

# Cartographic Visualization

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CPSC 533c  
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## Papers covered

- **Geographic visualization: designing manipulable maps for exploring temporally varying georeferenced statistics.** MacEachren, A.M. Boscoe, F.P. Haug, D. Pickle, L.W. *InfoVis* 1998, pp. 87-94.
- **Conditioned Choropleth Maps and Hypothesis Generation.** Carr, D.B., White, D., and MacEachren, A.M., *Annals of the Association of American Geographers*, 95(1), 2005, pp. 32-53
- **CartoDraw: A Fast Algorithm for Generating Contiguous Cartograms.** Keim, D.A, North, S.C., Panse, C., *IEEE Transactions on Visualization and Computer Graphics (TVCG)*, Vol. 10, No. 1, 2004, pp. 95-110
- **The space-time cube revisited from a geovisualization perspective.** Kraak, M.J., *Proceedings of the 21st International Cartographic Conference (ICC)*, 2003, pp. 1988-96

"Everything is related to everything else, but closer things are more closely related."

- Waldo Tobler

How does geographic/cartographic visualization relate to the SciVis/InfoVis continuum?

A bridge?

A separate third category?

## Designing Manipulable Maps for Exploring Temporally Varying Georeferenced Statistics MacEachren et al. (1998)

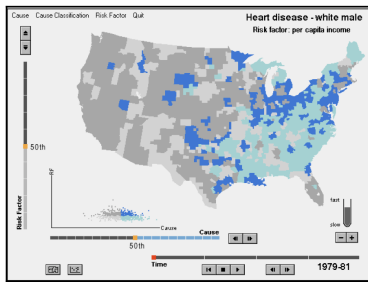
Knowledge construction via Geographic Visualization (GVIS)

Four conceptual goals of GVIS

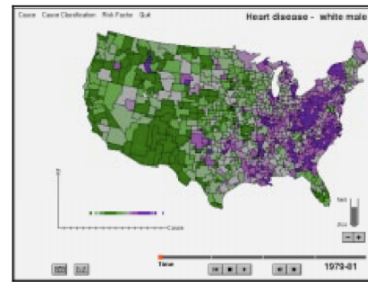
- Exploration
- Analysis
- Synthesis
- Presentation

Foundations

- Map Animation
- Multivariate Representation
- Interactivity

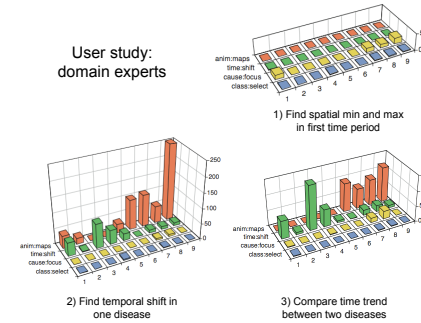


4-class bivariate map ("cross map")



7-class diverging colour scheme

User study:  
domain experts



User study: conclusions

- People preferred to use only animation or only time-stepping, few used both.
- Those who used animation spotted more patterns than those who used time-stepping.
- Interactively focusing the cross map is more effective than standard 7-class maps

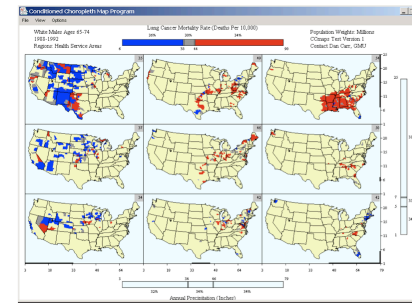
## Critique of MacEachren

- Interactive classification solves a major problem in cartography: choosing the best category breaks.
- What if there were more than 4 or 5 time slices?
- Both animation and time-stepping require user to keep patterns in memory.

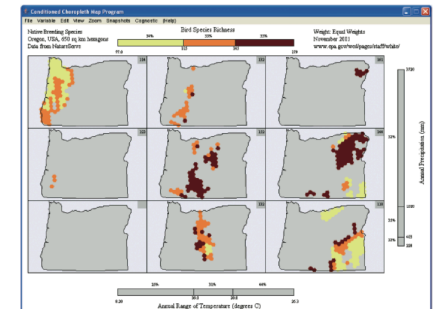
## Conditioned Choropleth Maps Carr, White & MacEachren (2005)

- What is a choropleth map?
  - Statistical data aggregated over previously defined regions
  - Each region is displayed with a uniform value
- What is conditioning?
  - Another variable is used to divide the data.
  - Data satisfying each condition is displayed separately using small multiples

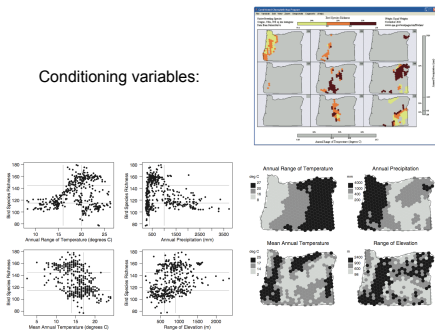
## Conditioned Choropleth Maps



## Conditioned Choropleth Maps



Conditioning variables:



## Critique of Conditioned Choropleth Maps

- Is all the wasted screen space worth it?
- Use of hexagons is an important step away from pure choropleth maps
  - No longer based on arbitrary regions that may be irrelevant to the analysis
  - However, still aggregate statistics, possibility of patterns being missed that straddle boundaries between areas

## CartoDraw: A Fast Algorithm for Generating Contiguous Cartograms Keim, North & Panse (2004)

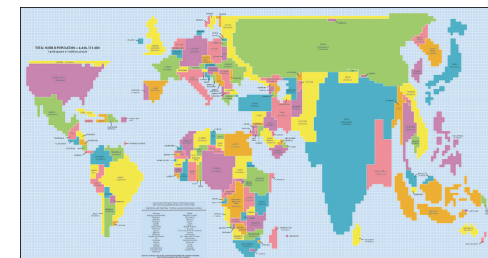
A cartogram is a map where area on the map represents some value other than real-world area

Important trade-off between retaining familiar shapes and representing area accurately (and in a useful way)

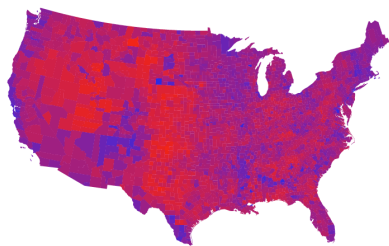
Computer generated cartograms are:

- often not aesthetically pleasing
- computationally intensive

## World Population Cartogram



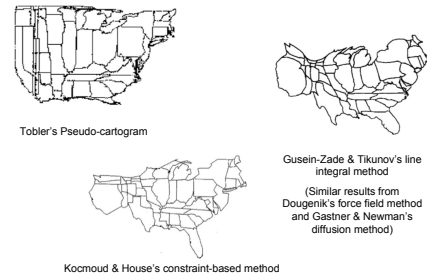
### Bush vs Kerry by county



### Bush vs Kerry cartogram

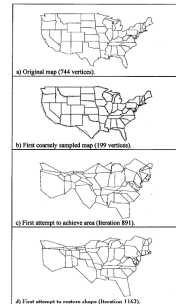
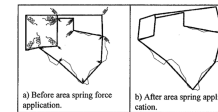


### Types of contiguous cartograms

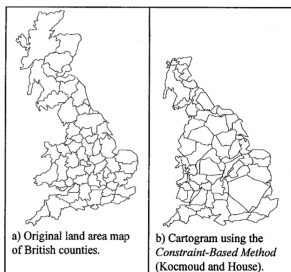


### Kocmoud and House:

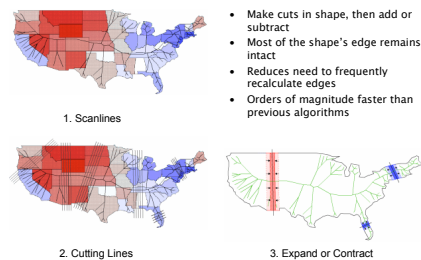
- Repeated iterations to adjust area
- Vertices have "spring effect" to maintain original orientation



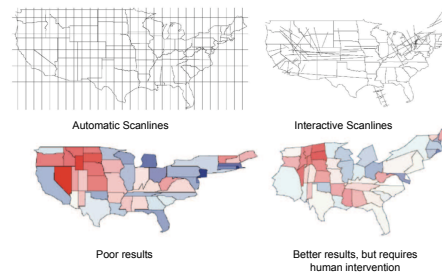
### Kocmoud and House:



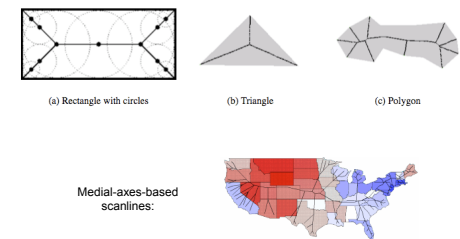
### CartoDraw: Keim, North, Panse



### Scanline placement

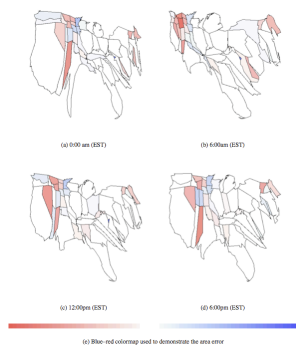


### Solution: medial axes



### Possible use of a fast cartogram algorithm:

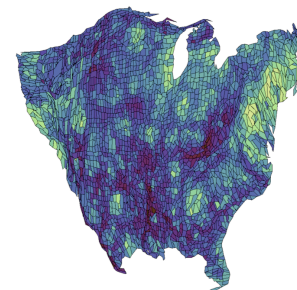
Long-distance call volume during one day



### CartoDraw Keim, North, Panse

- What is a "good" cartogram?
  - Tradeoff between area error and shape error.
  - Few or no studies have been done to determine what are the most important parts of a map for recognition: Size? Proportion? Edge detail?
- Are cartograms really that useful?
  - Do people remember what the original shapes looked like?
  - Very hard to make fair areal comparisons between irregular shapes.
- Cartograms can easily be used badly.
- Do **not** use cartograms to show average values, per capita values, etc
  - People are not only looking at what's on the map, but they're comparing to what's in their head.

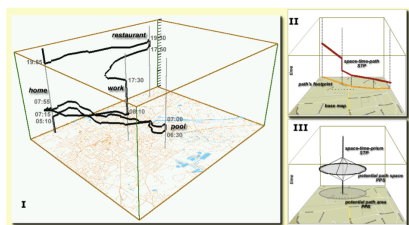
### Mean Household Income Cartogram



### The Space-Time Cube Revisited From a Geovisualization Perspective Kraak (2003)

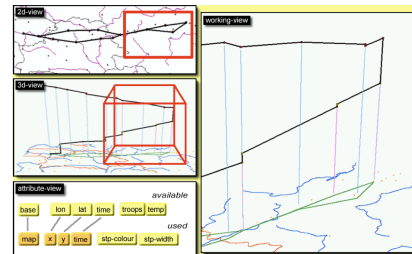
- Torsten Hägerstrand, "Time geography", 1970
  - Map daily paths of individuals in space-time
  - 3-dimensional space: x, y and time mapped onto z axis
  - Shifted geographers' focus onto individual people and experience
  - Disaggregated human behaviour
  - Ideas of "space-time cube" with "paths" and "prisms" within it
- Kraak's paper is a survey:
  - How has the space-time cube returned with new visualization tools?
  - Attempt at a classification of interactions
  - What are possible applications today?

### Space-Time Paths



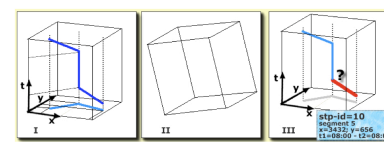
- Space-time path: movement and "stations". "Activity bundles" with others.
- Projection of path's footprint on base map.
- Space-time prism of potential path space.

### Space-Time Cube in Interactive Environment



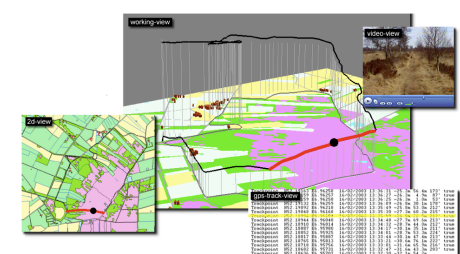
Napoleon's march into Russia: building linked views

### Space-Time Cube Interactions



- Drag axes into cube for measurement
- Rotate view
- Select and query

### Space-Time Cube with Linked Views



## Kraak, Space-Time Cube

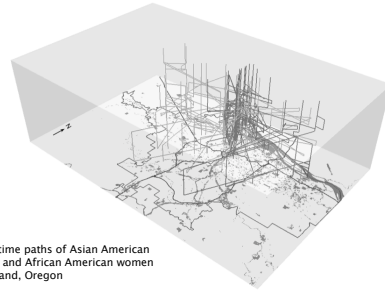
### Proposed applications:

- Real-time or retrospective visualization of an orienteering event
- Archaeological finds plotted in S-T cube, showing time uncertainty

### Critiques:

- Is this truly useful, or just a toy? Are we learning anything?
- Uninspiring examples. Doesn't show more than one person's path.
- What about objects with higher dimensions than a moving point, such as moving lines or areas?

## Space-Time Aquarium, Kwan (2003)



Space-time paths of Asian American women and African American women in Portland, Oregon

## The Future of Space-Time Point Data

- Rapidly increasing availability of point-based geodata from GPS systems
- GPS apps that don't use the space-time cube (yet)
  - Geocoded photos: Flickr, Geograph.org.uk
  - Real-time photos and GPS traces and photos: geotracing.com
- Collaborative GPS mapping: [openstreetmap.org](http://openstreetmap.org)

