Information Visualization

John Stasko

Spring 2007

Agenda

- Why visualization?
- Definitions
- Examples

Exercise

- House directions

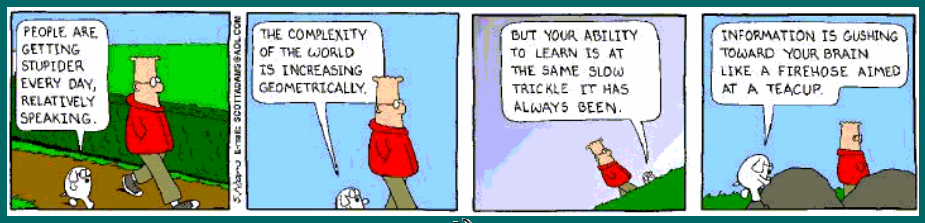
Data Explosion

- Society is more complex
  - There simply is more "stuff"

- Computers, internet and web give people access to an incredible amount of data
  - news, sports, financial, purchases, etc...

Data Overload

- Confound: How to make use of the data
  - How do we make sense of the data?
  - How do we harness this data in decision-making processes?
  - How do we avoid being overwhelmed?



The Problem

Web,
Books,
Papers,
Game scores,
Scientific data,
Biotech,
Shopping
People
Stock/finance
News

Data Transfer

How?

Vision: 100 MB/s
Ears: <100 b/s
Telepathy
Haptic/tactile
Smell
Taste

Two slides courtesy of Chris North

Human Vision

- Highest bandwidth sense
- Fast, parallel
- Pattern recognition
- Pre-attentive
- Extends memory and cognitive capacity
- People think visually

Impressive. Lets use it!

Want More Evidence?

Questions:

Which state has the highest income?
Is there a relationship between income and education?
Are there any outliers?

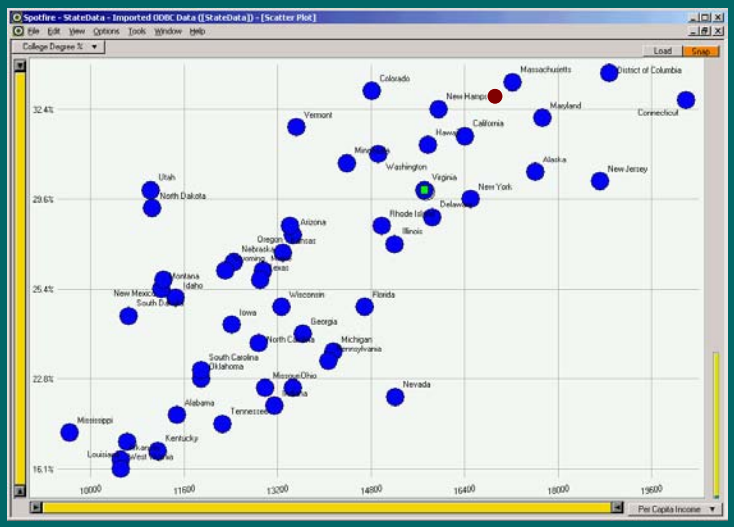
Table - StateData ()

Load Snap

State	College Degree %	Per Capita Income
Alabama	20.6%	11486
Alaska	30.3%	17610
Arizona	27.1%	13461
Arkansas	17.0%	10520
California	31.3%	16409
Colorado	33.9%	14821
Connecticut	33.8%	20189
Delaware	27.9%	15854
District of Columbia	36.4%	18881
Florida	24.9%	14698
Georgia	24.3%	13631
Hawaii	31.2%	15770
Idaho	25.2%	11457
Illinois	26.8%	15201
Indiana	20.9%	13149
Iowa	24.5%	12422
Kansas	26.5%	13300
Kentucky	17.7%	11153
Louisiana	19.4%	10635
Maine	25.7%	12957
Maryland	31.7%	17730
Massachusetts	34.5%	17224
Michigan	24.1%	14154
Minnesota	30.4%	14389
Mississippi	19.9%	9648
Missouri	22.3%	12989
Montana	25.4%	11213
Nebraska	26.0%	12452
Nevada	21.5%	15214
New Hampshire	32.4%	15959
New Jersey	30.1%	18714
New Mexico	25.5%	11246
New York	29.6%	16501
North Carolina	24.2%	12885
North Dakota	28.1%	11051
Ohio	22.3%	13461
Oklahoma	22.8%	11893
Oregon	27.5%	13418
Pennsylvania	23.2%	14068
Rhode Island	27.5%	14981
South Carolina	23.0%	11897
South Dakota	24.6%	10661
Tennessee	20.1%	12255
Texas	25.5%	12904
Utah	30.0%	11029
Vermont	31.5%	13527
Virginia	30.0%	15713
Washington	30.9%	14923
West Virginia	16.1%	10520
Wisconsin	24.9%	13276
Wyoming	25.7%	12311

Example courtesy of Chris North

Visualize the Data



Even Tougher?

- What if you could only see 1 state's data at a time? (e.g. Census Bureau's website)
- What if I read the data to you?

Exercise Redux

- An interesting query…

- People work differently

Our Challenge

- Transform *data* into *information* (understanding, insight) thus making it useful to people

Visualization

- Often thought of as process of making a graphic or an image
- Really is a cognitive process
  - Form a mental image of something
  - Internalize an understanding
- "The purpose of visualization is insight, not pictures"
  - Insight: discovery, decision making, explanation

Main Idea

- Visuals help us think
  - Provide a frame of reference, a temporary storage area
  - "Seeing is believing"
  - "A picture is worth a thousand words"
- External cognition aid
  - Role of external world in thinking and reason
  - An illustrative example

Examples

- Images
  - Are these static pictures information visualizations?

Information Visualization

- What is "information"?
  - Items, entities, things which do not have a direct physical correspondence
  - Notion of abstractness of the entities is important too
  - Examples: baseball statistics, stock trends, connections between criminals, car attributes...

Information Visualization

- What is "visualization"?
  - The use of computer-supported, interactive visual representations of data to amplify cognition.
    - From [Card, Mackinlay Shneiderman '98]

Two Key Attributes

- Scale
  - Challenge often arises when data sets become very large
- Interactivity
  - Want to show multiple different perspectives on the data

Domains for Info Vis

- Text
- Statistics
- Financial/business data
- Internet information
- Software
- ...

Components of Study

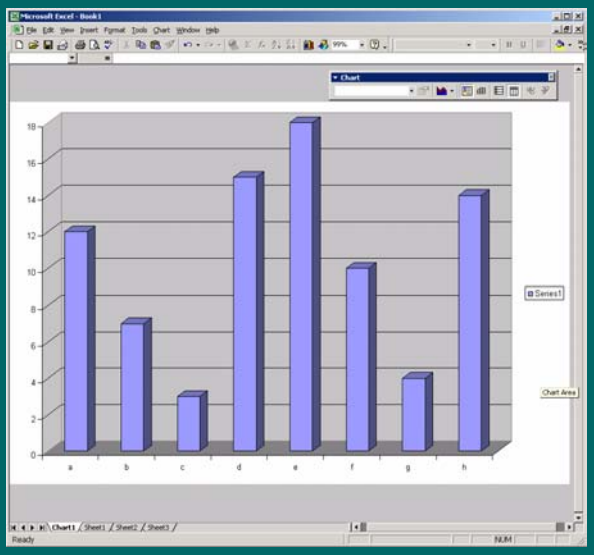
- Data analysis
  - Data items with attributes or variables
  - Generate data tables
- Visual structures
  - Spatial substrate, marks, graphical properties of marks
- UI and interaction
- Analytic tasks to be performed
  - Browse, correlate, identify, associate…

More Examples

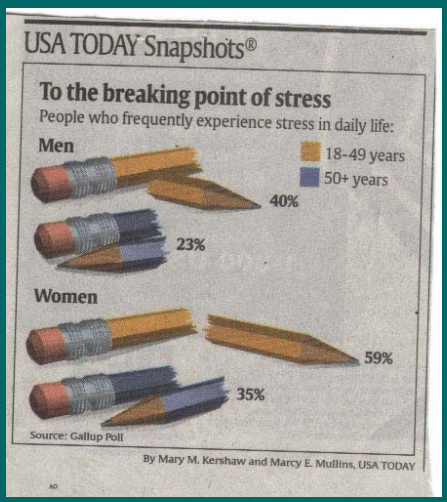
- Seeing is believing…

Excel

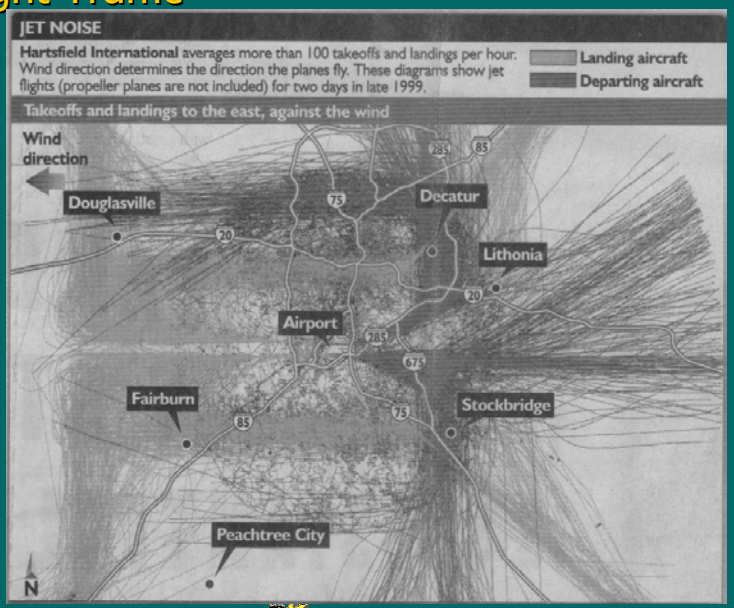
Get rid of those darn 3D bars!



USA Today Graphics



Atlanta Flight Traffic



Atlanta Journal
April 30, 2000

In Living Color

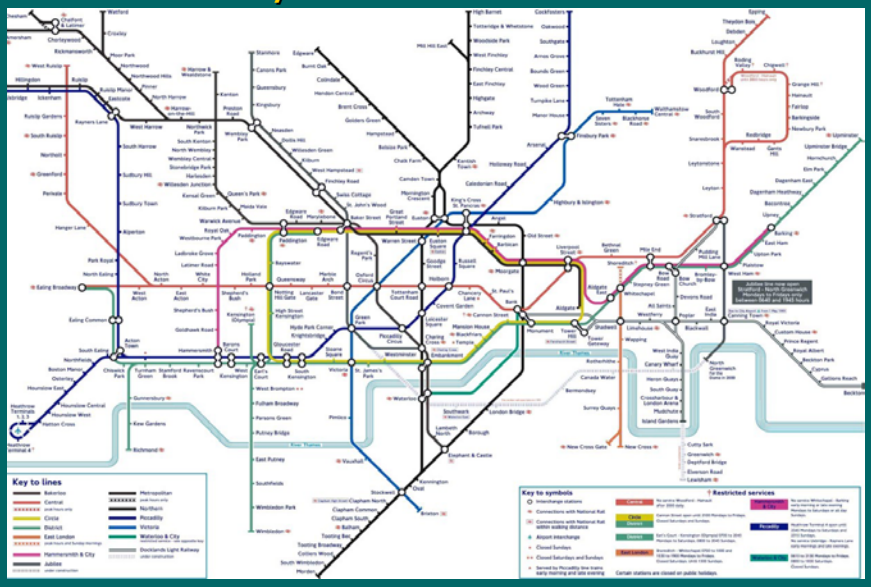
Maxim Magazine, July '01

Country Music

Figure 14. States Mentioned in Country-Music Lyrics
Source: Ben Marsh, "A Rose-Colored Map," *Harper's*, July 1977, 80. Used by permission.
Note: The size of each state is proportional to the number of times it is mentioned.

London Subway

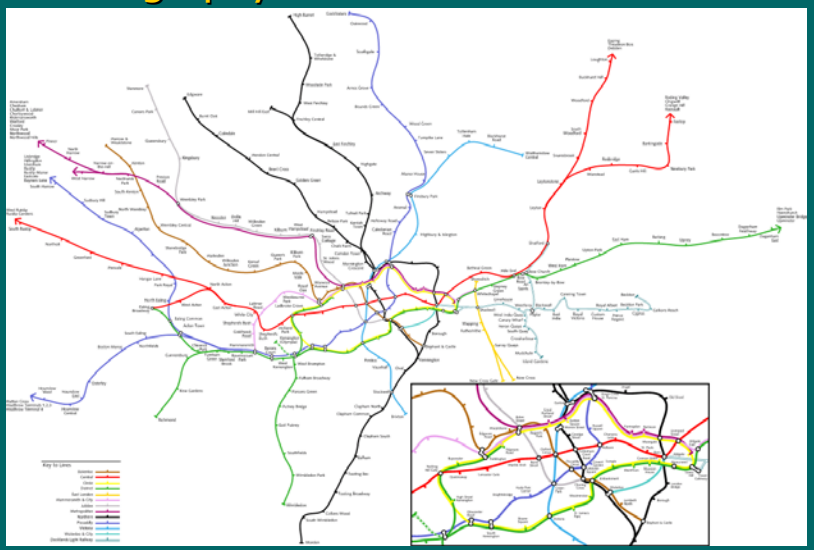
www.thetube.com



Harry Beck

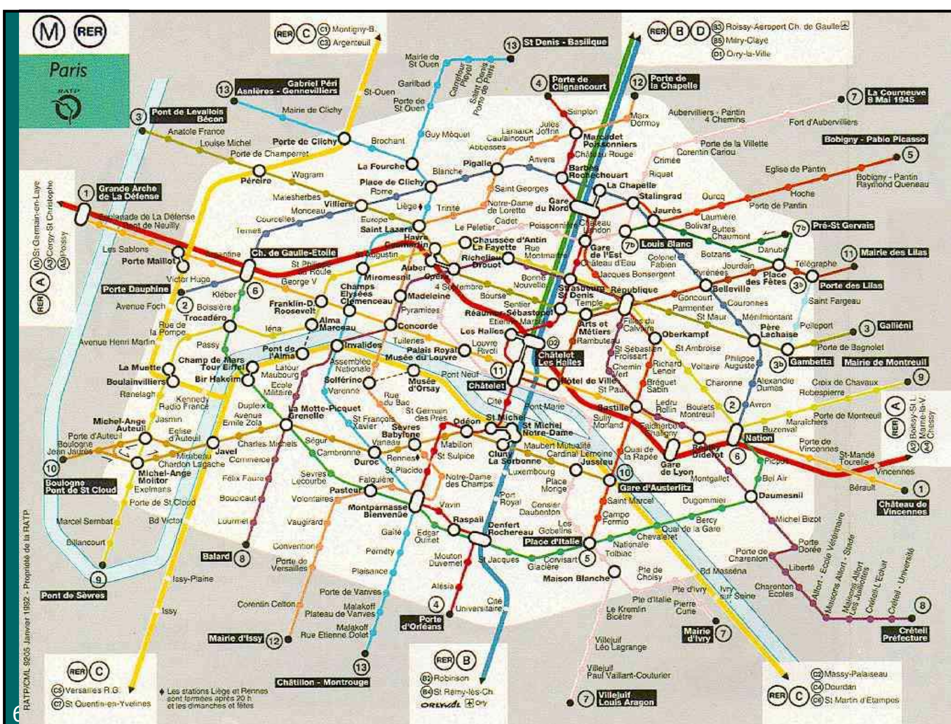
True Geography

www.kottke.org/plus/misc/images/tubegeo.gif



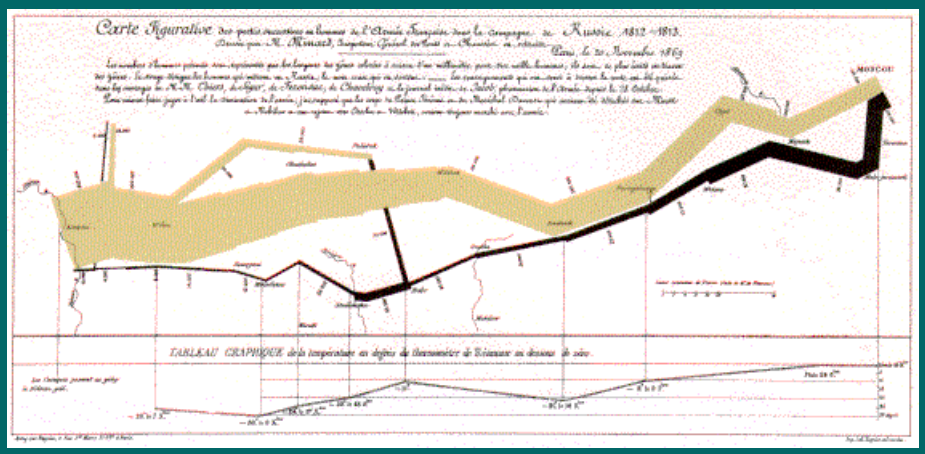
rodcorp.typepad.com/photos/art_2003/tube_walklines_final_lmfaint.html

Easy Walking Lines Added



Napolean's March

From E. Tufte
The Visual Display of Quantitative Information



Minard graphic

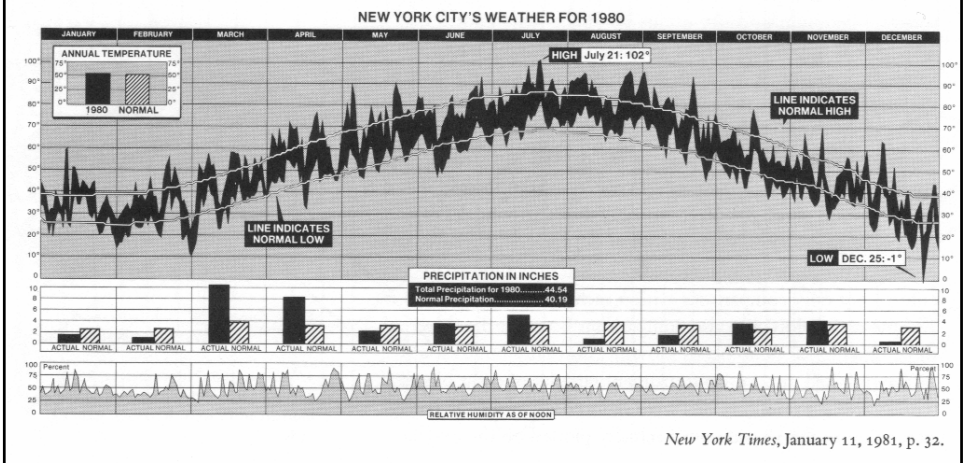
size of army
direction

latitude
longitude

temperature
date

NYC Weather

2220 numbers



New York Times, January 11, 1981, p. 32.

Tufte, Vol. 1

Data Table Format

	$Case_1$	$Case_2$	$Case_3$	...
$Variable_1$	$Value_{11}$	$Value_{21}$	$Value_{31}$	
$Variable_2$	$Value_{12}$	$Value_{22}$	$Value_{32}$	
$Variable_3$	$Value_{13}$	$Value_{23}$	$Value_{33}$	
...				

Dimensions

Think of as a function
$f(case_1) = <Val_{11}, Val_{12},...>$

Time series data a special case

Data Structure

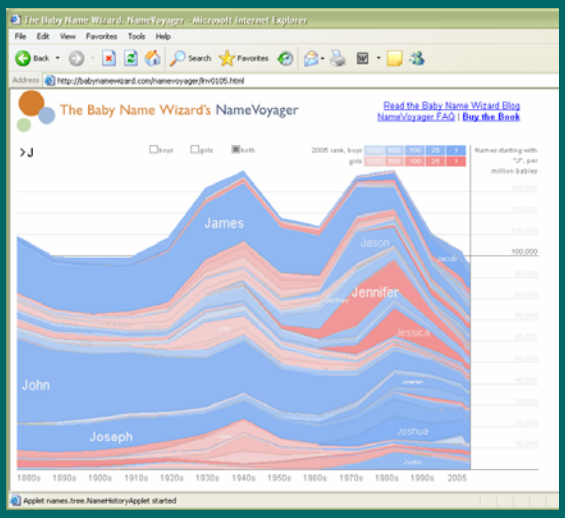
- Sometimes the data has additional structure
  - Network/graph data
  - Hierarchical data
  - Important meta-data

True InfoVis Examples

- Systems – Key part of information visualization is the interactive capability (view different perspectives on data)

Baby Names

Viewing historical trends in baby names



`http://babynamewizard.com/namevoyager/`

Spotfire

`www.spotfire.com`

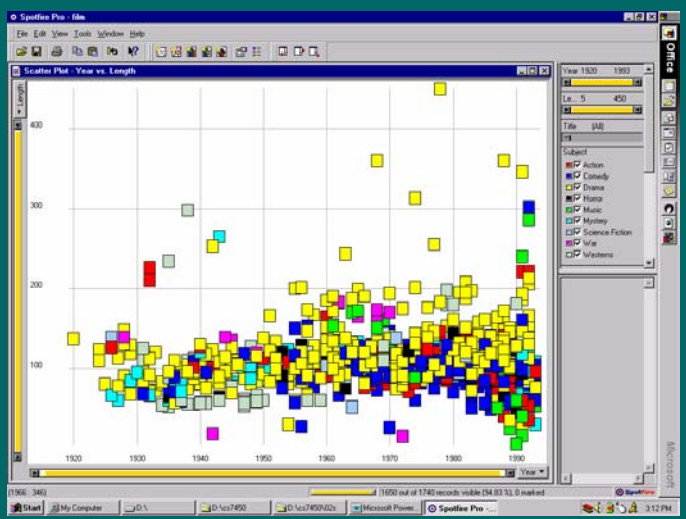
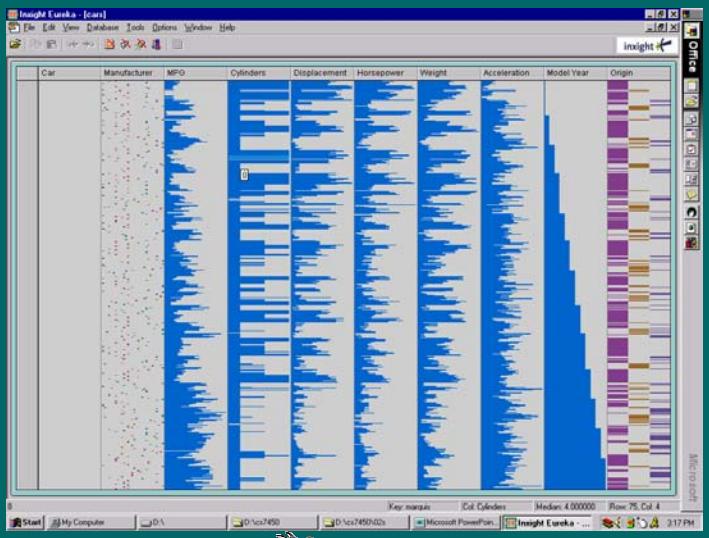


Table Lens

www.inxight.com



Tasks in Info Vis

- Search (not so much)
  - Finding a specific piece of information
    - How many games did the Braves win in 1995?
    - What novels did Ian Fleming author?
- Browsing (much more)
  - Look over or inspect something in a more casual manner, seek interesting information
    - How did the Falcons season go last year?
    - What's a good car to buy?

Tasks in Info Vis

- Analysis & exploration
  - Comparison-Difference
  - Outliers, Extremes
  - Patterns
- Assimilation
- Monitoring
- Awareness
- Presentation

Case Study

- Understanding hierarchies
- Learn about some InfoVis techniques

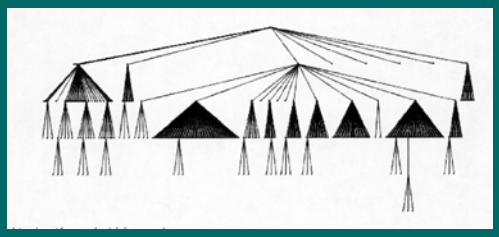
Hierarchies

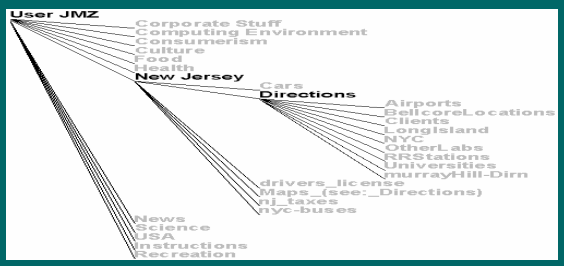
- Definition
  - Data repository in which cases are related to subcases
  - Can be thought of as imposing an ordering in which cases are parents or ancestors of other cases

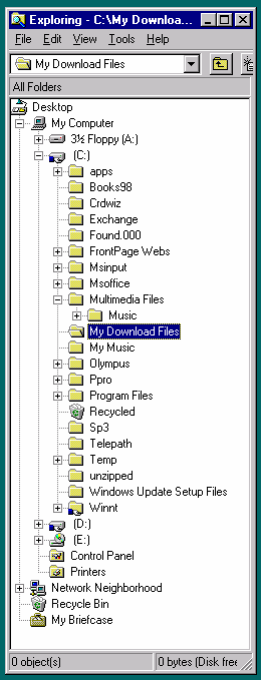
Hierarchies in the World

- Pervasive
  - Family histories, ancestries
  - File/directory systems on computers
  - Organization charts
  - Animal kingdom: Phylum,…, genus,…
  - Object-oriented software classes
  - ...
- Hierarchies often represented as trees

Representations



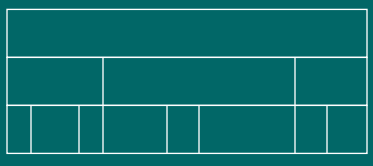




Space-Filling Representation

Each item occupies an area

Children are "contained" under parent

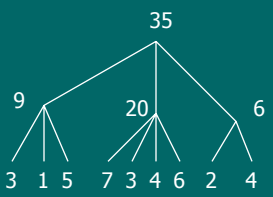


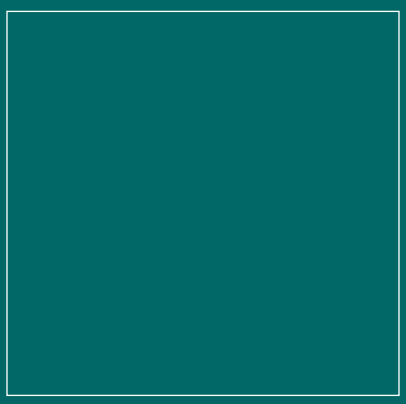
One example

Treemap

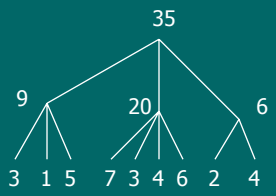
- Space-filling representation developed by Shneiderman and Johnson, Vis '91
- Children are drawn inside their parent
- Alternate horizontal and vertical slicing at each successive level
- Use area to encode other variable of data items

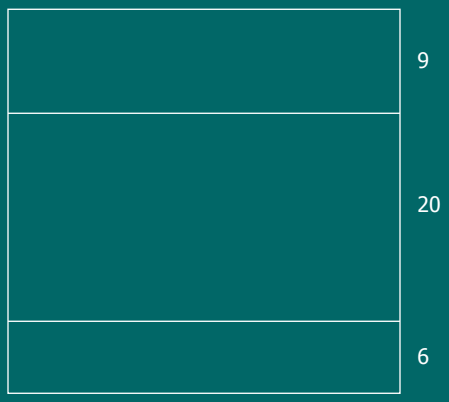
Example



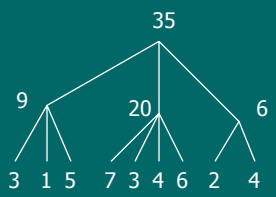


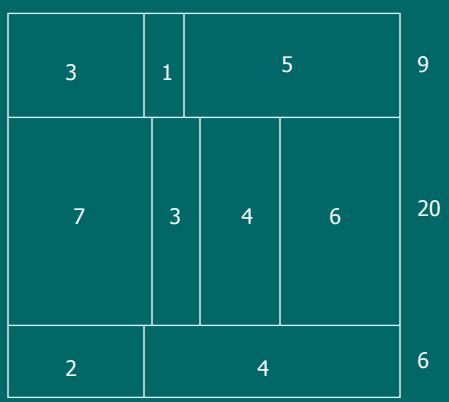
Example





Example

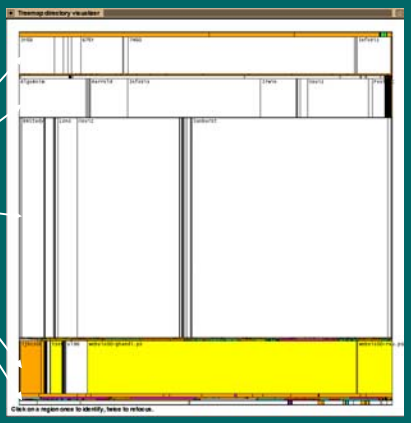




Treemap

- Example

Directories

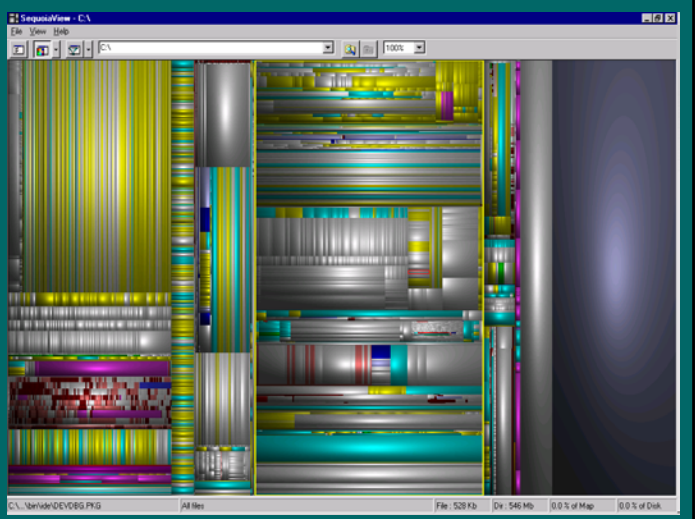


SequoiaView

www.win.tue.nl/sequoiaview/

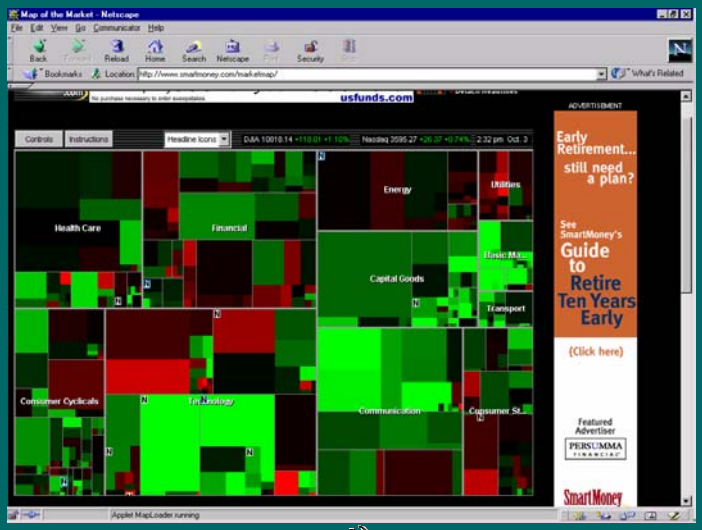
File visualizer built using cushion treemap notion

Demo



Map of the Market

www.smartmoney.com/marketmap



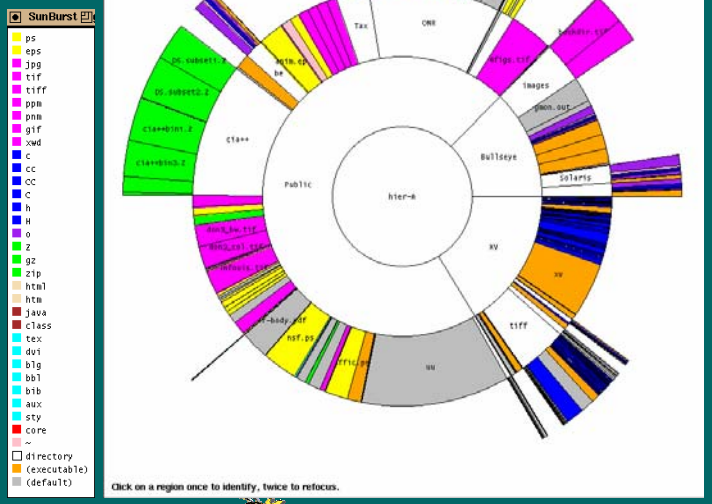
Demo

Sunburst

Visualizing file and directory structures

Root dir at center
Color - file type
Angle - file/dir size

Demo



InfoVis Techniques

- Aggregation
  - Accumulate individual elements into a larger unit to be presented as some whole
- Overview & Detail
  - Provide both global overview and detail zooming capabilities
- Focus + Context
  - Show details of one or more regions in a more global context (eg, fisheye)

InfoVis Techniques

- Drill-down
  - Select individual item or smaller set of items from a display for a more detailed view/analysis
- Brushing
  - Select or designate/specify value, then see pertinent items elsewhere on the display

To Learn More

CS 7450
Spring term

Course foci

–Examine research ideas

–Work with commercial systems

–Assignments and term project

HW 4

- Find an InfoVis-style graphic
- Critique the graphic (+/-) 1-page
- Due next Thursday

Upcoming

- WWW design and evaluation
- Embodied agents