Hierarchies and Trees 2 (Space-filling)

CS 4460 – Intro. to Information Visualization
November 1, 2017
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Learning Objectives

- Understand original treemap algorithm
- Appreciate different applications of treemaps
  - Stocks, tennis, geography, elections, …
- Explain shortcomings of original algorithm and why squarified treemaps often preferred
- Describe SunBurst layout
- Compare and contrast SunBurst to Treemap (+/-)
- Describe circle-packing approach

Hierarchies

Recall

- Definition
  - Data repository in which cases are related to subcases
  - Can be thought of as imposing an ordering in which cases are parents or ancestors of other cases

Last Time: Node-Link Reps

Hyperbolic tree

Traditional
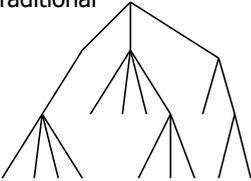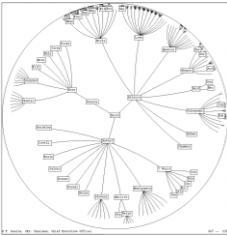
Lamping & Rao

ConeTree
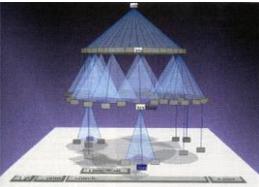
SpaceTree

Card, Mackinlay & Robertson

Plaisant, Grosjean & Bederson

Treemap Example
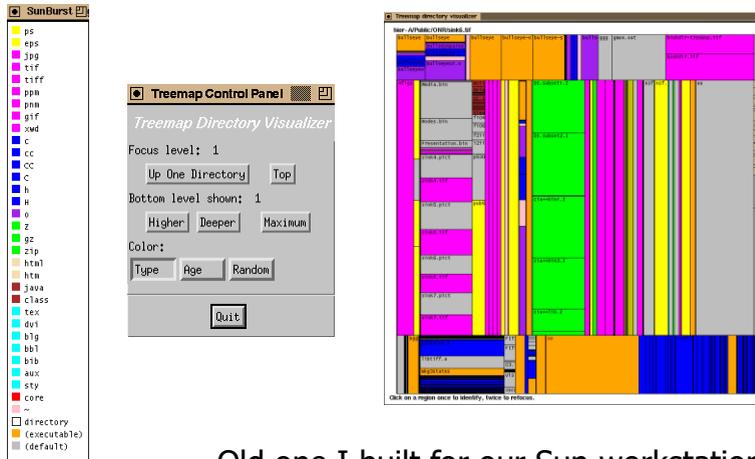
Old one I built for our Sun workstations

Quiz

3

Applications

- Can use Treemap idea for a variety of domains
  - File/directory structures
  - Basketball statistics
  - Software diagrams
  - Tennis matches

Tennis Viewing Application

- Analyze, review and browse a tennis match
- Space-filling/treemap-like hierarchy representation for a competition tree
- Shows match,sets,games,points
- Uses lenses to show shot patterns
- Red/green to encode two players
- Composite colors on top of each other

Jin and Banks
IEEE CG&A `97

4

Visualization Make-up

Composite

Games

Set
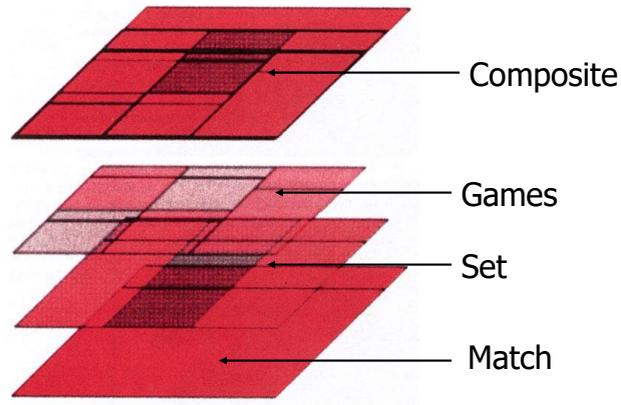
Match

Simulated Match Results

Match view

Bond won

Set results

Lens showing
ball movement on
individual points

Game results

Treemap?

Very nice infographic

Figure 4.1 Global distribution of the world's water

Note: see Chapter 3 on water that is easily available to plants.

Total water
Oceans 97.5%

Freshwater 2.5%

Freshwater

Glaciers 68.7%

Groundwater 30.1%

Permafrost 0.8%

Surface and atmospheric water 0.4%

Surface and atmospheric water

Freshwater lakes 67.4%

Soil moisture 12.2%

Atmosphere 9.5%

Other wetlands 8.5%

Rivers 1.6%

Plants and animals 0.8%

Source: WWAP 2006, based on data from Shiklomanov and Rodda 2003
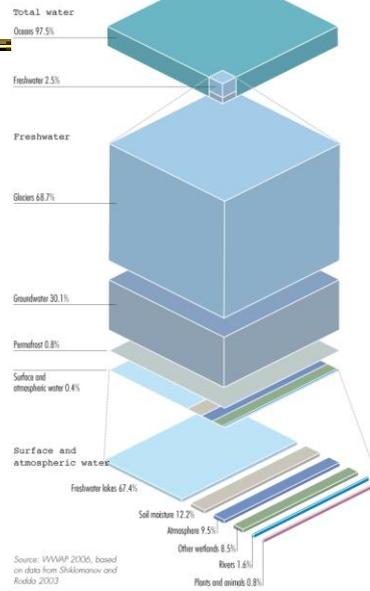
Treemap Affordances

- Good
  - Representation of two attributes beyond node-link: color and area
- Not as good
  - Representing structure
    - What happens if it's a perfectly balanced tree of items all the same size?
    - Also can get long-thin aspect ratios
    - Borders help on smaller trees, but take up too much area on large, deep ones

Aspect ratios

These kinds of rectangles are visually unappealing

Which has bigger area?

Variation

- What could we do to remedy those issues?

- Can rectangles be made more square?
  ……think about it……
  - In general, a very hard problem!

Variation: "Cluster" Treemap

- SmartMoney.com Map of the Market
  - Illustrates stock movements
  - "Compromises" treemap algorithm to avoid bad aspect ratios
  - Basic algorithm (divide and conquer) with some hand tweaking
  - Takes advantage of shallow hierarchy
  - `www.smartmoney.com/marketmap`
    Defunct now

Image on next slide

Wattenberg
CHI '99
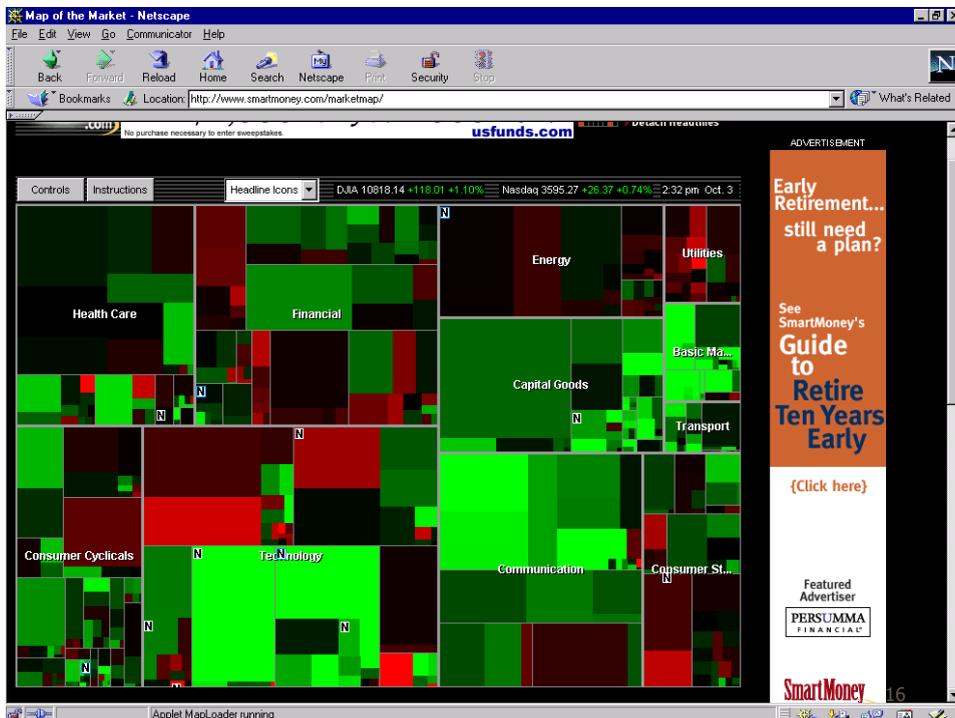
Fall 2017   CS 4460   15

A good
day :^)
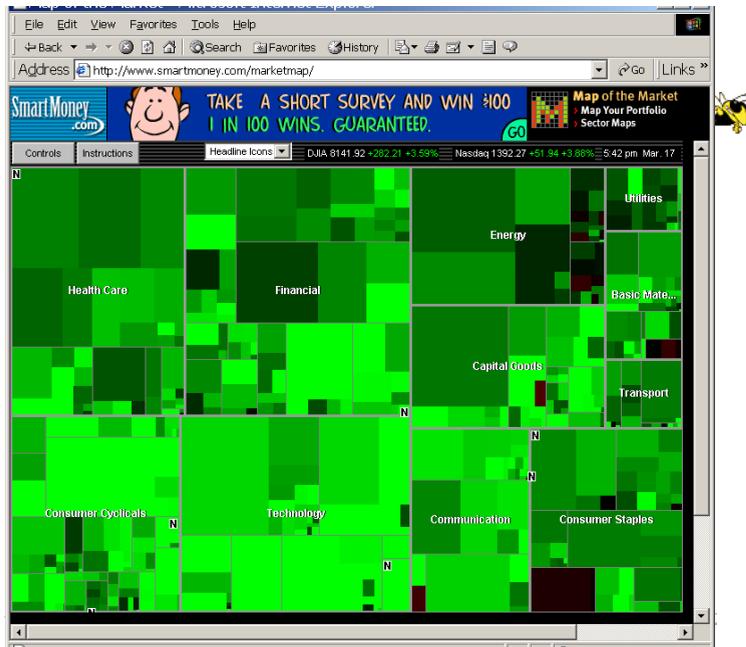
More recent times   Sept. 29, 2008

9
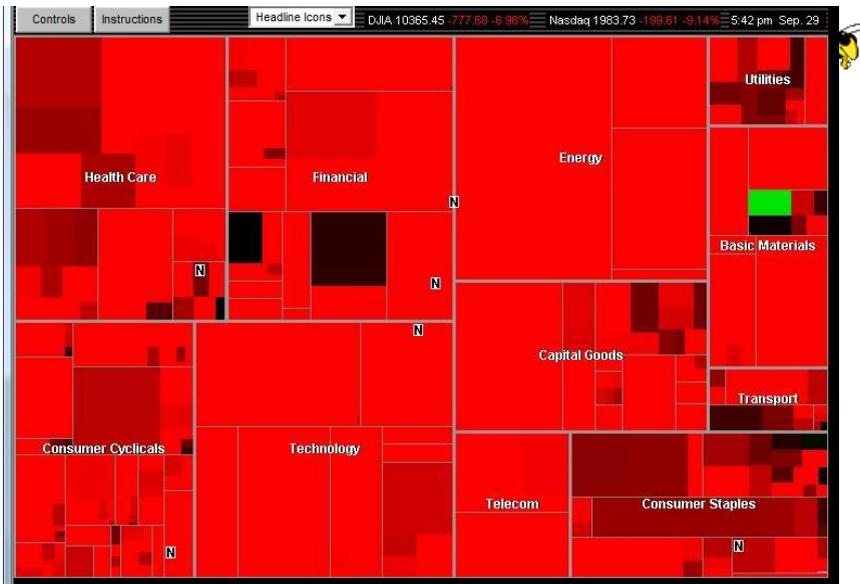
Newer One (also now defunct)
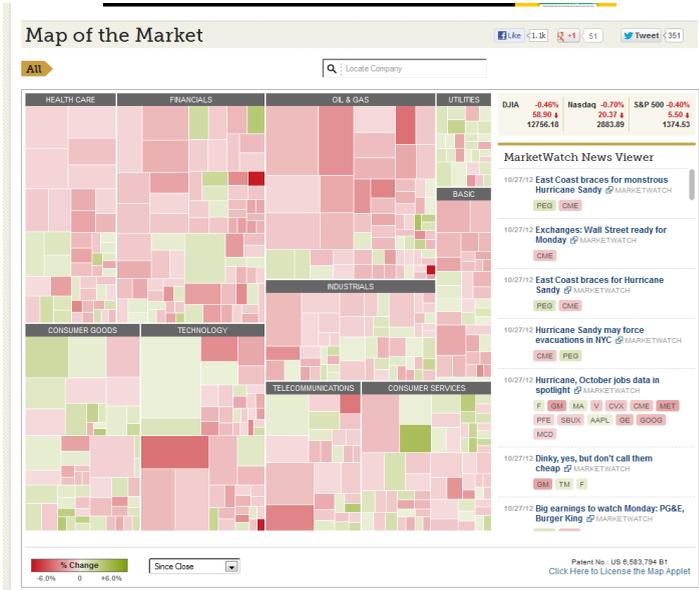
I don't like it as much

(Where's the nice control panel?)

A variant

https://finviz.com/map.ashx

SmartMoney Review

- Tufte-esque micro/macro view
- Dynamic user interface operations add to impact
- One of best applications of an InfoVis techniques that I've seen

Squarified Problem

- On some of the algorithms, a small change in data values makes all the rectangles drastically change position (unstable layout)

- Newer variants developed to address that problem

Other Variants Arose
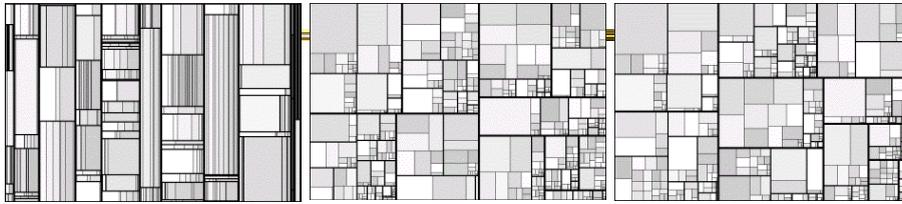
Slice-and-dice

Cluster

Squarified
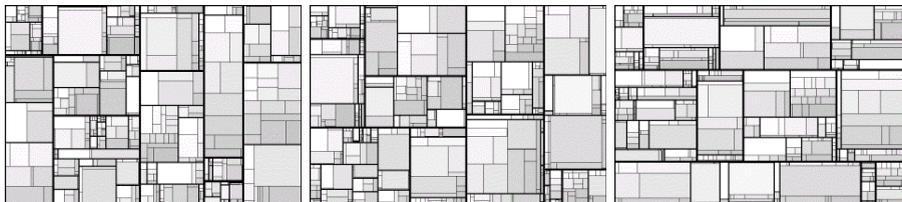
Pivot-by-middle

Pivot-by-size

Strip

Showing Structure

- Regular borderless treemap makes it challenging to discern structure of hierarchy, particularly large ones
  - Supplement Treemap view
  - Change rectangles to other forms

Variation: Cushion Treemap

Add shading and texture
to help convey structure
of hierarchy

Van Wijk & van de Wetering
InfoVis '99
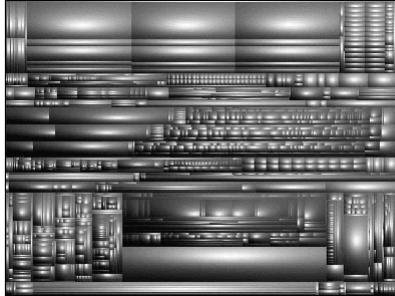
SequoiaView

`www.win.tue.nl/sequoiaview/`

File visualizer
built using
cushion treemap
notion
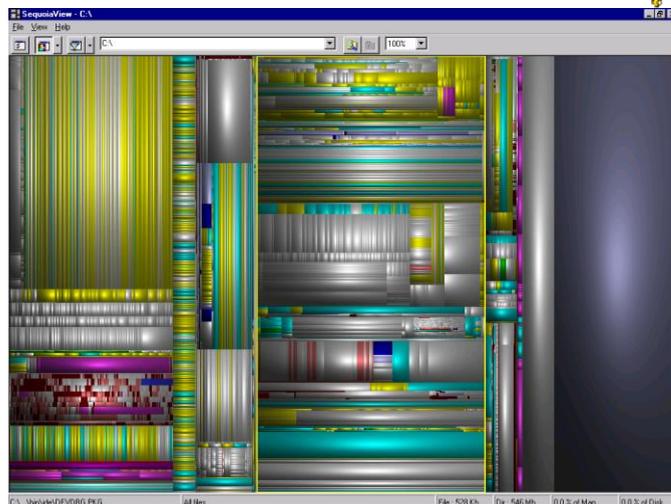
Demo

Treemap Applications

Product Sales

www.hivegroup.com/amazon.html

The Hive
Group

14

News Stories

Marumushi

Investment Portfolios
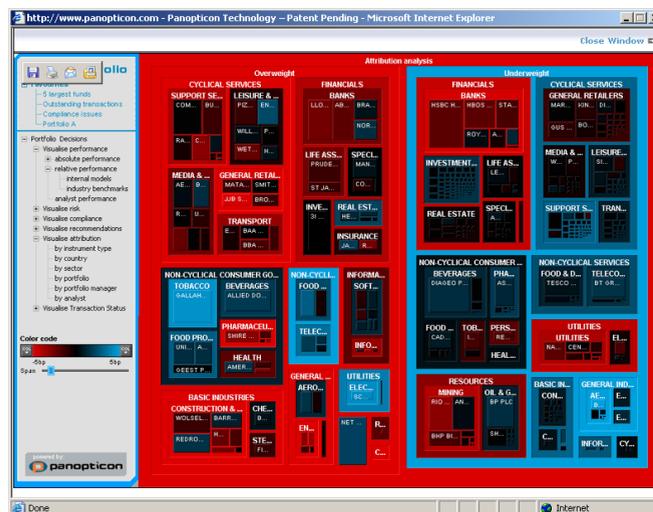
Panopticon

15

Federal Budget
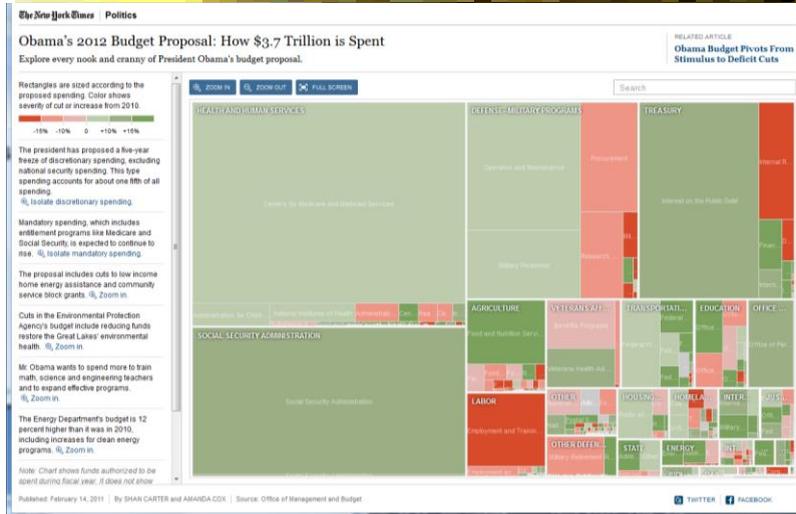
Geography

2012 Presidential Election
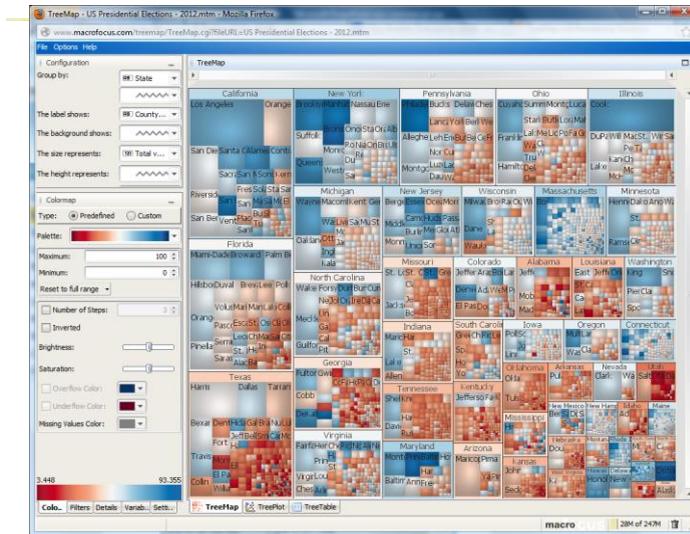
Scaling Up

Fig. 5. *Hierarchical Network Map* displaying all 19,731 autonomous systems (one can still zoom in twice for details) on a large display wall (5.20m × 2.15m, 8.9 Megapixels, powered by eight projectors). The query interface on the top left shows the traffic distribution over time and specifies the selected data, in this case the traffic entering the gateway of the University of Konstanz on *well-known ports (0-1023)* on 29 November 2005 using "transferred bytes" as measure with logarithmic color mapping. One recognizes a heavy traffic load from AS 3320 (red) of "Deutsche Telekom" as well as to neighboring autonomous systems in Germany. A port histogram reveals high activity on the Web ports 80 and 443. For security and privacy reasons, the data was aggregated and sanitized.

Mansmann & Vinnik
TVCG '06

Voronoi Treemaps
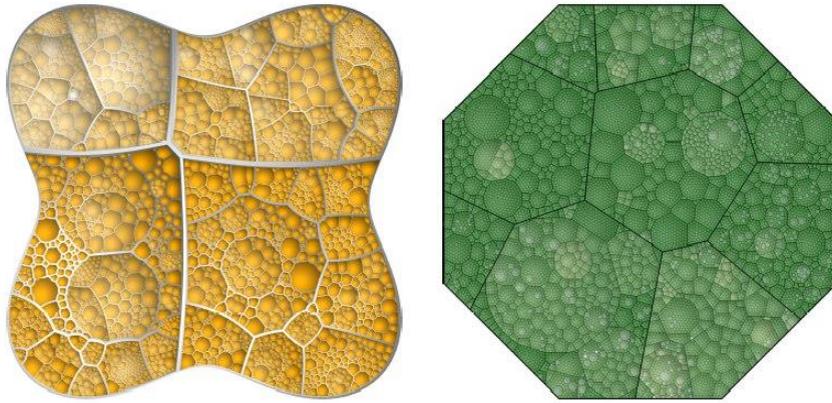
Fit hierarchy to arbitrary shaped regions

FoamTree

https://carrotsearch.com/foamtree/
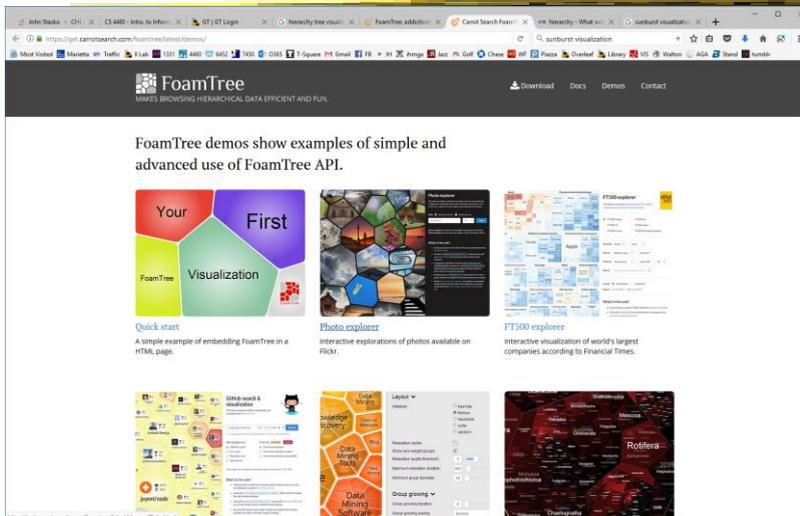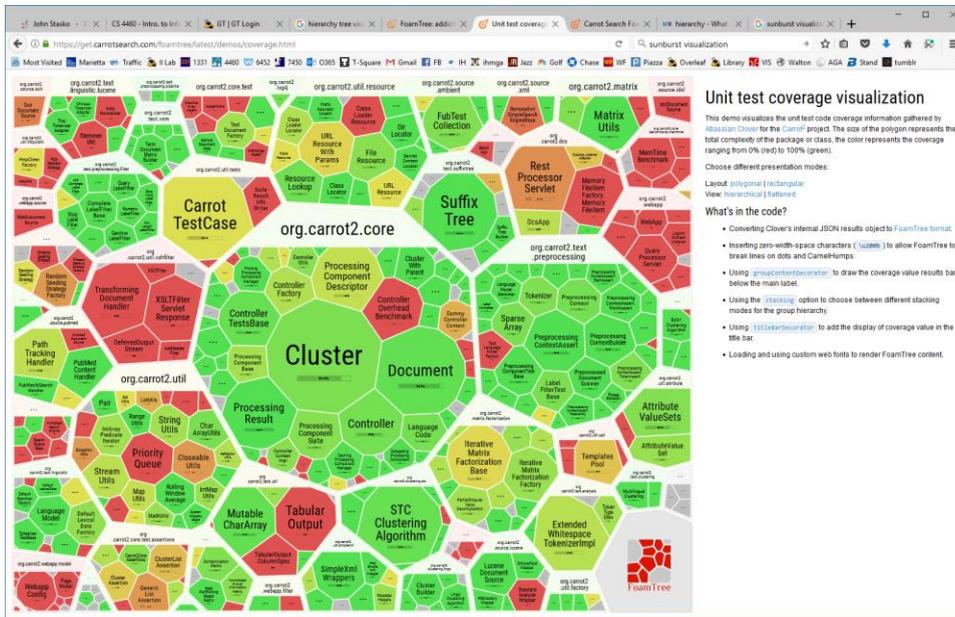
www.cs.umd.edu/hcil/treemap-history/

The World of Treemaps

Maryland HCIL
website devoted
to Treemaps
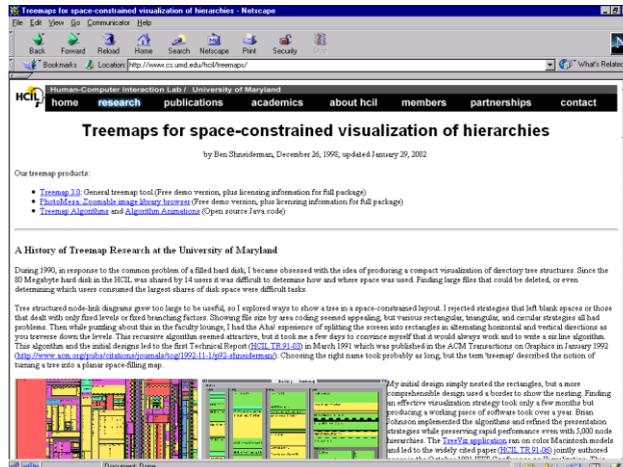
Limitation?

- What is primary shortcoming of treemap as a hierarchical data set representation?

- How could we do better?
  - Keep advantages without incurring disadvantages

Another Technique

- What if we used a radial rather than a rectangular space-filling technique?
  - We saw node-link trees with root in center and growing outward already...
- Make pie-tree with root in center and children growing outward
  - Radial angle now corresponds to a variables rather than area
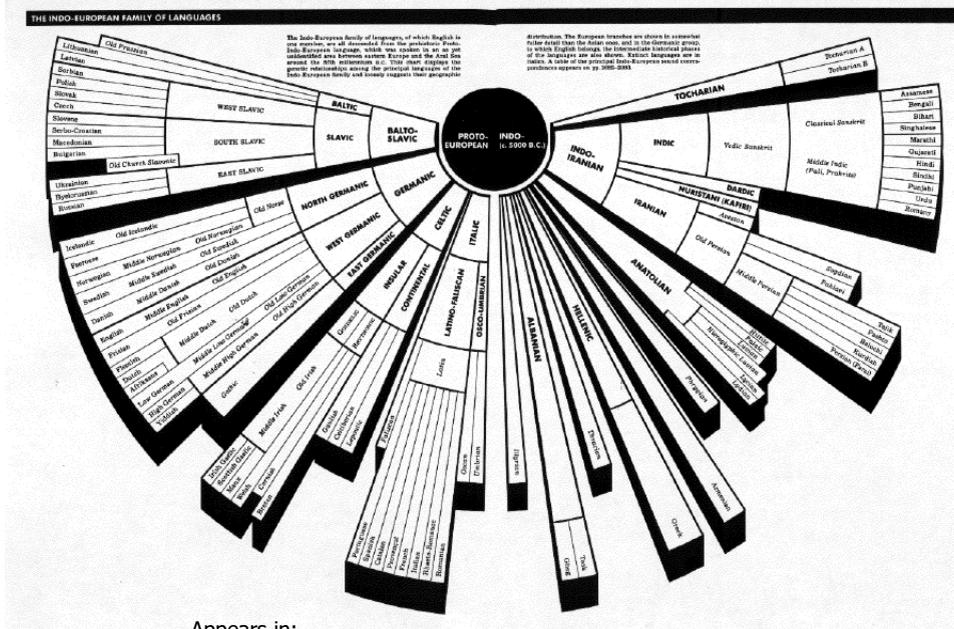
Appears in:
American Heritage Dictionary, 3rd Ed. Houghton Mifflin, 1992

Radial Space-Filling

Chuah
InfoVis '98

Andrews &
Heidegger
InfoVis '98

SunBurst

Demo

SunBurst

- Root directory at center, each successive level drawn farther out from center
- Sweep angle of item corresponds to size
- Color maps to file type or age
- Interactive controls for moving deeper in hierarchy, changing the root, etc.
- Double-click on directory makes it new root

Empirical Study

- Compared SunBurst to Treemap (borderless) on a variety of file browsing tasks
  - SunBurst performed as well (or better) in task accuracy and time
  - Learning effect - Performance improved with Treemap on second session
  - Strong subjective preference (51-9) for SunBurst
  - Participants cited more explicit depiction of structure as an important reason

More to come on evaluation...

SunBurst Negative

- In large hierarchies, files at the periphery are usually tiny and very difficult to distinguish

examples

Displaying 2965 files.

Help the Problem

(a) (b) (c)

(d) (e) (f)

Use interaction and animation to select and focus on areas

Pull out a subtree

Video

Stasko & Zhang
InfoVis '00

SunBurst-omania
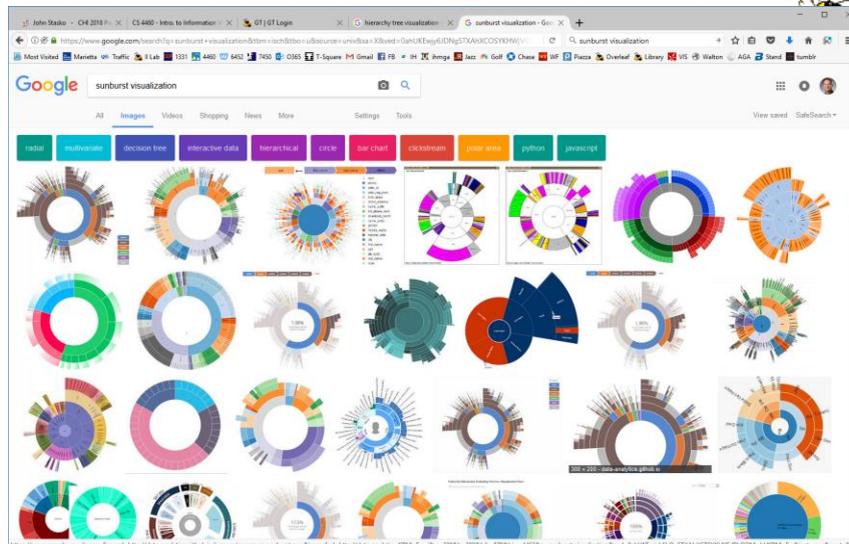
Even Sand Crabs Do It

http://www.flickr.com/photos/jkr1812/2234846316/in/gallery-49563472@N07-72157624817856060/lightbox/

Some Other Approaches

Zoomology

CS 7450
Spring '03
project

InfoVis '03
Contest Winner
Best Student
entry
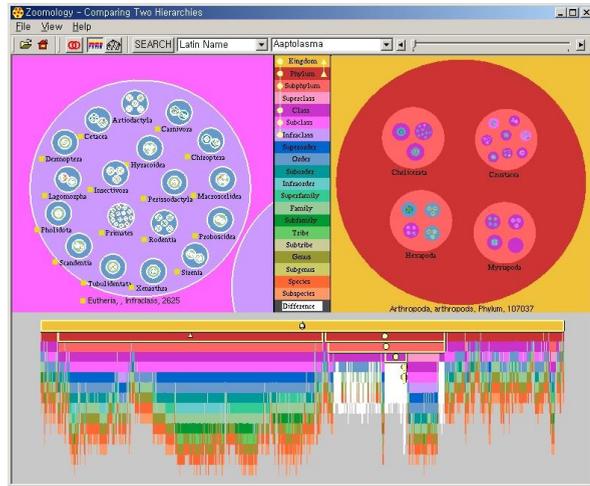
Alternate View

Video
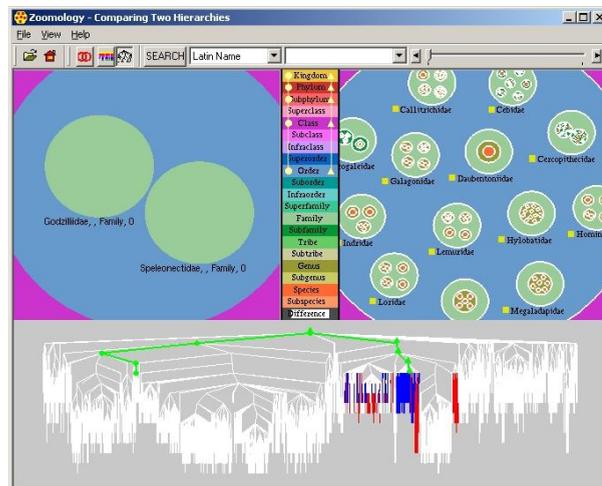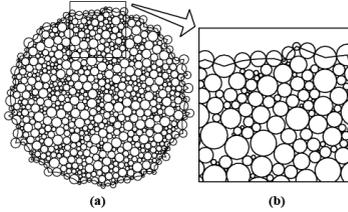
Circle Packing

Figure 4. Packing 1000 circles with random radii
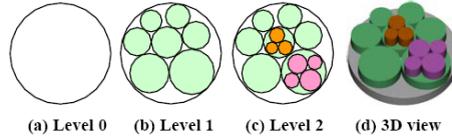
(a) Level 0   (b) Level 1   (c) Level 2   (d) 3D view
Figure 5. Pack circles into a circle recursively
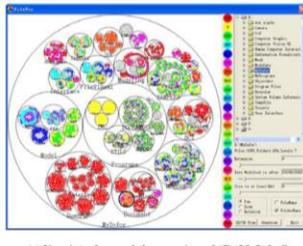
(a) User interface and the overview of "D:\MyInfor"
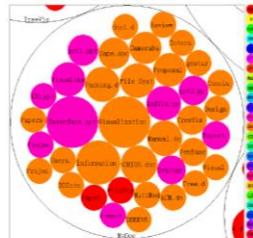
(b) The details of the focus "MyInfor\Document\MyDoc"
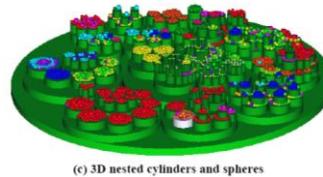
(c) 3D nested cylinders and spheres

Summary

- Node-link diagrams or space-filling techniques?
- It depends on the properties of the data
  - Node-link typically better at exposing structure of information structure
  - Space-filling good for focusing on one or two additional variables of cases

Great Visual Summary

Downloadable poster
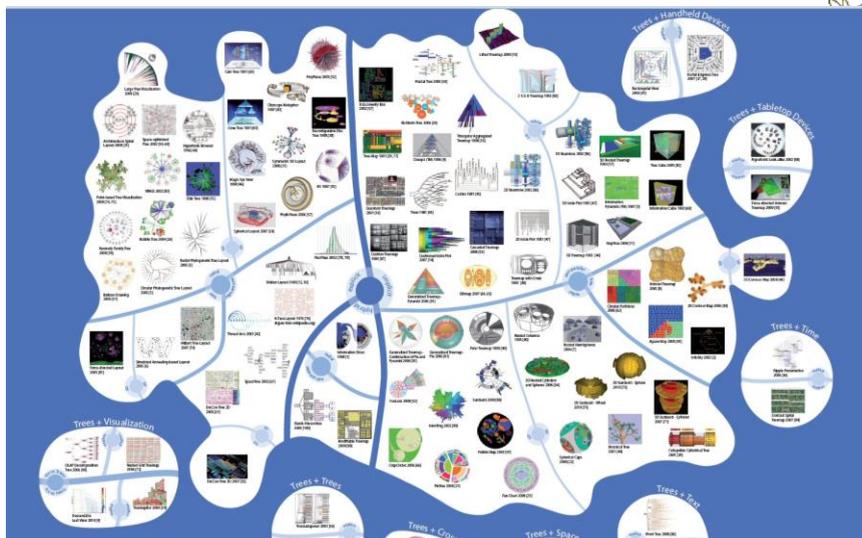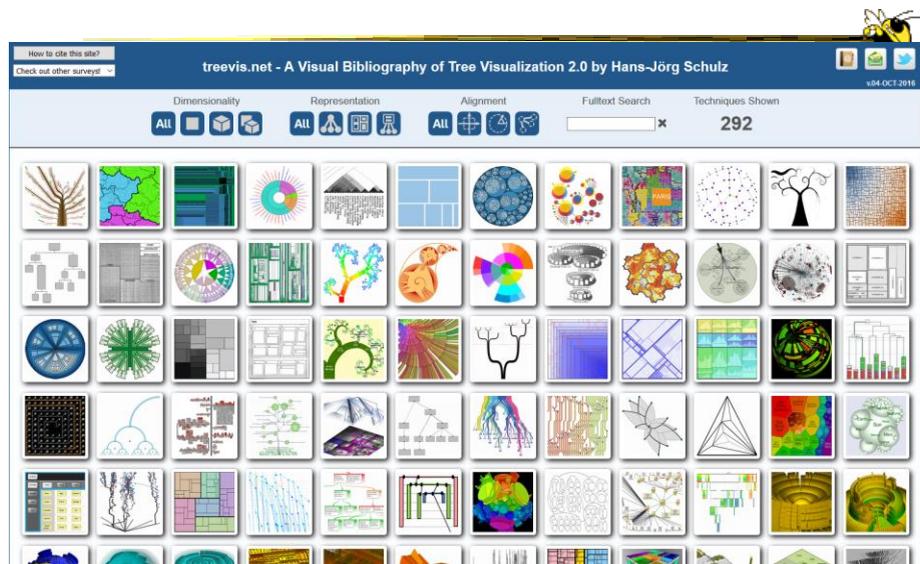
http://www.informatik.uni-rostock.de/~hs162/treeposter/oldposter/poster.html

Zoomed In

Version 2

Learning Objectives

- Understand original treemap algorithm
- Appreciate different applications of treemaps
  - Stocks, tennis, geography, elections, …
- Explain shortcomings of original algorithm and why squarified treemaps often preferred
- Describe SunBurst layout
- Compare and contrast SunBurst to Treemap (+/-)
- Describe circle-packing approach

HW 5

- Draw a graph
- 10-vertex abstract graph provided
- You draw a node-link representation
- Follow the directions!
  - Bring one copy
  - Name on back
- Due Monday 6th (no late submissions)
- Don't spend a lot of time

Upcoming

- Lab 7 – D3 animations & transitions 1
  - Prep:

- Graphs & Networks 1

References

- Spence and CMS texts
- All referred to papers