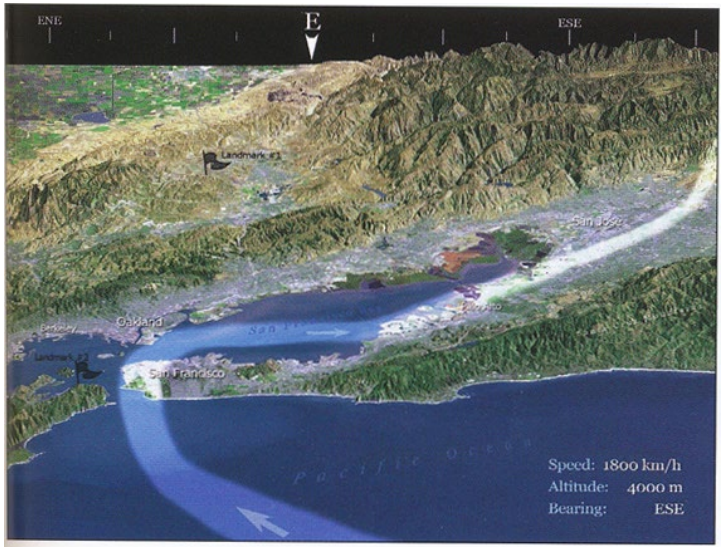
Geovisualization I

GEOG380 FA2018

Outline

- Geovisualization I
  - Visualization and geovisualization
  - Geovisualization and cartography
  - Visualization techniques
  - Examples
- Geovisualization II
  - Visualization techniques (cont.)
  - 3D geovisualization
  - Map animation
  - Web mapping
  - Virtual environments



Definition

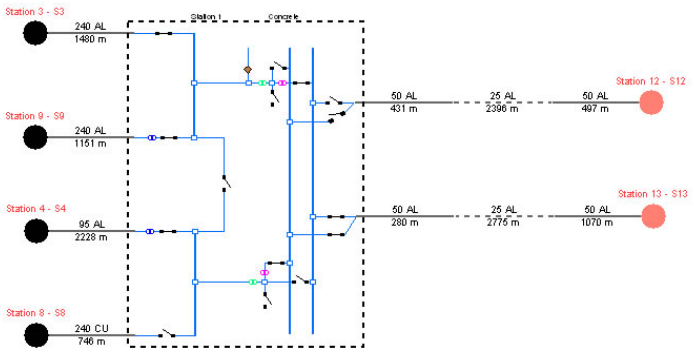
- Geovisualization
  - geographic visualization

o_O ! Well…

- Visualization
  - *"…the process of transforming information into a visual form, enabling users to observe the information…" (Gershon 1994)*
  - Used in many scientific areas
    - Medicine, biology, chemistry, engineering, mathematics, …also geography

Definition (cont.)

- Geovisualization
  - Mapping + Scientific visualization
  - A spatial approach to scientific visualization whereby the cartographic output is designed to elicit responses from the map reader that formulates new scientific hypotheses (Demers, 2005)
  - The concept and techniques of working with maps such as…
    - Interactive maps, 3D scenes, summary charts and tables, time-based views, schematic views of network relationships, animated maps, etc. (Lo and Yeung, 2002)

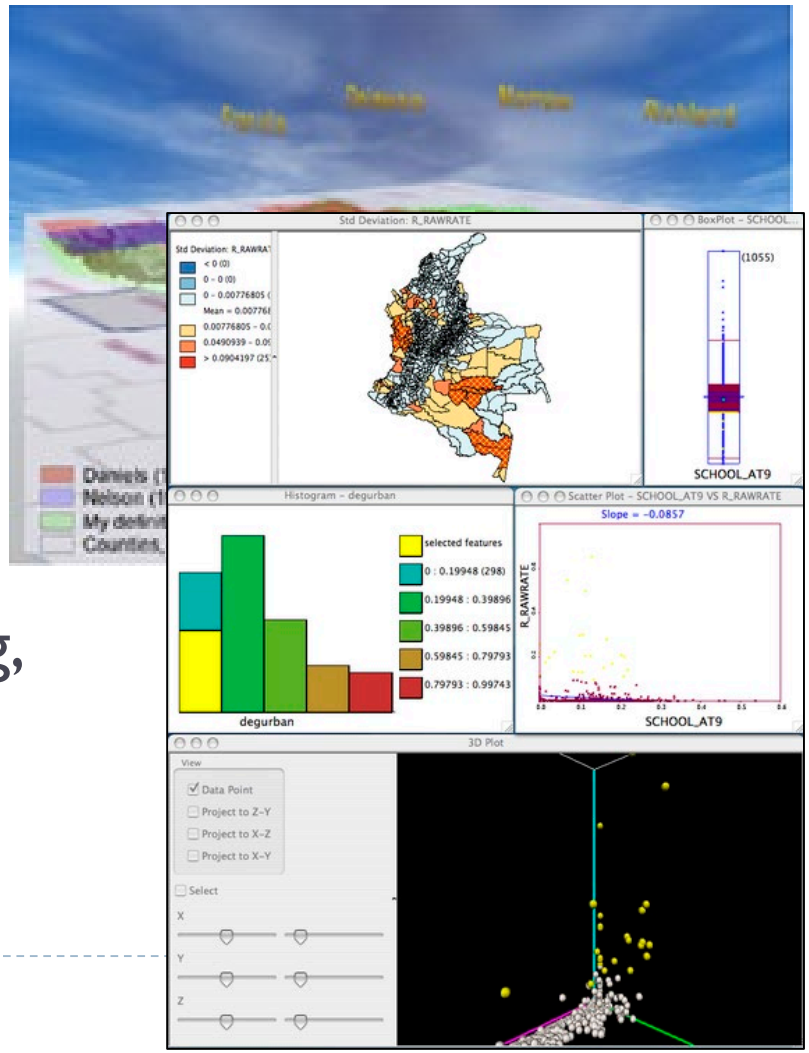


  - Creation and use of visual representations to facilitate thinking, understanding, and knowledge construction about human and physical environments at geographic scales of measurement (MacEachren)

(image source: http://www.esri.com/software/arcgis/extensions/schematics/index.html)

Definition (cont.)

- Geovisualization is more than geographic + visualization
- An integration of
  - Visualization
  - Cartography
  - Image analysis
  - Exploratory Spatial Data Analysis (ESDA) (later)
  - GIS and GIScience
- Important methodology for geoprocessing, spatial data mining, and consequently spatial decision making



https://www.hcu-hamburg.de/research/citysciencelab/

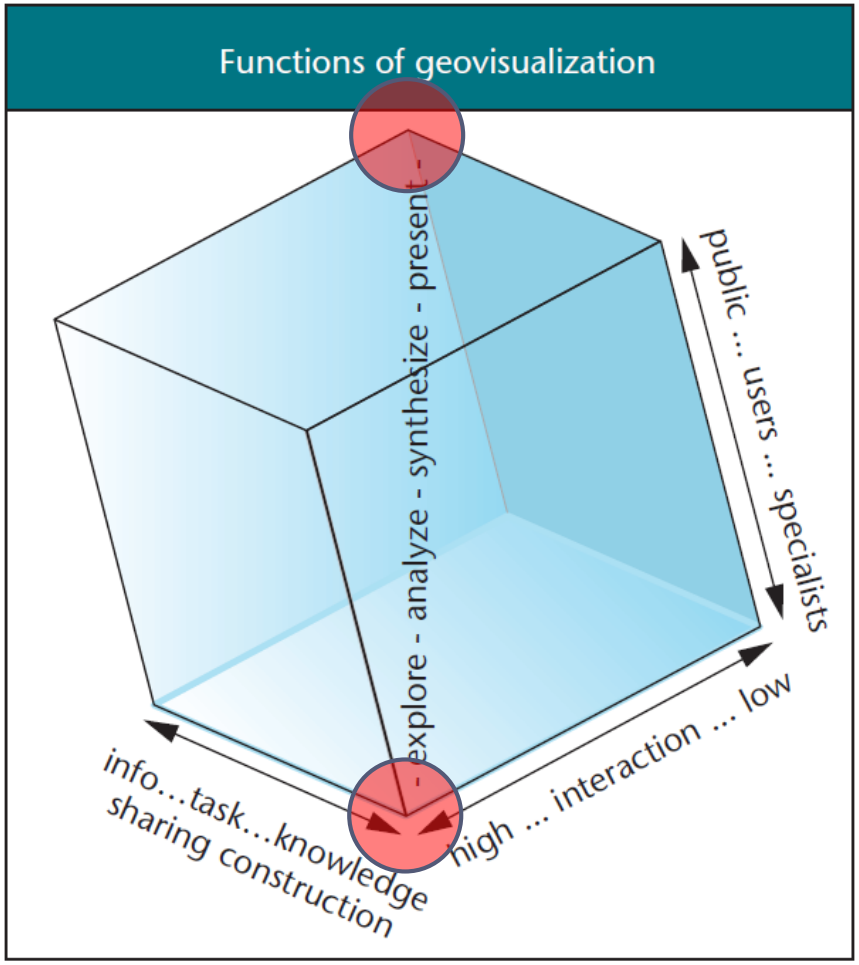
Why Geovisualization?

- The human mind!
  - "Sight" is a huge part of human cognition
  - About 50% of neurons in human brain are involved in vision
  - The basis of human language is on vision 
  - We typically cannot make sense of long lists of numbers or statistics
  - When data is converted into *graphics* such as a map, table, chart the facts begin to take shape, and consequently patterns are more easily identifiable
  - Geovisualization brings order to what was *chaos!*

(Source: http://www.geeksofdoom.com/2011/01/23/keanu-reeves-confirms-the-matrix-sequels-in-development/)

Dimensions and Functions of Geovisualization

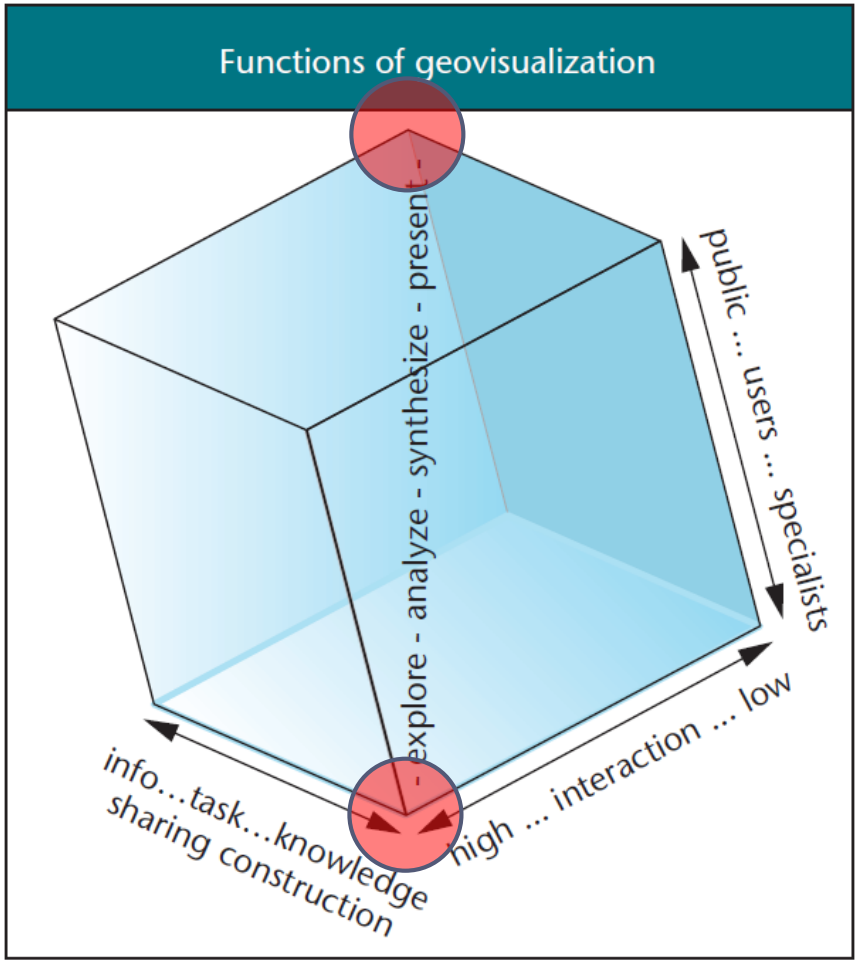
- Dimensions of geovisualization
  - Task
  - Users
  - Interaction
- Functions of geovisualization
  - Explore
  - Analyze
  - Synthesize
  - Present



(Source: MacEachren, Gahegan, Pike, Brewer, and Cai 2004)

Group Activity

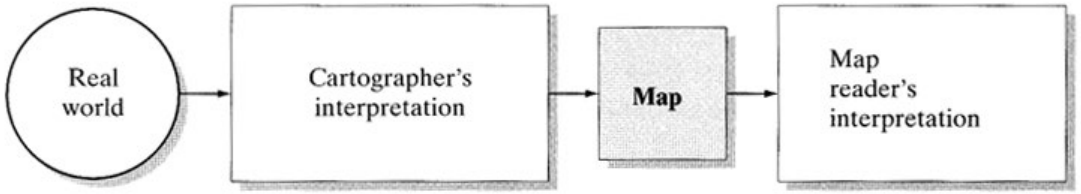
- With your group member,
- Find an existing web-based map service that can be an example for each of the two red dots in the figure.
- Share your findings with others.



(Source: MacEachren, Gahegan, Pike, Brewer, and Cai 2004)

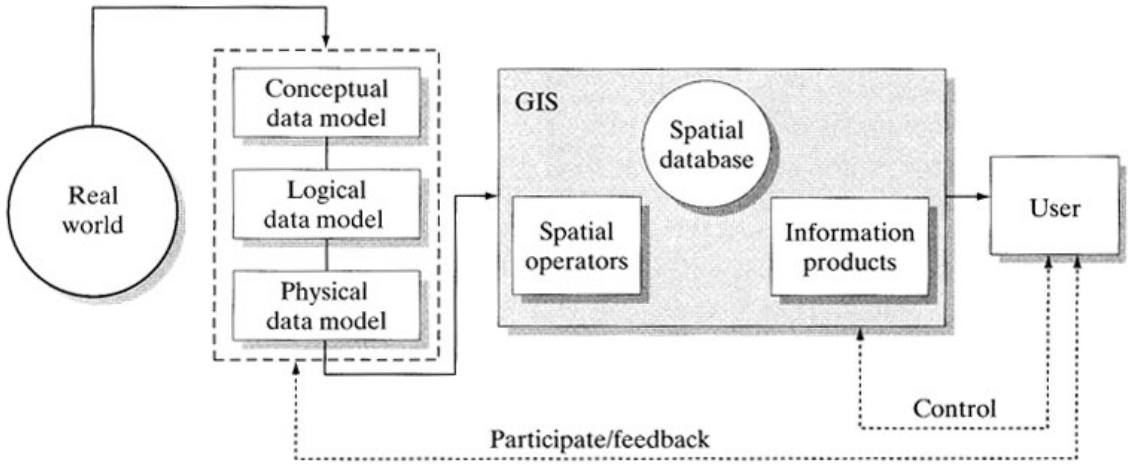
Information flow in Cartography vs. GIS

- Conventional cartographic visualization: cartographer-oriented
  - Low interaction, public use, information sharing



(a) Conventional model of cartographic communication

- GIS information communication: user-participation

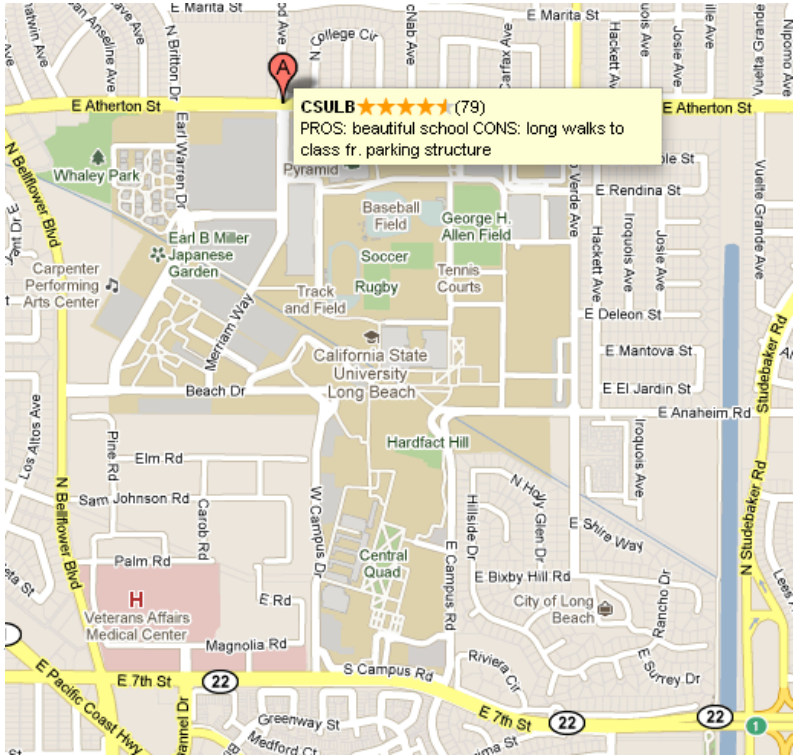


(b) New model of GIS information communication

(Source: Lo and Yeung 2007, Fig 7.2)

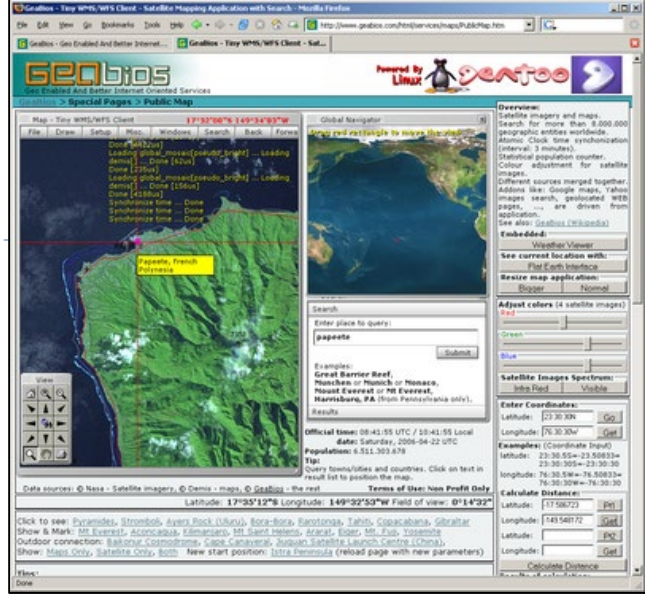
Benefits of GIS for Geovisualization

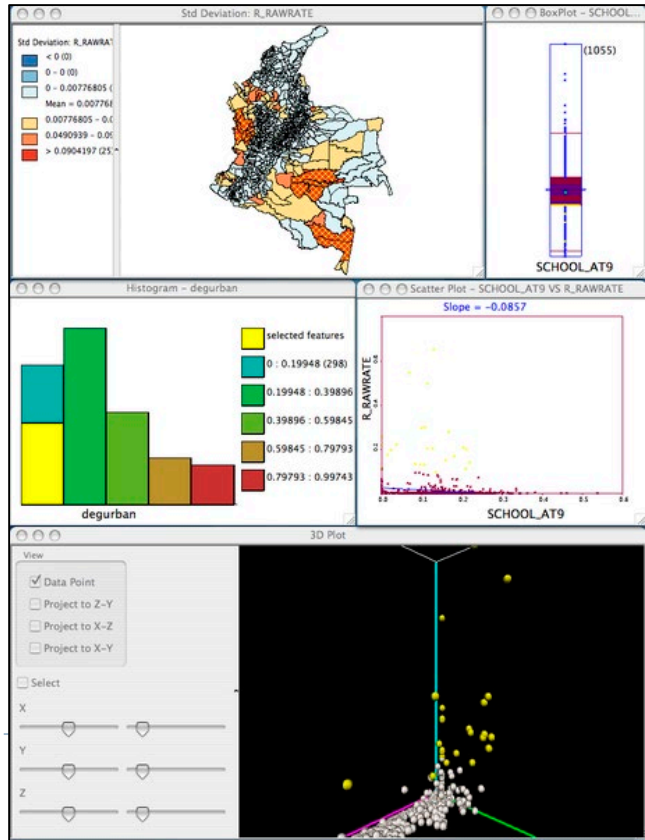
- GIS has advanced efficiency and analytical power as compared with traditional cartography
  - GIS allows for dynamic, interactive mapping for changing environments
- Map Interactions for users
  - Zoom-in/out, pan, rotate, fly-by, walk-in, …
  - Symbol applications
    - Assign/change attributes
    - Object identifiers/attribute tables
  - Layers (on/off, overlay, geoprocessing)
  - Equation applications for research
  - Etc.



GIS vs. Geovisualization

- GIS in general…
  - Static analyses, maps, and graphics (recently decreasing)
  - Designed for prescribed analysis (results are expected)
  - Provides a single view
- Geovisualization in general…
  - Interactive maps and graphics
  - Designed for data exploration (results are unexpected)
    - Exploratory Spatial Data Analysis (ESDA)
  - Multiple, coordinated views
- However, their boundaries are getting more blur

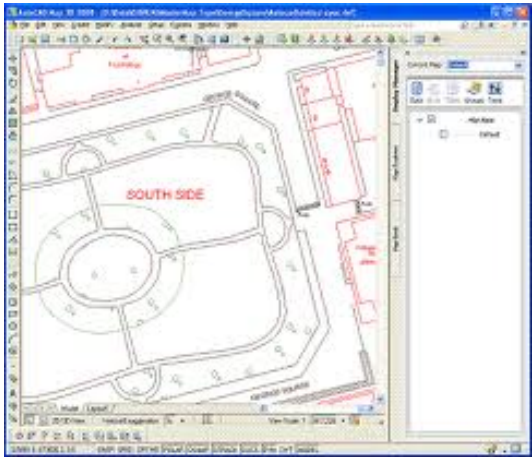




(image source: http://en.wikipedia.org/)

Geovisualization approaches

- Generic display function of GIS software
- GIS in conjunction with CAD (Computer Aided Design) systems
- Link GIS to statistics s/w
  - E.g., GGobi, GeoVista Studio, SPSS, S-Plus
- Standalone visualization software
  - E.g., Google Earth, Flash, etc.
- Dynamic visualization via the internet
  - E.g., VRML, augmented reality, etc.



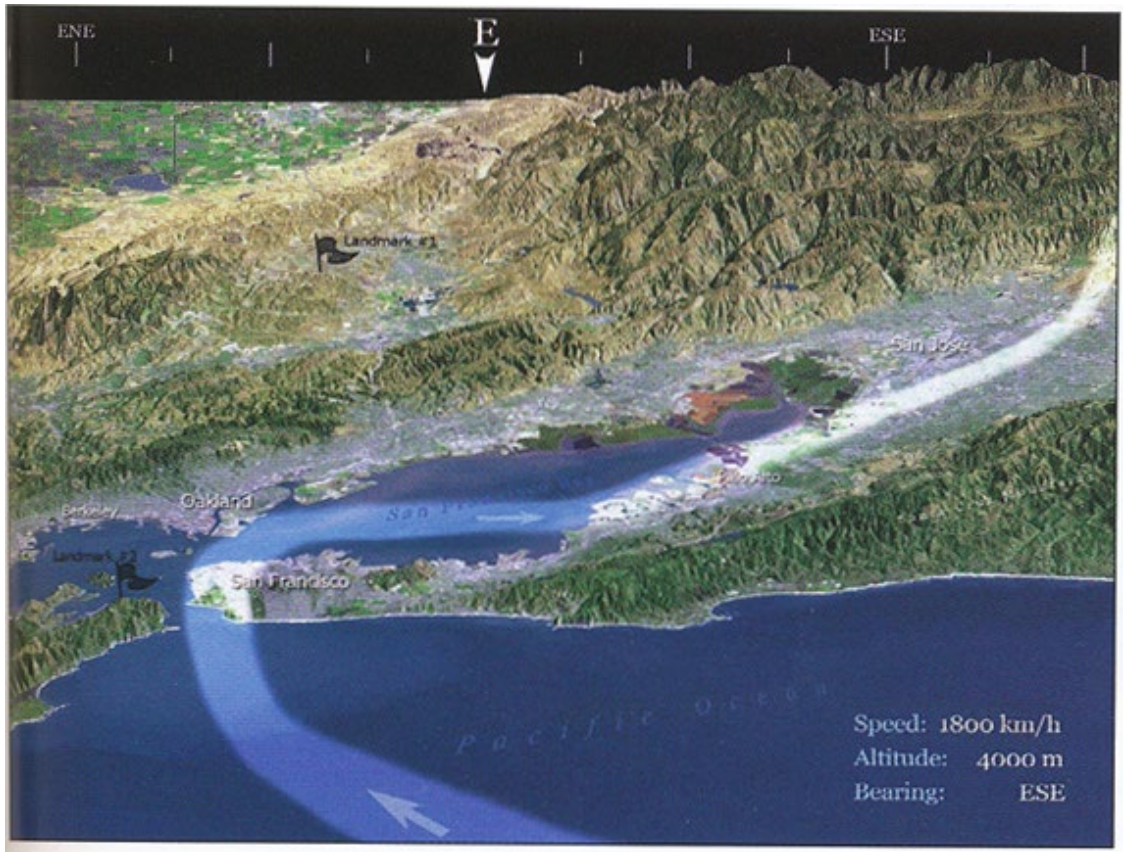
http://christiandownloads.dwnldr.mobi/download-ftd2xx/auto-cad-software-download.html

Group Activity

- With your group members,
- Search any particular areas from Google Maps.
- Open "Street View" option of Google Maps so that you could see some photographs of the areas.
- Interact on the Street View using your mouse pointer. FYI, you can turn around, tilt up/down, zoom in/out, move along the street on the Street View.
- Q. What kind of information about the place can you find from the Street View?
- Q. Discuss with your neighbors *whether the Street View of Google Maps is geovisualization or not.*
- Share your conclusion with others.

Examples of geovisualization

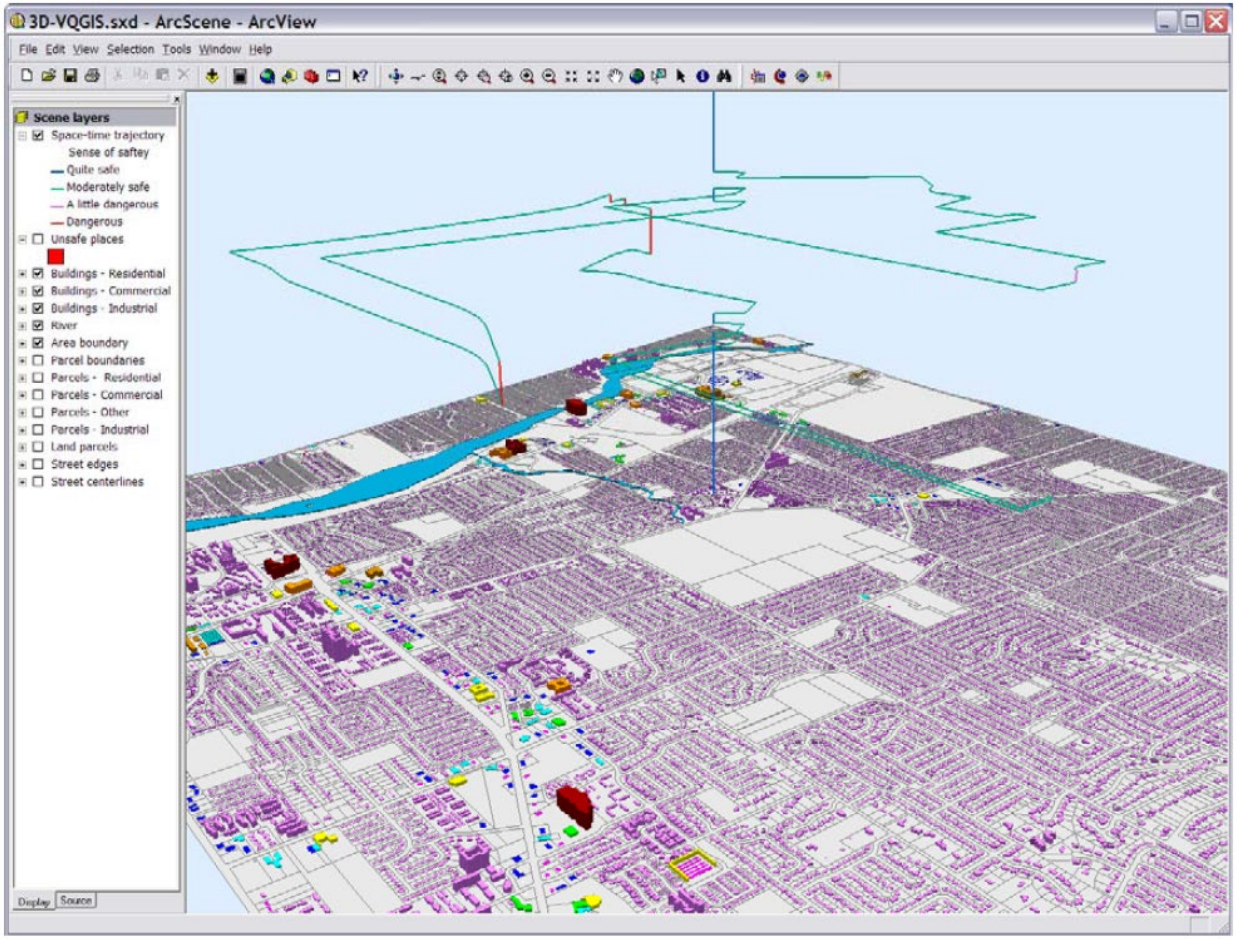
- E.g., Visualizing terrain
  - 3D Perspective view



(Source: Slocum et al. 2009)

Visualization of qualitative data

- E.g., "Sense of safety along space-time trajectory"



(Source: Kwan and Ding 2008, Fig. 3)

Visualization of qualitative data (cont.)

- Cidell, J. (2010). Content clouds as exploratory qualitative data analysis. *Area*, 42(4), 514-523.

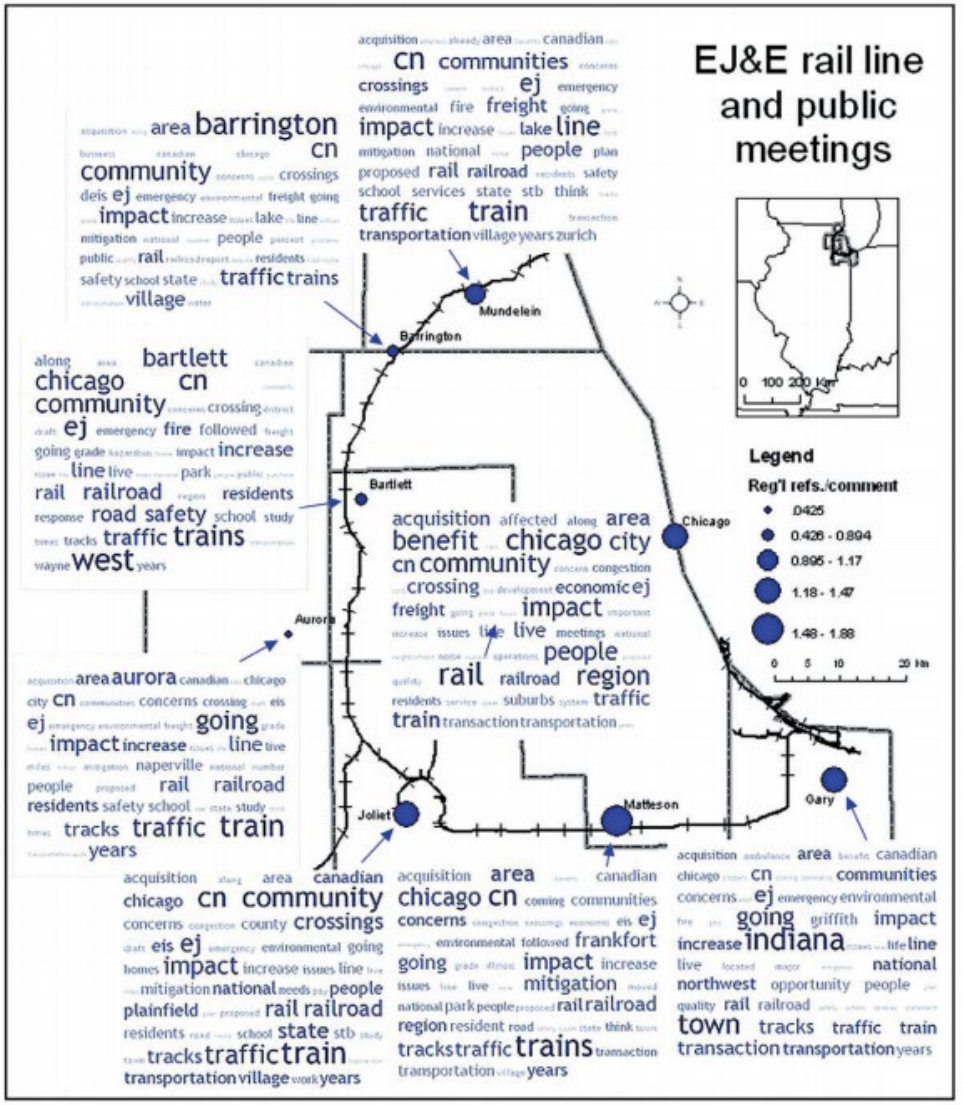


Figure 2 Content clouds from CN/EJ&E public meeting transcripts, generated by the author using TagCrowd.com

Visualization of qualitative data (cont.)

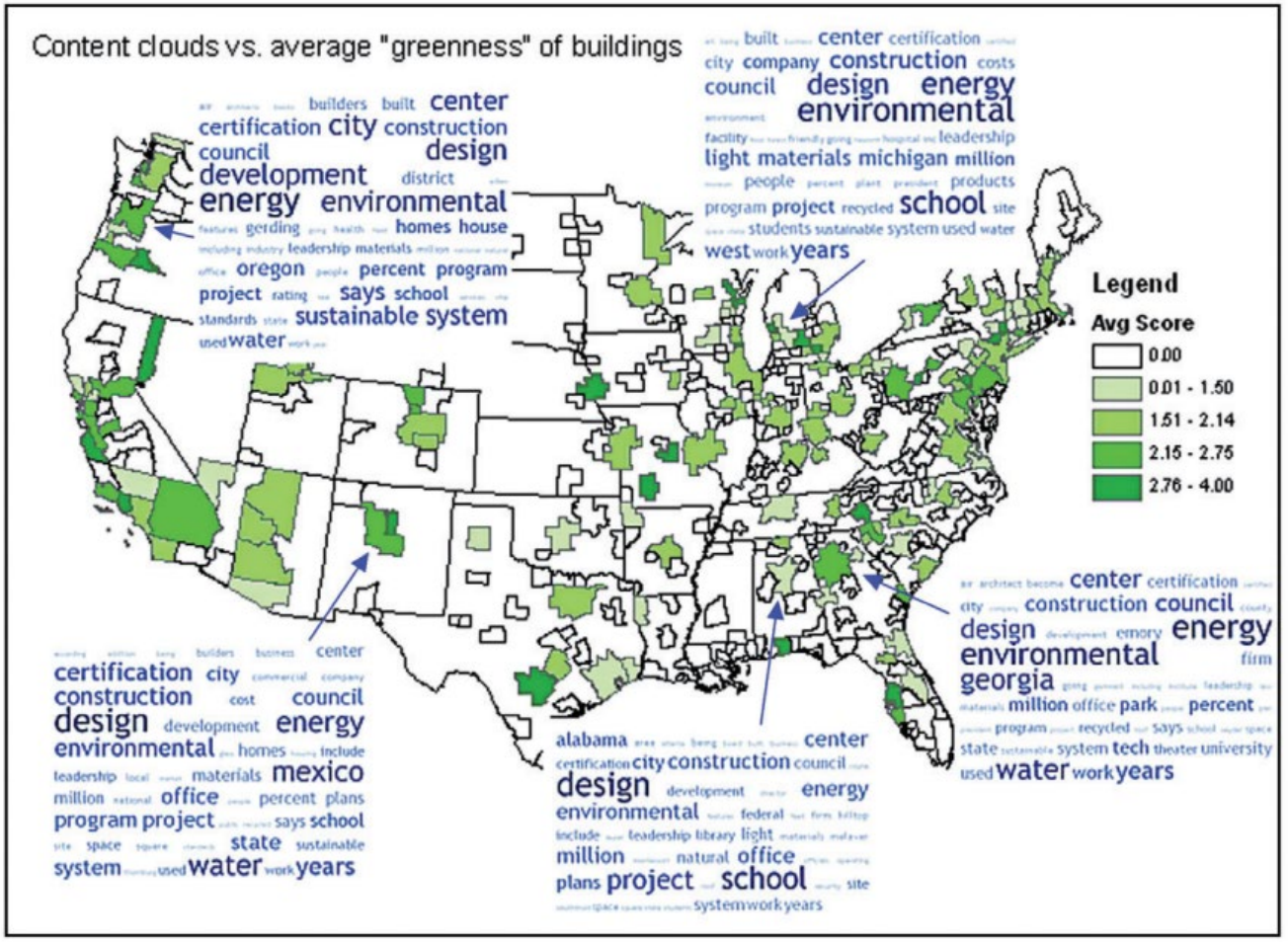


Figure 3 Sample content clouds from green building newspaper articles, generated by the author using TagCrowd.com

(Cidell 2010)

Geovisualization for decision-making using Exploratory Spatial Data Analysis (ESDA)

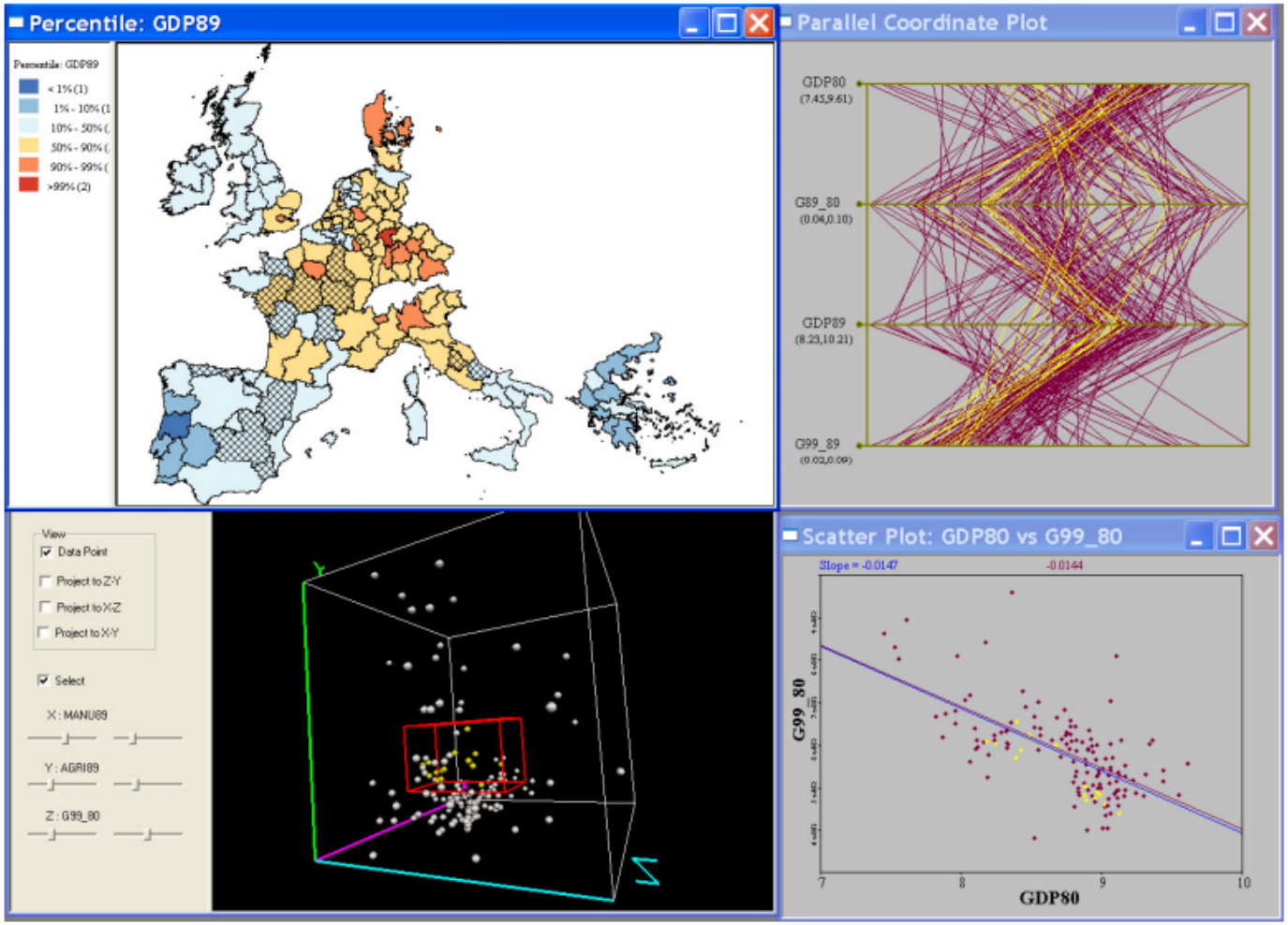


Fig. A.4.3. Multivariate exploratory data analysis with linking and brushing

(source: Anselin, L., Syabri, I., & Kho, Y. (2010). GeoDa: an introduction to spatial data analysis. *Handbook of applied spatial analysis*, 73-89.)

Visualization of high-dimensional objects

- Visualization of two-dimensional spatial objects is straightforward

- Visualization of higher-dimensional (3D, 4D, 5D…) spatial objects is far more difficult and is one of recent topics in GIScience research
  - E.g., spatio-temporal data with multiple attributes, the ESDA example
  - Complicated to understand
  - S/w h/w limitations may exist

Any users of HMD?

Visualization and five human senses

- Human beings have five well-known senses
  - Sight
  - *Smell*
    - E.g., Smell-O-Vision, odorama (1950's)
  - Hearing
    - Can we see sound?
      - Music scores, visual music
  - Taste
  - Touch
    - E.g., sensorama

(source: http://filmusik.com/smell-o-vision-vs-aromarama/)
http://blog.nothingbutsoftware.com/2011/07/the-future-of-television-the-smell-o-vision/)

Visualization and five human senses (cont.)

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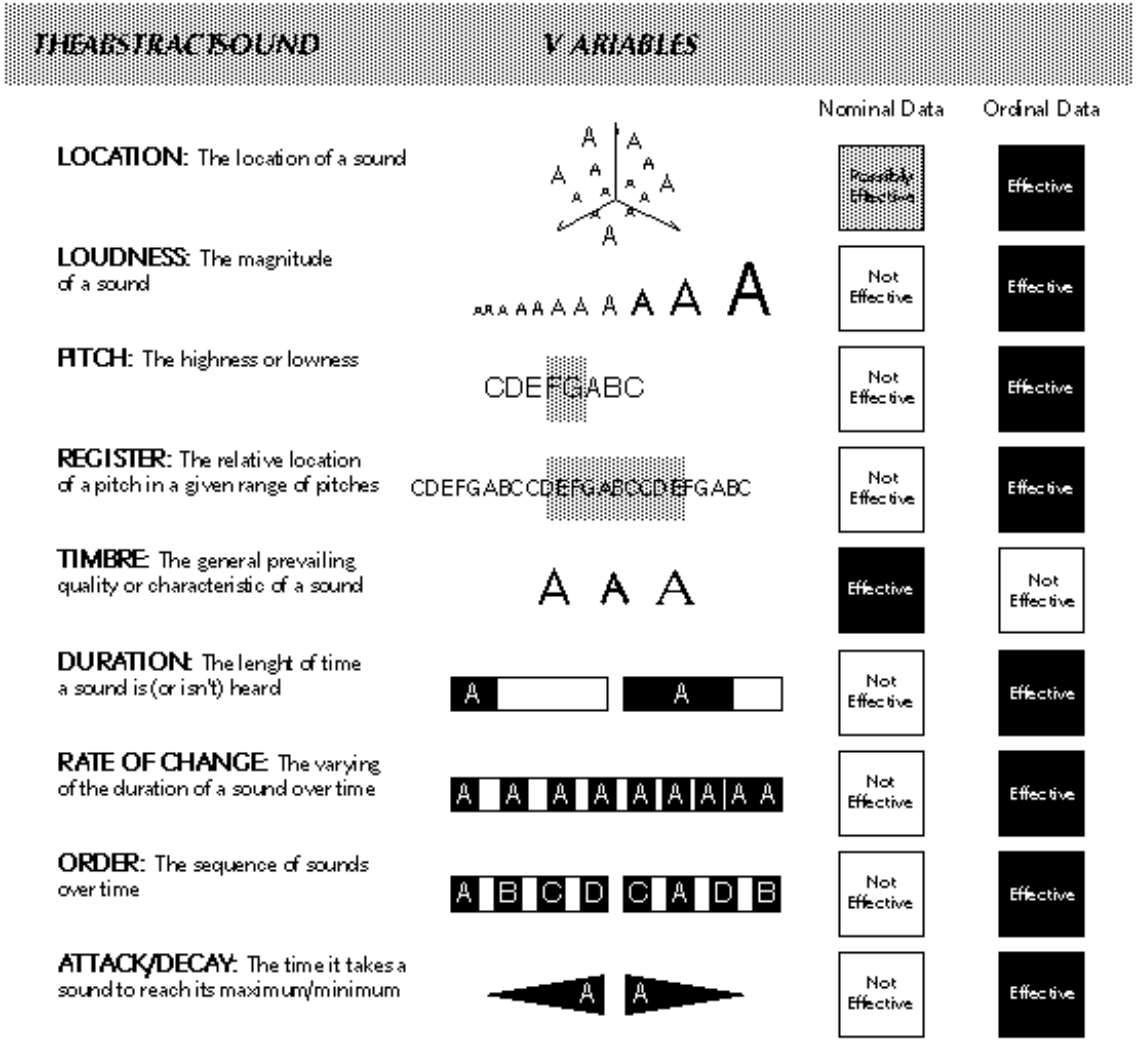

(source: Krygier (1994), http://go.owu.edu/~jbkrygie/krygier_html/krysound.html, http://en.wikipedia.org/wiki/Visual_music)

Visualization and five human senses (cont.)

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(source: http://filmusik.com/smell-o-vision-vs-aromarama/)

Example: Interactive 3D visualization of sound

- Sound map, soundscape
  - https://www.nps.gov/subjects/sound/soundmap.htm
  - https://www.microsoft.com/en-us/research/product/soundscape/
  - https://acousticecologyuoh.wordpress.com/2013/12/04/how-to-make-a-sound-map/
- The Art and Science of Visualizing Sound

  https://www.youtube.com/watch?v=CgoMnNghHy4

(source: Matthew Bain, Drums Downtown 2008: https://www.youtube.com/watch?v=mosIfEr5fmY)

Strengths of geovisualization

- Compared to traditional cartography products
  - Query
    - You can make a simple geographic inquiry
    - Message is sensitive to input data elements (unit, data range, ..)
  - Transformation
    - Data can be manipulated to better serve objectives
    - Helpful to overcome limitation of traditional cartographic products
      - Ex) cartogram: adjusted areal-size to represent values
  - Immersive visualization
    - Expand the capacity to experience the world through virtual environment
  - Animation: Spatio-temporal information representation

(Source: Slocum et al. 2009)

Challenges in visualization

- Interactivity
- Media issues
- Computer interface design
- Visual design issues
- Cognitive issues
- Perceptual differences between users
- Multi-user/collaborative visualization
- Non-conventional graphics

(source: Buckley, Gahegan, and Clarke 2004)

For next time…

- Reading
  - Ch. 1, 20, and 23

- PM1 due today
- Let's start PM2

- Test2 on Nov. 6
- VR headset experience after Test 2
  - Bring your smart phone!