Information Visualization and Knowledge Management

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Trees and Networks

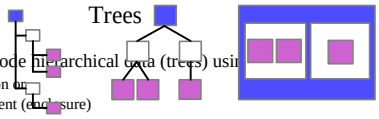
London underground (before Beck's idea)

Beck's original map of London underground

Visualizing structures

- Node-link diagrams can be used to encode relationships between data
- Space is always a big issue
  - Wasted space for many tree layouts (enclosure layouts tend to be more space efficient)
  - Never enough for large trees and networks
- Difficulties navigating
  - "Lost in space"
    - Can use context and detail views
    - Distortions
- Position is usually very important for tree structures (and sometimes networks)
  - Importance of "Preserving the Mental Map"
- Let's look at two types of structures: trees and networks

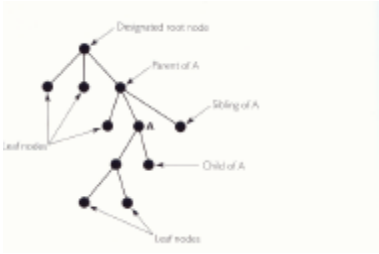
Trees



- We can encode hierarchical data (trees) using
  - Connection or
  - Containment (enclosure)

- Use different approaches to show different kinds of information:
  - Node link better for trees that have an uneven shape, enclosure (such as Treemaps) preferred if there is a quantitative variable you want to encode using size
  - But it really depends on the questions you are trying to answer or the concepts you are trying to communicate…

Terminology of a tree

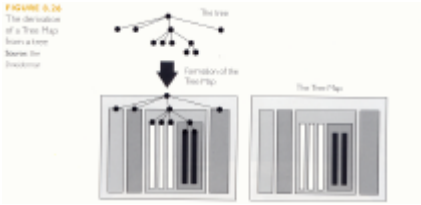


Broad trees

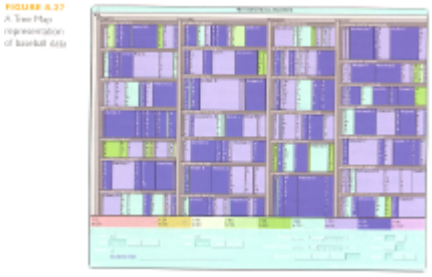
Treemaps

- Issues:
  - Nesting vs. non-nesting, when to nest?
  - May be hard to use if large
  - Layout issues
- Advantages
  - Interactive
  - Customizable (for example colour, depth)
  - Shows both structure and content
  - Shows the “gestalt” nature of the data

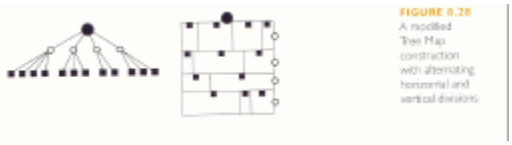
Treemap idea



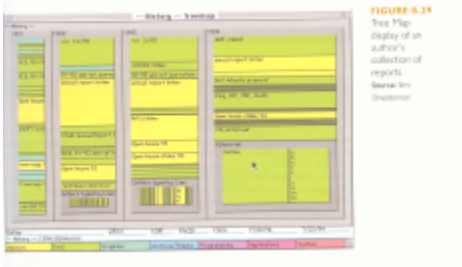
Treemap (baseball data)



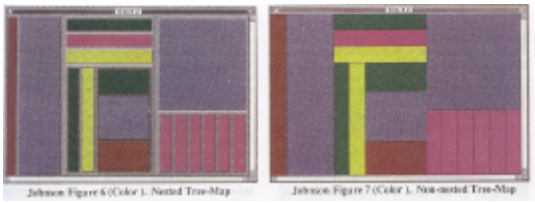
Treemap idea



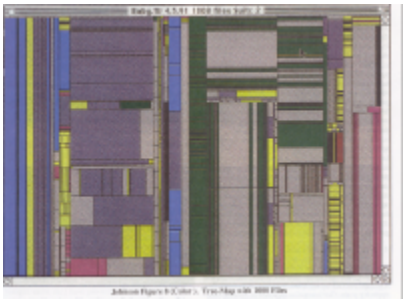
Treemap example



Treemaps (nesting vs. non-nesting)

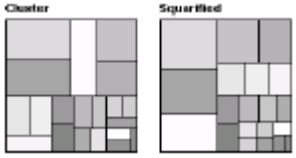


Treemap of 1000 files



Other approaches

- Original algorithm – preserves order, stable with respect to small changes, but an result in areas with a high aspect ratio
- Other approaches (not stable, order not preserved):



Ordered Treemaps

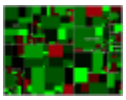
- See ftp://ftp.cs.umd.edu/pub/hcil/Reports-Abstracts-Bibliography/2001-06html/2001-06.htm
- Observation – it is possible to layout items that are adjacent in a list adjacent in a treemap (so not strictly linear ordering)
- Idea – place the largest item first

Algorithm

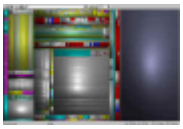
1. Let P, the pivot, be the item with the largest area in the list of items.
2. If the width of R is greater than or equal to the height, divide R into four rectangles, R_1, R_p, R_2, and R_3
3. Place P in the rectangle R_p, exact dimensions of it determined in Step 4.
4. Divide the items in the list, other than P, into three lists, L_1, L_2, and L_3, to be laid out in R_1, R_2, and R_3. L_1 and L_3 all may be empty lists. (Note that the contents of these three lists completely determine the placement of the rectangles in Figure 3.) Let L_1 consist of all items whose index is less than P in the ordering. Let L_2 and L_3 be such that all items in L_2 have an index less than those in L_3, and the aspect ratio of P is as close to 1 as possible.
5. Recursively lay out L_1, L_2, and L_3 (if any are non-empty) in R_1, R_2, and R_3 according to this algorithm.

Other Treemap examples

www.smartmoney.com



SequoiaView

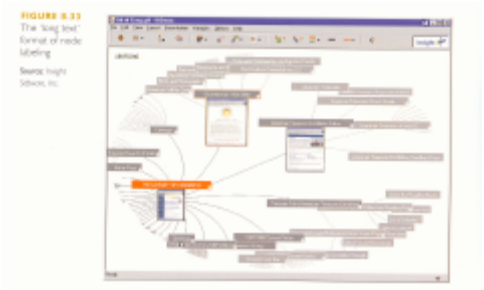


PhotoMesa

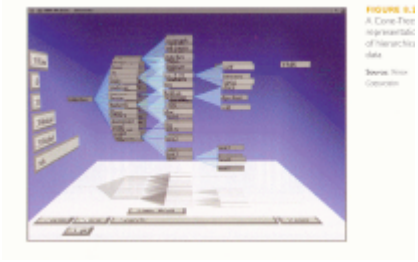
More on Treemaps

- History -- http://www.cs.umd.edu/hcil/treemaps/
- Algorithm variations
  - SliceAndDice - Ordered, very bad aspect ratios, stable
  - BinaryTree - Partially ordered, not very good aspect ratios, stable
  - Ordered - Partially ordered, medium aspect ratios, medium stability
  - Squarified - Unordered, best aspect ratios, medium stability
  - Strip - Ordered, medium aspect ratios, medium stability
  - http://www.cs.umd.edu/hcil/treemaps/java_algorithms/LayoutApplet.html -- compare them, open source available

Hyperbolic Trees



Cone Trees



The Brain

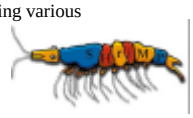
http://www.thebrain.com/BrainEKPtour/ekptour.htm

Networks

- Network structures used for many things:
  - WWW, telephone networks, personal communications…
- Network have cycles (consequently not suitable for containment layouts)
- Often very large, with lots of links
- Problems:
  - Positioning nodes
  - Managing links
  - Scalability
  - Interactivity

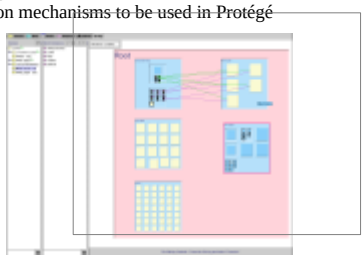
SHriMP Views

- **S**imple **H**ierarchical **M**ulti-**P**erspective Views
- A prototype environment for integrating various visualization techniques
- Improves use of limited screen area
- Integrates text browsing using hypertext (HTML objects) embedded in a graphical view
- Supports navigation and exploration of diverse perspectives of the information space
- Domain independent



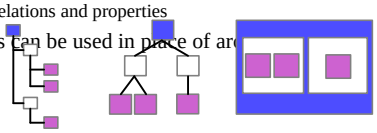
Jambalaya

- Protégé + SHriMP, using the Java Bean plug-in architecture supported by both tools
- The integration enabled alternative visualization and navigation mechanisms to be used in Protégé

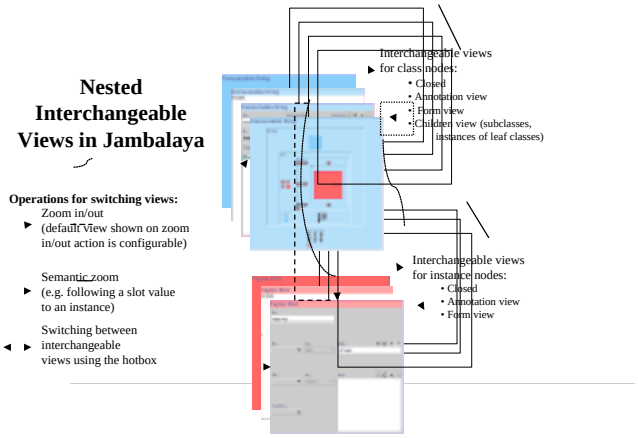


Using Jambalaya to model knowledge

- Directed graph consisting of nodes and arcs
- Nodes represent concepts (classes) and instances
- Arcs represent relations between concepts and instances
  - Hierarchy relations (is-a, instance-of)
  - Structural relations and properties
- Nested nodes can be used in place of arcs of relation



Nested Interchangeable Views in Jambalaya



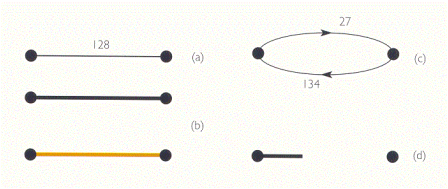
Navigation and Browsing

- 2 aspects of navigation
  - Recognizing location (orientation)
    - Current viewpoint
    - Show path to the current location
  - Controlling location
    - Relative movement
    - Absolute movement
    - Teleportation (bookmarks)
    - Hyperspace movement (using relationships)
    - Moving the space

Scalability – dealing with links

- Filtering
- Fisheye views (distortion)
- Abstractions (nodes and arcs)

Link representations (SeeNet)

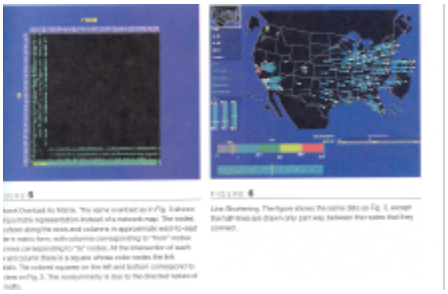


SeeNet

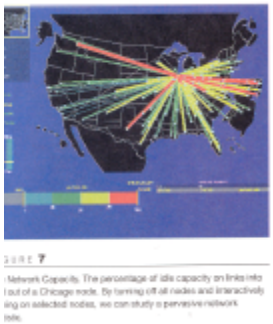
SeeNet -- Linkmap

SeeNet-- Nodemap

SeeNet (variations in dealing with many links)



SeeNet – looking at inverse of information



SeeNet – zooming in

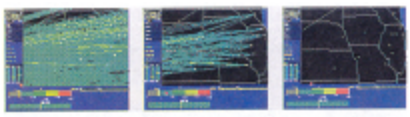
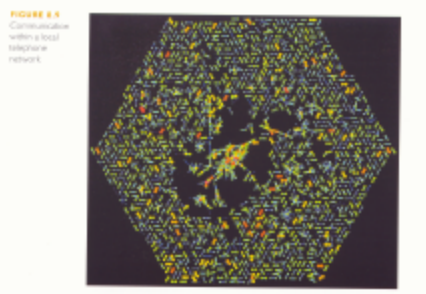


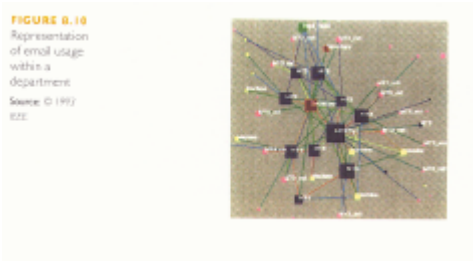
FIGURE 8

Interaction Between Links And Zooming. The zoomed area is in the interior of the network shown in Fig. 3. The left pane shows all lines, the middle pane shows all lines termination within the zoomed area, and the right pane shows all lines that both originate and terminate in the zoomed area.

Local telephone network

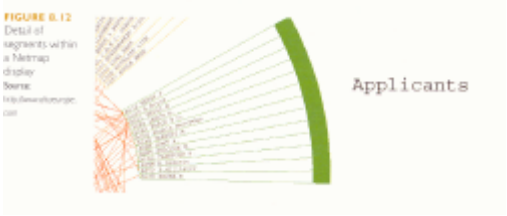


Electronic mail



Netmap

Netmap



Netmap

Netmap

Netmap

Netmap

Daisy

Parameter Focusing

- Statistics
- Levels (thresholds)
- Geography/Topography
- Time
- Aggregation
- Size
- Color

Summary of Direct Manipulation Controls in SeeNet

- Identification
- Linkmap Parameter Controls
- Matrix Display Parameter Controls
- Nodemap Parameter Controls
- Animation
- Zooming and birds-eye views
- Conditioning (filtering)
- Sound
  - Node state changes
  - Slider values
  - Animation frame changes