Data Visualization (CSCI 627/490)

Geospatial Data

Dr. David Koop
**Colormap**

- A colormap specifies a mapping between colors and data values
- Colormap should follow the expressiveness principle
- Types of colormaps:
  - **Binary**
    - Y
    - N
  - **Diverging**
    - -1
    - 0
    - +1
  - **Categorical**
    - T
    - F
    - A
  - **Sequential**
    - 3
    - 2
    - 1

[Munzner (ill. Maguire), 2014]
Categorical Colormap Guidelines

- Don't use too many colors (~12)
- Use other categories or create groups if you have too many values!
- Nameable colors help
- Be aware of luminance (e.g. difference between blue and yellow)
- Think about other marks you might wish to use in the visualization
Continuous Colormap for Ordered Data

US EPA Regional Oxidant Model -- Midwest Ozone (ppbv): June 26, 1987, 18:00

[Bergman et al., 1995]
Segmented Colormap for Ordered Data

US EPA Regional Oxidant Model -- Midwest
Ozone (ppbv): June 26, 1987, 18:00

[Bergman et al., 1995]
Continuous vs. Segmented Test Results

- "[C]ontrary to the expressiveness principle, no cases were found in which a continuous encoding of 2D scalar field data was advantageous for task accuracy, and for some tasks, specific binned encodings facilitated accuracy."
- "[S]upport for the counterintuitive finding that decisions with binned encoding were slower than those made with continuous encoding"
- Word of caution: single image!
Rainbow Colormap

[Bergman et al., 1995]
Two-Hue Colormap

[Bergman et al., 1995]
Artifacts from Rainbow Colormaps

[Borland & Taylor, 2007]
Artifacts from Rainbow Colormaps

[Borland & Taylor, 2007]
Turbo: Improving Rainbow Colormaps

Jet  Viridis  Turbo
Bivariate Colormaps

- Binary
- Categorical
- Diverging
- Sequential

[Munzner (ill. Maguire), 2014]
Value-Suppressing Uncertainty Palette

[Correll et al., 2018]
Midterm

- Monday, October 23
- Covers material through this week
- Format:
  - In Person, Pen(-cil) & Paper
  - Multiple Choice
  - Free Response (often multi-part)
  - CS 627 students will have extra questions related to the research papers discussed
Project

• Two Possibilities:
  - Create an interactive visualization
  - Work on a research project

• Dataset Choices
  - Louisiana Home Rebuilding
  - New Mexico School Discipline
  - NFL Data
  - US Severe Storm Data

• Work on Proposal
Next Two Weeks

- Wednesday: No Lecture
- Monday, Oct. 23: Midterm Exam
- Wednesday, Oct. 25: Synchronous Zoom Lecture
Geospatial Data
Geographic Data

- Spatial data (have positions)
- Cartography: the science of drawing maps
  - Lots of history and well-established procedures
  - May also have non-spatial attributes associated with items
  - Thematic cartography: integrate these non-spatial attributes (e.g. population, life expectancy, etc.)
- Goals:
  - Respect cartographic principles
  - Understand data with geographic references with the visualization principles
Map Projection
Flattening the Sphere?
Lambert Conformal Conic Projection

Two standard parallels (selected by mapmaker)

Large-scale map sheets can be joined at edges if they have the same standard parallels and scales
Standard Projections

Regular Cylindrical

Regular Conic

Transverse Cylindrical

Polar Azimuthal (plane)
Map Projections

What your favorite map projection says about you

[xcvd]
Projection Classification

Myriahedral projections

Dymaxion map

Goode’s homolosine

equal area

conformal

no interrupts

Lambert cyl. eq. area

Plate carree

Mercator

Angle-preserving

[J. van Wijk, 2008]
Myriahedral Projections

Taken together, these constraints imply that a spanning tree of the mesh should exist from any node (face of the mesh) to any other node. This gives an optimal solution. The neighbouring edges of the growing tree are stored in a priority queue, for which the highest weight and the corresponding vertex is added. In order to find a high value, we inserted interior edges with very high weights, such that the weights its edges is maximal (or minimal). The term spanning tree suggests a solution for labelling the foldout can be flattened. Hence, in order to label a set of edges as folds and cuts, we obtain two connected graphs such that the sum of weights of the cuts in the set of neighbouring edges (otherwise the foldout can not be flattened), and cycles in the cuts would lead to a set of cuts unfolding to a single boundary, with a length of twice the sum of lengths of the splits of the foldout. The set of cuts unfolds to a single foldout is connected. In other words, in order to label a set of edges as cuts, the folded out mesh should not only be planar, it should be such that the foldout does not suffer from fold-overs. The folded out mesh should not only be planar, it should be such that the fold-out does not suffer from fold-overs. The folded out mesh should not only be planar, it should be such that the fold-out does not suffer from fold-overs. The folded out mesh should not only be planar, it should be such that the fold-out does not suffer from fold-overs.

The geography of the earth (or whatever image on a spherical surface has to be displayed) is mapped as a texture (examples are shown in http://www.win.tue.nl/jvw/myriahedral). Rendering maps for presentation purposes requires proper anti-aliasing, because regular patterns and very thin gaps have to be dealt with. For the images shown, 100-fold supersampling per pixel with a jittered grid was used, followed by filtering with a Mitchell filter. The use of gnomonic projection here.

There is a third constraint to be satisfied: The labelling of edges should exist from any node (face of the mesh) to any other node. After labelling edges as folds and cuts, we obtain two connecting two faces instead of two vertices (Figure 2).

Figure 2. (a) Mesh; (b) Dual mesh; (c) Cuts and folds; (d) Cuts in the set of neighbouring edges (otherwise the foldout can not be flattened), and cycles in the cuts would lead to a set of cuts unfolding to a single boundary, with a length of twice the sum of lengths of the splits of the foldout. The set of cuts unfolds to a single foldout is connected. In other words, in order to label a set of edges as cuts, the folded out mesh should not only be planar, it should be such that the fold-out does not suffer from fold-overs. The folded out mesh should not only be planar, it should be such that the fold-out does not suffer from fold-overs.

Next, calculate a maximal spanning tree such that the labelling of edges should be done labelled the same. The labelling of edges should be done labelled the same. The labelling of edges should be done labelled the same. The labelling of edges should be done labelled the same.

The performance is instantaneous to a few seconds, which enables fast calculating and rendering the results, running under MS Windows. Response times on standard PCs range from a few seconds to a few minutes, for graphs with ten thousands of edges and within a second for graphs with ten thousands of edges and within a second for graphs with ten thousands of edges.

For the calculation of the maximal spanning tree we follow the classical algorithm to produce a myriahedral projection is now as follows: All vertices should have one or more edges labelled as cuts should be a spanning tree of the mesh are triangles. Faces with more edges can be handled by inserting interior edges with very high weights, such that the new angle is determined, and the new angle is determined, and the new angle is determined, and the new angle is determined. When the triangles are large compared with the radius of the globe, like in standard polyhedral projections, the triangles have to be subdivided further to be seen as follows. All vertices should have one or more edges labelled as cuts should be a spanning tree of the mesh are triangles. Faces with more edges can be handled by inserting interior edges with very high weights, such that the new angle is determined, and the new angle is determined, and the new angle is determined, and the new angle is determined.
Cut along parallels or meridians (graticules)

The simplest way to define a mesh is to use the graticule itself, and to cut along parallels or meridians. The results can be used as an introduction to map projection. A weight for edges, using the value of $w$ and $l$ of the midpoint of an edge, can be defined as

$$w(w, l) \sim \left\{ \begin{array}{ll}
W w_j w_j & \\
W l_{min} k_j l_j & \end{array} \right.$$

where $W w$ and $W l$ are overall scaling factors, and $w_0$ and $l_0$ denote where a maximal strength is desired. Different values for these lead to a number of familiar looking projections (Figure 3). The use of a high value for $W w$ gives cuts along meridians. Dependent on the value of $w_0$ a cylindrical projection ($0^\circ$, equator), an azimuthal projection ($90^\circ$, North pole), or a conical projection ($25^\circ$) is obtained when the meridian strips are unfolded. Use of a negative value for $W w$ gives two hemispheres, each with an azimuthal projection. The meridian at which to be centred can be controlled by using a low value for $W l$ and a suitable value for $l_0$. The use of a high value for $W l$ gives cuts along parallels. Unfolding these parallels gives a result resembling the polyconic projection of Hassler (1820).

The relation between a spatially varying weight $w$ and the decision where to cut and fold can be understood by considering Prim’s algorithm. Suppose, without loss of generality, that we start at a maximum of $w$ and proceed to attach the edges with the highest weight. At some point, edges at the boundary will have approximately the same weight and, after a number of additions, a ring of faces is added, with cuts in between neighbouring faces in this ring. Hence, edges aligned with contours of $w$ typically turn into folds, whereas edges aligned with gradients of $w$ turn into cuts. Each strip is almost free of angular or area distortion, however, a large number of interrupts occur with varying widths. These gaps visualise, just like the Tissot indicatrix, the distortion that occurs when a non-interrupted map is used, and can be used to explain the basic problem of map projection. If we want to close these gaps, the strips must be broadened. However, to maintain an equal area, they have to be shortened, and to maintain the same aspect ratio they have to be lengthened, which is not possible simultaneously. Also, it is clearly visible that mapping a point (such as a pole) to a line leads to a strong distortion. When the number of strips is increased, the gaps are less visible, and the distortion is shown via the transparency of the map (Figure 4).

Figure 3. Graticular projections, derived from a 5° graticule. 2592 polygons: a) cylindrical; b) conical; c) azimuthal; d) azimuthal, two hemispheres; e) polyconical

[J. van Wijk, 2008]
Subdividing regular polyhedra

For the graticular projections, thin strips of faces are attached to one single strip or face. This is a degenerated tree structure. In this section, we consider what results are obtained when a more balanced pattern is used. To this end, we start with Platonic solids for the projection of the globe, and recursively subdivide the polygons of these solids. This approach has been used before for encoding and handling geospatial data (Dutton, 1996).

At each level \(i\), each edge is split and the new centres, halfway on the greater circle connecting the original endpoints, are connected. As a result, for instance each triangle is replaced at each level by four smaller triangles. Other subdivision schemes can also be used, for instance triangles can be subdivided into nine smaller ones.

The edge weights are set as follows. We associate with each edge three numbers \(w_0\), \(w_1\), and \(w_c\), where the first two correspond with the endpoints and the latter with the centre position. For new edges, \(w_0^r\), \(w_1^r\), and \(w_c^r\), if an edge \(e\) is split into two edges \(e'\) and \(e''\), we use linear interpolation for the new values:

\[
\frac{w_0^r}{w_0}, \frac{w_1^r}{w_c}, \frac{w_c^r}{w_0^c}\text{ and }\frac{w_0^r}{w_c^r} = \frac{w_0^c}{w_1^c}.
\]

As a result, the weights are highest close to the centre of original edges. Finally, we use \(w_c\) as the edge weight for the edges of the final mesh, plus a graticule weight \(w\) with small values for \(W_l\) and \(W_w\) to select the aspect.

The resulting unfolded maps are, at first sight, somewhat surprising (Figure 5). One would expect to see interesting fractal shapes, however, at the second level of subdivision the gaps are already almost invisible (Figure 6). Indeed, the structure of the cuts is self-similar, however, for higher levels of subdivision and smaller triangles, the surface of the sphere quickly approaches a plane, which has Hausdorff dimension 2. Only when areas would be removed, such as the centre triangles in the Sierpinski triangle, a fractal shape would be obtained.

As a step aside, fractal surfaces and foldouts do not match well either. Unfolding, for instance, a recursively subdivided surface with displaced midpoints leads to a large number of fold-overs (Figure 7).

As another step aside, let us consider optimal mapping on Platonic solids. We consider a map optimal when the cuts do not cross continents. To find such mappings, we assign to each edge a weight proportional to the amount of land cut, computed by sampling the edges at a number of positions (here we used 25) and looking up if land or sea is covered in a texture map of the earth. Next, the map is unfolded using the standard method and the sum of weights of cut edges is determined. This procedure is repeated for a large number of orientations of the mesh, searching for a minimal value. We used a sequence of three rotations to vary the orientation of the mesh, and used steps of 1\(^\circ\) per rotation. Results are shown in Figure 8.

Figure 4. Polyconical projection, derived from a 1\(^\circ\) graticule, 64 800 polygons

Figure 5. Recursive subdivision of Platonic solids, using five levels of subdivision, 4096\(^2\) 20 480 polygons

Figure 6. Close-up of icosahedral projection

Figure 7. Folding out a fractal surface gives a mess

Figure 8. Map unfolding with minimal cut edges

[D. Koop, CSCI 627/490, Fall 2023]
Geographically-aligned

aligned with continents

continents and oceans separated

north-up, south-down

north-up, south-down, graticular mesh

[J. van Wijk, 2008]
Australia-centric

[J. van Wijk, 2008]
## Search Tasks

<table>
<thead>
<tr>
<th></th>
<th>Target known</th>
<th>Target unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location known</td>
<td><img src="image" alt="Lookup" /></td>
<td><img src="image" alt="Browse" /></td>
</tr>
<tr>
<td>Location unknown</td>
<td><img src="image" alt="Locate" /></td>
<td><img src="image" alt="Explore" /></td>
</tr>
</tbody>
</table>

[Munzner (ill. Maguire), 2014]
Lookup

Northern Illinois University

4.2 ★★★★★ (206)
University

1425 Lincoln Hwy, DeKalb, IL 60115
Located in: Northern IL, unit: Graham Hall
Open now: Open 24 hours

Add missing information
Add phone number

Photos

[Google Maps]
Rendering Effective Route Maps: Improving Usability Through Generalization

Maneesh Agrawala Chris Stolte
Stanford University

Figure 1: Three route maps for the same route rendered by (left) a standard computer-mapping system, (middle) a person, and (right) LineDrive, our route map rendering system.

The standard computer-generated map is difficult to use because its large, constant scale factor causes the short roads to vanish and because it is cluttered with extraneous details such as city names, parks, and roads that are far away from the route. Both the handdrawn map and the LineDrive map exaggerate the lengths of the short roads to ensure their visibility while maintaining a simple, clean design that emphasizes the most essential information for following the route. Note that the handdrawn map was created without seeing either the standard computer-generated map or the LineDrive map. (Handdrawn map courtesy of Mia Trachinger.)

Abstract

Route maps, which depict a path from one location to another, have emerged as one of the most popular applications on the Web. Current computer-generated route maps, however, are often very difficult to use. In this paper we present a set of cartographic generalization techniques specifically designed to improve the usability of route maps. Our generalization techniques are based both on cognitive psychology research studying how route maps are used and on an analysis of the generalizations commonly found in handdrawn route maps. We describe algorithmic implementations of these generalization techniques within LineDrive, a real-time system for automatically designing and rendering route maps. Feedback from over 2200 users indicates that almost all believe LineDrive maps are preferable to using standard computer-generated route maps alone.

Keywords: Information Visualization, Non-Realistic Rendering, WWW Applications, Human Factors

1 Introduction

Route maps, which depict a path from one location to another, are one of the most common forms of graphic communication. Although creating a route map may seem to be a straightforward task, the underlying design of most route maps is quite complex. Mapmakers use a variety of cartographic generalization techniques including distortion, simplification, and abstraction to improve the clarity of the map and to emphasize the most important information [16, 21]. This type of generalization, performed either consciously or sub-consciously, is prevalent both in quickly sketched maps and in professionally designed route maps that appear in print advertisements, invitations, and subway schedules [25, 13].

Recently, route maps in the form of driving directions have become widely available through the Web. In contrast to hand-designed route maps, these computer-generated route maps are often more precise and contain more information. Yet these maps are more difficult to use. The main shortcoming of current systems for automatically generating route maps is that they do not distinguish between essential and extraneous information, and as a result, cannot apply the generalizations used in hand-designed maps to emphasize the information needed to follow the route.

Figure 1 shows several problems arising from the lack of differentiation between necessary and unnecessary information. The primary problem is that current computer-mapping systems maintain a constant scale factor for the entire map. For many routes, the lengths of roads can vary over several orders of magnitude, from tens of feet within a neighborhood to hundreds of miles along a highway. When a constant scale factor is used for these routes, it forces the shorter roads to shrink to a point and essentially vanish. This can be particularly problematic near the origin and destination of the route where many quick turns are often required to enter or exit a neighborhood. Even though precisely scaled roads might help navigators judge how far they must travel along a road, it is far more important that all roads and turning points are visible. Handdrawn maps make this distinction and exaggerate the lengths of shorter roads to ensure they are visible.

Another problem with computer-generated maps is that they are often cluttered with information irrelevant to navigation. This extraneous information, such as the names and locations of cities, parks, and roads far away from the route, often hides or masks information that is essential for following the route. The clutter makes the maps very difficult to read, especially while driving. Handdrawn maps usually include only the most essential information and are very simple and clean. This can be seen in figure 1(middle) where even the shape of the roads has been distorted and simplified to improve the readability of the map. Furthermore, distorting
Locate
Adding Data

• Discrete: a value is associated with a specific position
  - Size
  - Color Hue
  - Charts

• Continuous: each spatial position has a value (fields)
  - Heatmap
  - Isolines
Discrete Categorical Attribute: Shape
Discrete Categorical Attribute: Shape

[Map of Acadia National Park with various icons indicating locations such as Ranger station, Picnic area, Campground, Swimming (seasonal), Boat launch, Restrooms, Lighthouse, Food service, Parking, Bus stop, Ferry to park areas, and Park Loop Road Entrance.}

[Acadia NP, National Park Service]
Discrete Quantitative Attribute: Color Saturation
Discrete Quantitative Attribute: Size
Discrete Quantitative Attributes: Bar Chart

Railway Network Development and Bar Chart of Province Population in Turkey

[http://mis4gis.com/hgistr.org/]
Continuous Quantitative Attribute: Color Hue

[http://tampaseo.com/2012/02/websites-heat-mapping-users/]
Time as the attribute

[NYTimes]
Isolines
Isolines

- Scalar fields:
  - value at each location
  - sampled on grids
- Isolines use **derived data** from the scalar field
  - Interpret field as representing continuous values
  - Derived data is **geometry**: new lines that represent the same attribute value
- Scalability: dozens of levels
- Other encodings?
Choropleth (Two Hues)

M. Ericson, New York Times
Choropleth Map

- Data: geographic geometry data & one quantitative attribute per region
- Tasks: trends, patterns, comparisons
- How: area marks from given geometry, color hue/saturation/luminance
- Scalability: thousands of regions

Design choices:
- Colormap
- Region boundaries (level of summarization)
Choropleth (Two Hues)
2008 Popular Vote

Obama: 68 million
McCain: 59 million

[M. Ericson, New York Times]
Problem?

2008 Popular Vote

- Obama: 68 million votes
- McCain: 59 million votes

Amount of red and blue shown on map

- Obama: 850,000 mi²
- McCain: 2,150,000 mi²

[M. Ericson, New York Times]
Adding Saturation

[Washington Post, 2018]
Area Marks and Color Hue & Saturation

 GENERIC NAMES FOR SOFT DRINKS BY COUNTY

Most Popular Term Used

Map by Matthew T. Campbell
Spatial Graphics and Analysis Lab
Department of Geography and Geography
East Central University (Oklahoma)
Map Template courtesy of www.mymaps.com
Map based upon 120,464 Respondents

Respondents through March 1, 2003

[popvssoda.com]
Aggregation: 2016 Election by Precinct

[Interactive Version, NYTImes]  [R. Rohla and Washington Post, 2018]
Aggregation: 2016 Election by State

[Washington Post, 2018]
Aggregation: 2016 Election by Country

[Washington Post, 2018]
Maps: What trends do you see?

Number of Votes Cast

[Desaturated by D. Koop, M. Ericson, New York Times]
Don't Just Create Population Maps!

OUR SITE'S USERS

SUBSCRIBERS TO MARTHA STEWART LIVING

CONSUMERS OF FURRY PORNOGRAHY

THE BUSINESS IMPLICATIONS ARE CLEAR.

PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE BASICALLY JUST POPULATION MAPS.
Size Encoding

[M. Ericson, New York Times]
Dasymetric Dot Density
Glyphs: xkcd's Map
Cartograms

US Presidential Election 2016
Results mapped at county level showing the candidate with the largest vote share in each area

**Overall result:**
- **Trump:** 62,979,536 votes (48.1%)
- **Clinton:** 65,844,610 votes (46.2%)
- **Other candidates:** 7,804,215 votes (5.7%)

**Vote share of candidate with most votes**

**Reference map**

**Gridded population cartogram:** areas resized according to the total number of people living there (Alaska and Hawaii not included)

Map by Benjamin Hennig
www.viewsoftheworld.net

B. Hennig
Cartograms

- Data: geographic geometry data & two quantitative attributes (one part-of-whole)
- Derived data: new geometry derived from the part-of-whole attribute
- Tasks: trends, comparisons, part-of-whole
- How: area marks from derived geometry, color hue/saturation/luminance
- Scalability: thousands of regions
- Design choices:
  - Colormap
  - Geometric deformation

[New York Times]
Hexagonal Cartogram

District totals by category

189

17
6
14
21
44
144

MAJORITY

FiveThirtyEight, 2018
Non-Contiguous Cartogram

[M. Bostock, 2012]
World Cartograms

[M. Newman, 2009]
World Energy Consumption

[M. Newman, 2009]
House Races: Map?

House Race Ratings by the Cook Political Report

- 183 solid Democratic seats
- 1212 Most competitive
- 27 seats needed for House majority
- 145 solid Republican seats

193 current Democratic seats
7 vacancies
235 current Republican seats

[New York Times, 2018]
House Races: Cartogram?

Solid D
≥95% D
≥75% D
≥60% D
<60% both

Likely D
≥60% R
≥50% R
≥35% R

Lean D
Lean R
Likely R
Solid R

Toss-up

Party flip
>50% nonincumbent party

= one district

District totals by category

189
17
6
14
21
44
144

MAJORITY

[FiveThirtyEight, 2018]
This is our overview of the race to control the House, but if you want to see a specific race, check out the search bar in the top left.

There are three versions of our congressional forecasts, and this year we're defaulting to the Deluxe version.

Click on the magnifying glass to see the others.

Will it be a close race or a landslide? Hover to see the percentage of the vote we're forecasting each candidate to win.

Forecasting each House seat
Each party's chances of winning every House seat
Solid R ≥ 95%
Likely R ≥ 75%
Lean R ≥ 60%
Toss-up <60%
Lean D ≥ 60%
Likely D ≥ 75%
Solid D ≥ 95%

Current House
201 Republican, 1 Libertarian, 233 Democratic seats up for election

Forecasted House
154 seats
23 seats
15 seats
11 seats
14 seats
26 seats
192 seats

The current House seat count assigns vacant seats to the party that held them last. Forecasts do not add to 100 in some races due to rounding.

House Races: Non-Contiguous "Cartogram"
Maps Aren't Always Best: Close House Races

<table>
<thead>
<tr>
<th>12 Lean Democratic</th>
<th>31 Tossups</th>
<th>25 Lean Republican</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZ-02 Open (McSally)</td>
<td>CA-10 Denham</td>
<td>AR-02 Hill</td>
</tr>
<tr>
<td>CA-49 Open (Issa)</td>
<td>CA-25 Knight</td>
<td>CA-50 Hunter</td>
</tr>
<tr>
<td>CO-06 Coffman</td>
<td>CA-39 Open (Royce)</td>
<td>FL-15 Open (Ross)</td>
</tr>
<tr>
<td>IA-01 Blum</td>
<td>CA-45 Walters</td>
<td>FL-16 Buchanan</td>
</tr>
<tr>
<td>KS-03 Yoder</td>
<td>CA-48 Rohrabacher</td>
<td>GA-06 Handel</td>
</tr>
<tr>
<td>MI-11 Open (Trott)</td>
<td>FL-26 Curbelo</td>
<td>GA-07 Woodall</td>
</tr>
<tr>
<td>MN-02 Lewis</td>
<td>FL-27 Open (Ros-Lehtinen)</td>
<td>IL-13 Davis</td>
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<tr>
<td>MN-03 Paulsen</td>
<td>IL-06 Roskam</td>
<td>IL-14 Hultgren</td>
</tr>
<tr>
<td>NV-03 Open (Rosen)</td>
<td>IL-12 Bost</td>
<td>MO-02 Wagner</td>
</tr>
<tr>
<td>NJ-11 Open (Frelinghuysen)</td>
<td>IA-03 Young</td>
<td>MT-AL Gianforte</td>
</tr>
<tr>
<td>PA-07 Vacant (formerly Dent)</td>
<td>KS-02 Open (Jenkins)</td>
<td>NE-02 Bacon</td>
</tr>
<tr>
<td>VA-10 Comstock</td>
<td>KY-06 Barr</td>
<td>NY-24 Katko</td>
</tr>
</tbody>
</table>
If President Obama were to win all of the states above this line, he would need an additional 17 electoral votes from states below it in order to win in 2012.

Circles are sized according to the number of electoral votes in 2012.

Maps Aren't Always Best: Obama Targets

Circles are sized according to the number of electoral votes in 2012.