Spatial Layout

Maneesh Agrawala

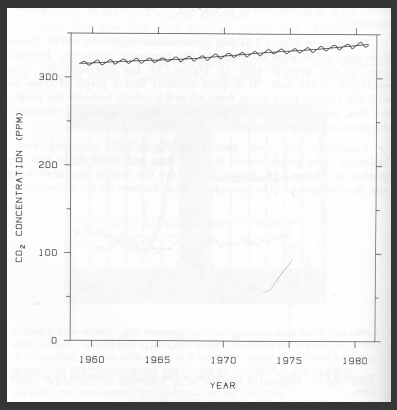
CS 294-10: Visualization
Fall 2013

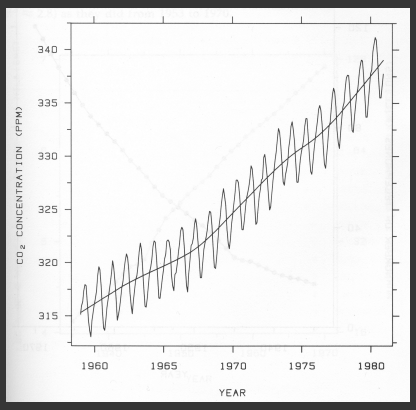
Last Time: Using Space Effectively: 2D

Aspect ratio

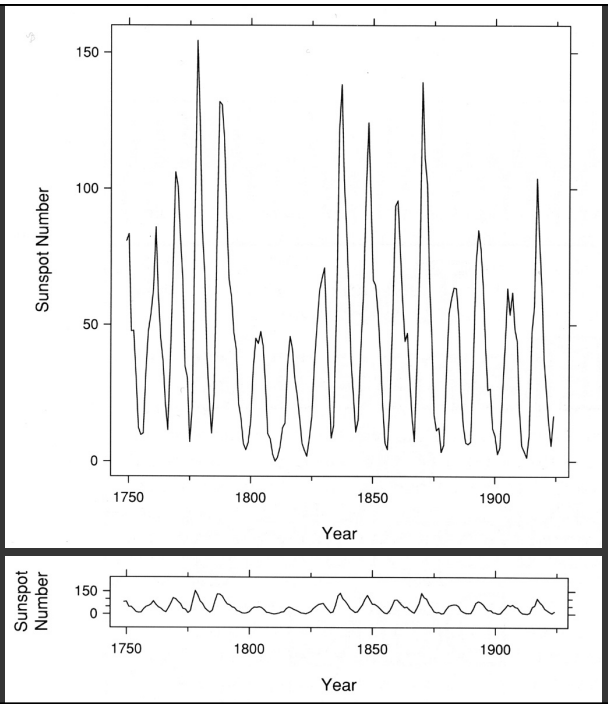
Fill space with data

Don't worry about showing zero



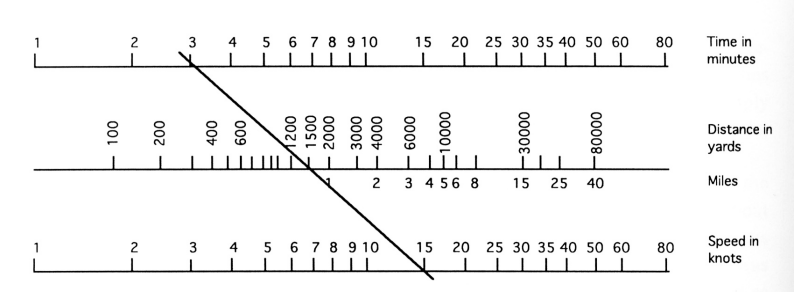


Yearly CO2 concentrations [Cleveland 85]



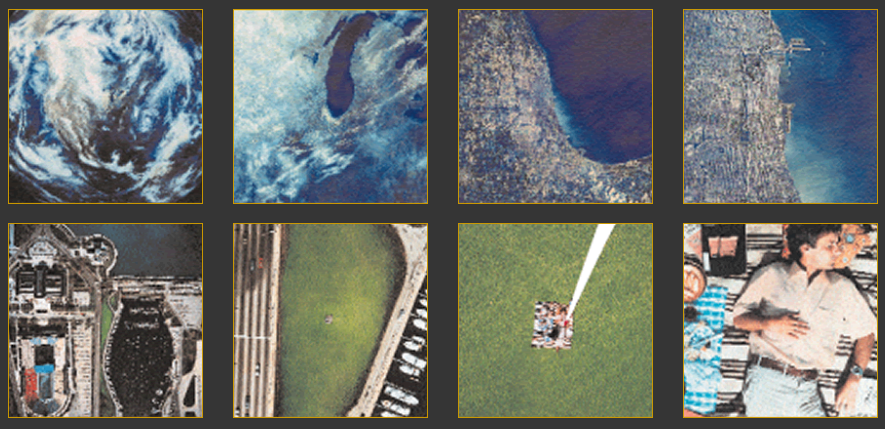
William S. Cleveland
The Elements of Graphing Data

Nomograms



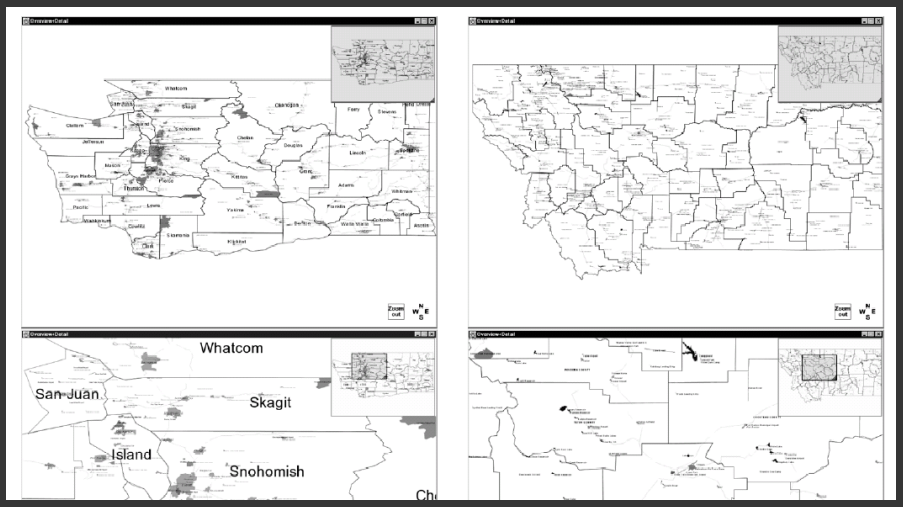
1. Compute in any direction; fix n-1 params and read nth param
2. Illustrate sensitivity to perturbation of inputs
3. Clearly show domain of validity of computation

Zooming



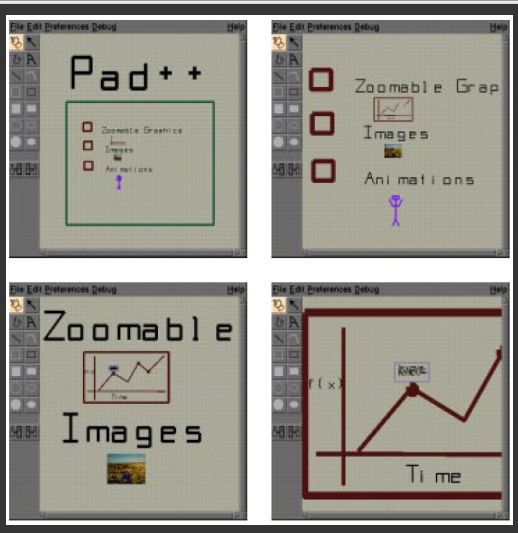
Eames' Powers of Ten [http://www.powersof10.com/film]

Overview + details

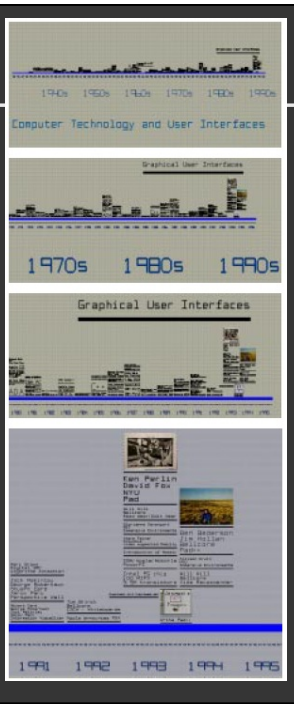


[Hornbaek et al. 2002]

Interactive zooming



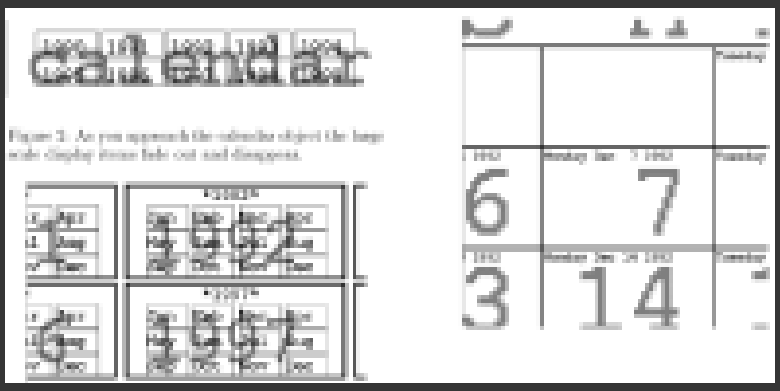
Pad++ [Bederson and Hollan 94]



Pad++

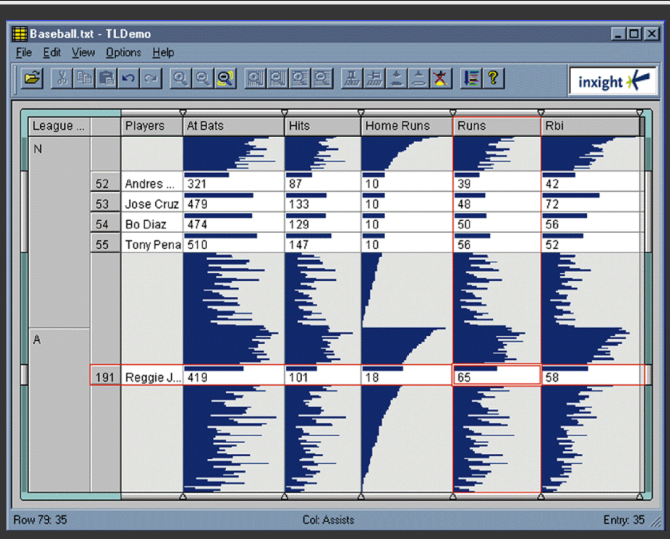
Semantic zooming

Change visual representations as zoom level changes



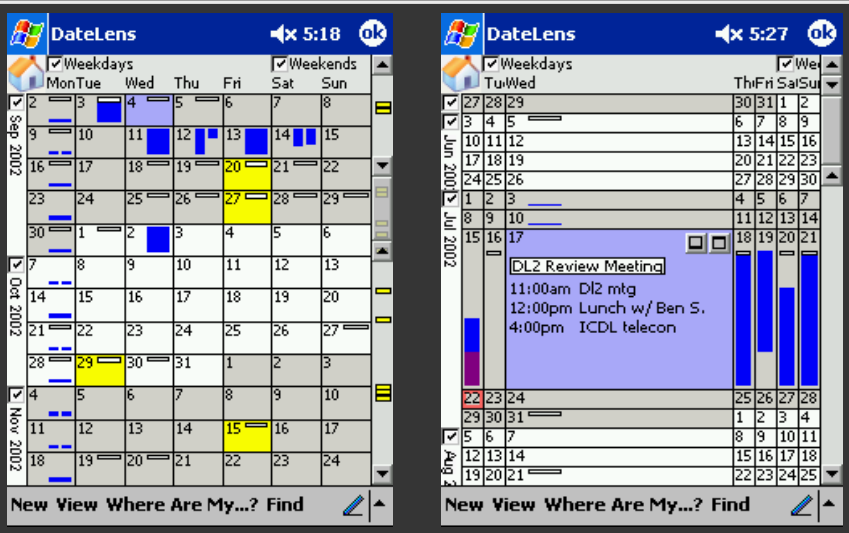
PAD [Perlin and Fox 93]

TableLens [Rao & Card 94]



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

Datelens

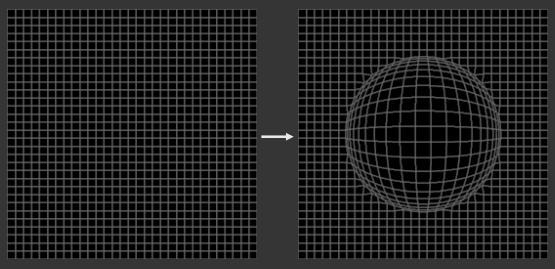


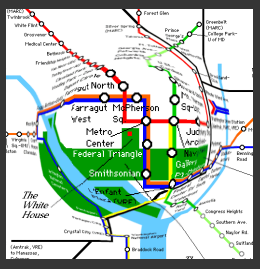
[Bederson et al. 04]

Distortion

Single view detail + context

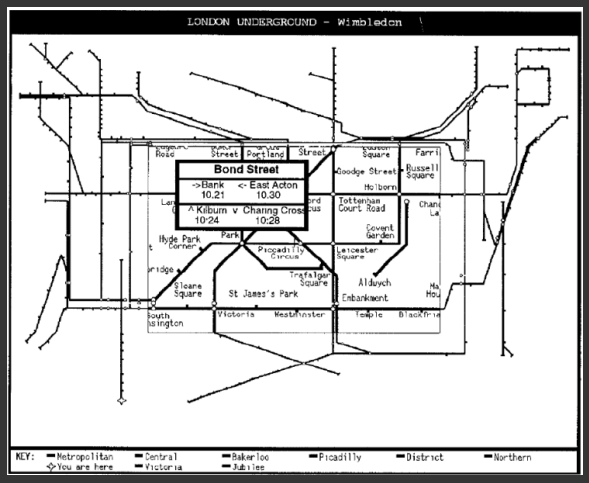
- Focus area – local details
- De-magnified area – surrounding context
- Like a rubber sheet with borders tacked down

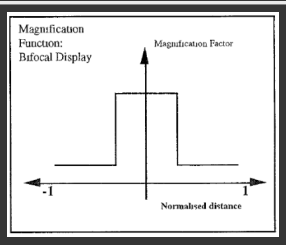


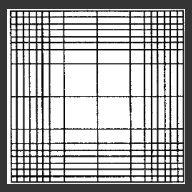


Nonlinear Magnification Infocenter [http://www.cs.indiana.edu/%7Etkeahey/research/nlm/nlm.html]

Bifocal display [Leung and Apperley 94]

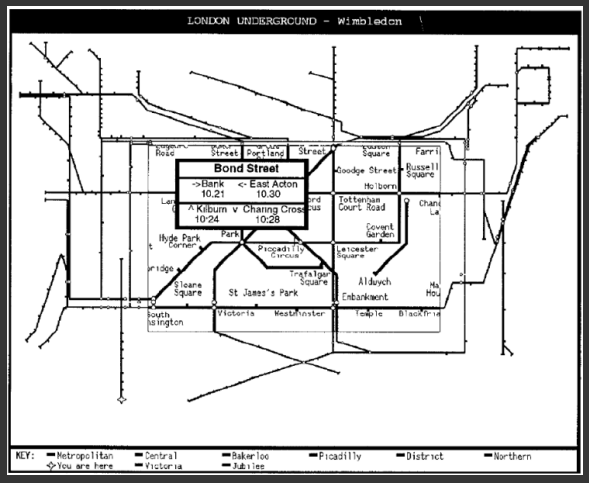


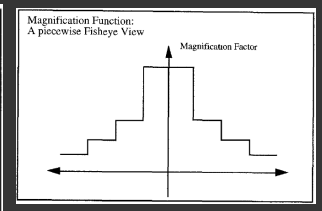




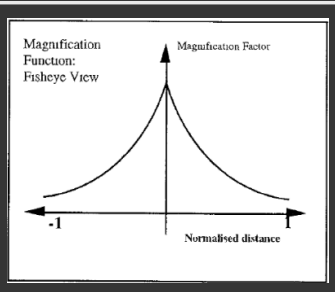
2D distortion

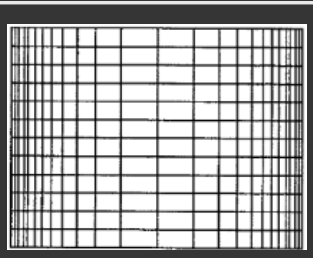
Multifocal display [Leung and Apperley 94]



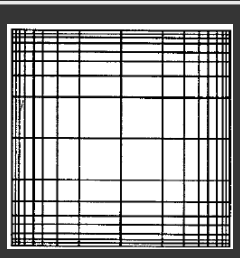


Fisheye [Leung and Apperley 94]

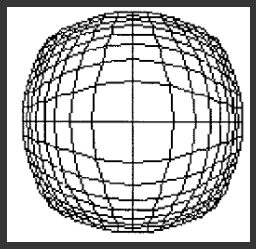




1D

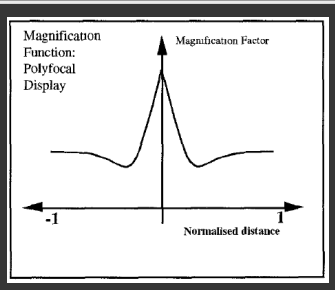


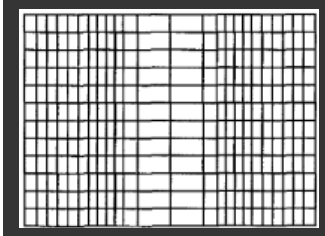
2D



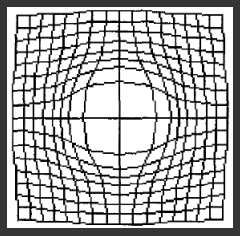
Polar

Nonlinear magnification [Leung and Apperley 94]

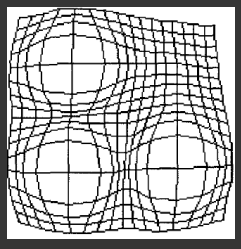


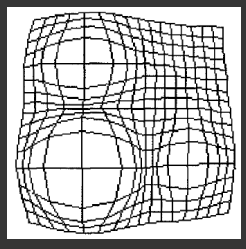


1D



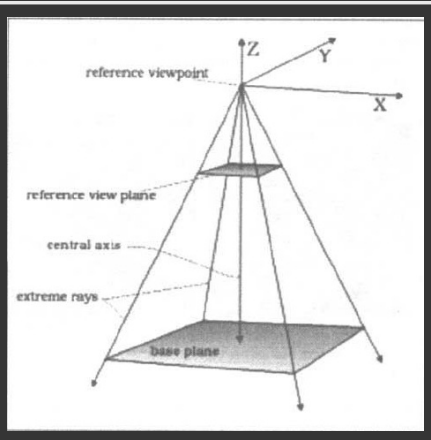
2D

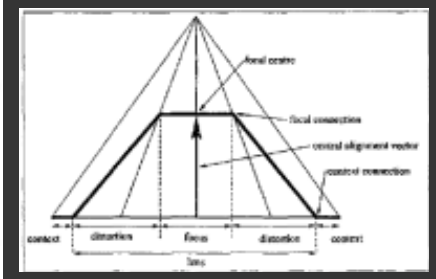




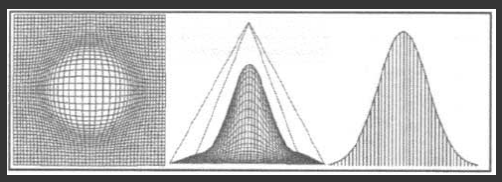
Multifocal

3D pliable surface [Carpendale & Montagnese 01]

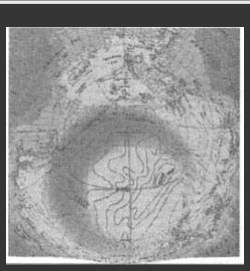


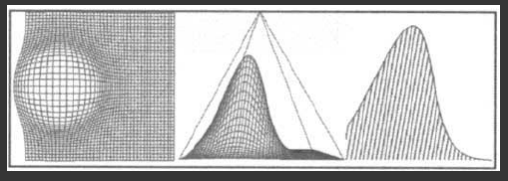


Aligned and sheared [Carpendale & Montagnese 01]

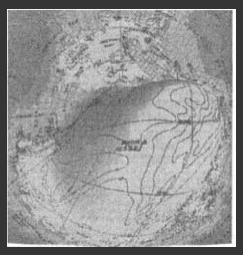


Aligned with viewer

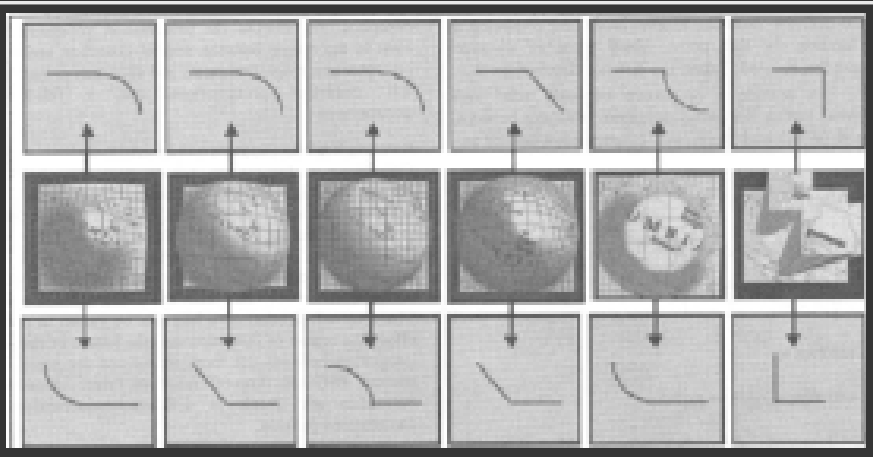




Sheared



6 types of distortions [Carpendale & Montagnese 01]



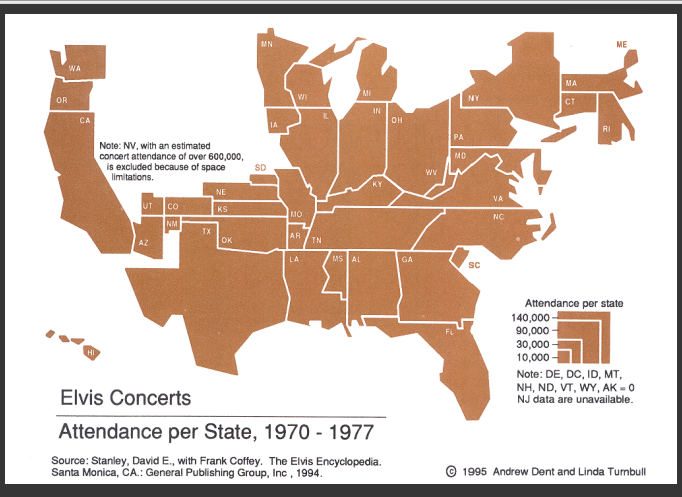
Gaussian, Cosine, Hemisphere, Linear, Inverse Cosine and Manhattan. Top row shows transition from focus to distortion, bottom row from distortion to context.

Transmogrifiiers [Brosz et al. 13]

http://www.transmogrifiers.org/

Cartographic Distortions

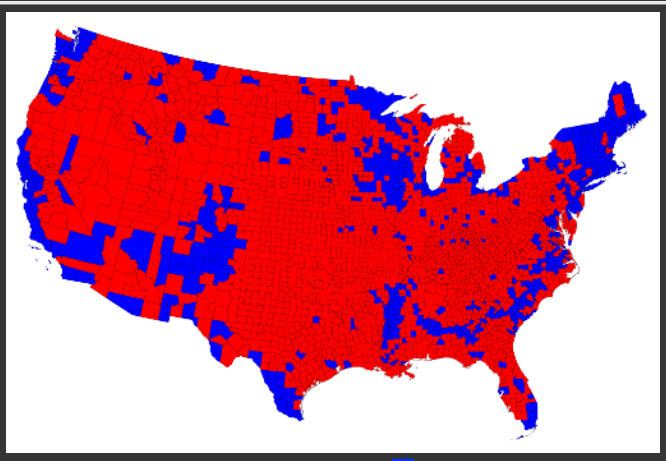
Cartograms: Distort areas



Scale area by data

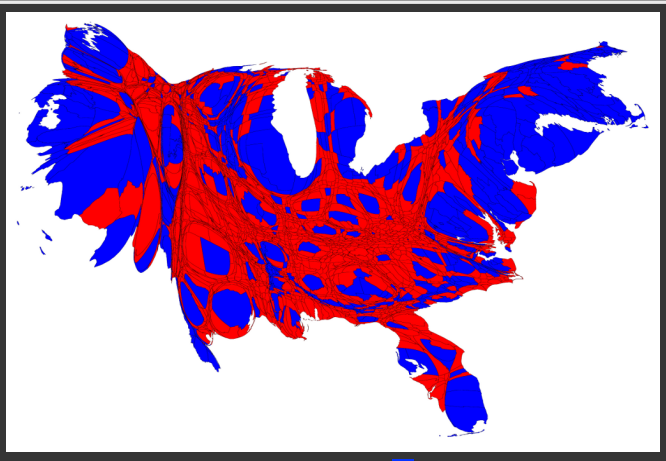
[From *Cartography*, Dent]

Election 2012 map



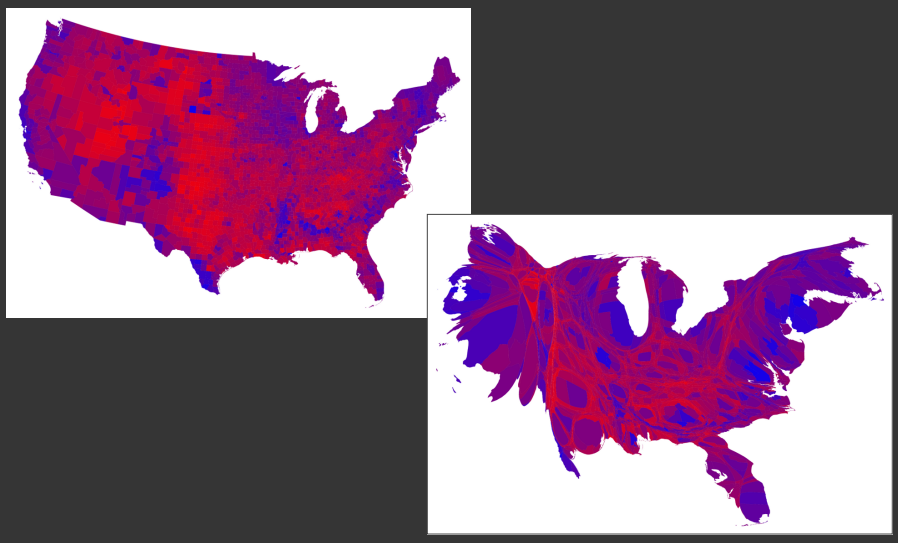
http://www-personal.umich.edu/~mejn/election/

Election 2012 map



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

Election 2012 map



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

Statistical map with shading

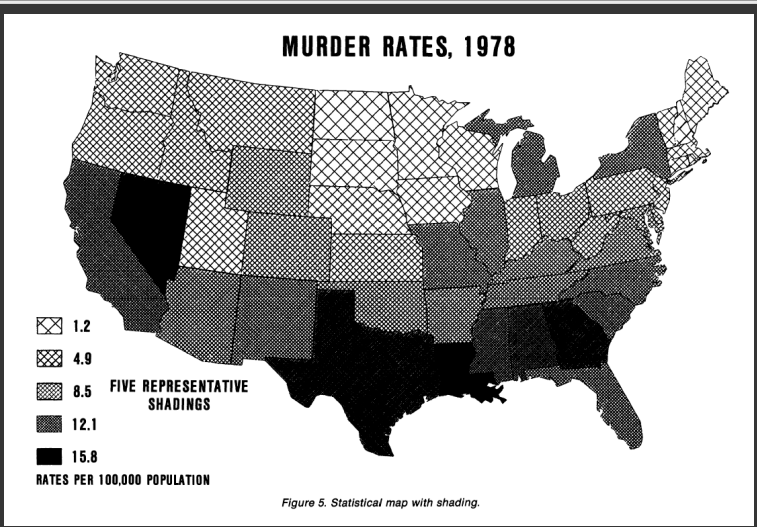
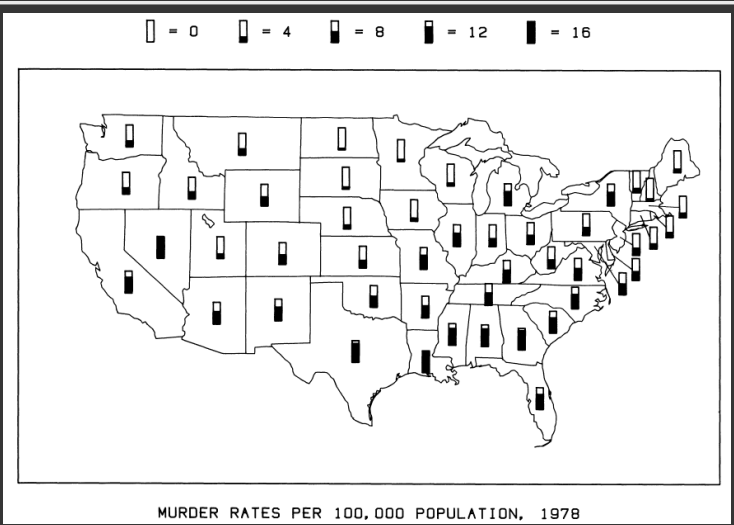


Figure 5. Statistical map with shading.

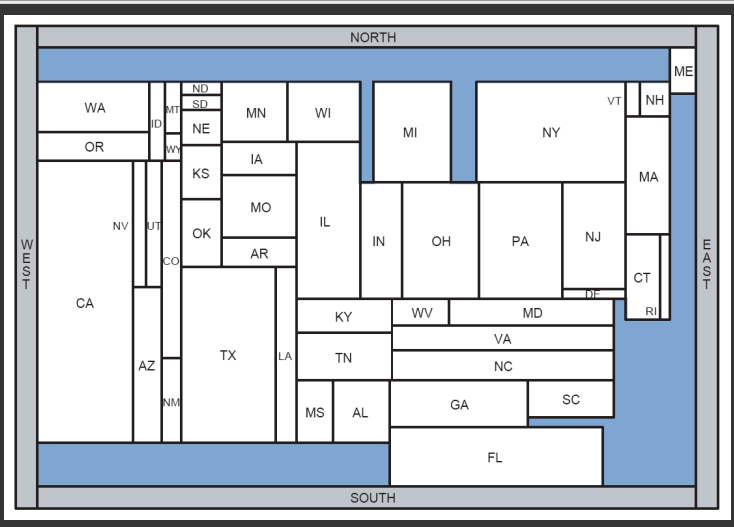
[Cleveland and McGill 84]

Framed rectangle chart



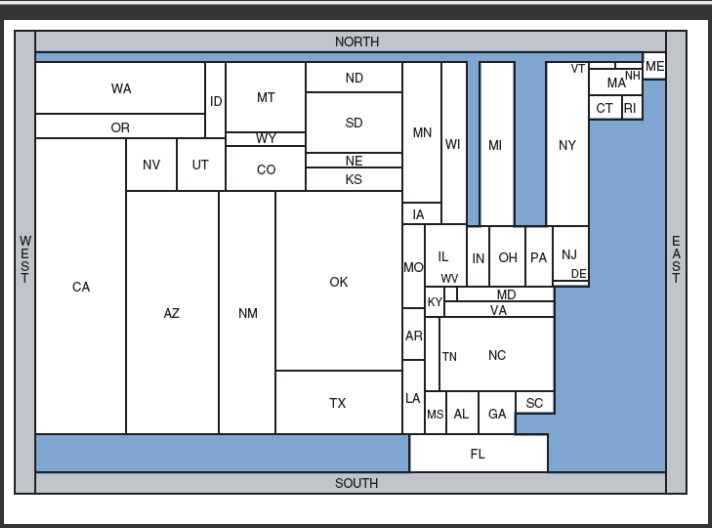
[Cleveland and McGill 84]

Rectangular cartogram



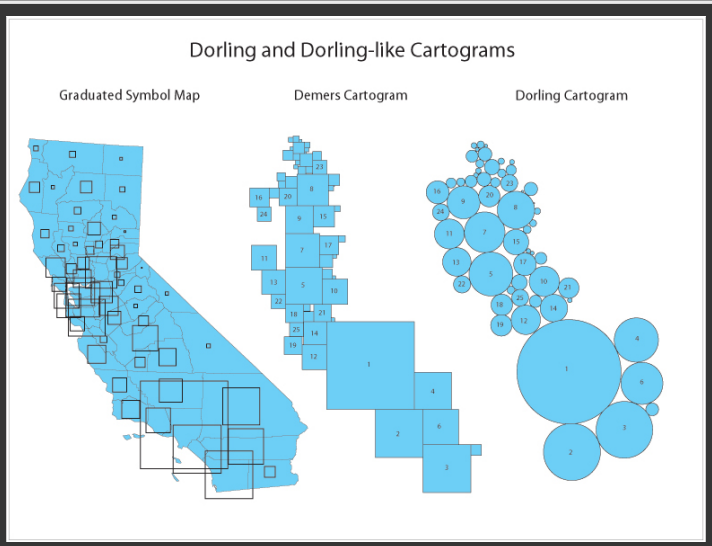
American population [van Kreveld and Speckmann 04]

Rectangular cartogram



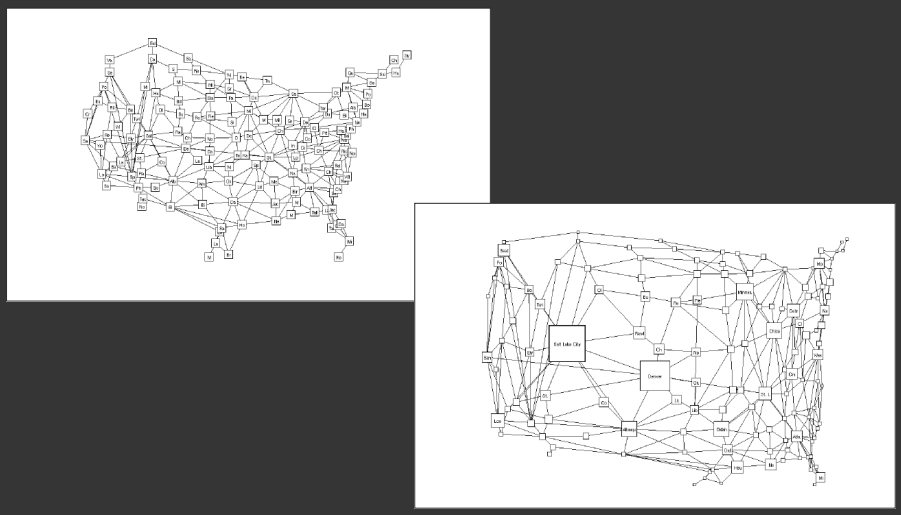
Native American population [van Kreveld and Speckmann 04]

Dorling cartogram



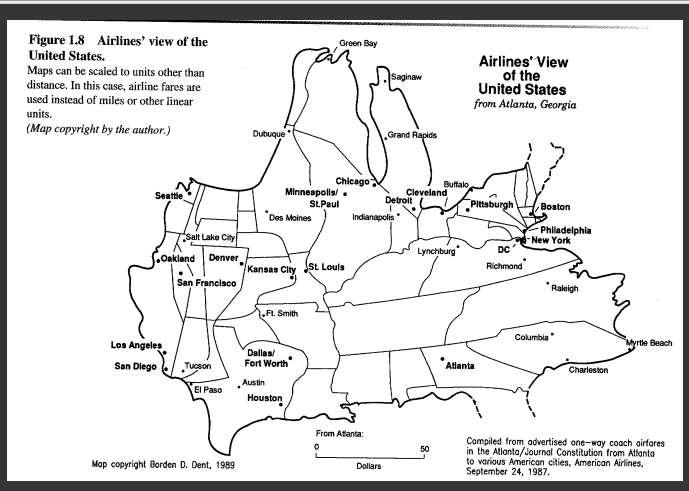
http://www.ncgia.ucsb.edu/projects/Cartogram_Central/types.html

States as nodes in a graph



Graphical fisheye views of graphs [Sarkar & Brown 92]

Distorting distances



Scale distance by data

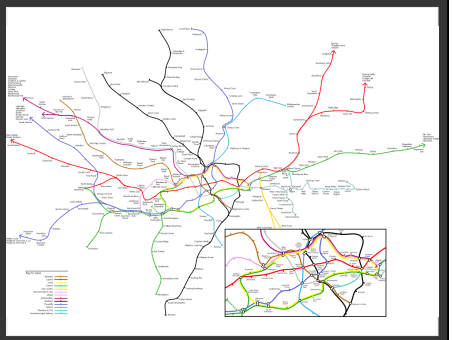
[From *Cartography*, Dent]

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

Announcements

Assignment 2

Grades have been posted to bspace

If you used real estate data please let Jennifer Baires know what you did
bairesjen@gmail.com

Final project

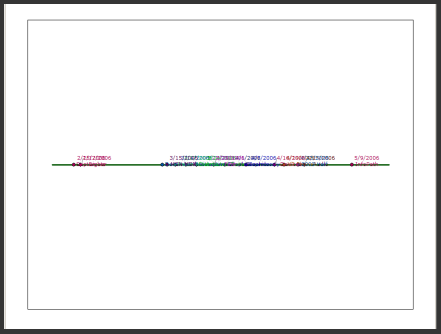
Design new visualization method
- Pose problem, Implement creative solution

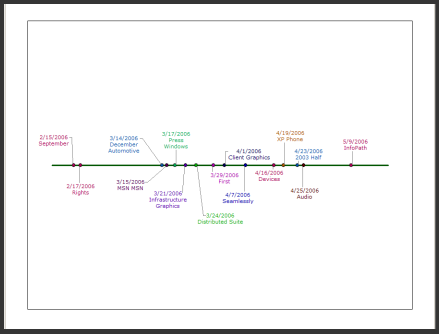
Deliverables
- Implementation of solution
- 8-12 page paper in format of conference paper submission
- 1 or 2 design discussion presentations

Schedule
- Project proposal: 10/28
- Project presentation: 11/11-11/13
- Final paper and presentation: 12/2-12/6

Grading
- Groups of up to 3 people, graded individually
- Clearly report responsibilities of each member

Example: Timeline label layout



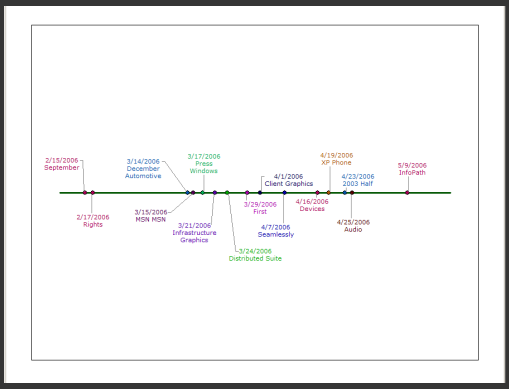


Problem

Input: Set of graphic elements (scene description)

Goal: Select visual attributes for elements

- **Position**
- Orientation
- Size
- Color
- …

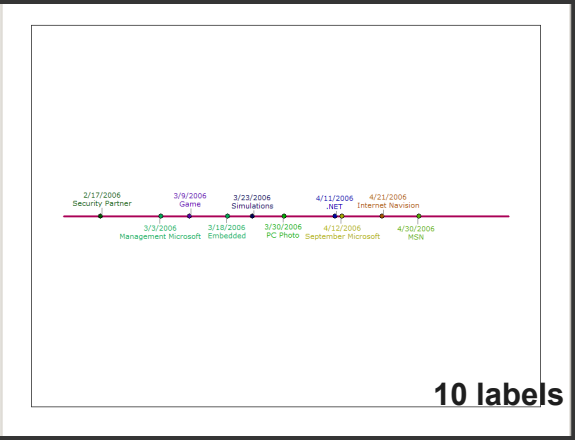


Approaches

Direct rule-based methods
Constraint satisfaction
Optimization
Example-based methods

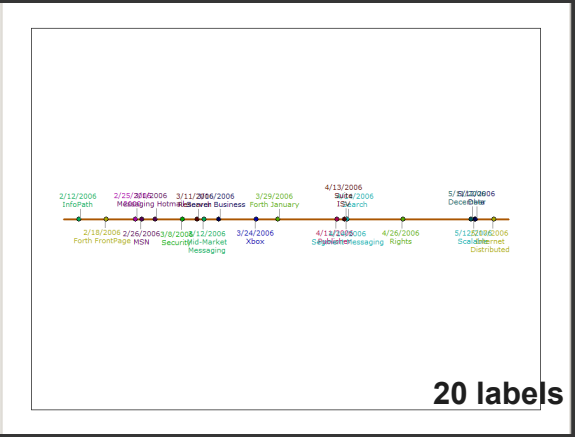
Direct Rule-Based Methods

Rule-based timeline labeling



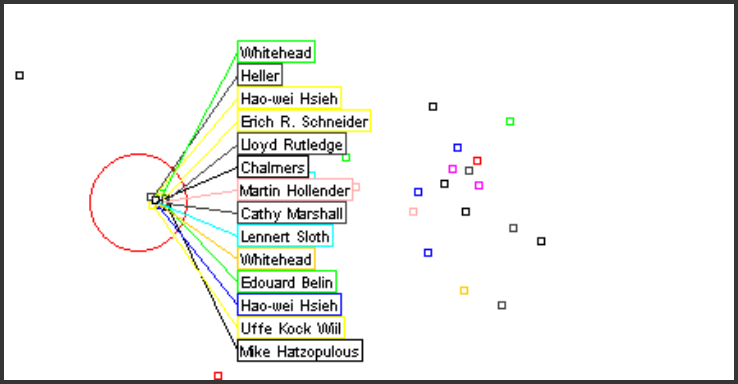
- Alternate above/below line
- Center labels with respect to point on line

Rule-based timeline labeling



- Alternate above/below line
- Center labels with respect to point on line

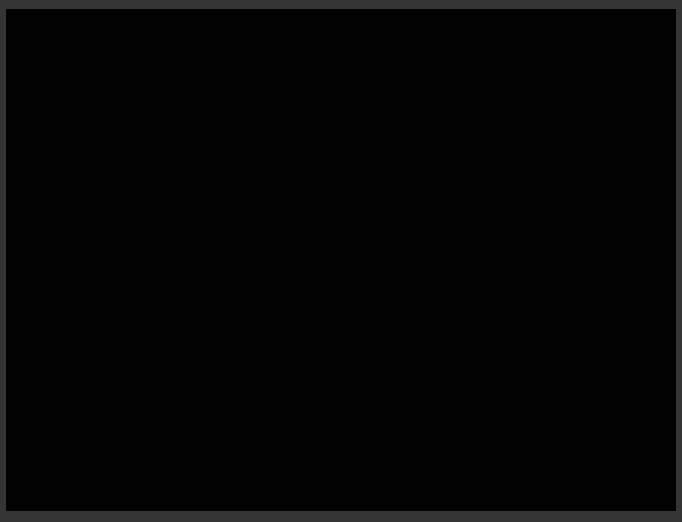
Excentric labeling [Fekete & Plaisant 99]



http://www.cs.umd.edu/hcil/excentric/

Dynamic space management [Bell 00]

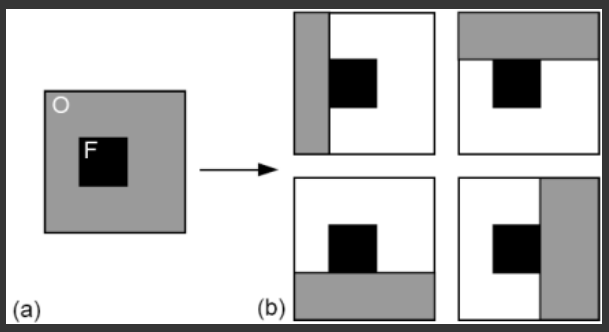
Manage *free space* on desktop to prevent window overlap



Dynamic space management [Bell 00]

Goal: Place new elements to avoid overlap

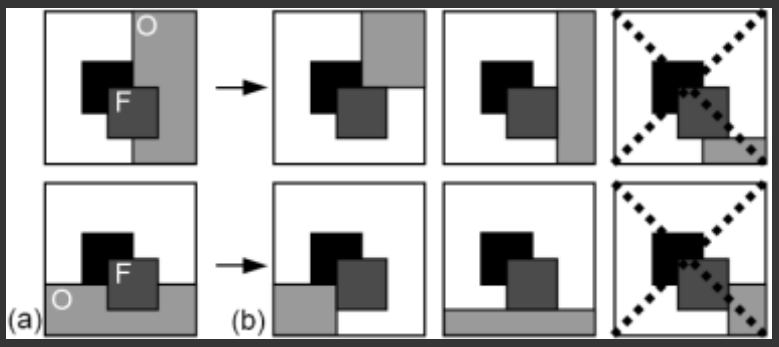
- Elements are axis-aligned rectangles
- Keep track of largest empty space rectangles



Dynamic space management [Bell 00]

Goal: Place new elements to avoid overlap

- Elements are axis-aligned rectangles
- Keep track of largest empty space rectangles



Pros and cons

Pros

- Designed to run extremely quickly
- Simple layout algorithms are easy to code

Cons

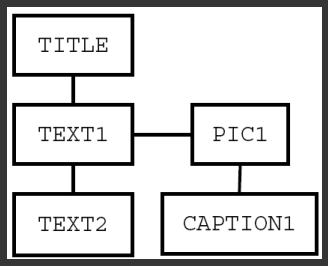
- Complex layouts require large rule bases with lots of special cases

Linear Constraint Satisfaction

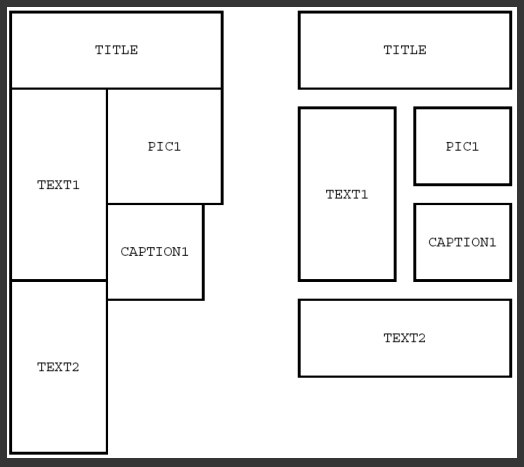
Network of layout constraints

TITLE ABOVE TEXT1
TITLE FULL PAGE WIDTH
TEXT1 LEFT OF PIC1
CAPTION1 BELOW PIC1
TEXT2 BELOW TEXT1

Constraints



Network



Two possible layouts

[from Lok and Feiner 01]

Constraints as linear equations

C1: rect2.top = rect1.top + rect1.height + 10
C2: rect2.height = rect1.height
C3: rect2.bottom = rect2.top + rect2.height

Local propagation
- Set any variable
- Update other variables to maintain constraints

One-way
- Each constraint has 1 output variable
- Update output when any input changes

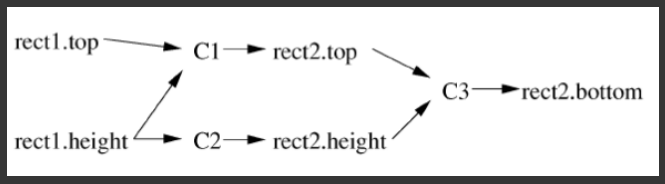
Multi-way
- Each constraint can be written so that any variable is output
- More complicated to maintain

One-way constraints

C1: rect2.top = rect1.top + rect1.height + 10

C2: rect2.height = rect1.height

C3: rect2.bottom = rect2.top + rect2.height



One-way constraints form a directed acyclic graph (DAG). Given the value for any variable we propagate it's value locally through the graph updating the other variable.

Page layout example [Weitzman and Wittenburg 94]

```
(Defrule (Make-Article The-Grammar)
  Article -> Text Text Text Number Image
     0         1    2    3     4     5
  (Author-Of 2 1)
  (Description-Of 4 1)
  (Page-Of 4 1)
  (Image-Of 5 1)
  (article-name 0) = r
  (article-image 0) = 5
  :OUT
  (right-of 1 5)
  (top-aligned 1 5)
  (top-aligned 5 4)
  (spaced-below 2 1)
  (spaced-below 3 2)
)
```