TREE

Hierarchies

- 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

Tree

- A tree is defined as a set of nodes and edges.
- Every edge has a pair of nodes: the parent node and the child node.
- **A child node has only one parent node**.
- **Between any two notes in the tree, there is a unique path**.
- A tree is a network of connected nodes where there are **no loops**.
- Root node: the single node that has no parents.
- Leaf node: the nodes that have no children.
- Depth of the tree: number of nodes from the root to the leaf.

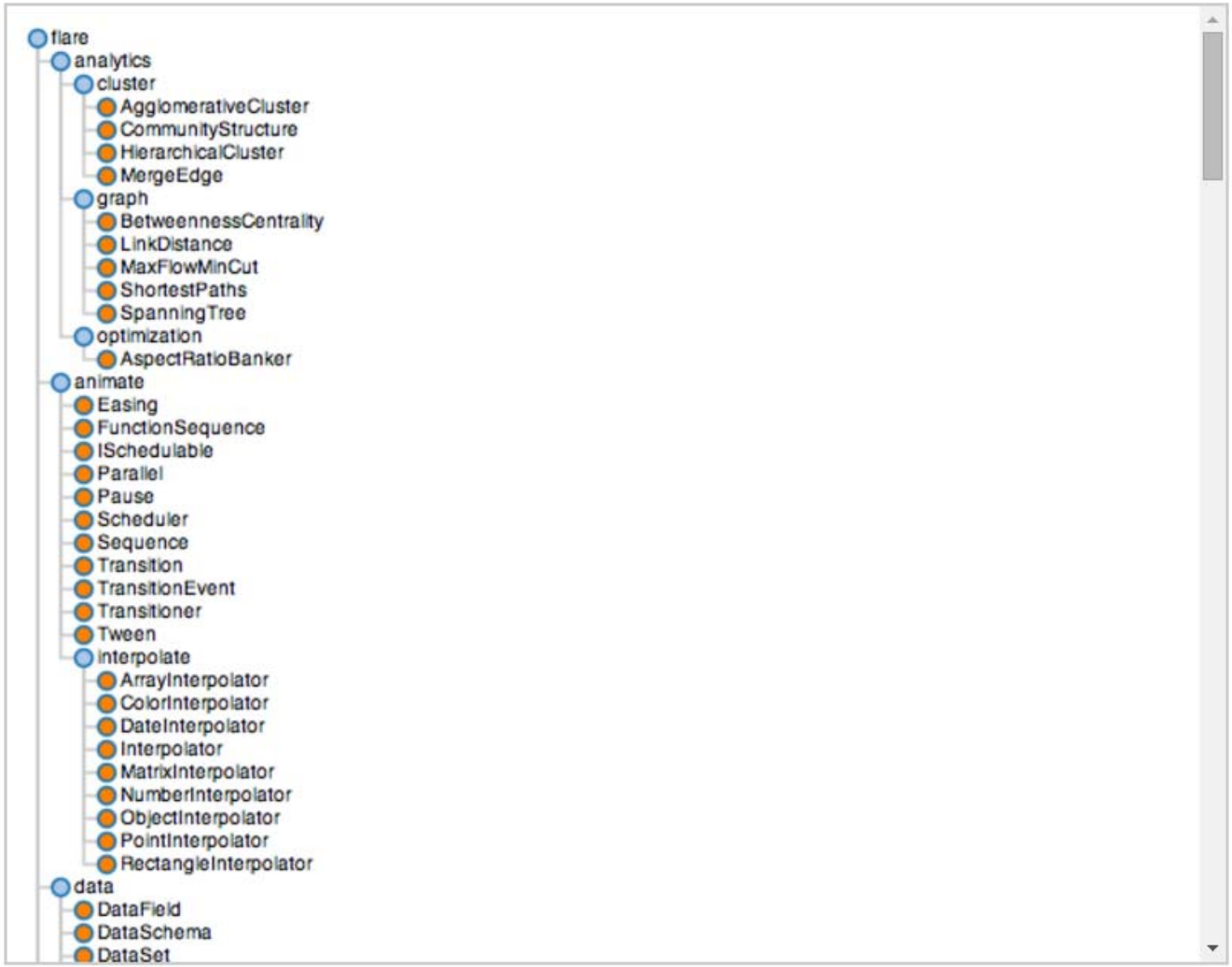
Tree Visualization

- Two main representation schemes
  - Node-link
  - **Space-filling**

Tree Visualization Survey

http://Treevis.net

Data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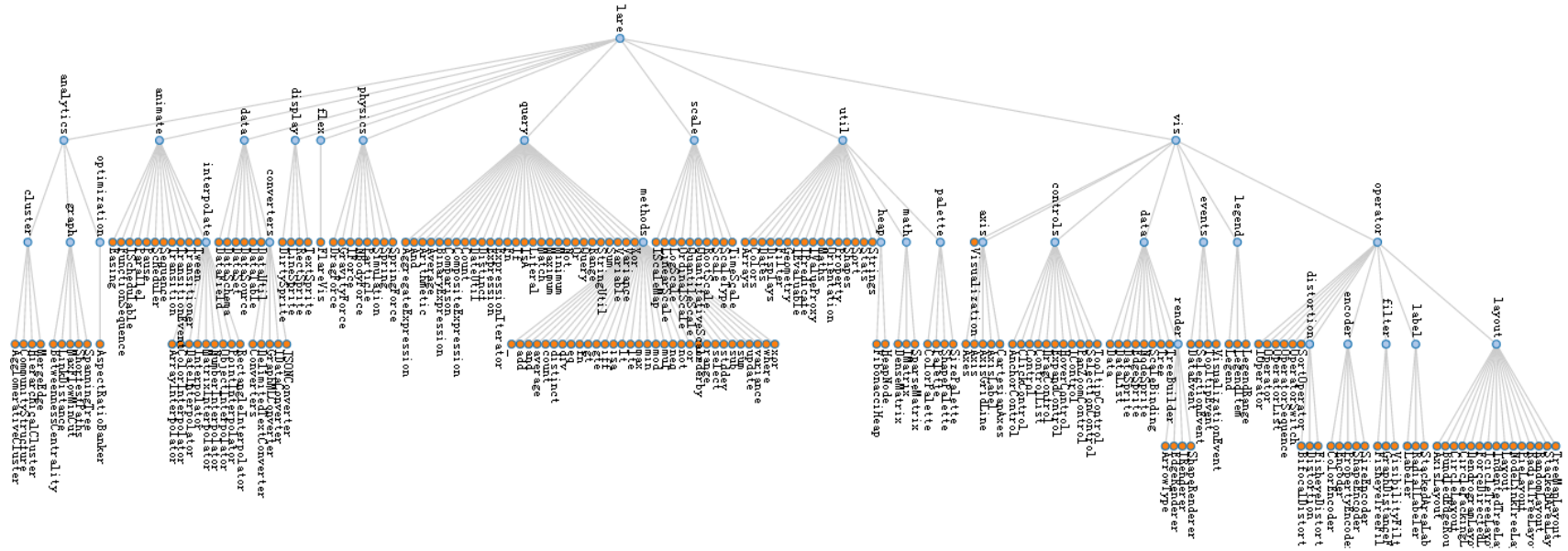
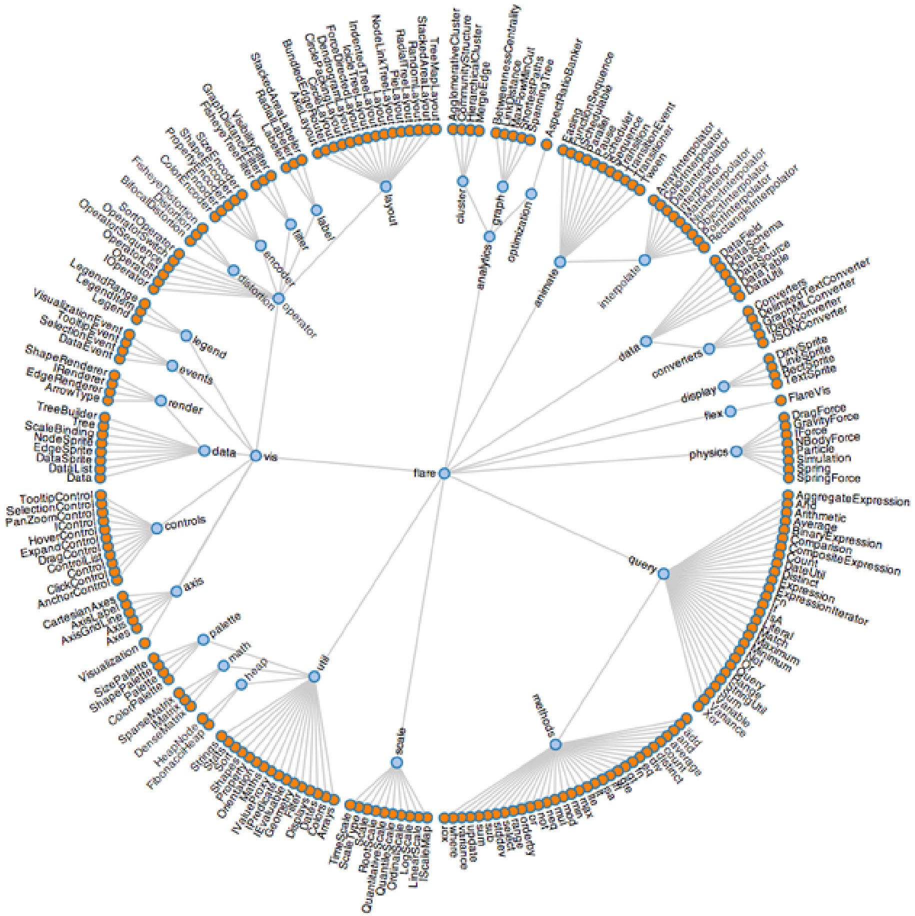
cluster
AgglomerativeCluster
CommunityStructure
HierarchicalCluster
MergeEdge
graph
BetweennessCentrality
LinkDistance
MaxFlowMinCut
ShortestPaths
SpanningTree
optimization
AspectRatioBanker
animate
Easing
FunctionSequence
ISchedulable
Parallel
Pause
Scheduler
Sequence
Transition
TransitionEvent
Transitioner
Tween
interpolate
ArrayInterpolator
ColorInterpolator
DateInterpolator
Interpolator
MatrixInterpolator
NumberInterpolator
ObjectInterpolator
PointInterpolator
RectangleInterpolator
data
DataField
DataSchema
DataSet

Node-link diagram



Dendrogram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physics
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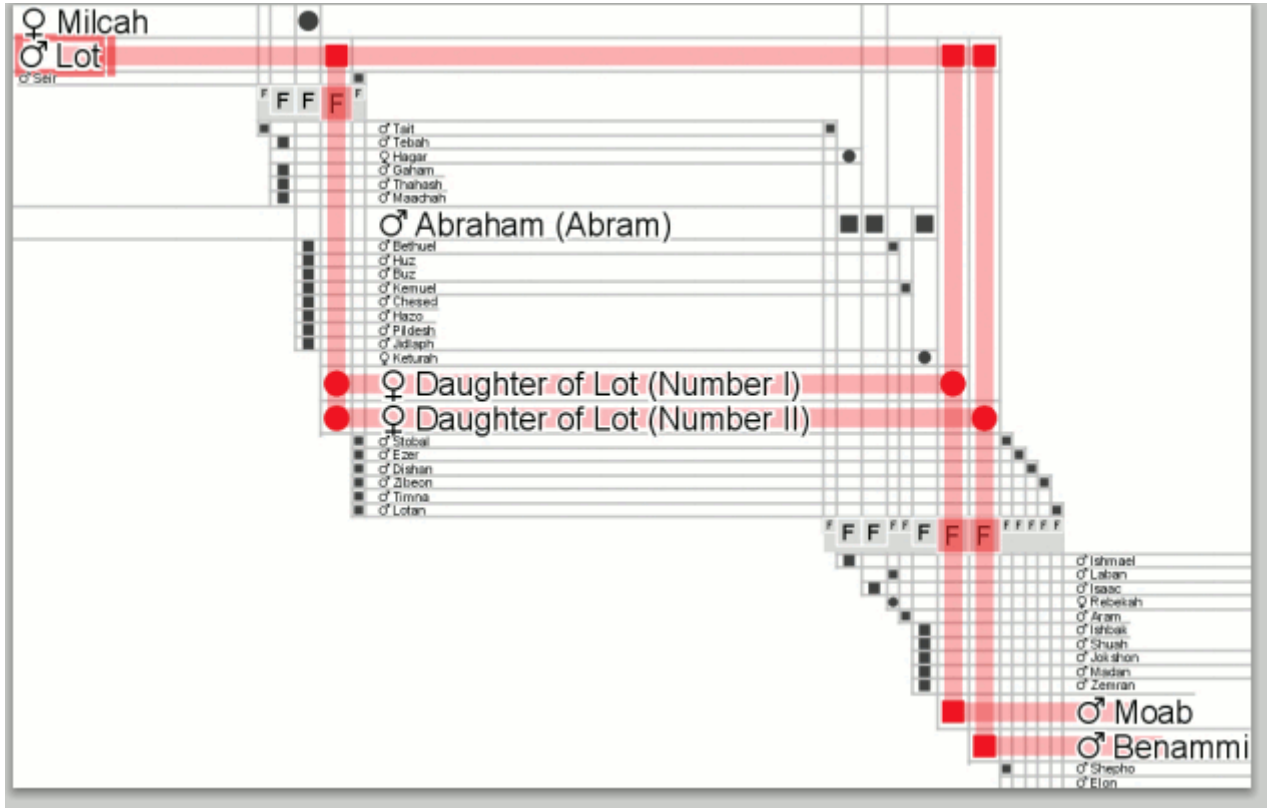
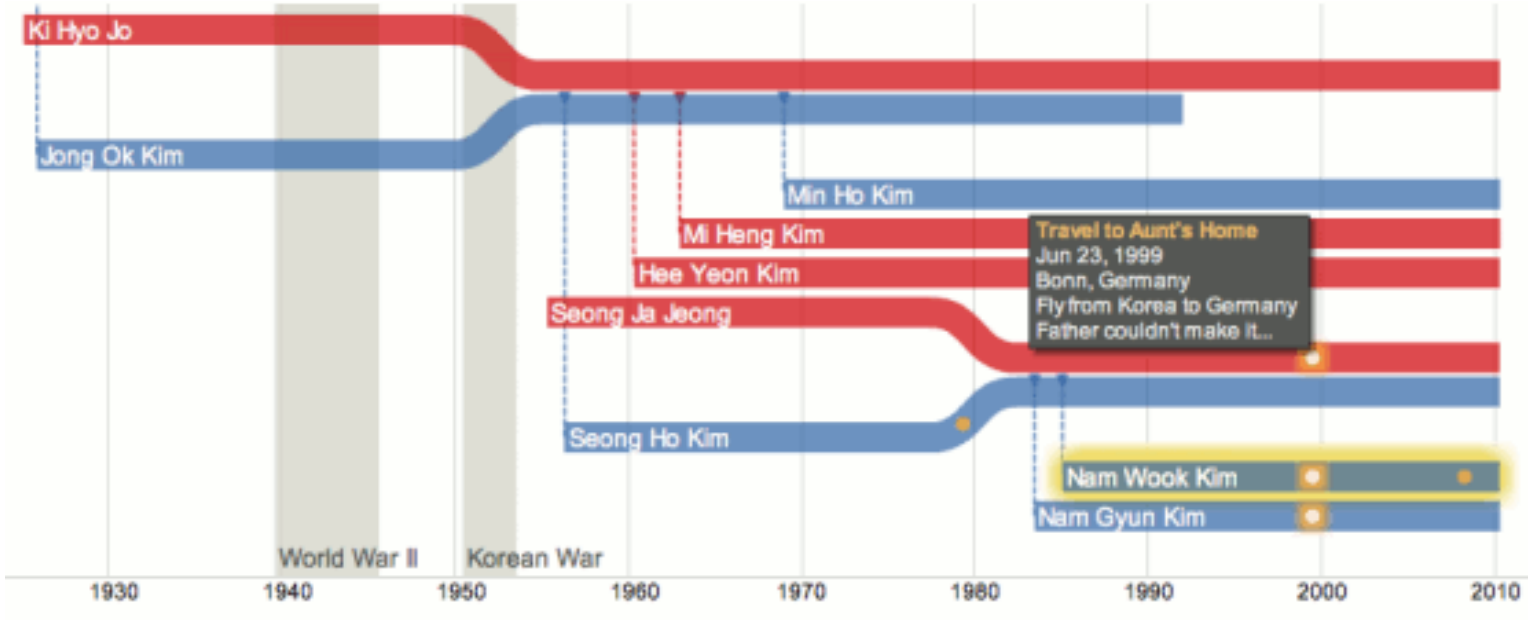
controls
axis
render
events
legend
FlareVis

Quilts

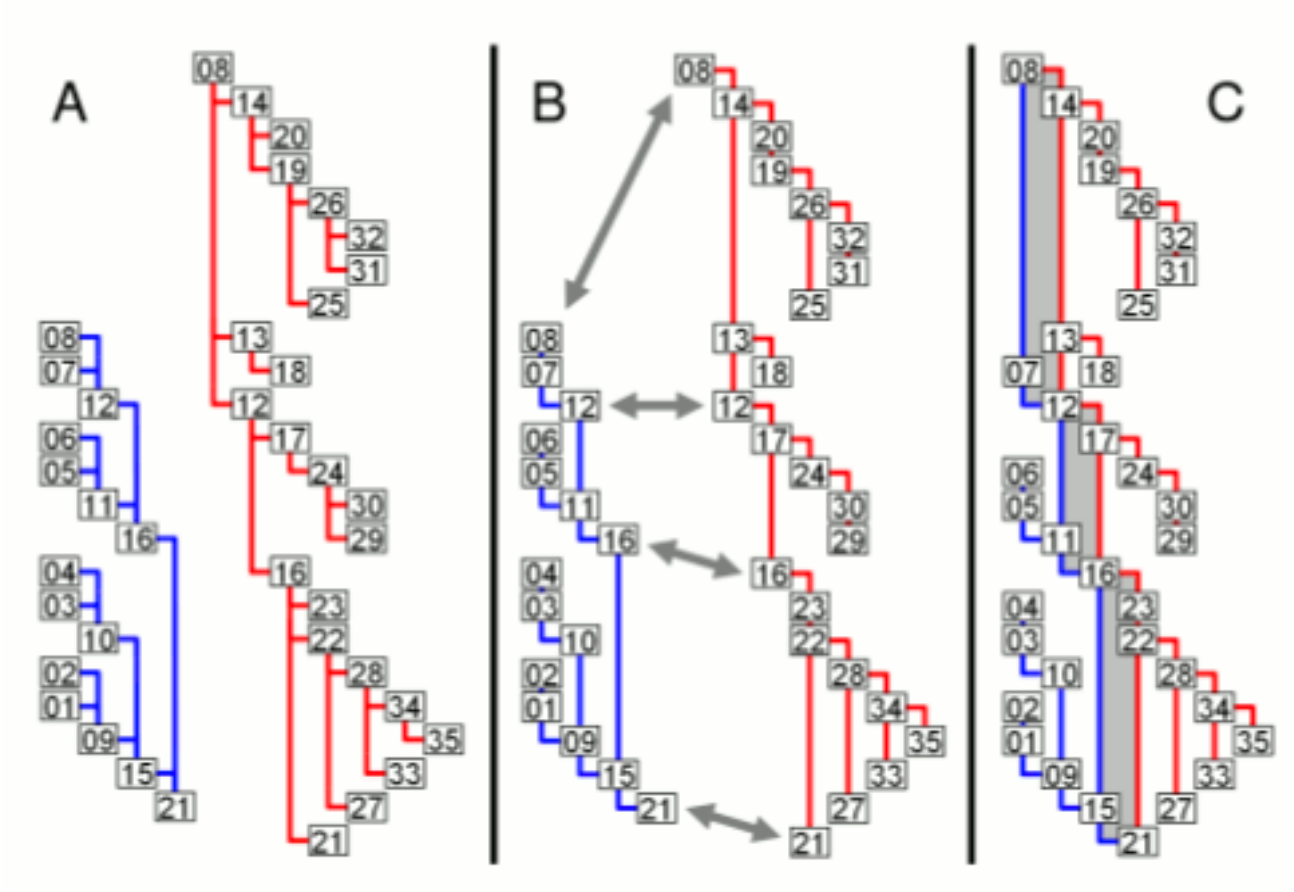


https://gramps-project.org/wiki/index.php?title=GEPS_030:_New_Visualization_Techniques

Timenet


Ki Hyo Jo
Jong Ok Kim
Min Ho Kim
Mi Heng Kim
Hee Yeon Kim
Seong Ja Jeong
Seong Ho Kim
Nam Wook Kim
Nam Gyun Kim
Travel to Aunt's Home
Jun 23, 1999
Bonn, Germany
Fly from Korea to Germany
Father couldn't make it...
World War II
Korean War
1930
1940
1950
1960
1970
1980
1990
2000
2010

Dual-tree


A
B
C
08
14
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03
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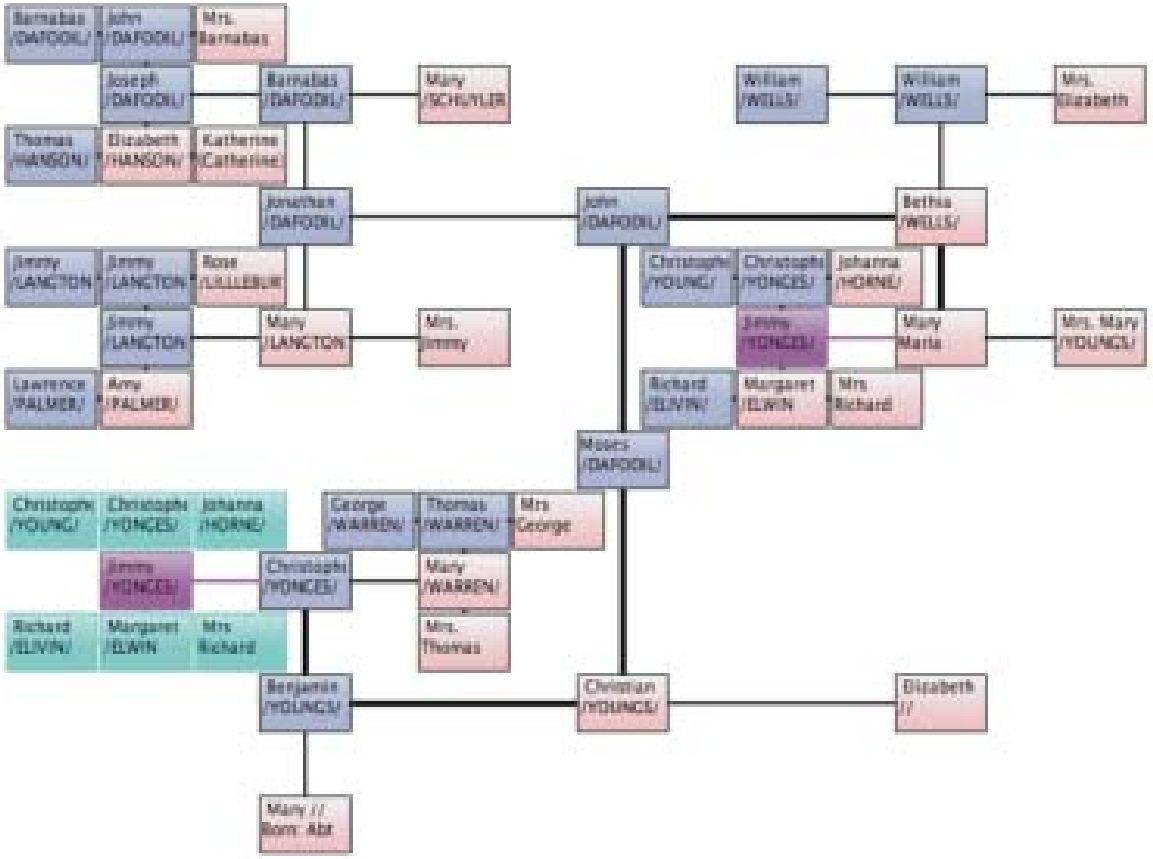
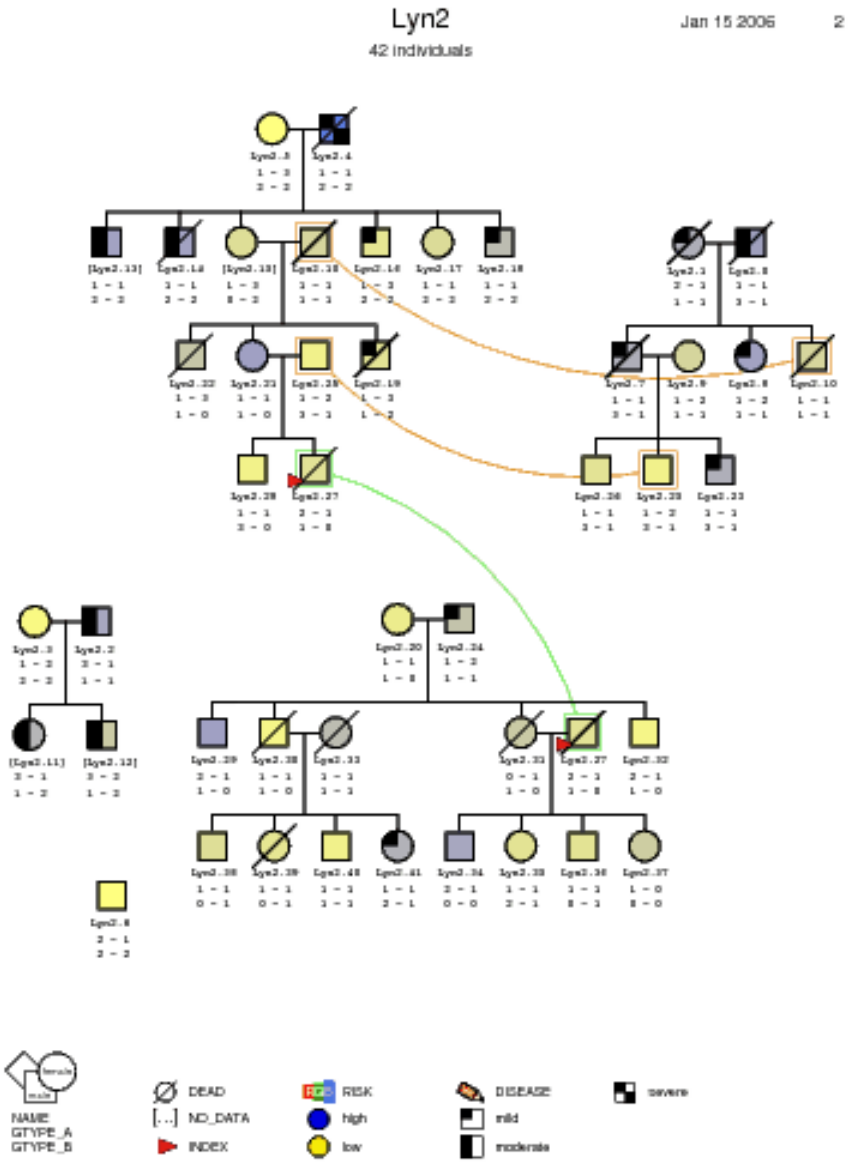
02
01
09
15

H-tree


Barnabas /DAFODIL/
John /DAFODIL/
Mrs. Barnabas
Joseph /DAFODIL/
Barnabas /DAFODIL/
Mary /SCHUYLER
Thomas /HANSON/
Elizabeth /HANSON/
Katherine /Catherine/
Jonathan /DAFODIL/
Jimmy /LANGTON
Jimmy /LANGTON/
Rose /LILLEBUR
Jimmy /LANGTON/
Mary /LANGTON/
Mrs. Jimmy
Lawrence /PALMER/
Amy /PALMER/
William /WILLS/
William /WILLS/
Mrs. Elizabeth
John /DAFODIL/
Bethia /WILLS/
Christoph /YOUNG/
Christoph /YONCES/
Johanna /HORNE/
Jimmy /YONCES/
Mary Maria
Mrs. Mary /YOUNGS/
Richard /ELVIN/
Margaret /ELWIN
Mrs Richard
Moses /DAFODIL/
Christoph /YOUNG/
Christoph /YONCES/
Johanna /HORNE/
George /WARREN/
Thomas /WARREN/
Mrs George
Jimmy /YONCES/
Christoph /YONCES/
Mary /WARREN/
Mrs. Thomas
Richard /ELVIN/
Margaret /ELWIN
Mrs Richard
Benjamin /YOUNGS/
Christian /YOUNGS/
Elizabeth //
Mary // Born: Abt

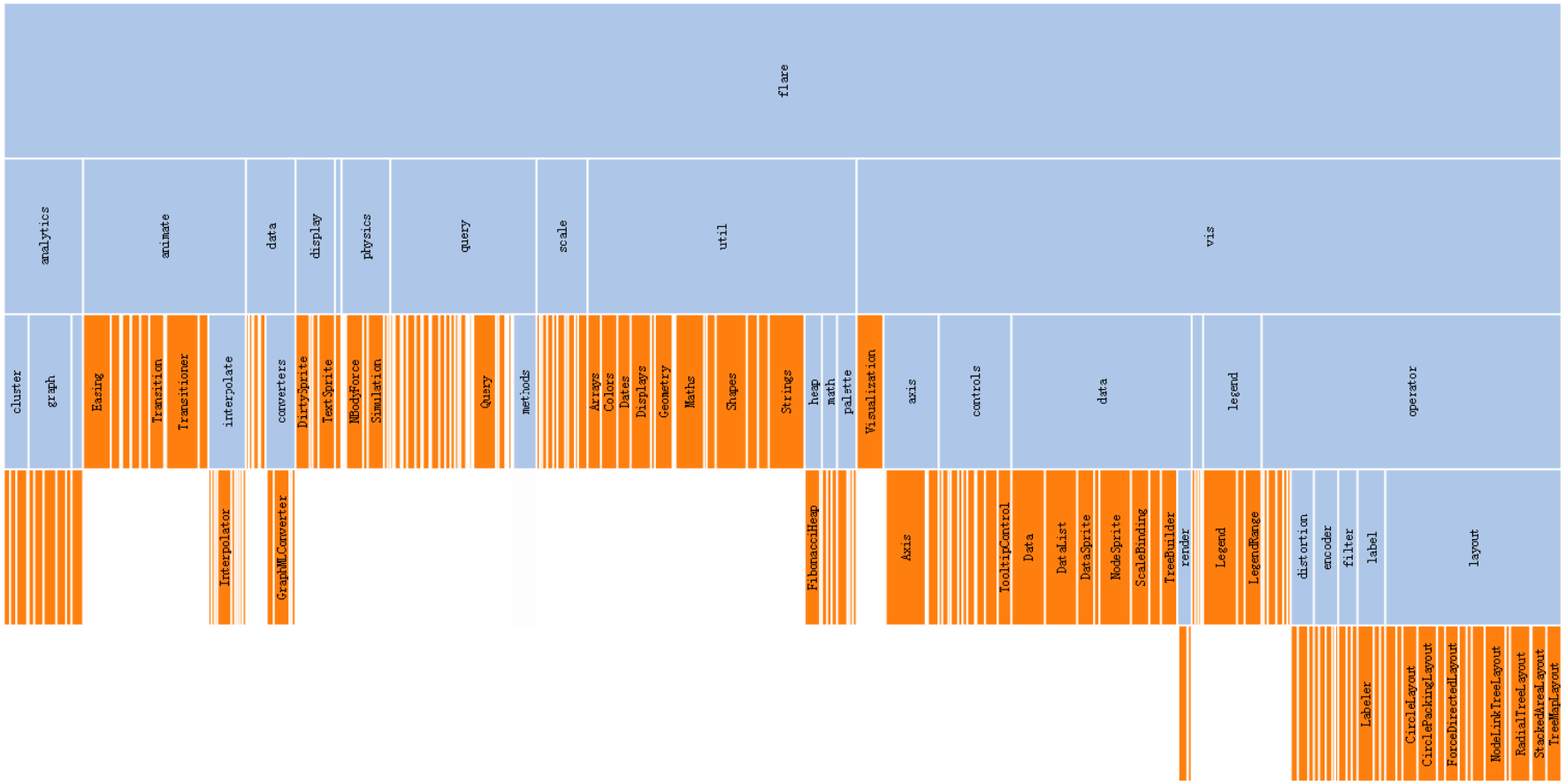
Gene-Tree


Lyn2
42 individuals
Jan 15 2006
2
NAME
GTYPE_A
GTYPE_B
DEAD
[...] NO_DATA
INDEX
RISK
high
low
DISEASE
mild
moderate
severe

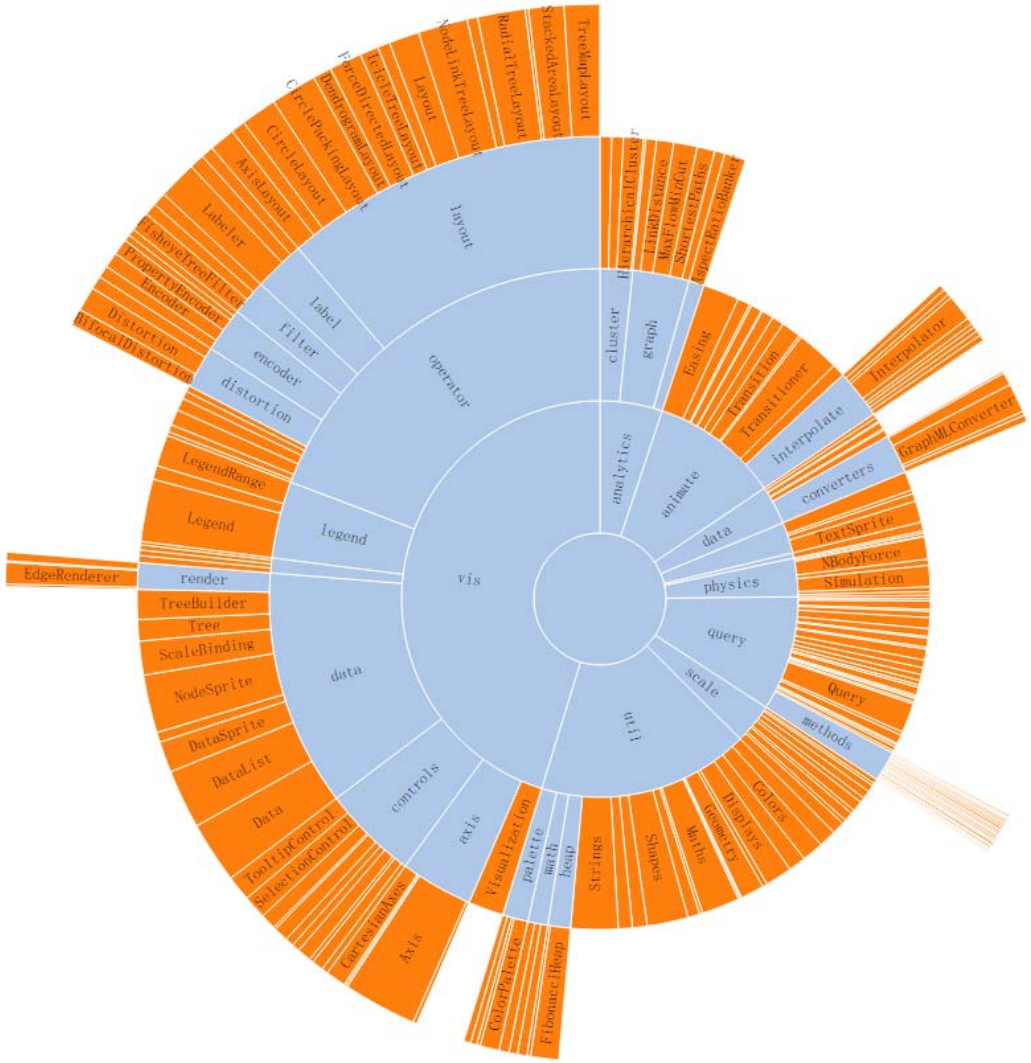
Node-link Shortcoming

- Difficult to encode more variables of data cases (nodes)
  - Shape
  - Color
  - Size
  - …but all quickly clash with basic node-link structure

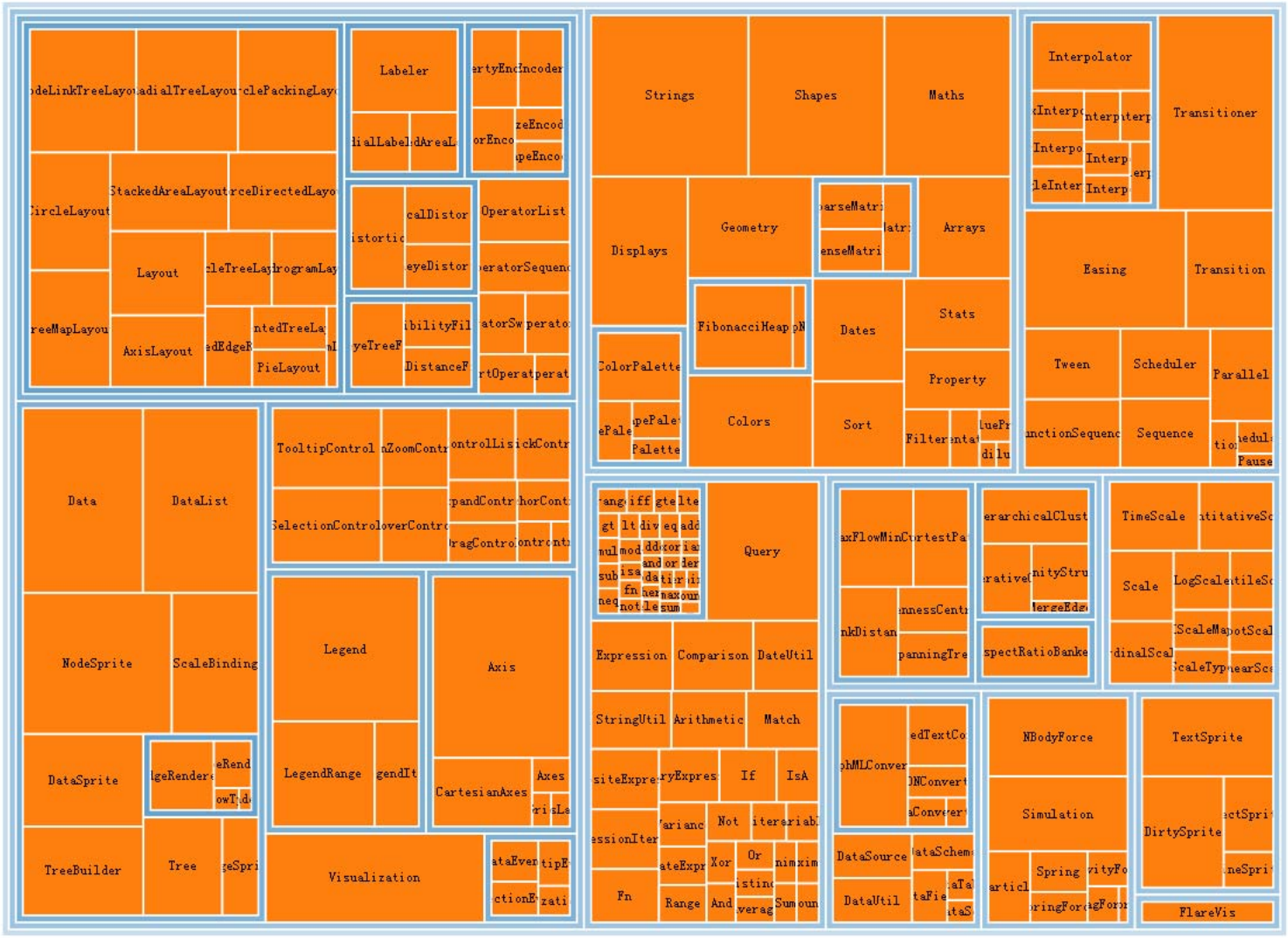
Adjacency Diagrams



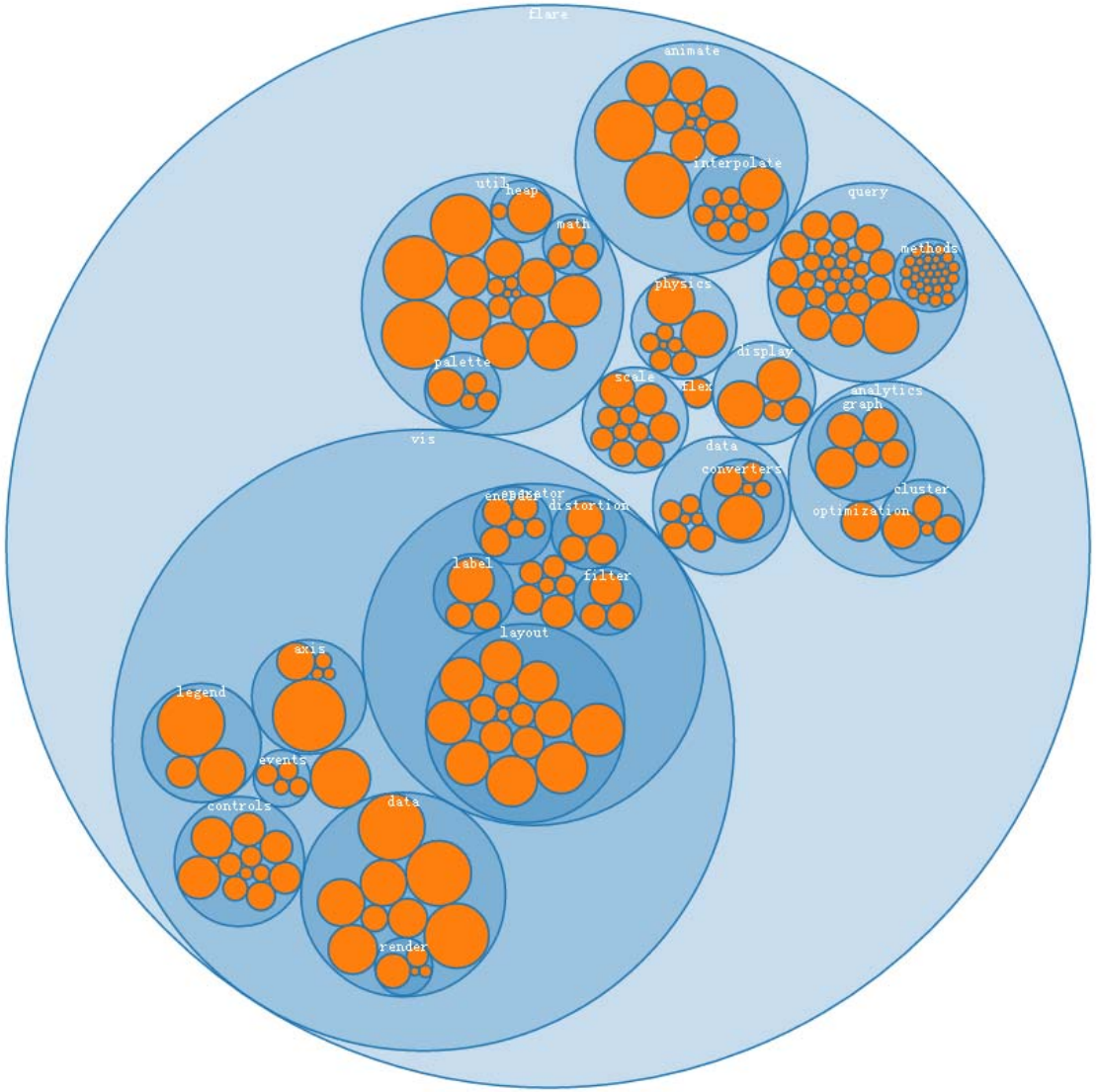
Sunburst


vis
operator
layout
label
filter
encoder
distortion
legend
data
controls
axis
analytics
cluster
graph
animate
interpolate
data
physics
query
scale
util
methods
render
EdgeRenderer
LegendRange
Legend
TreeBuilder
Tree
ScaleBinding
NodeSprite
DataSprite
DataList
Data
ToolTipControl
SelectionControl
CartesianAxes
Axis
Visualization
palette
math
heap
Strings
Shapes
Maths
Displays
Colors
Query
Simulation
NBodyForce
TextSprite
converters
GraphMLConverter
Interpolator
Easing
Transition
Transitioner
ColorPalette
FibonacciHeap

Treemap

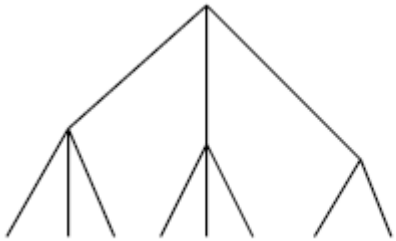

Labeler
Strings
Shapes
Maths
Interpolator
Transitioner
Displays
Geometry
Arrays
Easing
Transition
Layout
AxisLayout
PieLayout
StackedAreaLayout
OperatorList
FibonacciHeap
Dates
Stats
Property
Tween
Scheduler
Parallel
ColorPalette
Colors
Sort
Data
DataList
TooltipControl
SelectionControl
Query
Expression
Comparison
DateUtil
StringUtil
Arithmetic
Match
Legend
LegendRange
Axis
CartesianAxes
Axes
NodeSprite
ScaleBinding
DataSprite
TreeBuilder
Tree
Visualization
Fn
Range
And
Or
Not
If
IsA
Query
Scale
TimeScale
LogScale
NBodyForce
Simulation
Spring
TextSprite
DirtySprite
FlareVis
DataSource
DataUtil

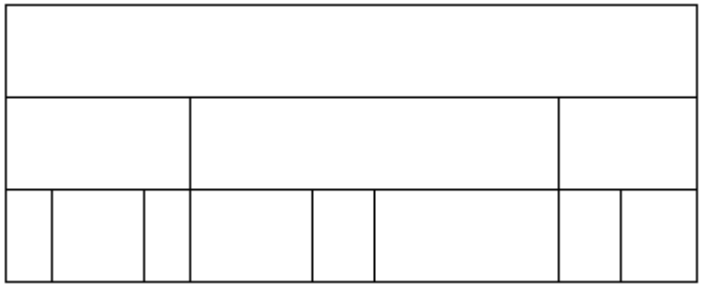
Circle treemap



Space-Filling Representation

- Each item occupies an area
- Children are “contained” under parent
  - Example shows each horizontal slice corresponding to a tree level
  - Width of box displays node size

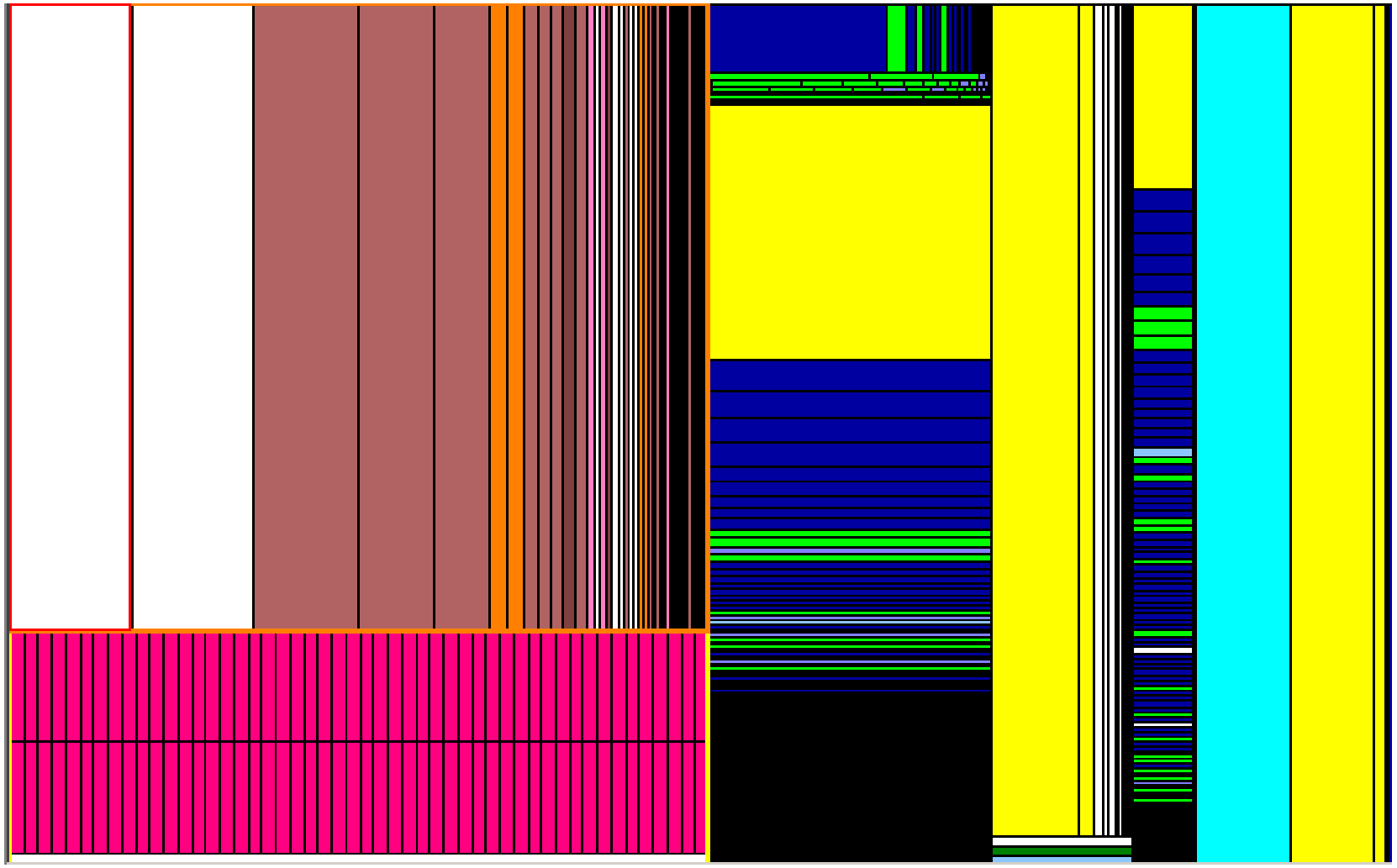




Treemap

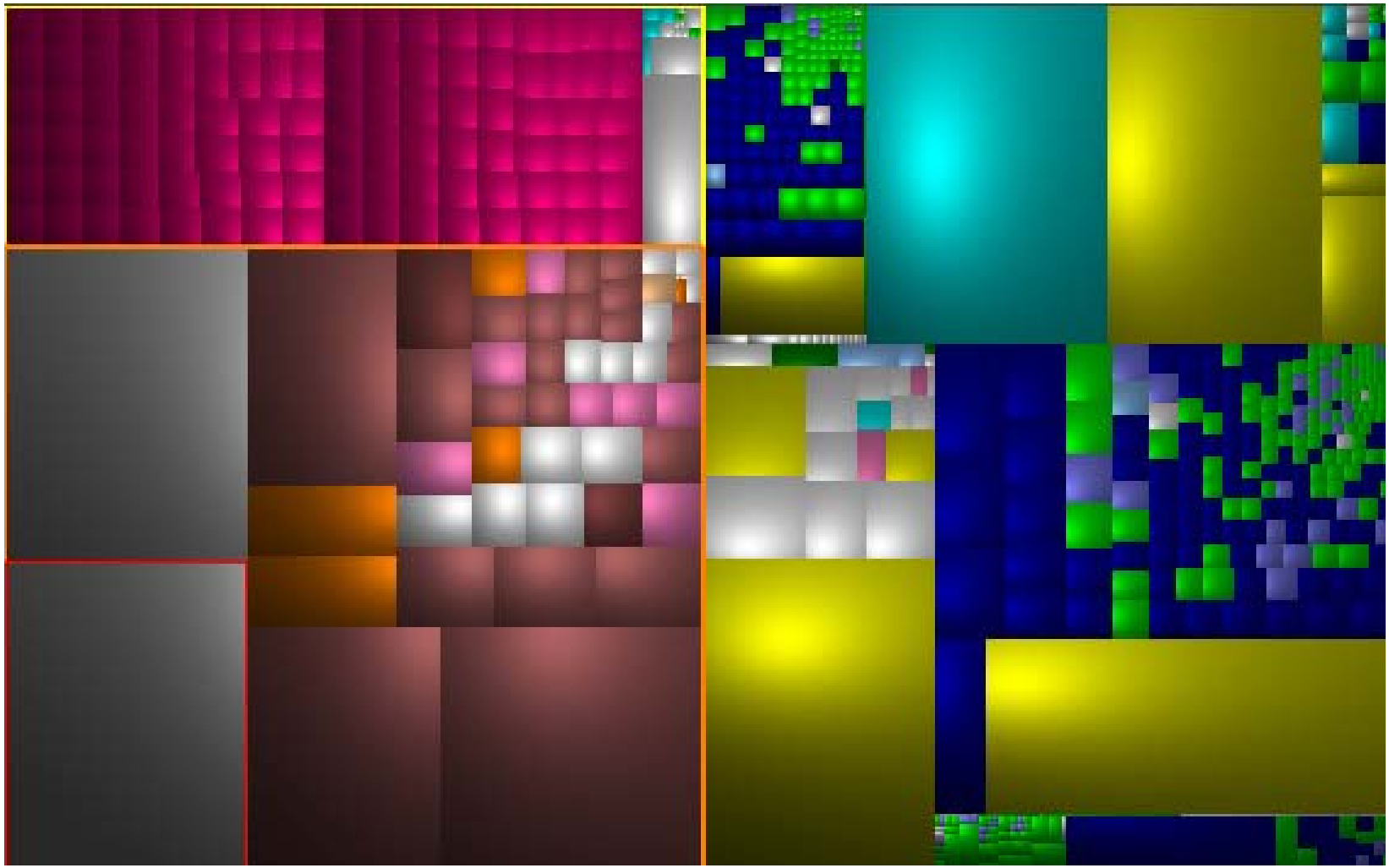
- **Treemap** method: visualize the tree structure that uses virtually every pixel of the display space to convey information.
- Every subtree is represented by a rectangle, that is partitioned into smaller rectangles which correspond to its children.
- The position of the slicing lines determines the relative sizes of the child rectangles.
- For every child, repeat the slicing recursively, swapping the slicing direction from vertical to horizontal or conversely
- Use area to encode other variable of data items

Tree Visualization



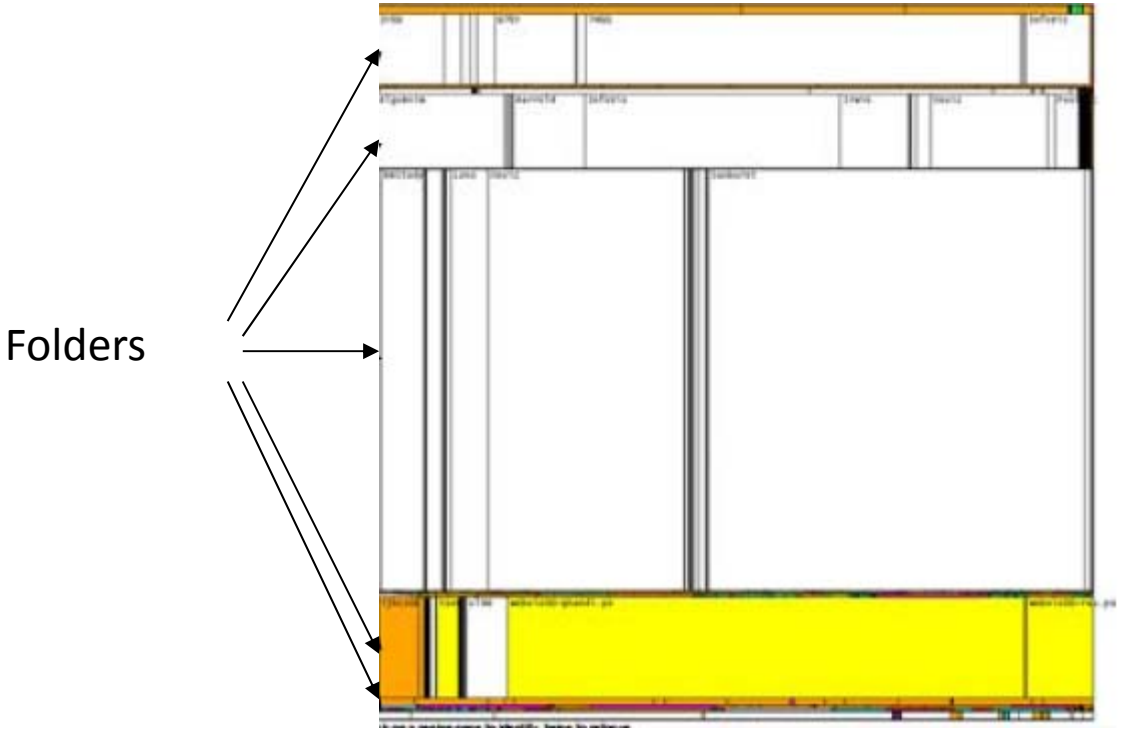
Treemap of the FFmpeg software

Tree Visualization



Treemap

- Example

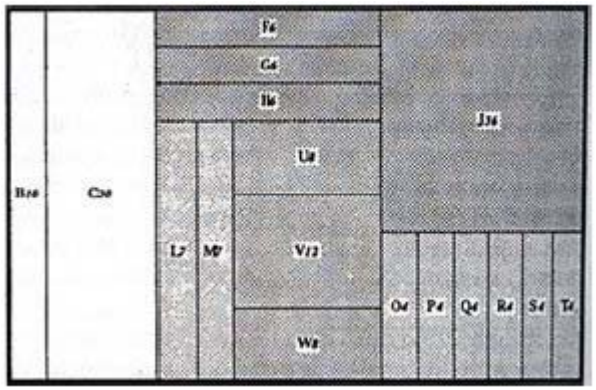


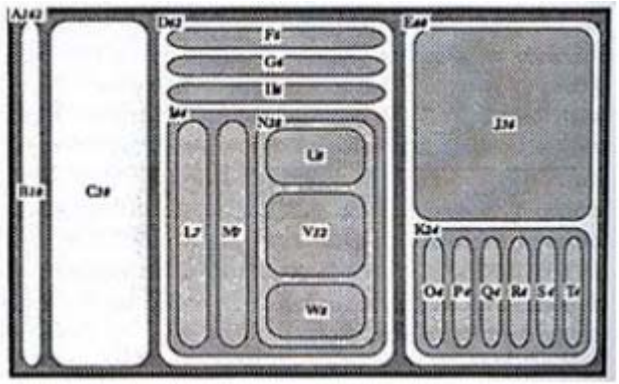
TreeMap Demo

Treemap Algorithm

```
Draw()
{
    Change orientation from parent (horiz/vert)
    Read all files and directories at this level
    Make rectangle for each, scaled to size
    Draw rectangles using appropriate size and color
    For each directory
        Make recursive call using its rectangle as focus
}
```

Nested vs. Non-nested





- Non-nested Nested

Applications

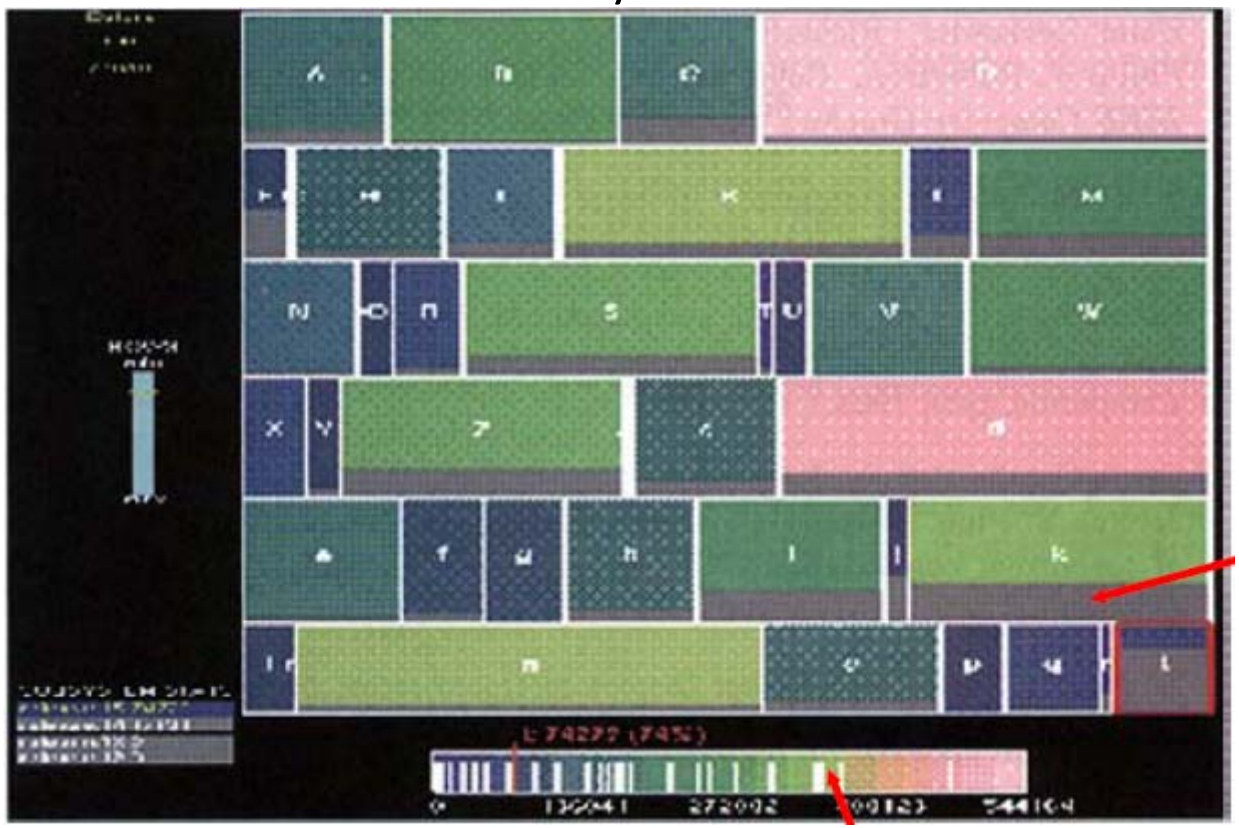
- Can use Treemap idea for a variety of domains
  - File/directory structures
  - Basketball statistics
  - Software diagrams
- Useful where there is a size query

Software Visualization App

- SeeSys: Software Metrics Visualizing System
- Uses treemap-like visualization to present different software metrics
- Displays:
  - Size
  - Recent development
  - High fix-on-fix rates
  - History and growth

SeeSys sample 2

- Subsystems in a software system. Each rectangle represents the non-comment source code in a subsystem. Area means size

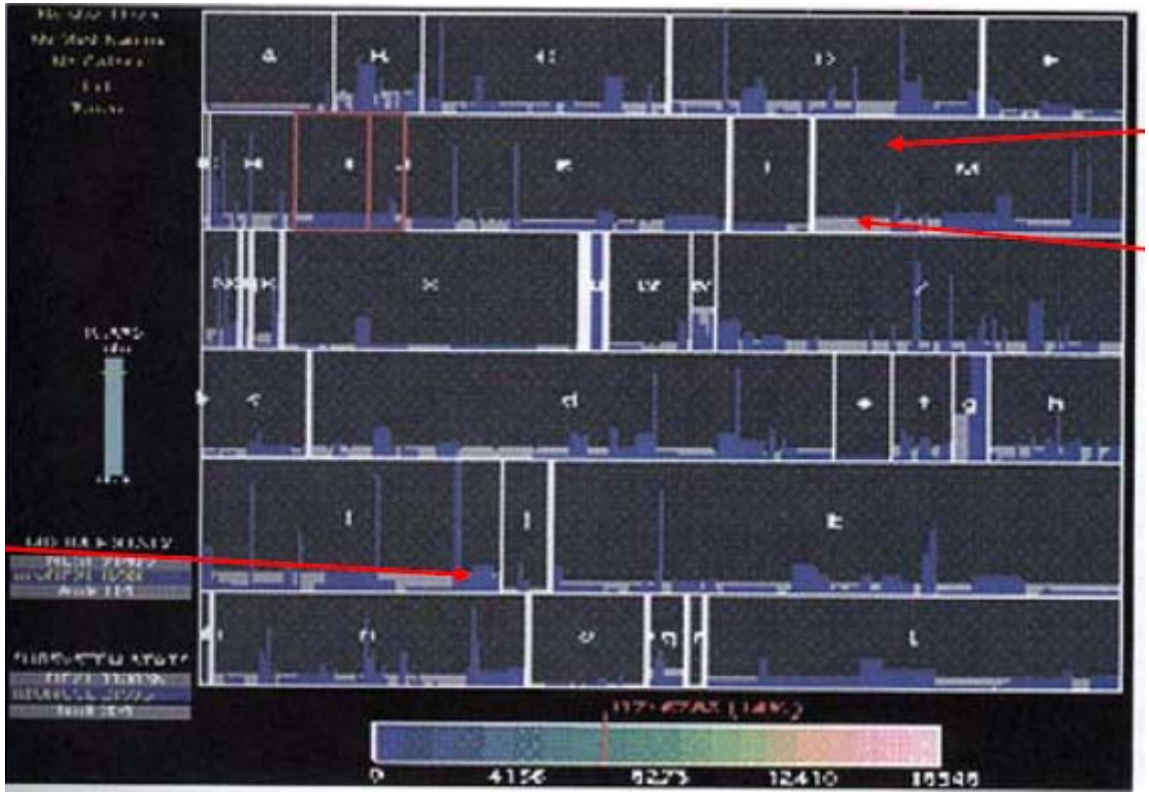


New Code in this release

Size

SeeSys sample 2

- Bug Rates by Subsystem and Directory
- New Code in this release



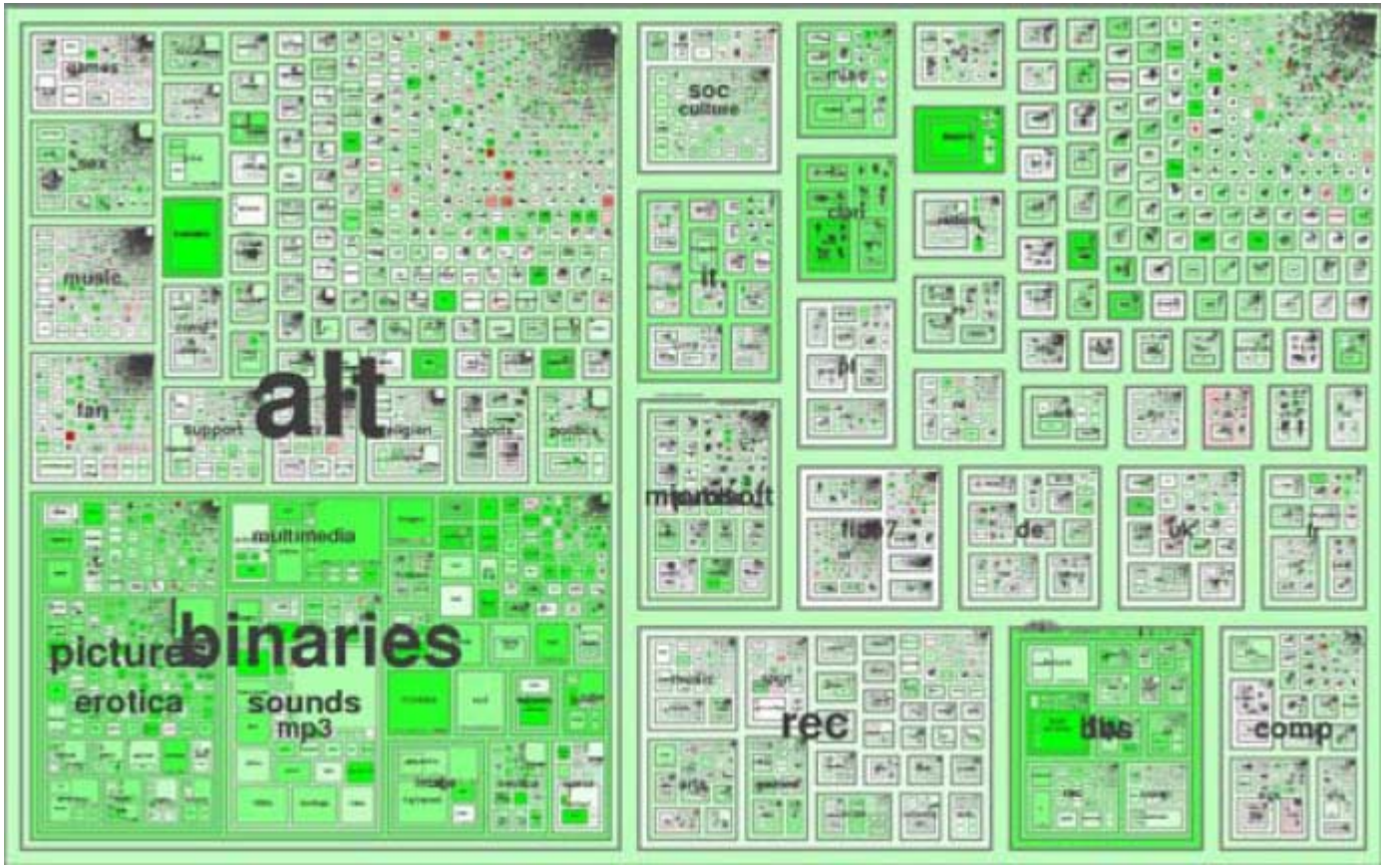
Added Funtionality

Bug Fixes

Bars represent individual directories in the subsystem

Internet News Groups

- NetScan

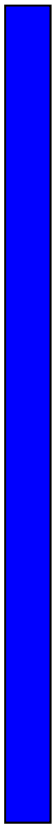


Treemap Affordances

- Good representation of two attributes beyond node-link: color and area
- Not as good at 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

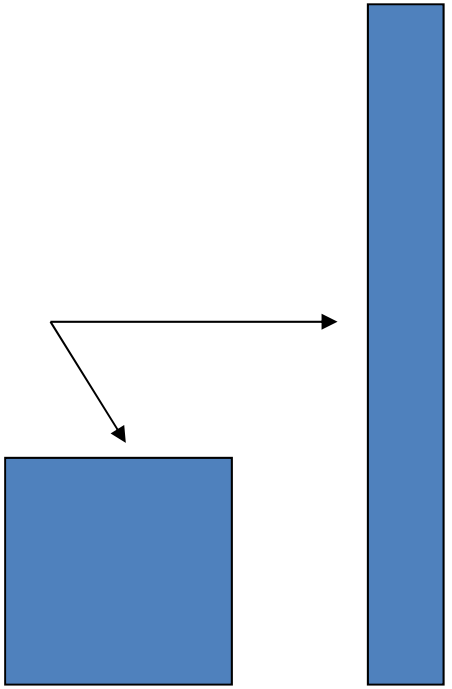
Aspect ratios

- ~~Long thin rectangles hard to use~~



Hard to estimate area

Which one is bigger?

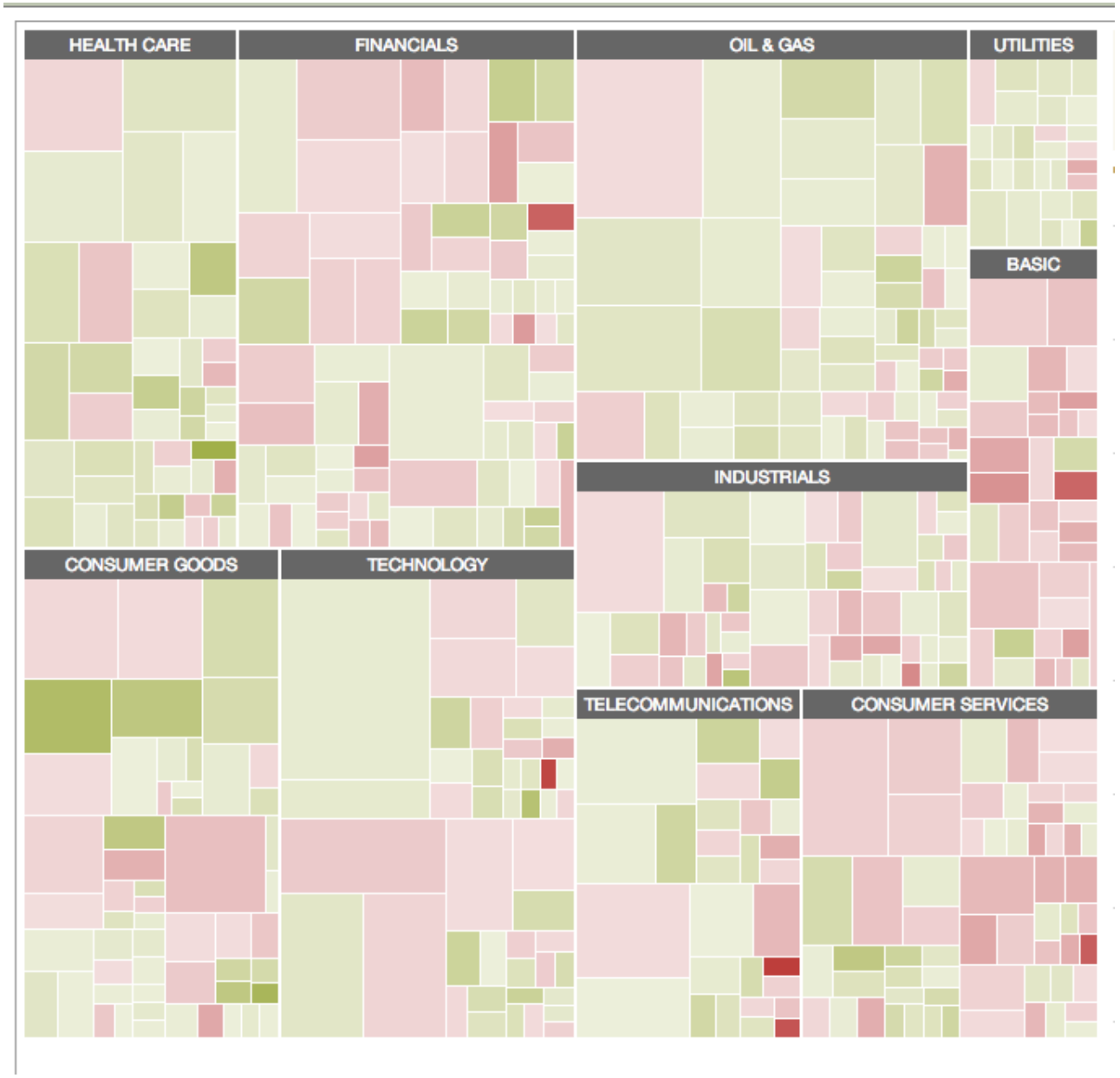


More squareness!

- Can we force a rectangle to be “more square”?
- Problem is that other rectangles have to change shape
- NP Hard problem (Optimization, bin packing..)

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


HEALTH CARE
FINANCIALS
OIL & GAS
UTILITIES
BASIC
INDUSTRIALS
CONSUMER GOODS
TECHNOLOGY
TELECOMMUNICATIONS
CONSUMER SERVICES

SmartMoney Review

- Dynamic user interface operations add to impact

Square Algorithm Problems

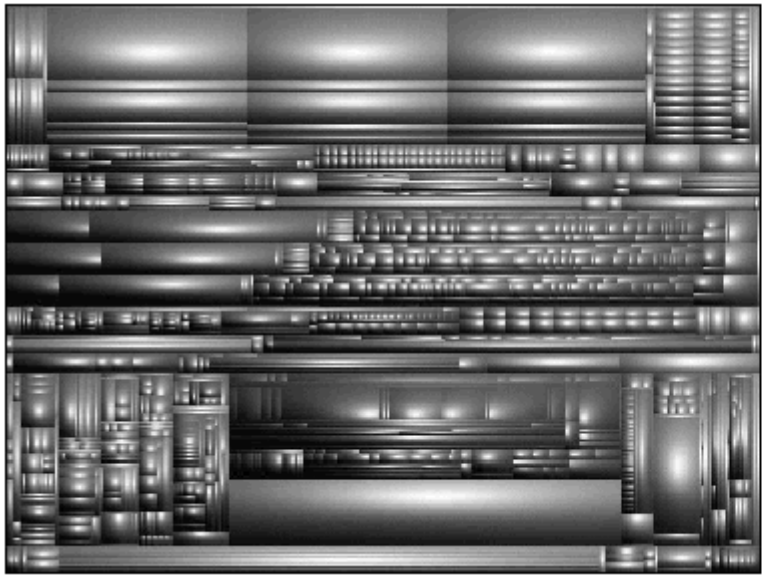
- Small changes in data values can cause dramatic changes in layout
- Order of items in a group may be important

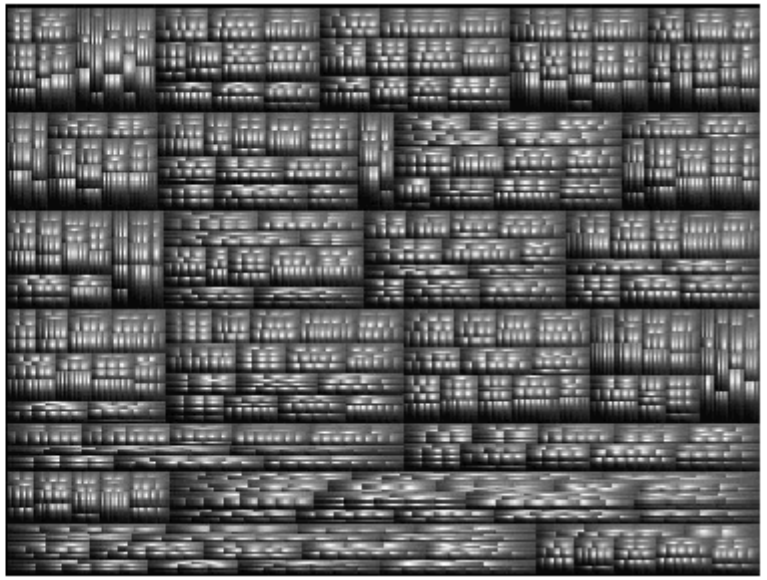
Showing Structure

- 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

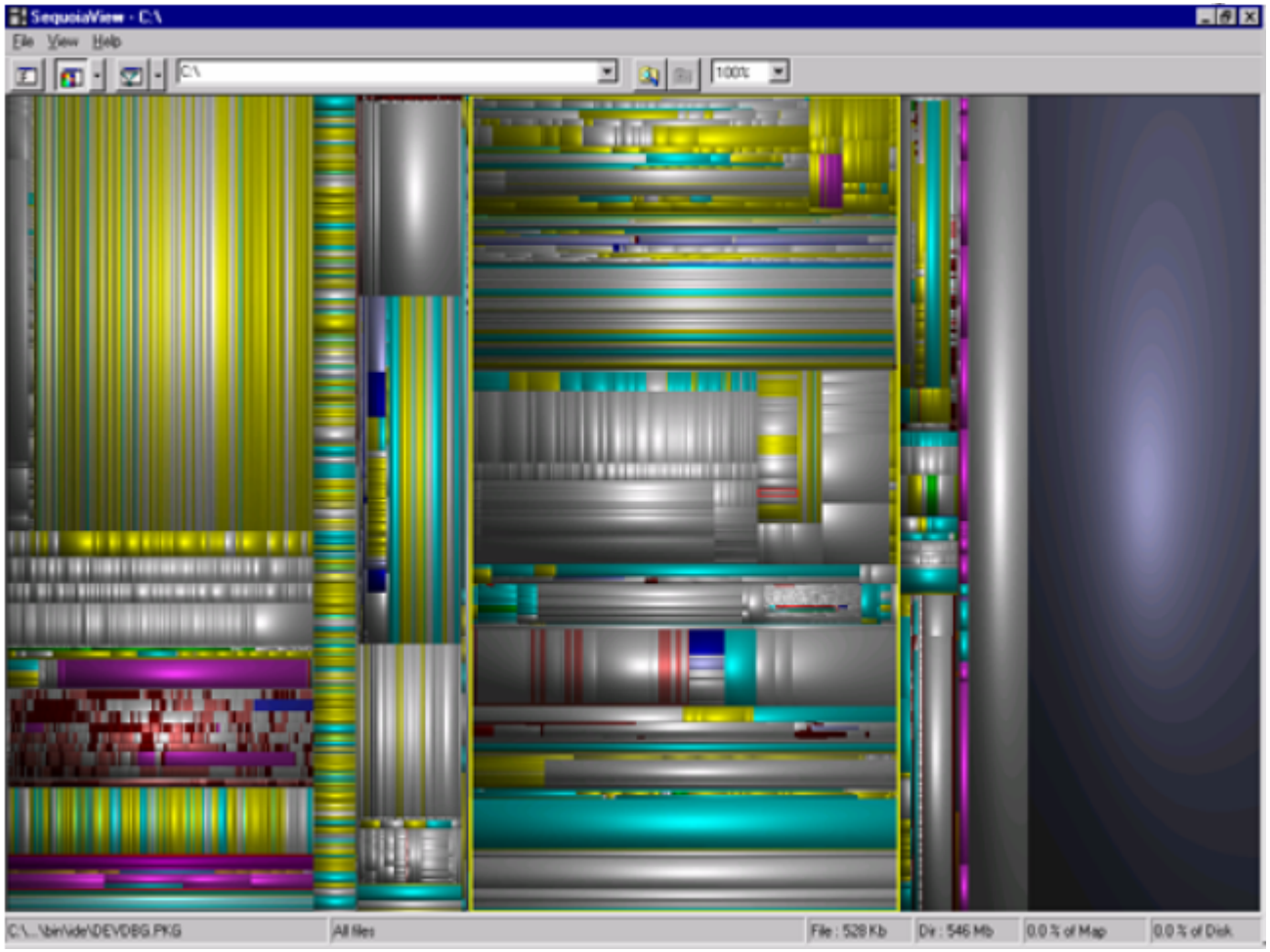
- Add shading and texture to convey structure of hierarchy





SequoiaView

- File visualizer using cushion treemap
- www.win.tue.nl/sequoiaview/



News Stories

- http://newsmap.jp

Investment Portfolios

- www.panopticon.com

Another Problem

- What if nodes with zero value (mapped to area) are very important?
  - Example: Stock or mutual fund portfolios: Funds you don't currently hold have zero value in your portfolio, but you want to see them to potentially buy them

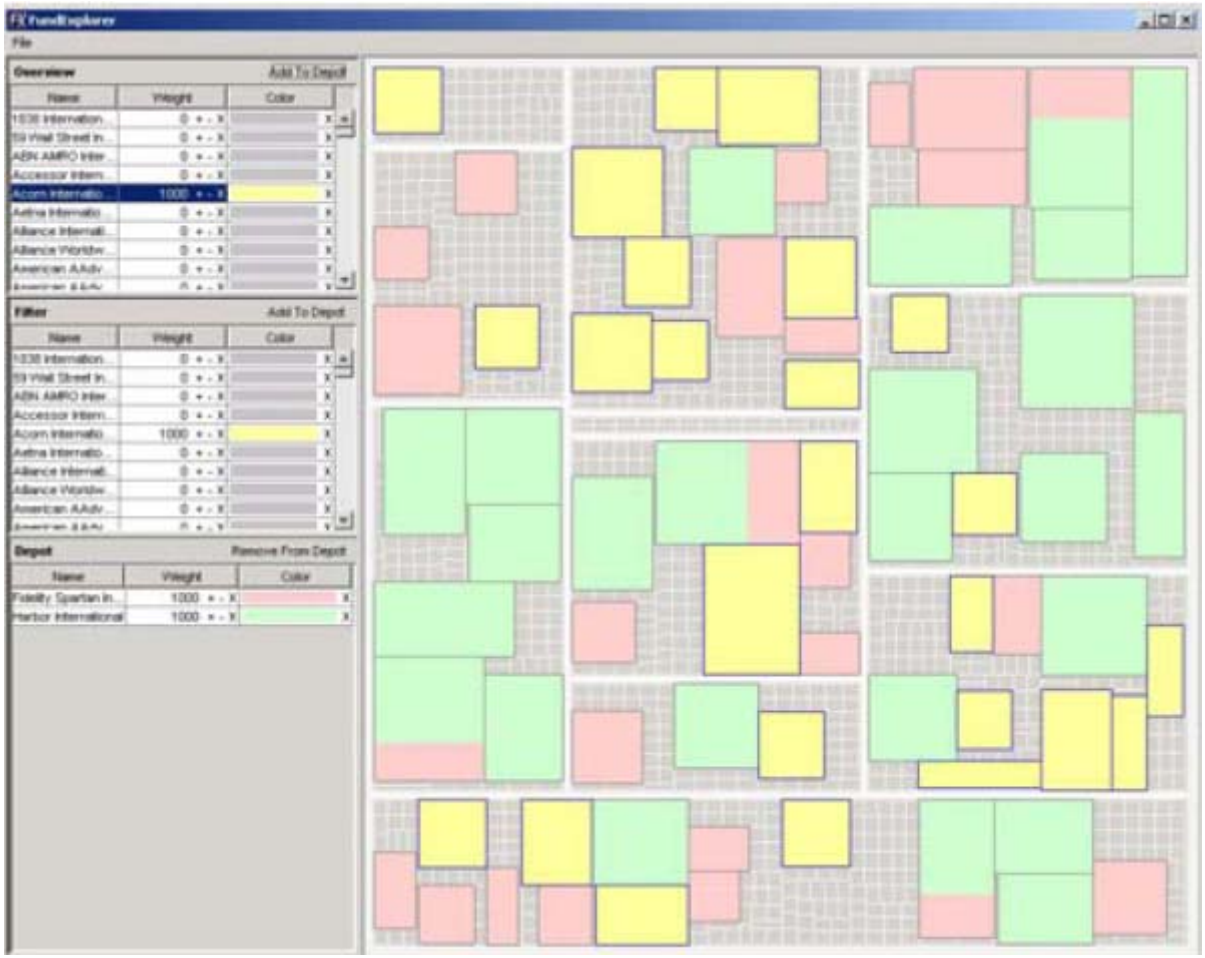
FundExplorer

- Show mutual fund portfolios, including funds not currently held
  - Area maps to your relative investment in fund
- Want to help the user with portfolio diversification as well
  - If I add fund X, how does that overlap with my current fund holdings?

Solution

- Context Treemap – Treemap with small distortion
  - Give zero-valued items (all together) some constant proportion of screen area
  - Provide dynamic query capabilities to enhance exploration leading to portfolio diversification

FundExplorer

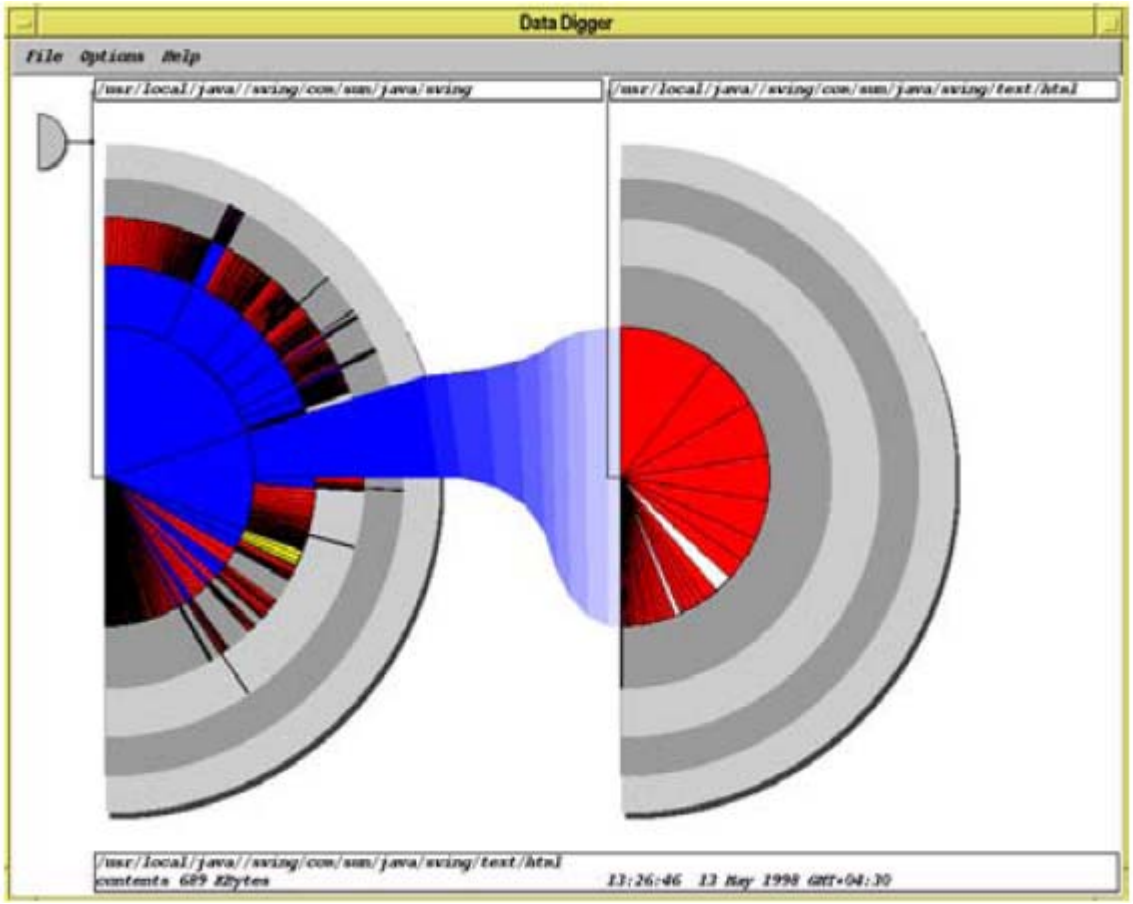


What about Radial Space filling?

- 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

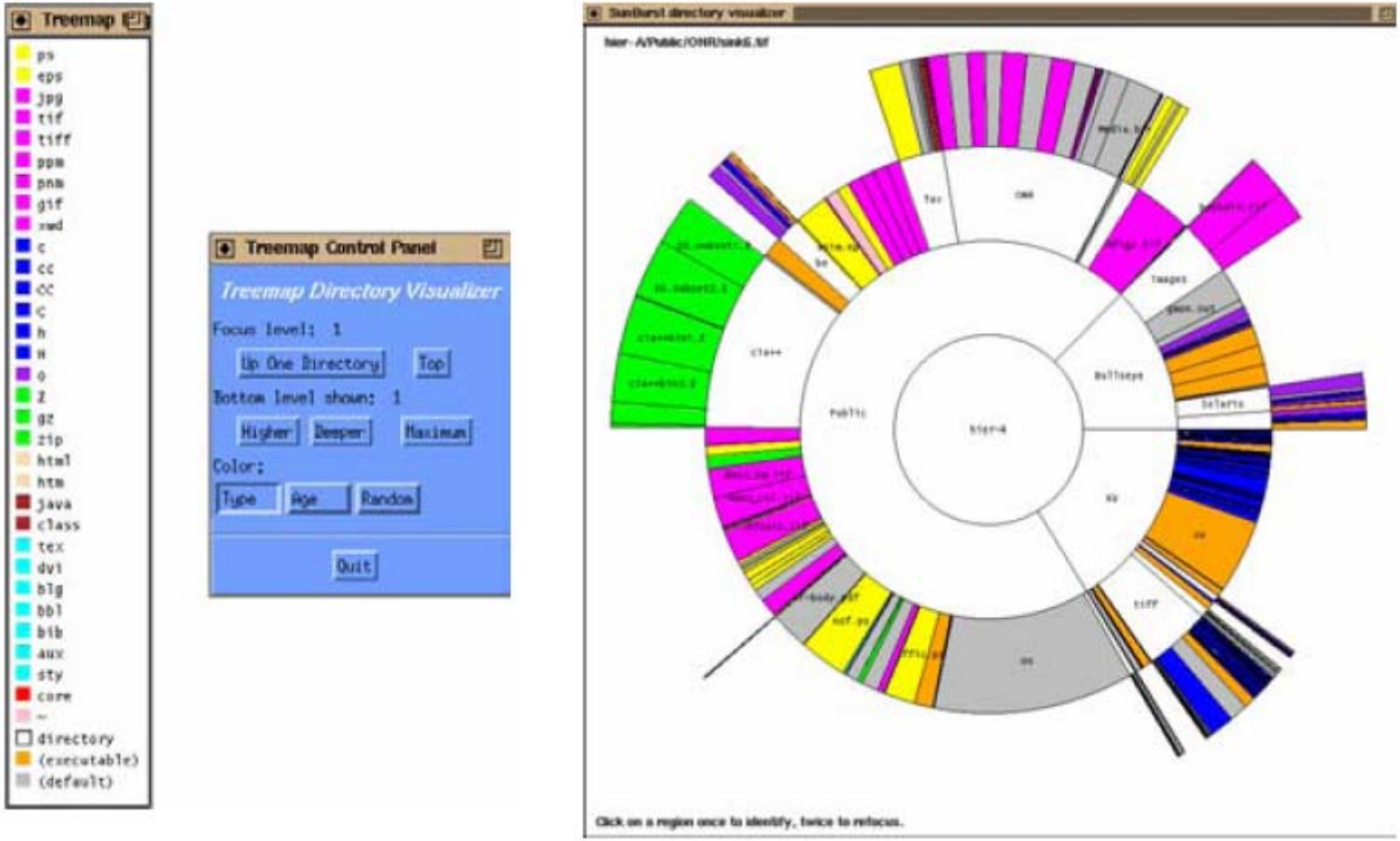
Radial Space-Filling

- Chuah InfoVis ‘98
- Andrews & Heidegger InfoVis ‘98



SunBurst

- Stasko et al 2000



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

SunBurst Negative

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