Slide 1

why does this suck?

1

Slide 2
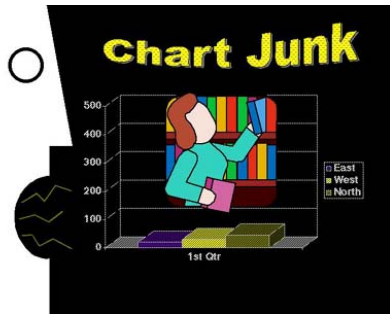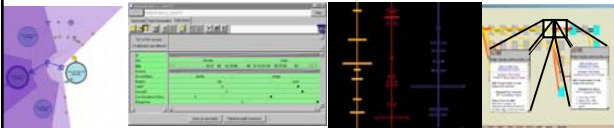
some of the reasons it sucks

- 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?

2

Slide 3

Information Visualization
Ryan Aipperspach (slides from Jeffrey Heer)

April 19, 2006

3

Slide 4

overview

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

4

Slide 5

overview

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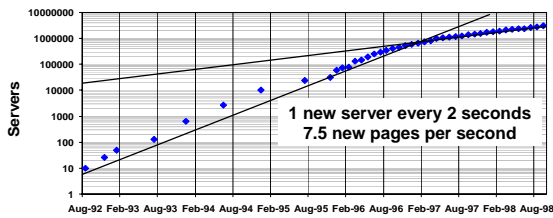- modeling visualizations

5

Slide 6

basic problem

We live in a new ecology.

6

web ecologies

1 new server every 2 seconds
7.5 new pages per second

Aug-92 Feb-93 Aug-93 Feb-94 Aug-94 Feb-95 Aug-95 Feb-96 Aug-96 Feb-97 Aug-97 Feb-98 Aug-98
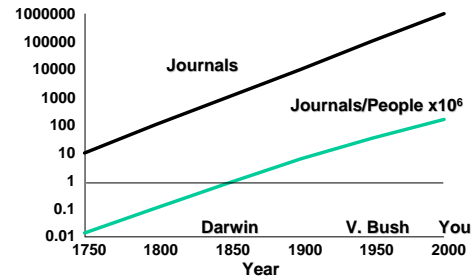
Source: World Wide Web Consortium, Mark Gray, Netcraft Server Survey

(slide "borrowed" from PARC User Interface Research Group) 7
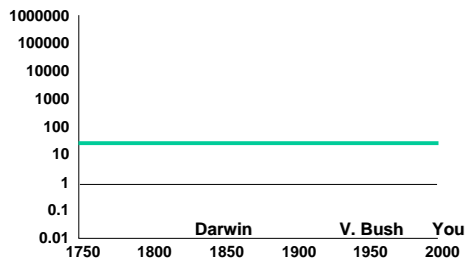
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scientific journals

Journals/person increases 10X every 50 years

(slide "borrowed" from PARC User Interface Research Group) 8

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innate human capacity

(slide "borrowed" from PARC User Interface Research Group) 9

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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."
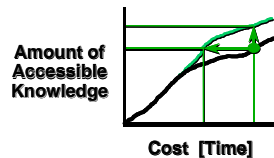
~Herb Simon
as quoted by Hal Varian
Scientific American
September 1995

(slide "borrowed" from PARC User Interface Research Group) 10

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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.
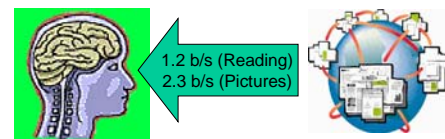
Amount of Accessible Knowledge

Cost [Time]

(slide "borrowed" from PARC User Interface Research Group) 11

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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)

(slide "borrowed" from PARC User Interface Research Group) 12

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

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Visualization Success Story

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

14

Visualization Success Story

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

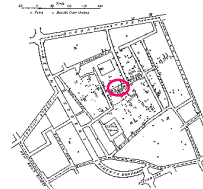Horizontal lines indicate location of deaths.

From Visual Explanations by Edward Tufte, Graphics Press, 1997

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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
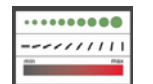
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overview

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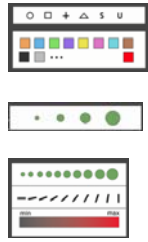- modeling visualizations

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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)

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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

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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
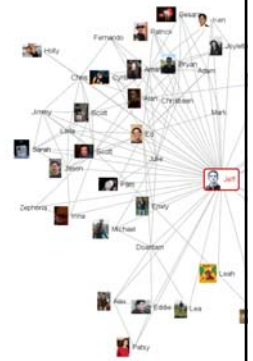
20

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
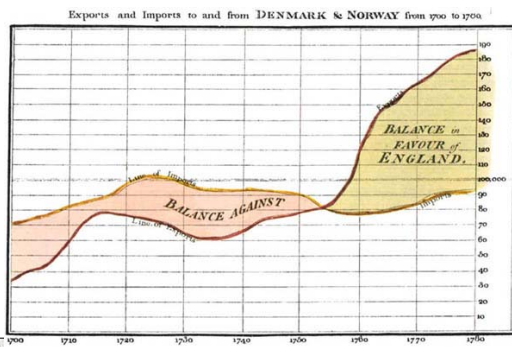- Extract
  - Make subcollections

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overview

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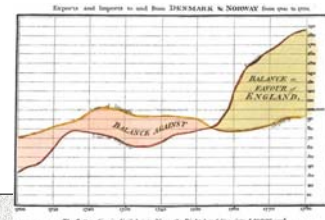- modeling visualizations

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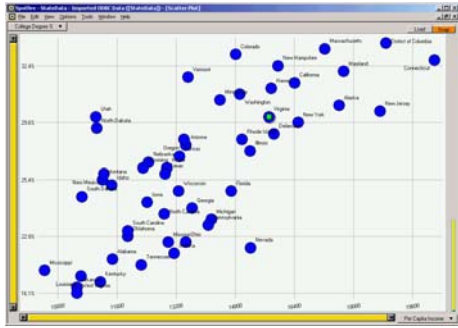## data graphics (Playfair, ca.1780)

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characterizing the visualization

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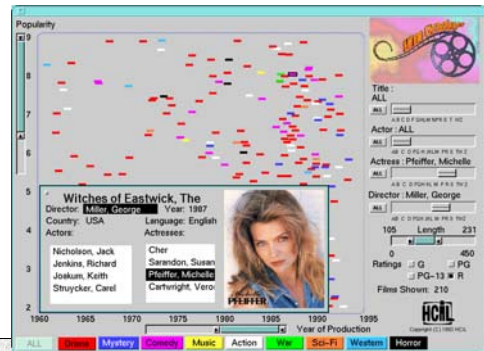- color: positive/negative (nominal/ordinal)

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starfield displays (spotfire)

25

starfield displays (spotfire)

26

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)

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principle: interactivity

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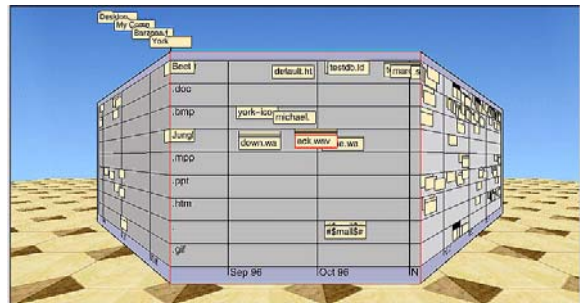- get details on demand

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issue: multi-dimensional data

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

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perspective wall

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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
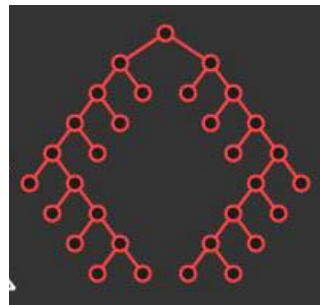 - de-emphasize peripheral data

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
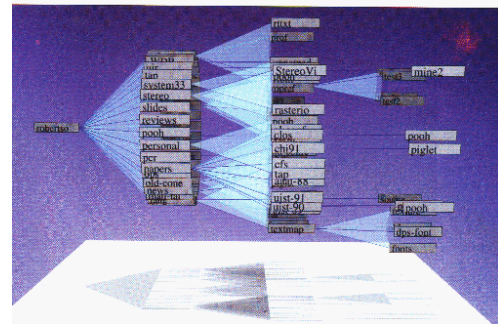
tidier drawing of trees - reingold, tilford

TreeMaps

Space-filling technique that divides space recursively

Segments space according to 'size' of children nodes

map of the market – smartmoney.com

cone trees

cone trees

- Video online at:
http://www.sims.berkeley.edu/courses/is247/f05/movies/ConeTree.mov

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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

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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)
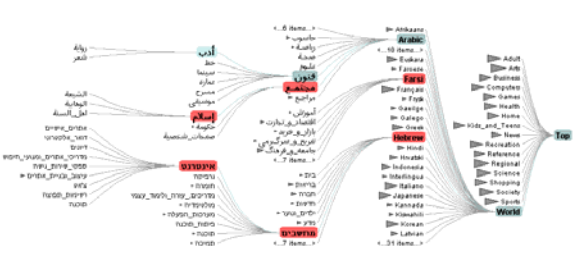
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principle: 3D

- 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
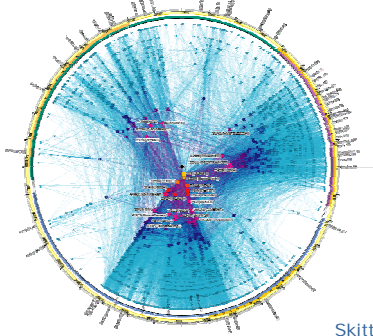
40

a re-design: doi trees

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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
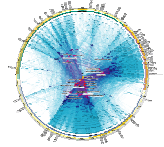
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network visualization

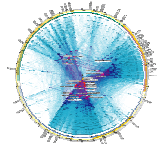Skitter, www.caida.org

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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

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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

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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.
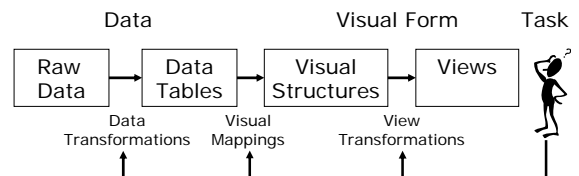 – http://prefuse.sourceforge.net

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overview

- why infovis?
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- examples deconstructed
- **modeling visualizations**

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infovis reference model

Data   Visual Form   Task

Raw Data → Data Tables → Visual Structures → Views

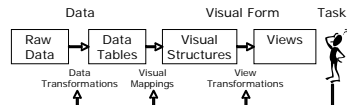Data Transformations   Visual Mappings   View Transformations

- 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
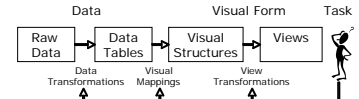
48

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)

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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

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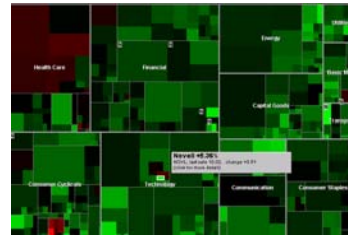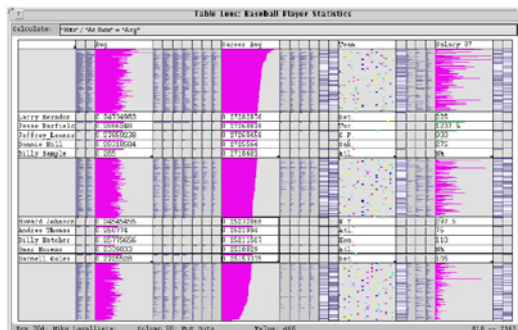## other examples

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TreeMaps

Space-filling technique that divides space recursively

Segments space according to 'size' of children nodes

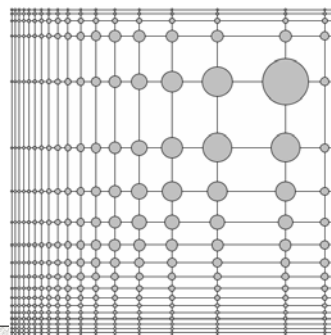map of the market – smartmoney.com

52

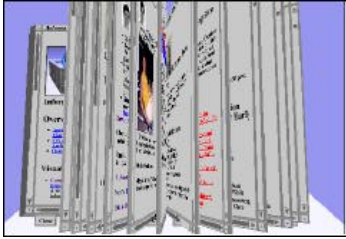## Table Lens

53

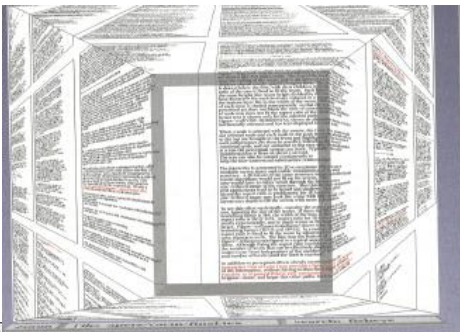## Distortion Techniques

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WebBook

55

Web Forager

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Document Lens

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Data Mountain

Supports document organization in a 2.5 dimensional environment.

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summary

- why infovis?
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- examples deconstructed
- modeling visualizations

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