Cartography
Spatial Computing – University of Minnesota
Learning Objectives

1. Understand the drastically changed (and changing) professional context of modern cartography.

2. Be able to distinguish between and understand the purpose of the two major types of maps: reference and thematic.

3. Know the limitations of popular online and mobile reference maps. (Technical track: Know how to get around them)

4. Be able to distinguish between types of thematic maps and choose the correct type for a given geocommunication need.

5. Have an understanding of some of the computing-oriented innovation going on in cartography (i.e. spatialization)
Thematic maps are “used to emphasize the spatial distribution of one or more geographic attributes”.

(Slocum et al. 2009)
Election maps:

http://election2012.npr.org/results-map.html
Above: Number of jobs accessible from different points within 30 minutes, between 7 a.m. and 9 a.m. Click here to see the full map, with a legend.
Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dessiné par M. Minard, Inspecteur Général des Tours et Chausées en retraite.

Paris, le 11 Novembre 1869.

Les nombres d'hommes portés sur les longues des gares cédées à raison d'une millième pour dix mille hommes, et donc relevés à travers des gares. Le rouge indique les hommes qui entrent en Russie, le bleu ceux qui en sortent. Les conclusions qui ont été faites sur la carte ont été quittées dans le mouvement de M. Chier, de Chambry, de Chambry et du journaliste de Paris, photographe, à partir des 18 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps de l'armée Française, et du Maréchal Davoust, qui sont attachés aux Minsk et Bialow, sont moins 30 000. Le tableau graphique montre la progression des pertes de l'armée française.

TABLEAU GRAPHIQUE de la température enregistrée du thermomètre de Réaumur au dessous de zéro.

Les chiffres portés sur le graphe indiquent les valeurs minimales de la température.

Adv. par Dupuis, 2 Rue St-Marce 27 1/2 Paris.

Imp. lith. Regnier et Brodard.
Types of thematic maps we’re going to cover:

Choropleth

Graduated / Proportional Symbol

Cartograms
Poverty in the United States

Percent of the Population Below the Poverty Line

Data sources: U.S. Census American Community Survey 2006-2010, ESRI
COLOR-related challenges when making choropleth maps:

1. Deciding on the set of colors you will use

2. Deciding how to assign colors to specific data values (data classification)
COLOR-related challenges when making choropleth maps:

1. Deciding on the set of colors you will use

QUANTITATIVE attributes

QUALITATIVE attributes
With **quantitative** attributes, you want color schemes like:

[Color schemes diagram]

[Source: colorbrewer.org]
Poverty in the United States

Percent of the Population Below the Poverty Line

- 0.00 - 11.3%
- 11.4 - 16.2%
- 16.3 - 21.7%
- 21.8 - 29.6%
- 29.7 - 49.5%

Data sources: U.S. Census American Community Survey 2006-2010, ESRI

Classification: Natural Breaks
Population Density in the U.S.

People per Square Mile by County

Data sources: U.S. Census, ESRI

People per Square Mile

- 0 - 822
- 833 - 3270
- 3721 - 9675
- 9676 - 20418
- 20419 - 69568

Classification: Natural Breaks
85+ Population in the United States

Pct of the Population that is 85 Years Old or Older

Pct. Pop 85+
Years Old

0.0 - 1.4%
1.4 - 2.0%
2.0 - 2.8%
2.8 - 3.9%
3.9 - 8.3%

Data sources: U.S. Census, ESRI
Classification: Natural Breaks
Poverty in the United States

Percent of the Population Below the Poverty Line

Pct. Below Poverty Line

- 0.00 - 11.3%
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Slides for Spatial Computing MOOC (By Brent Hecht)

Data sources: U.S. Census American Community Survey 2006-2010, ESRI
Classification: Natural Breaks
Poverty in the United States

Percent of the Population Below the Poverty Line

Data sources: U.S. Census American Community Survey 2006-2010, ESRI

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Pct. Below Poverty Line

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Data sources: U.S. Census American Community Survey 2006-2010, ESRI
Classification: Natural Breaks
Divergent color schemes:
Diverging Color Scheme
COLOR-related challenges when making choropleth maps:

1. Deciding on the set of colors you will use

- Quantitative attributes
- Qualitative attributes
Examples of qualitative spatial attributes:

1. Land cover type (e.g., urban, forest, water)
2. The primary religion in an area
3. The primary language spoken in area
4. The region of an area like East Coast, West Coast, Midwest, etc.
http://506sports.com/nfl.php?yr=2014&wk=1
Implies increasing values
COLOR-related challenges when making choropleth maps:

1. Deciding on the set of colors you will use

2. Deciding how to assign colors to specific data values (data classification)
Poverty in the United States

Percent of the Population Below the Poverty Line

Classification: Natural Breaks

Data sources: U.S. Census American Community Survey 2006-2010, ESRI

Data sources: U.S. Census American Community Survey 2006-2010, ESRI
Classification: Natural Breaks
Example Unclassed Choropleth Map

In the map below, notice how you can easily see a large geographic pattern of unemployment rates, but it is very hard to compare or rank counties: try to accurately arrange the counties in California from lowest to highest...it’s nearly impossible.

Limitations

There are at least three major drawbacks with unclassed choropleth maps. First, while the idea of letting our data speak for itself is appealing we often find it has too much to say. Cartographers have long relied on classification to suppress random noise or insignificant variations to highlight large, major differences. For example, a very simple 2-class map of unemployment (using only 2 colors) would quickly show whether a place is above or below the national average: More detail

Natural Breaks Classification

Pct. Below Poverty Line Attribute Value Distribution
Natural Breaks Classification

Pct. Below Poverty Line Attribute Value Distribution

- 0.00 - 11.3%
- 11.4 - 16.2%
- 16.3 - 21.7%
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Natural Breaks Classification

Population Density (People per Square Mile)
Population Density in the U.S.
People per Square Mile by County

Data sources: U.S. Census, ESRI

Classification: Natural Breaks
<table>
<thead>
<tr>
<th>State Name</th>
<th>Attribute Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Wyoming</td>
<td>0.628684744</td>
</tr>
<tr>
<td>2 Wisconsin</td>
<td>0.2816115406</td>
</tr>
<tr>
<td>3 West Virginia</td>
<td>0.2724013457</td>
</tr>
<tr>
<td>4 Washington</td>
<td>0.4908310038</td>
</tr>
<tr>
<td>5 Virginia</td>
<td>0.9769108994</td>
</tr>
<tr>
<td>6 Vermont</td>
<td>0.6578557848</td>
</tr>
<tr>
<td>7 Utah</td>
<td>0.3490212685</td>
</tr>
<tr>
<td>8 Texas</td>
<td>0.6763919496</td>
</tr>
<tr>
<td>9 Tennessee</td>
<td>0.9685244795</td>
</tr>
<tr>
<td>10 South Dakota</td>
<td>0.2681739626</td>
</tr>
<tr>
<td>11 South Carolina</td>
<td>0.7328552068</td>
</tr>
<tr>
<td>12 Rhode Island</td>
<td>0.522504366</td>
</tr>
<tr>
<td>13 Pennsylvania</td>
<td>0.3542625622</td>
</tr>
<tr>
<td>14 Oregon</td>
<td>0.3522289195</td>
</tr>
<tr>
<td>15 Oklahoma</td>
<td>0.6720866978</td>
</tr>
<tr>
<td>16 Ohio</td>
<td>0.3768142592</td>
</tr>
<tr>
<td>17 North Dakota</td>
<td>0.0045091594</td>
</tr>
<tr>
<td>18 North Carolina</td>
<td>0.3309581964</td>
</tr>
<tr>
<td>19 New York</td>
<td>0.1054128092</td>
</tr>
<tr>
<td>20 New Mexico</td>
<td>0.6218491374</td>
</tr>
<tr>
<td>21 New Jersey</td>
<td>0.5054483407</td>
</tr>
<tr>
<td>22 New Hampshire</td>
<td>0.0565240593</td>
</tr>
<tr>
<td>23 Nevada</td>
<td>0.3271966181</td>
</tr>
<tr>
<td>24 Nebraska</td>
<td>0.0646708442</td>
</tr>
<tr>
<td>25 Montana</td>
<td>0.6962972083</td>
</tr>
<tr>
<td>26 Missouri</td>
<td>0.0163905404</td>
</tr>
<tr>
<td>27 Mississippi</td>
<td>0.7700615935</td>
</tr>
<tr>
<td>State Name</td>
<td>Attribute Value</td>
</tr>
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<td>-----------------</td>
<td>-----------------</td>
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<td>1 Arizona</td>
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<td>0.7367502658</td>
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<td>23 Florida</td>
<td>0.4869914695</td>
</tr>
<tr>
<td>24 Kentucky</td>
<td>0.4696961681</td>
</tr>
<tr>
<td>25 Kansas</td>
<td>0.4348825025</td>
</tr>
<tr>
<td>26 Colorado</td>
<td>0.398861222</td>
</tr>
<tr>
<td>27 Connecticut</td>
<td>0.3847875695</td>
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Population Density in the U.S.

People per Square Mile by County

- 0 - 822
- 833 - 3270
- 3721 - 9675
- 9676 - 20418
- 20419 - 69568

Data sources: U.S. Census, ESRI

Classification: Natural Breaks
Population Density in the U.S.
People per Square Mile by County

Classification: Natural Breaks

Data sources: U.S. Census, ESRI
Choropleth Maps

Unclassed Maps
- Natural Breaks
- Pretty Breaks

Classed Maps
- Quantile
- Equal Interval
- Std. Deviation
- Manual
- Geom. Interval

Slides for Spatial Computing MOOC (By Brent Hecht)
Highest Attribute Value
(e.g. Manhattan’s population density)

Lowest Attribute Value
(e.g. Loving County, TX population density)

\[ \text{Number of classes} \] 
\( \text{we’ve been using ‘5’} \)

\[ \text{Class Width} \]

\[ \frac{\text{Highest Attribute Value}}{\text{Lowest Attribute Value}} \]
No, really! This is what the data says!

Lying with maps!
85+ Population in the United States

Pct of the Population that is 85 Years Old or Older

Data sources: U.S. Census, ESRI
Classification: Natural Breaks
85+ Population in the United States

Pct of the Population that is 85 Years Old or Older

- 0.0 - 1.7%
- 1.7 - 3.3%
- 3.3 - 5.0%
- 5.0 - 6.6%
- 6.6 - 8.3%

Data sources: U.S. Census, ESRI
Classification: EQUAL INTERVAL
COLOR-related challenges when making choropleth maps:

1. Deciding on the set of colors you will use

2. Deciding how to assign colors to specific data values (data classification)
http://www.colorbrewer.org
http://www.wired.com/2014/10/cindy-brewer-map-design/
http://www.colorbrewer.org
Types of thematic maps we’re going to cover:

- Choropleth
- Graduated / Proportional Symbol
- Cartograms
Population in the United States

Number of People per County

People per County

- 82 - 220000
- 220001 - 744344
- 744345 - 2035210
- 2035211 - 5194675
- 5194676 - 9818605

Data sources: U.S. Census, ESRI
Classification: Natural Breaks
Proportional Symbol Maps

Choropleth Maps

Unclassed Maps
- Natural Breaks
- Pretty Breaks

Classed Maps
- Quantile
- Defined Interval
- Manual
- Equal Interval
- Std. Deviation
- Geom. Interval

Graduated Symbol Maps
Population in the United States
Number of People per County

People per County
- 82 - 220000
- 220001 - 744344
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Data sources: U.S. Census, ESRI
Classification: Natural Breaks
Population in the United States

Number of People per County

Data sources: U.S. Census, ESRI

Classification: Natural Breaks
Pros and cons of graduated/proportional maps relative to choropleth maps:

**Pro:** Differences in size may be better than differences in color for some purposes

**Con:** Symbols overlap
Population in the United States

Number of People per County

Data sources: U.S. Census, ESRI

Classification: Natural Breaks

People per County

- 47420
- 800647
- 1951269
- 9818605

Data sources: U.S. Census, ESRI
Classification: Natural Breaks
Pros and cons of graduated/proportional maps relative to choropleth maps:

**Pro:** Differences in size may be better than differences in color for some purposes

**Con:** Symbols overlap

**Con:** Confusing to use size for percentages, densities, etc.
Types of thematic maps we’re going to cover:

- Choropleth
- Graduated / Proportional Symbol
- Cartograms
http://www-personal.umich.edu/~mejn/election/2012/statemap1024.png
Indegree Sum
Japanese Wikipedia

- 10 - 629,319
- 629,320 - 1,258,628
- 1,258,629 - 1,887,936
- 1,887,937 - 2,517,245
- 2,517,246 - 3,146,554
Indegree Sum
Japanese Wikipedia

- 10 - 629,319
- 629,320 - 1,258,628
- 1,258,629 - 1,887,936
- 1,887,937 - 2,517,245
- 2,517,246 - 3,146,554
A New York Times assessment of how states may vote, based on polling, previous election results and the political geography in each state.

**Obama**

**Electoral Votes**: 243

Needs 27 to win

**States sized by number of electoral votes**

- **Calif.**
- **Tex.**
- **Fla.**
- **N.Y.**
- **Pa.**
- **Ohio**
- **Tenn.**

**Romney**

**Electoral Votes**: 206

Needs 64 to win

- **Maine and Nebraska** give two electoral votes to the statewide winner and allocate the rest by congressional district.

**Leaning Democratic (6)**

- Maine: Maine has largely slipped from the ranks of top battleground states, with Democrats winning here in the last five presidential elections.

**Tossup (7)**

- **Colorado**: President Obama’s victory in Colorado was among his most prized accomplishments in 2008, after the state had voted reliably Republican for more than 20 years.

**Leaning Republican (2)**

- **Arizona**: The politics of Arizona are gradually shifting with its demographics. For now, Republicans believe their party has an advantage in presidential races.
Types of thematic maps we’re going to cover:

- Choropleth
- Graduated / Proportional Symbol
- Cartograms
Dot Maps

http://demographics.coopercenter.org/DotMap/
Heat Maps

Above: Number of jobs accessible from different points within 30 minutes, between 7 a.m. and 9 a.m. Click here to see the full map, with a legend.
Flow Maps

Foreign fighters flow to Syria
An estimated 15,000 militiamen from at least 80 nations are believed to have entered Syria to help push back the regime of President Bashar al-Assad according to the CIA and studies by ISCR and the Soufan Group. Many of these fighters are believed to have joined units that are not part of the Islamic State. Western officials are concerned about what these individuals may do upon returning to their native countries.

Countries from which citizens or residents have reportedly gone to fight.

- Belgium 296
- Netherlands 40
- Finland 8
- Germany 210
- Poland 10
- France 412
- Austria 50
- Italy 95
- Spain 95
- United Kingdom 488
- Canada 70
- United States 130
- Australia 2,500
- Saudi Arabia 2,500
- United Arab Emirates 14
- Qatar 15
- Kuwait 71
- Bahrain 14
- Oman 60
- Indonesia 60
- Iran 800
- Iraq 247
- Jordan 2,092
- Lebanon 890
- Israel 20
- Tunisia 3,000
- Morocco 1,500
- Algeria 1,200
- Turkey 1,200
- Libya 526
- Egypt 336
- Yemen 96
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