Geo visualization

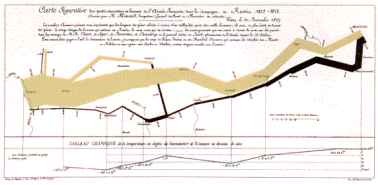
Among others:

Space, time and visual analytics, 2010
G. Andrienko et.al.

Wood: Interactive Visual Exploration of a Large Spatio-Temporal Dataset: Reflections on a Geovisualization Mashup, 2006

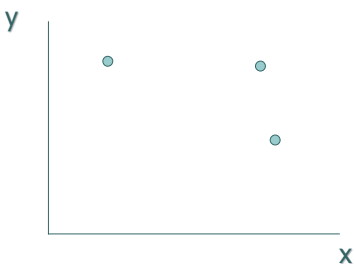
Wijk and Nuij: A Model for Smooth Viewing and Navigation of Large 2D information Spaces, 2004

Introduction

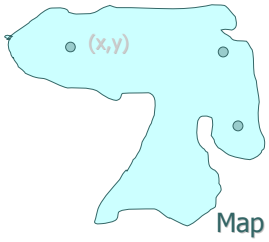


It is a geovisualization also

Quantitative: spatial



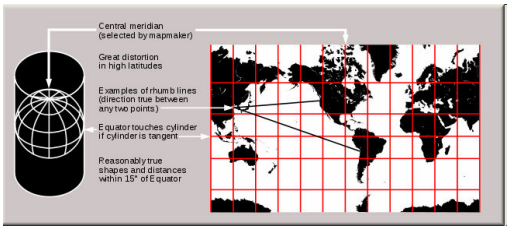
Quantitative: geophysical



What makes it different?

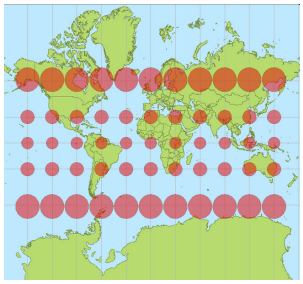
Projections

Source Wikipedia



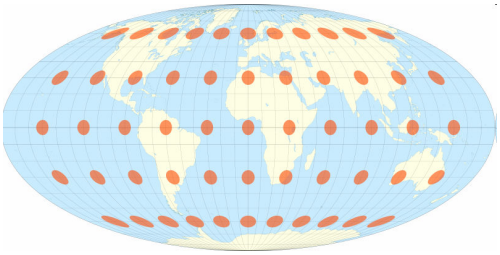
Mercator projection

Source Wikipedia



Source Wikipedia

Mollweide projection



Equal area

And many others

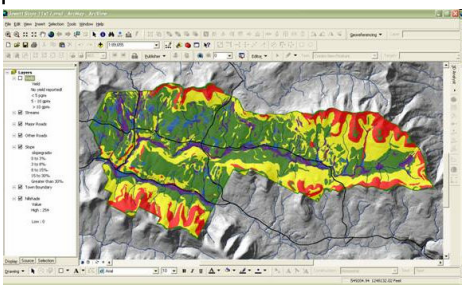
http://www.nevron.com/Gallery.DiagramFor.NET.Maps.MapProjections.aspx

http://www.gis.com/content/what-gis

GIS

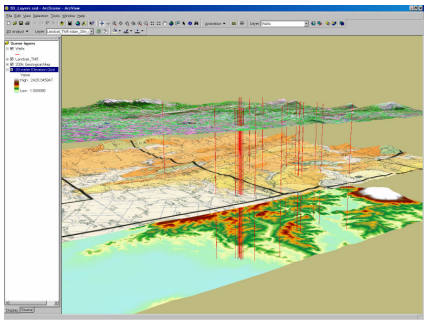
- Definition
  - A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information and allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

GIS

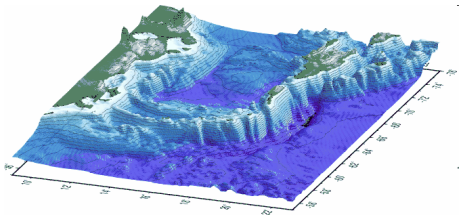


http://www.alphageoscience.com/GIS.html

GIS



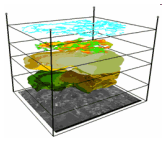
GIS

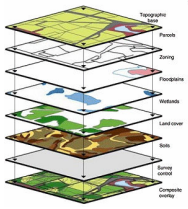


http://web.ics.purdue.edu/~ecalais/teaching/gmt/gmt.html

GIS

- Layered visualization
  - World observations
  - Abstract layers



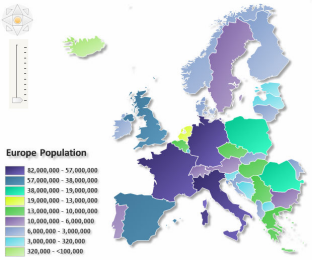


http://www.ruraltech.org/gis/

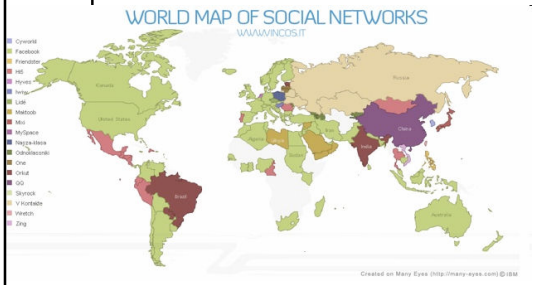
http://www.co.cal.md.us/government/departments/technology/gis/

Chloropleth map

Integrating it with information visualization



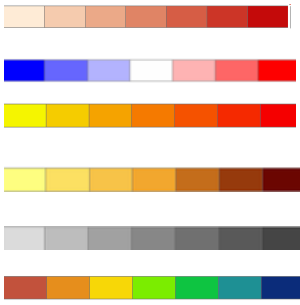
Another example



What colors to use?

Source http://en.wikipedia.org/wiki/Choropleth_map

Color sequences



Single hue color progression
e.g. map magnitude

Bi-polar color progression
e.g. change form positive->negative

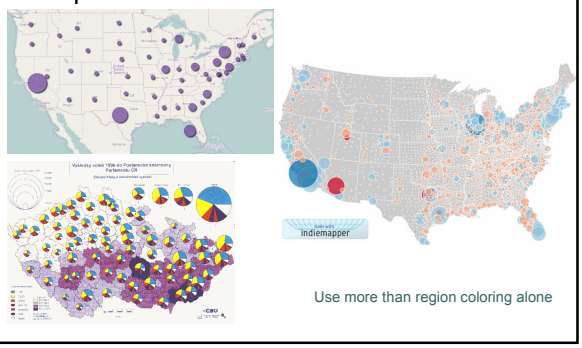
Partial spectral color progression
e.g. mixtures of two distinct sets of data

Blended hue color progression
e.g. elevation changes

Value progression
Best for magnitude message

Full spectral color progression
only for relief or weather

Graduated Symbol Maps



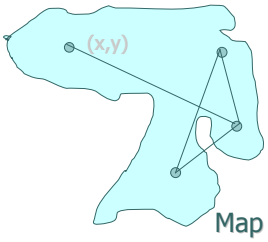
Use more than region coloring alone

Another example

http://www.flickr.com/map/

Networks on maps

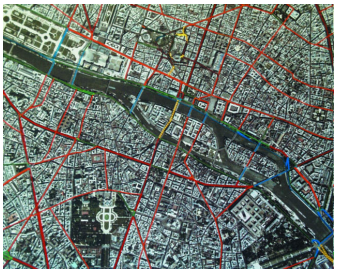
Note: we don't have to compute the positions of nodes



Edges can follow the map elements or can be symbolic

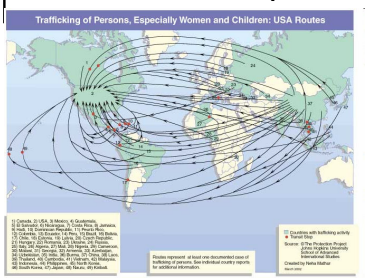
Networks on maps

http://heaven.rec.org/Earth/Paris/feature.html



Note: one-to-one correspondence

Networks on maps



Visualization of relations

http://tfgwebmaster.site.aplus.net/sitebuildercontent/sitebuilderpictures/us-map.jpg

A nice flow example

http://www.win.tue.nl/~speckman/papers/whisky.pdf

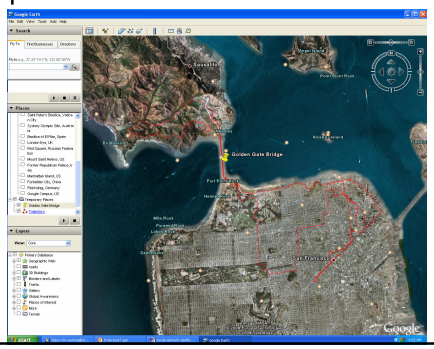
GIS

- Integration of
  - Real world data (satellite images)
    - Scientific visualization to make it 3D
    - Simulations
  - Abstractions
    - Vector Graphics / Information Visualization

Commonalities between time and space

- Dependencies between observations
  - Tobler's first law
    - "Everything is related to everything else, but near things are more related than distant things"
- This allows
  - Interpolation and extrapolation
  - Integration of information of different types and/or from different sources using references to common locations and/or time units
  - Spatial and temporal inference, and many other operations

Close and related?



Dependencies between observations

- But geographic space is heterogeneous
  - Water differs from land, mountain ranges are different from valleys etc.
- Relatedness between things may depend on
  - Distance/Proximity
  - Direction

Dependencies between observations

- Proximity is phenomenon dependent
  - Could be defined spatially
    - E.g. distance by road
    - E.g. Euclidean distance
    - Earth surface distance
  - But also on other attributes
    - Ignoring spatial characteristics

Scale

- Spatio-temporal phenomena
  - Exist and operate at different spatial and temporal extents
- Scale of spatial analysis
  - Reflected in the size of the units in which phenomena are measured and the size of the units in which measurements are aggregated
  - Choosing the right scale very important as otherwise patterns might be missed

Scale

- Scales should match the phenomenon
  - Both spatial and temporal scale of visualization should match the scale of the phenomenon
- Scale should also match the goal
  - Analysis should be at the scale where reasoning is performed

Scale

- Consequences
  - An interactive multi-scale exploration is required
  - As various layers might interact, a hierarchy of scales is needed with proper embedding and smooth navigation

What is needed?

- Seamless integration of visualization and computational techniques
- Support for documenting the analysis process
- (Support for collaboration)
- Information from diverse sources

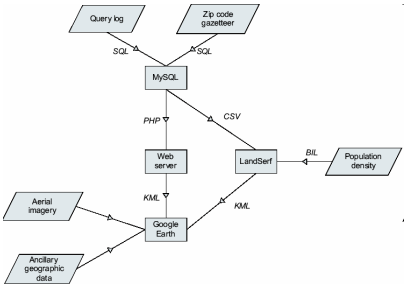
A very nice example

Organisation for Economic Cooperation and Development eXplorer

http://stats.oecd.org/OECDregionalstatistics/

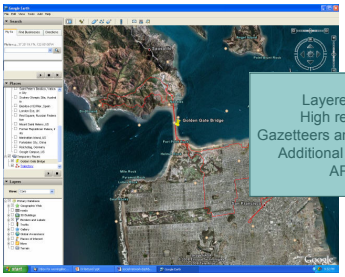
Wood et.al. Interactive Visual Exploration, 2007

There are many tools



Information should be gathered from many open source places.
Paper is good source of inspiration.

Google Earth



Layered representation
High resolution imagery
Gazetteers and boundaries available
Additional information via KML
API accessible

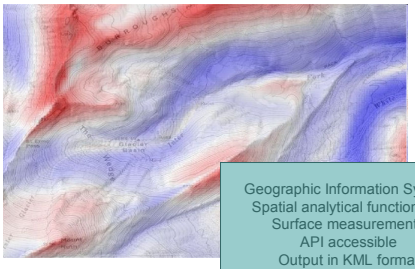
KML

A markup language specifically designed for geo visualization

A basic example

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
        <Placemark>
        <name>Simple placemark</name>
        <description>Attached to the ground. Intelligently places itself at the height of the underlying terrain.</description>
        <Point>
                <coordinates>-122.0822035425683,37.42228990140251,0</coordinates>
        </Point>
        </Placemark>
</kml>
```

LandSerf



Geographic Information System
Spatial analytical functionality
Surface measurements
API accessible
Output in KML format

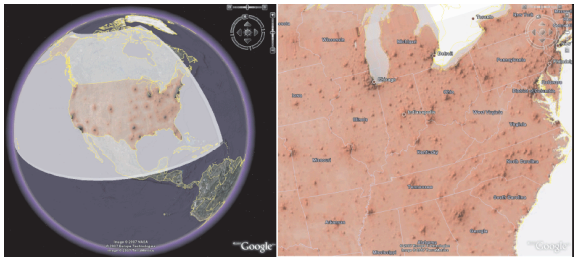
Case study

- US-based mobile telephone service
  - 1.42 million requests
  - Result location sensitive business or service
  - Attributes
    - Location where query was made
    - Time and date
    - Service/business name
    - Zip code
    - User ID
    - …..

Another example

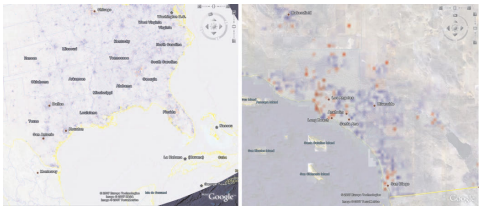
An example

An example



Population density surface using LandSerf

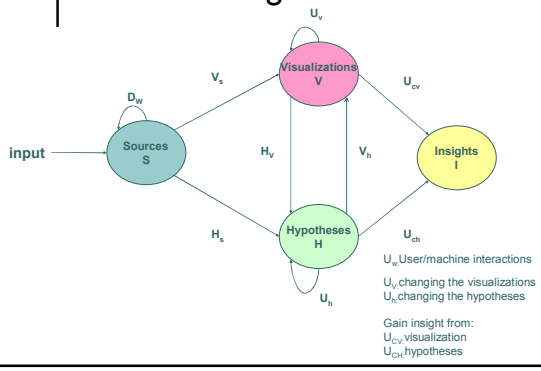
And analysis



Population in relation to queries

Keim 2008

Rethink in a geo context



Conclusion

- Geovisualization
  - Requires to look at both spatial and temporal components
  - GIS are heavyweight solutions
  - We need lightweight solutions with information from various sources
  - A tight integration of GeoData, Interactive Visualization, and Computational techniques