Lecture 18: Research in Cartography and Visualization
Key Journals

<table>
<thead>
<tr>
<th>Primary journals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cartographic Perspectives</td>
</tr>
<tr>
<td>Cartographica</td>
</tr>
<tr>
<td>Cartography</td>
</tr>
<tr>
<td>Cartography and Geographic Information Science</td>
</tr>
<tr>
<td>The Cartographic Journal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary journals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annals, Association of American Geographers</td>
</tr>
<tr>
<td>Byte</td>
</tr>
<tr>
<td>Computer Graphics</td>
</tr>
<tr>
<td>Computers &amp; Geosciences</td>
</tr>
<tr>
<td>Environment and Planning A</td>
</tr>
<tr>
<td>Environment and Planning B: Planning and Design</td>
</tr>
<tr>
<td>Geographical Analysis</td>
</tr>
<tr>
<td>Geospatial Solutions</td>
</tr>
<tr>
<td>GEOWorld</td>
</tr>
<tr>
<td>IEEE Computer Graphics &amp; Applications</td>
</tr>
<tr>
<td>IEEE Transactions on Visualization and Computer Graphics</td>
</tr>
<tr>
<td>Information Visualization</td>
</tr>
<tr>
<td>International Journal of Geographical Information Science</td>
</tr>
<tr>
<td>International Journal of Human-Computer Studies</td>
</tr>
<tr>
<td>Journal of Geography</td>
</tr>
<tr>
<td>Journal of the American Statistical Association</td>
</tr>
<tr>
<td>Landscape and Urban Planning</td>
</tr>
<tr>
<td>Photogrammetric Engineering and Remote Sensing</td>
</tr>
<tr>
<td>Presence</td>
</tr>
<tr>
<td>Progress in Human Geography</td>
</tr>
<tr>
<td>Statistical Computing &amp; Statistical Graphics Newsletter</td>
</tr>
<tr>
<td>The American Statistician</td>
</tr>
<tr>
<td>The Professional Geographer</td>
</tr>
<tr>
<td>Transactions in GIS</td>
</tr>
<tr>
<td>Transactions, Institute of British Geographers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proceedings</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACM SIGGRAPH (Association for Computing Machinists, Special Interest Group on Graphics and Interactive Techniques)</td>
</tr>
<tr>
<td>ICA (International Cartographic Association)</td>
</tr>
<tr>
<td>Innovations in GIS (Proceedings of the U.K. National Conference on GIS Research: GISRLUK)</td>
</tr>
<tr>
<td>International Symposium on Spatial Data Handling (International Geographical Union)</td>
</tr>
<tr>
<td>Visualization (IEEE)</td>
</tr>
</tbody>
</table>

Note: For proceedings, the name of the sponsoring organization is provided in parentheses.
International Journal of Cartography
### Professional Organizations

**TABLE 26.2** Conferences having topics of interest to cartographers

<table>
<thead>
<tr>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAG (Association of American Geographers)</td>
</tr>
<tr>
<td>ACM SIGGRAPH (Association for Computing Machinists, Special Interest Group</td>
</tr>
<tr>
<td>on Graphics and Interactive Techniques)</td>
</tr>
<tr>
<td>ACSM/ASPRS Annual Convention (American Congress on Surveying and Mapping)</td>
</tr>
<tr>
<td>ESRI International User Conference (ESRI)</td>
</tr>
<tr>
<td>GIScience (University Consortium for Geographic Information Science)</td>
</tr>
<tr>
<td>ICA (International Cartographic Association)</td>
</tr>
<tr>
<td>International Symposium on Spatial Data Handling (International Geographical</td>
</tr>
<tr>
<td>Union)</td>
</tr>
<tr>
<td>NACIS (North American Cartographic Information Society)</td>
</tr>
<tr>
<td>Visualization (IEEE)</td>
</tr>
</tbody>
</table>

Copyright © 2009 Pearson Prentice Hall, Inc.
CaGIS

Welcome: The Cartography and Geographic Information Society (CaGIS) is composed of educators, researchers and practitioners involved in the design, creation, use and dissemination of geographic information. CaGIS provides an effective network that connects professionals who work in the broad field of Cartography and Geographic Information Science both nationally and internationally.

News

CaGIS at the AAG
On Tuesday, April 8, the CaGIS board will meet at the AAG in Tampa, Florida. If you have ideas, suggestions, or topics of concern, please contact one of the officers or board members as listed on the web page and share your thoughts with them to be raised at the meeting.

CaGIS Members’ Reception - Thursday, April 10, 7:30 - 9:00 p.m., Garrison Room, 2nd Floor, Westin Hotel
CaGIS Members’ Reception - Thursday, April 10, 7:30 - 9:00 p.m.

Join CaGIS
Join the largest network of professionals who are at the leading edge of education, research and practice in Cartography and Geographic Information Science. This network provides a wealth of opportunities to advance your career. Click here to learn what you should know about CaGIS.

ICC 2015 in Rio de Janeiro
Learn more about the upcoming International Cartographic Conference this
NACIS

ATLAS OF DESIGN

We're excited to announce that the 2014 Atlas of Design is now available to order! A distillation of some of the best modern cartography from around the world, now available at a discount to NACIS members.

Do you #lovemaps? Welcome home.
Journal of Maps now published by Taylor and Francis

Enter your search keywords below

Look for matches on any word (recommended)
Home link on ALL words
Include the following 'Regions' to limit my initial search
All Regions

Search

Map Details
Cartography Blogs

• http://mycarta.wordpress.com/
• http://artcarto.wordpress.com/
• http://bigthink.com/blogs/strange-maps
• http://mappingcenter.esri.com/ {ESRI Centric}
• http://kelsocartography.com/blog/
• http://www.mapsandthecity.com/
• http://gis.blogoverflow.com/tag/cartography-2/
• http://cartonerd.blogspot.co.uk/
• http://mapperz.blogspot.com/
• http://gretchenpeterson.com/
• http://www.cartogrammar.com/blog/
• http://www.radicalcartography.net/
• http://samplecartography.com/work.html
• http://www.maproomblog.com/
• http://www.bigmapblog.com/
• http://somethingaboutmaps.wordpress.com/
• http://mapoftheweek.blogspot.com/
• http://timwallace.wordpress.com/
• http://makingmaps.net/
• http://flowingdata.com/
• http://indiemaps.com/blog/
• http://chadrobin.blogspot.com/
• http://oliviasmapcatalog.blogspot.com
• http://makingmaps.net/
• http://andywoodruff.com/blog/
• http://cartastrophe.wordpress.com/
• http://cartophile.tumblr.com/
“I parsed and compiled individual XML files into one large CSV, opened it in Quantum GIS, and got to mapmaking. After drawing and discarding roughly 20 iterations of SVG symbols representing wind—ranging from spirals to raindrops—I finally created a simple icon that I felt expressed the movement and strength of wind without overwhelming the viewer. The CSV file gave me latitude and longitude values to place my wind points on the map. Fields for wind direction and speed allowed me to rotate and size the icons.”

Figure 1. Connecting the JTC lines frequently creates a very complicated graphic with extreme overplotting of the lines. This is a demonstration of 4500 (simulated) JTC lines for Baltimore county Maryland that come as example data with the CrimeStat spatial statistics program. The map on the left is the default in ESRI’s ArcGIS software. A simple improvement over the initial default drawing of JTC lines is to make the line elements smaller, and draw them with semitransparency, shown in the map on the right.
Figure 2. Using colors to visualize the direction of flow lines. This map shows how the direction of long flows is intrinsically dictated by the selection of crime events within one jurisdiction. For example, if a crime happens to the east of Baltimore county, the direction of the JTC has to be westerly to end up within Baltimore county.

<table>
<thead>
<tr>
<th>Field</th>
<th>Image</th>
<th>Thematic</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data or value</td>
<td>Measurement error and precision</td>
<td>Quantization of value in terms of spectral bands and dynamic range</td>
<td>Labeling uncertainty (classification error)</td>
</tr>
<tr>
<td>Space</td>
<td>Locational error and precision</td>
<td>Registration error, sampling precision</td>
<td>Combination effects when data represented by different spatial properties are combined</td>
</tr>
<tr>
<td>Time</td>
<td>Temporal error and precision</td>
<td>(Temporal error and precision are usually negligible for image data)</td>
<td>Combination effects when data representing different times are combined</td>
</tr>
<tr>
<td>Consistency</td>
<td>Samples / readings collected or measured in an identical manner</td>
<td>Image is captured identically for each pixel, but medium between satellite and ground is not consistent, inconsistent sensing, light falloff; shadows</td>
<td>Classifier strategies are usually consistent in their treatment of a dataset</td>
</tr>
<tr>
<td>Completeness</td>
<td>Sampling strategy covers space, time and attribute domains adequately</td>
<td>Image is complete, but parts of ground may be obscured</td>
<td>Completeness depends on the classification strategy. (Is all the dataset classified or are only some classes extracted?)</td>
</tr>
</tbody>
</table>

Figure 2. Butterfield and Webster’s (1988) initial framework for matching types of uncertainty, kinds of data, and methods of representation. Characterization of representational methods focuses on matching visual variables to kinds of data/uncertainty. Forms of representation are also mentioned, but not systematically addressed (e.g., use of error ellipses, production of prism maps, addition of marginalia). (Modified from a version appearing in Butterfield (1991), reproduced with author’s permission.)

Table 1. Types of uncertainty in four models of geographic space (Source: Gahegan and Ehlers, 2000)
Uncertainty review article: MacEachren 2005

Figure 4. Point symbol sets depicting uncertainty with variation in (a) saturation, i.e., colors vary from saturated green, bottom, to unsaturated—top; (b) crispness of symbol edge—middle; and (c) transparency of symbol—right. In (c), transparency is applied to the smaller symbol in the foreground.

Figure 9. Screen capture from weather model uncertainty animation. [For details, see Fauerbach et al. (1996).]
The Potential of the Lenticular Foil Technique for Thematic Cartography

Frank Dickmann

Department of Geography, Ruhr University Bochum, Germany
Email: frank.dickmann@rub.de

Figure 5. Combination of a thematic map with 3D relief information (simulated representation)
New variants on flow maps

Flow Map Layout via Spiral Trees

Kevin Verbeek, Kevin Buchin, and Bettina Speckmann

Fig. 1. Flow maps: Migration from Colorado, migration from Norway and Latvia, whisky exports from Scotland.
Fig. 2. Maps illustrating migration from California 1995–2000. Top: flow maps, Tobler [1, 22] (arrows of varying width), Phan et al. [16] (edge-bundeling with crossings), and our output. Bottom: subgraphs of the bundled complete migration graph, Cui et al. [5] and Holten & van Wijk [11].
Fig. 9. Flow map illustrating migration from Texas 1995–2000 after computing the spiral tree (left), subdividing and thickening the edges (middle), and finally minimizing the cost function (right).

Fig. 11. Various results of our algorithm. We use $\alpha = 15^\circ$ (left), $\alpha = 25^\circ$ (middle), and $\alpha = 35^\circ$ (right). The top figures use standard parameters. For the bottom figures, we increased buffer size $B$ by a factor of 1.5 (left), set $c_3 = 0$ (middle), and set $c_{str} = 0$ (right).
Fig. 14. Flow of embodied CO$_2$ to the United Kingdom. Embodied CO$_2$ refers to the entire amount of CO$_2$ emitted for the production and transportation of goods to consumers. The map shows the CO$_2$ flows into the United Kingdom from each of its trading partners. CO$_2$ emissions from transportation are shown as originating from the country that provides the transportation fuel. The embodied CO$_2$ flows in this map have been calculated using the Eora MRIO Model being built at the University of Sydney.
Spatialization Methods: A Cartographic Research Agenda for Non-geographic Information Visualization

André Skupin and Sara Irina Fabrikant

ABSTRACT: Information visualization is an interdisciplinary research area in which cartographic efforts have mostly addressed the handling of geographic information. Some cartographers have recently become involved in attempts to extend geographic principles and cartographic techniques to the visualization of non-geographic information. This paper reports on current progress and future opportunities in this emerging research field commonly known as spatialization. The discussion is mainly devoted to the computational techniques that turn high-dimensional data into visualizations via processes of projection and transformation. It is argued that cartographically informed engagement of computationally intensive techniques can help to provide richer and less opaque information visualizations. The discussion of spatialization methods is linked to another priority area of cartographic involvement, the development of theory and principles for cognitively plausible spatialization. The paper distinguishes two equally important sets of challenges for cartographic success in spatialization research. One is the recognition that there are distinct advantages to applying a cartographic perspective in information visualization. This requires our community to more thoroughly understand the essence of cartographic activity and to explore the implications of its metaphoric transfer to non-geographic domains. Another challenge lies in cartographers becoming a more integral part of the information visualization community and actively engaging its constituent research fields.

KEYWORDS: Visualization, spatialization, cartography, dimensionality, self-organizing maps, multidimensional scaling, spatial cognition, human-computer interaction
Figure 12. Density surfaces derived from a single, two-dimensional, spring configuration.

Figure 16. Visual support for evaluating cluster validity. The visualization is based on a 60-by-80 neuron SOM. It shows individual point locations for several thousand AAG conference abstracts, the 25-cluster level of a hierarchical cluster solution, ranked cluster labels, and an indication of how much the highest-ranked terms dominate particular regions. Low term dominance may indicate a lack of sharply defined themes and therefore the existence of relatively heterogeneous clusters.
Current “hot” research

• Mapping social media data
• Human terrain and geography
• Visualization of space-time and trajectories
• Visual analytics, information graphics, geovisualization and spatialization
• Uncertainty
• Showing results from models as globes, animations, etc
• Web mapping with new attributes and methods
• 3D visualization and interior space mapping

Figure 3. Comparison between (a) a bonemap visualization of the central site of El Pilar and (b) a Terrscan-produced DTM visualized with shaded relief.
Figure 3. Input data: (a) rasterized source zones overlapping with counts of tweets per cell (tweets collected during workday sleeping hours), and (b) validation population data.

Figure 5. PopCR1b and 1c models: (a) best PopCR1b model, (b) best PopCR1c model, and (c) population difference between the PopCR1c and validation data.
Figure 7. Statistical comparison of PopCR1 and PopCR2 (best models): (a) Significant local correlations of PopCR2 with robberies, (b) significant local correlations of PopCR1 with robberies, (c) geographically weighted regression residuals between PopCR2 and robberies, (d) geographically weighted regression residuals between PopCR1 and robberies.

**Figure 1.** Tobler’s hiking function.

**Figure 4.** On-road speed of navigation – males.
Figure 10. Irmischer model of off-road navigation speed – males.

Figure 12. Comparison of predicted vs. actual completion times using the Irmischer algorithm.
Hiking function from data

(equation 3). The models reduce movement speeds by 5% for females (as shown by the .95 scaling factor present in equations 3 and 5). Off-road movement equations for males and females are shown as equations 4 and 5, respectively. The results of the curve fitting are shown in Figures 8–11.

\[
\text{Speed}(\text{m/s}) = 0.11 + e^{-\frac{(\text{Slope} + 5)^2}{2 	imes 30^2}}
\]  
(2)

\[
\text{Speed} = 0.95 \times \left( 0.11 + e^{-\frac{(\text{Slope} + 5)^2}{2 	imes 30^2}} \right)
\]  
(3)

\[
\text{Speed} = 0.11 + 0.67 \times e^{-\frac{(\text{Slope} + 2)^2}{2 	imes 30^2}}
\]  
(4)

\[
\text{Speed} = 0.95 \times \left( 0.11 + 0.67 \times e^{-\frac{(\text{Slope} + 2)^2}{2 	imes 30^2}} \right),
\]  
(5)

where: \( \text{Slope} = \frac{\Delta \text{elevation}}{\Delta \text{distance}} \times 100 \)

Visual inspection of the figures indicates that the equations predict the bin means rather successfully. Figures 9 and 11 show more variability than Figures 8 and 10, especially at extreme slopes, due to significantly
Figure 6. Off-road speed of navigation – males.

Figure 8. Irmischer model of on-road navigation speed – males.
Cartographic Research in 2019

The titles of papers published since 2015 in four leading cartographic journals yielded a corpus of 245 documents containing 1109 unique terms.
Themes extracted by Latent Dirichlet Allocation

Figure 2. Radar plots of the LDA probabilities for terms within topic clusters.

Figure 3. Word clouds for the five topic clusters (showing most frequent 50 words).
Cartographic Research in 2019

Five themes

• Theme 1: information visualization and cartography
• Theme 2: cartographic data and mapping
• Theme 3: spatial analysis and applications in cartography
• Theme 4: methods and models in cartography
• Theme 5: GIScience
Class summary
What we have covered

• Lecture 1: Scope of the class--GIMP and Inkscape fundamentals
• Lecture 2: The human vision system
• Lecture 3: Thematic cartography, geovisualization and visual analytics
• Lecture 4: A brief history of information graphics
• Lecture 5: Choropleth and bivariate maps and classification
• Lecture 6: Map types and Data types
• Lecture 7: Color and its use
• Lecture 8: Toponymy, typography and map text
• Lecture 9: Principles of map design and layout
What we have also covered

- Lecture 10: Production, Reproduction and Dissemination
- Lecture 11: Dasymetric and isarithmic mapping
- Lecture 12: Point symbol and flow maps
- Lecture 13: Map animation
- Lecture 14: Visual analytics and data exploration
- Lecture 15: Dealing with Uncertainty
- Lecture 16: Web-based cartography
- Lecture 17: Cartography in virtual environments
- Lecture 18: Research in Cartography and Visualization
In labs

• GIMP/Inkscape and others
• Choropleth mapping, QGIS
• QGIS for proportional circles, cartogram
• Design of a locator map for navigation/hiking
• Interactive web mapping with R-shiny and COVID-19 data
Learning Goals for Geog 183

• Understand and implement principles of good design in cartography
• Understand human vision and how it influences perception and cognition
• Become familiar with using open source tools to improve the visual quality of web-based and other maps
• Cover the scope of contemporary thematic cartography and web mapping
• Gain hands-on experience in designing and improving web based maps
• Master skills that will transfer to a host of other classes and to life beyond UCSB
Consider....

• Using web and other software mapping tools, almost any idiot (or bot) can create a map
• It takes knowledge and skill to create a good map
• It takes experience, skill, creativity and hard work to create a great map
• Fortunately, maps can be sequentially improved
• Good design follows known principles, and uses cartographic methods correctly
• Can also employ user centered design
• Same goes for much of graphic design, information graphics etc.
Final...ly

• Take home exam distributed by Gauchospace on 6/4/2020
• Due by Thursday June 11th 5:00pm
• Covers whole class
• 3 Essay style short answers—2-3 paragraphs
• Use word doc and your own words
• Open book, notes, web
• Use graphics if you wish
• Submit final to kclarke@geog.ucsb.edu, or upload in Gauchospace
• Grades will be posted to Gauchospace and egrades at the same time