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Geovisualization

Introduction of Geovisualization

Xiaojiang Li, Ph.D
Assistant Professor,
Department of Geography and Urban Studies

Today's agenda

- Introduction
  - Who am I?
  - Who you are?
- Course overview and Expectations
  - Syllabus
- What is Geovisualization?
- Geovisualization Tools
- Special Topics in Geovisualization

About me

Assistant Professor, Temple University

Education:

Postdoc, Senseable City Lab, MIT

Ph.D Department of Geography, University of Connecticut

M.S. Cartography and GIS, Chinese Academy of Science

B.S Environmental Science, Henan University

About me

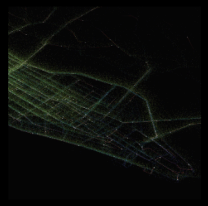
senseable city lab.

Urban imagination and social innovation through design & science

The real-time city is real! As layers of networks and digital information blanket urban space, new approaches to the study of the built environment are emerging. The way we describe and understand cities is being radically transformed—as are the tools we use to design them. The mission of the Senseable City Laboratory—a research initiative at the Massachusetts Institute of Technology—is to anticipate these changes and study them from a critical point of view.

Not bound by the methodologies of a single field, the Lab is characterized by an omni-disciplinary approach: it speaks the language of designers, planners, engineers, physicists, biologists and social scientists. Senseable is as fluent with industry partners as it is with metropolitan governments, individual citizens and disadvantaged communities. Through design and science, the Lab develops and deploys tools to learn about cities—so that cities can learn about us.

Projects


Urban Sensing
2019

2019 Forum on Future Ci...
2019


Driving DNA
2019

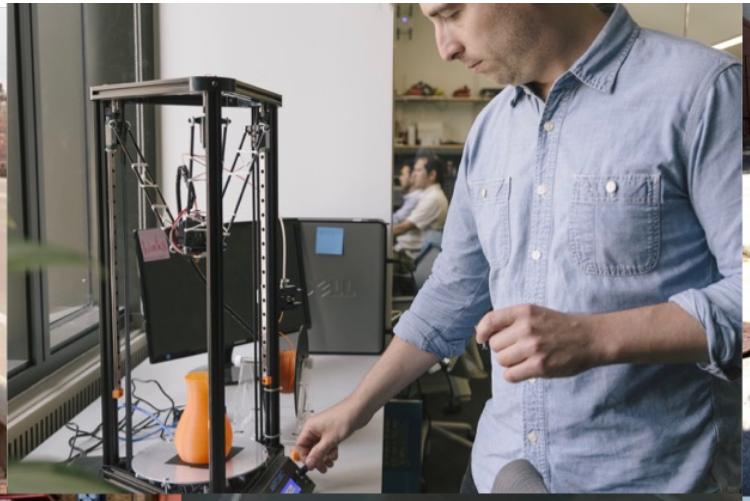
Weibo Smog
2019


Good Vibrations
2018

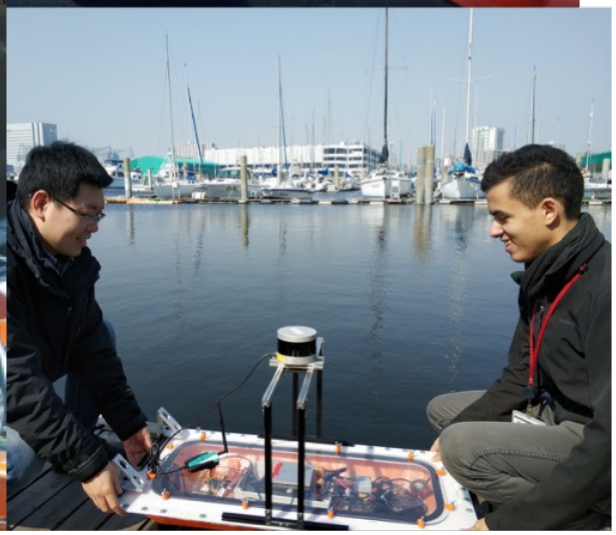

Unparking
2018


Roboat
2018


Minimum Fleet
2018





My research

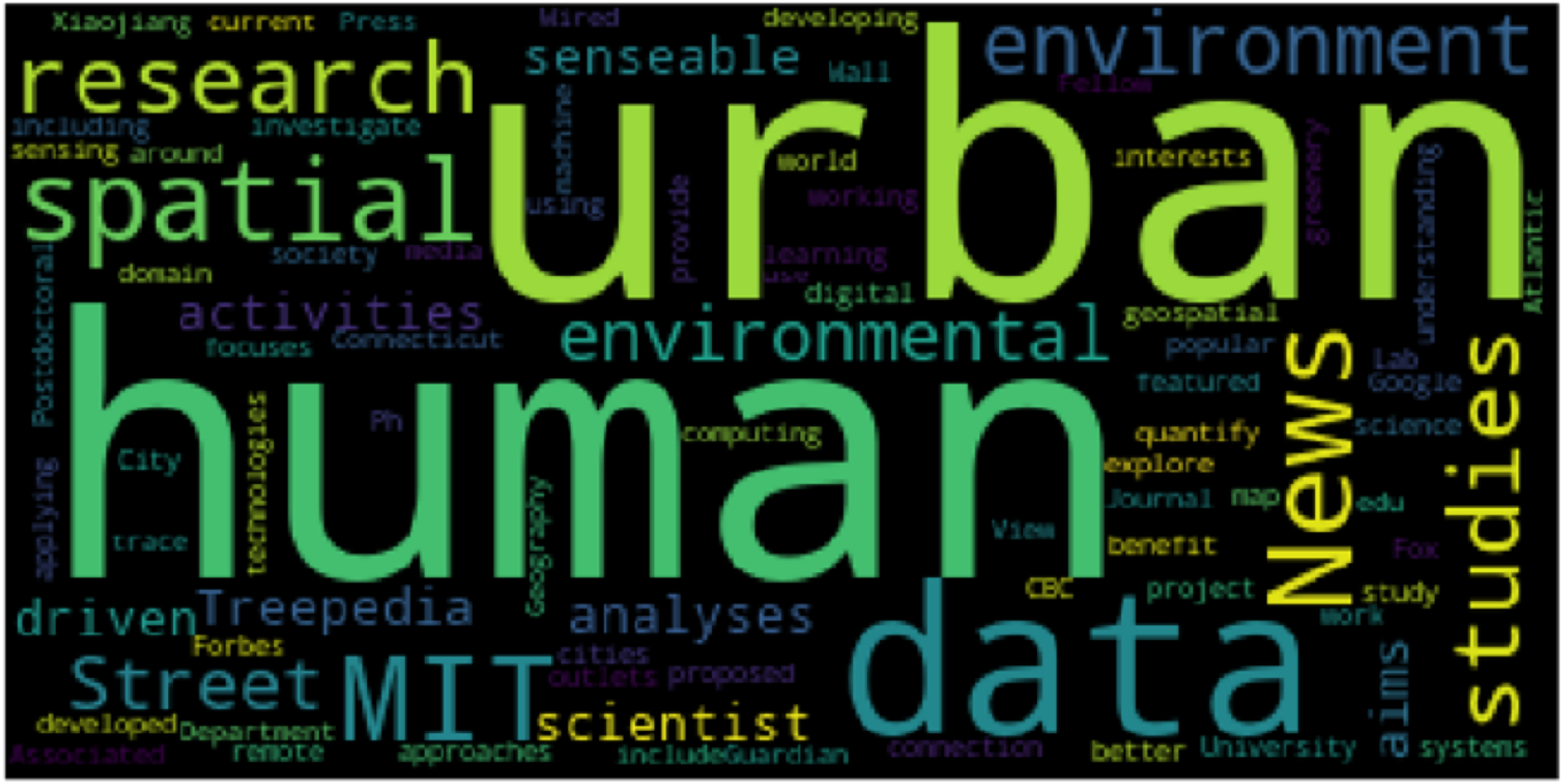
1. Urban Analytics for sustainability

2. Urban Science

3. Spatial Data Science

4. Urban Sensing and Urban Computing

My research


urban
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driven
analyses
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current
Press
Wired
developing
Mall
Fellow
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world
working
interests
grocery
understanding
Atlantic
provide
learning
digital
geospatial
popular
featured
Lab
Google
science
quantify
explore
journal
map
edu
Fox
benefit
project
study
work
aims
systems
University
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Connecticut

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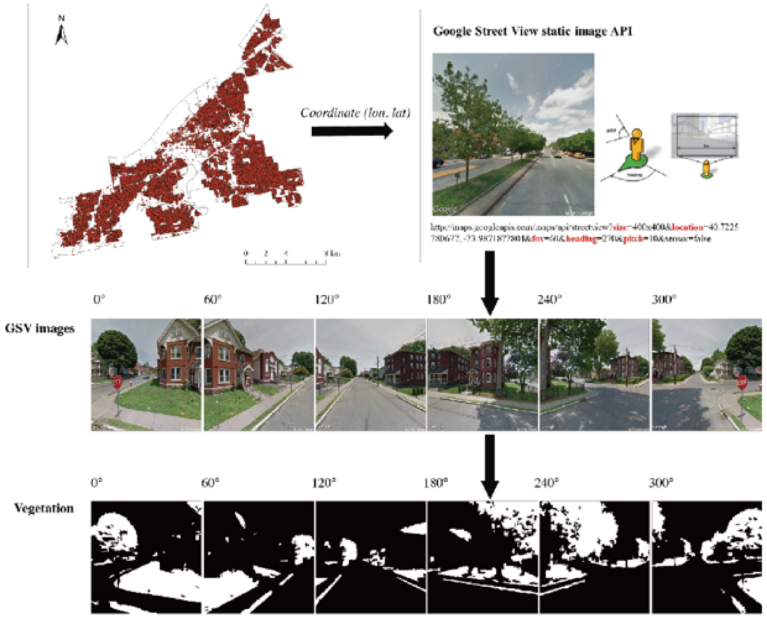
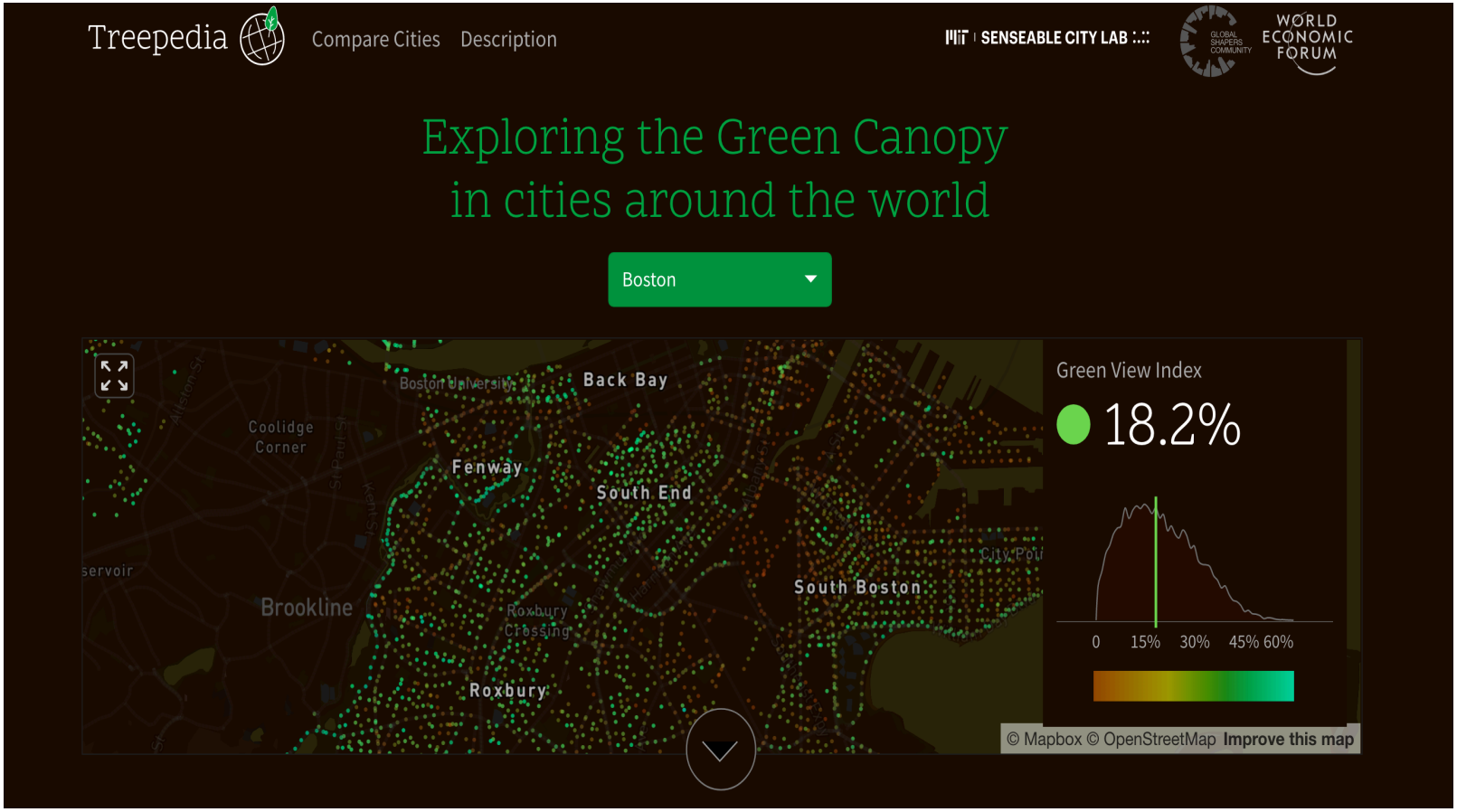
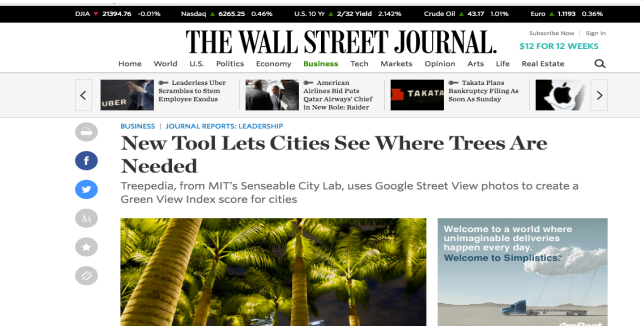
Mapping street greenery

Treepedia

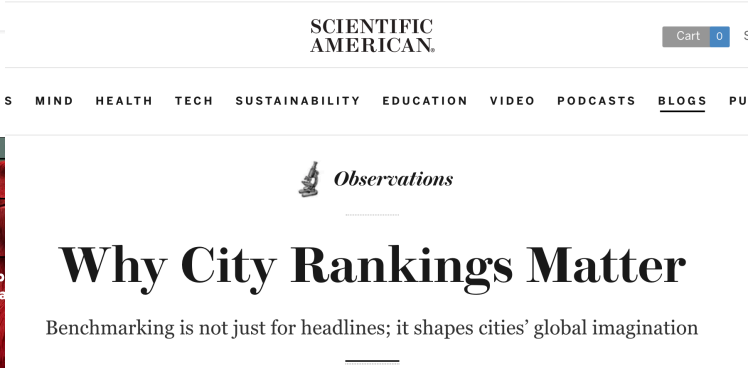

Coordinate (lon, lat)
Google Street View static image API
0°
60°
120°
180°
240°
300°
GSV images
Vegetation


100 Massachusetts Ave
Boston, Massachusetts
Google, Inc.
Street View - Aug 2017
Rockn&Board
MUJI
Google


Treepedia
Compare Cities
Description
MIT | SENSEABLE CITY LAB
GLOBAL SHAPERS COMMUNITY
WORLD ECONOMIC FORUM
Exploring the Green Canopy in cities around the world
Boston
Boston University
Back Bay
Coolidge Corner
Fenway
South End
Brookline
Roxbury Crossing
Roxbury
South Boston
Green View Index
18.2%
0
15%
30%
45%
60%
© Mapbox © OpenStreetMap Improve this map


THE WALL STREET JOURNAL.
$12 FOR 12 WEEKS
Home World U.S. Politics Economy Business Tech Markets Opinion Arts Life Real Estate
BUSINESS | JOURNAL REPORTS: LEADERSHIP
New Tool Lets Cities See Where Trees Are Needed
Treepedia, from MIT's Senseable City Lab, uses Google Street View photos to create a Green View Index score for cities
Welcome to a world where unimaginable deliveries happen every day.
Welcome to Simplistics.


TIME
How Green Is Your City? In Paris, the Answer Is Not Green Enough
WORLD • FRANCE
How Green Is Your City? In Paris, the Answer Is Not Green Enough


SCIENTIFIC AMERICAN.
Cart 0
MIND HEALTH TECH SUSTAINABILITY EDUCATION VIDEO PODCASTS BLOGS
Observations
Why City Rankings Matter
Benchmarking is not just for headlines; it shapes cities' global imagination

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Human mobility

Human mobility - *Cityways*

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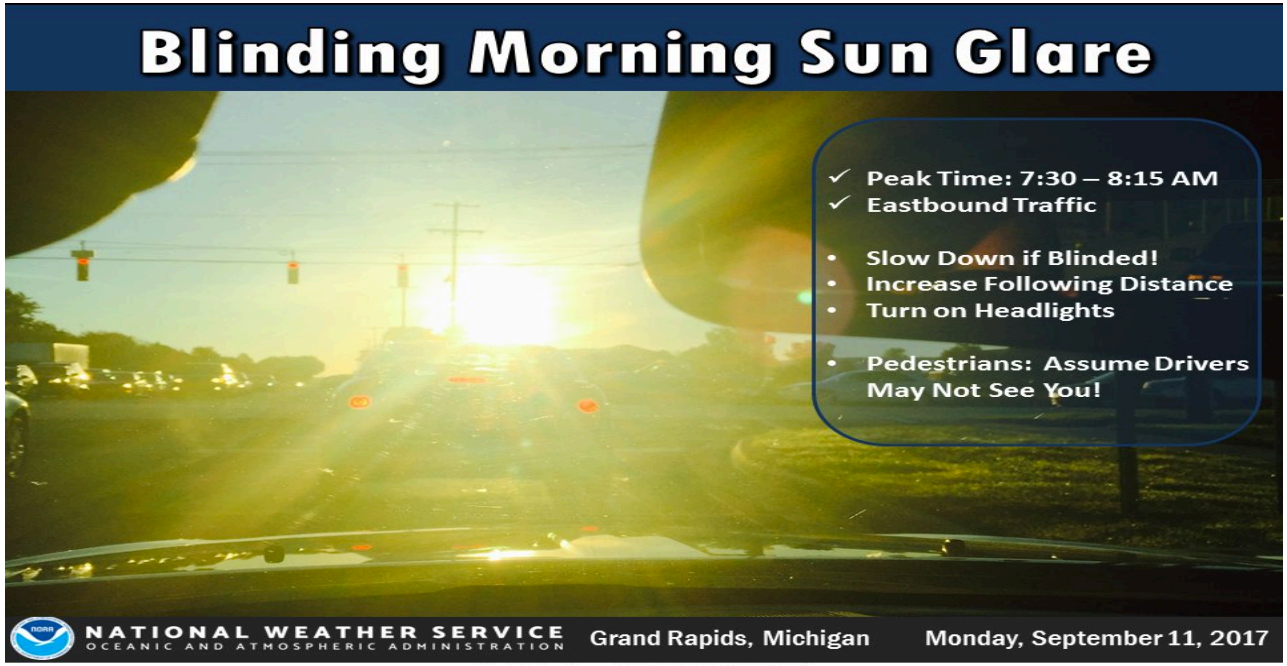
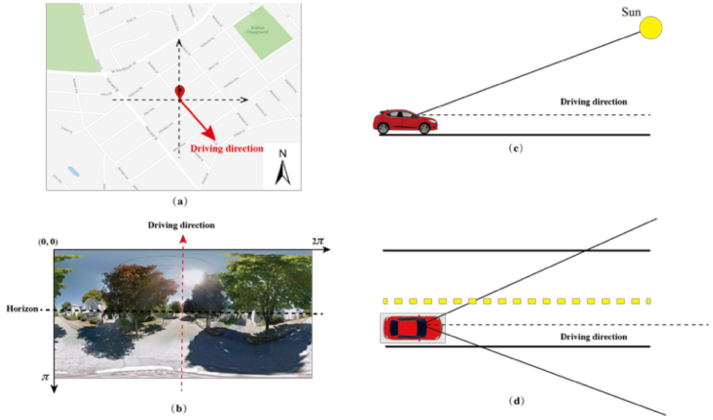
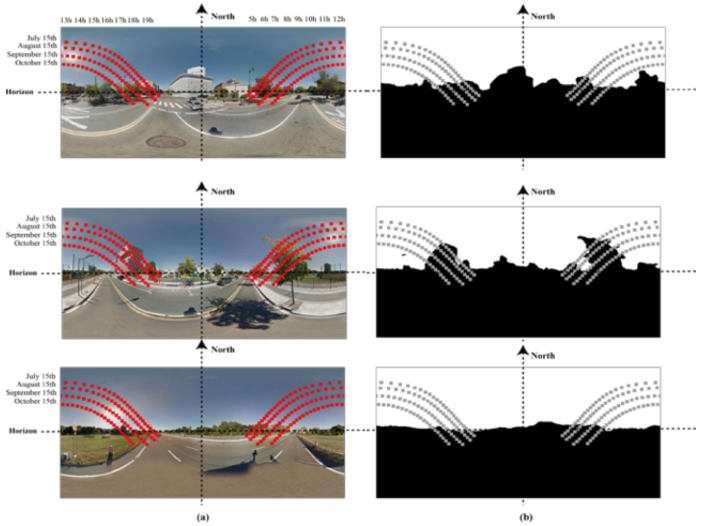
Sun glare mapping

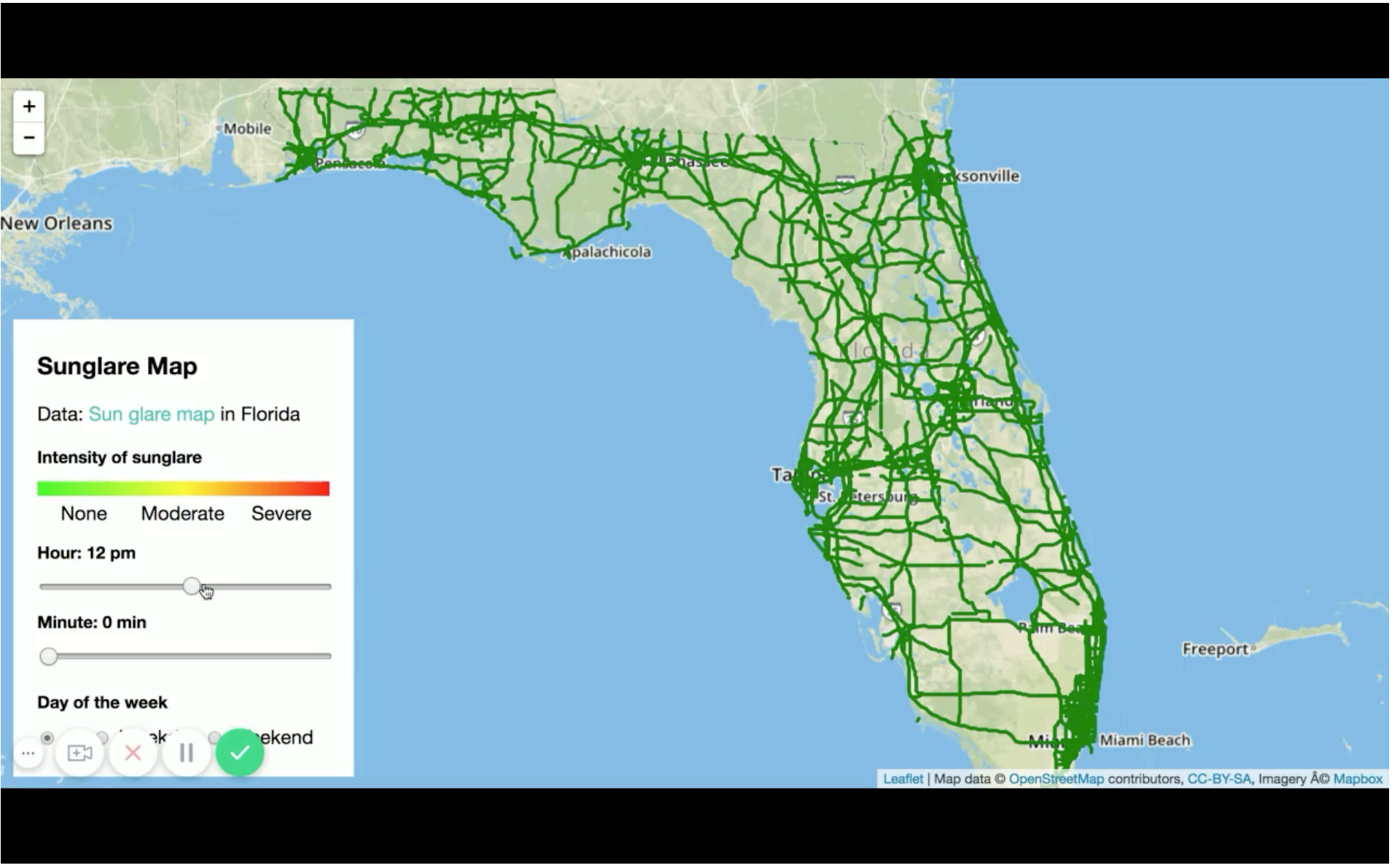


Published on: 09/11/2017 at 8:31AM





https://www.sciencedirect.com/science/article/pii/S0968090X18311252



https://www.youtube.com/watch?v=WWSXl8OiM5w

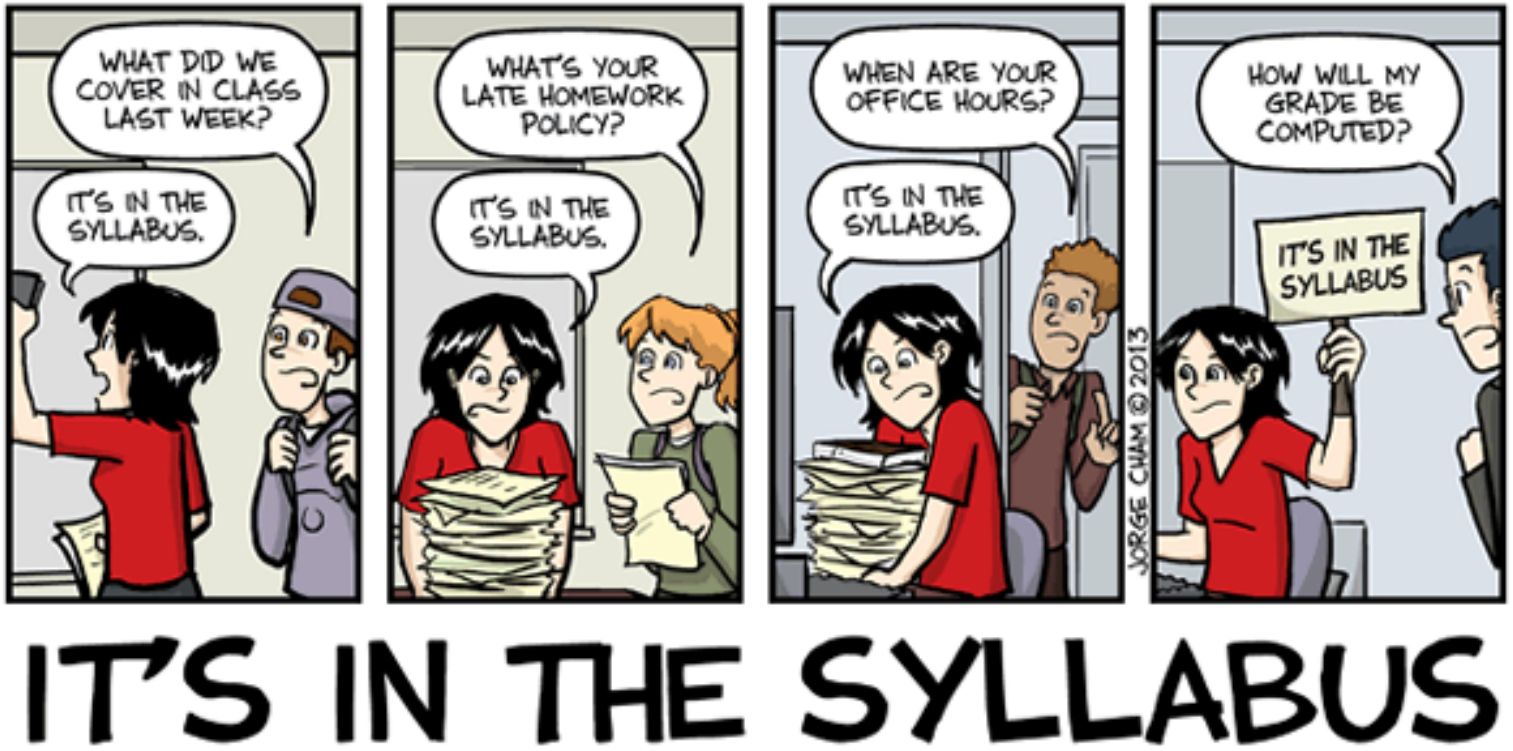
About You

- Your name and degree program
- Your study/research interests

- GIS Knowledge?
- Programing knowledge?

- Why did you sign up for this class?
- What do you expect from this class?

Course Expectations



Course Description (I)

Geospatial + Visualization

Dual purpose of maps

- Information representation
- Exploration of relationships among social and physical processes manifesting in space

Technology is always changing, but the principles that lead to good map design remain the constant

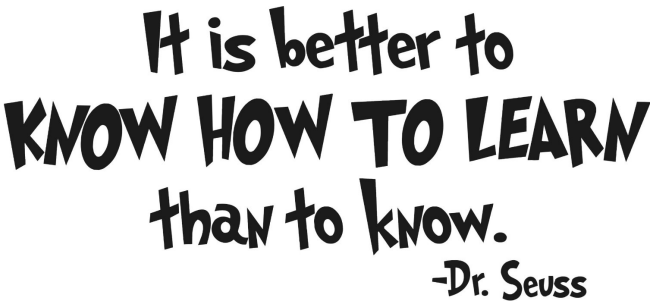
Course Description (II)

This course requires time, creativity, and a drive to learn

- I want to give you a flavor of various geovisualization tools and help you to learn how to find, test, and teach new software to yourselves and each other
- I believe this will give you valuable experience into how actual research takes place in academia and industry
- Tools and standards are constantly changing, and it is not enough to learn one software
- Sometimes you will be learning a tool or technology that I am not an expert in, and we will be learning together

Course Description (III)

- You will learn design maps
- Knowledge of map design: understand projections, basic spatial analysis, and data processing
- No math required
- You will need to write code, Python and Javascripts
- Learn from examples: The best way to learn is to learn from geovisualization examples



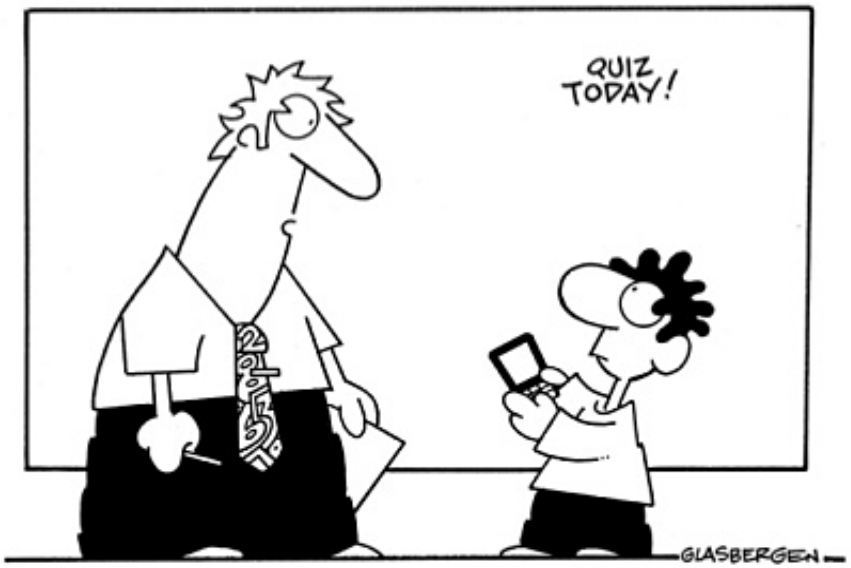
Course Objectives

Upon completion of this course, you will be able to

- Understand **the theoretical concepts and methods of cartographic and geographic visualization**
- Understand **principles of symbolization** and which **visual variables** to use for what purposes
- Understand **principles of color theory** and how they affect map symbolization and interpretation
- Create **effective visualizations** of geographic data
- Create **balanced and informative layouts**
- **Critique maps** for improved design skills
- **Use interactive visualization to explore spatial data sets**, including linking and brushing
- Develop the ability to **apply principles already learned to new projects or situations**
- **Learn how to gain new knowledge and skills** in cartography and geovisualization **on your own**

Attendance

- **Prolonged absence from class will inhibit your understanding of the lecture material and prevent you from receiving help on assignments**
- The final grade for the semester will be ***lowered by 10% upon the third absence***
- If you cannot attend class, you must ***contact me before class***!



**"You have to attend classes.
You can't just follow me on Twitter."**

Equipment/Class Room

Computers in Gladfelter Hall 336 have the necessary software installed

- If you of your work on you have access to a laptop, you may find it easier to install the free software and do most r personal machine

Some assignments will require lab work outside of the class times

- Gladfelter Hall 336 is generally open M-F from 8:30 am - 7:00 pm and is available when other classes are not using the lab
- Many other computer labs administered by the College of Liberal Arts (http://www.temple.edu/cs/labs/index.htm) offer access

It is the student's responsibility to understand how data and projects are saved, and to manage and back up their own data and assignments

- I suggest purchasing a USB port-based data storage device with a 1 GB capacity or greater

Course Structure

Lecture (30 - 60 min)

- Interactive and inclusive environment
- Feel free at any time during lecture to ask a question and make a comment

In class exercise

- Work individually on the in class exercise
- Answer questions

Graduate Student-led Lectures

Start from week 7, each student will present a geovisualization from any source, news paper's website, research group, blog, etc.

- Topics are flexible, static or dynamics, video or website…
- Introduce the technique used in the geovisualization if possible
- Geovisualization Critiques.

Final Project

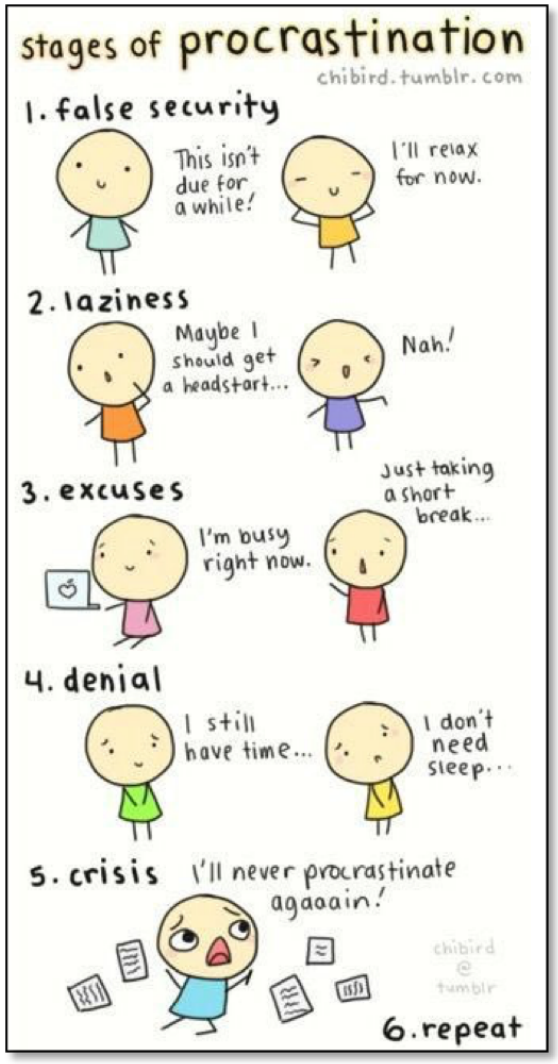
- Apply your acquired geovisualization skills to a research question
- Create two high quality visualization products

  Static and dynamic visualization using a platform or tool your choice and principles and techniques you have learned throughout the course
- Present your project on the last days of class

Late Policy

- Assignments that are turned in late will be penalized 10% for each calendar day beyond the due date and time!

- Assignments will not be accepted more than 7 days after they are due!



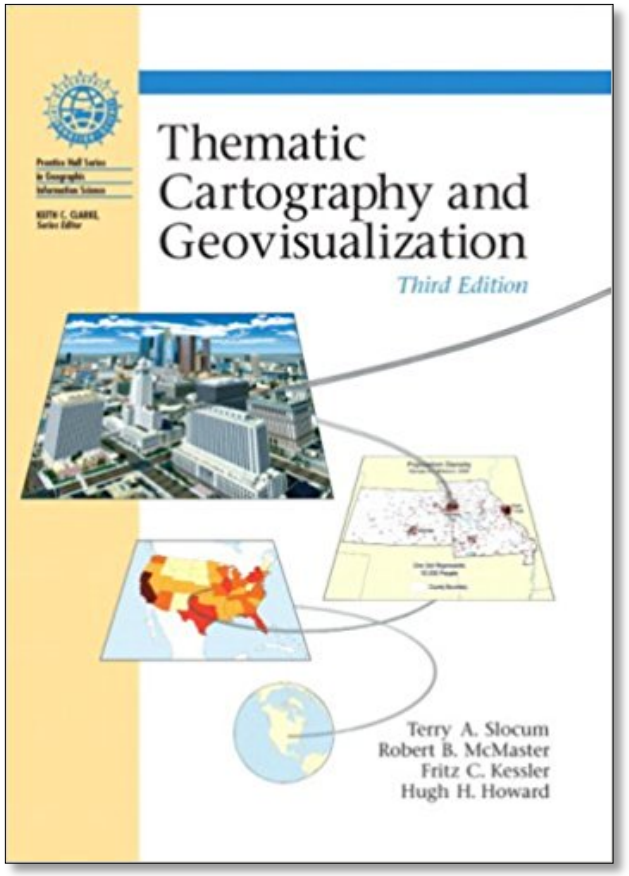
Books

Thematic Cartography and Geovisualization, 3rd Edition

by Terry A. Slocum, Robert B. McMaster, Fritz C. Kessler, Hugh H. Howard (Prentice Hall)

Rent it on Amazon: $39.76

Buy it on Amazon: $198.63



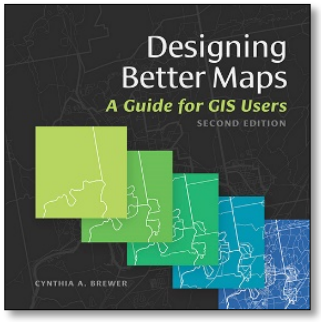
More Books (not required)

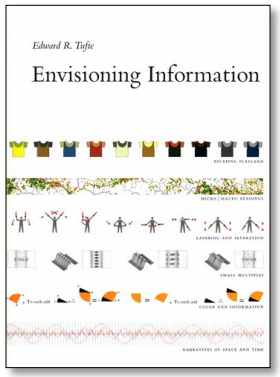
Brewer, Cynthia. *Designing better Maps: A Guide for GIS users*. Esri Press, 2015.

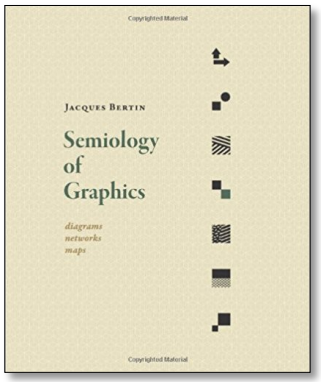
Tufte, Edward R. *Envisioning information*. Graphics press, 1990.

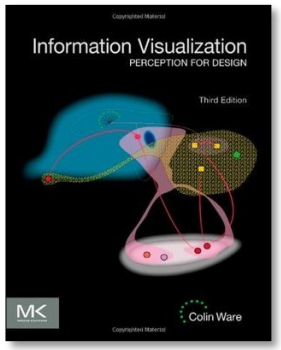
Bertin, Jacques. *Semiology of graphics: diagrams, networks, m*aps. 1983.

Ware, Colin. *Information visualization: perception for design*. Elsevier, 2012.









Grading

Graduate Section		Undergraduate Section	
Student-led Lectures	15%	Student-led Lectures	20%
Homework	40%	Homework	40%
Final Project	40%	Final Project	30%
Participation	5%	Participation	10%

100% - 95.00%	A	94.99% - 90.00%	A-		
89.99% - 87.00%	B+	86.99% - 84.00%	B	83.99% - 80.00%	B-
79.99% - 77.00%	C+	76.99% - 74.00%	C	73.99% - 70.00%	C-
69.99% - 67.00%	D+	66.99% - 60.00%	D	59.99% - 0.00%	F

Preliminary Schedule (I)

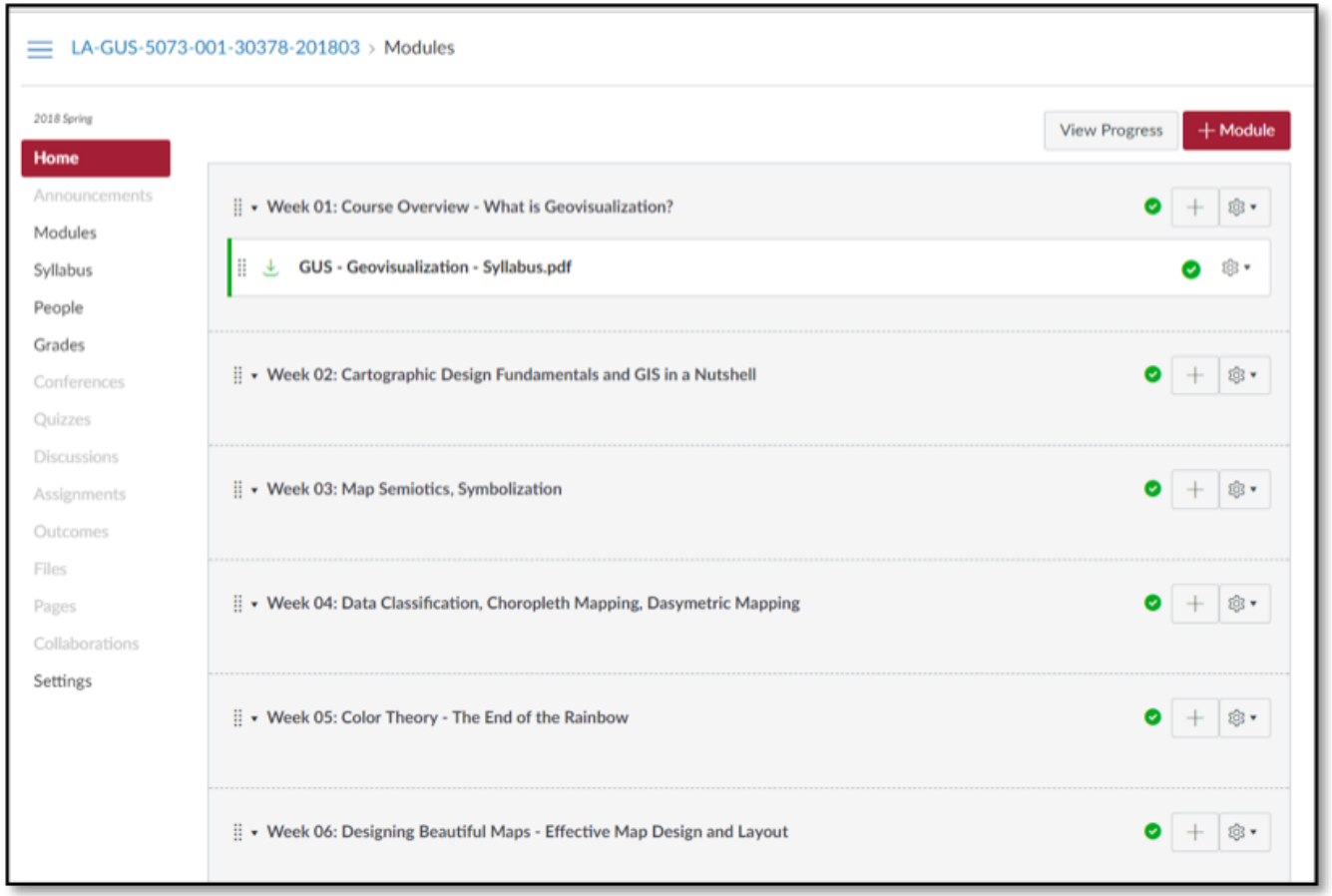
Week	Date	Lecture Topic	Readings	Activities	Due Dates
1	08/26/19	Course Overview - What is Geovisualization?	Ch. 1		
2	09/02/19	No Class – Labor Day			
3	09/09/19	Cartographic Design Fundamentals and GIS in a Nutshell (I)	Ch. 6, 7, 8	Work on Tutorials	
4	09/16/19	Cartographic Design Fundamentals and GIS in a Nutshell (II)	Ch. 6, 7, 8	Work on Tutorials	
5	09/23/19	Map Semiotics, Symbolization	Ch. 5, 17	Work on Tutorials	
6	09/30/19	Data Classification, Choropleth Mapping, and Dasymetric Mapping	Ch. 4, 14, 15	Work on Tutorials	
7	10/07/19	Color Theory: The end of the rainbow MIDTERM	Ch. 10	Work on Tutorials	
8	10/14/19	Designing Beautiful Maps: Effective Map Design and Layout	Ch. 9, 11, 12, 13	Student-led Lecture Work on Tutorials	

Preliminary Schedule (II)

9	10/21/19	Exploratory Spatial Data Analysis, Multivariate Spatial Data Analysis	Ch. 18, 22	Student-led Lecture Work on Tutorials	
10	10/28/19	Web Mapping	TBD	Work on Tutorials	
11	11/04/19	Uncertainty of Geovisualization	Ch. 23	Work on Tutorials	
12	11/11/19	No Lecture –Work on Final Project 11/13 GIS Day			
13	11/18/19	Flow Visualization & Spatio-Temporal Visualization	-	Student-led Lecture Work on Tutorials	
14	11/25/19	Fall Break	-		
15	12/02/19	Special Topics in Geovisualization: Virtual and Immersive Environments, Collaborative Geovisualization, Future of Geovisualization	-		
16	12/09/19	Last Day of Class: Final Project Presentations during CAPSTONE event Final Project Presentations (last day of class), FINAL EXAM REVIEW		Student	
17	12/16/19				Final Project Report due

Canvas

Syllabus, Course Materials, Updates, Announcements…



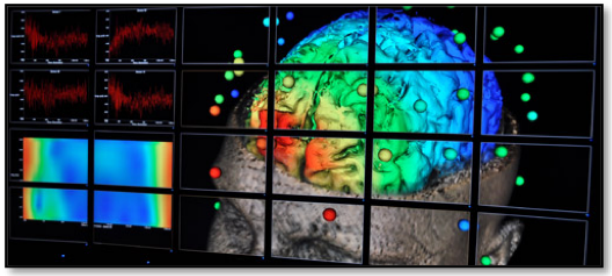
Course Structure

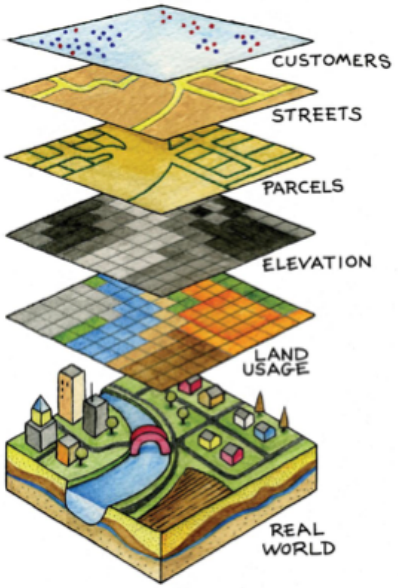
What is Geovisualization?

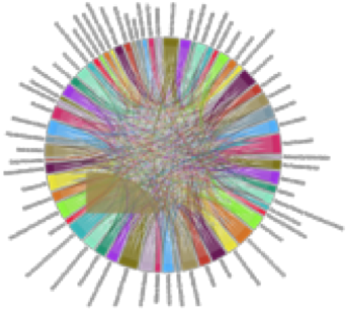
Discipline emerged in the mid 90's

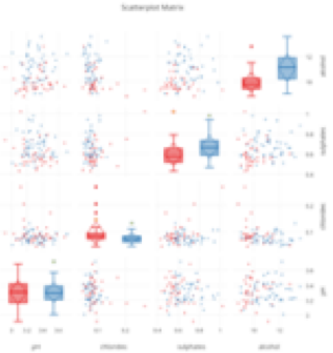
Roots in Computer Graphics and Cartography

- Scientific Visualization (SciVIS)
- Information Visualization (InfoVIS)
- Abstract data spaces
- Exploratory data Analysis (EDA)
- Geographic Information Systems (GIS)









Definition of Geovisualization?

Geographic Visualization (Geovisualization)

- Set of tools and techniques supporting the analysis of geospatial data through the use of visualization

MacEachren et al. (1992)

- Geographic visualization can be defined as the use of concrete visual representations – whether on paper or through computer displays or other media – to make spatial contexts and problems visible, so as to engage the most powerful human information-processing abilities associated with vision.

MacEachren (1995)

- Geovisualization is the creation and use of visual representations to facilitate thinking, understanding, and knowledge construction about human and physical environments at geographic scales of measurement.

Function of Geovisualization?

Geovisualization is more than conventional map design!

Four principal purposes

- **Exploration**: Is the dataset sensitive to including certain samples?
- **Synthesis**: See the wood for the trees
- **Presentation**: Communicate the overall message of a representation
- **Analysis**: Support a range of methods and techniques of spatial analysis

Function of Geovisualization?

MacEachren's Cartography Cube

Private vs. Public

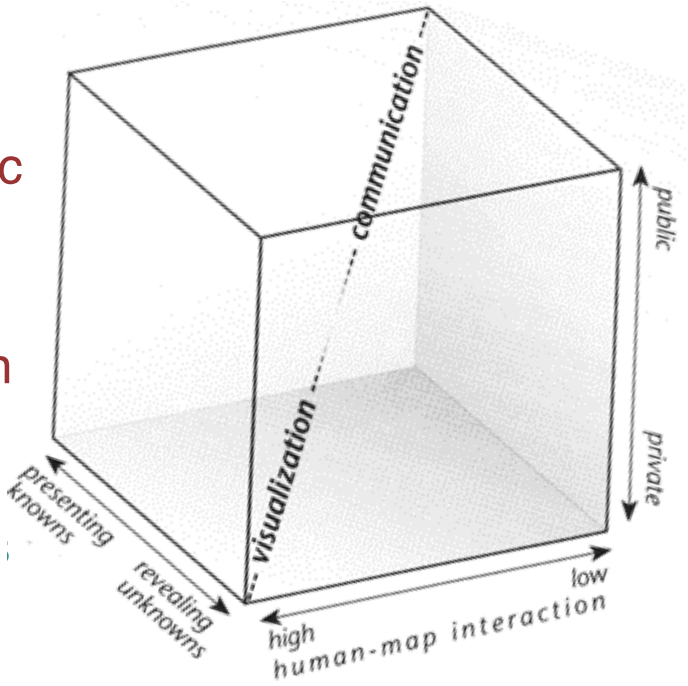
Is the visualization targeted to one person or a restricted group of people to solve a specific problem or it is more intended to address public audience?

Static vs. Interactive

Is the visualization a static representation or an interactive tool that people can use to explore alternative views?

Revealing Knowns vs. Revealing Unknowns

Is the goal to communicate a number of findings or messages to an audience or to provide people ways to explore the data and make sense of it?



Tutorial Choices

- Creating Choropleth maps with Python

- Creating Choropleth maps with Leaflet and/or D3.js

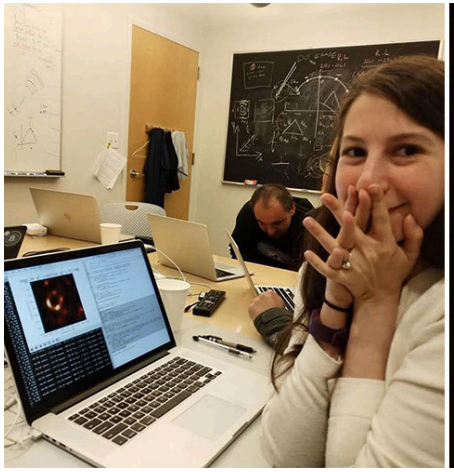
- Mapbox

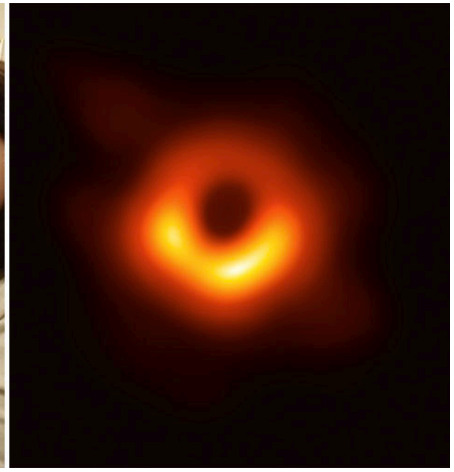
Python

One of the most popular Programing language in data science community. Easy to learn.

Popular geospatial libraries

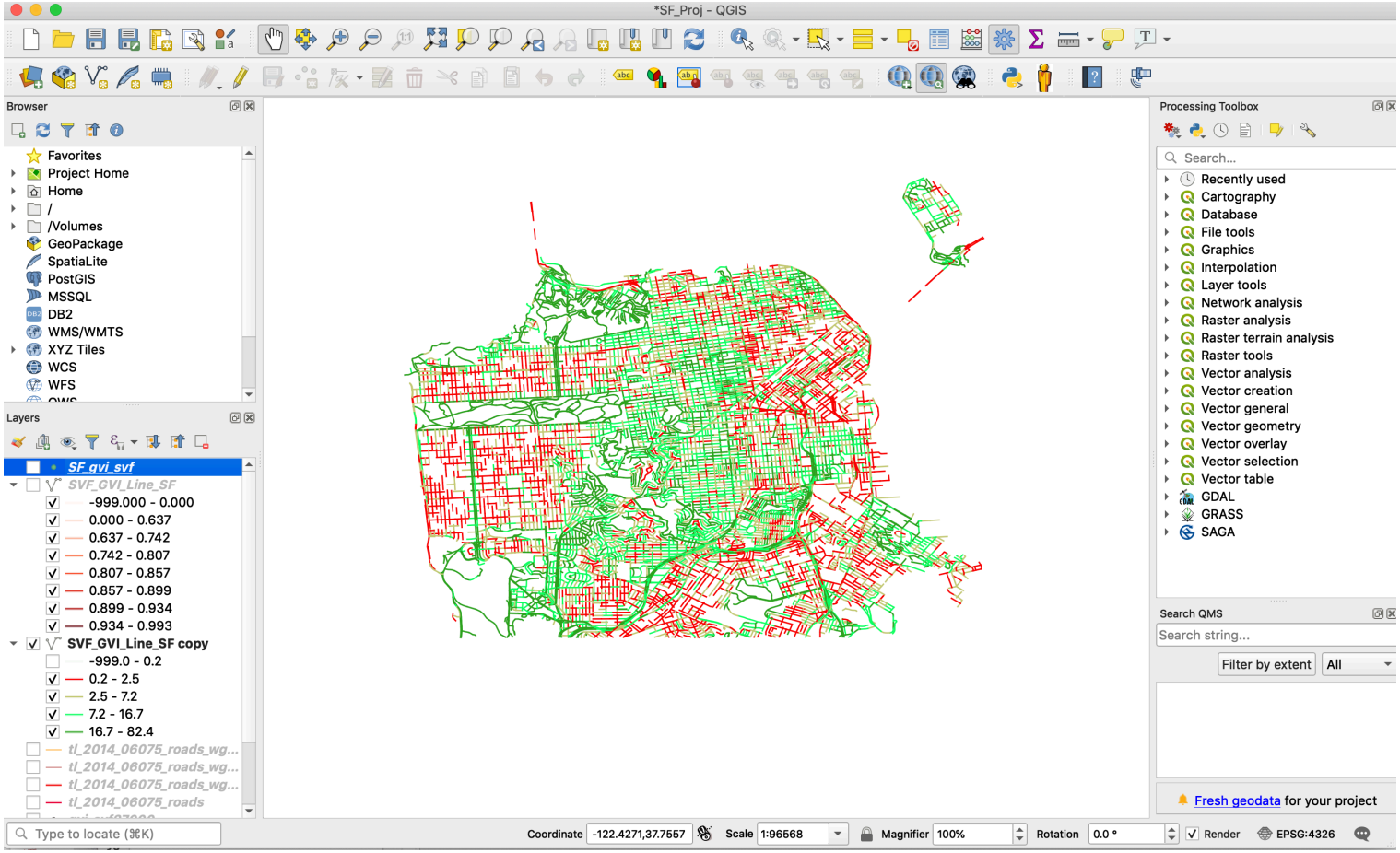
- Geopandas
- Matplotlib
- Geoplot





QGIS

Open-source desktop GIS software

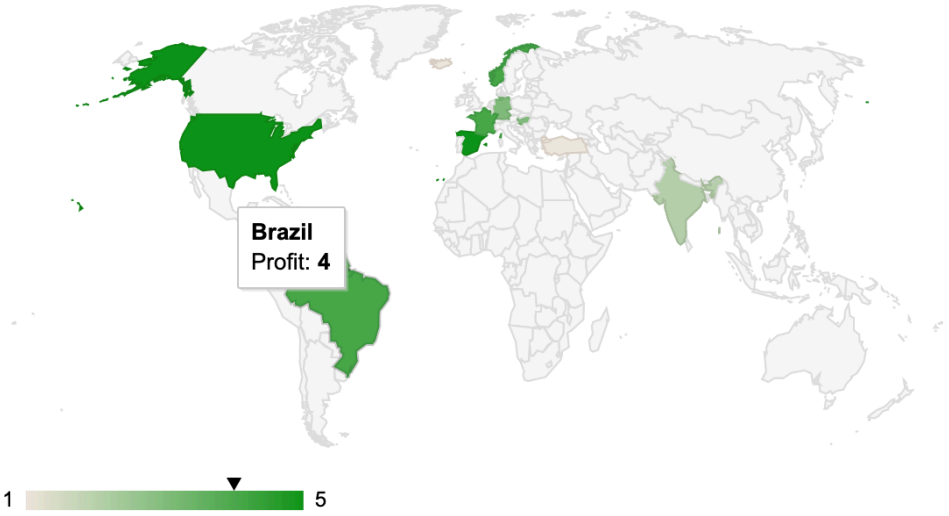


R

Software and Programing language and for statistical computing and graphics, https://www.r-project.org/

Popular libraries

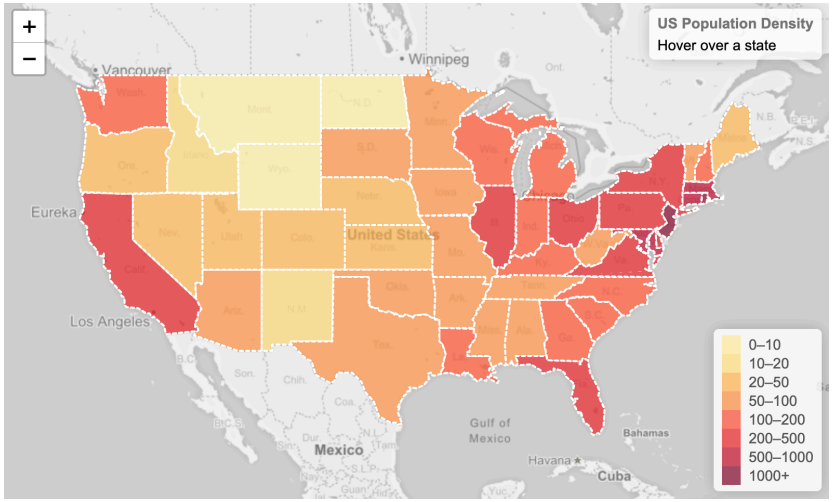
- ggplot2
- plotly
- googleViz



Leaflet.js

Open-source Javascript library for mobile-friendly interactive maps, http://leafletjs.com/

```
L.tileLayer('https://api.tiles.mapbox.com/v4/{id}/{z}/{x}/{y}.png?a
IjoibWFwYm94IiwiYSI6ImNpejY4NXVycTA2emYycXBndHRqcmZ3N3gifQ.rJcFIG21
    maxZoom: 18,
    attribution: 'Map data &copy; <a
        href="https://www.openstreetmap.org/">OpenStreetMap</a> con
        '<a href="https://creativecommons.org/licenses/by-sa/2.0/">
        'Imagery © <a href="https://www.mapbox.com/">Mapbox</a>',
    id: 'mapbox.light'
}).addTo(map);

// get color depending on population density value
function getColor(d) {
    return d > 1000 ? '#800026' :
           d > 500  ? '#BD0026' :
           d > 200  ? '#E31A1C' :
           d > 100  ? '#FC4E2A' :
           d > 50   ? '#FD8D3C' :
           d > 20   ? '#FEB24C' :
           d > 10   ? '#FED976' :
                      '#FFEDA0';
}
```

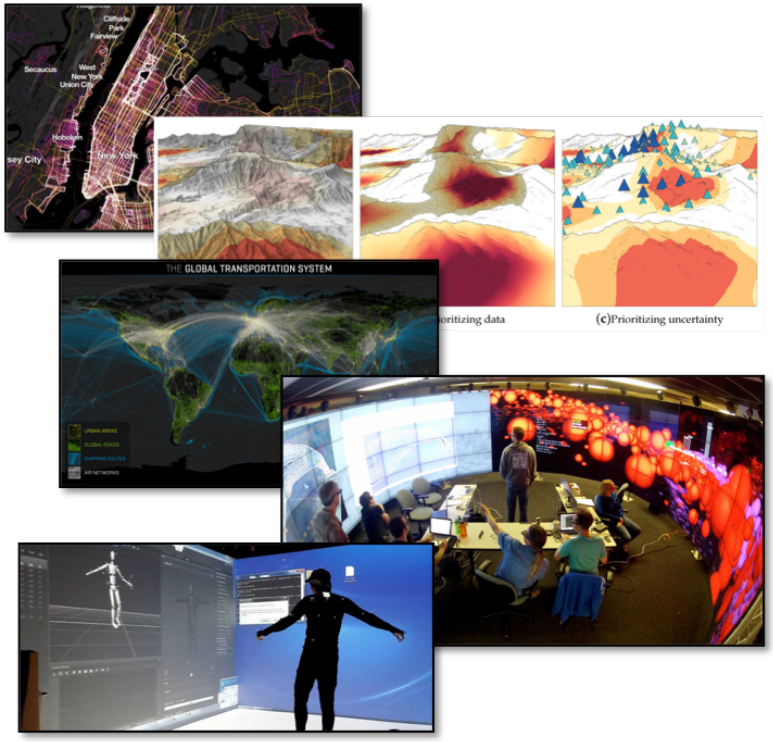


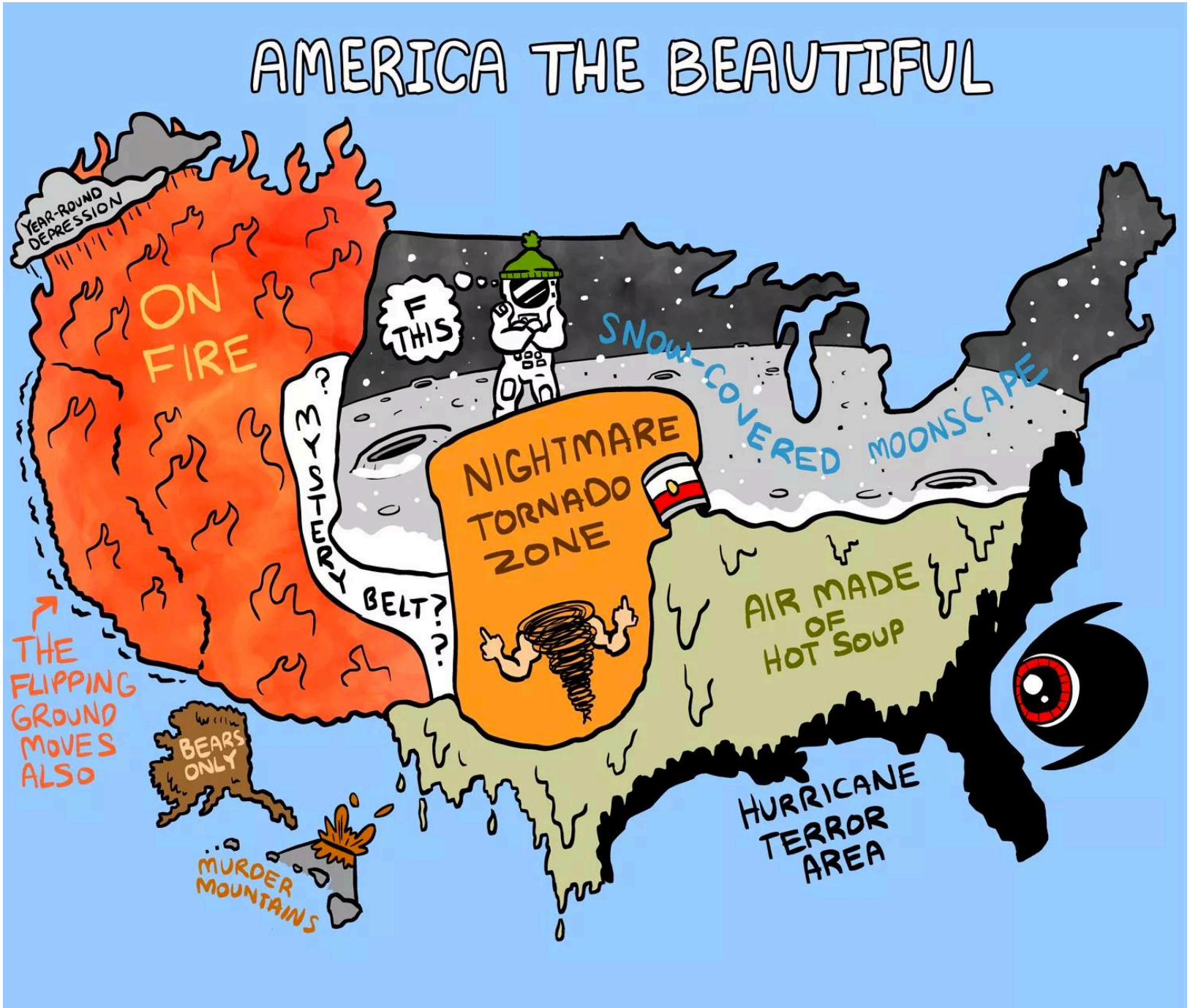
Mapbox GL JS

```
<script>
mapboxgl.accessToken = 'pk.eyJ1IjoieGlhb2ppYW5nZ2lzIiwiYSI6ImNqdW91bHY2NzBnOD
pcnMifQ.ovrl0VtRBMz23pfOIz4_hA';
    var map = new mapboxgl.Map({
    style: 'mapbox://styles/mapbox/light-v10',
    center: [-74.0066, 40.7135],
    zoom: 15.5,
    pitch: 45,
    bearing: -17.6,
    container: 'map'
});

// The 'building' layer in the mapbox-streets vector source contains building
// data from OpenStreetMap.
map.on('load', function() {
// Insert the layer beneath any symbol layer.
var layers = map.getStyle().layers;

var labelLayerId;
    for (var i = 0; i < layers.length; i++) {
        if (layers[i].type === 'symbol' && layers[i].layout['text-field']) {
        labelLayerId = layers[i].id;
        break;
    }
}
```

Special Topics

- Web-based Geovisualization
- Uncertainty Visualization
- Flow Visualization
- Collaborative Geovisualization
- Spatio-temporal Geovisualization
- Virtual Environments




AMERICA THE BEAUTIFUL
YEAR-ROUND DEPRESSION
ON FIRE
F THIS
SNOW-COVERED MOONSCAPE
MYSTERY BELT??
NIGHTMARE TORNADO ZONE
AIR MADE OF HOT SOUP
THE FLIPPING GROUND MOVES ALSO
BEARS ONLY
MURDER MOUNTAINS
HURRICANE TERROR AREA

Comprehension of graphics

Comprehension involves direction of visual attention, which can be driven by the visual features of the graphic and by the viewer's expectations from their prior knowledge.

Comprehension of attended information takes place in the context of prior knowledge using working memory, and enables inferences to be drawn from the data, creating new knowledge in long-term memory.