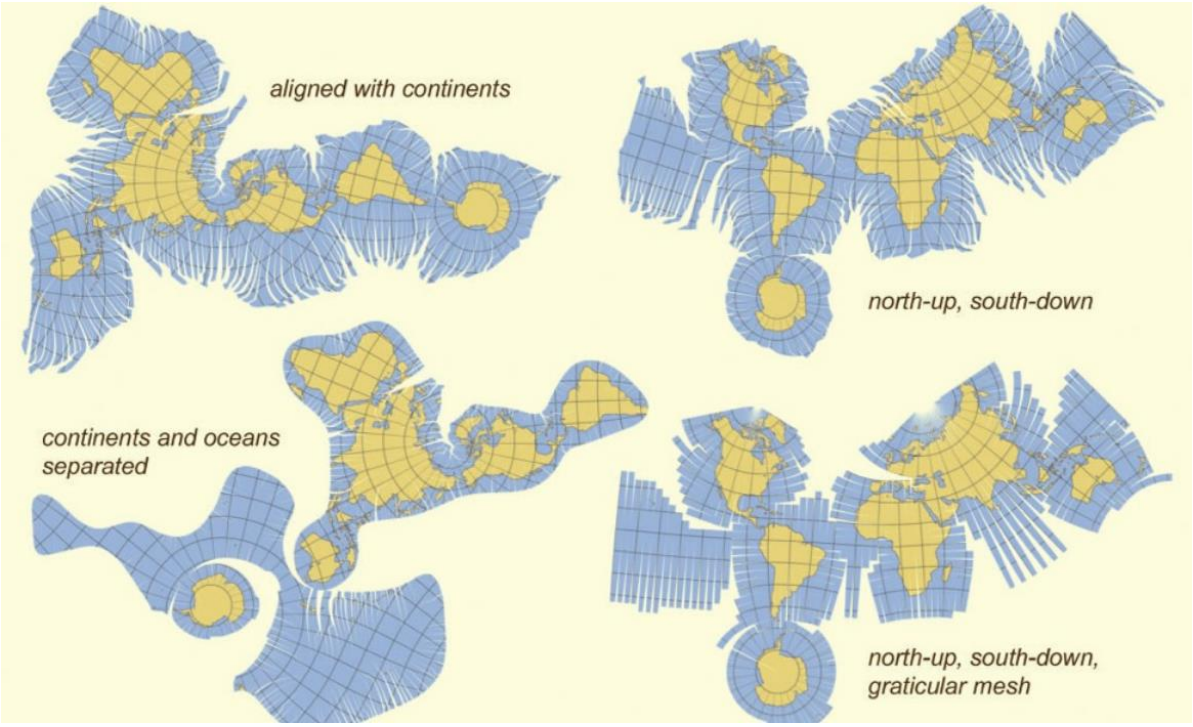


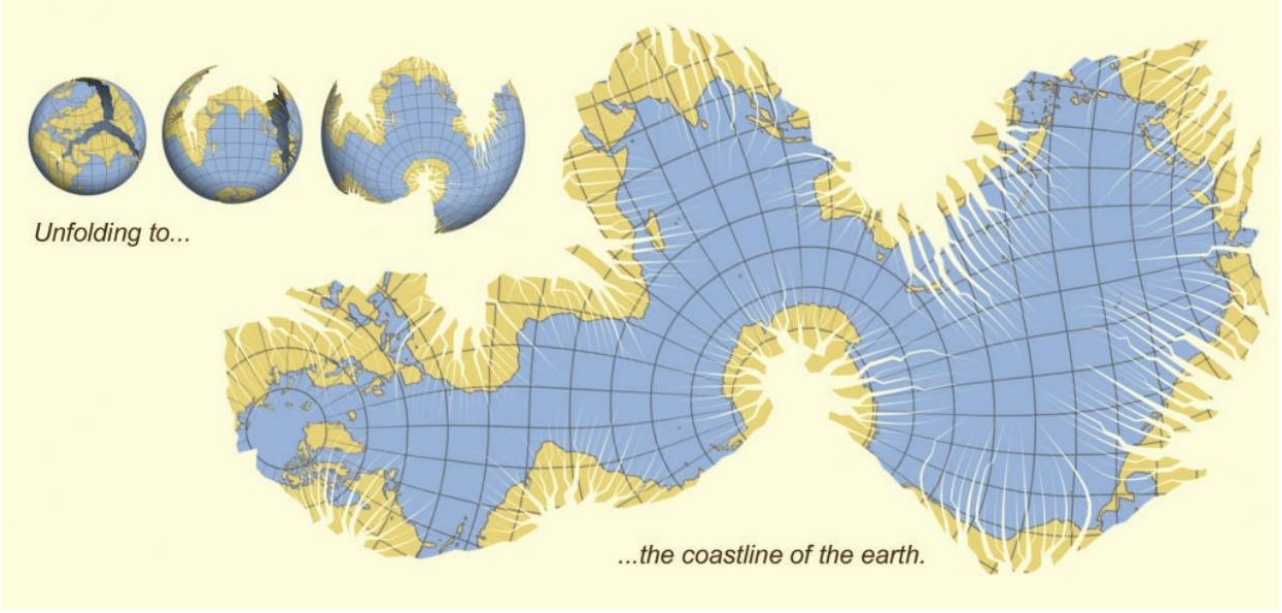


Van Wijk, J. J. (2013). Unfolding the earth: myriahedral projections. *The Cartographic Journal*.


tetrahedron
cube
octahedron
dodecahedron
icosahedron

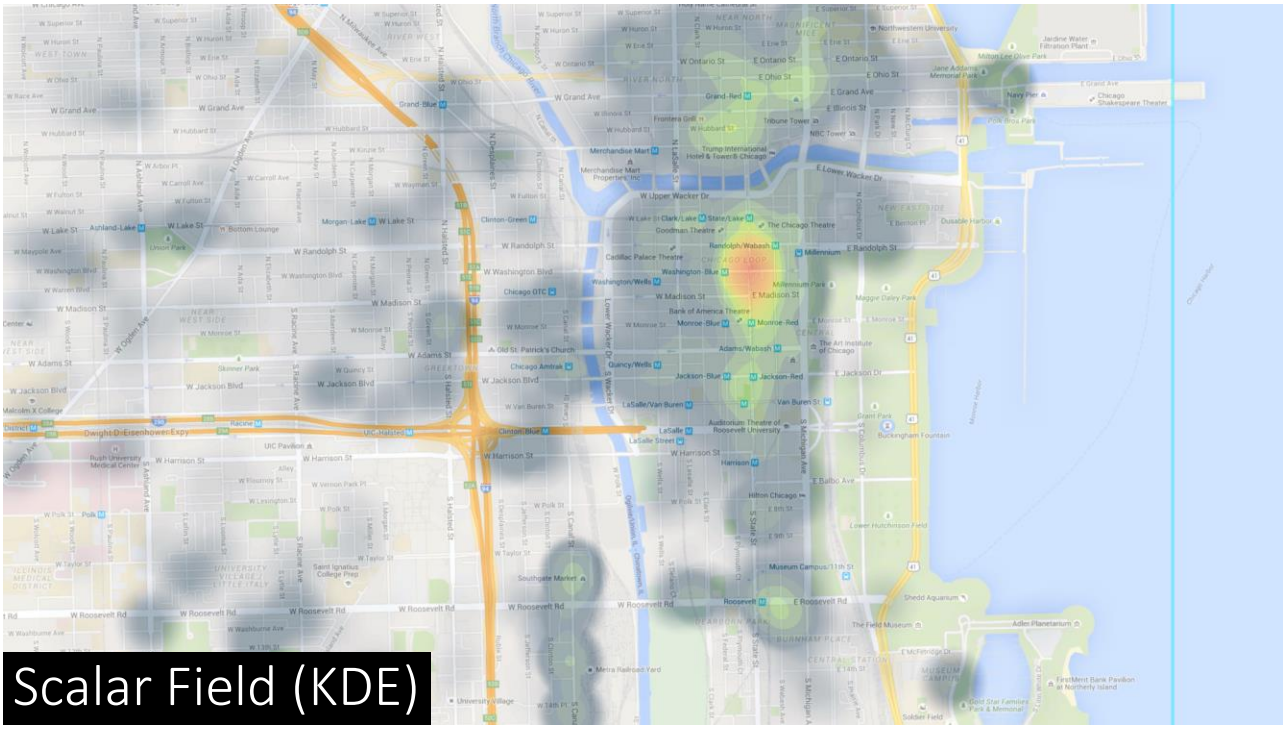

tetrahedral
octahedral
cubical
icosahedral


aligned with continents
north-up, south-down
continents and oceans separated
north-up, south-down, graticular mesh

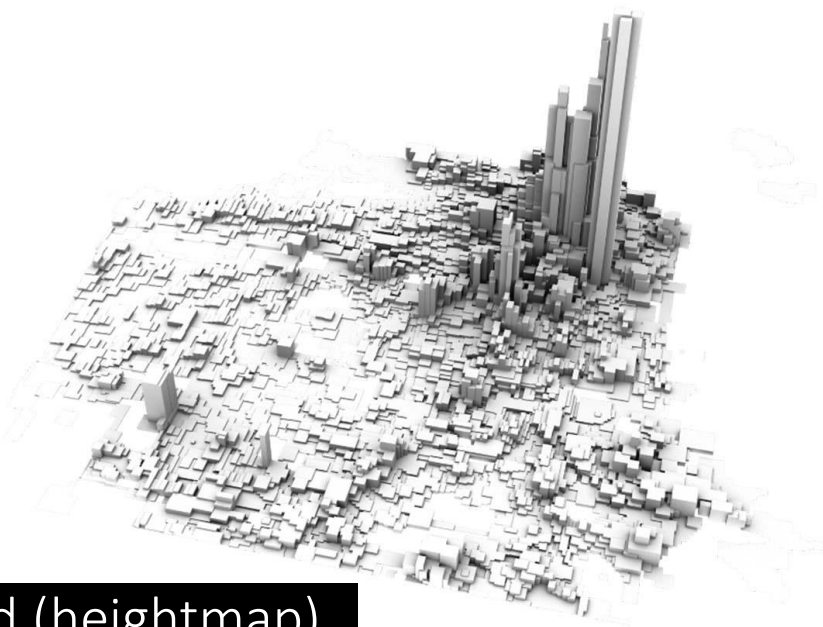

Unfolding to...
...the coastline of the earth.

Scalar Fields

Single Value

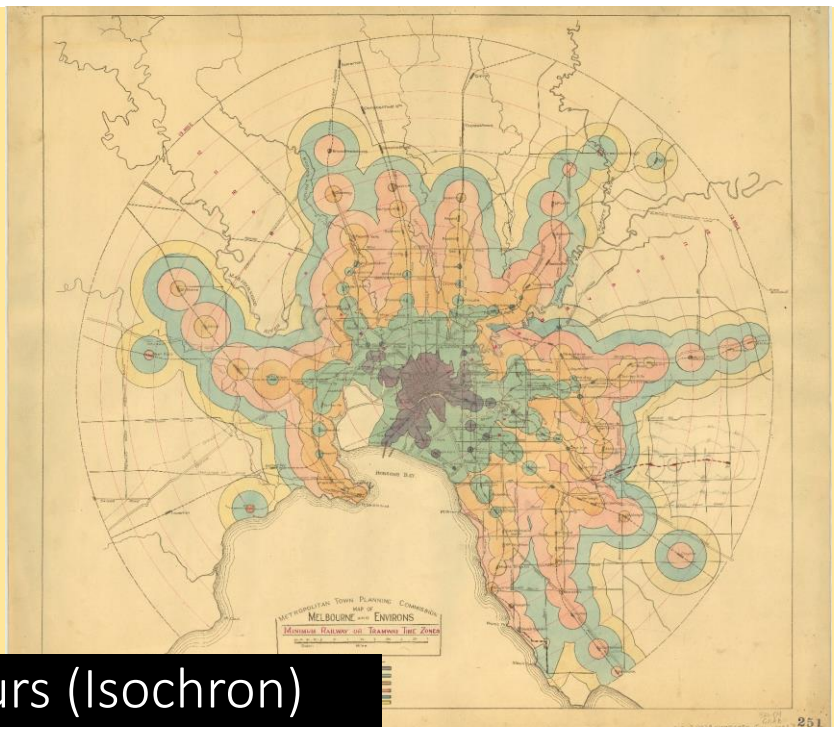


Scalar Field (KDE)



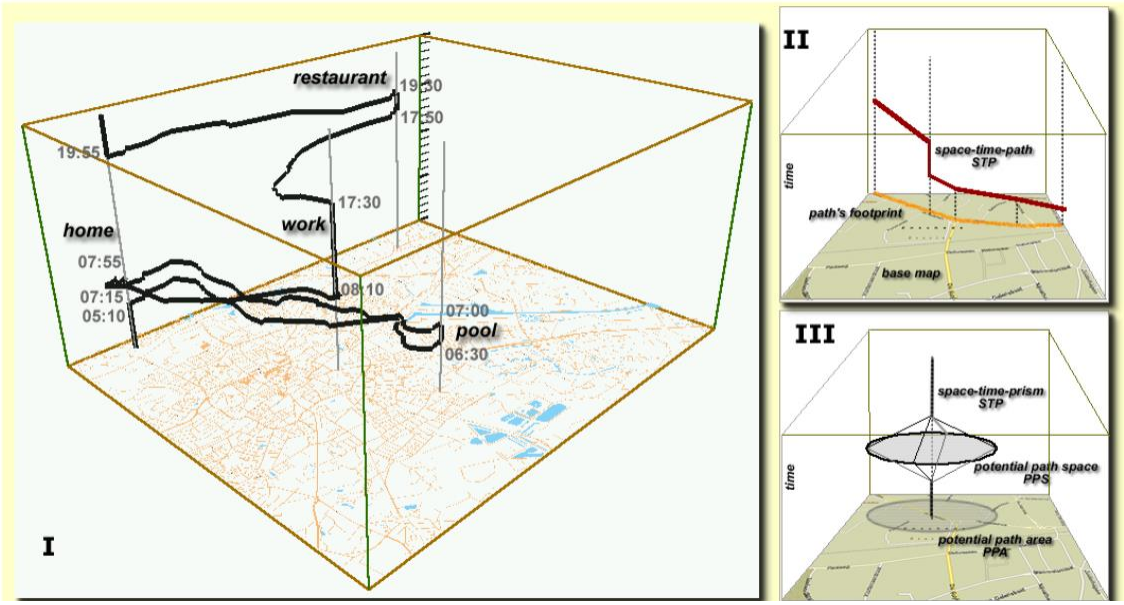
Scalar Field (heightmap)

Isocontours (Terrain)

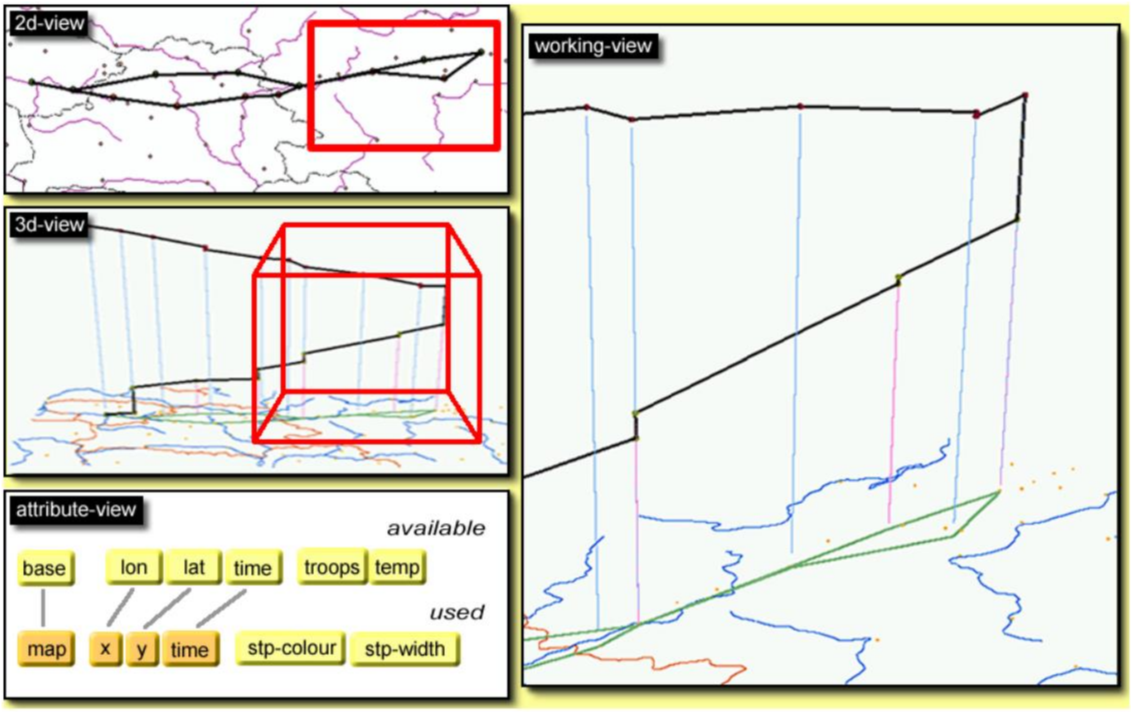


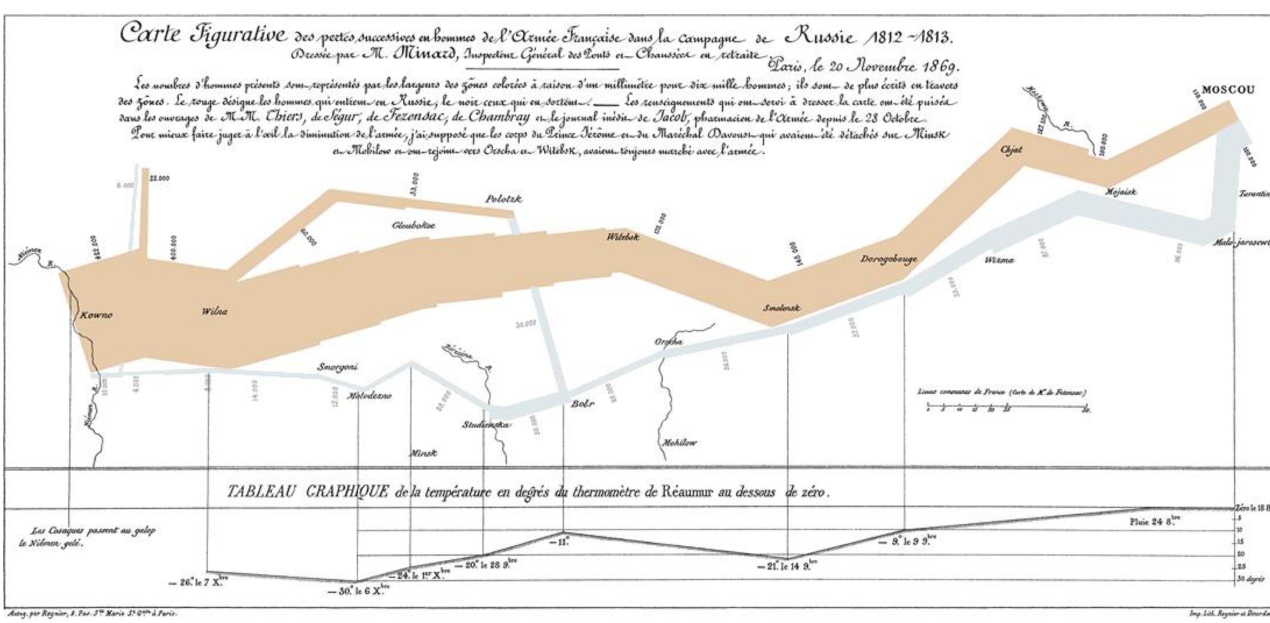
Isocontours (Isochron)

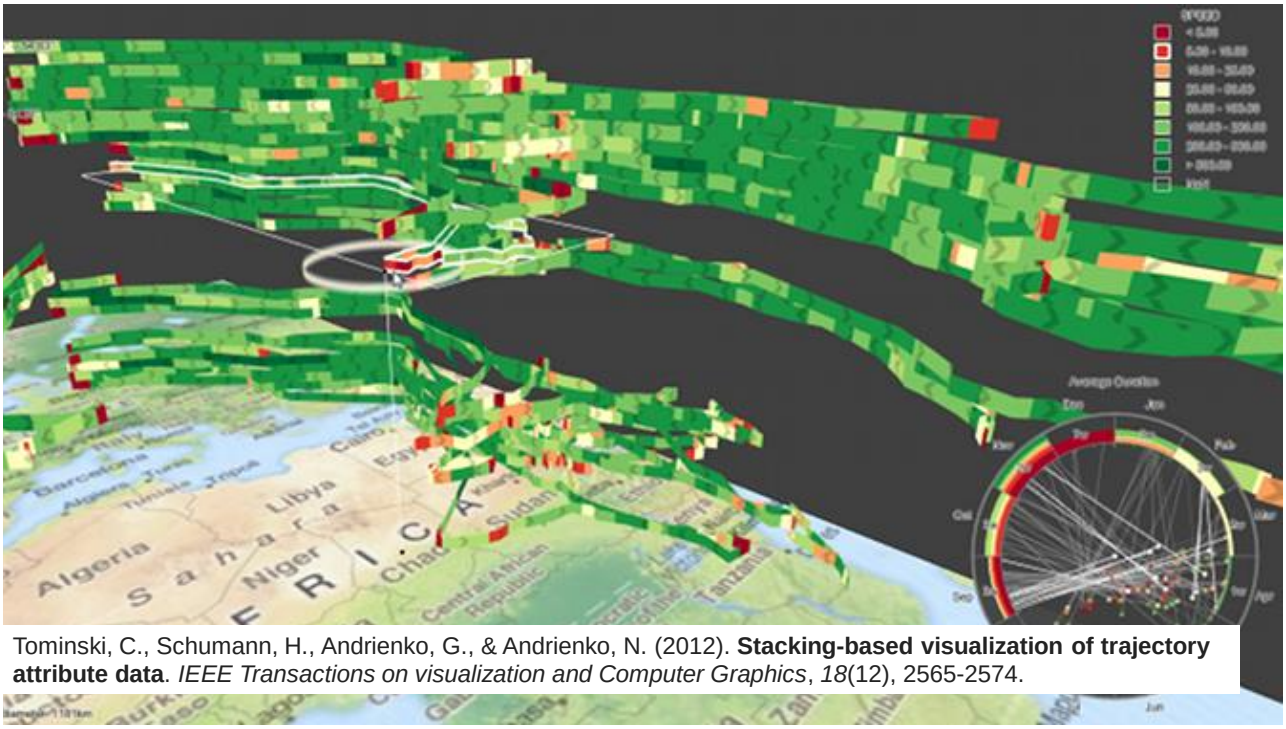
Space + Time



Kraak, M. J. (2003, August). **The space-time cube revisited from a geovisualization perspective**. In *Proc. 21st International Cartographic Conference*(pp. 1988-1996).

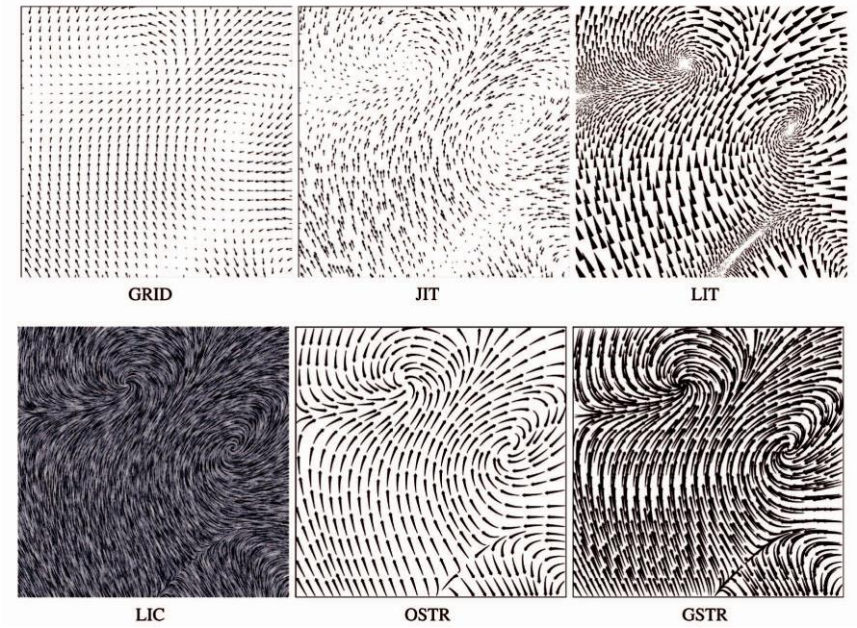

2d-view
3d-view
working-view
attribute-view
available
base
lon
lat
time
troops
temp
used
map
x
y
time
stp-colour
stp-width


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.
MOSCOU
Kowno
Wilna
Gloubokoe
Polotzk
Witebsk
Smolensk
Dorogobouge
Chjat
Mojaisk
Tarantino
Malo-jarosewli
Wixma
Orscha
Bobr
Studienska
Smorgoni
Molodezno
Minsk
Mohilow
TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.
Les Cosaques passent au galop le Niémen gelé.
Zéro le 18 8.bre
Pluie 24 8.bre
− 9.° le 9 9.bre
− 21.° le 14 9.bre
− 11.°
− 20.° le 28 9.bre
− 24.° le 1.er X.bre
− 30.° le 6 X.bre
− 26.° le 7 X.bre



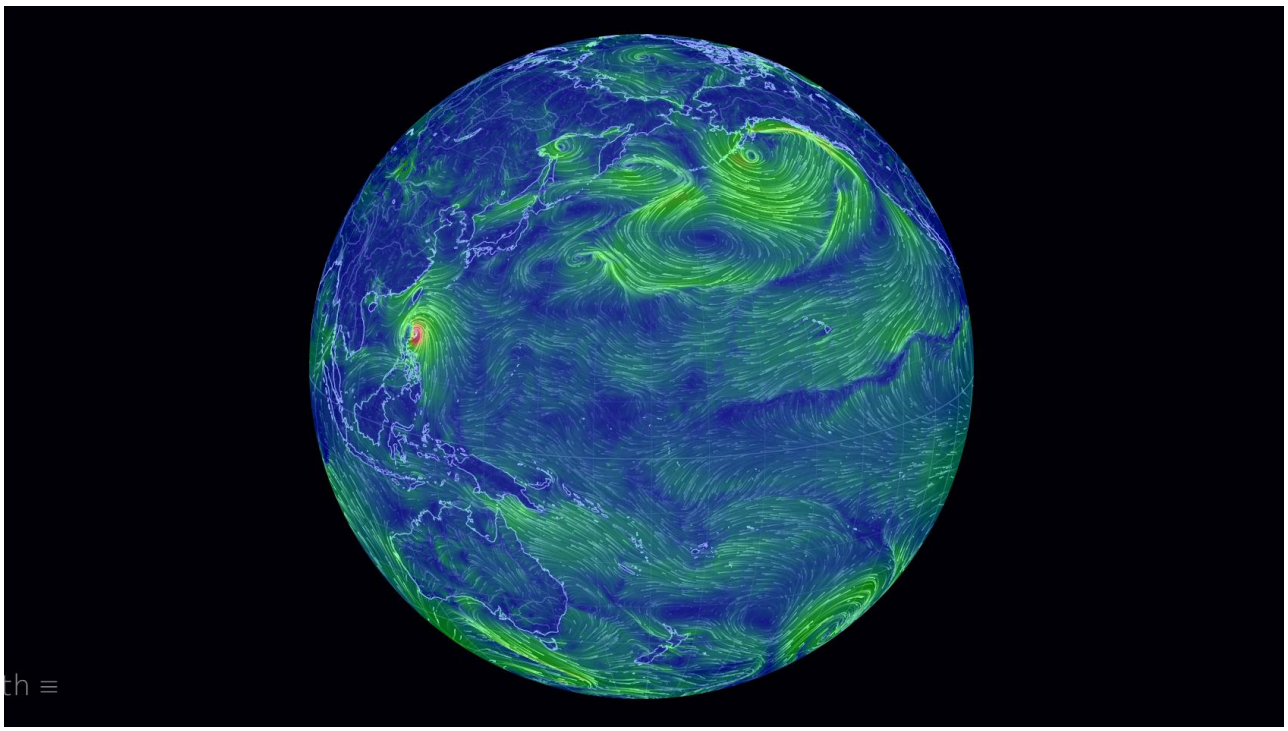
Tominski, C., Schumann, H., Andrienko, G., & Andrienko, N. (2012). **Stacking-based visualization of trajectory attribute data**. *IEEE Transactions on visualization and Computer Graphics*, *18*(12), 2565-2574.

Vector Fields

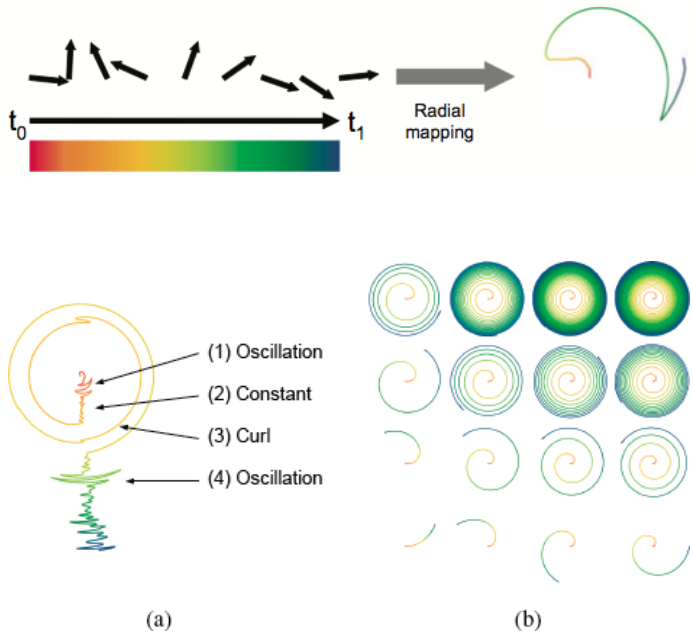


1. GRID: icons on a regular grid,
2. JIT: icons on a jittered grid
3. LIT: icons using one layer of a visualization method that borrows concepts from oil painting
4. LIC: line-integral convolution
5. OSTR: image-guided streamlines (integral curves)
6. GSTR: streamlines seeded on a regular grid

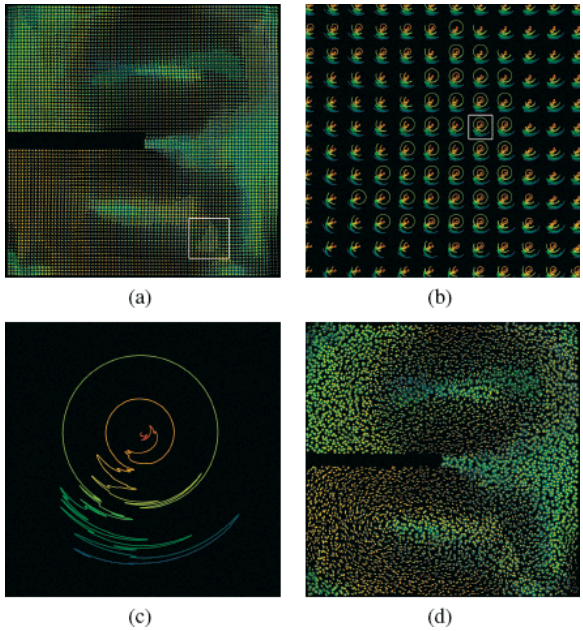
Laidlaw, D. H., Kirby, R. M., Jackson, C. D., Davidson, J. S., Miller, T. S., Da Silva, M., ... & Tarr, M. J. (2005). Comparing 2D vector field visualization methods: A user study. *IEEE Transactions on Visualization and Computer Graphics*, *11*(1), 59-70.



Flow Glyphs



Flow Radar Glyphs -- Static Visualization of Unsteady Flow with Uncertainty. Hlawatsch, Leube, Nowak, and Weiskopf. IEEE TVCG 17(12):1949-1958, 2011.

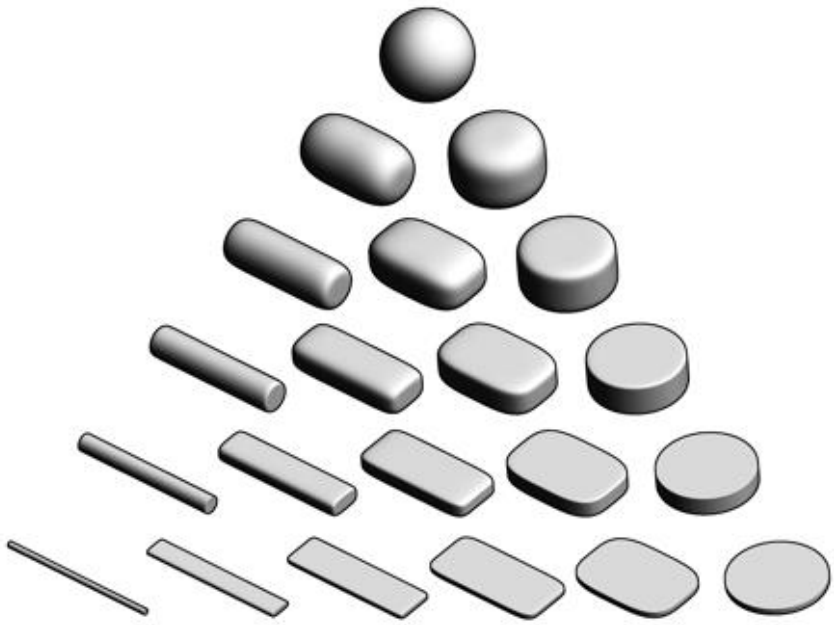


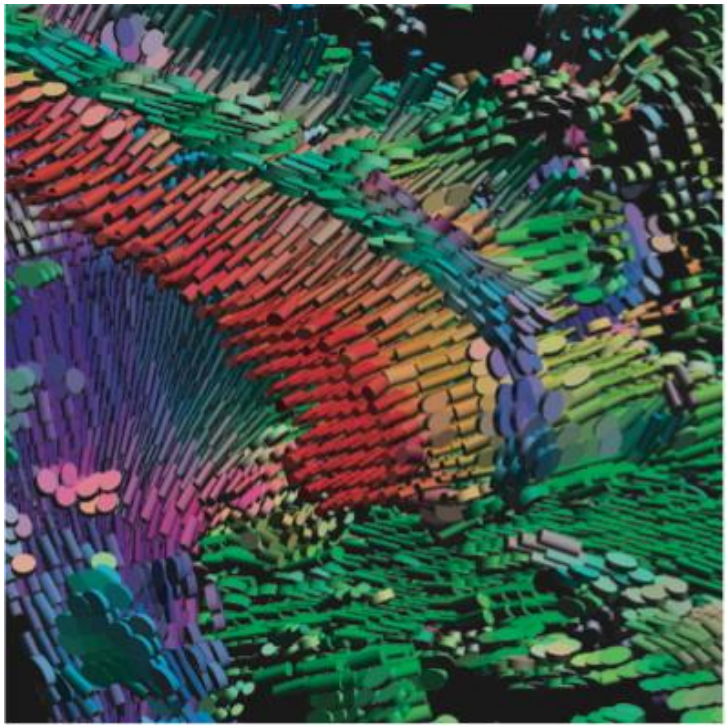
Flow Radar Glyphs -- Static Visualization of Unsteady Flow with Uncertainty. Hlawatsch, Leube, Nowak, and Weiskopf. IEEE TVCG 17(12):1949-1958, 2011.

Ellipsoid Tensor Glyphs

Many Values

Kindlmann, G. (2004, May). **Superquadric tensor glyphs**. In *Proceedings of the Sixth Joint Eurographics-IEEE TCVG conference on Visualization* (pp. 147-154). Eurographics Association.



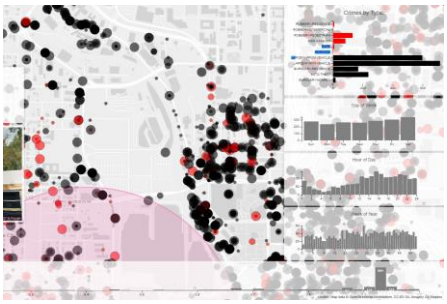


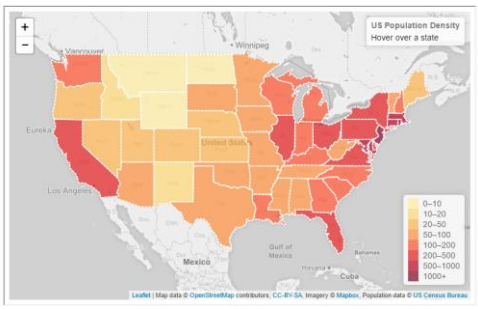
Practicum

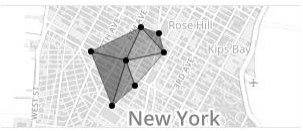
Leaflet

TURF

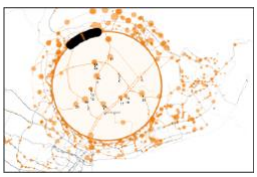
- Measure and aggregate spatial data
- Determine if points are inside boundaries
- Convert points to triangulations
- Create regular grids (hex, square, etc)
- And much more.

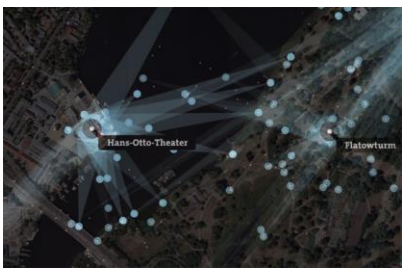


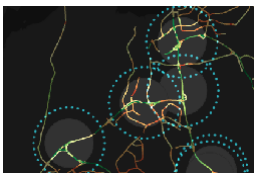


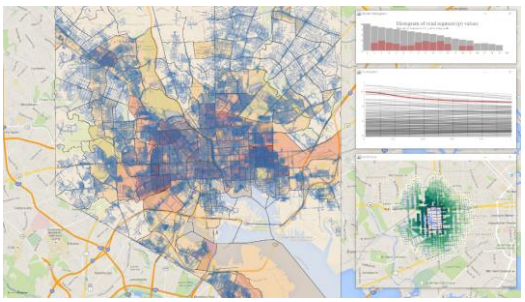


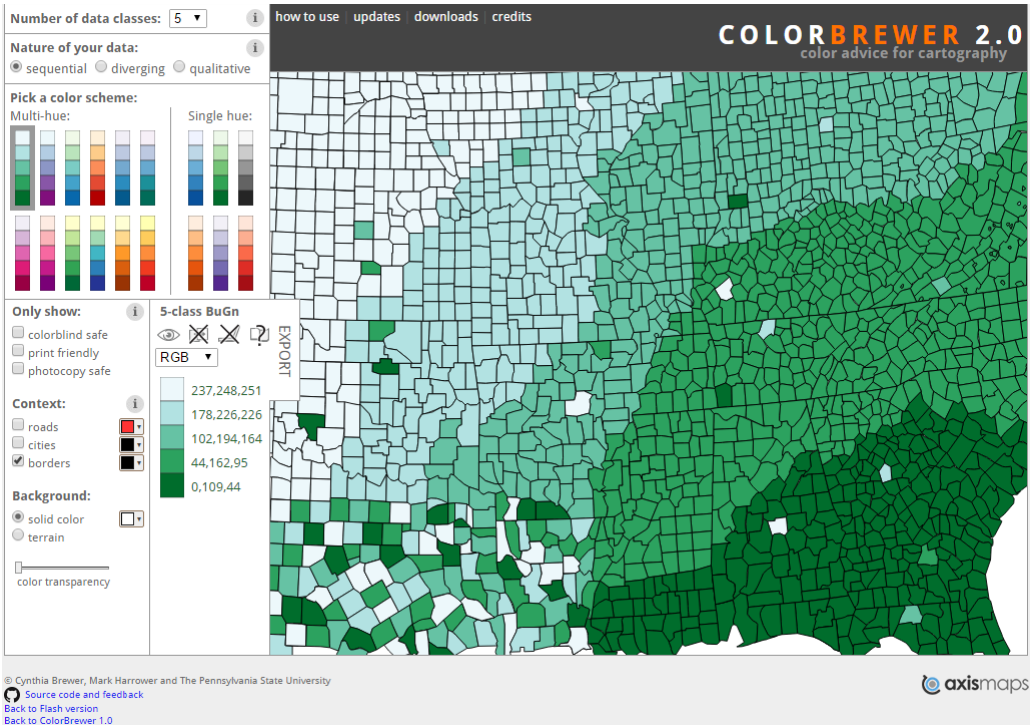
unfolding











Stretch Break!

Let's Play a Game!

Design a Spatial Data Set for Atlanta

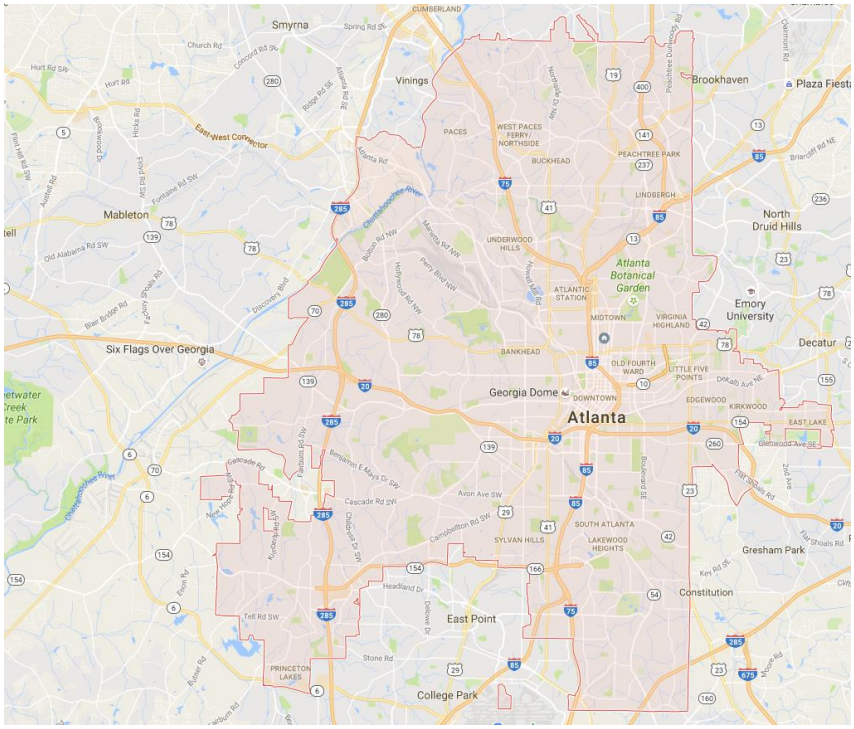
- Think of a dataset that is important to you that has a spatial component (i.e., location).
- What are the items (e.g., people, businesses, events)?
- What are the attributes: location + what else?
  - Time
  - Name
  - Type
- What are the important insights about this data that analysis could reveal?

Quickly Pair Up

- Find someone nearby to work with.
- If everyone nearby is paired up, teams of three are OK.

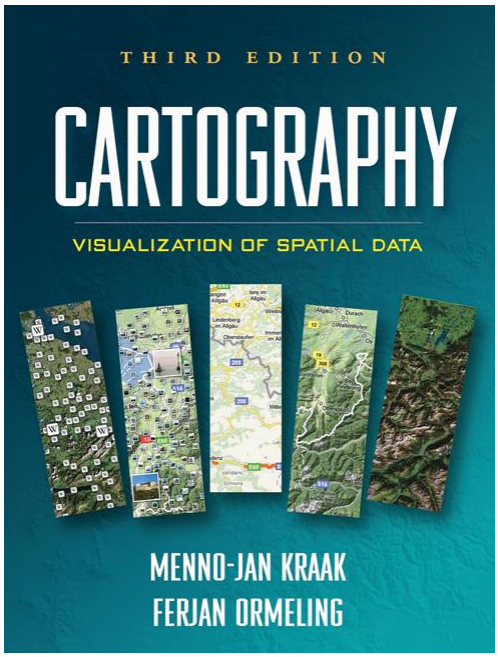
Design a Spatial Visualization

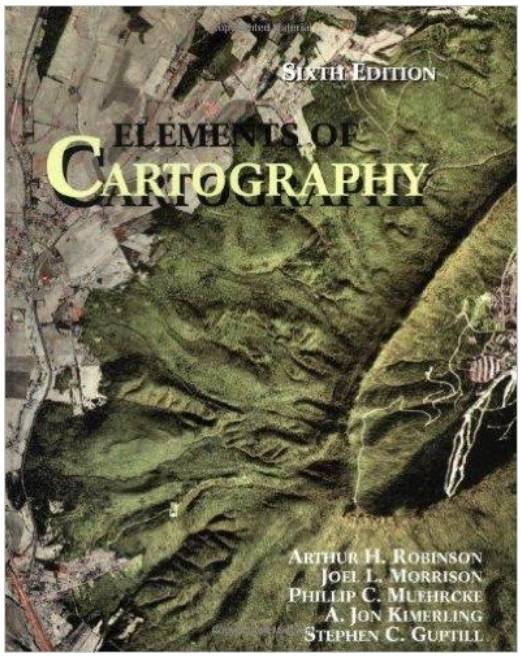
- Using the dataset you've designed, design a spatial visualization with your team.
- This visualization should combine both data sets on the map.
  - This should allow for insights related to each data set.
  - You might have to compromise a little, but both should be present.
- You can create a choropleth map, scalar fields, vector fields – whatever you think best represents your data.
- What interactions are present?



Let's see what you've made!

I need volunteers.





Learning Objectives

- Process of encoding Geospatial Visualization
- Common Geospatial Visualizations
- Benefits and tradeoffs of map types

HW 5

- Design problem
- Text and document collection
  - Amazon TV reviews
  - Narrative text paired with some other attributes
- Due on Monday 31st
- Bring two copies

Upcoming

- Geospatial visualization

- No class next week
  - Assignment: Watch a video