# Hierarchies, Graphs, and Networks (oh my)

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### **Hierarchies**



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### **Hierarchies**



Chart reflects PAS officials and those reporting directly to the Secretary and Deputy Secretary of Defense

Management

Prepared by: Organizational & Management Planning, ODA&M, OSD Date: January 2008

Evaluation

### Hierarchies

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10 items, 674.18 GB available							

### What are we trying to discover?

It is all about structure and relationships

![](_page_6_Figure_2.jpeg)

### Trees

### Node-link graph

![](_page_7_Figure_2.jpeg)

![](_page_8_Figure_0.jpeg)

![](_page_9_Figure_0.jpeg)

![](_page_10_Figure_0.jpeg)

### Challenges

We need to display both structure **and** data

Structure consumes space

The amount of data grows exponentially with the depth

### **Conventional tree visualization**

![](_page_11_Figure_1.jpeg)

### **Radial layout**

![](_page_12_Figure_1.jpeg)

### **SpaceTree**

![](_page_13_Figure_1.jpeg)

Grosjean, et al. "SpaceTree: Supporting Exploration in Large Node Link Tree, Design Evolution and Empirical Evaluation"

### Two views of a tree

![](_page_14_Figure_1.jpeg)

### **Cone Trees**

![](_page_15_Figure_1.jpeg)

## Hyperbolic browser

The tree is laid out in hyperbolic space and mapped back to the unit circle.

> Can show 10x the number of nodes of a standard 2D approach (1000 vs. 100)

![](_page_16_Figure_3.jpeg)

Lamping et al. "A Focus + Context Technique Based on Hyperbolic Geometry for Visualizing large Hierarchies"

## **3D Hyperbolic Tree**

![](_page_17_Picture_1.jpeg)

## **Force-directed radial layout**

![](_page_18_Figure_1.jpeg)

### **Degree-of-Interest (DOI) Trees**

![](_page_19_Picture_1.jpeg)

![](_page_19_Figure_2.jpeg)

![](_page_19_Figure_3.jpeg)

Card and Nation, "Degree-of-Interest Trees: A Component of an Attention-Reactive User Interface"

### **Degree-of-Interest Trees**

![](_page_20_Picture_1.jpeg)

Card and Nation, "Degree-of-Interest Trees: A Component of an Attention-Reactive User Interface"

## Space filling trees

![](_page_21_Picture_1.jpeg)

![](_page_21_Picture_2.jpeg)

### Connections

### Containment

### Treemaps

#### http://www.cs.umd.edu/hcil/VisuMillion/

![](_page_22_Figure_2.jpeg)

### **Building a treemap**

makeTreeMap(node, orientation) for each child of node if orientation is vertical create rectangle with width scaled as proper percentage of node if child has children makeTreeMap(child, horizontal) else create rectangle with height scaled as proper percentage of node if child has children makeTreeMap(child, vertical)

### Treemaps

Example: Sales figures (\$M)

#### **North America**

United States (\$200) Canada (\$200)

#### Europe

Germany (\$150) Austria (\$100) Russia (\$150) Sweden (\$100)

#### Asia

S. Korea (\$50) China (\$50)

![](_page_24_Picture_8.jpeg)

### **Treemaps** Example: Sales figures (\$M)

#### North America (\$400)

United States (\$200) Canada (\$200) **Europe (\$500)** Germany (\$150) Austria (\$100) Russia (\$150) Sweden (\$100)

#### Asia (\$100)

S. Korea (\$50) China (\$50)

![](_page_25_Picture_5.jpeg)

### **Treemaps** Example: Sales figures (\$M)

### North America (\$400) United States (\$200) Canada (\$200) Europe (\$500) Germany (\$150) Austria (\$100) Russia (\$150) Sweden (\$100) S. Korea (\$50) China (\$50)

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\$150	\$150	\$100	\$100
\$50	\$50		

### **Treemaps** Example: Sales figures (\$M)

### North America (\$400)

- United States (\$200) Canada (\$200) **Europe (\$500)** Germany (\$150) Austria (\$100) Russia (\$150) Sweden (\$100) **Asia (\$100)** 
  - S. Korea (\$50) China (\$50)

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Germany	Russia	Austria	Sweden
(\$150)	(\$150)	(\$100)	(\$100)
S. Korea	China	a	
(\$50)	(\$50)	)	

### **Nested treemap**

![](_page_28_Figure_1.jpeg)

## **Cushion treemaps**

![](_page_29_Figure_1.jpeg)

## Not a cushion treemap

![](_page_30_Picture_1.jpeg)

### The aspect ratio problem...

![](_page_31_Picture_1.jpeg)

### The aspect ratio problem...

![](_page_32_Figure_1.jpeg)

## **Squarified treemaps**

![](_page_33_Figure_1.jpeg)

### Even more approaches...

![](_page_34_Figure_1.jpeg)

Slice-and-dice

Cluster

### Squarified

![](_page_34_Figure_5.jpeg)

Pivot-by-middle

Pivot-by-size

Strip

### **Example: Presidential election 2012**

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### **Example: Movie budgets**

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## **Example: News stories**

http://newsmap.jp

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### **Circular partition treemaps**

![](_page_38_Picture_1.jpeg)

![](_page_38_Figure_2.jpeg)

### Voronoi treemaps

![](_page_39_Figure_1.jpeg)

Balzer et al. "Voronoi Treemaps for the Visualization of Software Metrics"

### **Voronoi Treemaps**

![](_page_40_Figure_1.jpeg)

![](_page_40_Picture_2.jpeg)

### **Circular treemaps**

![](_page_41_Figure_1.jpeg)

http://visualign.wordpress.com/tag/treemap/

### Networks

![](_page_42_Figure_1.jpeg)

Network

## **Graph representations**

### vertex and edge tables

edge	source	sink	node	attr1	attr2
1	А	В	А	-	-
2	В	С	В	-	-
			C		

### adjacency lists

A:	В	
B:	Α,	С
C:	В	

#### adjacency matrix

	А	В	С
А	0	1	0
В	1	0	1
С	0	1	0

Node - link diagram

![](_page_43_Picture_8.jpeg)

### Shneiderman's NetViz Nirvana

Every node is visible

For every node, you can count its degree

For every link you can follow it from source to destination

Clusters and outliers are identifiable

### **Aesthetic considerations**

#### Minimize

- edge crossings
- area
- line bends
- line slopes
- total edge length
- max edge length
- edge length variance

#### Maximize

- smallest angle between edges
- symmetry

![](_page_45_Figure_12.jpeg)

### **Graph visualization**

What do nodes look like?

What do links look like?

![](_page_46_Figure_3.jpeg)

How do we lay out the graph?

![](_page_46_Picture_5.jpeg)

## Edge styles

![](_page_47_Picture_1.jpeg)

![](_page_47_Picture_2.jpeg)

Straight

![](_page_47_Picture_4.jpeg)

Orthogonal

## **Common layout styles**

![](_page_48_Figure_1.jpeg)

http://www.thenetworkthinkers.com/2013/03/big-data.html

### Hierarchical graph layout Sugiyama layout

![](_page_49_Figure_1.jpeg)

http://www.roguewave.com/

## **Force-directed layout**

### Constraint-based layout

![](_page_50_Figure_2.jpeg)

### Force directed layout

![](_page_51_Figure_1.jpeg)

## **Circular layout**

![](_page_52_Figure_1.jpeg)

http://www.perceptualedge.com/blog/?p=680

### Circular graph + hierarchical edge bundling

![](_page_53_Figure_1.jpeg)

http://mbostock.github.io/d3/talk/20111116/bundle.html

## Chord diagram

![](_page_54_Figure_1.jpeg)

![](_page_55_Figure_0.jpeg)

## Geographic

![](_page_56_Picture_1.jpeg)

## **Clustered graph layout**

![](_page_57_Picture_1.jpeg)

Balzer and Deussen, "Level of Detail Visualization of Clustered Graph Layouts"

![](_page_57_Figure_3.jpeg)

20110313-NodeXL-Twitter-msrtf11 OR techfest group layout
<u>http://research.microsoft.com/en-us/projects/nodexl/</u>

![](_page_57_Figure_5.jpeg)

http://www.personal.psu.edu/lug129/blogs/serendipity/graph-drawing/

### **Adjacency matrix**

![](_page_58_Figure_1.jpeg)

### MatrixExplorer

![](_page_59_Figure_1.jpeg)

Henry and Fekete, "MatrixExplorer: a Dual-Representation System to Explore Social Networks"

## MatrixExplorer

![](_page_60_Figure_1.jpeg)

Henry and Fekete, "MatrixExplorer: a Dual-Representation System to Explore Social Networks"

![](_page_61_Figure_0.jpeg)

![](_page_61_Picture_1.jpeg)

![](_page_62_Figure_0.jpeg)

### Case Study: VAST 2008 Challenge

![](_page_63_Figure_1.jpeg)

### Case Study: VAST 2008 Challenge

![](_page_64_Figure_1.jpeg)

### Jigsaw

![](_page_65_Figure_1.jpeg)