

# Hierarchical Data Visualization



# INTRODUCTION

Hierarchical Data Visualization

# Hierarchical Data

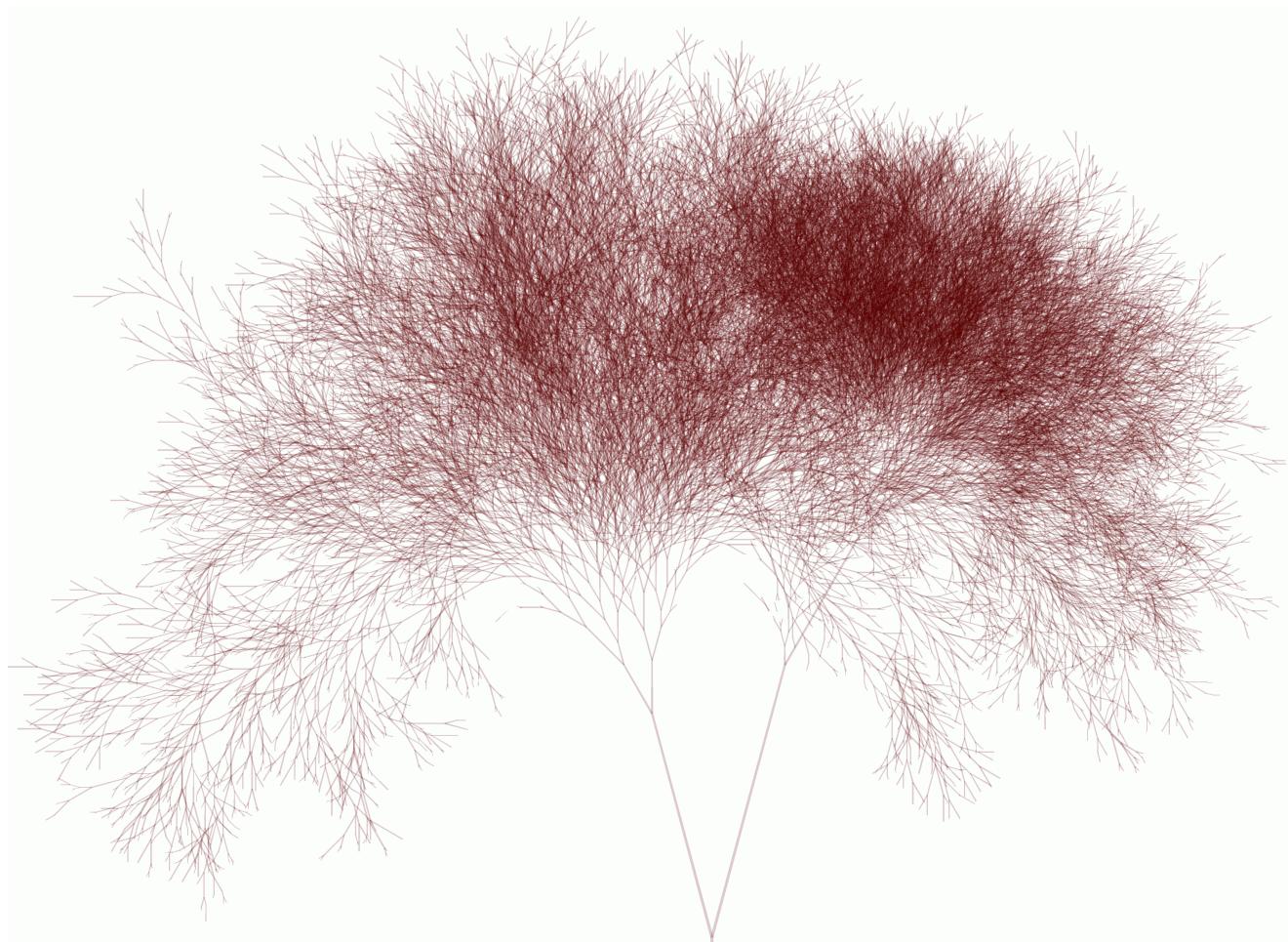
- Any data with some sort of **hierarchy**
  - *"Group of objects ranked so that every one but the topmost is subordinate to one above it."*
- Example hierarchy
  - Country: United States
  - Region: West
  - State: California
  - County: San Francisco County
  - City: San Francisco

<http://en.wiktionary.org/wiki/hierarchy>

# Examples of Hierarchical Data

- Evolutionary Tree
- Dendograms
- File Directory Structure
- Dewey Decimal System
- Family History
- Organization Charts
- Outlines

# Tree Structures



<http://drunkmenworkhere.org/219>

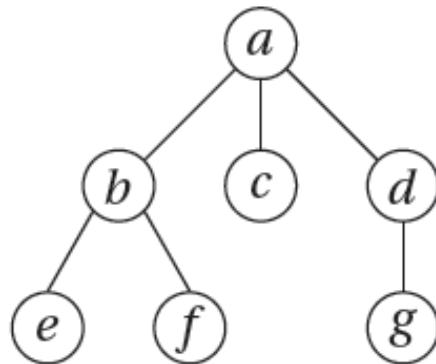
# Tree Structures

- Used to model hierarchical data
- Special type of graph
  - Must be **acyclic**, i.e. has no cycles or loops
  - Must be **undirected**, i.e. arrow-less edges
  - Usually **rooted** (a single node at top)
  - Each **subgraph** is also a tree (**subtree**)

<http://xlinux.nist.gov/dads/HTML/tree.html>

# Tree Terminology

FIGURE 2.8: TREE TERMINOLOGY AND NOTATION



$$G = (N, E) \text{ where}$$

$$N = \{ a, b, c, d, e, f, g \}$$

$$E = \{ (a, b), (a, c), (a, d), (b, e), (b, f), (d, g) \}$$

Example tree  $G = (N, E)$ . Some observations: Each node has a unique label. Node  $a$  is the root node. Nodes  $a$ ,  $b$ , and  $d$  are internal nodes. Nodes  $c$ ,  $e$ ,  $f$ , and  $g$  are leaf nodes. Node  $d$  is a parent node to node  $g$ , and node  $g$  is a child node to  $d$ . Nodes  $e$  and  $f$  share the same parent node  $b$  and are considered siblings.

# Tree Visualization

- Node-Link Diagrams
  - Traditional node-link diagram
  - Dendograms
  - Hyperbolic trees
- Space-Filling Diagrams
  - Treemaps
  - Sunbursts

# Considerations

- Is the hierarchical structure visible?
- What is the level of a specific node?
- What is the height of the tree?
- How many nodes on level  $x$ ?
- Are the labels readable? All nodes visible?
- What type of interaction is supported?
  - Focus + Context
  - Overview + Detail
  - Zoom + Filter

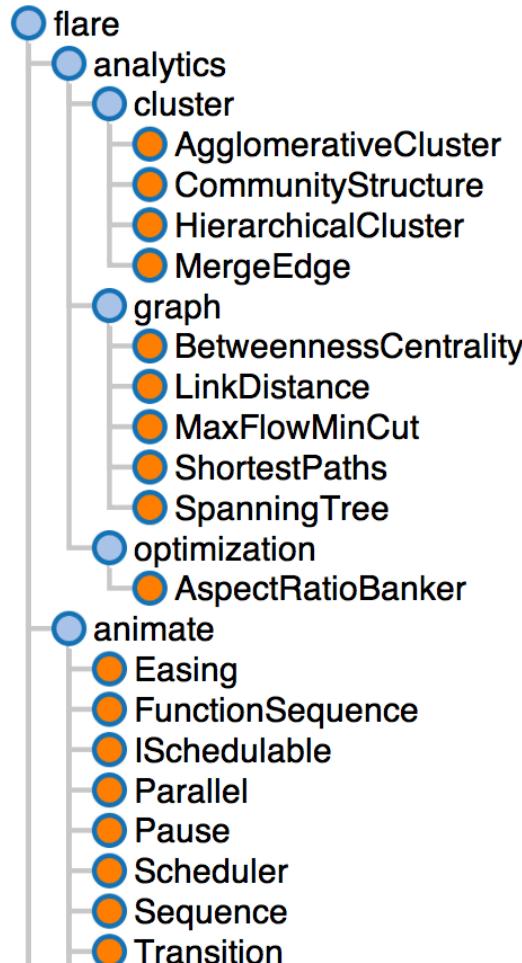
# NODE-LINK DIAGRAMS

Tree Visualization

# Node-Link Diagrams

- Indented Layout
  - Child nodes placed below parent and indented
  - Compact width
  - Height expands and shrinks
  - Often used to navigate file systems
  - Difficult to see all nodes of a specific level

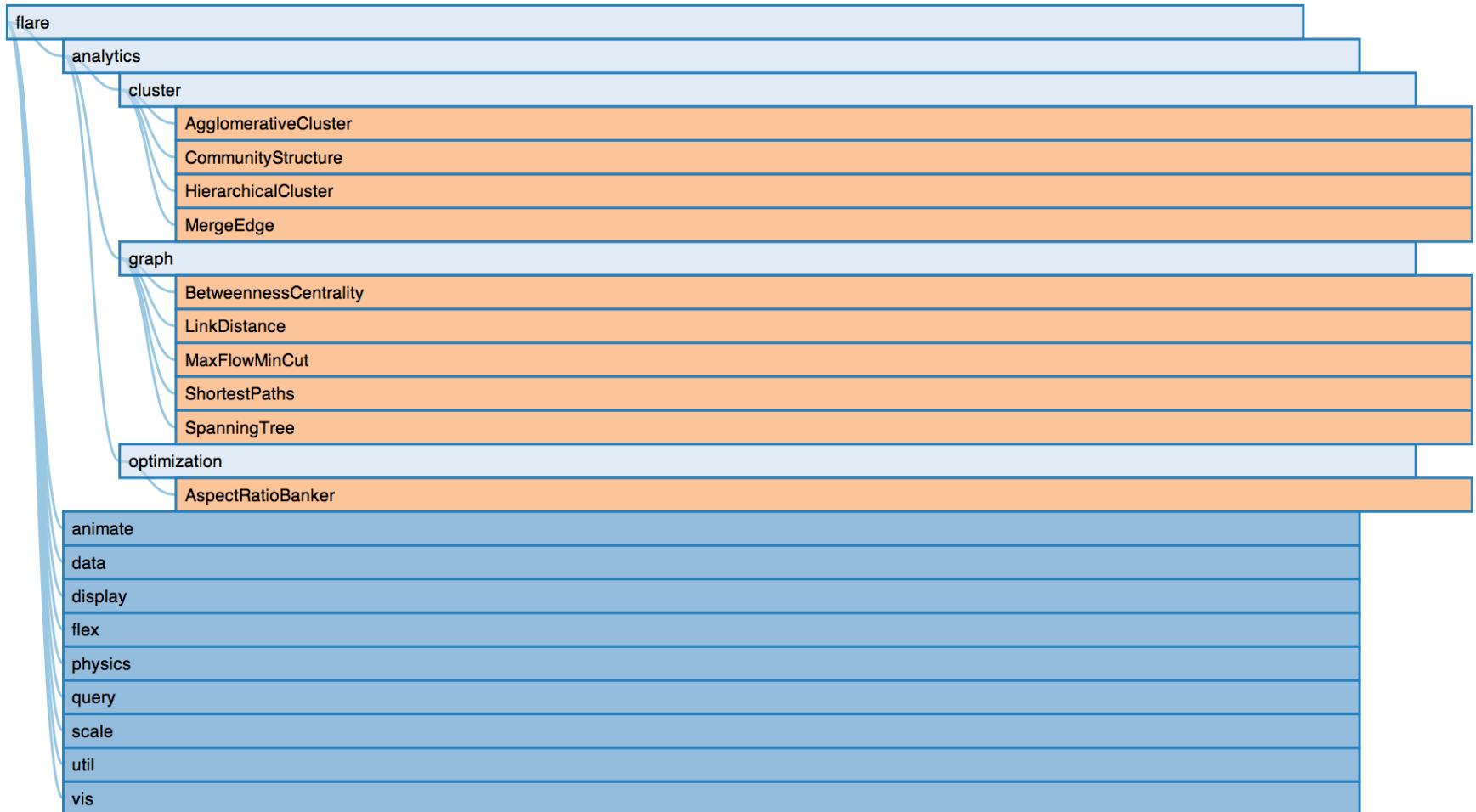
# Indented Layout



933KB	►  Archived Resources
47KB	►  CS 107 App Inventor
14KB	►  CS 110 Intro to CS I
3KB	►  CS 112 Intro to CS II
3KB	►  CS 212 Software Development
6KB	►  2012 Fall
0KB	►  2012 Spring
25KB	►  2013 Spring
3KB	►  Lectures
5KB	00 Eclipse Setup.pdf
7KB	00 Eclipse SVN Setup.pdf
5KB	01 Java Basics.pdf
3KB	02 Data Structures.pdf
6KB	03 Classes and Objects.pdf
6KB	04 Software Testing.pdf
97KB	05 Inheritance, Part 1.pdf
16KB	05 Inheritance, Part 2.pdf
5KB	
1KB	
5KB	
0KB	
5KB	
5KB	
8KB	

<http://mbostock.github.io/protovis/ex/indent.html>

# Indented Layout

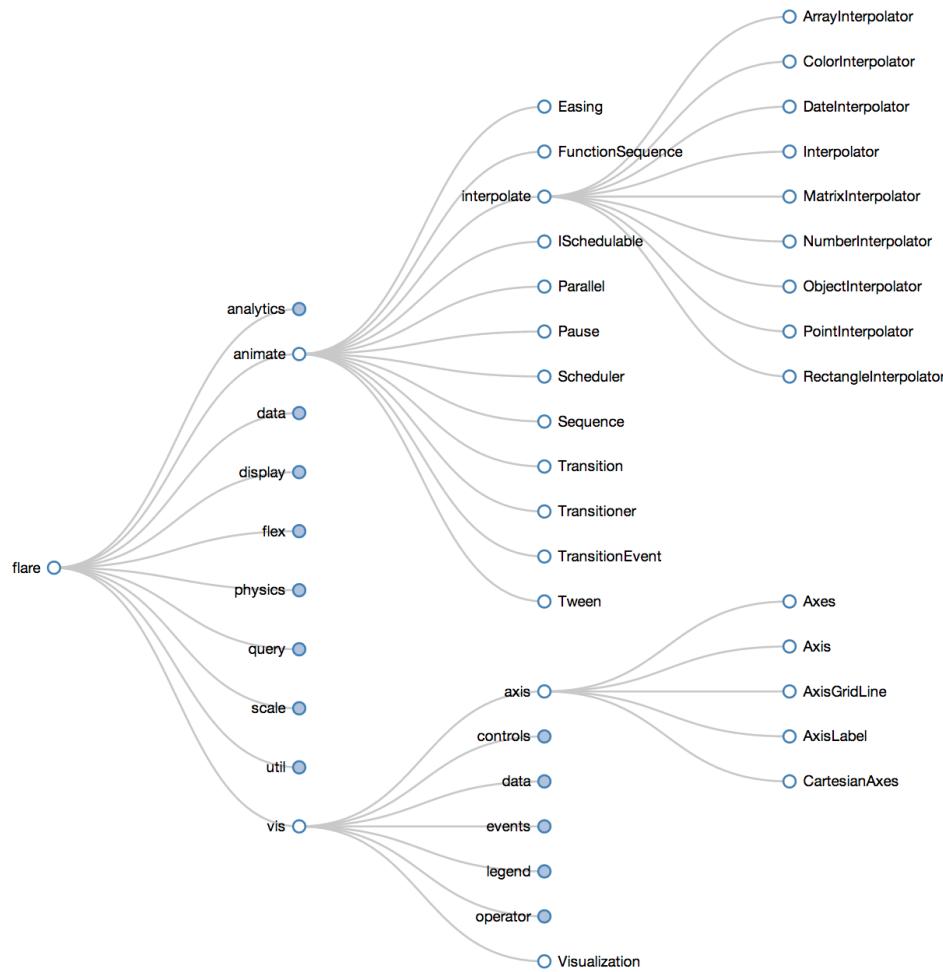


<http://bl.ocks.org/mbostock/1093025>

# Node-Link Diagrams

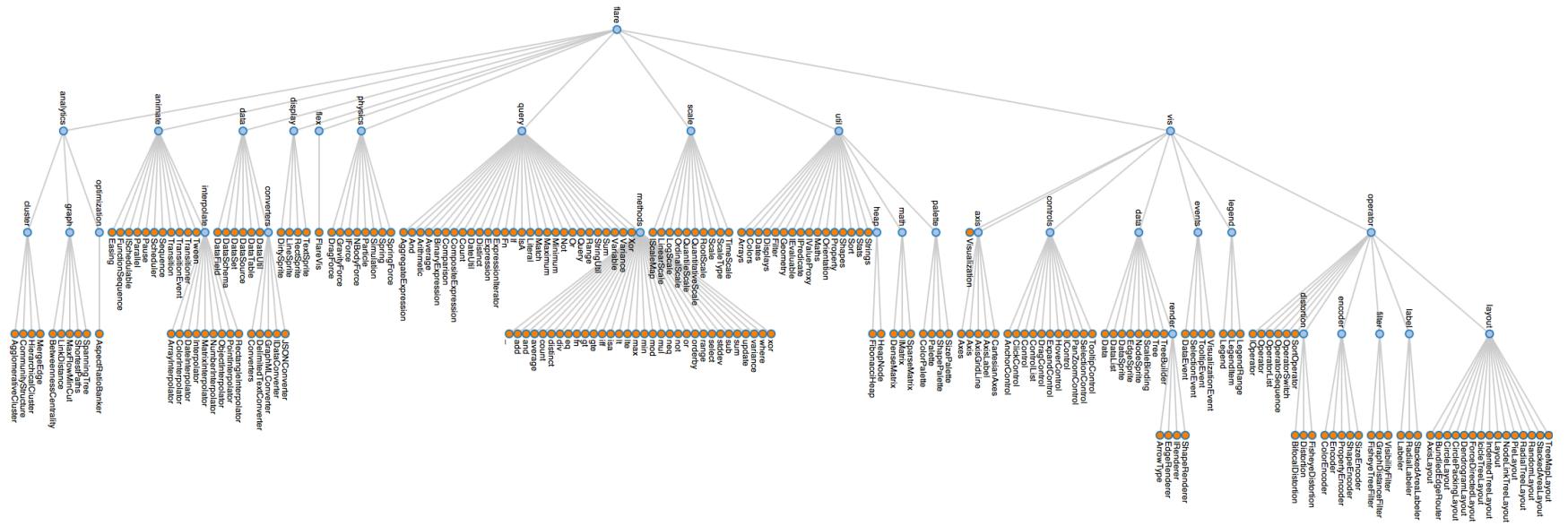
- Traditional Layout
  - Nodes laid out by level, root at top
  - Edges connect adjacent nodes
- Dendrogram
  - All leaves at bottom of diagram
  - Edges usually drawn with sharp corners
  - Often used to show clusters  
*(sometimes called cluster layout)*

# Traditional Layout



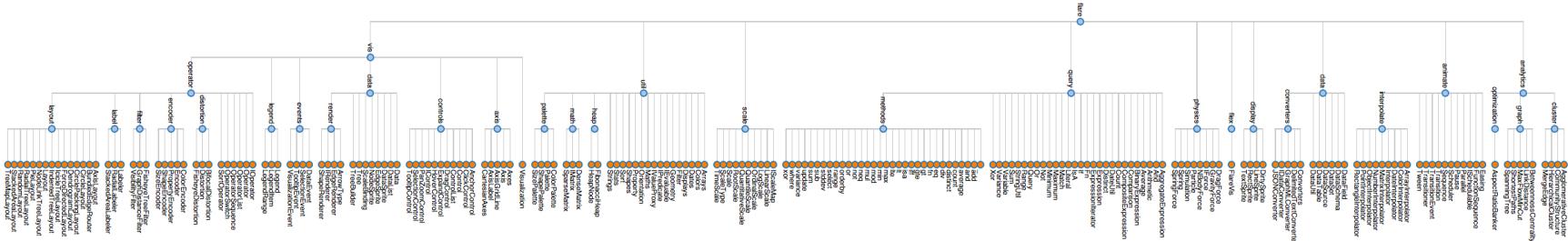
<http://mbostock.github.io/d3/talk/20111018/tree.html>

# Traditional Layout



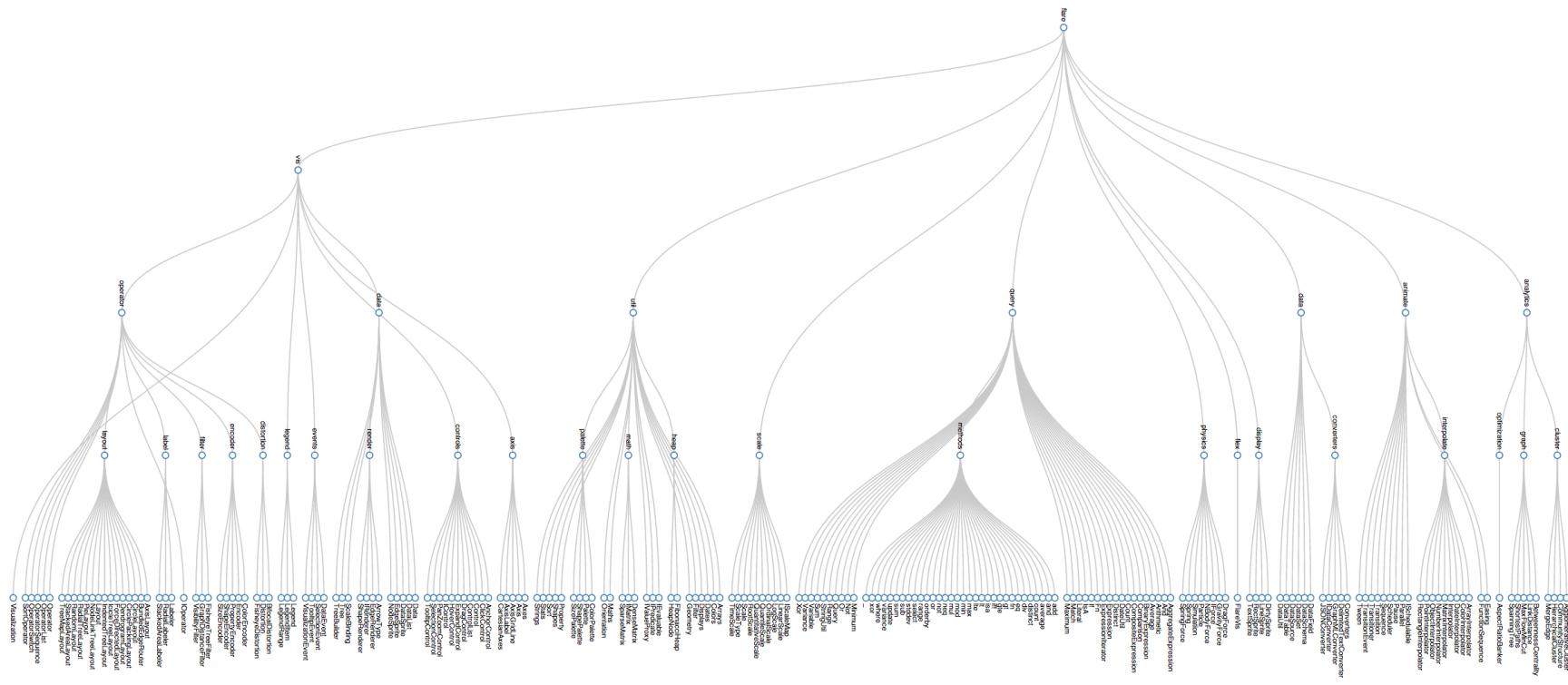
<http://hci.stanford.edu/jheer/files/zoo/ex/hierarchies/tree.html>

# Dendrogram



<http://mbostock.github.io/protovis/ex/dendrogram.html>

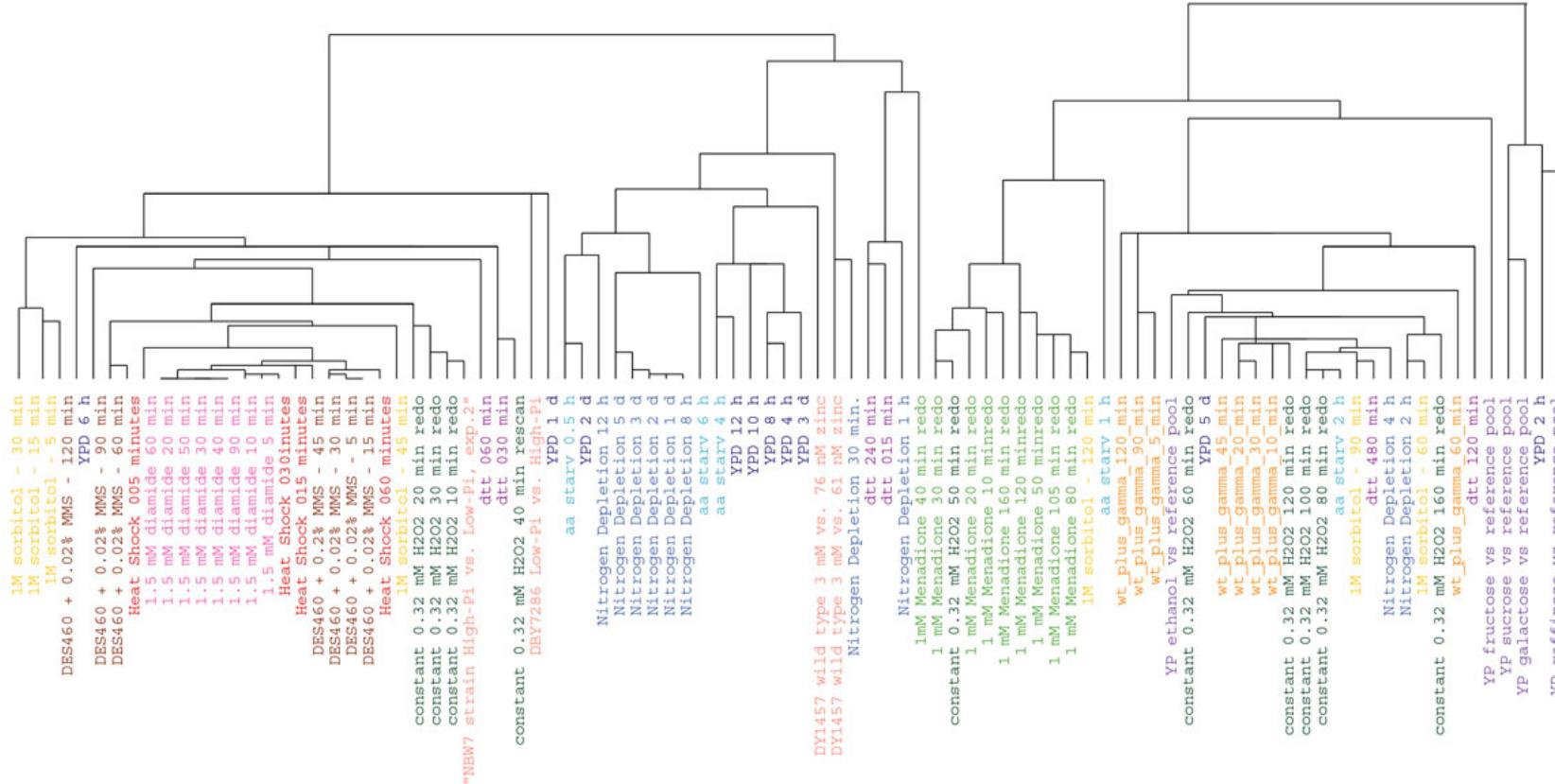
# Dendrogram



<http://mbostock.github.io/protovis/ex/dendrogram.html>

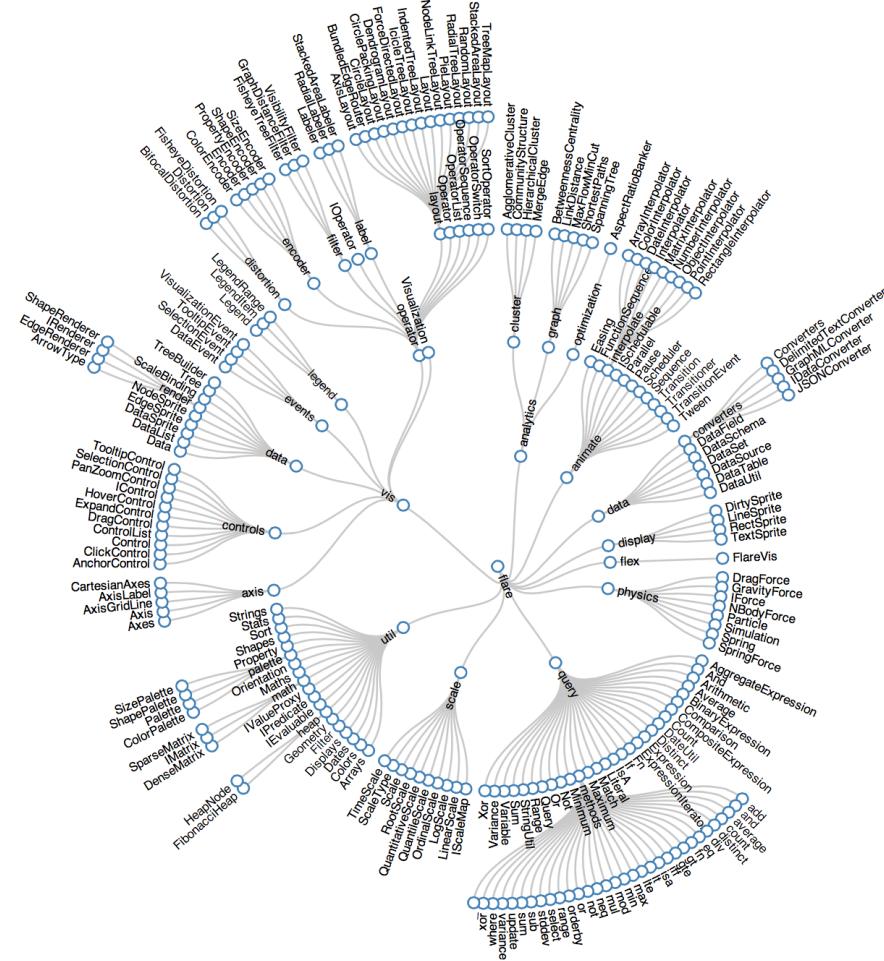
# Dendrogram

## Cluster 11: protein folding chaperones



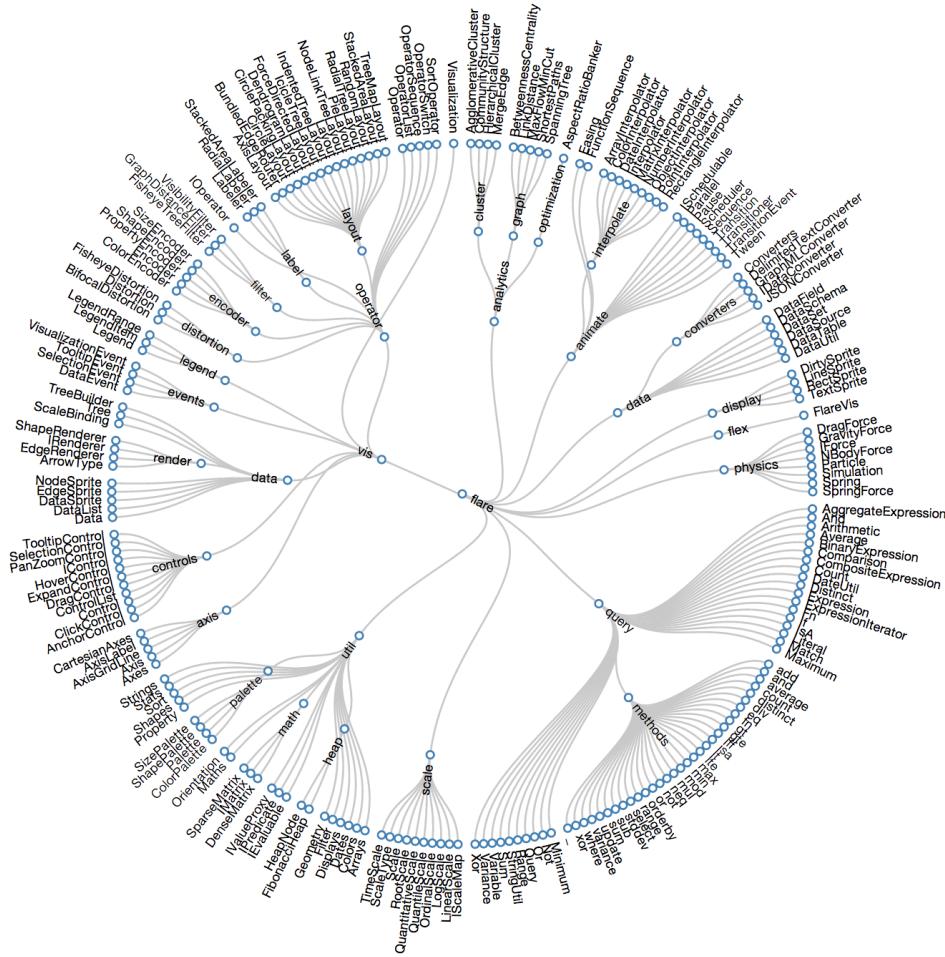
<http://rana.lbl.gov/FuzzyK/Home.htm>

# Circular Layout



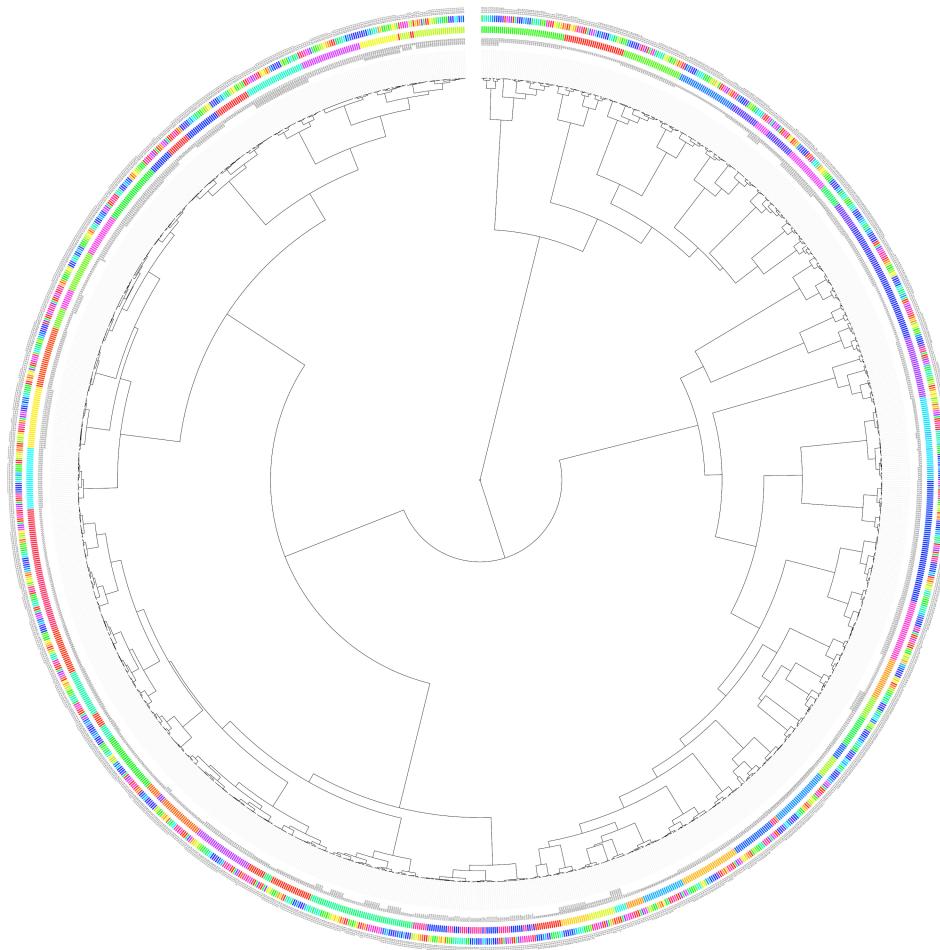
<http://blocks.org/mbostock/4063550>

# Circular Dendrogram



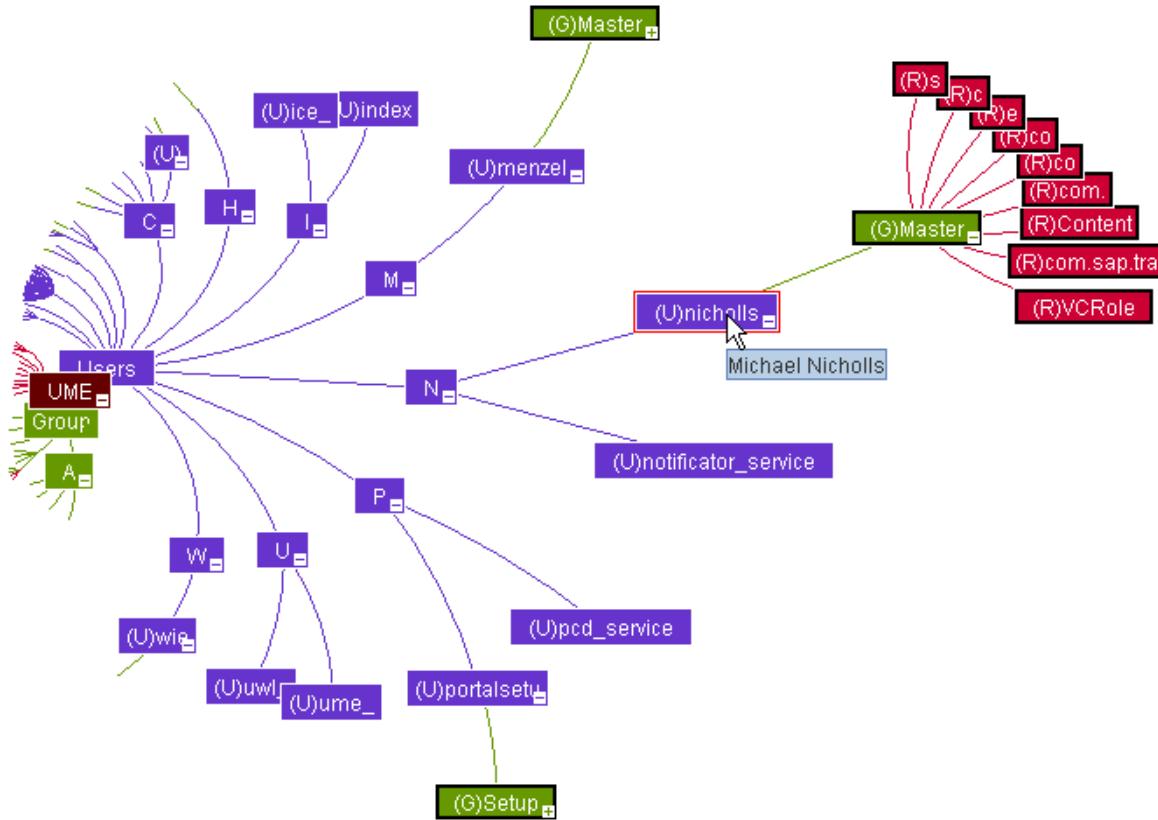
<http://mbostock.github.io/d3/talk/20111018/cluster.html>

# Circular Dendrogram



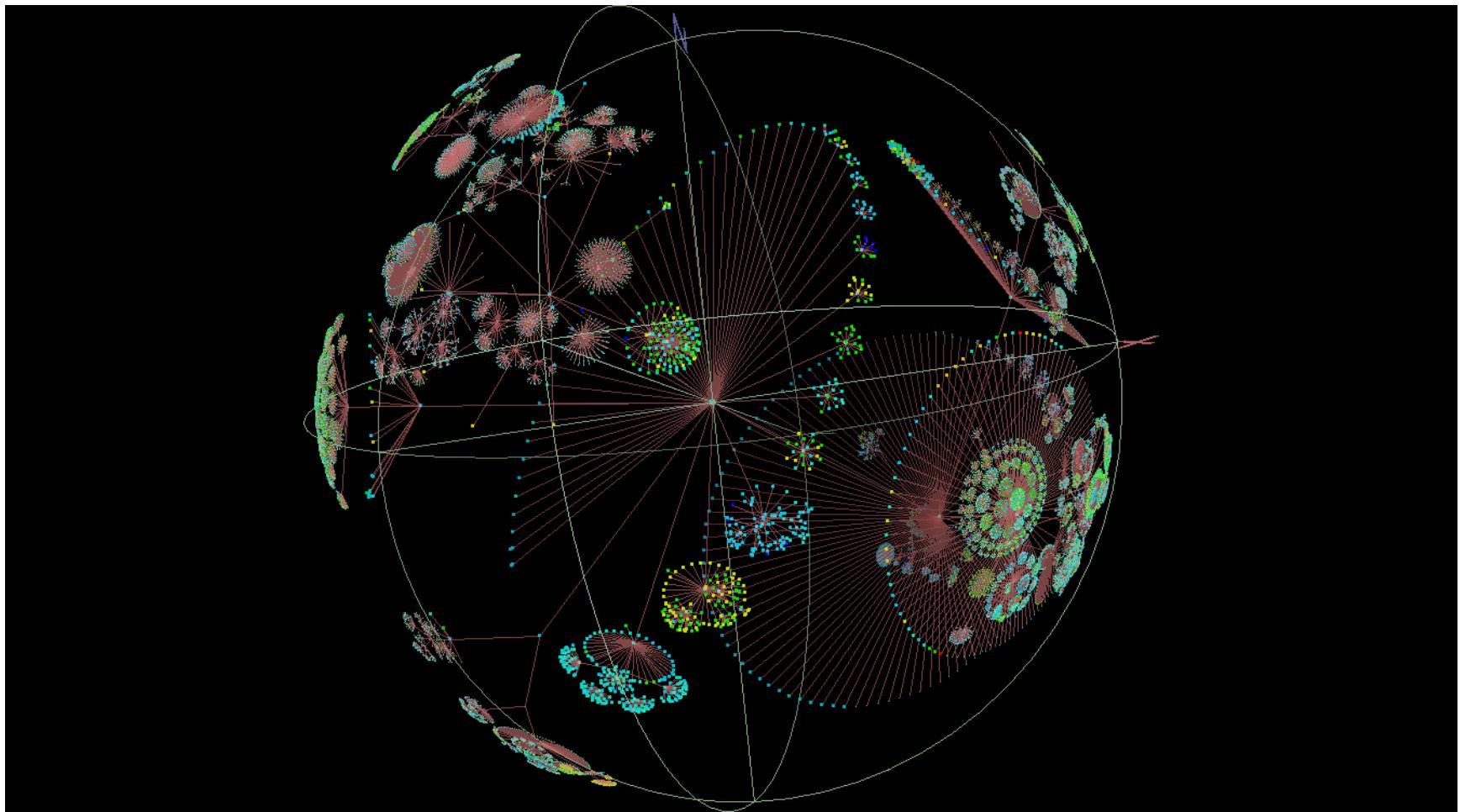
<http://cs.jhu.edu/~razvanm/fs-expedition/2.6.x.html>

# Hyperbolic Tree



<http://wiki.sdn.sap.com/wiki/display/EmTech/StarTree+examples>

# Hyperbolic Tree (3D)

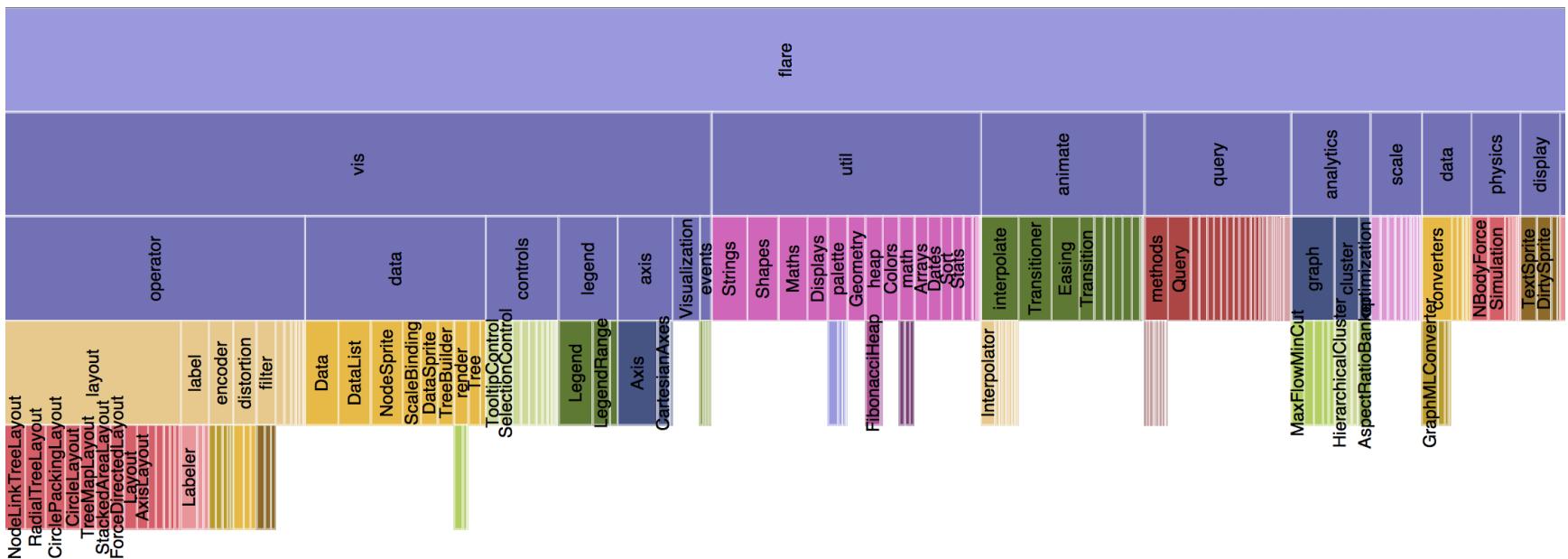


<http://www.caida.org/tools/visualization/walrus/>

# SPACE-FILLING DIAGRAMS

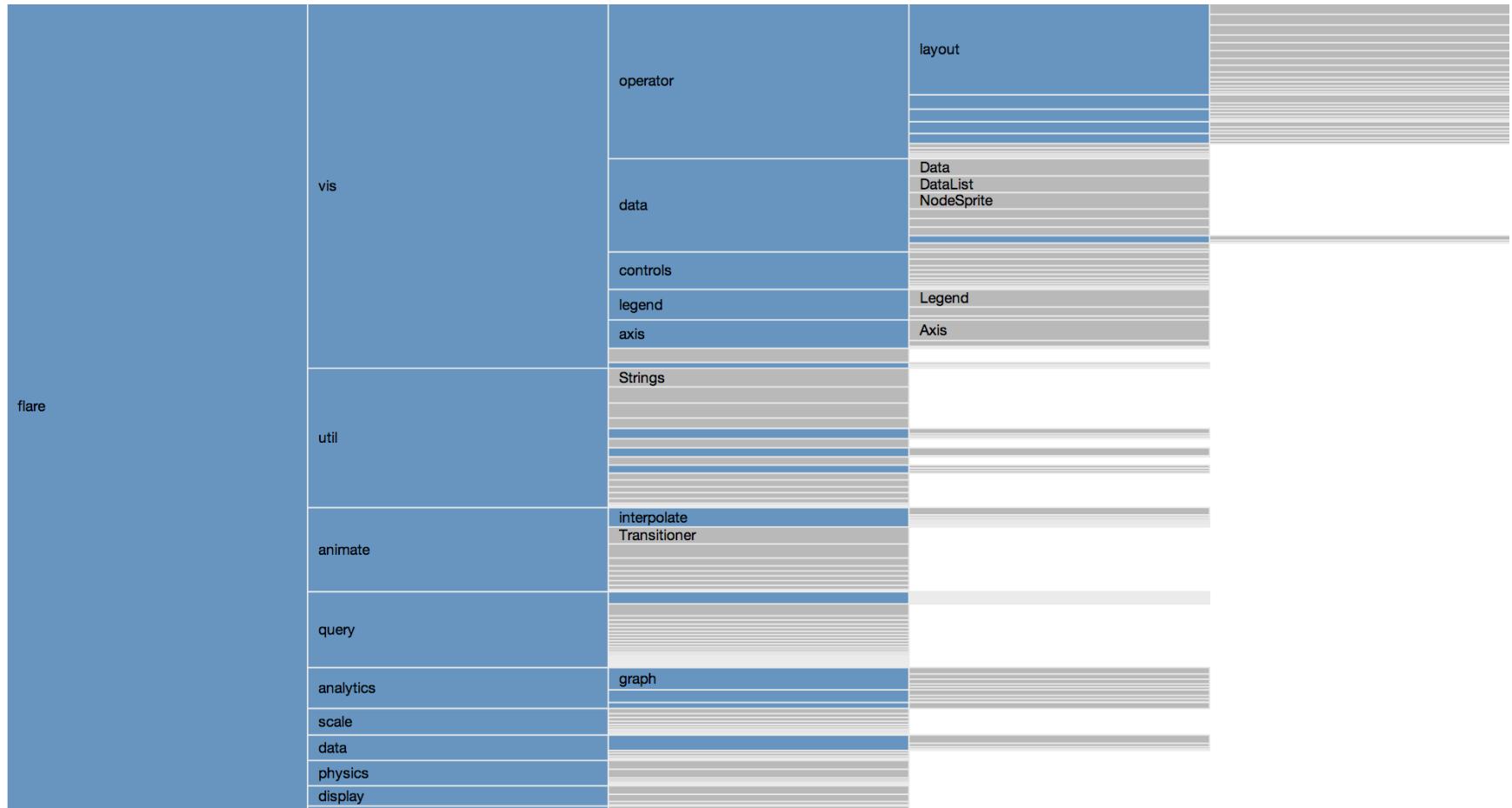
Tree Visualization

# Icicle Diagram



<http://mbostock.github.io/protovis/ex/icicle.html>

# Icicle Diagram



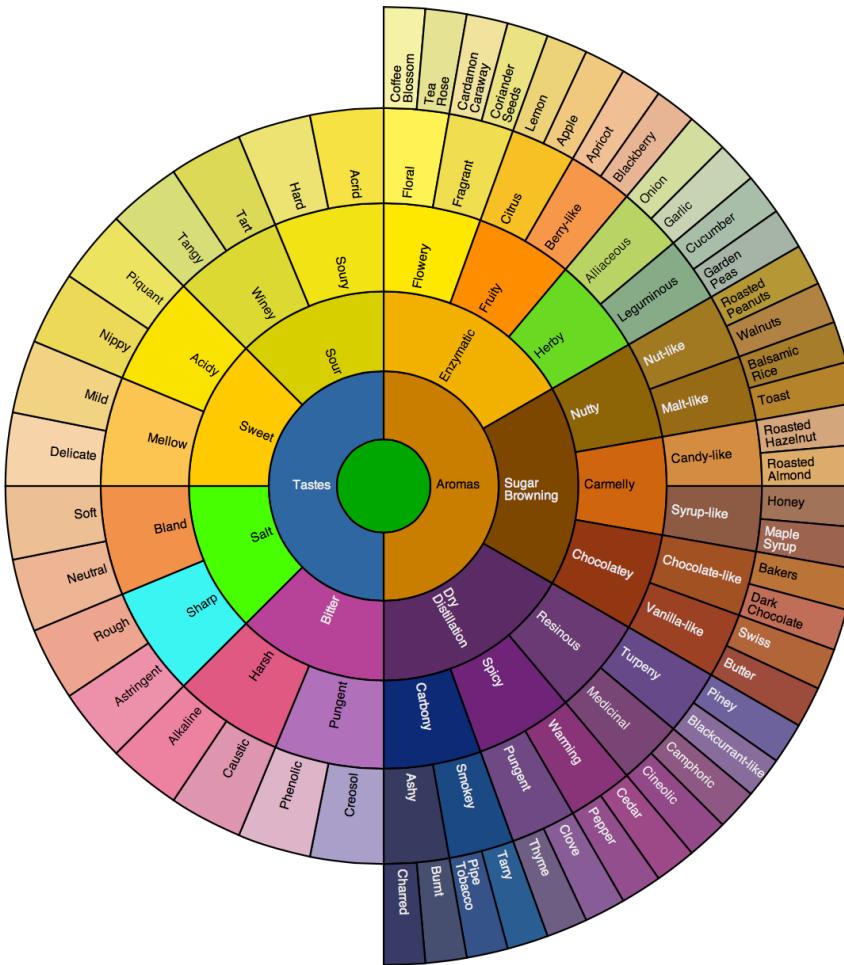
<http://mbostock.github.io/d3/talk/20111018/partition.html>

# Sunburst Diagram



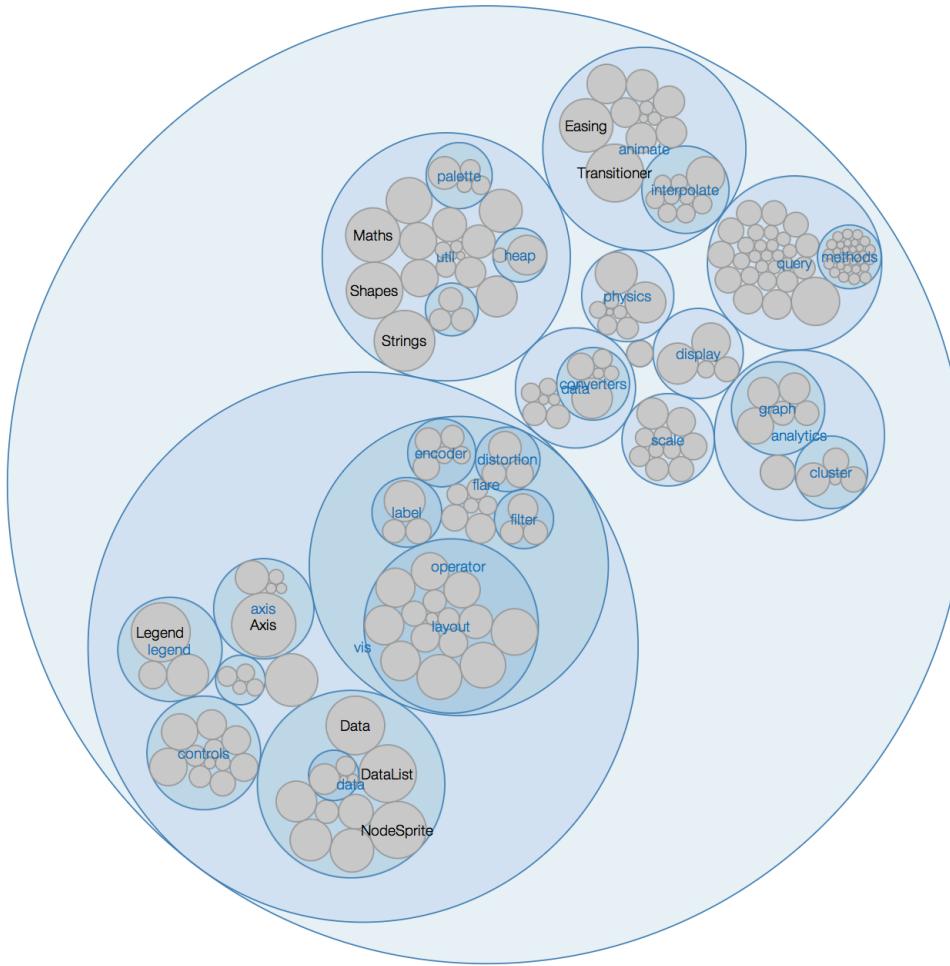
<http://bl.ocks.org/mbostock/4063423>

# Sunburst Diagram



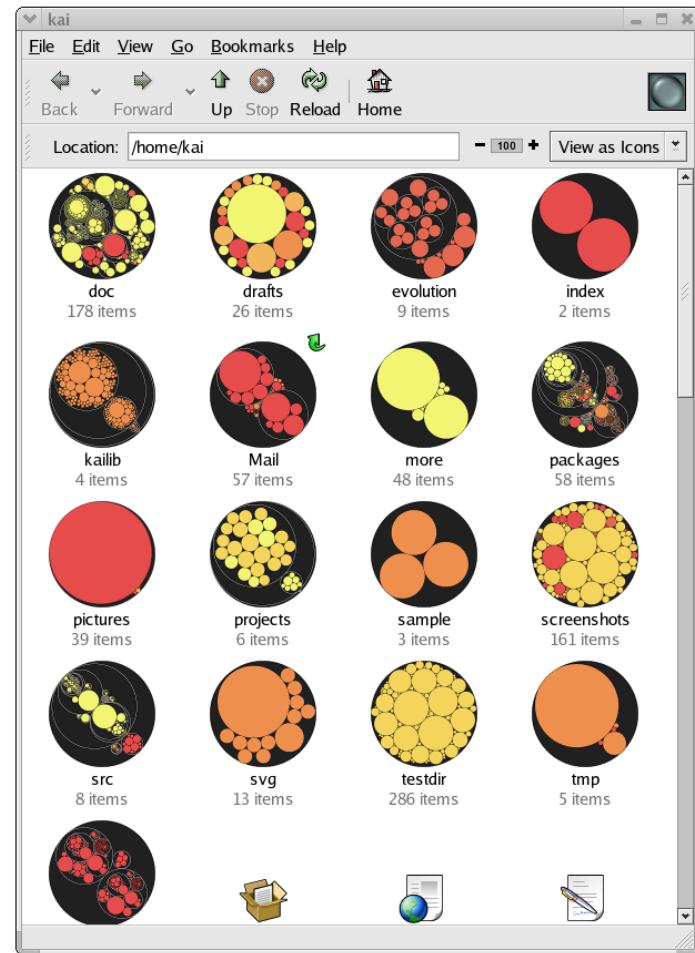
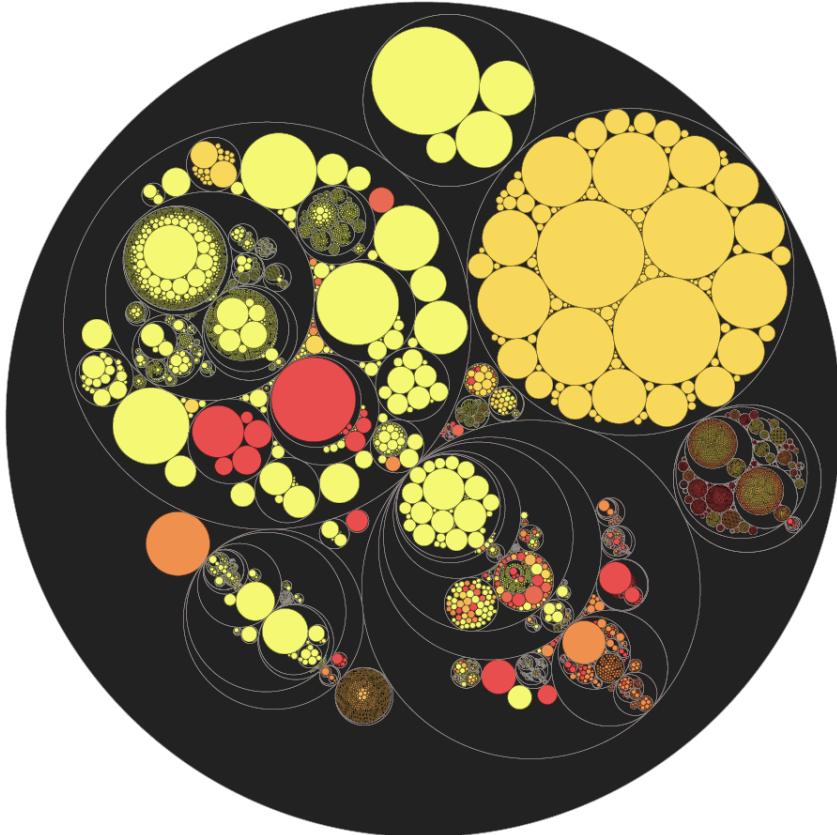
<http://www.jasondavies.com/coffee-wheel/>

# Circle Packing



<http://mbostock.github.io/d3/talk/20111116/pack-hierarchy.html>

# Pebbles File Manager



<http://lip.sourceforge.net/ctreemap.html>

# PRTG Network Monitor



[https://prtg.paessler.com/help/general\\_layout.htm](https://prtg.paessler.com/help/general_layout.htm)

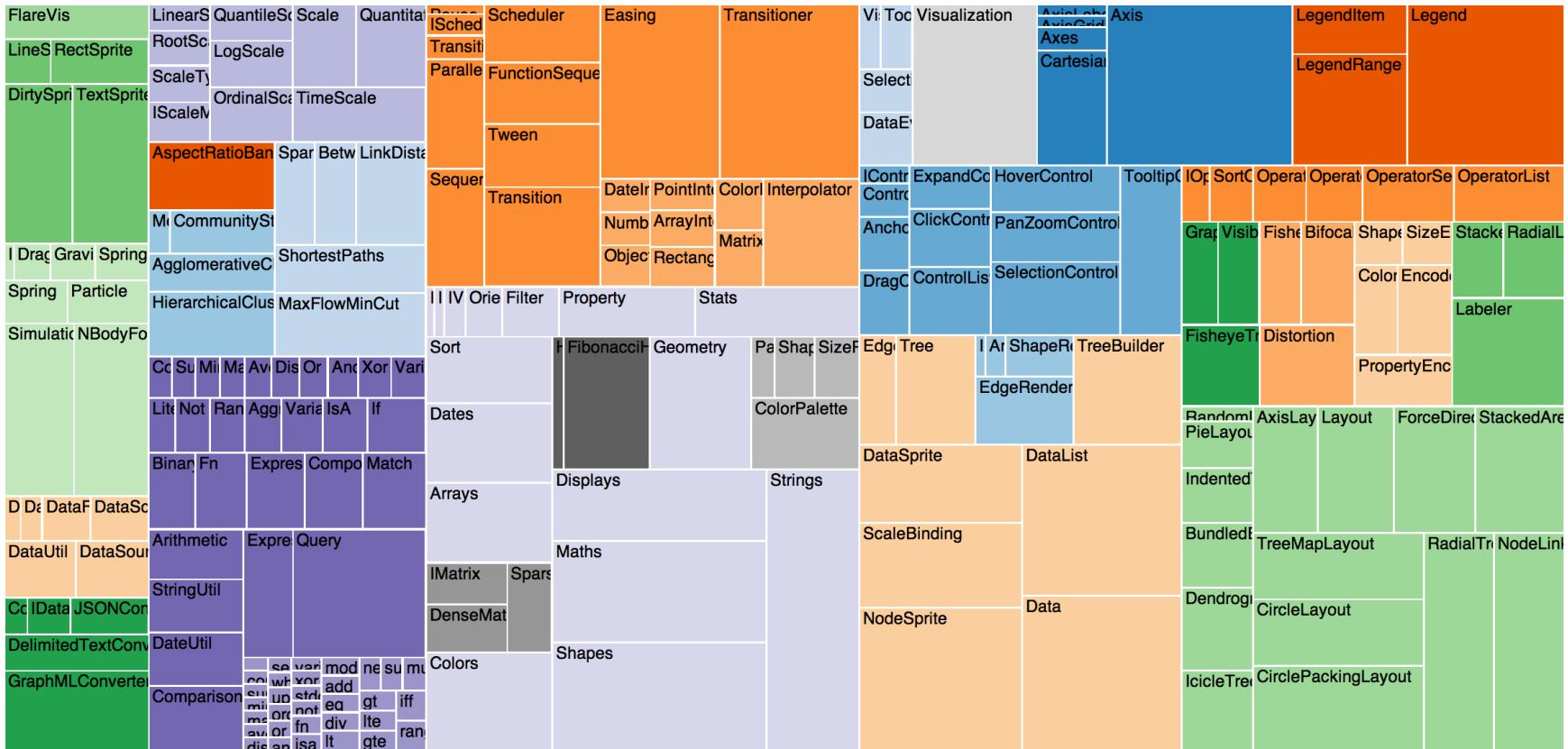
# TREEMAPS

Space-Filling Diagrams

# Treemaps

- Root is entire rectangle
- Recursively divide rectangles to show levels
- Two common visualization tasks
  - Promote comparison
  - Visualize hierarchy
- Task affects encoding
  - Use of color, outlines, shading, etc.
- See <http://www.cs.umd.edu/hcil/treemap-history/>

# Treemaps



<http://bl.ocks.org/mbostock/4063582>

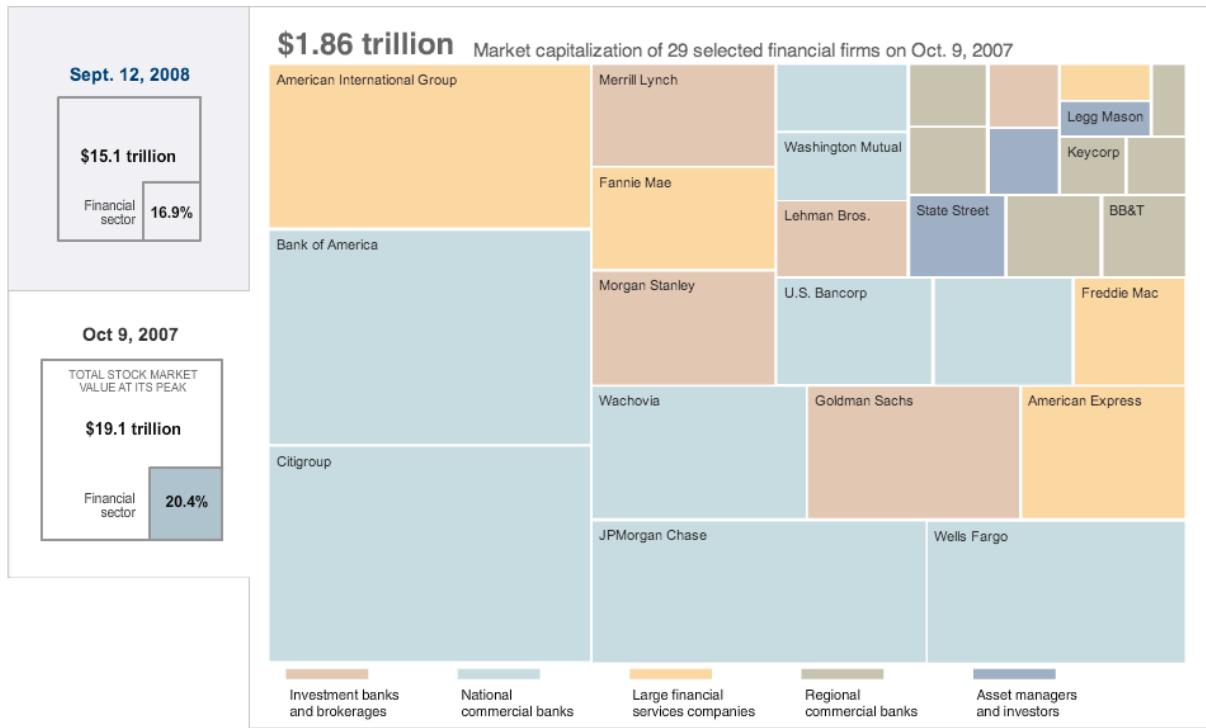
# A Year of Heavy Losses

September 15, 2008

[SIGN IN TO E-MAIL OR SAVE THIS](#) | FEEDBACK

## A Year of Heavy Losses

A year ago, financial companies were flying high. But as problems in the mortgage and credit markets have grown, the stocks of many Wall Street firms have been hard hit. Some of the biggest companies have been bought out, taken over by the government or gone bankrupt.



These two snapshots of the U.S. stock market and the financial sector are based on the Dow Jones Wilshire 5000 index, the market's broadest measure. Each box represents the market value of one company, which is found by multiplying the number of a company's shares outstanding by its stock price.

Source: Wilshire Associates

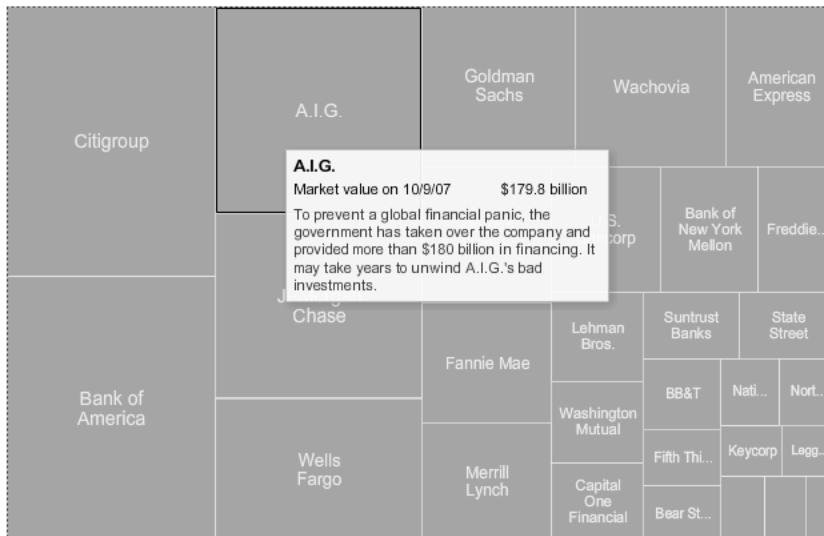
Kevin Quealy and Dylan Loeb McClain / The New York Times

<http://www.nytimes.com/interactive/2008/09/15/business/20080916-treemap-graphic.html>

# How the Giants of Finance Shrunk

Published: September 12, 2009

## How the Giants of Finance Shrunk, Then Grew, Under the Financial Crisis



### \$1.87 trillion

Market Capitalization of 29 of the biggest financial firms on Oct. 9, 2007

Since the stock market's peak in October 2007, Wall Street's landscape has been permanently altered. Lehman Brothers, gone. Bear Stearns, gone. Merrill Lynch, gone. Main Street's landscape has also changed. Wachovia, National City, Washington Mutual and Countrywide, all gone. These venerable financial giants all crumbled under the weight of the financial crisis.

Those that were left shrank down to a fraction of their former market capitalizations by early 2009, but since then, they all have grown. While most are nowhere near their former size, two — JPMorgan Chase and Wells Fargo — are slightly larger than they were at the market's peak.

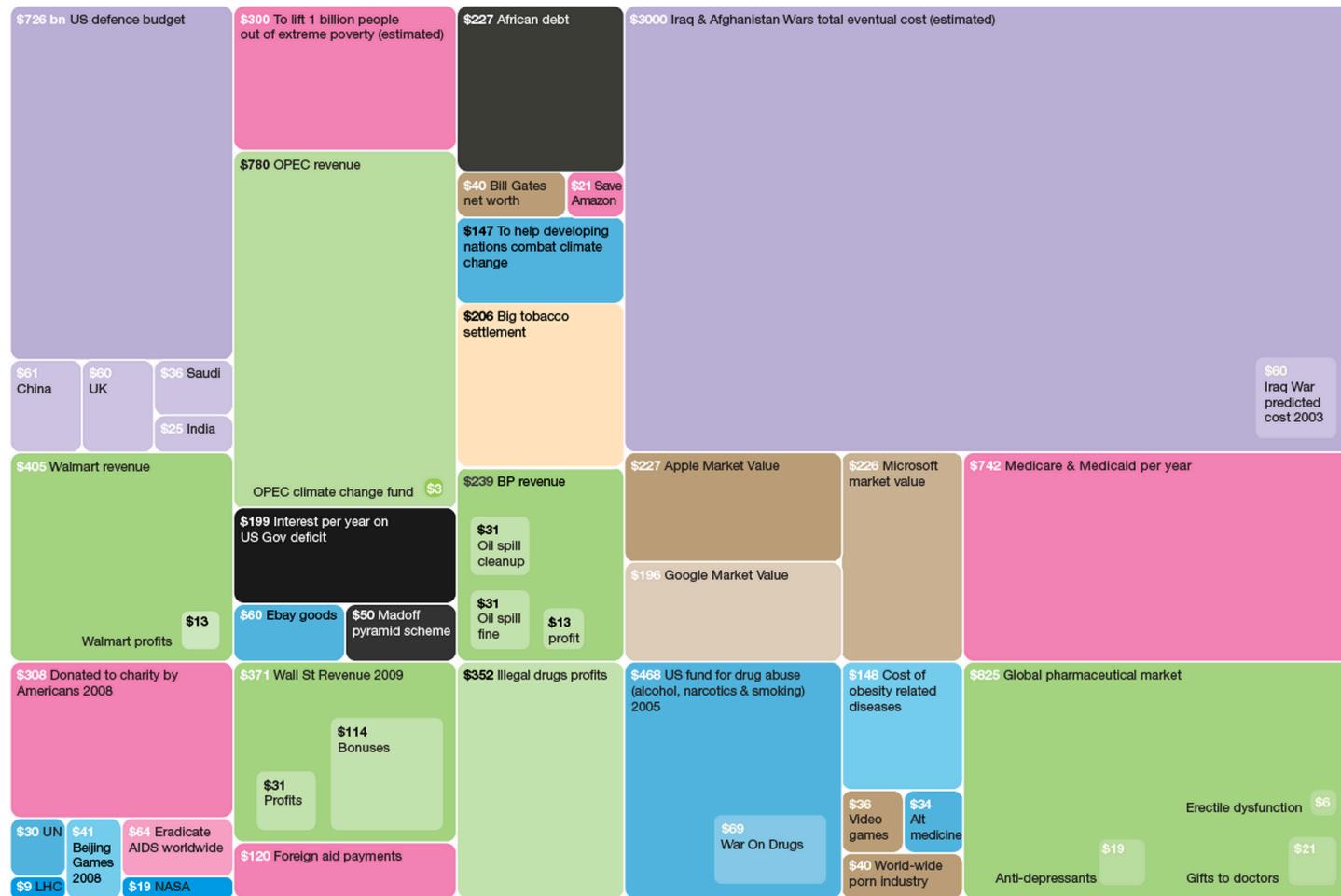
By KARL RUSSELL and SHAN CARTER | [Send Feedback](#)

Source: Bloomberg

**Correction:** September 20, 2009: The Metrics chart last Sunday, showing the changing market capitalization of financial companies, mistated actions taken by Citigroup. It has reorganized into two segments: Citicorp (core businesses) and Citi Holdings (other businesses). It has not set aside those plans.

<http://www.nytimes.com/interactive/2009/09/12/business/financial-markets-graphic.html>

# Billion-Dollar-O-Gram



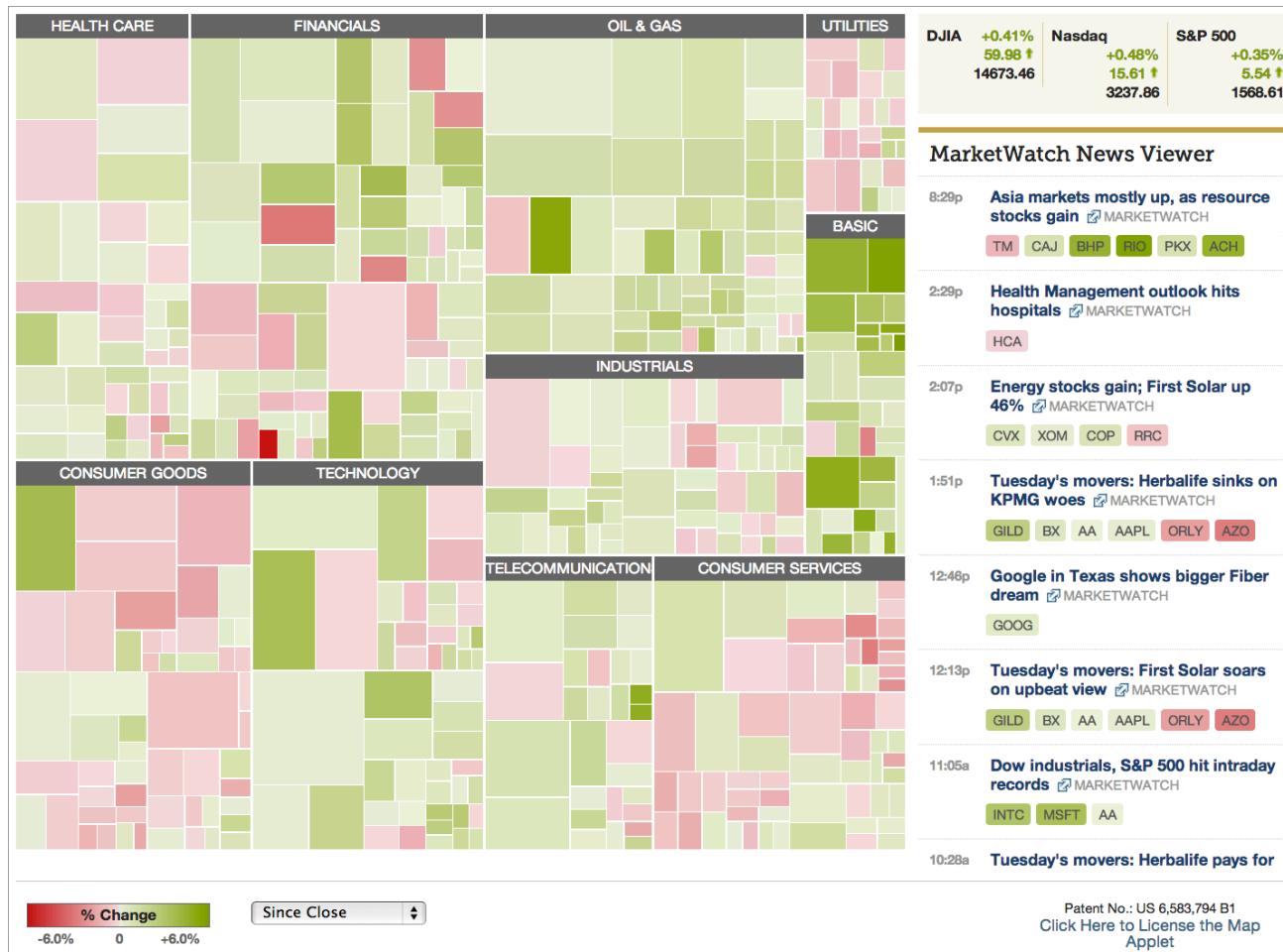
<http://www.informationisbeautiful.net/visualizations/the-billion-dollar-o-gram-2009/>

# Billion-Dollar-O-Gram

\$11,900 Worldwide cost of financial crisis

<http://www.informationisbeautiful.net/visualizations/the-billion-dollar-o-gram-2009/>

# Map of the Market



<http://www.smartmoney.com/map-of-the-market/>

# News Map

**Masters 2013: Rory McIlroy primed for Augusta and shot at third major**

**Brad Paisley Goes on Twitter to Defend 'Accidental Racist'**

**Ben & Jerry's Teams Up With PBHA**

**Lindsay Lohan Finds Herself In The Hot Seat On 'Letterman'**

**Drama drips in Dortmund as favorites advance in Champions League**

**Michigan's Spike Albrecht tweets at Kate Upton after loss to Louisville**

**Fireworks by Knicks, Followed by a Title**

**Judge breaks down arguments in concussion-related suit**

**Westbrook, Durant lead Thunder over Jazz 90-80**

**Matt Damon's 'Elysium' Trailer: Watch Now!**

**Chris Brown Goes to Rihanna's Concert Amid Breakup Reports**

**Dancing With the Stars Elimination: A Cut Weeks in the Making**

**Justin Timberlake, Mavis Staples and more bring sounds of soul to the White ...**

**Avril Is Planning Surprises for Her Fiancé on Their Wedding Day**

**AMC Actually Considering a Saul-based Breaking Bad Spinoff**

**Alec Baldwin in Talks to Replace ABC's Late-Night Lineup? 'There Have Been Some Offers ...'**

**Mick Fleetwood Spills From Third Wife**

**Death toll in Iran's 6.1-magnitude quake rises to 32**

**G8 foreign ministers to meet to address Syria**

**Margaret Thatcher funeral in security clampdown**

**Cuba to turn over Florida couple who allegedly kidnapped children**

**Japan readies defenses for possible missile test by North Korea**

**Bullying blamed in death of Nova Scotia teen**

**North Korea closes China border to tourists**

**Saudi Arabia Says Paralysis Sentence Is False**

**Apple's iMessage and FaceTime Back Up After Five-Hour Outage**

**GM Returns To Facebook Ads; Will Super Bowl Be Next?**

**Sharon Stone Sues NY for \$2 For Gay Sex Scene**

**Barnes & Noble launches new publishing platform**

**Vudu reveals March 24 lineups, says to reset passwords**

**Chrysler rolls out 6 recallers over warning lights, fuel pumps, and more**

**Ford's gas-sucking F-150 Radar gets special edition**

**Apple iPhone 5S' Face ID Feature Is Only Available on Certain Models**

**Intel's Broadwell Chip Delays Until 2015**

**Levi's Replaces Denim Baggage**

**Student charged after 14 wounded in mass stabbing at Texas college**

**GOP Senators Signal Possible Breakthrough in Gun Debate**

**Illinois black ministers split on same-sex marriage legislation**

**Heavy snow expected from Colorado to Minnesota**

**Democrats pressure Republicans for a vote on guns**

**Sandy Hook families push for votes on gun control**

**Biden calls GOP filibuster threat mind-boggling**

**American Eagle shot charged with stamping it by white intruder**

**Romeo and Juliet's Shakespearian Love Story: Michael Eberle: A Hero, A Teacher, An Inspiration**

**911 audio released from fugitive ex-LA cop manhunt**

**New Guidelines Call for Broad Changes in Science Education**

**Romantic comedies like 'Love, Rosie' and 'Marry Me' Make Michael Eberle: A Hero, A Teacher, An Inspiration**

**Lew calls on Germany to focus on growth to spur European economy**

**Scott London: Tipping Began at Golf Club**

**Dow Posts New Closing High; JCP Skids 12%, FSLR Soars 45%**

**China Posts Trade Deficit**

**30 percent cut in defense spending forces Oshkosh Corp. to lay off 900**

**Virgin America enters Newark Airport with a party**

**3 jobless Americans for every opening**

**FBI takes lead in search for missing family**

**Lenders Used Credit Scores to Identify 'Bad' Families**

**Marilyn Tavener soars through Senate Finance hearing**

**In Black, Alzheimer's Study Finds Same Variant Jones as in Whites**

**newspaper**  
Tue April 9, 2013 21:46:55  
powered by [Google News](#)

**SELECT ALL**  **WORLD**  **NATIONAL**  **BUSINESS**  **TECHNOLOGY**  **SPORTS**  **ENTERTAINMENT**  **HEALTH**

LESS THAN 10 MIN: 860  
MORE THAN 10 MIN: 460  
MORE THAN 1 HOUR: 850

<http://newsmap.jp/>

# Cushion Treemap

## Cushion TreeMaps

In this example a static JSON tree is loaded into a Cushion Treemap.

**Left click** to set a node as root for the visualization.

**Right click** to set the parent node as root for the visualization.

You can **choose a different tiling algorithm** below:

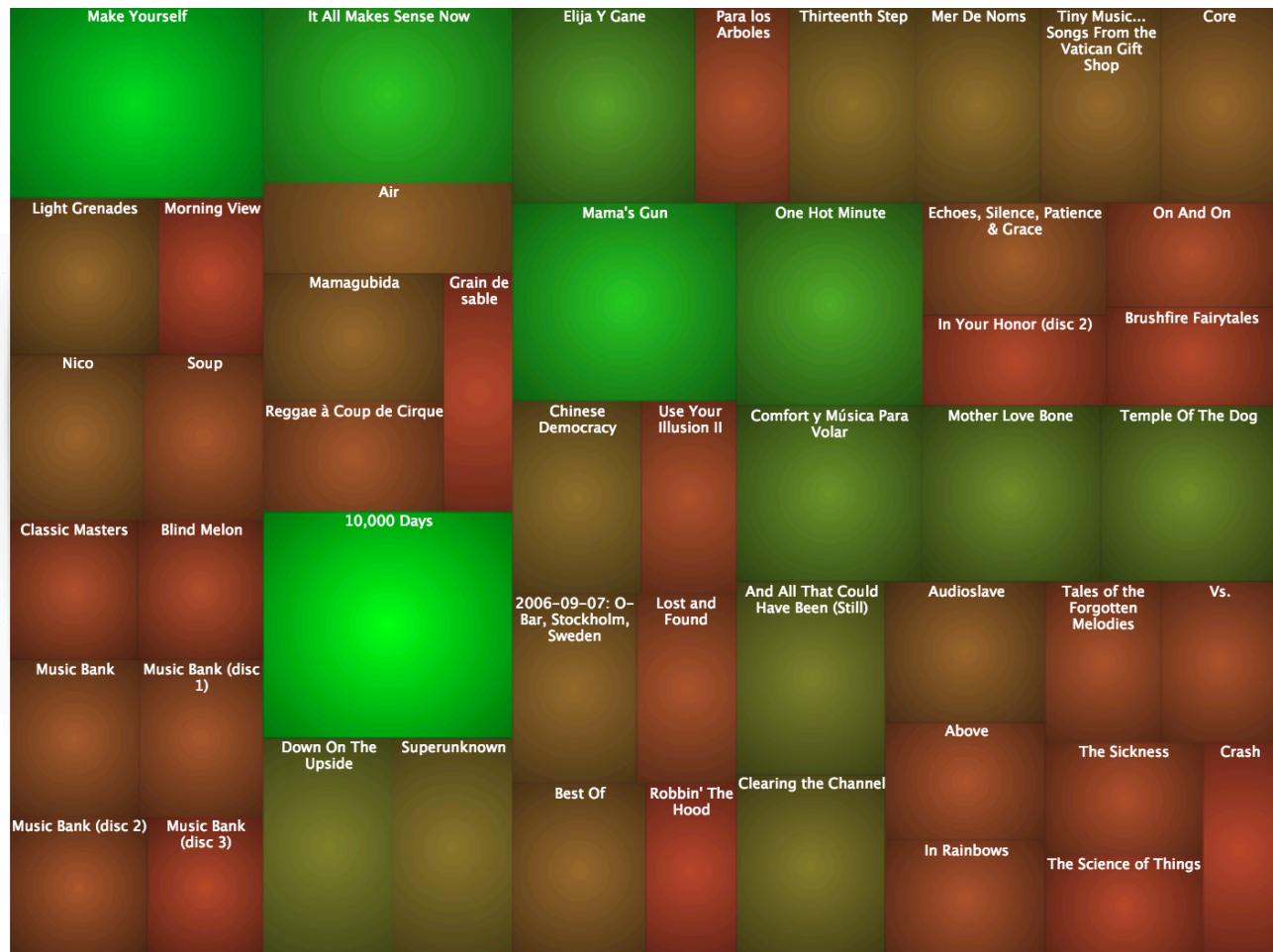
Squareified

Strip

SliceAndDice

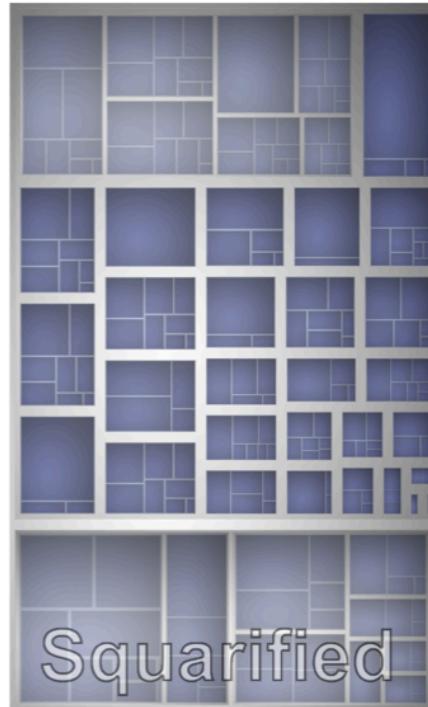
[Go to Parent](#)

[See the Example Code](#)



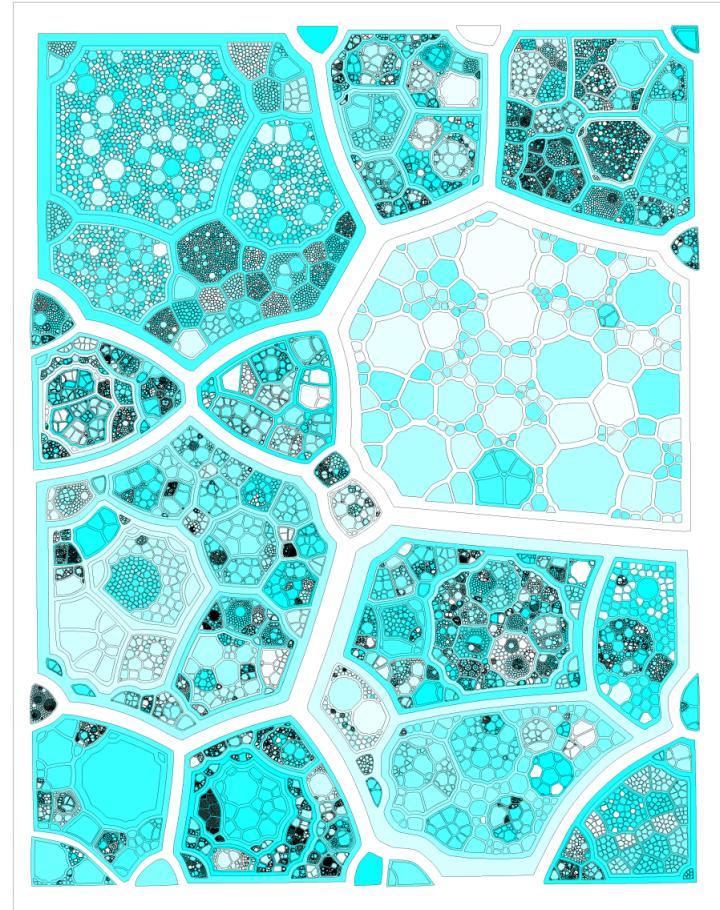
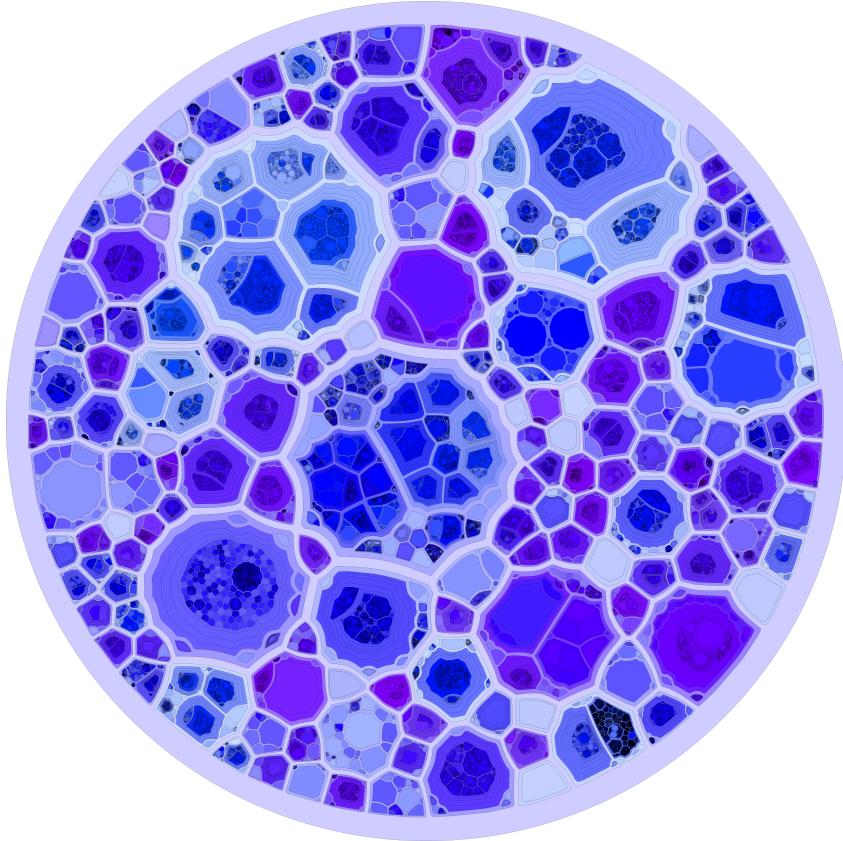
<http://philobg.github.io/jit/static/v20/Jit/Examples/Treemap/example3.html>

# Voronoi Treemaps



<http://www.informatik.uni-konstanz.de/en/deussen/publications/>

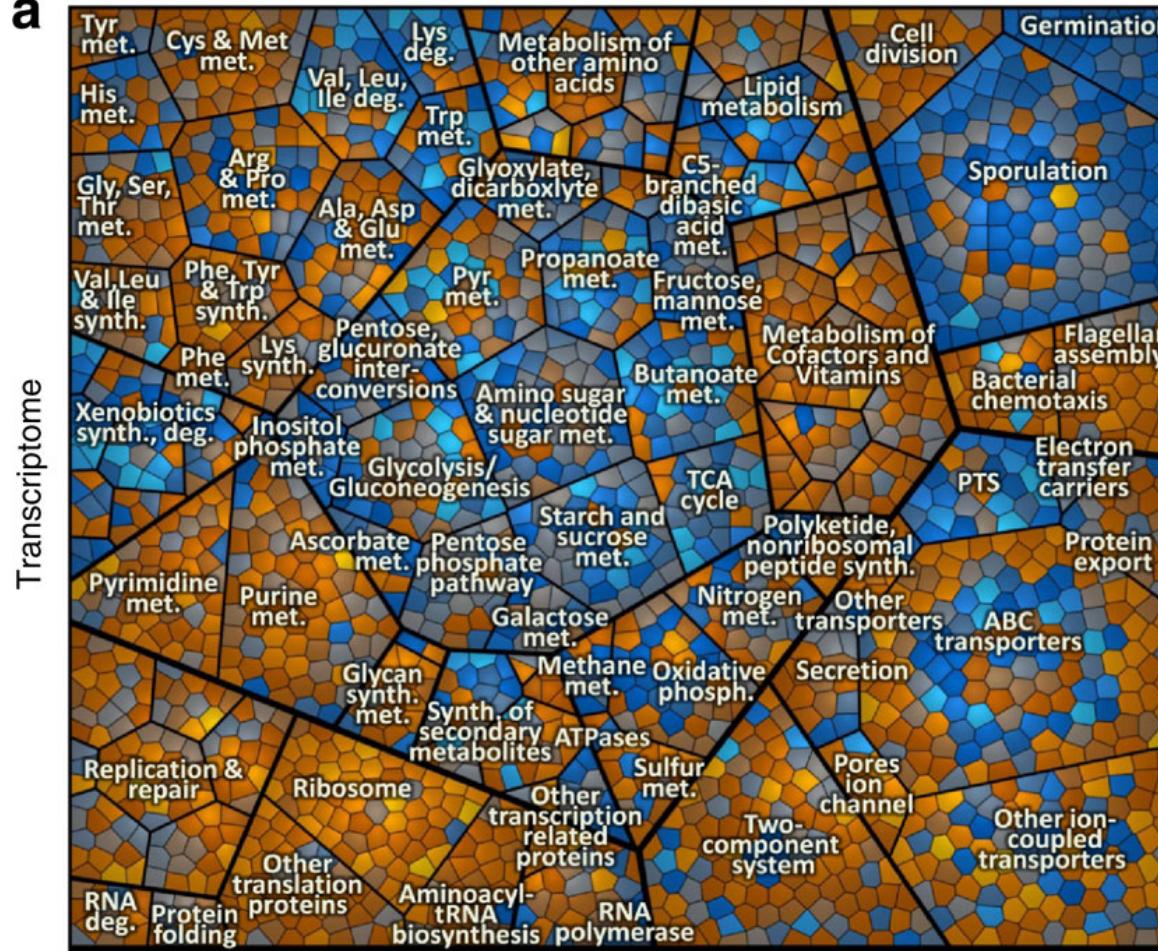
# Voronoi Treemaps



<http://graphics.uni-konstanz.de/~deussen/php/voronoitreemaps.php>

# KEGG-Orthology Treemap

a



<http://www.nature.com/ncomms/journal/v1/n9/full/ncomms1137.html>

# All of Inflation's Little Parts

ZOOM IN    ZOOM OUT

## Food and beverages 15%

The high price of oil is a factor that has made food prices rise quickly.

## Miscellaneous 3%

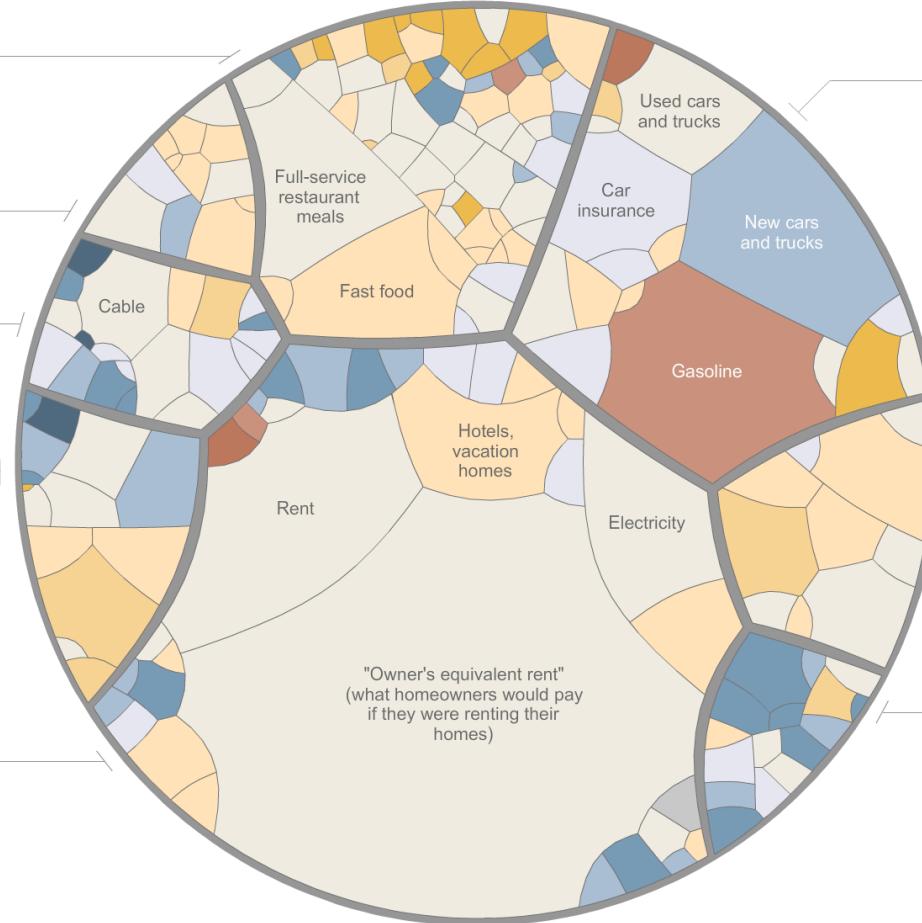
## Recreation 6%

## Education/Communication 6%

Cellphones were added to the index in 1997. Because the Consumer Price Index can be slow to add new goods, which are often cheaper, it may overstate parts of inflation.

## Housing 42%

In the C.P.I., home ownership costs track rent prices more closely than housing prices. This means inflation may have been understated when home prices were rising faster than rents.



## Transportation 18%

Gas is 5.2 percent of spending nationwide, but only 3.8 percent in the New York area.

## Health care 6%

As a group, the elderly spend about twice as much of their budget on medical care.

## Apparel 4%

The ratio of spending on women's clothes to that on men's clothes is about 2 to 1.

[http://www.nytimes.com/interactive/2008/05/03/business/20080403\\_SPENDING\\_GRAPHIC.html](http://www.nytimes.com/interactive/2008/05/03/business/20080403_SPENDING_GRAPHIC.html)

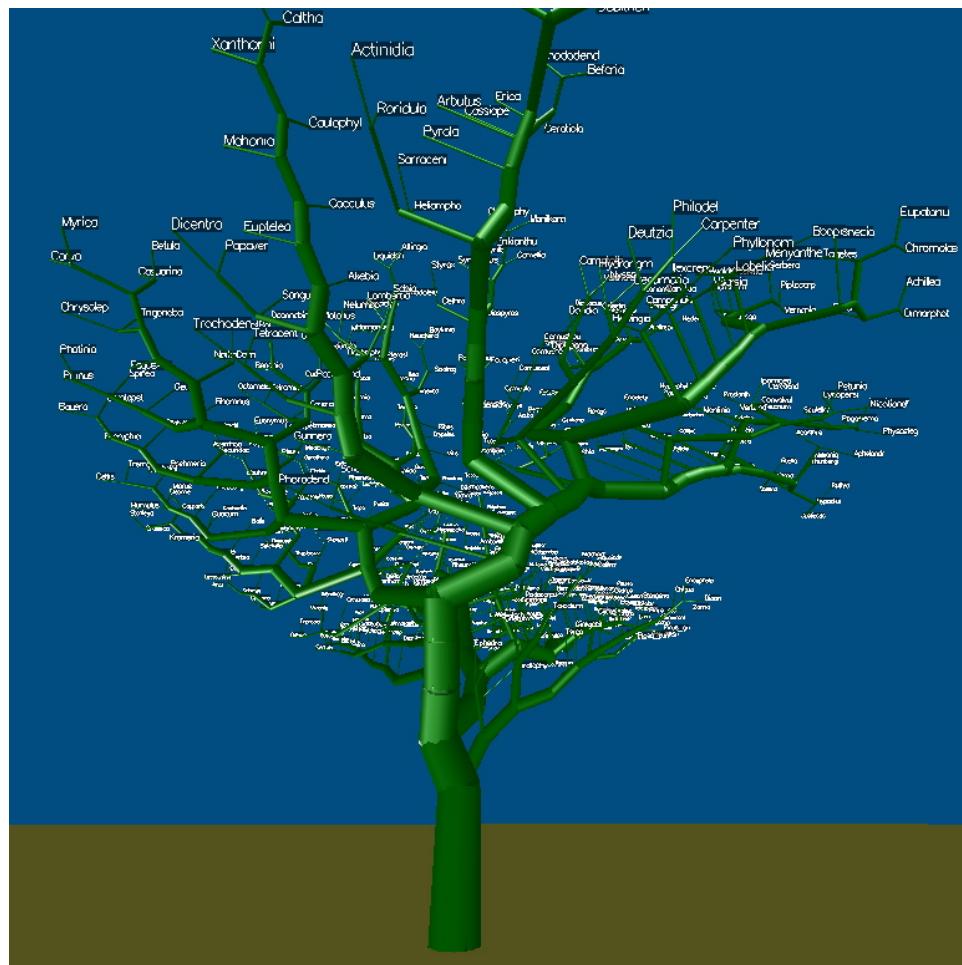
# TREE OF LIFE

Case Study

# Tree of Life

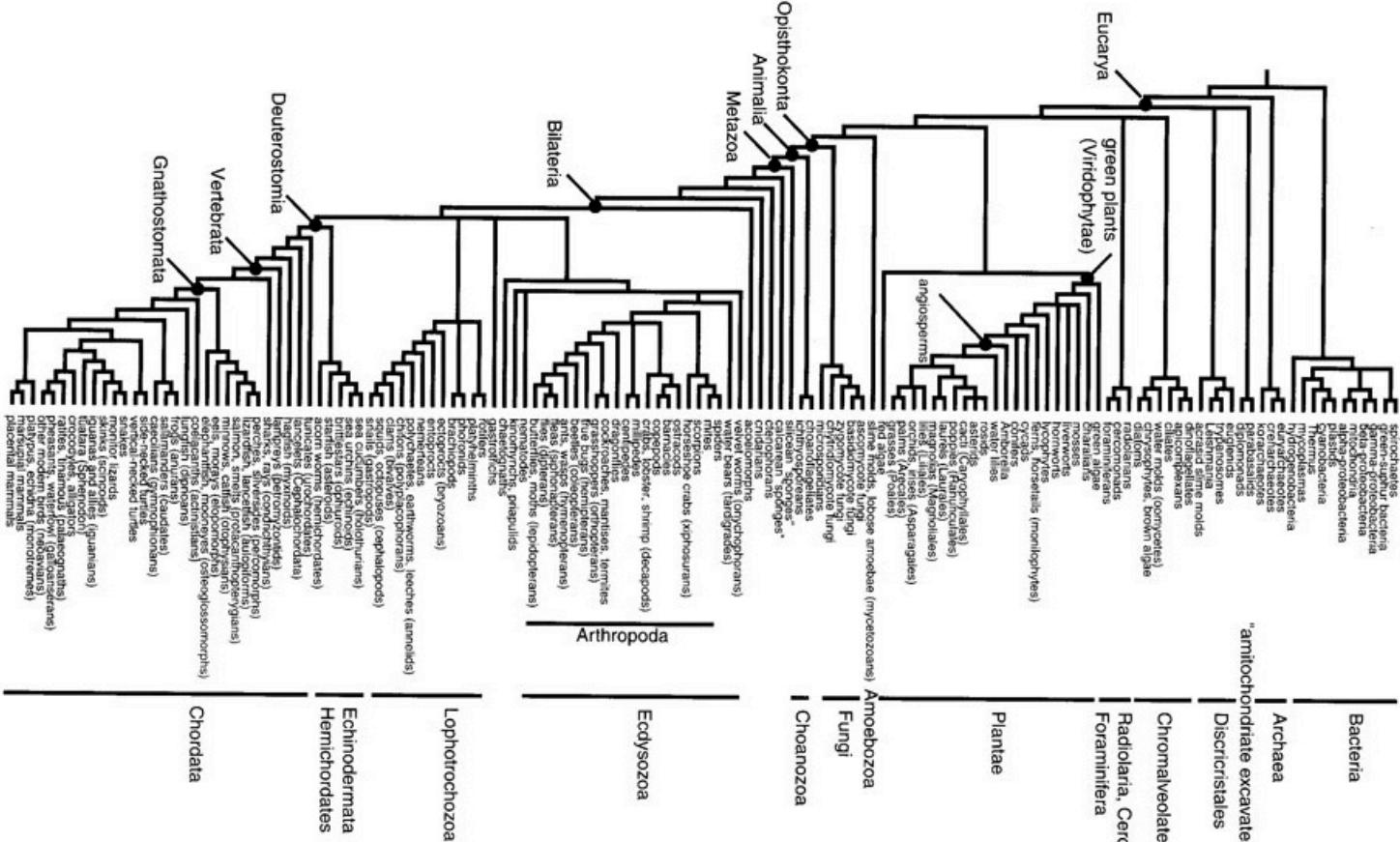
- Specifically **phylogenetic** tree of life
  - Evolutionary tree, showing where species branch
- Can be thousands to tens of thousands of nodes
- Many tools for the ToL exist using different visualization techniques
- See <http://tolweb.org/tree/phylogeny.html>

# Paloverde



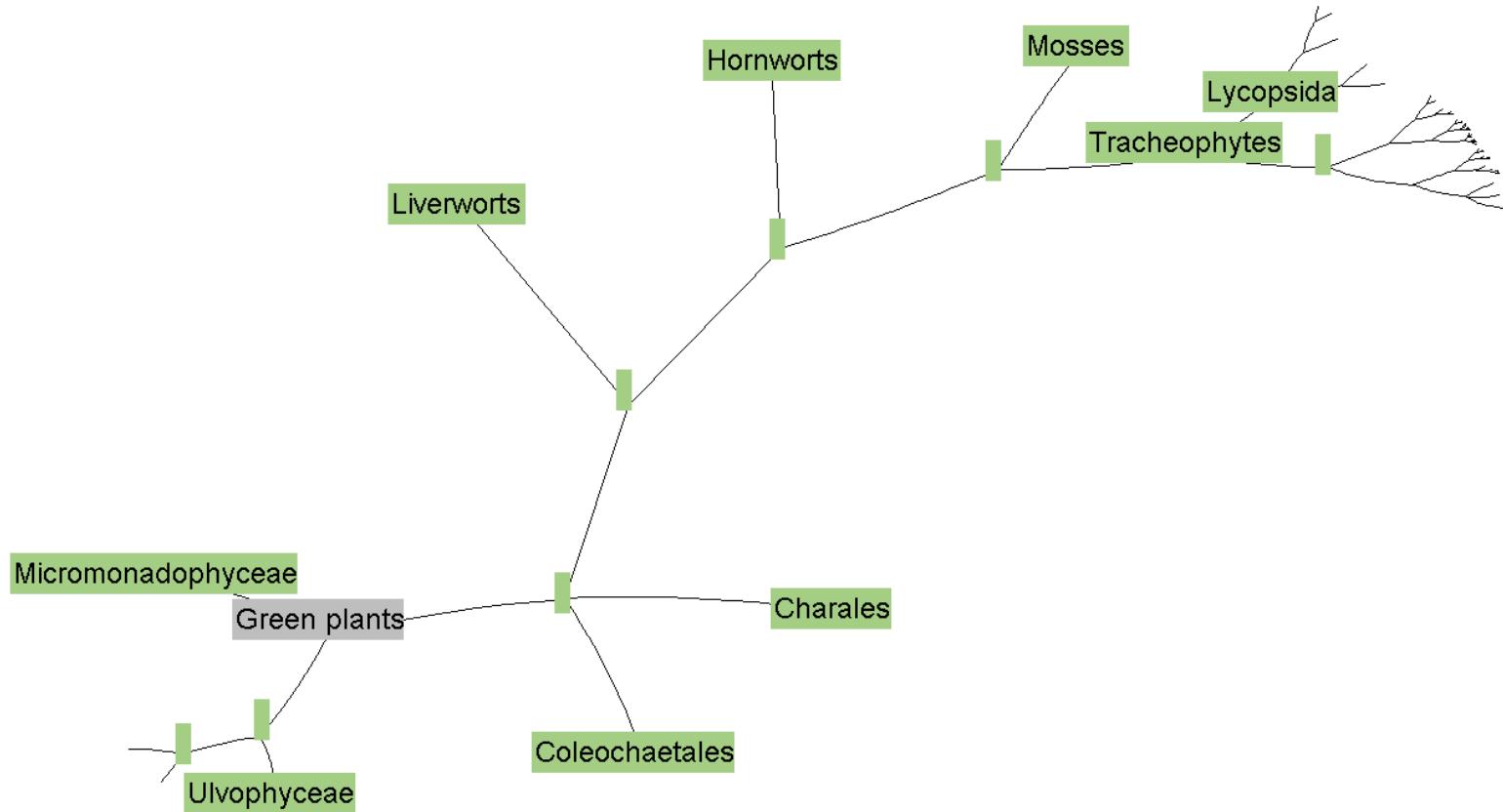
<http://loco.biosci.arizona.edu/paloverde/paloverde.html>

# Teachable ToL



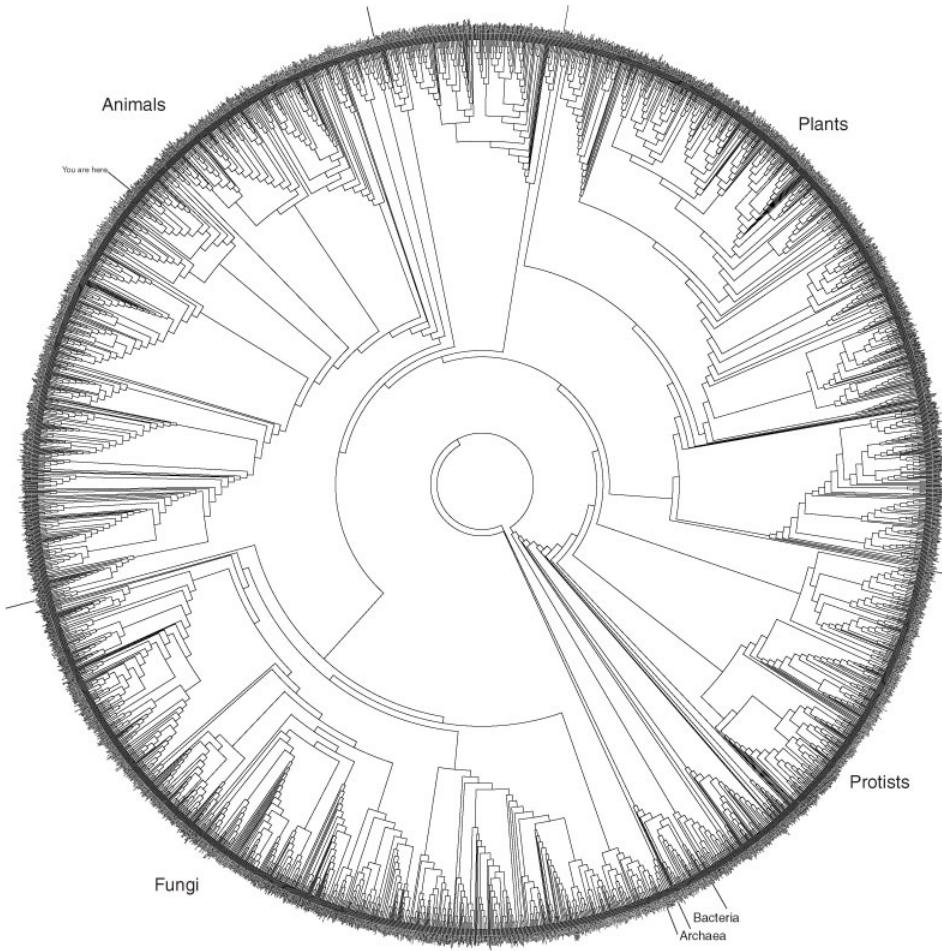
<http://www.rebeccashapley.com/cipres/telescoping.htm>

# Hyperbolic ToL (Plants Only)



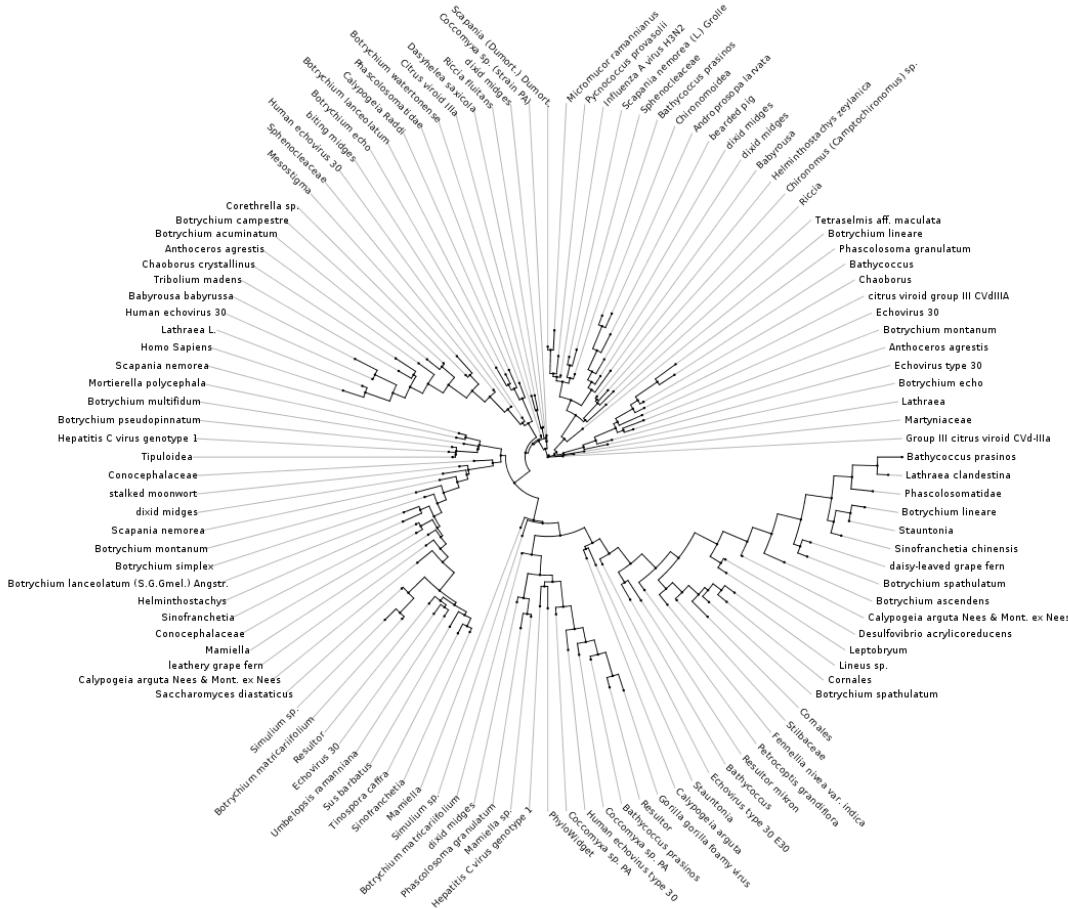
<http://ucjeps.berkeley.edu/TreeofLife/hyperbolic.php>

# Subset of 3,000 Species



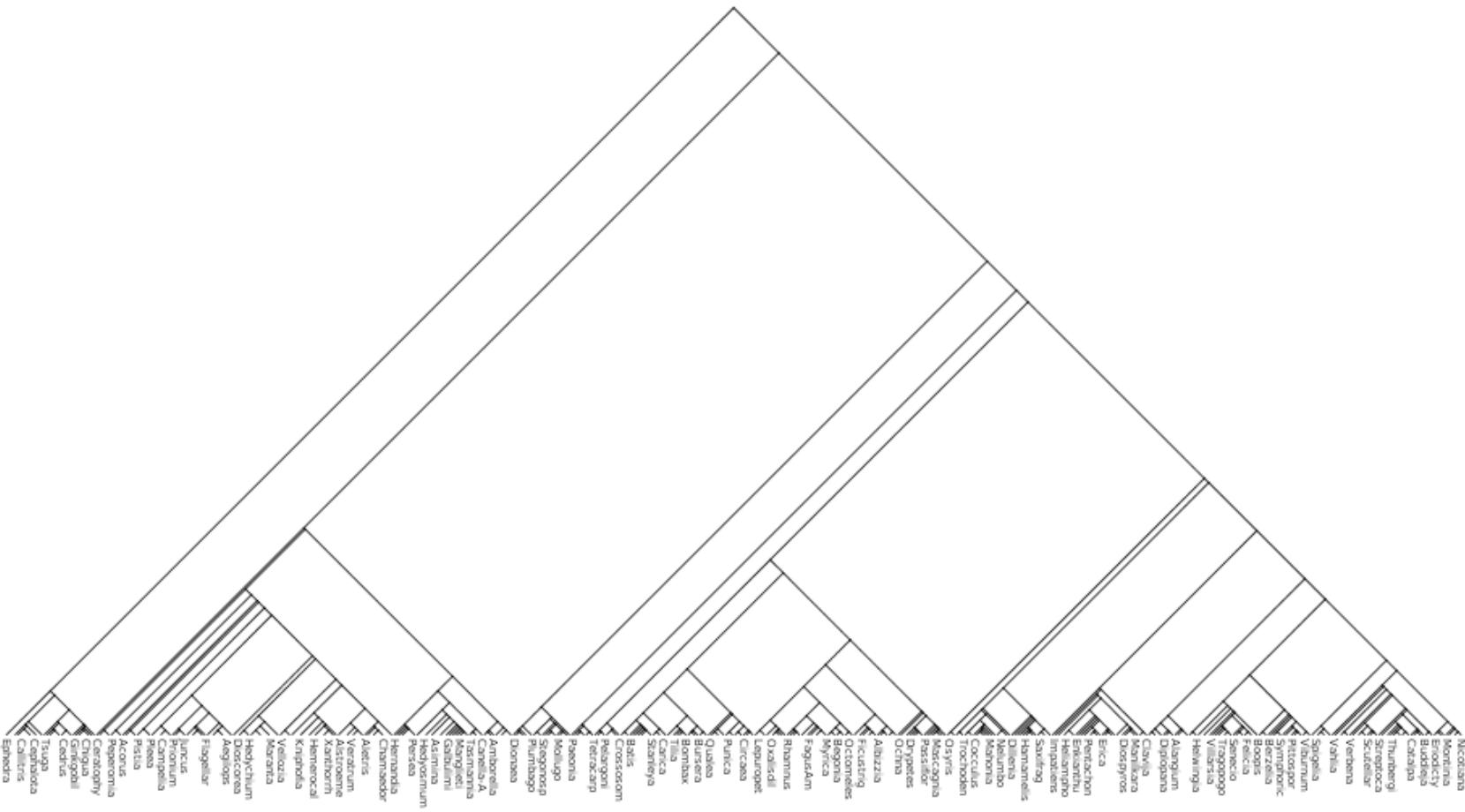
<http://www.zo.utexas.edu/faculty/antisense/DownloadfilesToL.html>

# PhyloWidget



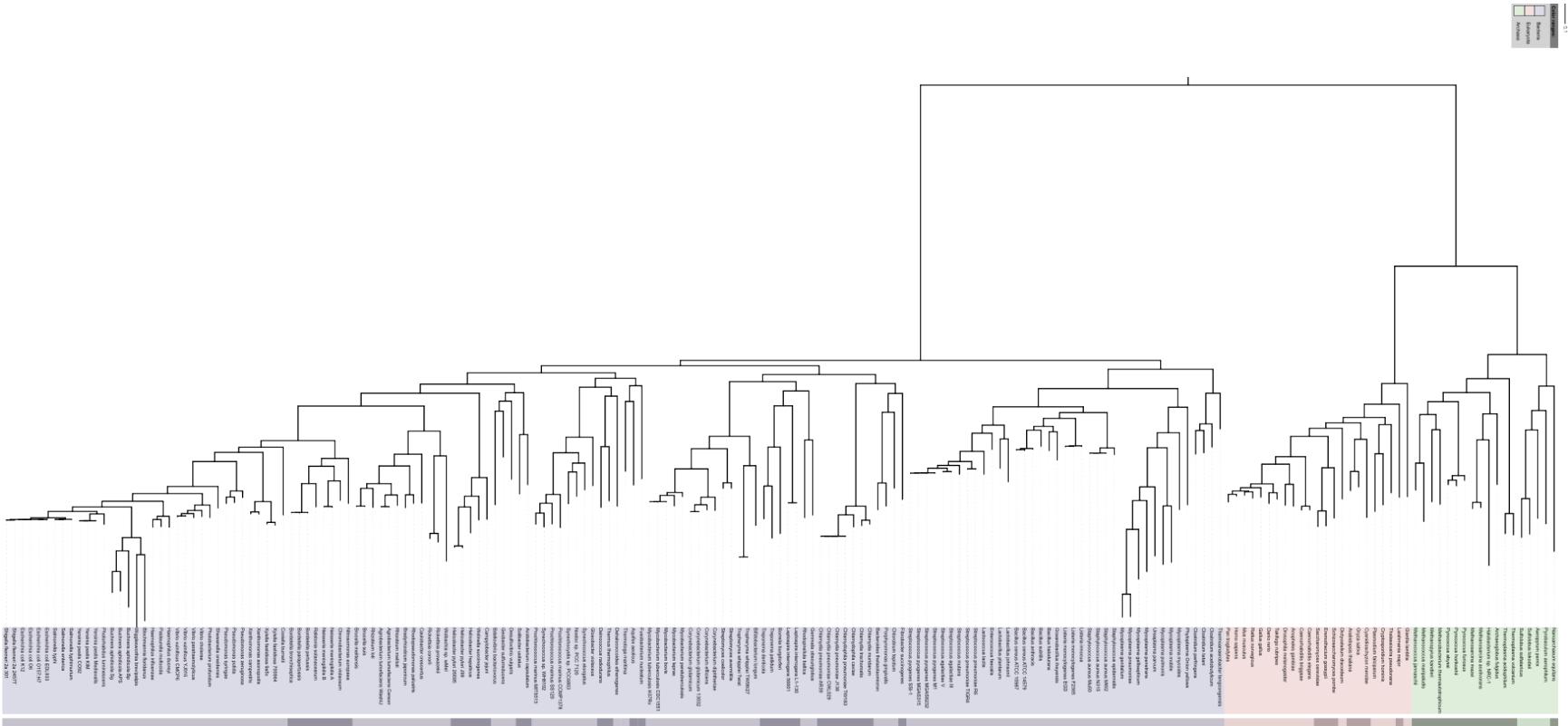
<http://www.phylowidget.org/>

# PhyloWidget



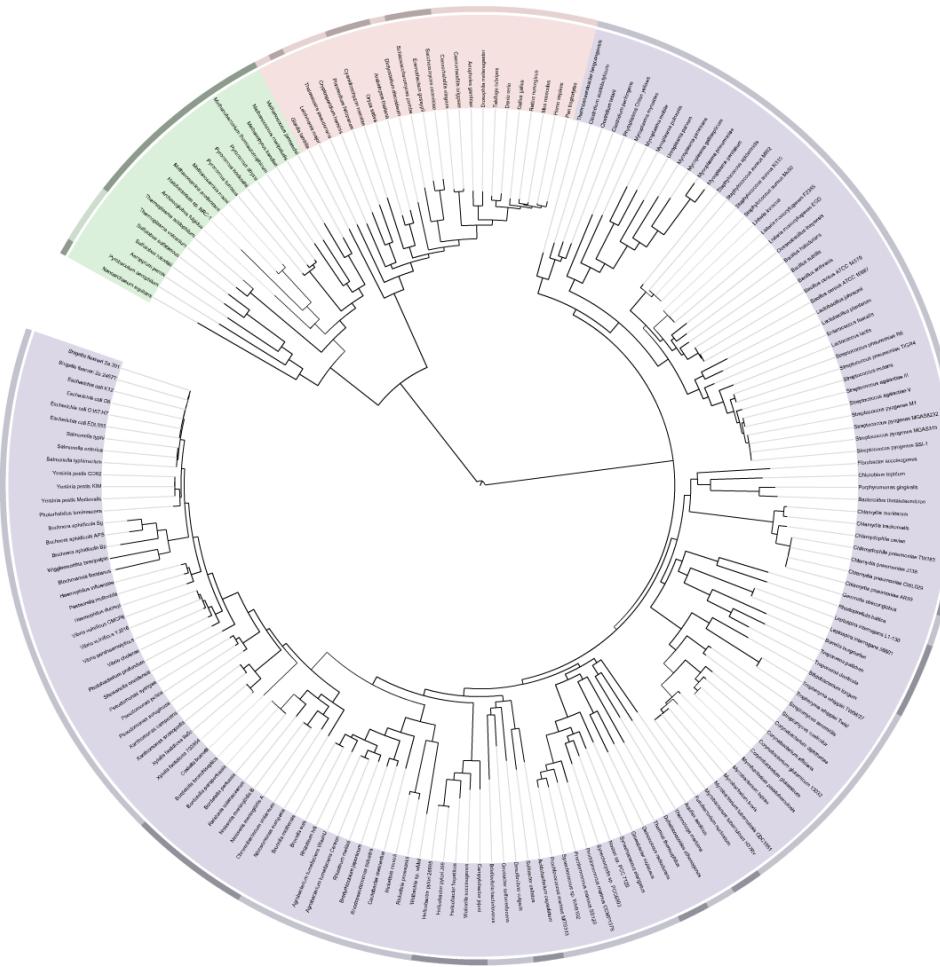
<http://www.phylowidget.org/>

# Interactive ToL



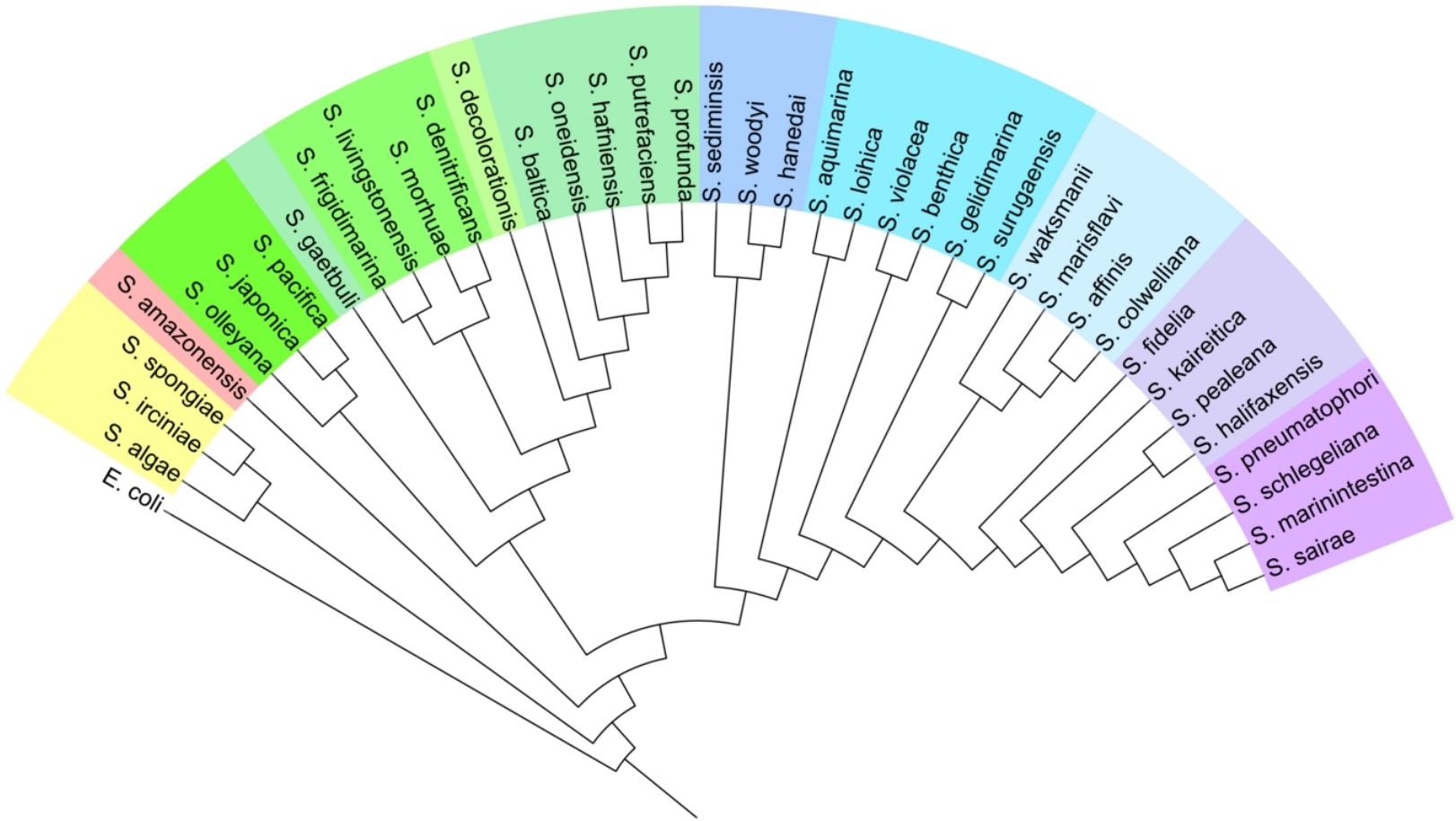
<http://itol.embl.de/>

# Interactive ToL



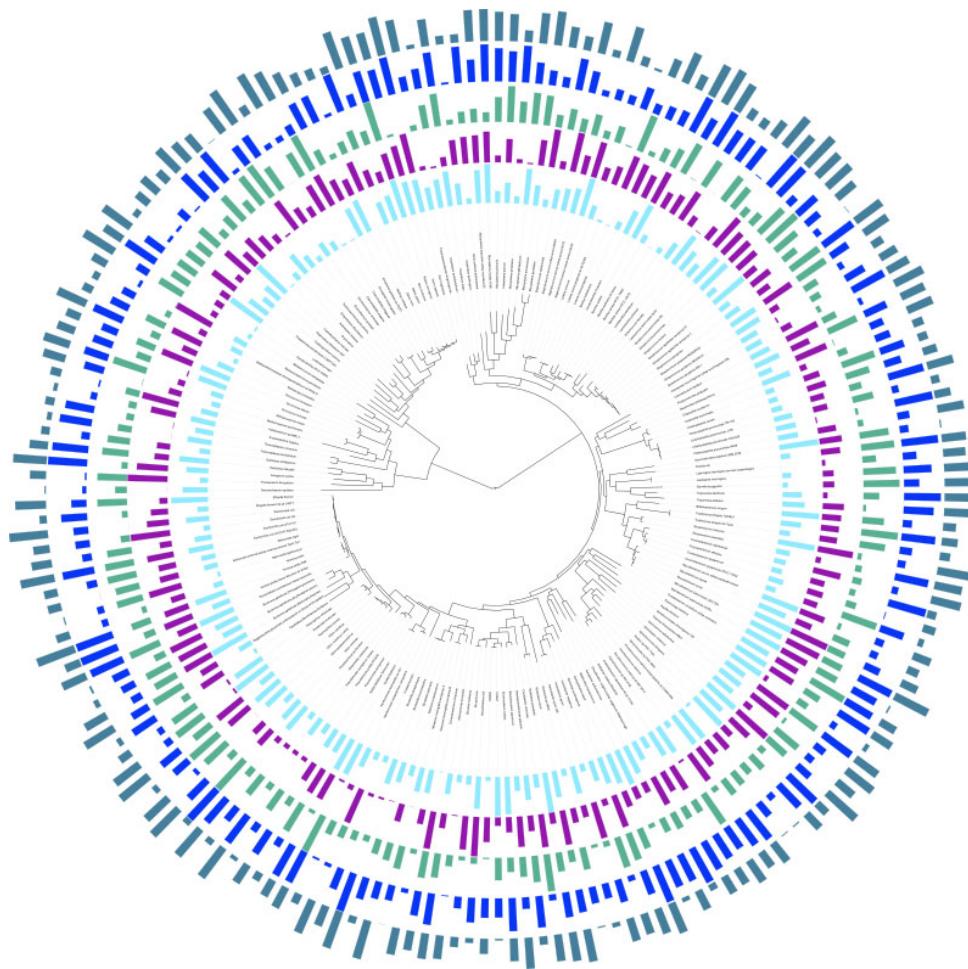
<http://itol.embl.de/>

# Interactive ToL



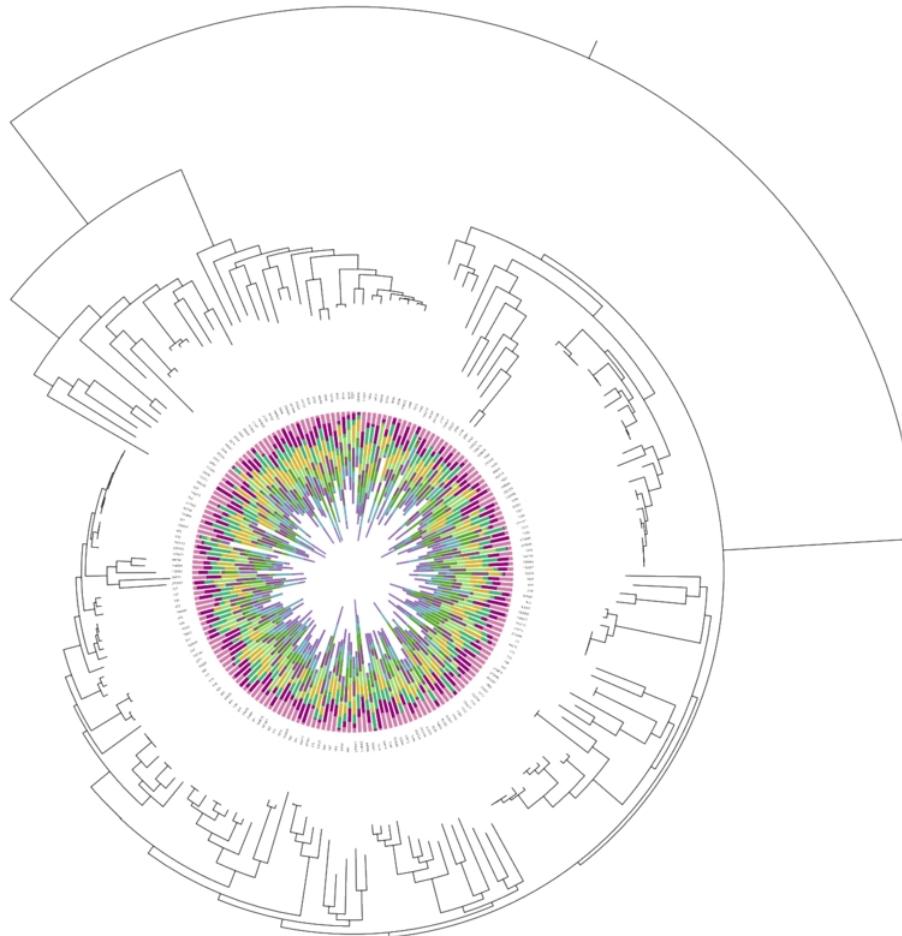
<http://itol.embl.de/>

# Interactive ToL



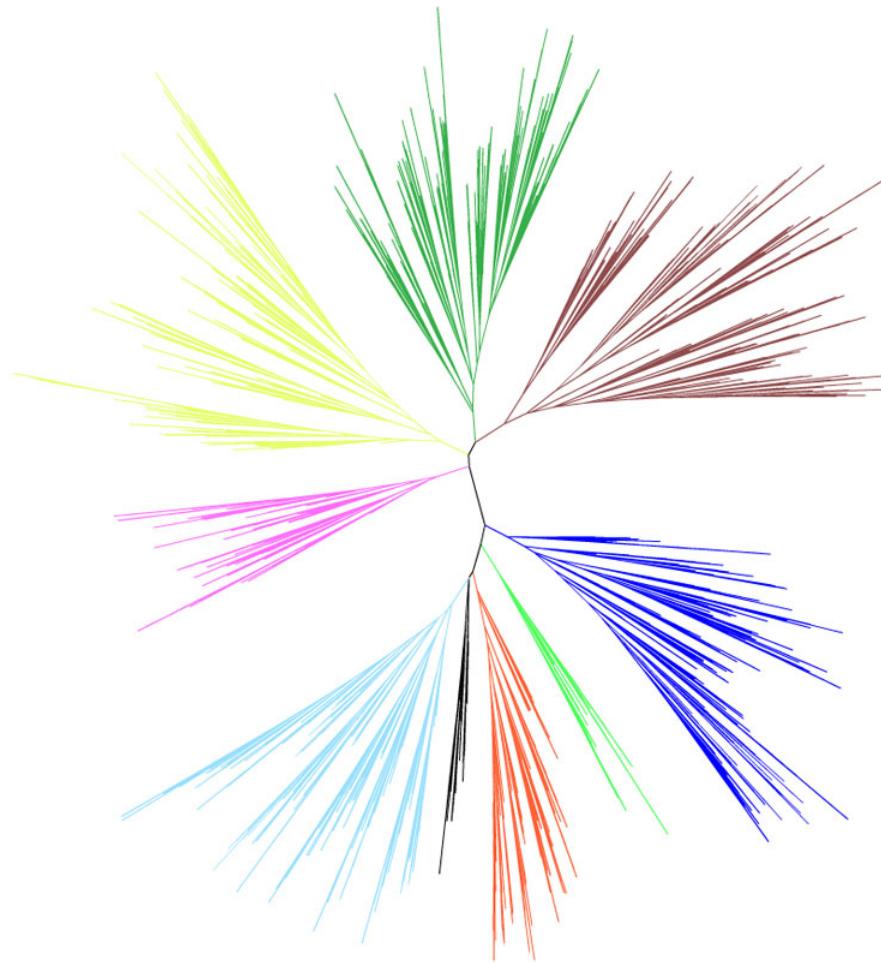
<http://itol.embl.de/>

# Interactive ToL



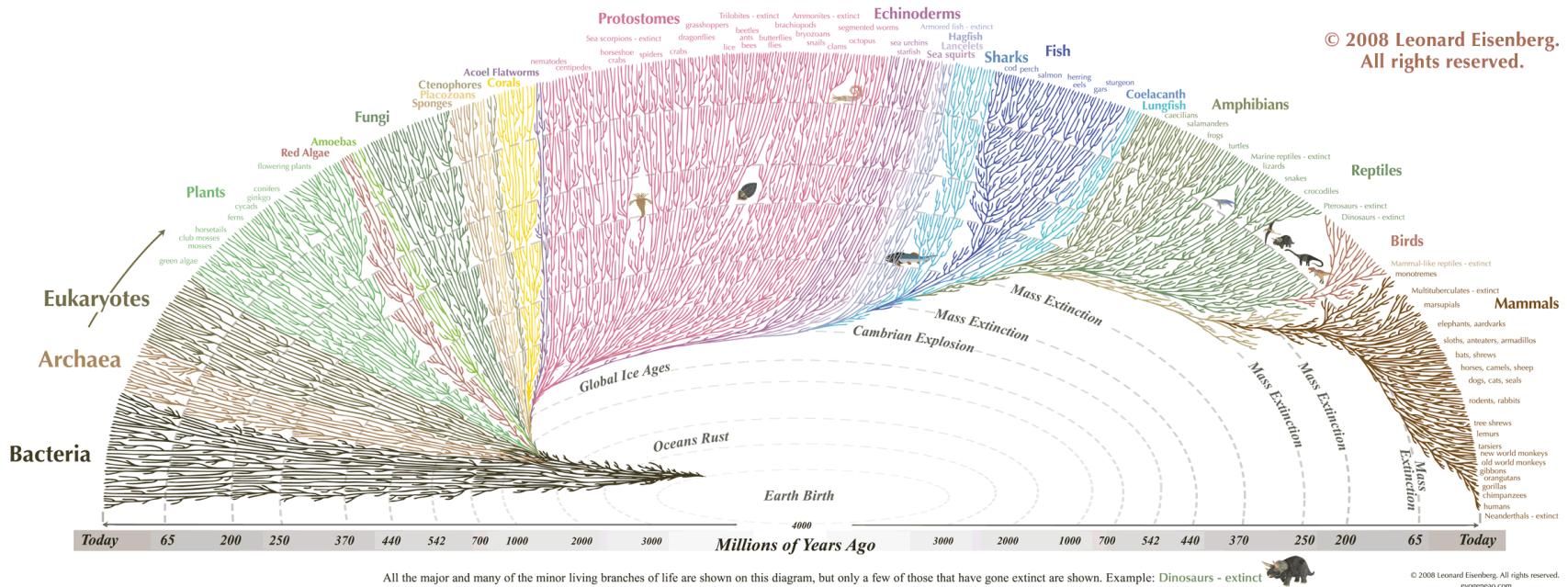
<http://itol.embl.de/>

# Interactive ToL



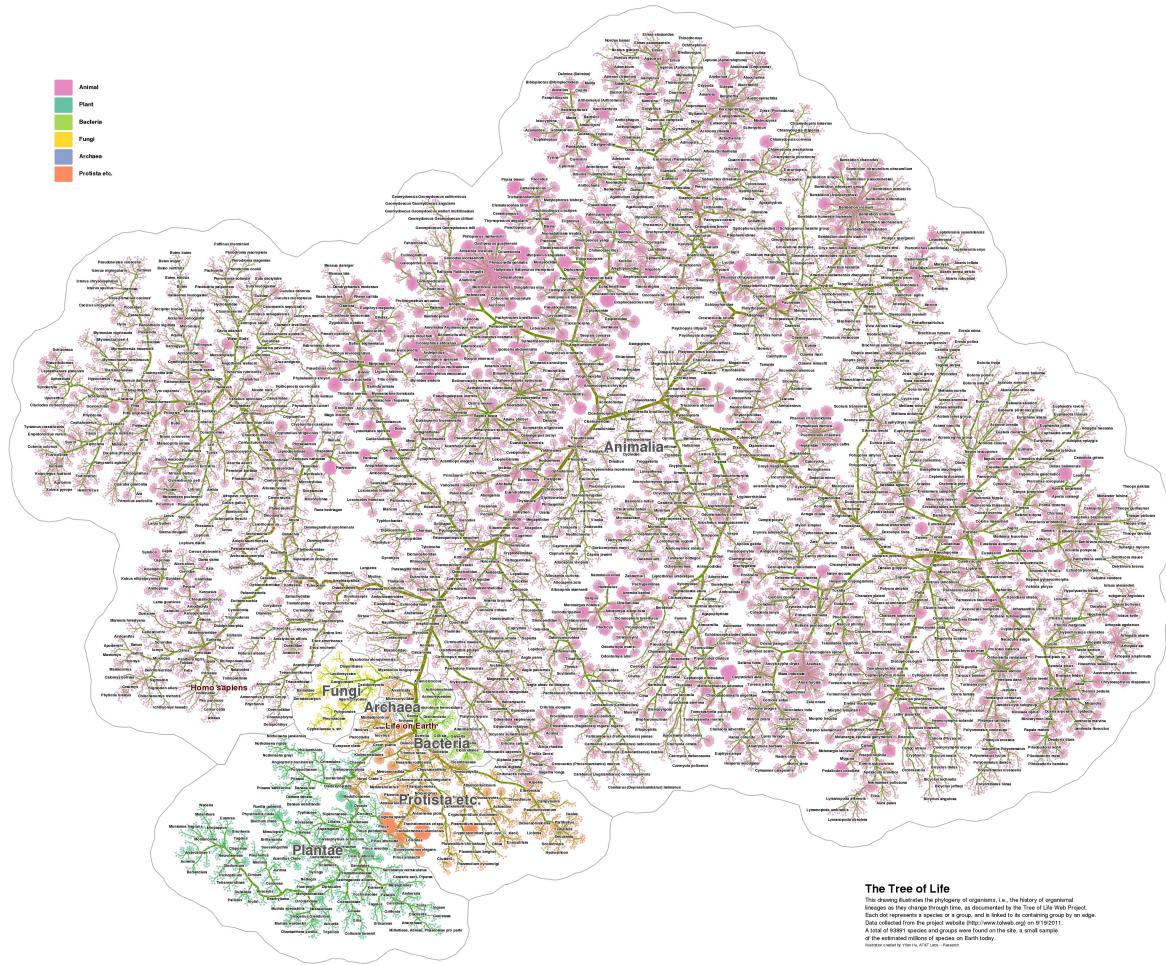
<http://itol.embl.de/>

# Illustration

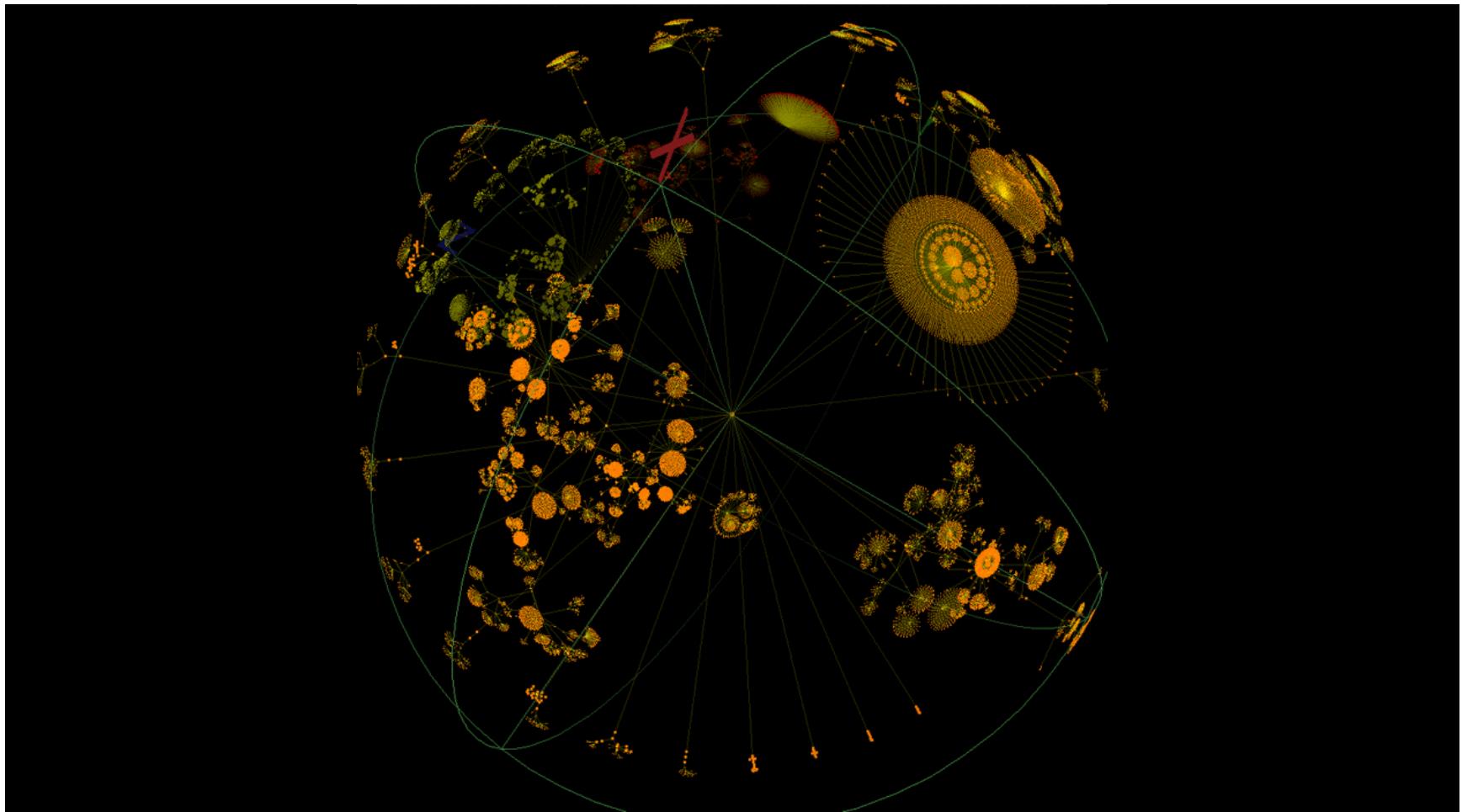


<http://www.evogeneao.com/>

# Interactive ToL (2)



# ToL Using Walrus



<http://digitised.info/content/view/20/51/>

# QUESTIONS?