Using Space Effectively: 2D II

Maneesh Agrawala

CS 294-10: Visualization
Spring 2010

Assignment 4: Visualization Software

Create an interactive visualization application – you choose data domain and visualization technique.

1. Describe data and storyboard interface
   due March 1 (before class)
2. Implement interface and produce final writeup
   due March 8 (before class)
3. Submit the application and a final writeup on the wiki

Can work alone or in pairs
Final write up due before class on Mar 8, 2010

Announcements: Ben Shneiderman

Speaking: March 3, 2010

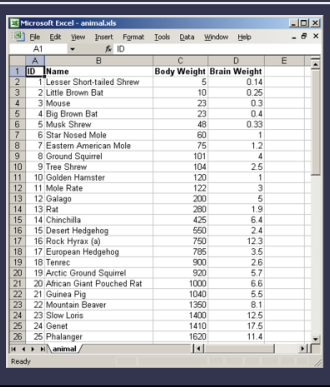
Noon – 1pm
Banatao Auditorium, Dai Hall

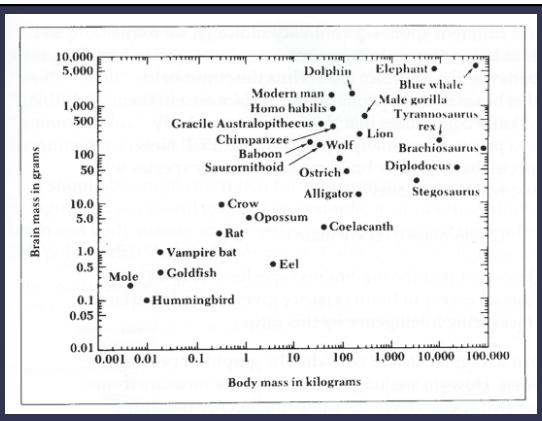
Please attend lecture instead of class

Topics

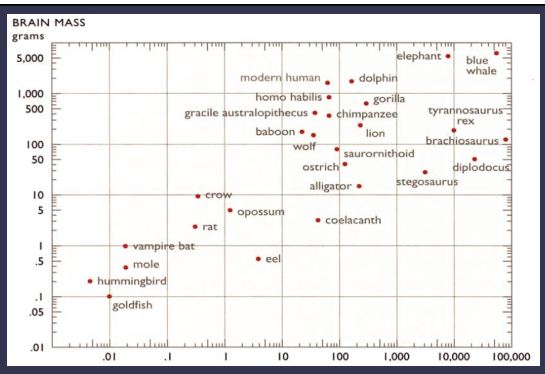
- Displaying data in graphs
- Banking to 45 degrees
- Fitting data and depicting residuals
- Displaying multidimensional data
- Graphical calculations
- Zooming and distortion

Most powerful brain?

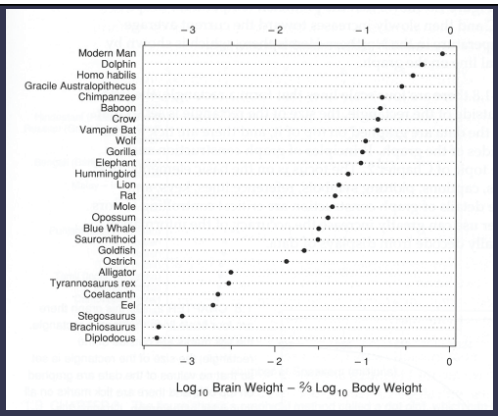




The Dragons of Eden [Carl Sagan]



Tufte redesign 1



The Elements of Graphing Data [Cleveland]

Parallel Coordinates

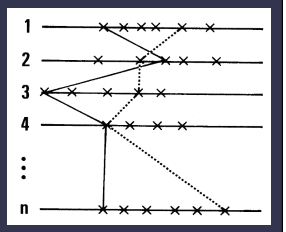
Parallel coordinates

Visualizing nD in planar image

- **Only 2 orthogonal axes**
- **Use parallel axes instead**

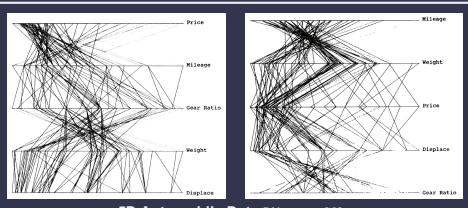
Plot each dimension of point *x* on separate axis

- ***x* = (*a*, *b*, *c*, *d*, …)**



[Wegman 90]

Parallel coordinates: Axis ordering

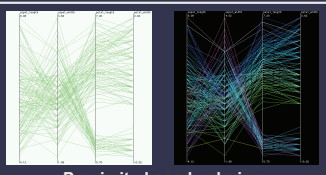


5D Automobile Data [Wegman 90]

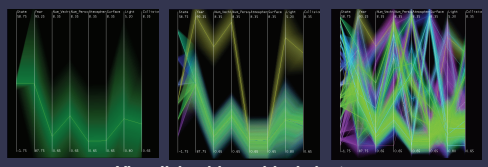
No intrinsic axis order

- Interactive axis swap
  - Bad: Relies on human examination
  - Good: Powerful interaction
- Machine learning of axis order [Inselberg 99]

Parallel coordinates



Proximity-based coloring

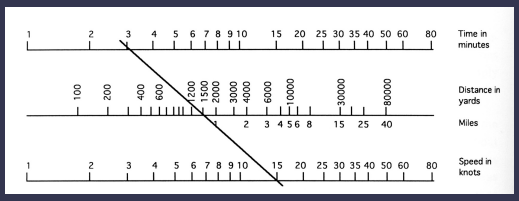


Visualizing hierarchical clusters

[Fua et al. 99]

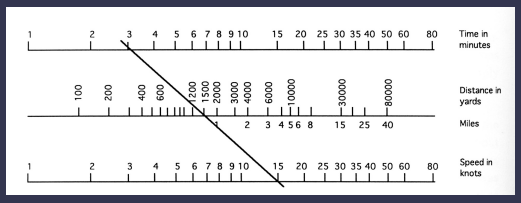
Graphical Calculations

Nomograms



Sailing: The Rule of Three

Nomograms

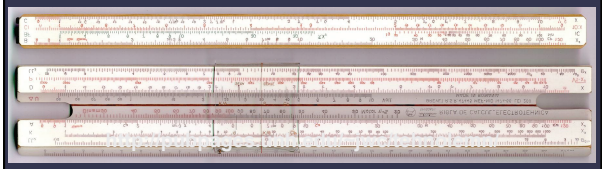


1. Compute in any direction; fix n-1 params and read nth param
2. Illustrate sensitivity to perturbation of inputs
3. Clearly show domain of validity of computation

Theory

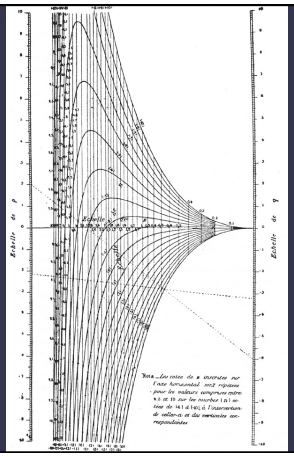
$$\begin{vmatrix} x_1(u) & y_1(u) & w_1(u) \\ x_2(v) & y_2(v) & w_2(v) \\ x_3(s,t) & y_3(s,t) & w_3(s,t) \end{vmatrix} = 0$$

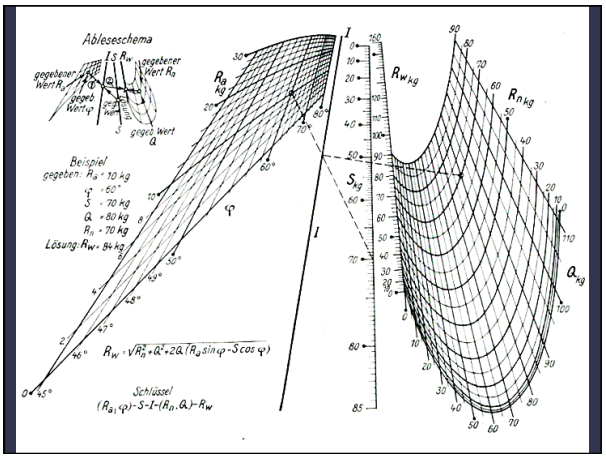
Slide rule



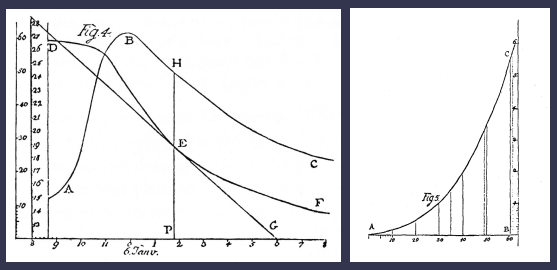
Model 1474-66 Electrotechnica 18 Scales

Tehnolemn Timisoara Slide Rule Archive
http://pubpages.unh.edu/~jwc/tehnolemn/

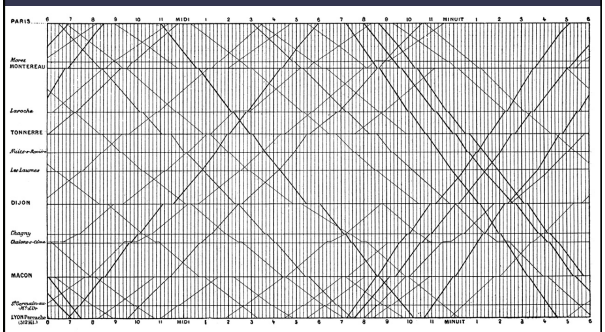




Lambert's graphical construction



Johannes Lambert used graphs to study the rate of water evaporation as function of temperature [from Tufte 83]

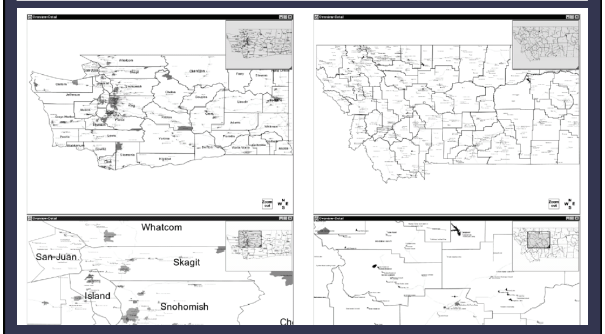


E. J. Marey, *La Méthode Graphique* (Paris, 1885), p. 20. The method is attributed to the French engineer, Ibry.

Zooming

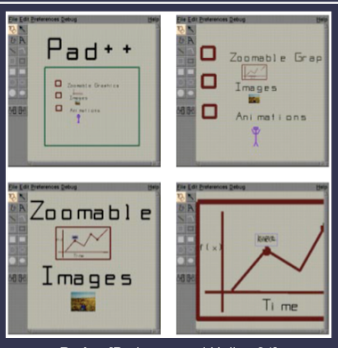
Eames' Powers of Ten [http://www.powersof10.com/]

Overview + details



[Hornbaek et al. 2002]

Interactive zooming

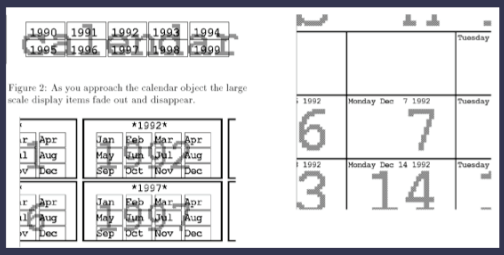


Pad++ [Bederson and Hollan 94]

Pad++

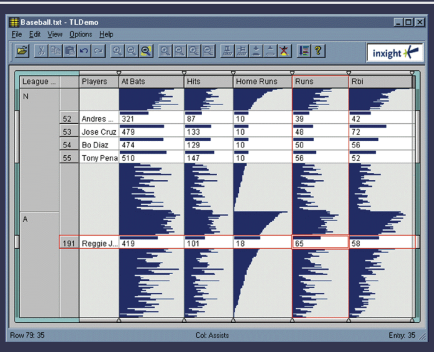
Semantic zooming

Change visual representations as zoom level changes



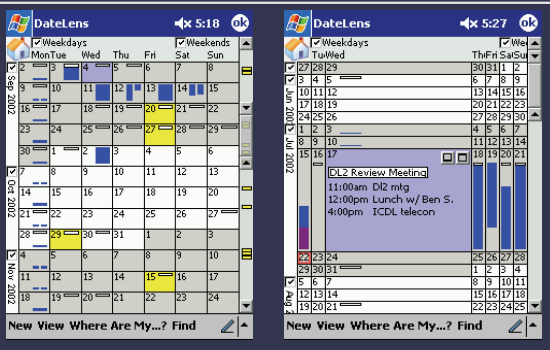
PAD [Perlin and Fox 93]

TableLens [Rao & Card 94]



http://www.youtube.com/watch?v=qWqTrRAC52U

Datelens

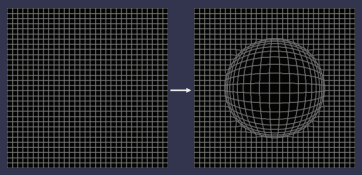


[Bederson et al. 04]

Distortion

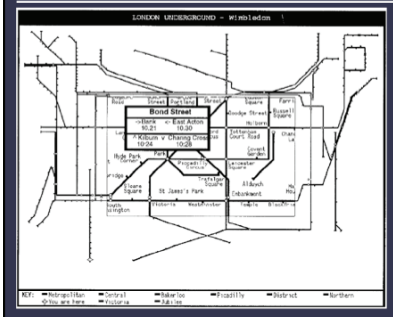
Single view detail + context

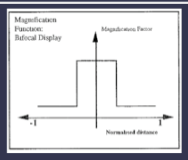
- Focus area – local details
- De-magnified area – surrounding context
- Like a rubber sheet with borders tacked down

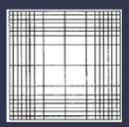


Nonlinear Magnification Infocenter [http://www.cs.indiana.edu/%7Etkeahey/research/nlm/nlm.html]

Bifocal display [Leung and Apperley 94]

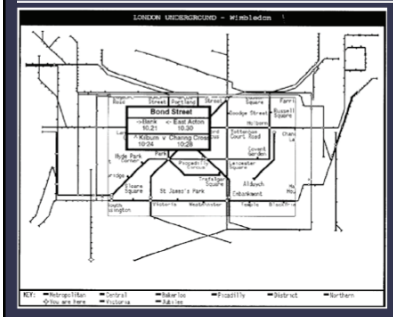


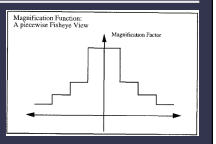




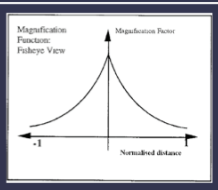
2D distortion

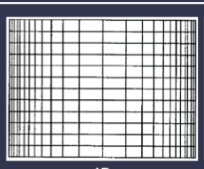
Multifocal display [Leung and Apperley 94]



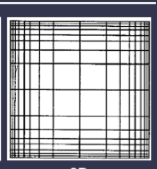


Fisheye [Leung and Apperley 94]

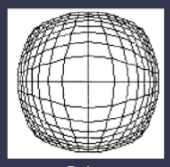




1D

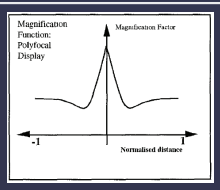


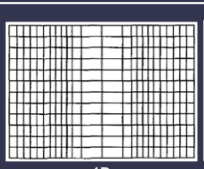
2D



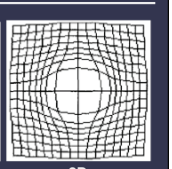
Polar

Nonlinear magnification [Leung and Apperley 94]

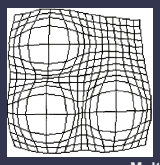


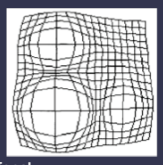


1D



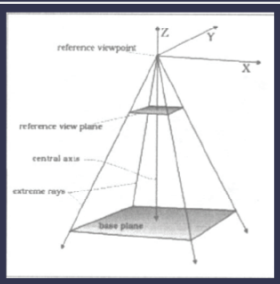
2D

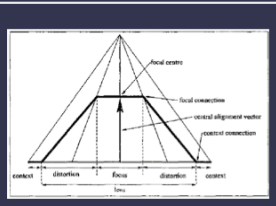




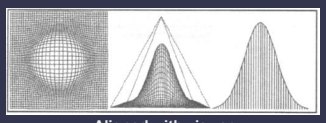
Multifocal

3D pliable surface [Carpendale & Montagnese 01]

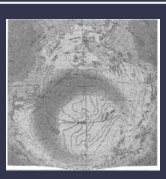


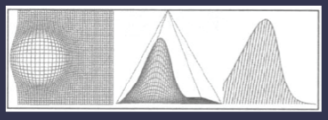


Aligned and sheared [Carpendale & Montagnese 01]

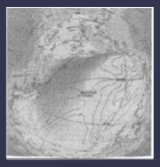


Aligned with viewer

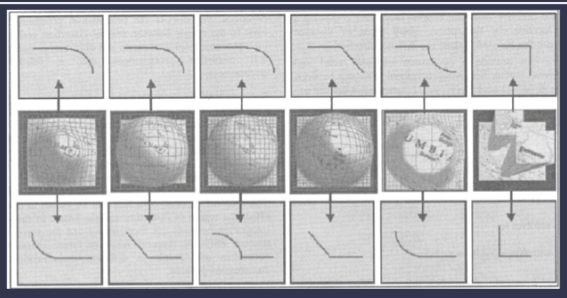




Sheared



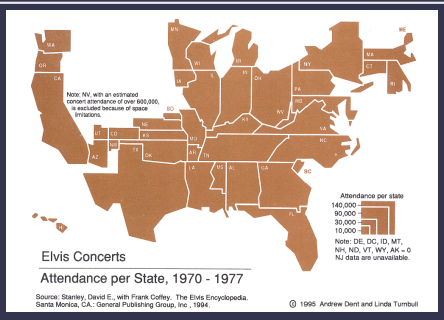
6 types of distortions [Carpendale & Montagnese 01]



Gaussian, Cosine, Hemisphere, Linear, Inverse Cosine and Manhattan. Top row shows transition from focus to distortion, bottom row from distortion to context.

Cartographic Distortions

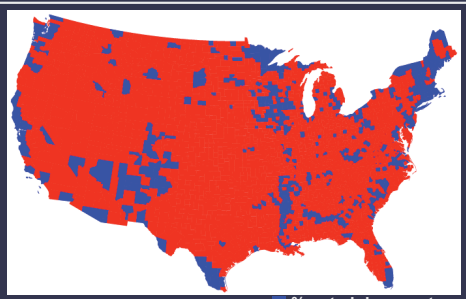
Cartograms: Distort areas



Scale area by data

[From *Cartography*, Dent]

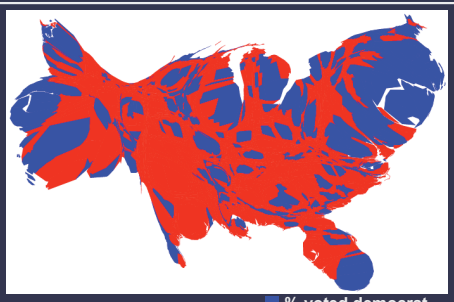
Election 2004 map



% voted democrat
% voted republican

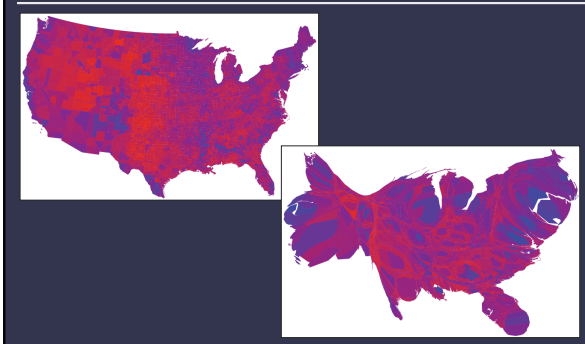
http://www-personal.umich.edu/~mejn/election/

Election 2004 map



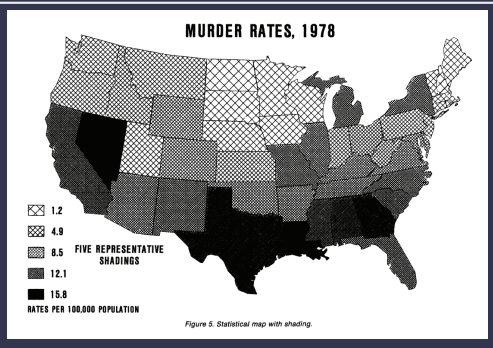
http://www-personal.umich.edu/~mejn/election/

Election 2004 map



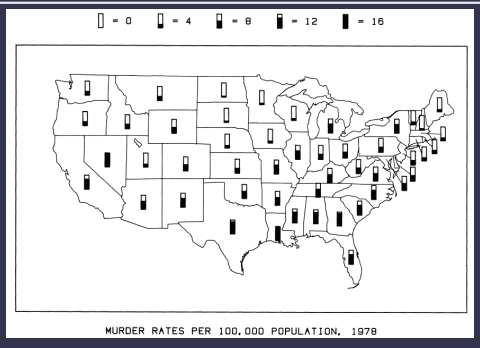
http://www-personal.umich.edu/~mejn/election/

Statistical map with shading



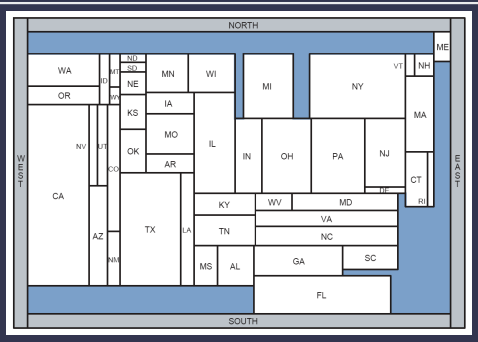
[Cleveland and McGill 84]

Framed rectangle chart



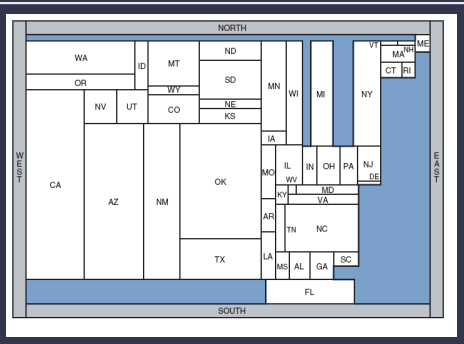
[Cleveland and McGill 84]

Rectangular cartogram



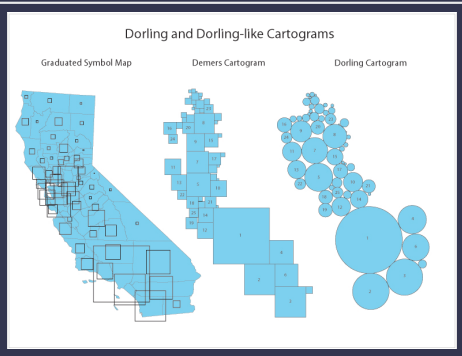
American population [van Kreveld and Speckmann 04]

Rectangular cartogram



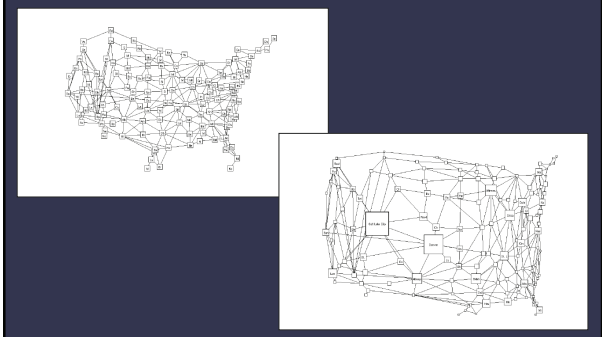
Native American population [van Kreveld and Speckmann 04]

Dorling cartogram



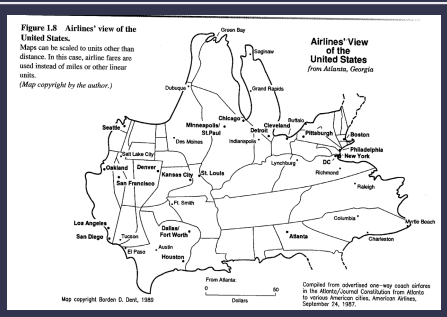
http://www.ncgia.ucsb.edu/projects/Cartogram_Central/types.html

States as nodes in a graph



Graphical fisheye views of graphs [Sarkar & Brown 92]

Distorting distances



Scale distance by data

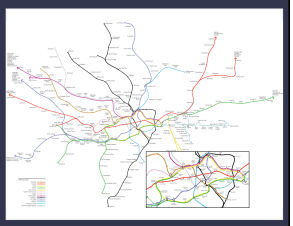
[From *Cartography*, Dent]

London underground

http://www.thetube.com/content/history/map.asp

Comparison to geographic map

Distorted



Undistorted

Summary

- Spatial layout is the most important visual encoding
- Geometric properties of spatial transforms support geometric reasoning
- Show data with as much resolution as possible
- Use distortions to emphasize important information