Overview

A) Hierarchical visualization techniques

B) Visualizing hierarchical data

[Keim, 2001]
Part A

hierarchical visualization techniques
Problem

Data
multivariate data (e.g., Movie DB, Car dataset)

Presentation space
display dimensionality constrained to 2D or 3D

Task
meaningful representation of all variables within a single plot

How?
Example

4 variables:
- longitude
- latitude
- ore grade
- depth
Dimensional Stacking

[LeBlance et al. 1990]

Visualization of oil mining data with longitude and latitude mapped to the outer x-, y- axes and ore grade and depth mapped to the inner x-, y- axes

Used by permission of M. Ward, Worcester Polytechnic Institute
Dimensional Stacking

Partitioning of the n-dim. attribute space in 2-dim. subspace, which are “stacked” into each other

Partitioning of the attribute value ranges into classes

Important attributes should be used on the outer levels

Adequate especially for data with **ordinal** attributes of **low** cardinality

[LeBlance et al. 1990]
Dimensional Stacking

Given

Variables $V_1 - V_m$
Power of the Domain: Cardinalities $K_1 - K_m$

Process

2 Variables $V_i, V_k \rightarrow K_i \times K_k$ Grid

[LeBlance et al. 1990]
Dimensional Stacking

Recursive Repetition with a Grid with Additional Pairs of Variables

Dummy-Variable: 2n-1 Variables

[LeBlance et al. 1990]
Example

Variable: $V_1 - V_6$

Numbers of Cardinality:
\[ K_1 = 4, K_2 = 2, K_3 = 2, K_4 = 3, K_5 = 3, K_6 = 2 \]

[LeBlance et al. 1990]
Example

Variables: $V_1$-$V_6$
Cardinalities: $K_1=4, K_2=2, K_3=2, K_4=3, K_5=3, K_6=2$
Pairs $P_1(V_1,V_3), P_2(V_4,V_5), P_3(V_2,V_6)$
Example - Combination: 4,2,3,2,2,2

[LeBlance et al. 1990]
Worlds-within-Worlds

Partitioning of the n-dim. Space into 3-dim. Subspace

Nested 3-dim coordinates

3-dim coordinate = one property

Selected points --> new coordinates’ system

[Feiner & Besherss 1990]
Worlds-within-Worlds

[Feiner & Besherss 1990]
Part B
visualizing hierarchical data
Basic Data Characteristics

network / graph
items (nodes) that have relationships (links)
no inherent hierarchical structure

hierarchical / tree
parent - child relationships
every node has at most one parent
exactly one root node
mostly non-leaf nodes are containers only
Data

Hierarchical data are **very common**

Hierarchies are one of the most prevalent organizing principles for coping with information

application examples

organizations, org-charts, taxonomies, table of contents, sitemaps, file system, genealogies, ...
Tasks

- reducing complexity
  - categorization - hierarchies (expand/collapse)
- overview of topology
  - distribution
- examine relationships
- examine paths
- examine elements
- identify
- locate
- distinguish
- relate
- compare
Illustrating example

Data: file system

Problem/task: disk is full --> free some space

How?

Tool?

Visualization?

Visual Encodings

indentation
representation of hierarchy level via indentation
focus on linear structure

connection
node-link diagrams
convention: root mostly on top, leafs on bottom
aspect ratio

containment
 summed values
propagation through hierarchy
space-filling graphs

adjacency matrices
graph as table
nodes as rows/columns
edges as table cells

Images 1 and 2:
Node-link diagrams

Graph drawing
huge area
lots of theory and algorithms

Good layout is important for effective presentation of inherent structure
basic layouts
linear
tree
radial
force directed
spring
gravity
magnetic

Links - Gestalt law - line smoothness

Images:
- Jeffrey Heer, Tree Visualization, SIMS 247: Information Visualization and Presentation, 2005.
- Max Baker, Netdisco, http://netdisco.net/
Interaction

why?

aspect ratio
large information space
do not fit onto display space
Problem: large structures that don't fit on a single view/screen

expand / collapse

navigate

focus + context

see upcoming lecture for details
visualization techniques
Indented Lists

representation of hierarchy level via indentation

focus on linear structure
SpaceTree / DOI Tree

[Plaisant et al., 2002]

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

http://prefuse.org/gallery/treeview/

[Heer and Card, 2004]
Cone Trees

[Robertson, Mackinlay, Card 1991]

Figure 5: A Standard 2D Cone Tree.

Figure 9: A 3D Cone Tree.
Cone Trees vs. Cam Trees

Vertical (Cone Tree) vs. Horizontal (Cam Tree)

Shadows provide 2D structure
Cone Trees

Important: Interaction!

Figure 1: Layout of a simple Cone Tree, before and after selection.

Figure 2: Layout of a simple Cam Tree, before and after selection.

Figure 4: Result of a Search Operation.

[Robertson, Mackinlay, Card 1991]
Starlight – File System

[Pacific Northwest National Laboratory – USA]
Balloon Trees

Flattened cone trees

[Herman, Melancon, and Marshall, 2000]
Hyperbolic Trees

Nodes are placed on hyperbolic geometry (inside of a sphere)

Projection into 2D

F+C

[Munzner, 1998] Demo
FAS.research
Social Network Analysis
http://www.fas.at/
Containment

[Shneiderman 1992; Johnson, 1993]
InfoCube

3 D Visualization of Hierarchical Data Using Transparent Boxes

[Rekimoto & Green 1993]
Application example: Clustering search engine

Vivisimo

Indented list

http://www.vivisimo.com
Application example: Clustering search engine

Grokker

Containment hierarchy

http://www.grokker.com
Venn-Diagram --> Treemaps

Nested Treemap

Treemap:

[Shneiderman 1992; Johnson, 1993]
Example: File Structure to Tree

File System:
3 Folders
6 Files

1) Root -> whole Screen
Example: File Structure to Tree

File System:
3 Folders
6 Files

2) Cutting - according to the size (30% and 70% of the space)
Example: File Structure to Tree

File System:
3 Folders
6 Files

3) Iteration: folder and subfolder
Example: File Structure to Tree

File System:
3 Folders
6 Files

One Solution

File System:
Dir 1
File 1 1 MB
File 2 2 MB

Dir 2
File 3 2 MB
File 4 3 MB
File 5 1 MB
File 6 1 MB

Demo
**Treemap:** View Large Trees with Node Values

- Space filling
- Space limited
- Color coding
- Size coding
- Requires learning

TreeViz (Mac, Johnson, 1992)
NBA-Tree (Sun, Turo, 1993)
Winsurfer (Teittinen, 1996)
Diskmapper (Windows, Micrologic)
Treemap3 (Windows, UMd, 2001)

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

(Shneiderman, *ACM Trans. on Graphics*, 1992)
Finance Analysis
Gainers (bright green)

http://www.smartmoney.com/marketmap
Finance Analysis

Losers (bright red)

http://www.smartmoney.com/marketmap
http://www.hivegroup.com/
http://www.hivegroup.com/

Wikipedia: Country Population, Density & Area

<table>
<thead>
<tr>
<th>GROUP by:</th>
<th>SIZE represents:</th>
<th>COLOR represents:</th>
</tr>
</thead>
</table>

**World -- Continents**

**Asia**
- People's Republic of China: 1,291,268,524 People, 0.6,667,775 Sq. KM, 195 People per Sq. KM, #1 in Population, #4 in Area, #67 in Density
- India: 1,085,070,677 People, 2,875,500 Sq. KM, 242 People per Sq. KM, #2 in Population, #7 in Area, #20 in Density

**Africa**
- Egypt: 92,474,337 People, 3,866,570Sq. KM, 237 People per Sq. KM, #1 in Population
- South Africa: 56,408,327 People, 5,178,888 Sq. KM, 109 People per Sq. KM, #2 in Population

**Europe**
- Germany: 82,424,370 People, 337,022 Sq. KM, 247 People per Sq. KM
- Italy: 63,981,320 People, 301,230 Sq. KM, 212 People per Sq. KM
- Spain: 46,940,091 People, 404,923 Sq. KM, 116 People per Sq. KM

**North America**
- United States: 293,776,777 People, 9,639,090 Sq. KM, 30 People per Sq. KM

**South America**
- Brazil: 184,183,911 People, 8,571,668 Sq. KM, 21 People per Sq. KM

**Australia & Oceania**
- Australia: 20,986,264 People, 7,692,024 Sq. Km, 277 People per Sq. KM
- New Zealand: 4,020,900 People, 268,680 Sq. KM, 149 People per Sq. KM

Displaying: 195 of 195 Countries

Labels: ✓ Turn Labels On/Off

Text Search Filter: 

Need Help?
Treemap: Product catalogs

Hierarchical techniques
Treemap: Newsmapper

http://marumushi.com/apps/newsmapper/
TreeMaps Summary

Turning a tree into a planar space-filling map

Capacity to see tens of thousands of nodes in a fixed space and find large areas or duplicate directories is very powerful

Treemap algorithms

- BinaryTree
- Ordered
- SliceAndDice
- Squarified
- Strip

Beamtree

Map of the market [Wattenberg, smartmoney.com]
Icicle Trees

Tree levels side by side horizontal / vertical

Subdivision by size

Sunburst Tree

Radial version of icicle trees

Interaction facilities to navigate / zoom

Botanical Visualization of Huge Hierarchies

[Holton’s “Strang Modell”]

Nodes and link diagram

Figure 10. Complete hard disk with $\alpha = 45$ and $\beta = 360/\phi$. 

[Kleiberg, van de Wetering & van Wijk, 2001]
Botanical Visualization

Alternative 3D Visualization to Big Hierarchies

Branches Clash Seldom, Even Though no Particular Algorithm is Included

Adapted Phi-Balls are Appropriate for Big Files
Botanical Visualization: Summary

Alternative 3D Visualization to Big Hierarchies

Branches Clash Seldom, Even Though no Particular Algorithm is Included

Adapted Phi-Balls are Appropriate for Big Files

[Kleiberg, van de Wetering & van Wijk, 2001]
[Slides from Novotny, 2003]
Summary

Hierarchical visualization techniques
Re-usage of display dimensions

Visualization of hierarchical data
Hierarchical / tree data
Parent/child relationships
Widespread and common data structure

Representations
Indented lists
Node-Link diagrams
Containment diagrams
Adjacency matrices
Useful Stuff

Treemap

HCIL Treemap Browser <http://www.cs.umd.edu/hcil/treemap>
Map of the Market <http://www.smartmoney.com/marketmap>
Newsmap <http://marumushi.com/apps/newsmap/>
The Hive Group <http://www.hivegroup.com>
HyperTree Java Library <http://hypertree.sourceforge.net/>

SpaceTree <http://www.cs.umd.edu/hcil/spacetree>

Tree Visualizer <http://www.randelshofer.ch/oop/treeviz/index.html>

VisualComplexity.com <http://www.visualcomplexity.com>

ManyEyes <http://www.many-eyes.com>

Search Engines / Clustering

Vivisimo <http://www.vivisimo.com>
Grokker <http://www.grokker.com>
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