# why does this suck?

some of the reasons it sucks

- y-axis unlabeled
- y-axis at poor scale
- needless use of 3D bar chart
- color used instead of x-axis labels
- x-axis label should be the title, and be more informative
  - for example, what metric? what year?
- giant face on left side
  - distracting by engaging human face perception
  - distracting by creating figure/ground separation illusion
- chart junk
  - useless image of librarian, tacky word art
- missing context
  - nothing to compare to! are these numbers good or bad? how do they compare to previous quarters/years or to the competition?

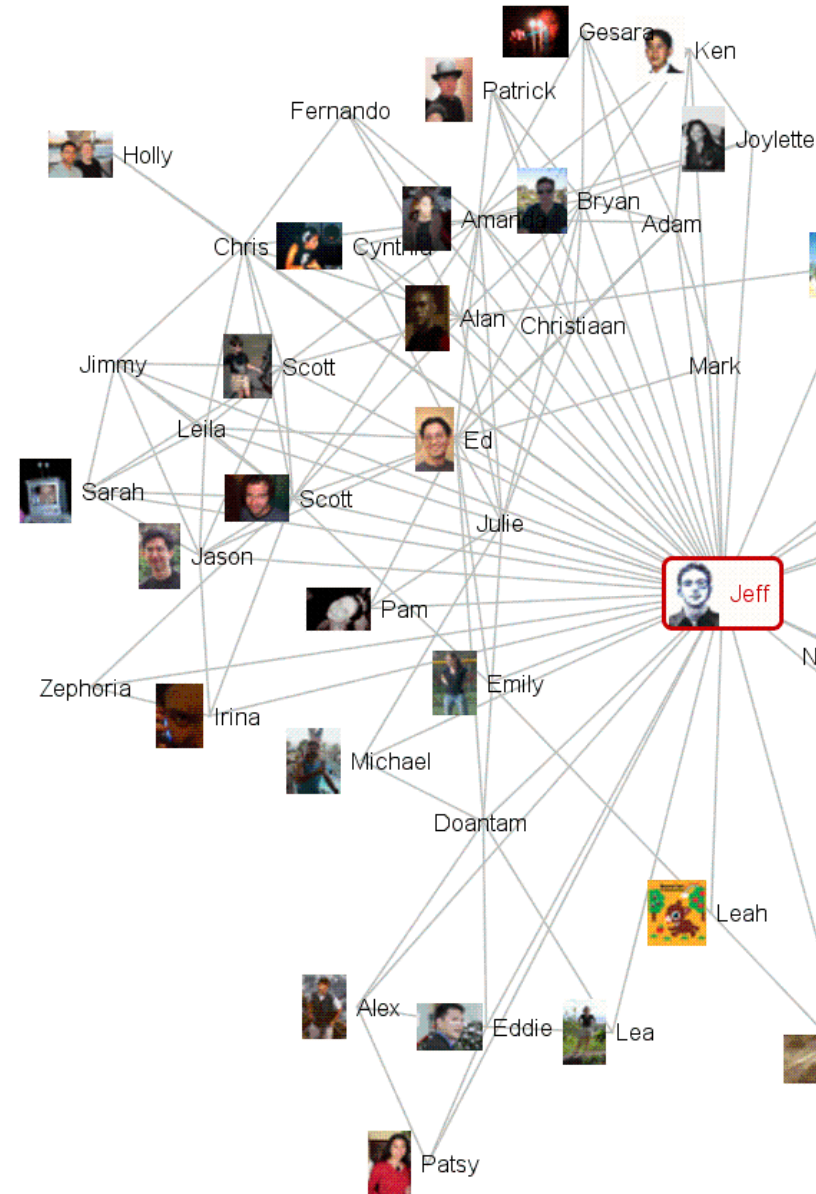# Information Visualization
Ryan Aipperspach (slides from Jeffrey Heer)
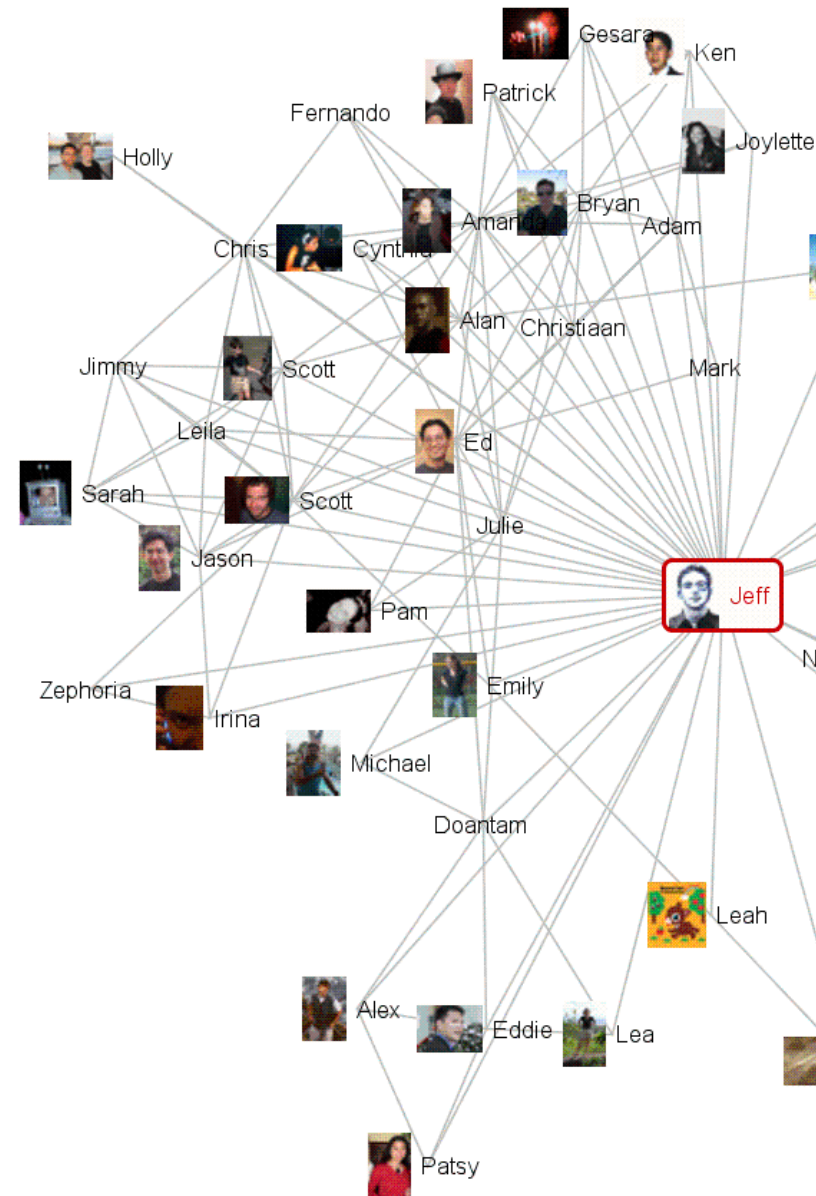
April 19, 2006
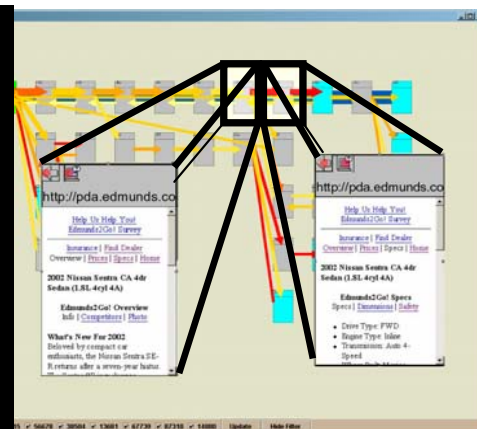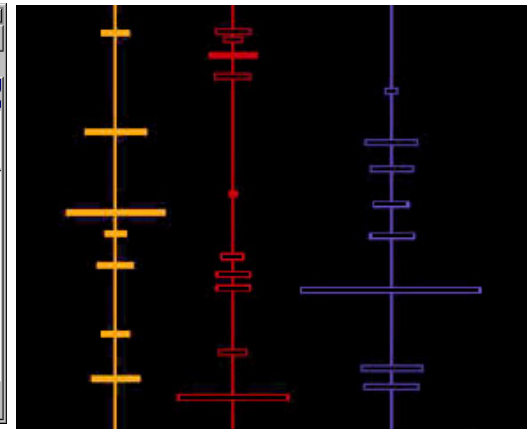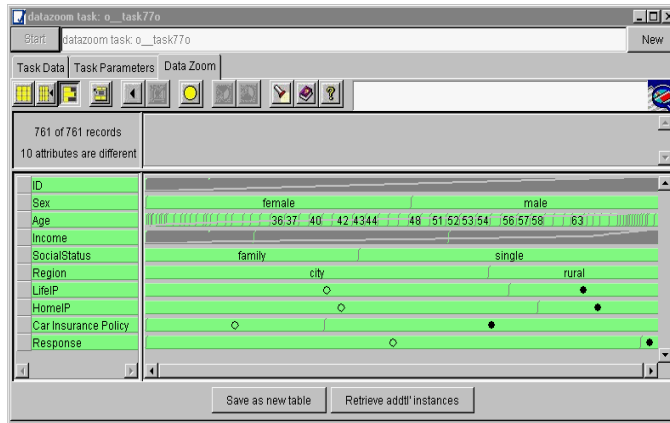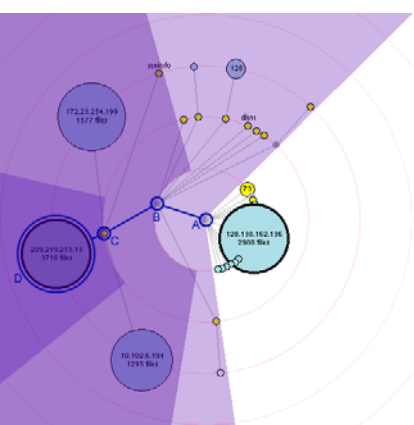
overview

- why infovis?
- review some basics
- examples deconstructed
- modeling visualizations

overview

- **why infovis?**
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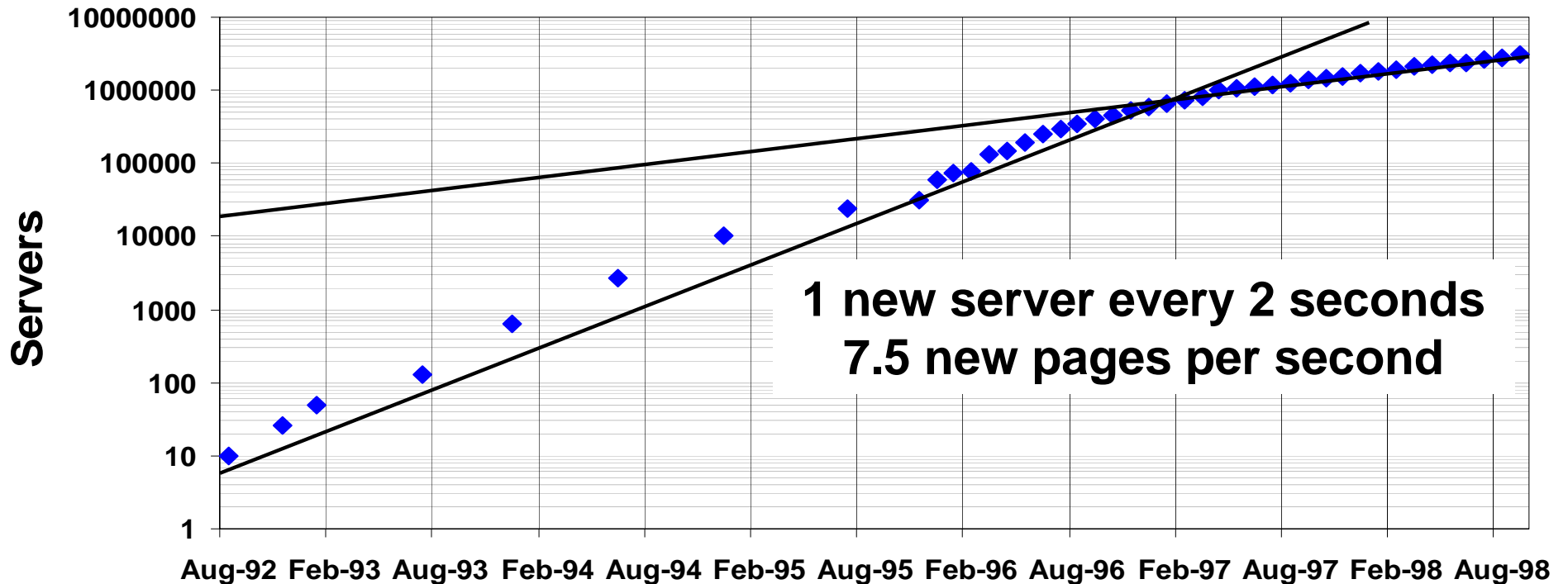
basic problem

We live in a
new ecology.

web ecologies

Servers vs. date (Aug-92 to Aug-98), log scale
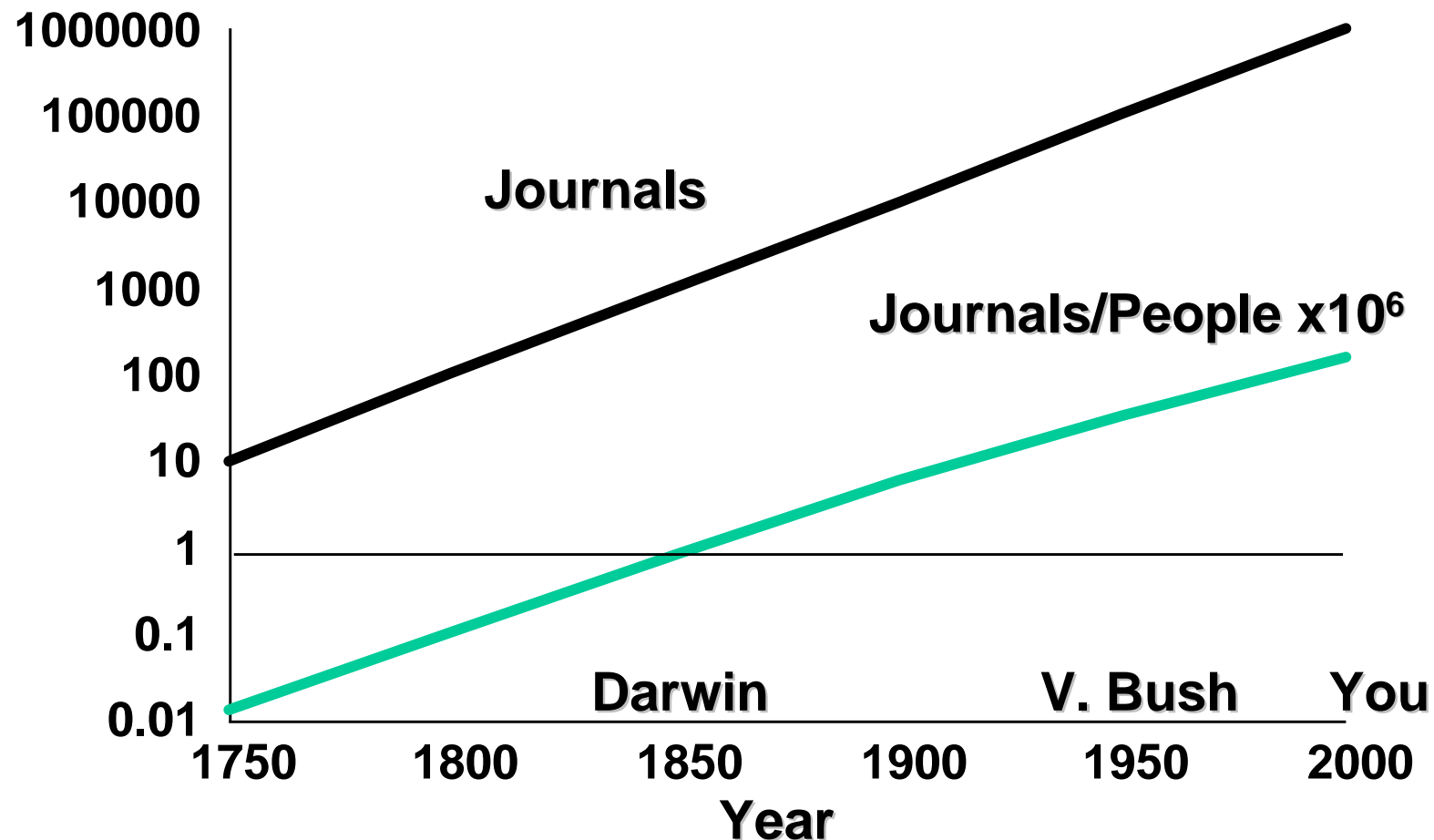
1 new server every 2 seconds
7.5 new pages per second

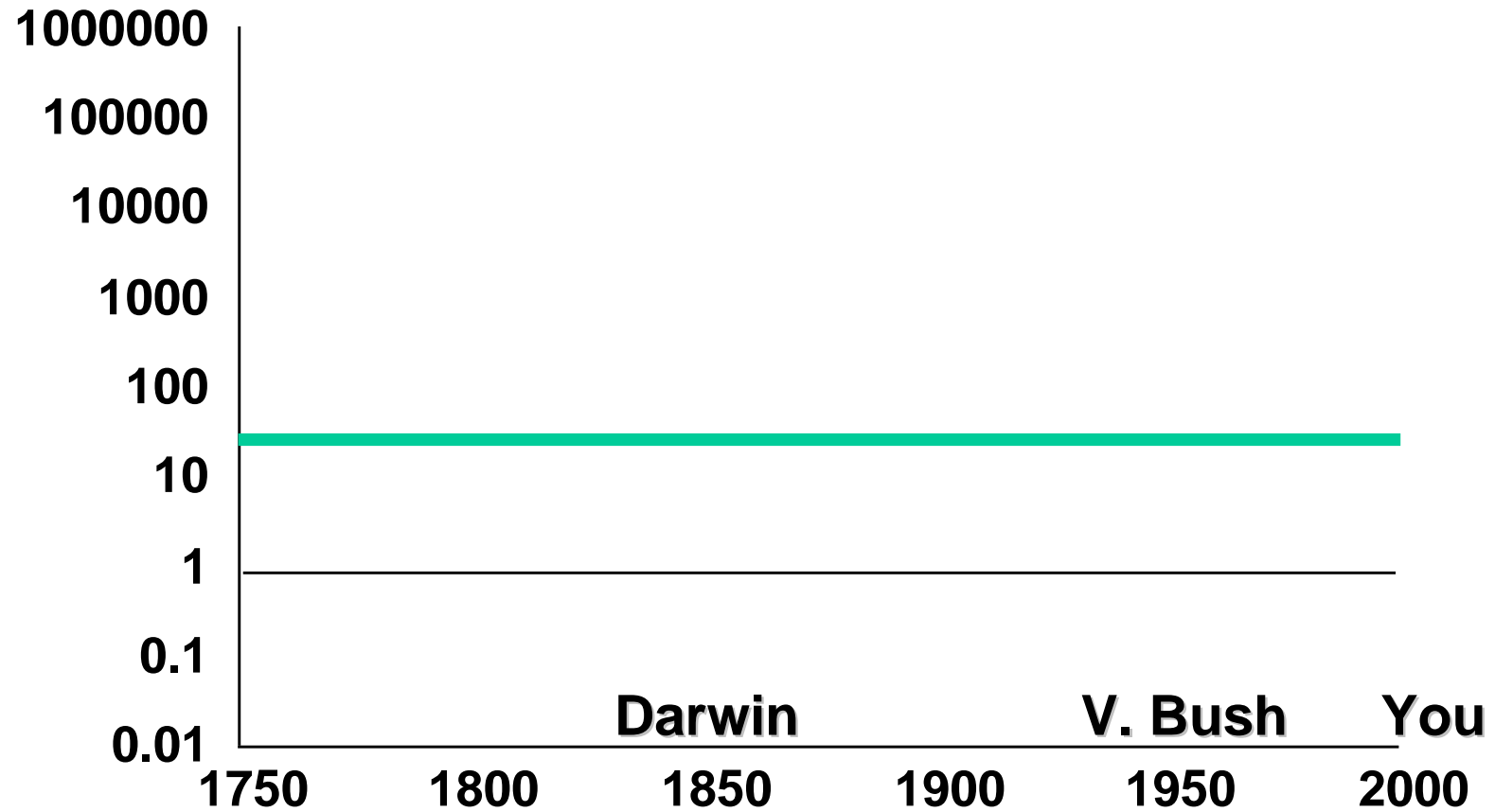**Source: World Wide Web Consortium, Mark Gray, Netcraft Server Survey**

scientific journals

## Journals/person increases 10X every 50 years

innate human capacity

attentional processes

"What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it."
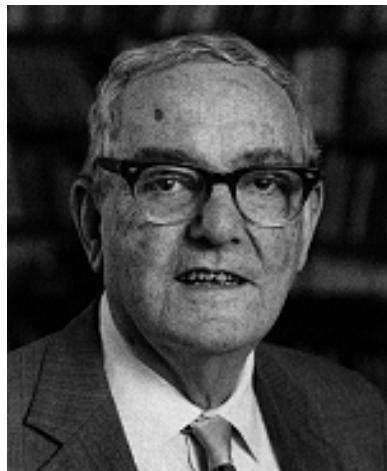
~Herb Simon
as quoted by Hal Varian
Scientific American
September 1995

human-information interaction

- The real design problem is not increased access to information, but greater efficiency in finding *useful* information.

- Increasing the rate at which people can find and use relevant information improves human intelligence.

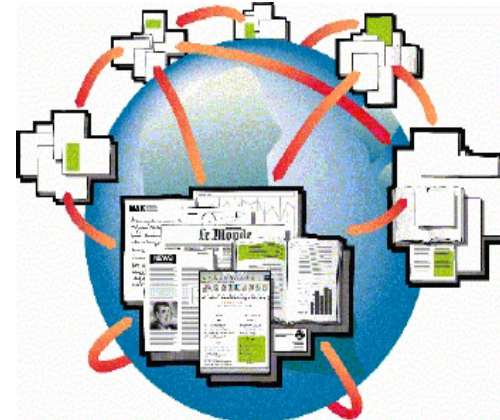
Amount of Accessible Knowledge

Cost [Time]
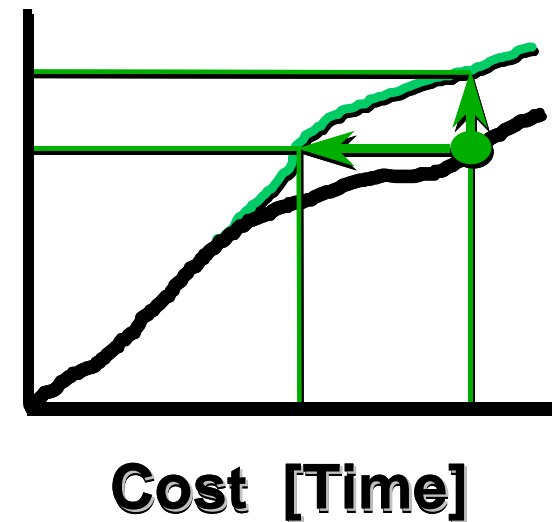
information visualization

- Leverage highly-developed human visual system to achieve rapid uptake of abstract information.
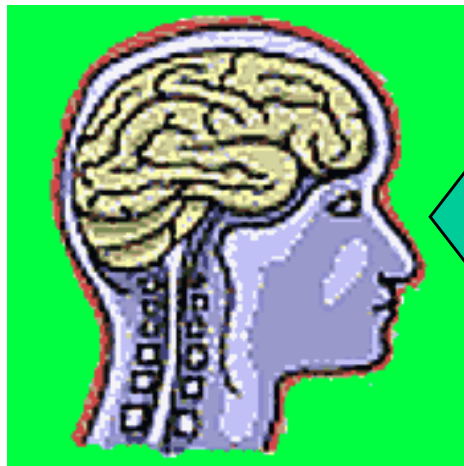
1.2 b/s (Reading)
2.3 b/s (Pictures)

augmented cognition

- Using external artifacts to amplify human mental abilities.
  - Classic examples: pen and paper, slide rules
  - A primary goal of Information visualization
- In the case of InfoVis, how?
  - Increased resources
  - Reduced search
  - Enhanced pattern recognition
  - Perceptual inference
  - Perceptual monitoring
  - Manipulable medium

Visualization Success Story

Mystery: what is causing a cholera epidemic in London in 1854?

Visualization Success Story

Illustration of John Snow's deduction that a cholera epidemic was caused by a bad water pump, circa 1854.

Horizontal lines indicate location of deaths.

From Visual Explanations by Edward Tufte, Graphics Press, 1997
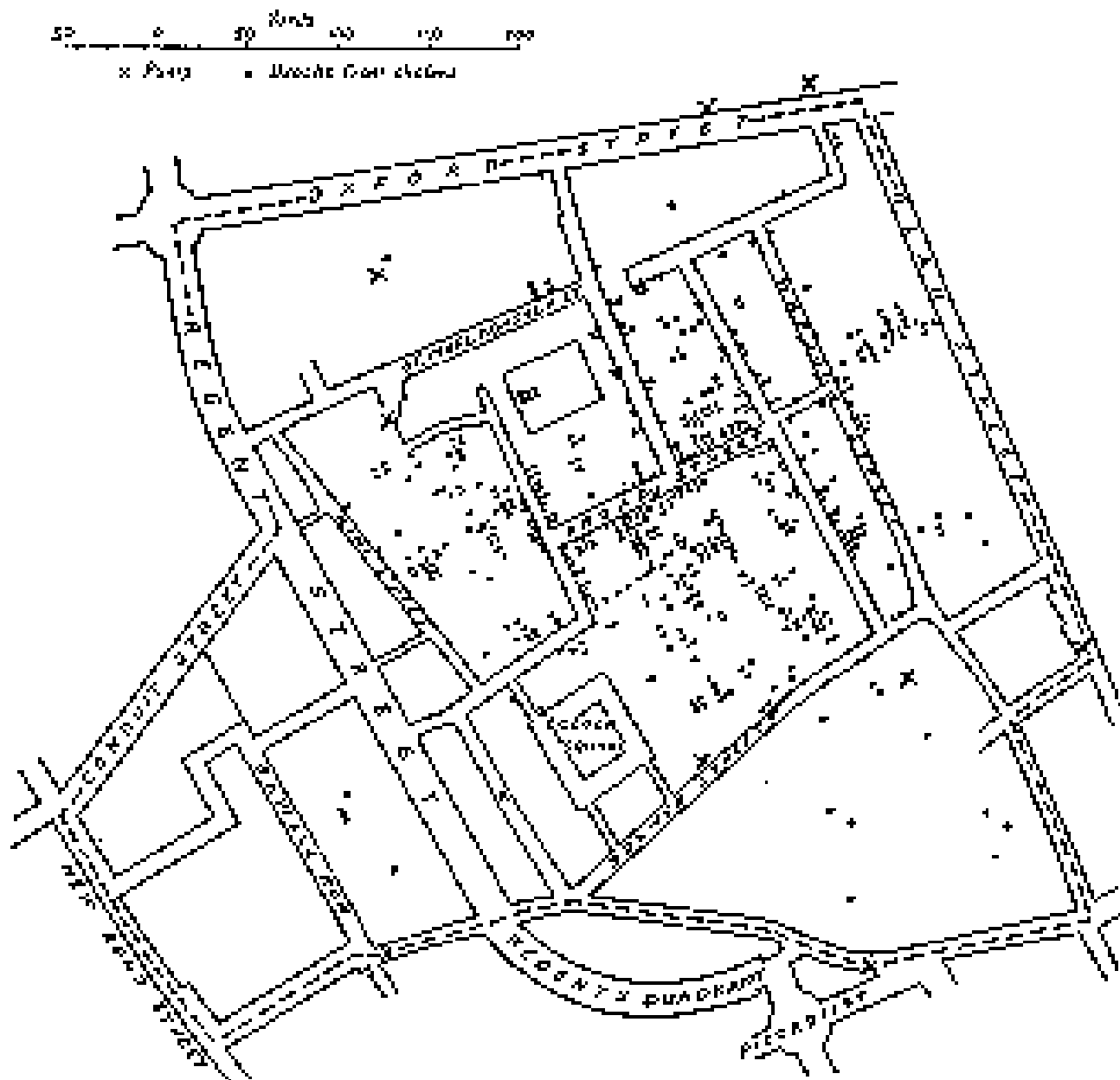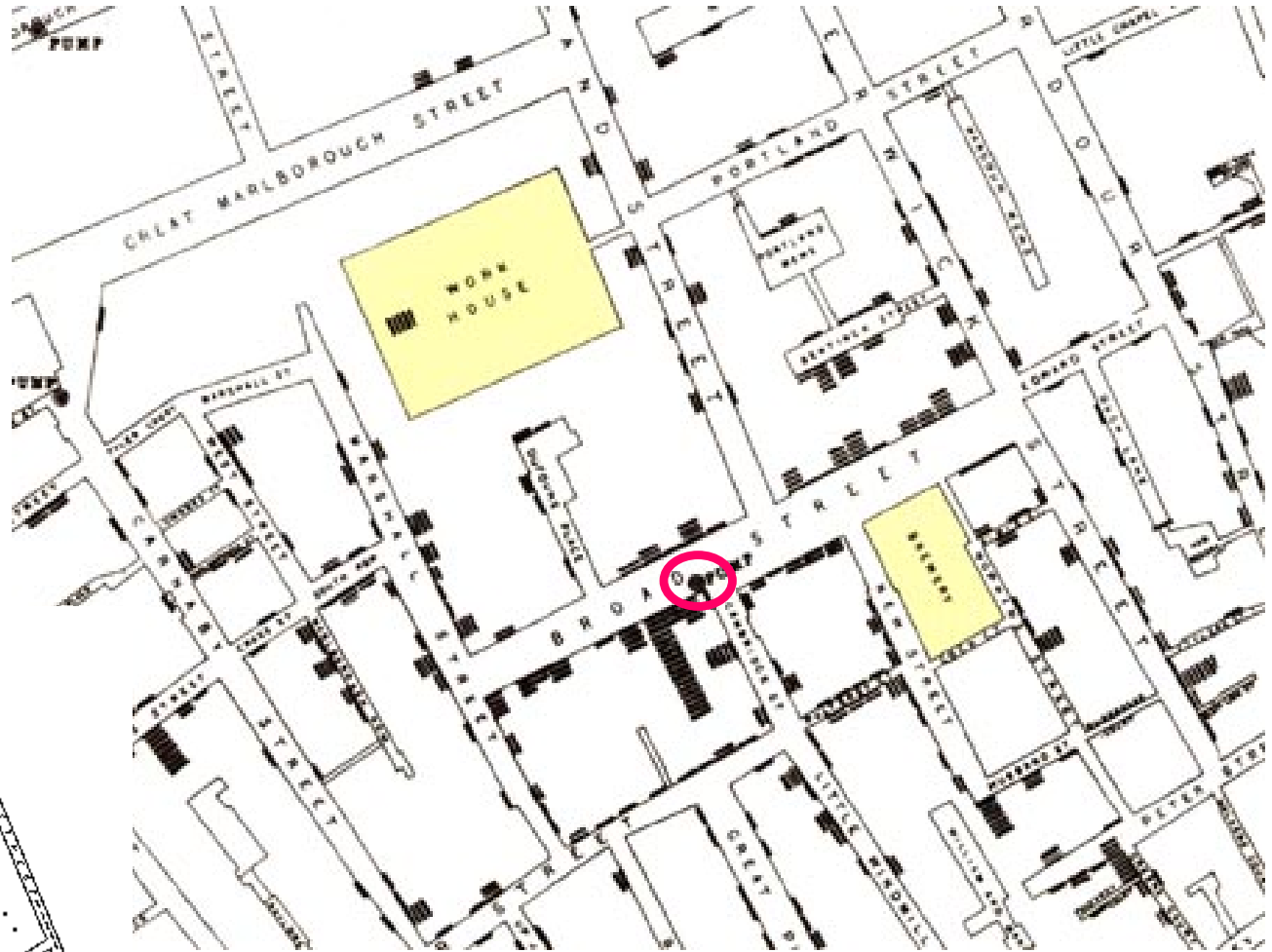
Visualization Success Story

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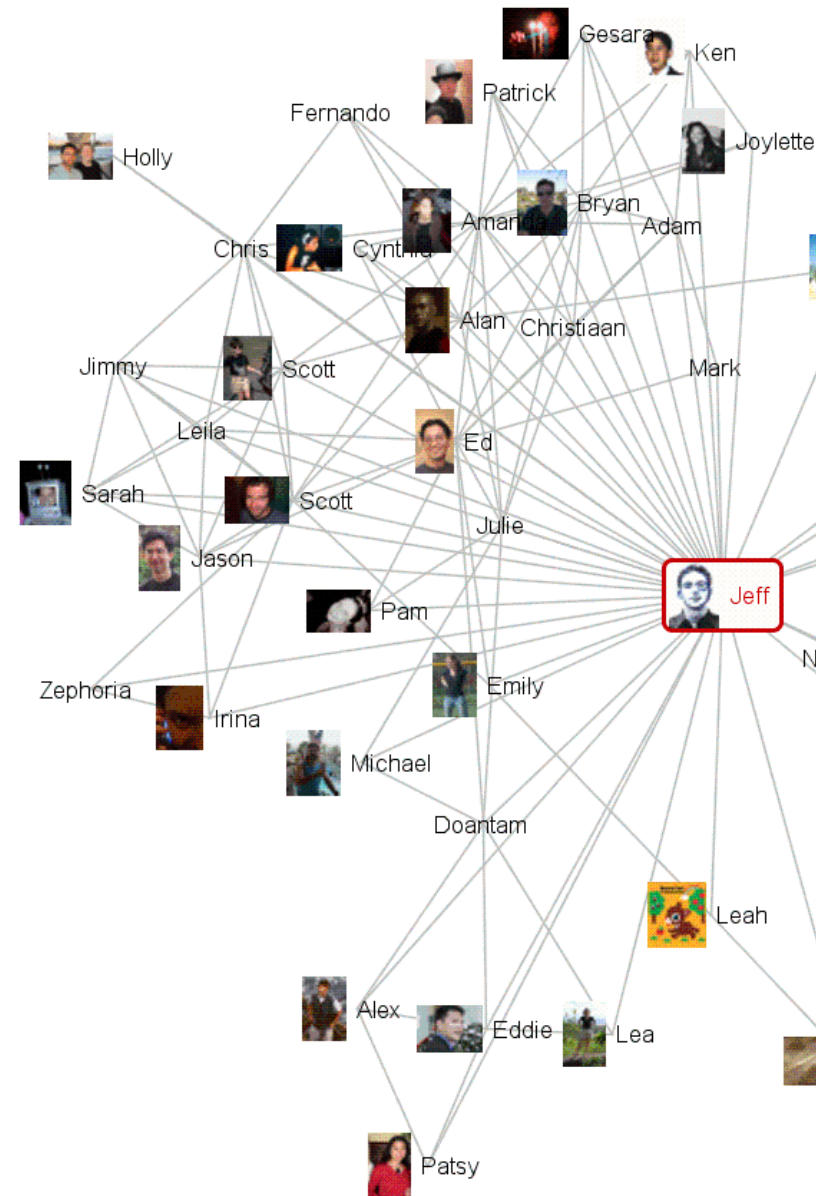
Horizontal lines indicate location of deaths.

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# basic types of data elements

- Nominal
  - (no inherent order)
  - city names, categories, …
- Ordinal
  - (ordered, but not at measurable intervals)
  - first, second, third, …
  - cold, warm, hot
  - Mon, Tue, Wed, Thu …
- Quantitative
  - (ordered, with measurable distances)
  - real numbers
- Relations
  - (relations between elements)
  - Networks
  - Hierarchical relationships (parent/child)
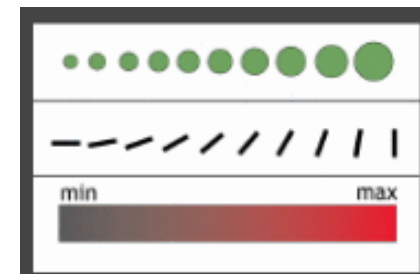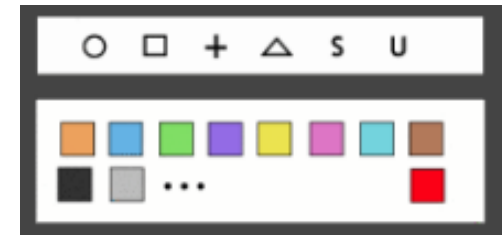
basic types of visual encodings

- "Retinal" properties
  - spatial position (e.g., x-y axes)
  - size
  - shape
  - color
  - orientation
  - texture
- "Gestalt" properties
  - connectivity
  - grouping (e.g., enclosure)
- Animation
  - view transitions
  - animated elements
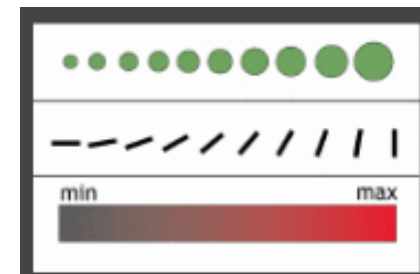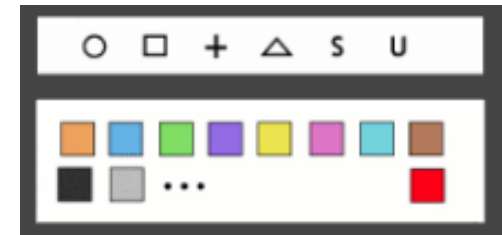
sensemaking tasks [Card et al]

- ## Information foraging
  - Collect information of interest

- ## Search for schema
  - Identify relevant dimensions of data

- ## Instantiate schema (with data!)
  - Schema == knowledge representation
  - Organize / codify information

- ## Analysis (problem solving)
  - Analyze and filter data, answer questions
  - Refine schema as needed

- ## Record / communicate
  - Make a decision, take action, or communicate results

interactive tasks [Shneiderman]

- **Overview**
  - Get an overview of the collection
- **Zoom**
  - Zoom in on items of interest
- **Filter**
  - Remove uninteresting items
- **Details on demand**
  - Select items and get details
- **Relate**
  - View relationships between items
- **History**
  - Keep a history of actions for undo, replay, refinement
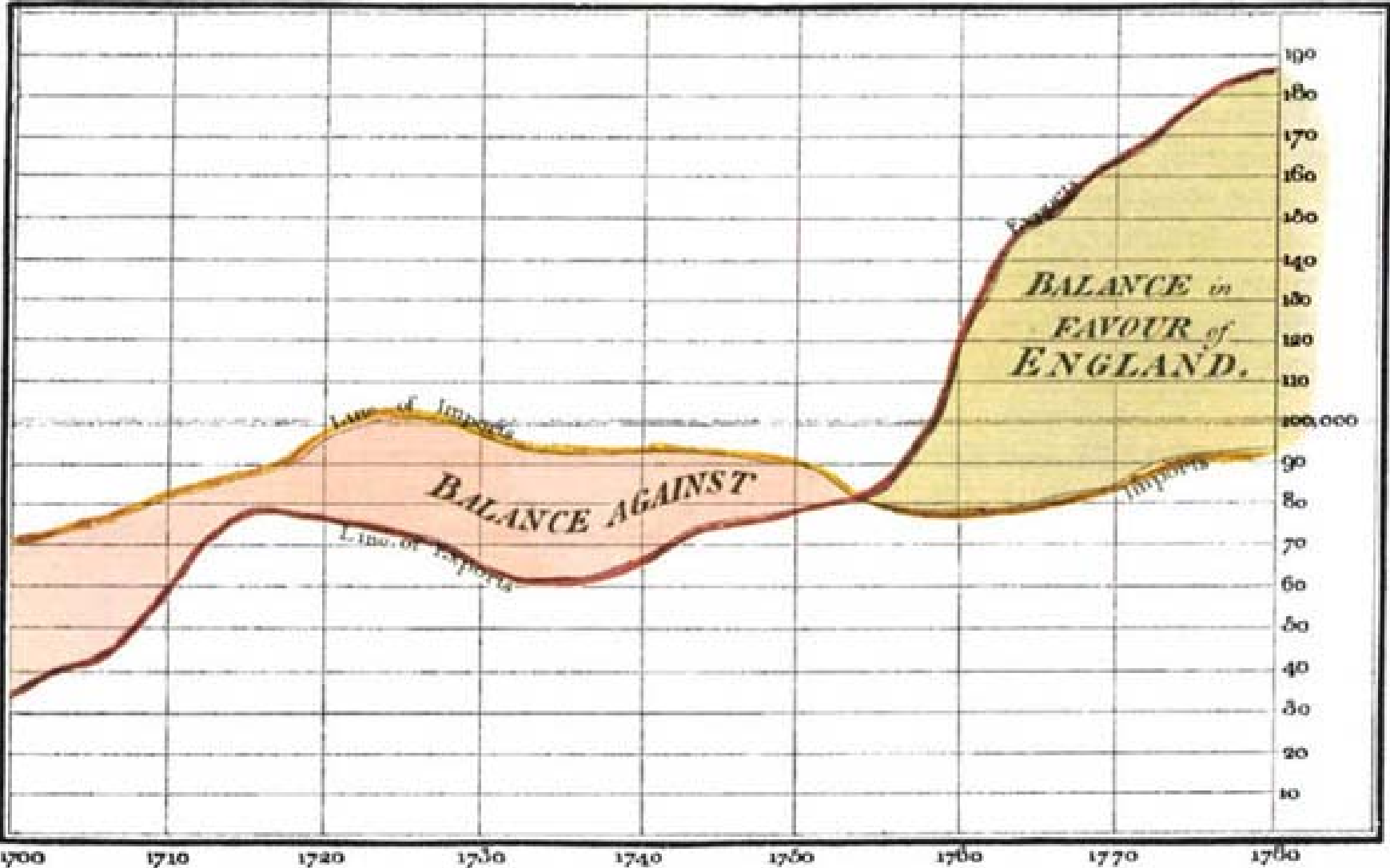- **Extract**
  - Make subcollections

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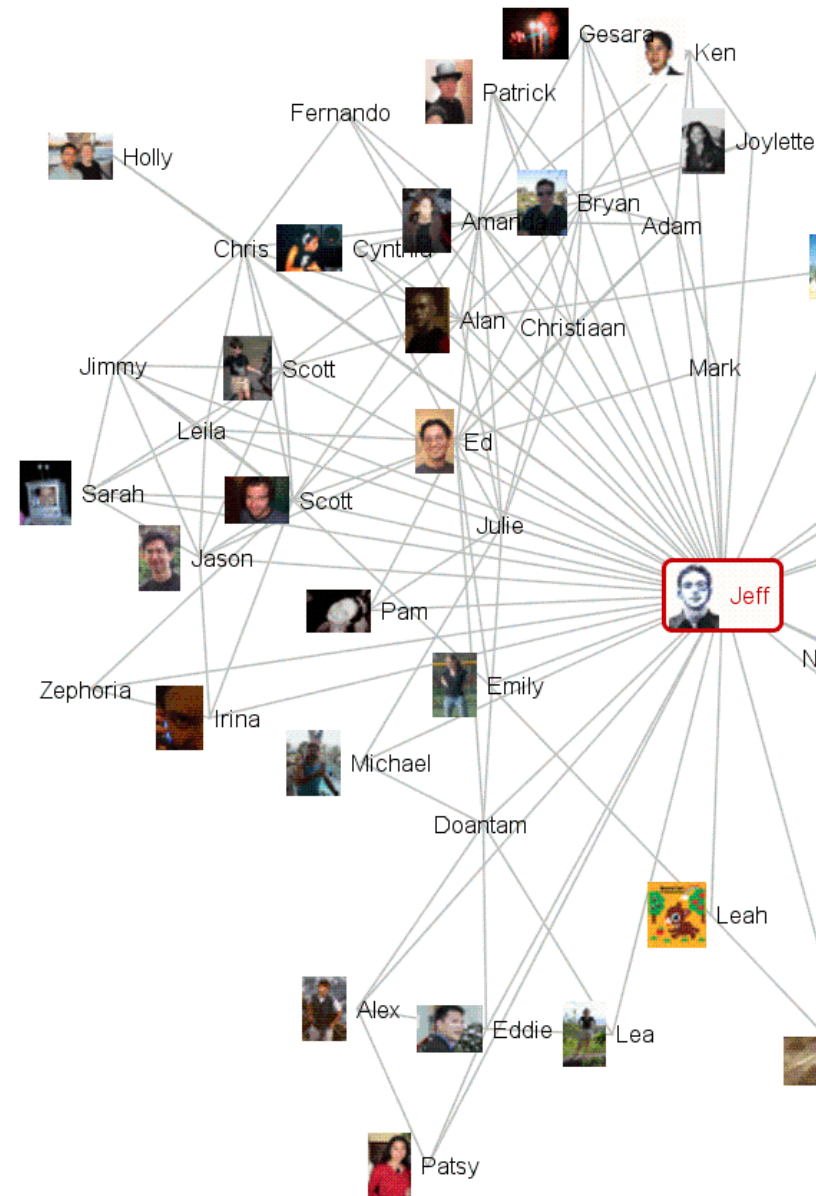
data graphics (Playfair, ca.1780)

Exports and Imports to and from DENMARK & NORWAY from 1700 to 1700.

BALANCE in FAVOUR of ENGLAND.

BALANCE AGAINST

The Bottom line is divided into Years, the Right hand line into L.10,000 each.
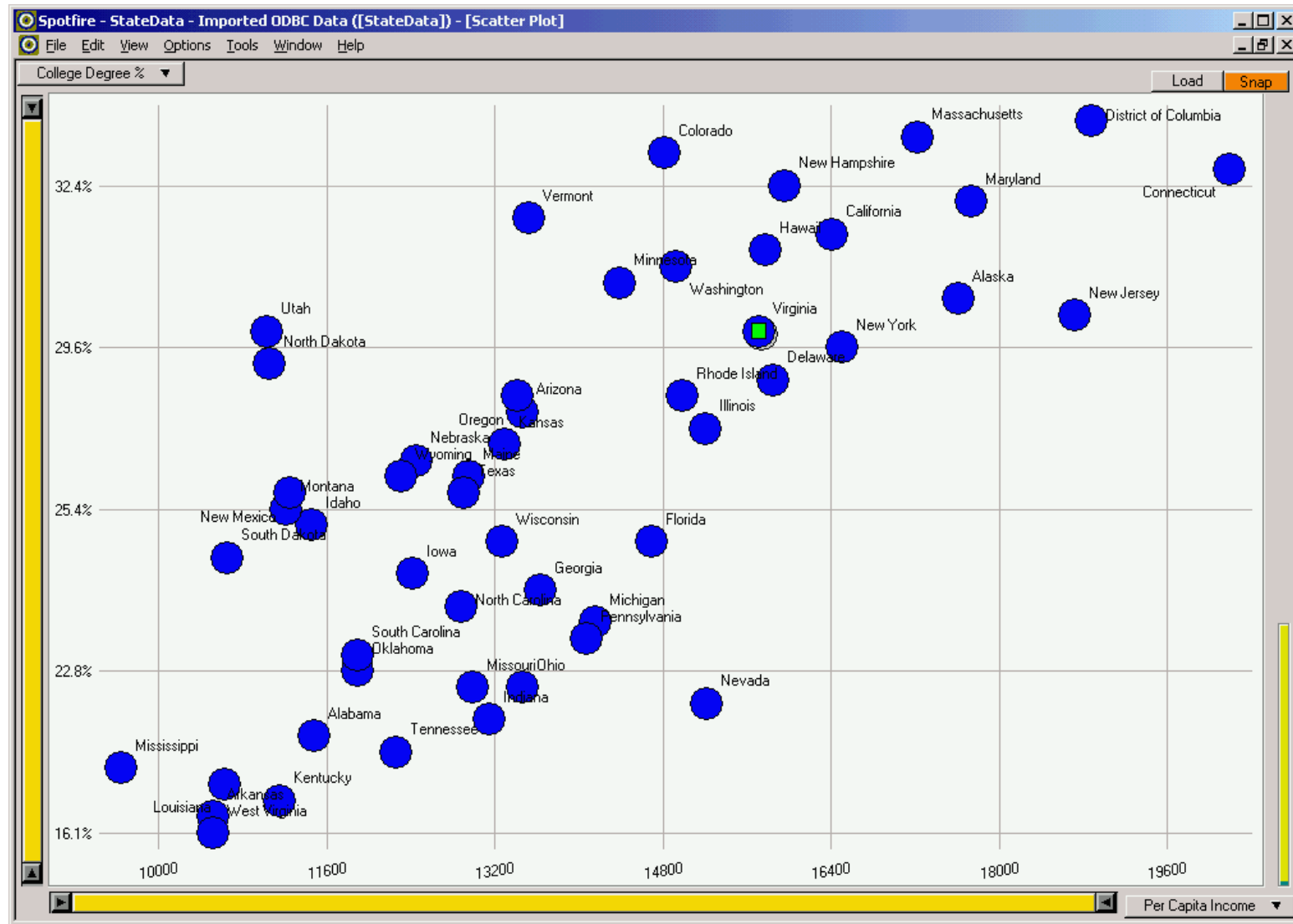
characterizing the visualization

- x-axis: year (quantitative)
- y-axis: currency (quantitative)
- color: imports/exports (nominal)
- color: positive/negative (nominal/ordinal)

Exports and Imports to and from DENMARK & NORWAY from 1700 to 1700.

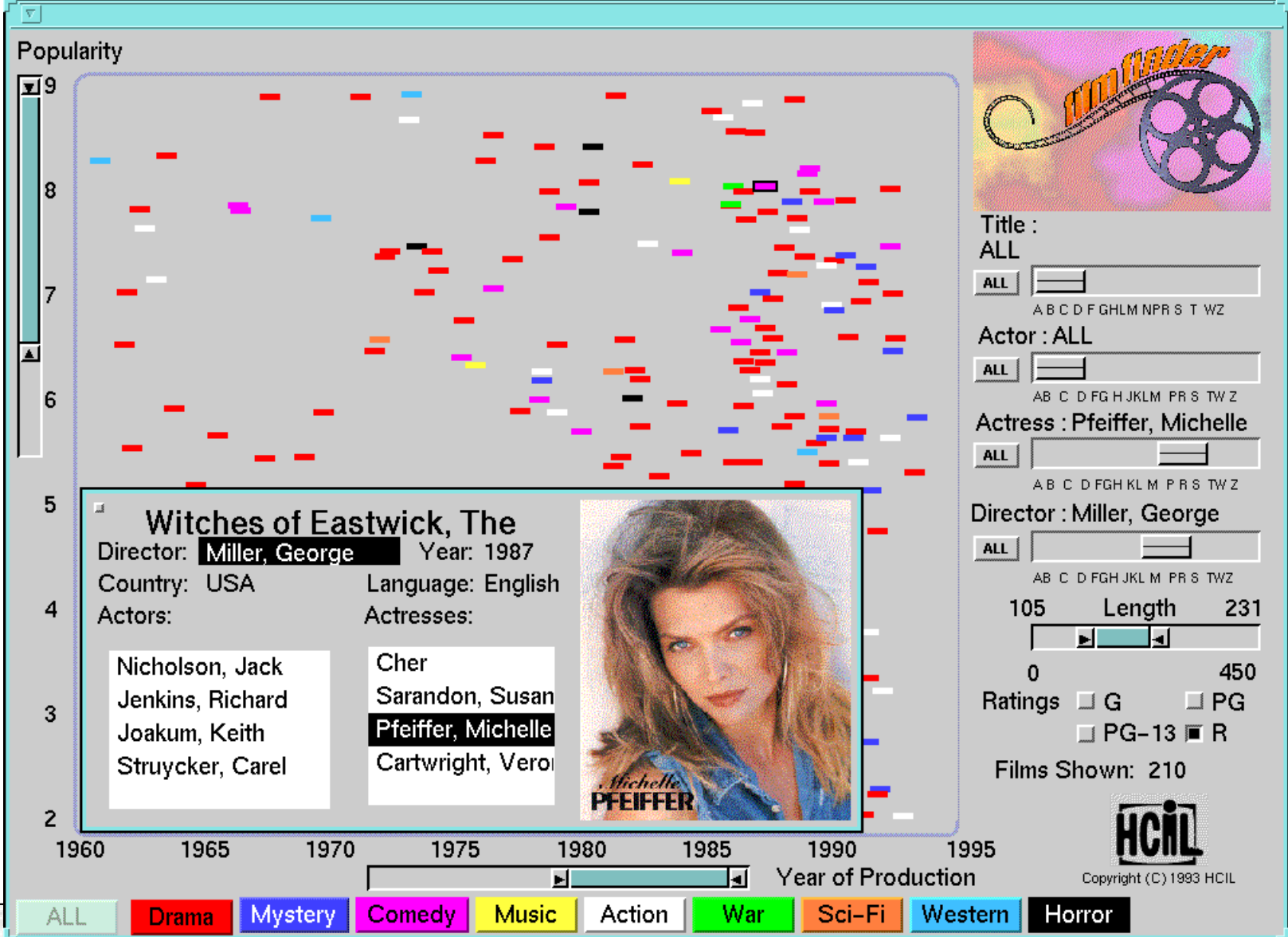The Bottom line is divided into Years, the Right hand line into L.10,000 each.
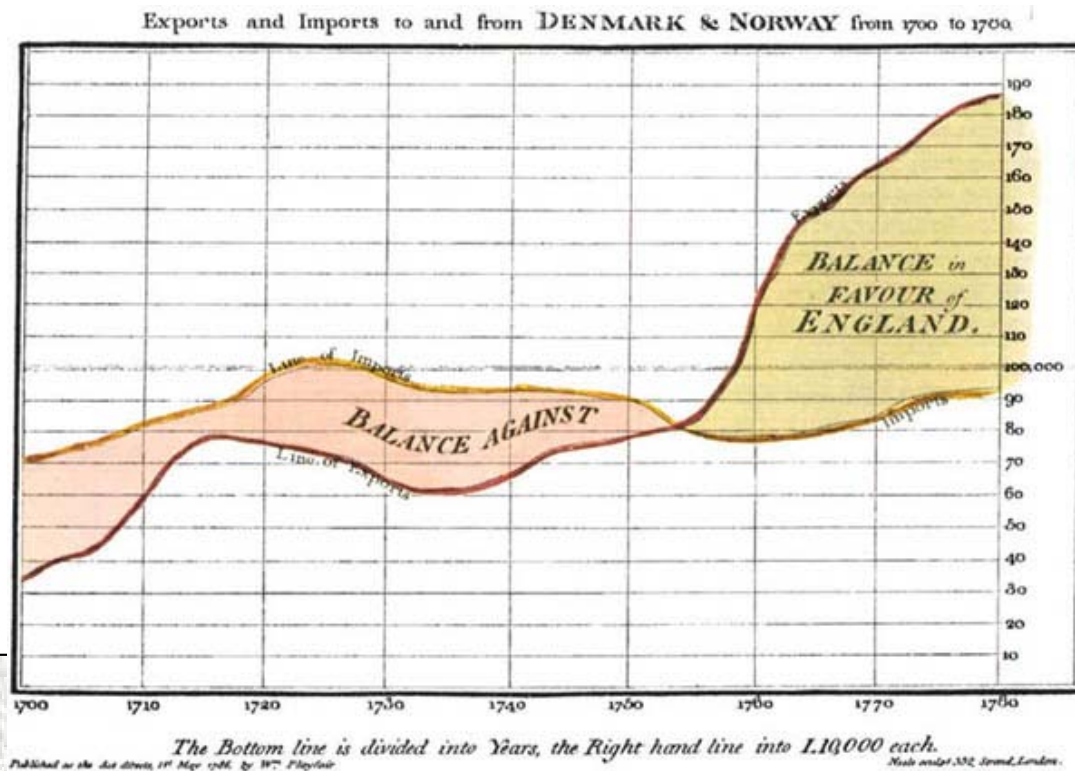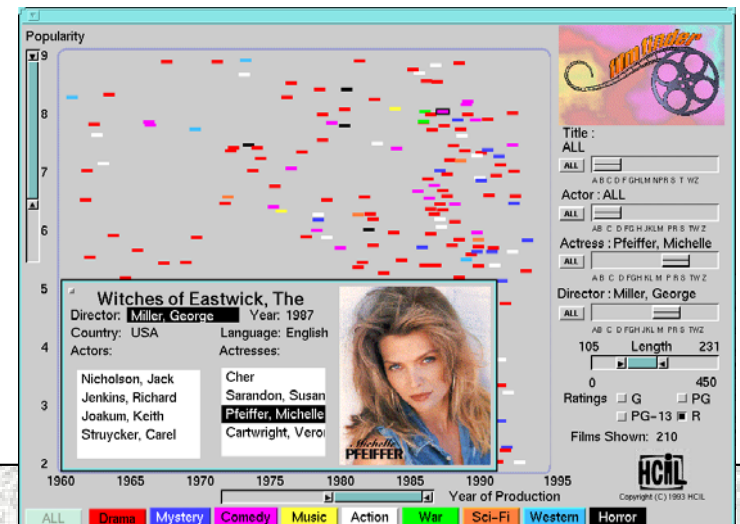
starfield displays (spotfire)

starfield displays (spotfire)

characterizing the visualization

- x-axis: year of release (quantitative)
- y-axis: popularity (quantitative)
- color: genre (nominal)
- dynamic query filters
  - title (nominal)
  - actor (nominal)
  - actress (nominal)
  - director (nominal)
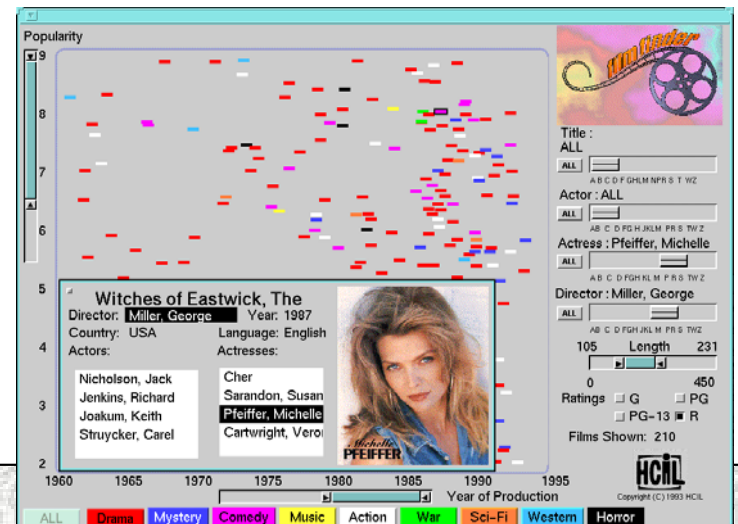 - length (quantitative)
  - rating (ordinal)

principle: interactivity

- turn visual analysis into a real-time iterative process
- explore various hypotheses or interests
- filter to hone in on data of interest
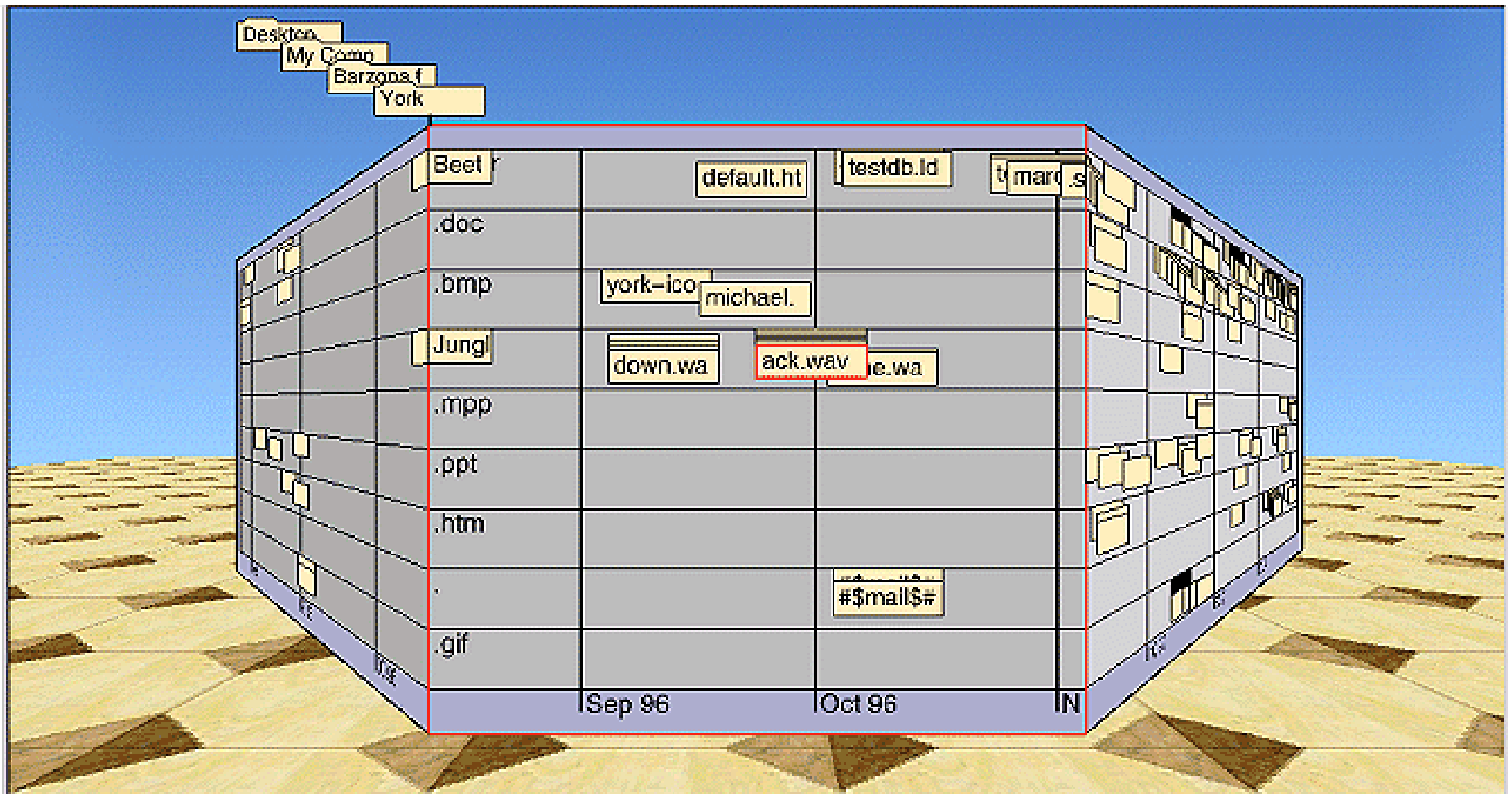- get details on demand
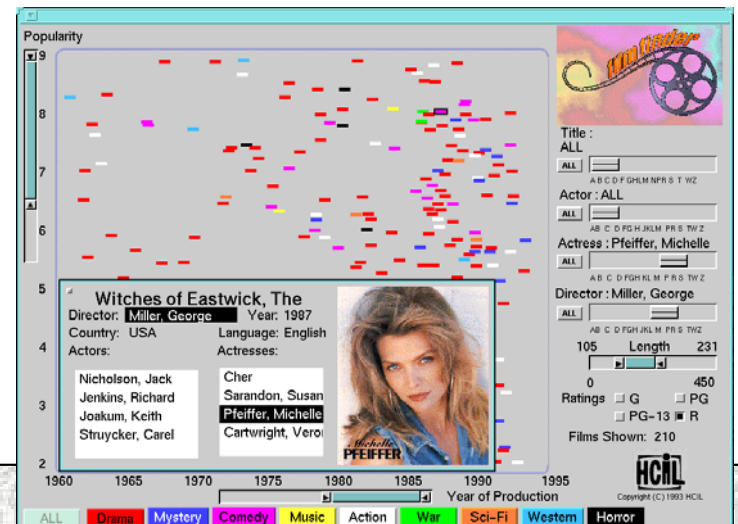
issue: multi-dimensional data

- FilmFinder visualizes 3 dimensions at a time, using 2 spatial dimensions and color
- can we effectively see more dimensions simultaneously?
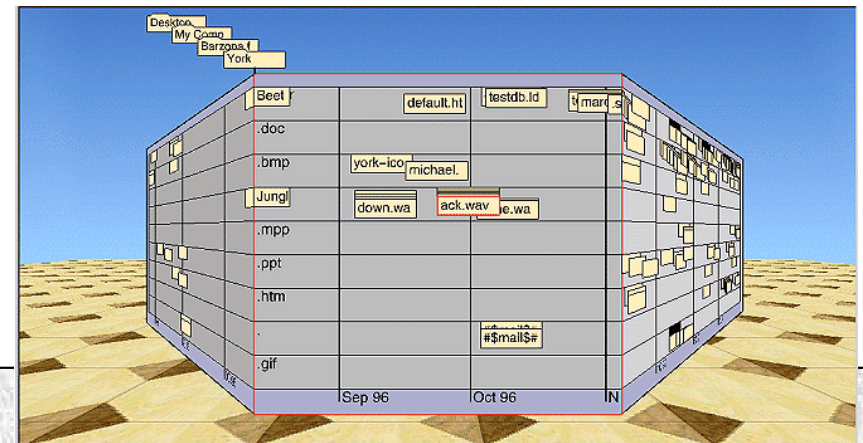
perspective wall

perspective wall

- Video online at:

  http://www.sims.berkeley.edu/courses/is247/f05/movies/PerspectiveWall.mov

characterizing the visualization

- x-axis: time of file access (quantitative)
- y-axis: file type (nominal)
- use of 3D perspective to
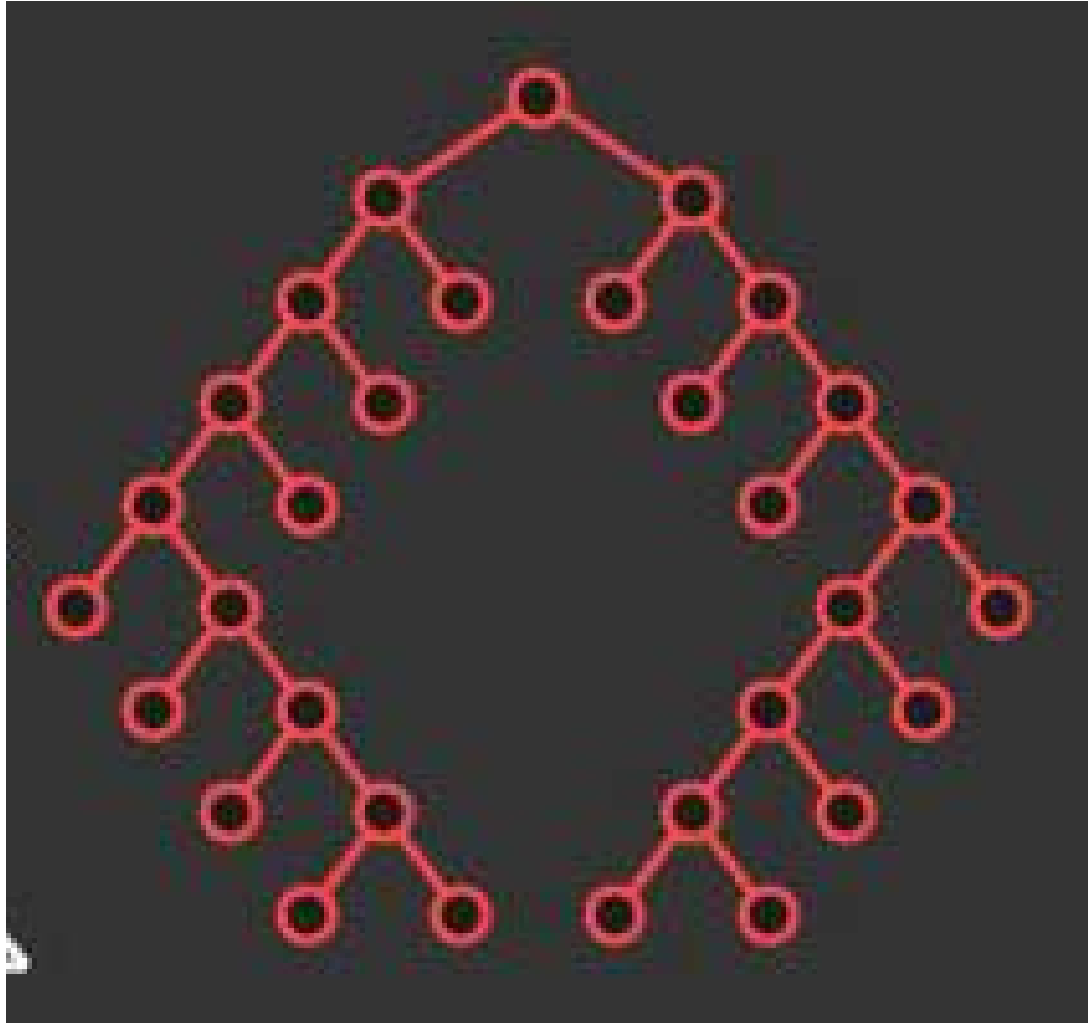 - fit more data in the display
  - de-emphasize peripheral data

principle: focus+context

- Keep all the data in view
- Show data of interest in high detail
- Show peripheral data in lower detail

- Often achieved through perspective or visual distortion
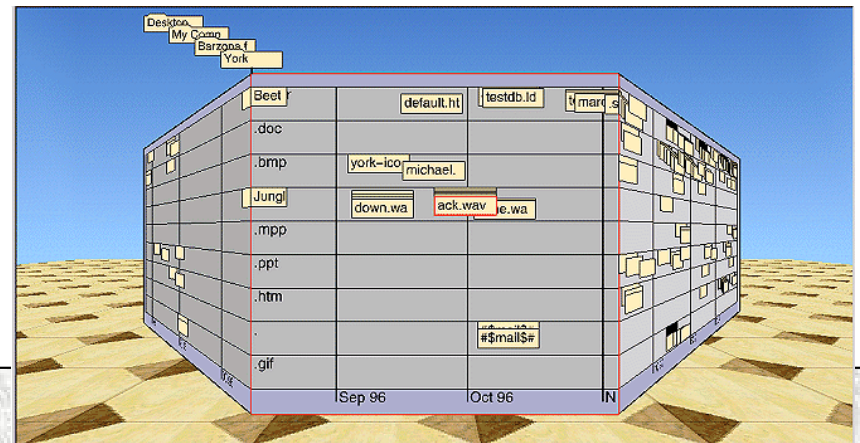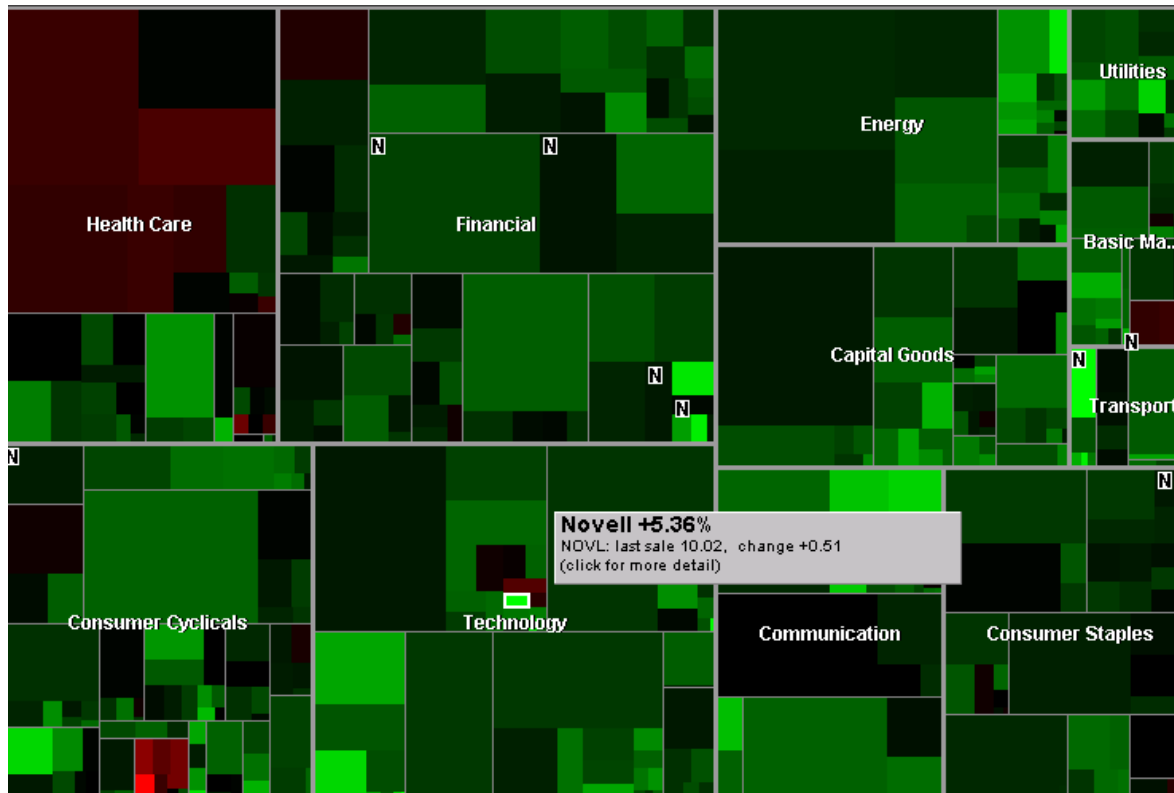
Reingold-Tilford Layout

Top-down layout

Uses separate dimensions for breadth and depth

tidier drawing of trees - reingold, tilford
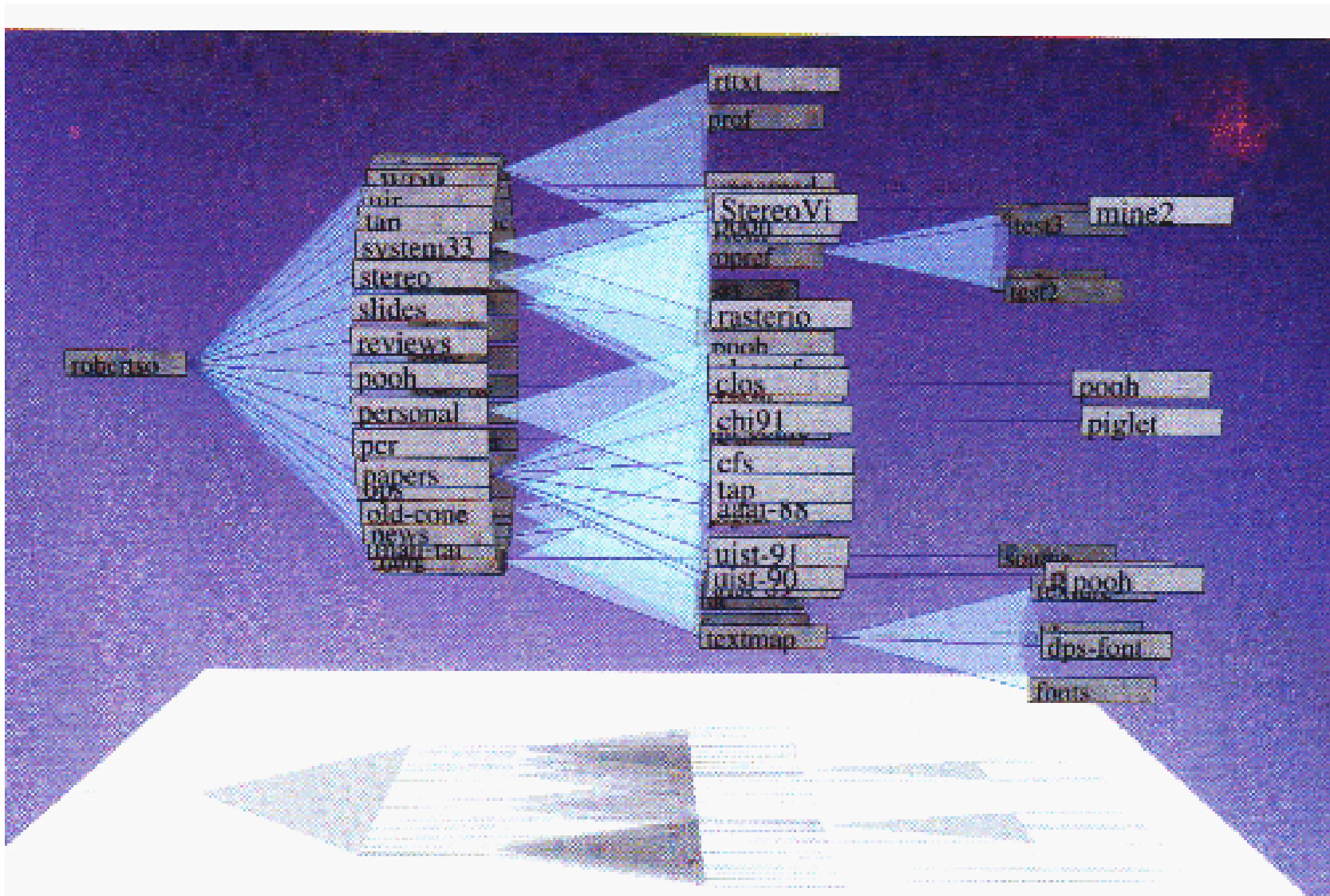
TreeMaps

map of the market – smartmoney.com

Space-filling technique that divides space recursively

Segments space according to 'size' of children nodes

cone trees

cone trees

- Video online at:

http://www.sims.berkeley.edu/courses/is247/f05/movies/ConeTree.mov

characterizing the visualization

- x-axis: tree depth (hierarchical)
- y-axis / z-axis: arrangement of sibling / cousin nodes (hierarchical)
- connectivity: parent-child relationships (hierarchical)
- animation: perform view transition
- lighting: shadow provides flattened 2D view of structure
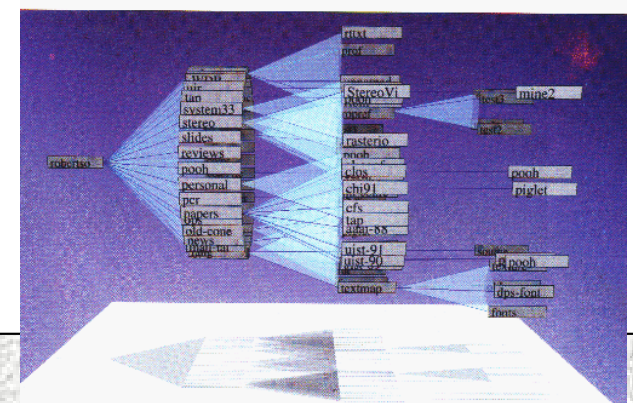
principle: animation

- depicts change over time
- invaluable for view transitions
- can communicate change, even on periphery of vision (eyes are very sensitive to motion)
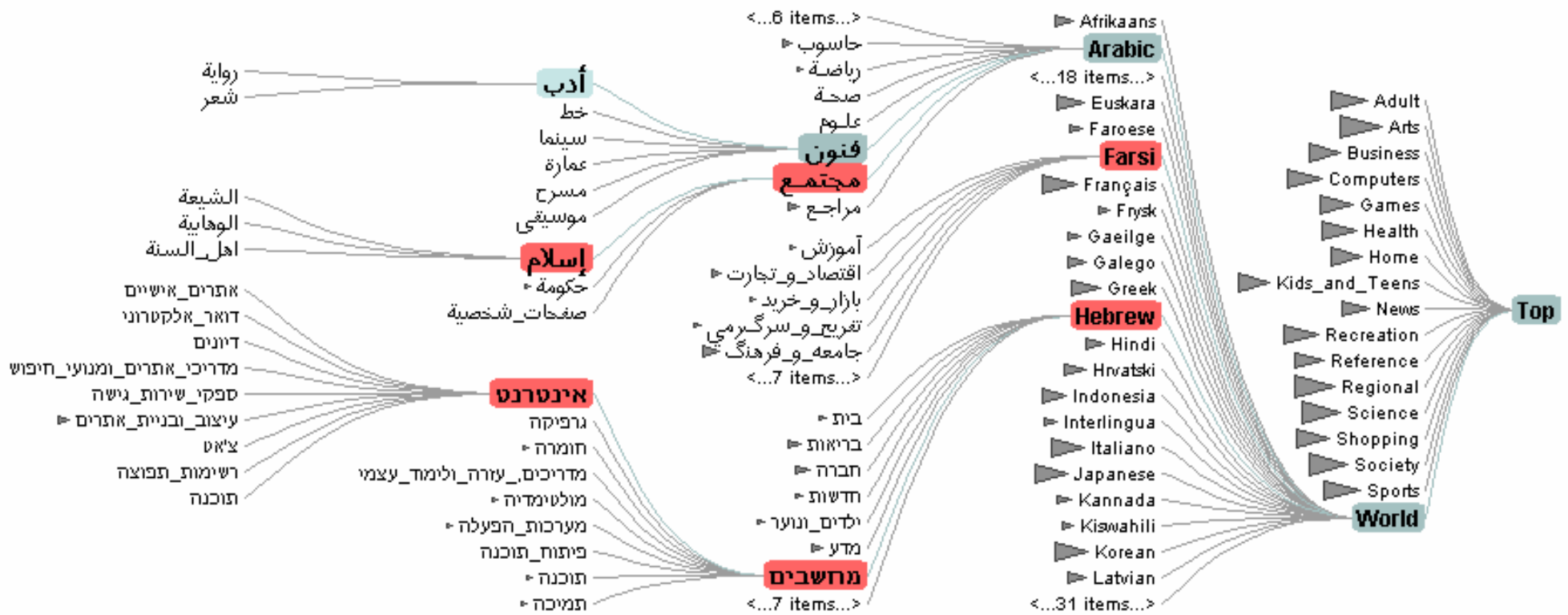- existing debate about the efficacy of animation (depends on usage)
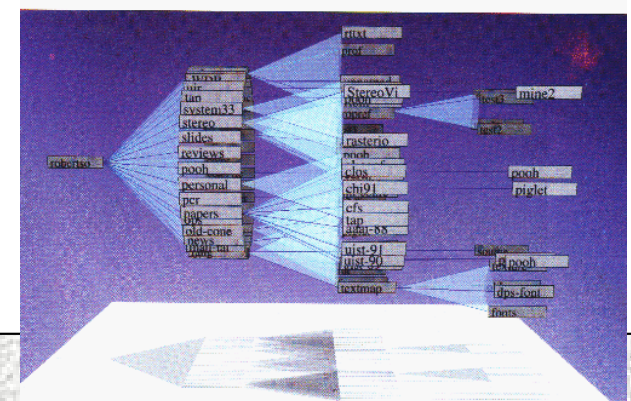
principle: 3D

- 2D or not 2D? Actually quite controversial!
- Though "cool", 3D can present problems with occlusion and navigation (and even sex/gender issues arise)
- Most visualizations stay in the 2D or 2.5D
 - Perspective Wall: 3D perspective, 2D interaction
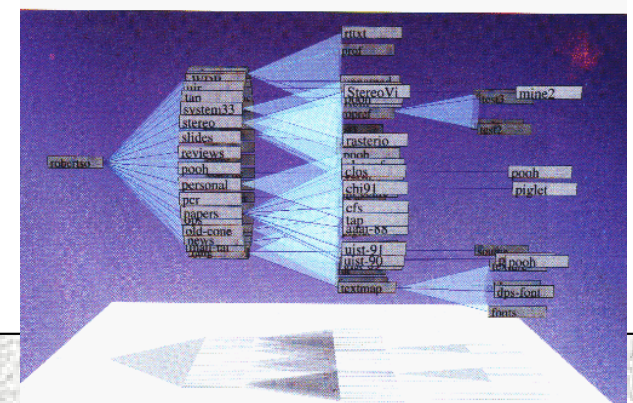
a re-design: doi trees

characterizing the visualization

- similar to cone-tree, but flattened
- color: selection/focus status of nodes (nominal)
- increased information density [Tufte]
- curved edges create funnel effect
  - allows greater y-separation of parents and children
- more focus+context
  - only show selected, expanded subtrees
  - collapsed subtrees replaced with a graphic, roughly indicating subtree size
 - if too many siblings, aggregate to keep legible

network visualization
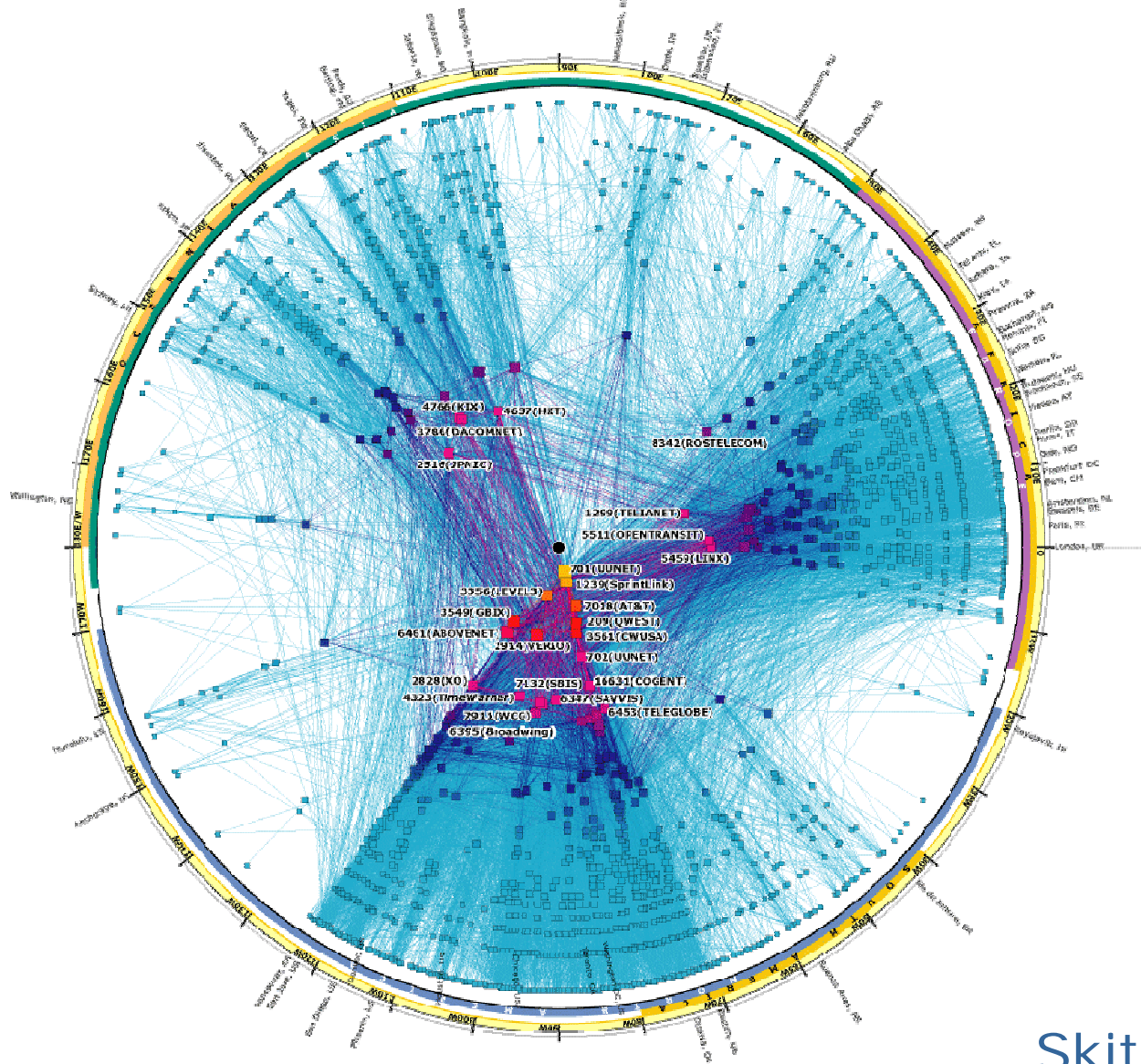

Skitter, www.caida.org

characterizing the visualization

- angle: longitude (quantitative)
- radius: number of connections (quantitative)
- color: number of connections (quantitative)
  - color spectrum moving from cool to hot colors
- color: continents (nominal/ordinal)
  - category colors along periphery
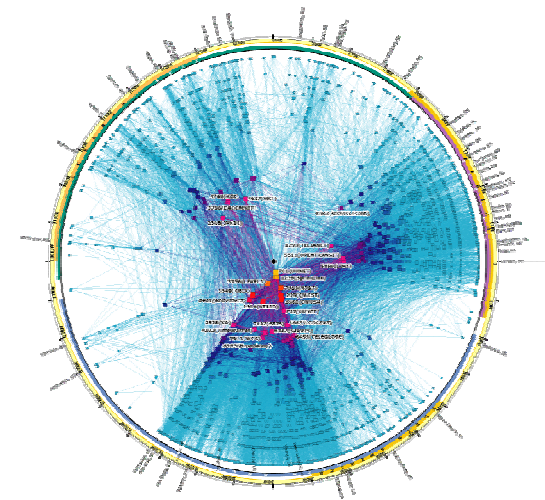
principles

- **redundant coding**
  - in this case radius and color
  - reinforce data of interest

- **design decision can obscure data**
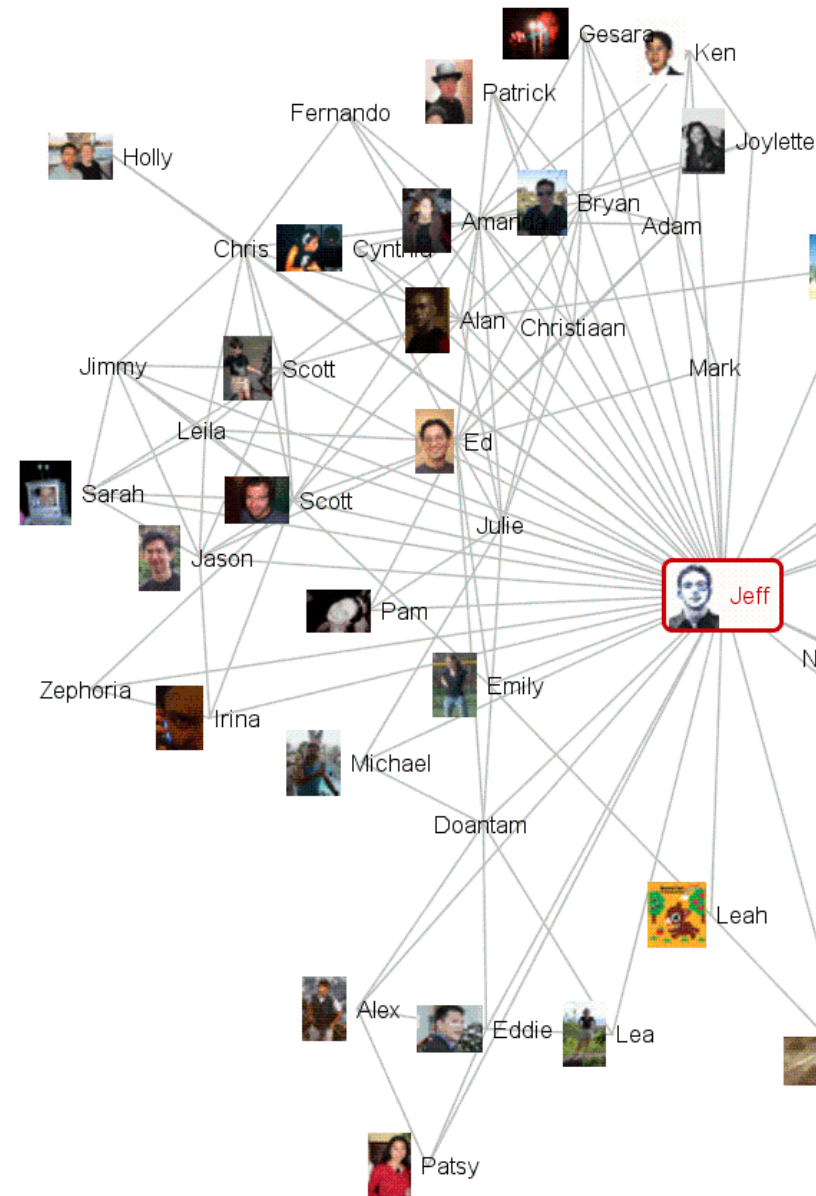 - network sparsity in Africa is masked by European networks
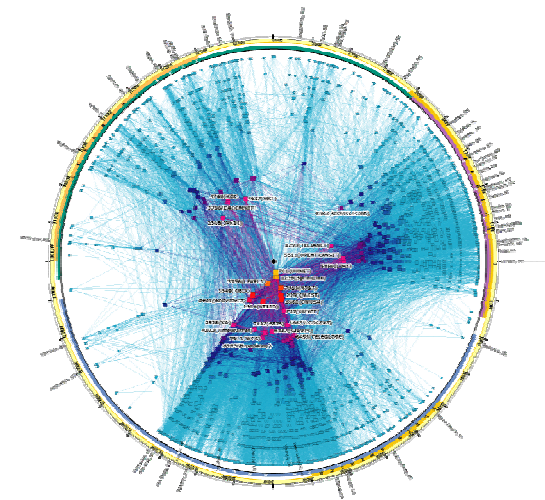
more video examples
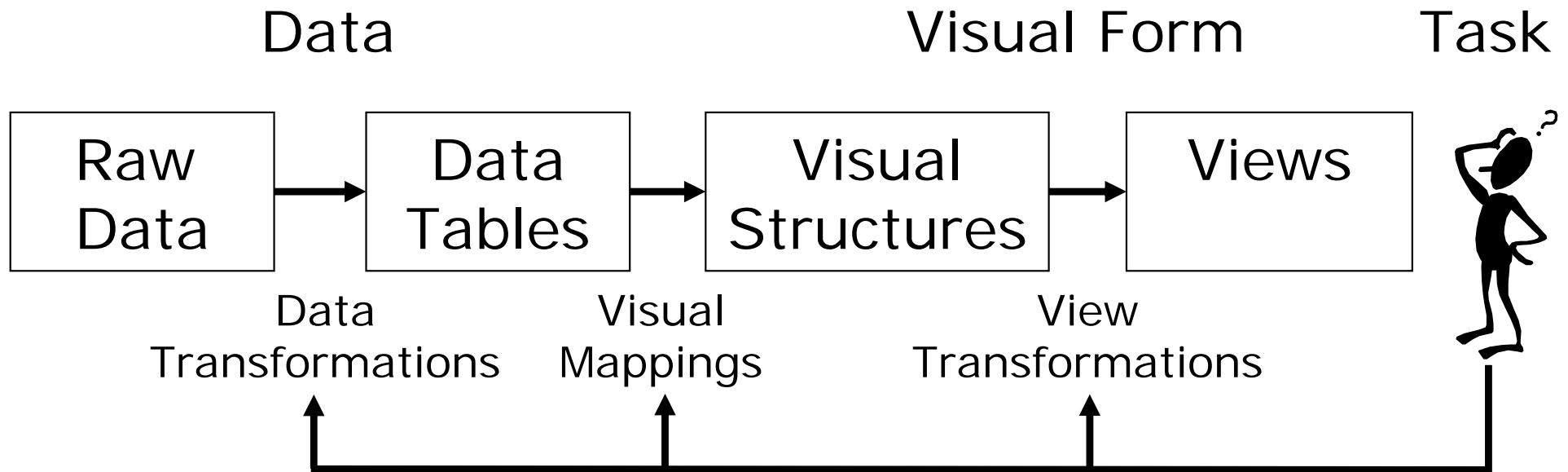
- Video online at:
  http://www.sims.berkeley.edu/courses/is247/f05/movies/prefuse.avi

- Shows selected applications built using the prefuse visualization toolkit for writing 2D visualizations in Java.
  - http://prefuse.sourceforge.net

overview

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- **modeling visualizations**

infovis reference model

Data			Visual Form		Task
Raw Data	→	Data Tables	→ Visual Structures	→ Views	

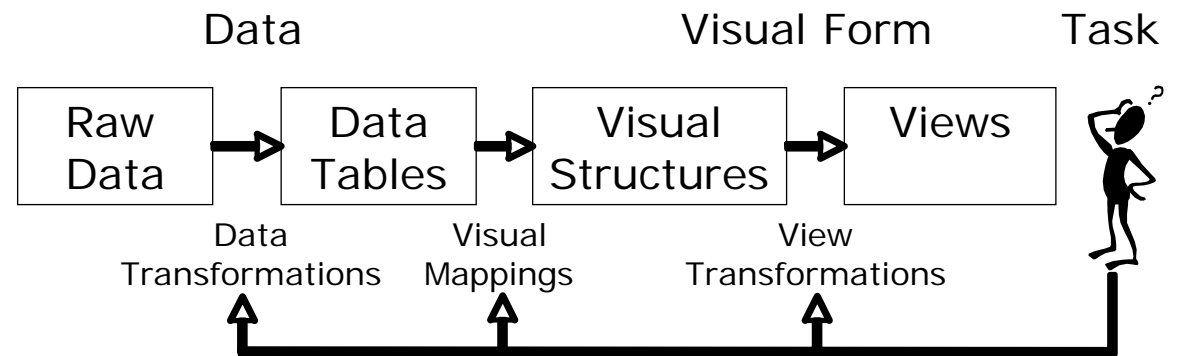Data Transformations   Visual Mappings   View Transformations

- Data Transformations
  - Mapping raw data into an organization fit for visualization
- Visual Mappings
  - Encoding abstract data into a visual representation
- View Transformations
  - Changing the view or perspective onto the visual representation
- User interaction can feed back into any level

reference model examples

- ## Visual mappings
  - Layout (assigning x,y position)
  - Size, Shape, Color, Font, etc...
- ## View Transformations
  - Navigation: Panning and Zooming
  - Animation
  - Visual Distortion (e.g., fisheye lens)

Data   Visual Form   Task

| Raw Data | → | Data Tables | → | Visual Structures | → | Views |

Data Transformations   Visual Mappings   View Transformations

apply the model: cone trees

- Raw Data: File system directories
  - Data Transformations: Traverse file system subtree
- Data Tables: Parsed/extracted directory tree
  - Visual Mappings: Assign 3D coordinates to tree elements (layout), assign colors, fonts. Set lighting.
- Visual Structures: 3D model of tree
  - View Transformations: Camera placement; animation between tree configurations
- View: Rendered, interactive visualization
- Interaction: Selection of new focus node
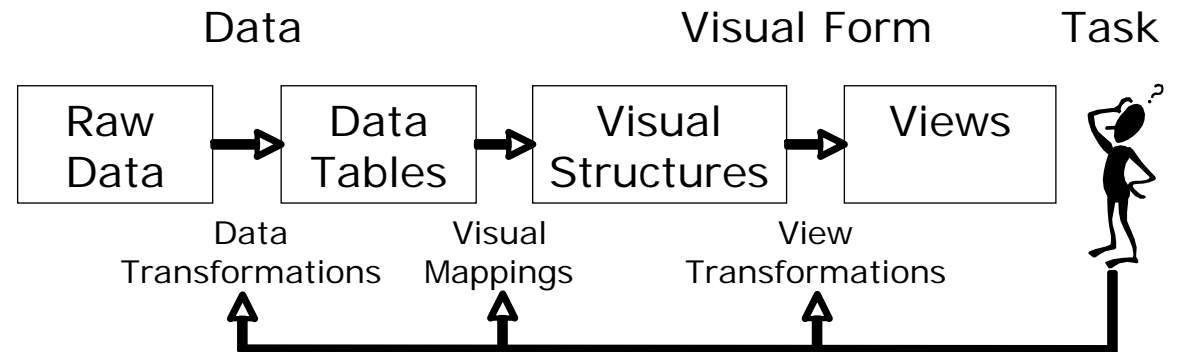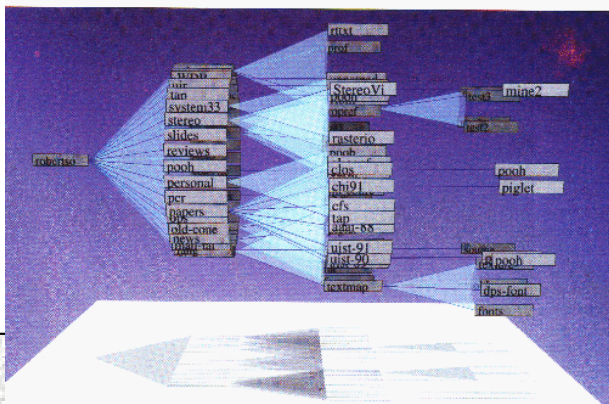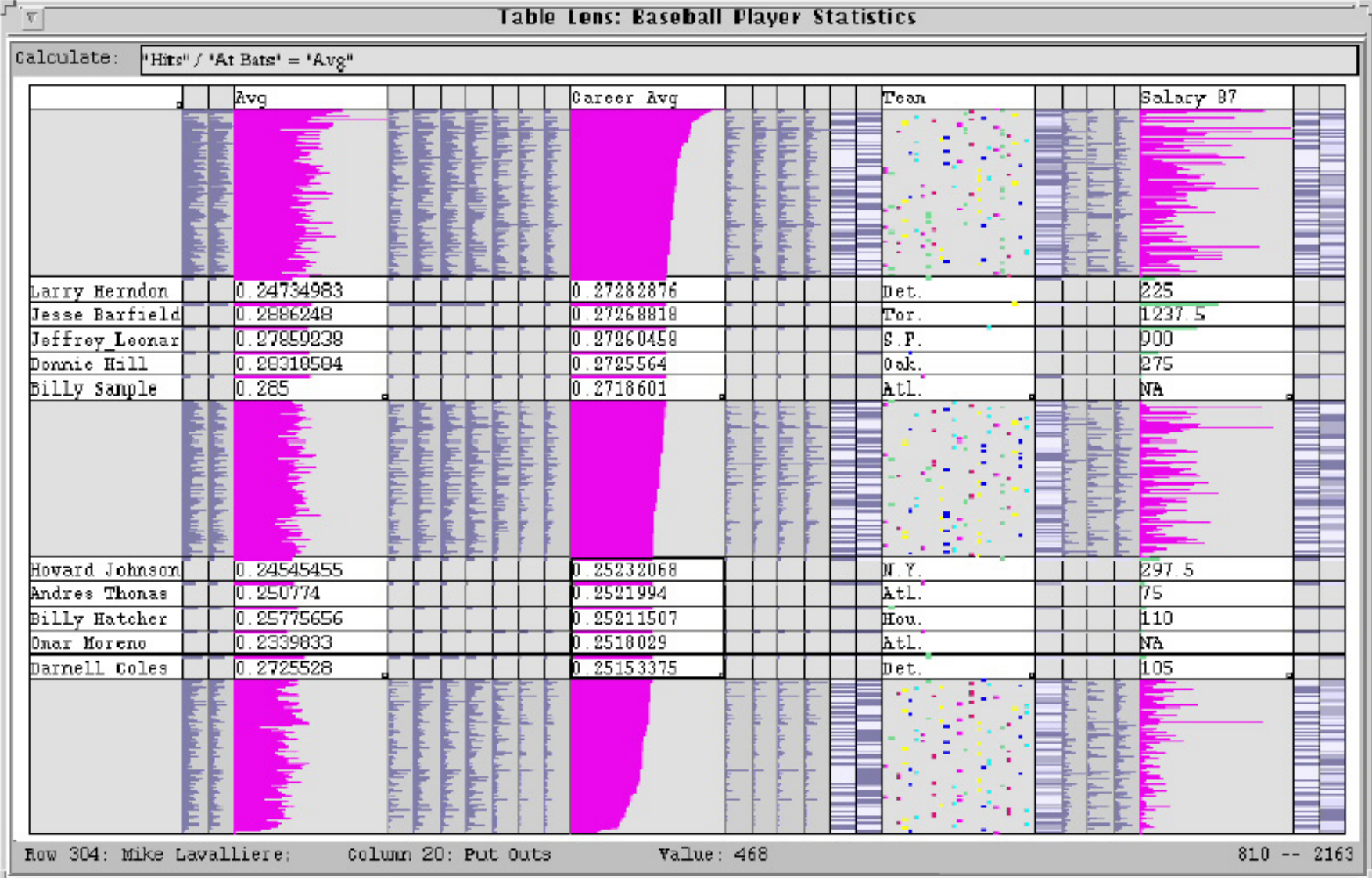
other examples

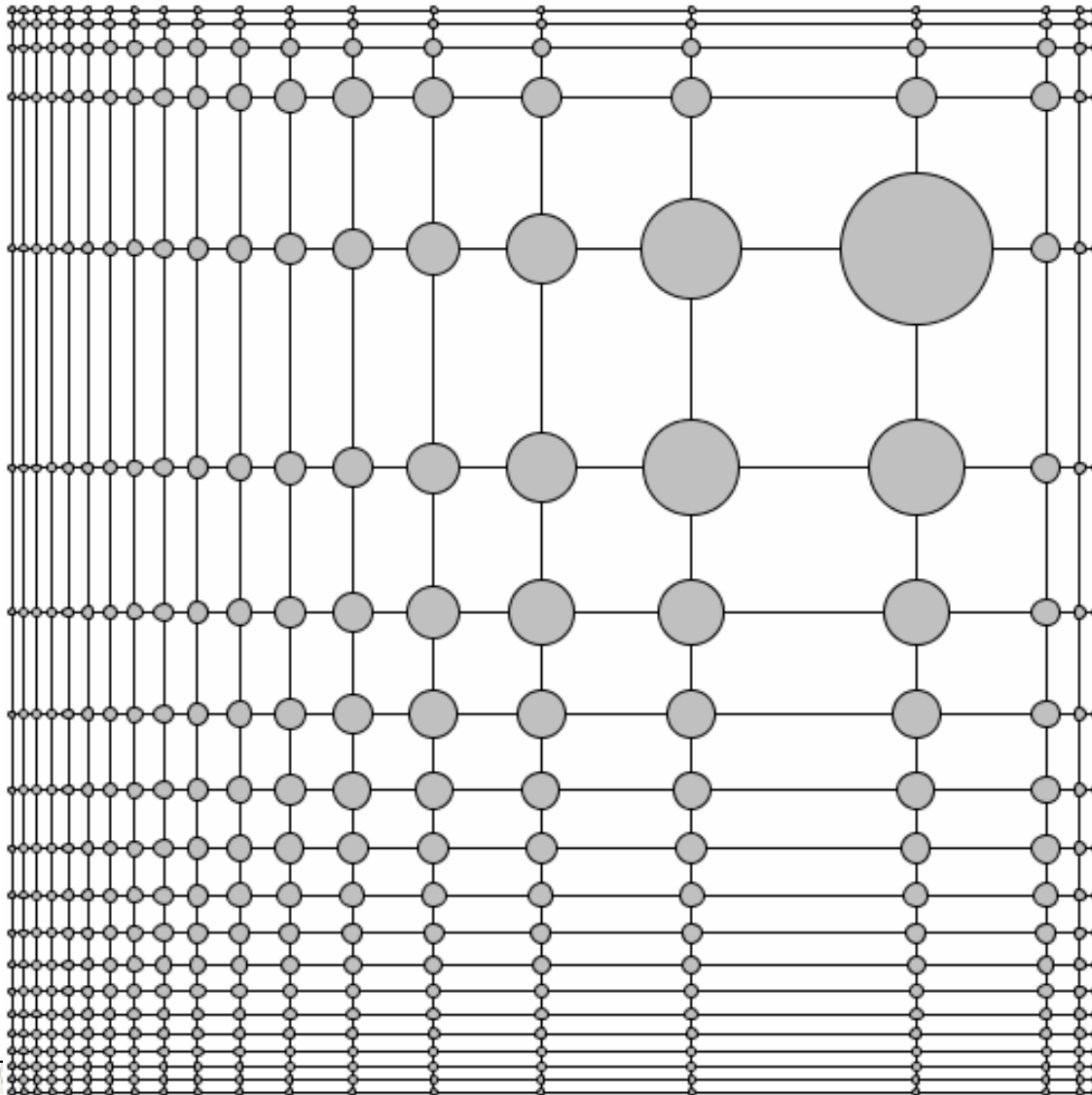# TreeMaps
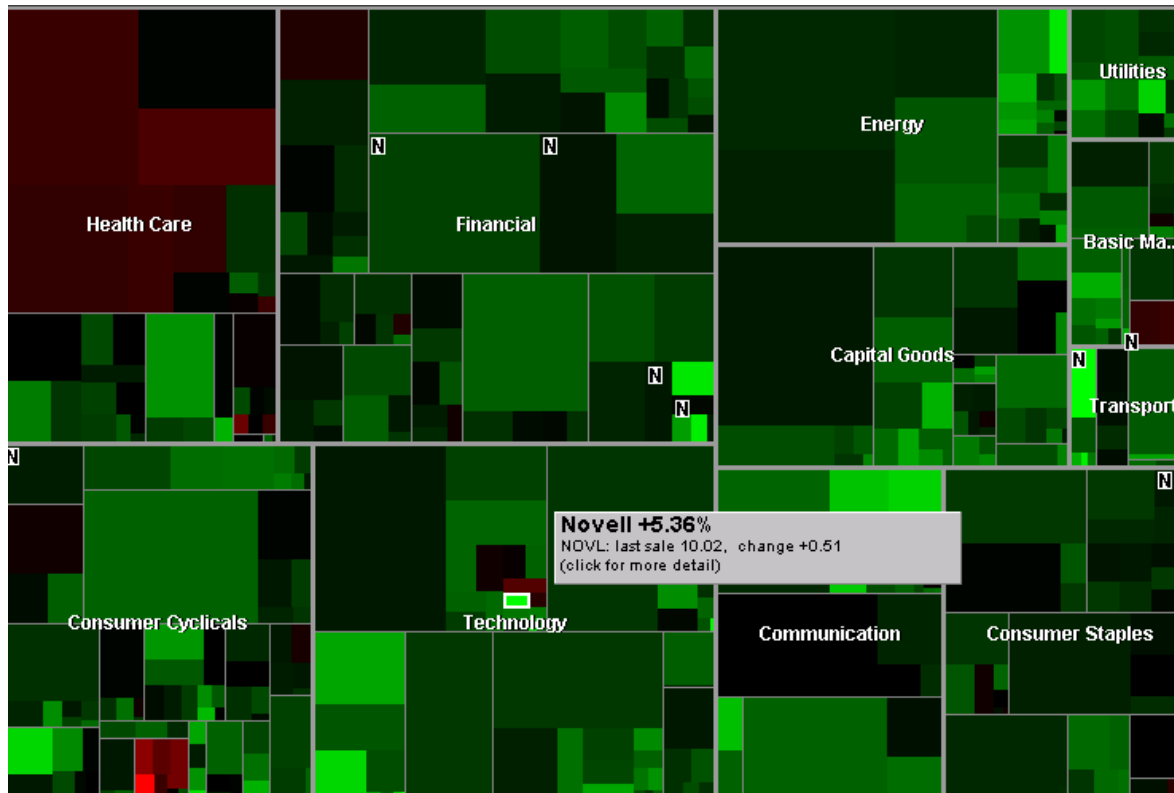
map of the market – smartmoney.com

Space-filling technique that divides space recursively

Segments space according to 'size' of children nodes
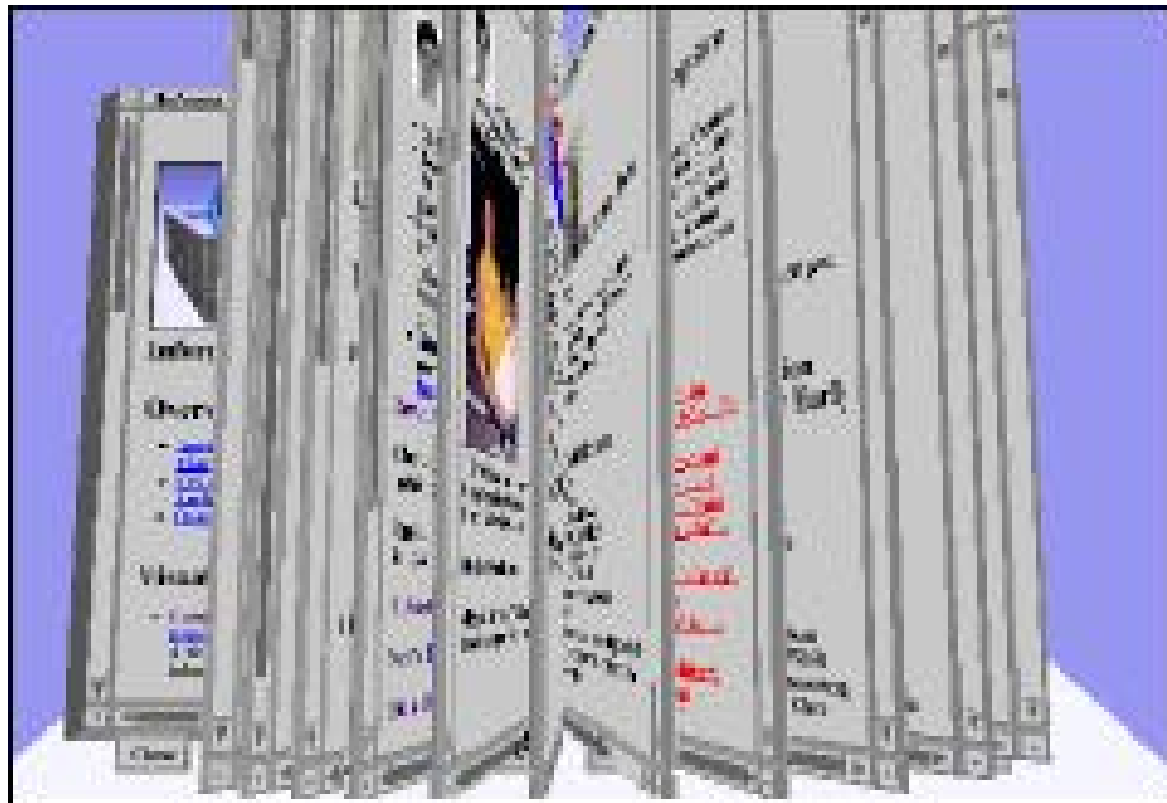
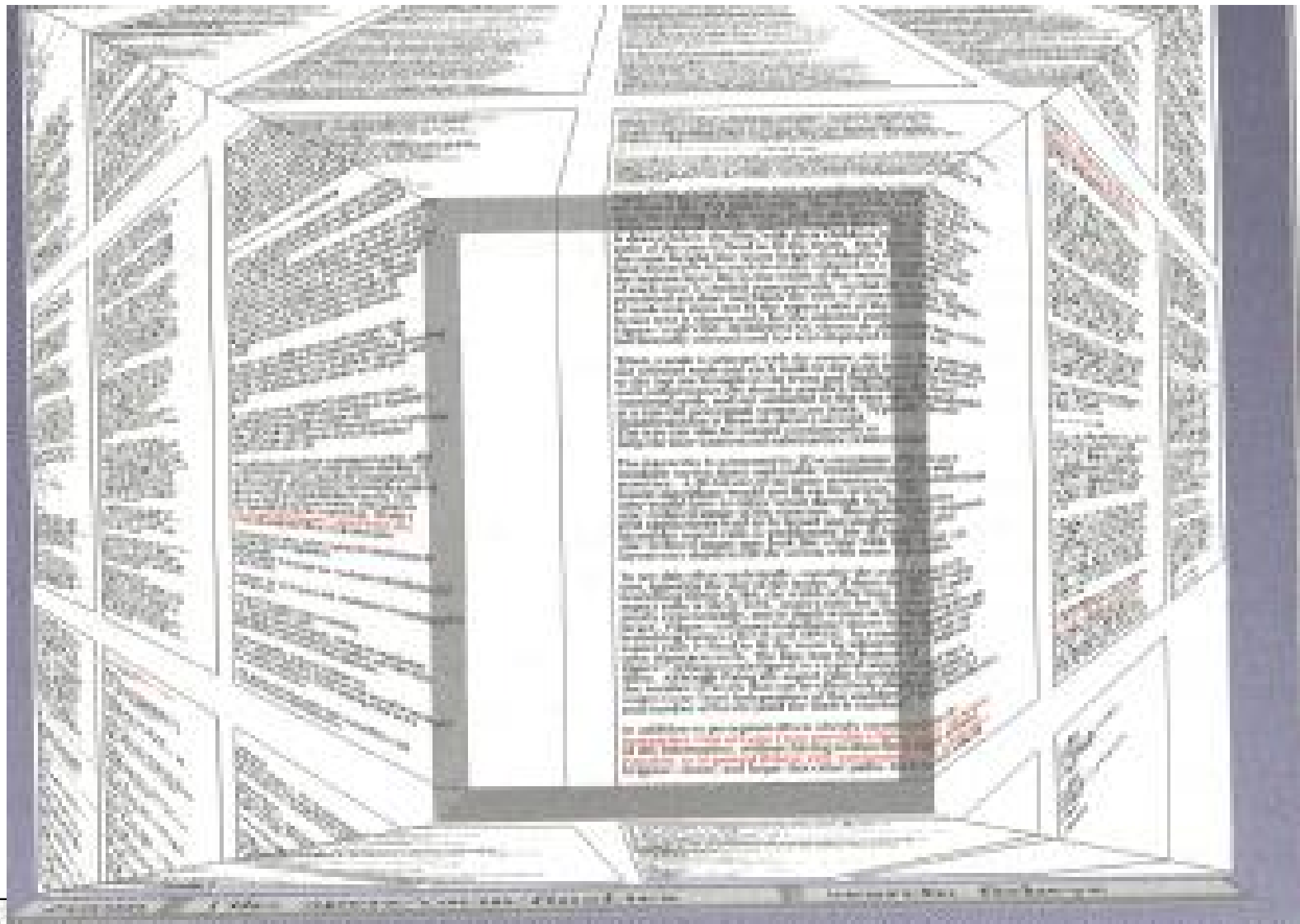# Table Lens

Distortion Techniques

WebBook

Web Forager

Document Lens

Data Mountain

Supports document organization in a 2.5 dimensional environment.

summary

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- modeling visualizations