

Visualizing Hierarchy

INTRODUCTION

Hierarchical Data

- Any data with some sort of hierarchy
- Example hierarchy
 - Country: United States
 - Region: West
 - State: California
 - County: San Francisco County
 - City: San Francisco

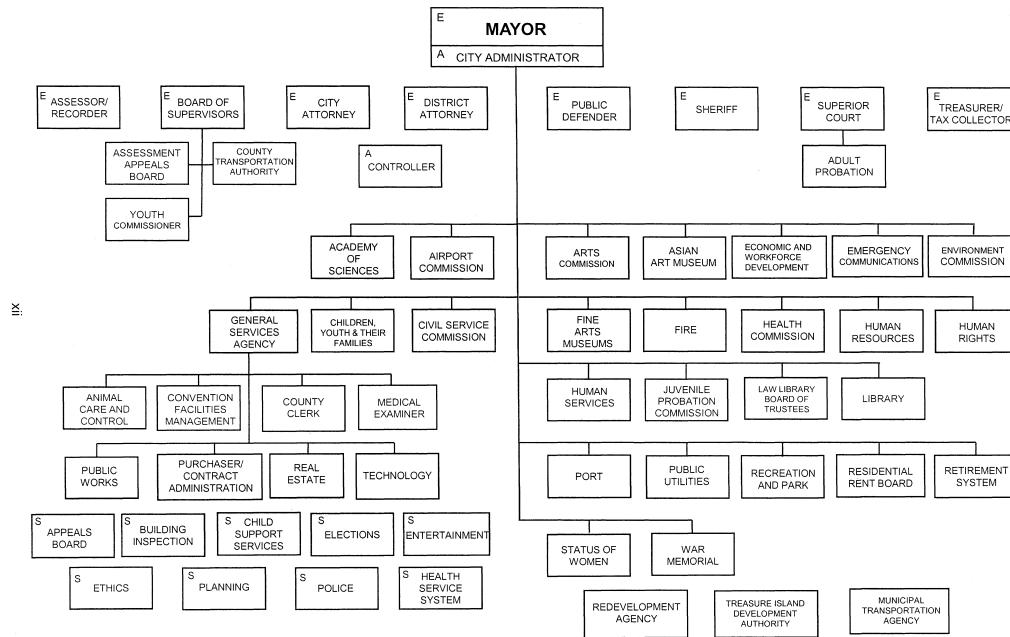
<http://en.wiktionary.org/wiki/hierarchy>

Example Hierarchies

- Evolutionary Tree
- Dendograms
- File Directory Structure
- Dewey Decimal System
- Family Tree
- Outlines
- Organization Charts
 - Businesses
 - Churches
 - Military
 - Government

City and County of San Francisco Organization Chart

(As of June 30, 2010)



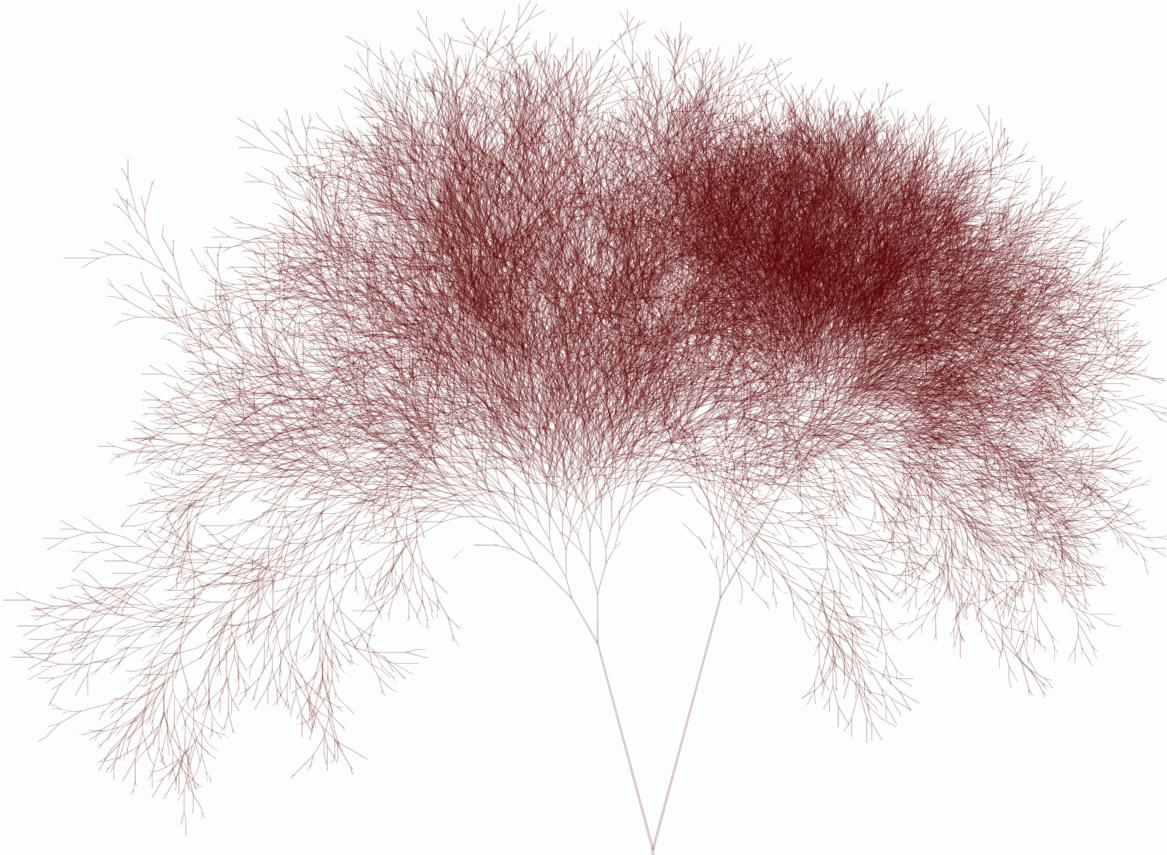
A = Appointed by Mayor and confirmed by Board of Supervisors / E = Elected / S = Shared – appointed by various elected officials.

<http://sfgov.org/citys-organizational-chart>

Trees

- Tree structure
- Tree (graph theory)
- Tree (set theory)
- Tree (data structure)

[https://en.wikipedia.org/wiki/Tree_\(disambiguation\)](https://en.wikipedia.org/wiki/Tree_(disambiguation))



<http://drunkmenworkhere.org/219>

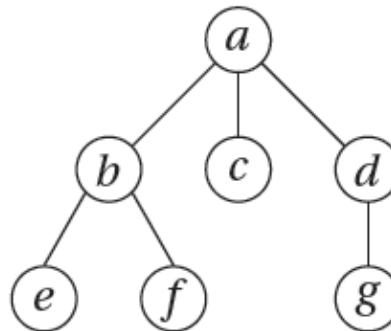
Trees

- 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



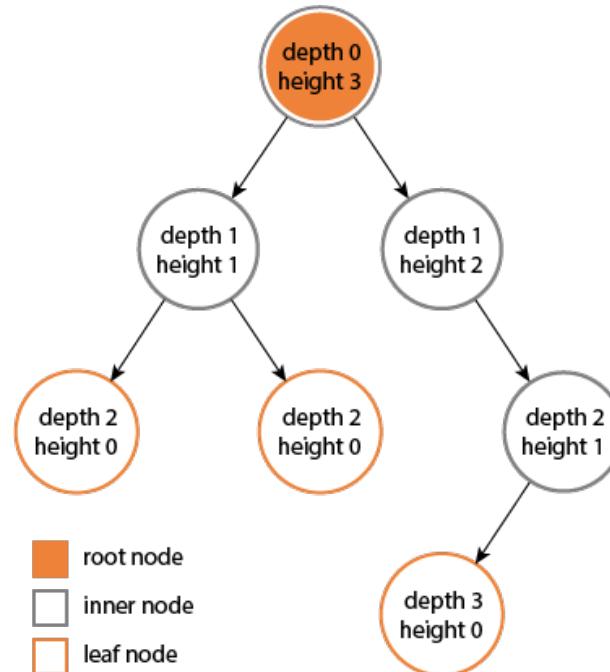
$G = (N, E)$ where

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

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

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 Terminology



<http://stackoverflow.com/questions/2603692/what-is-the-difference-between-tree-depth-and-height>

https://en.wikipedia.org/wiki/Tree_%28data_structure%29

Tree Visualization

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

How to cite this site?

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treevis.net - A Visual Bibliography of Tree Visualization 2.0 by Hans-Jörg Schulz



12

v.14-MAR-2016

Dimensionality



Representation



Alignment



Fulltext Search

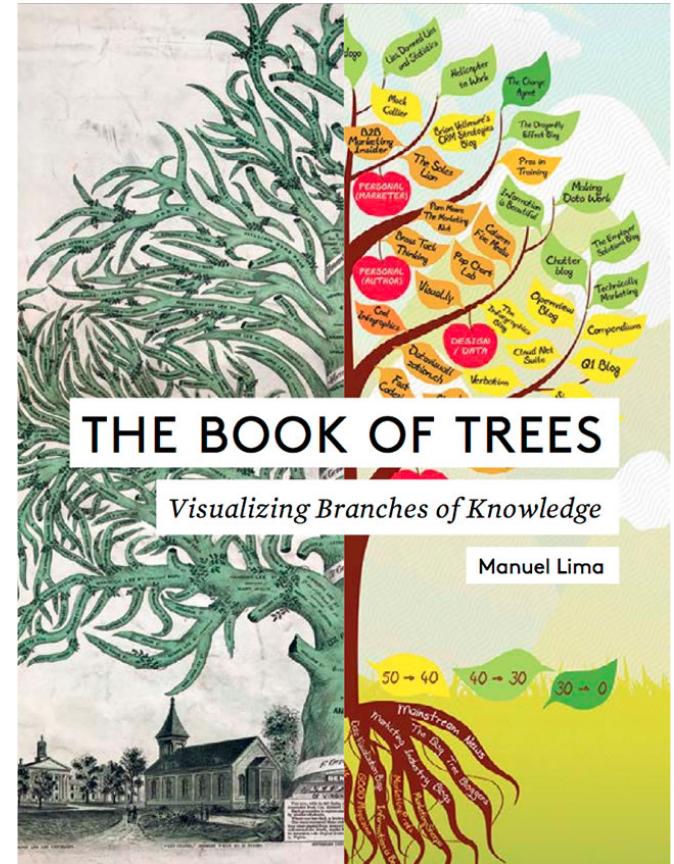
 x

Techniques Shown

292



<http://vcg.informatik.uni-rostock.de/~hs162/treeposter/poster.html>



<http://www.bookoftrees.info/bt/>



Considerations

- What is the root node? What is the parent/child of node x ? Can you find the path between node x and node y ?
- What is the height of the tree/subtree? What is the level of a specific node? How many nodes are on level x ?
- Are the labels readable? All nodes visible? Are node attributes visible? Are link attributes visible?
- Can both nodes and links be interacted with? What type of interaction is supported?
- How much space is required to visualize the tree? Are the nodes or the hierarchy given more space?

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

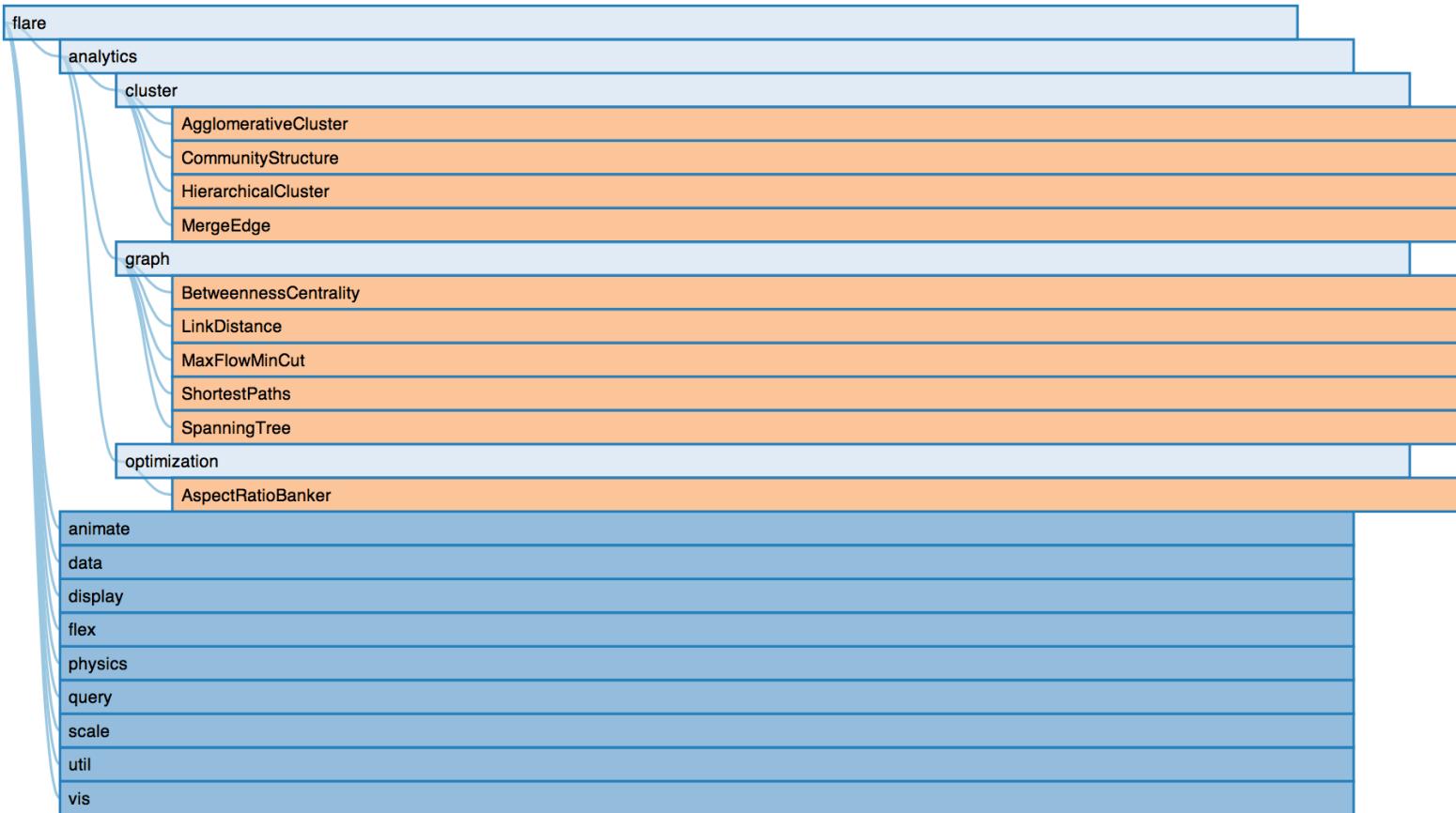
flare	933KB
analytics	47KB
cluster	14KB
AgglomerativeCluster	3KB
CommunityStructure	3KB
HierarchicalCluster	6KB
MergeEdge	0KB
graph	25KB
BetweennessCentrality	3KB
LinkDistance	5KB
MaxFlowMinCut	7KB
ShortestPaths	5KB
SpanningTree	3KB
optimization	6KB
AspectRatioBanker	6KB
animate	97KB
Easing	16KB
FunctionSequence	5KB
ISchedulable	1KB
Parallel	5KB
Pause	0KB
Scheduler	5KB
Sequence	5KB
Transition	8KB
TransitionEvent	1KB
Transitioner	19KB
Tween	5KB
interpolate	22KB
ArrayInterpolator	1KB
ColorInterpolator	1KB
DateInterpolator	1KB
Interpolator	8KB
MatrixInterpolator	2KB
NumberInterpolator	1KB
ObjectInterpolator	1KB
PointInterpolator	1KB
RectangleInterpolator	1KB

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

►	📁 Archived Resources
►	📁 CS 107 App Inventor
►	📁 CS 110 Intro to CS I
►	📁 CS 112 Intro to CS II
▼	📁 CS 212 Software Development
►	📁 2012 Fall
►	📁 2012 Spring
►	📁 2013 Spring
▼	📁 Lectures
 00 Eclipse Setup.pdf	
 00 Eclipse SVN Setup.pdf	
 01 Java Basics.pdf	
 02 Data Structures.pdf	
 03 Classes and Objects.pdf	
 04 Software Testing.pdf	
 05 Inheritance, Part 1.pdf	
 05 Inheritance, Part 2.pdf	
 06 Exceptions.pdf	
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 08 Multithreading Basics.pdf	
 09 Web, HTTP, and HTML.pdf	
 10 Dynamic Webpages.pdf	
 11 Relational Databases.pdf	
►	📁 CS 326 Operating Systems
►	📁 CS 360 Data Visualization
►	📁 MSAN 501 Computational Intensive
►	📁 MSAN 622 Information Visualization

Mac Finder



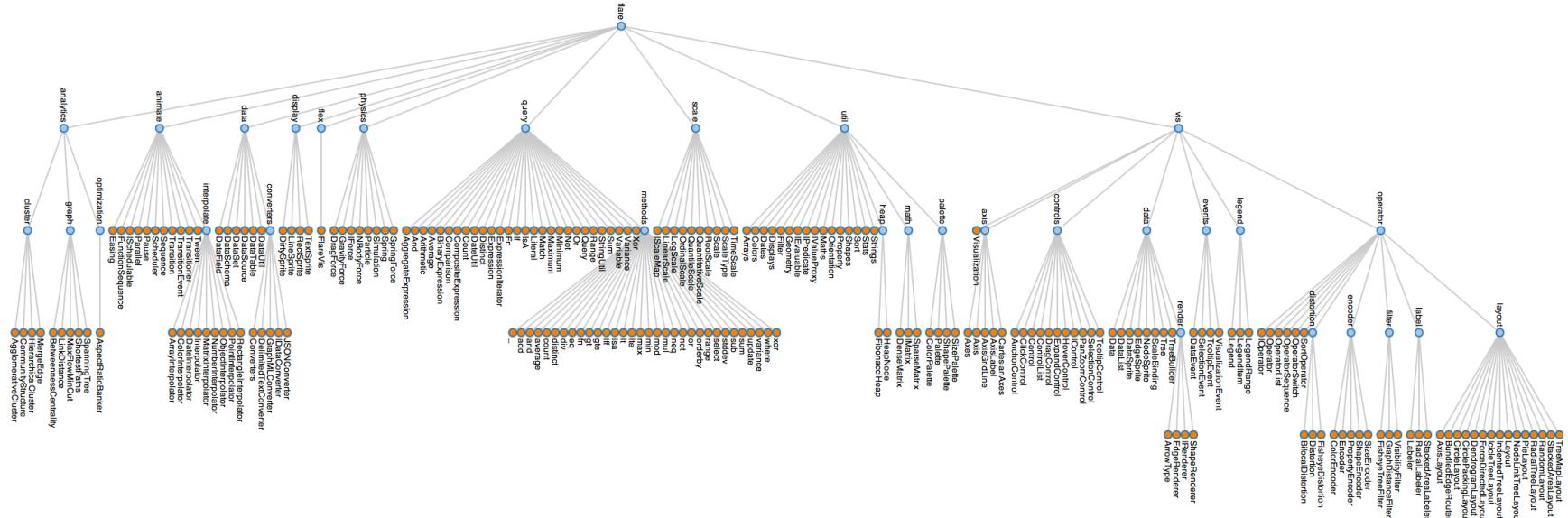


<http://bl.ocks.org/mbostock/1093025>

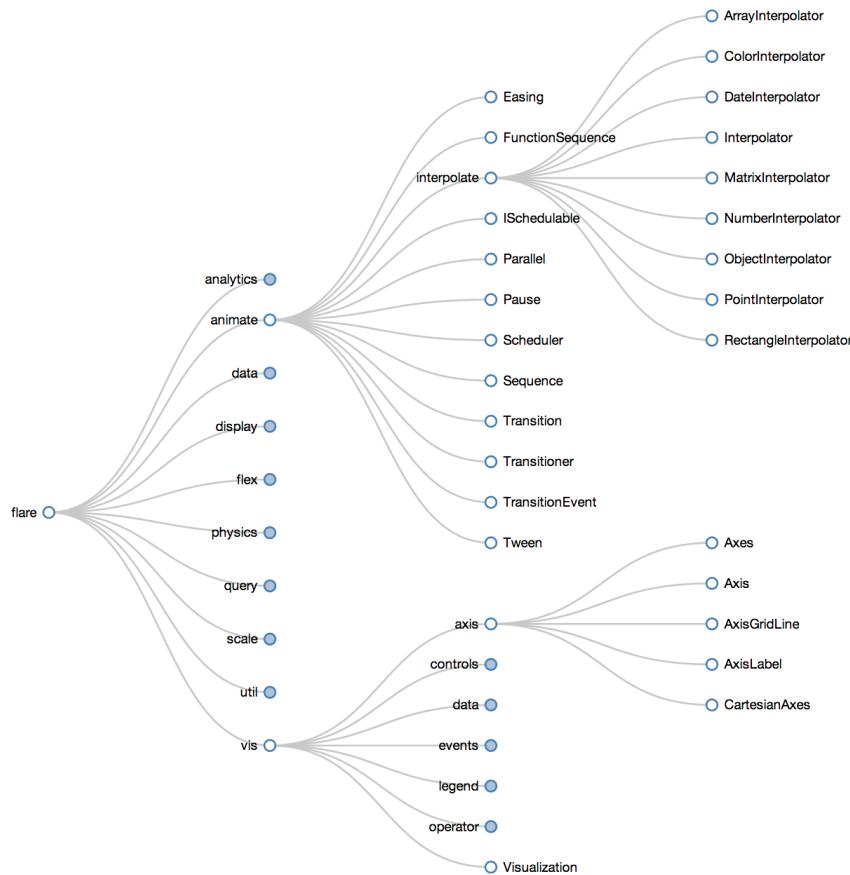
Node-Link Diagrams

- 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 (cluster layout)

Traditional Layout

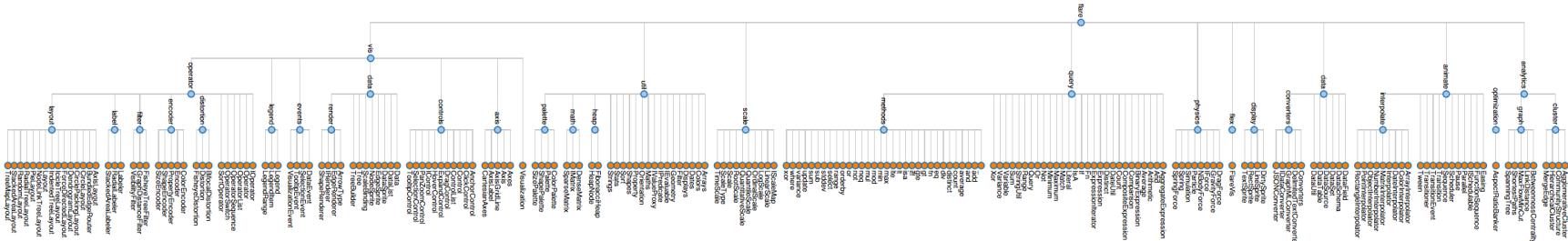


<http://hci.stanford.edu/jheer/files/zoo/ex/hierarchies/tree.html>



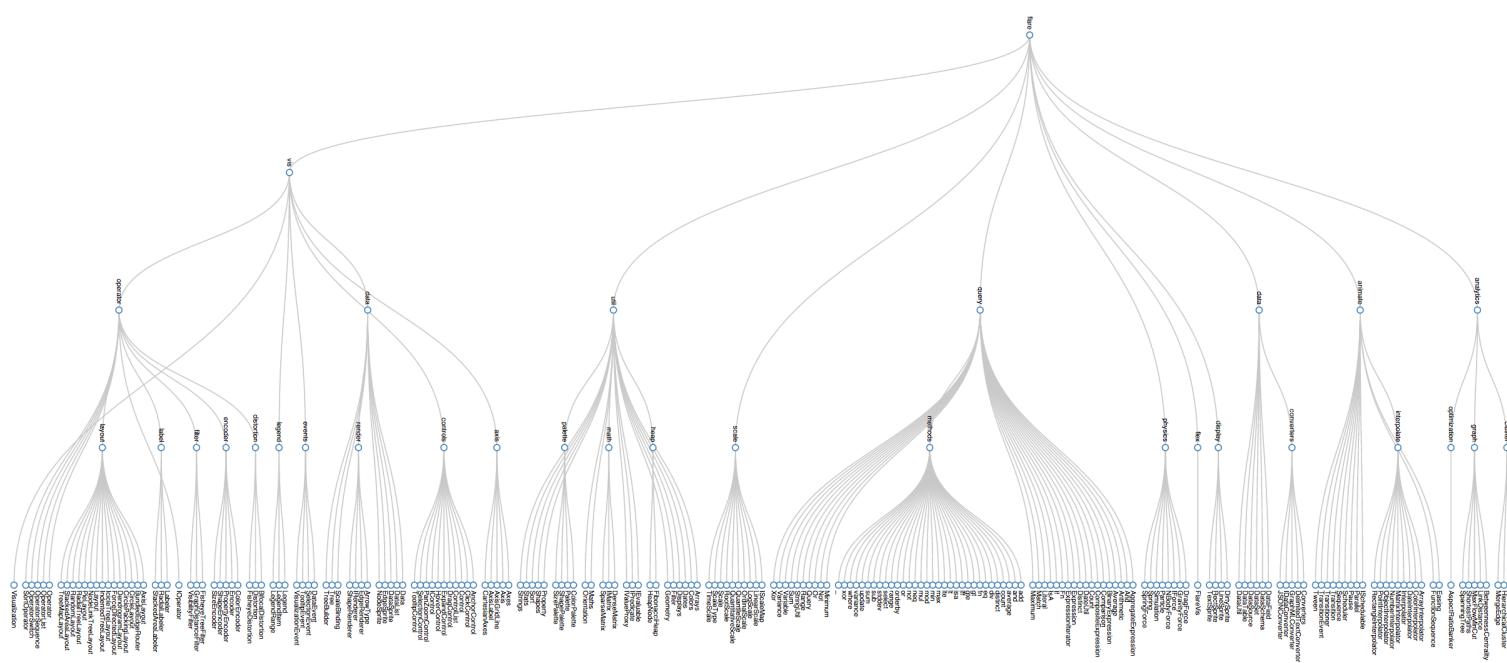
<http://mbostock.github.io/d3/talk/20111018/tree.html>

Dendrogram



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

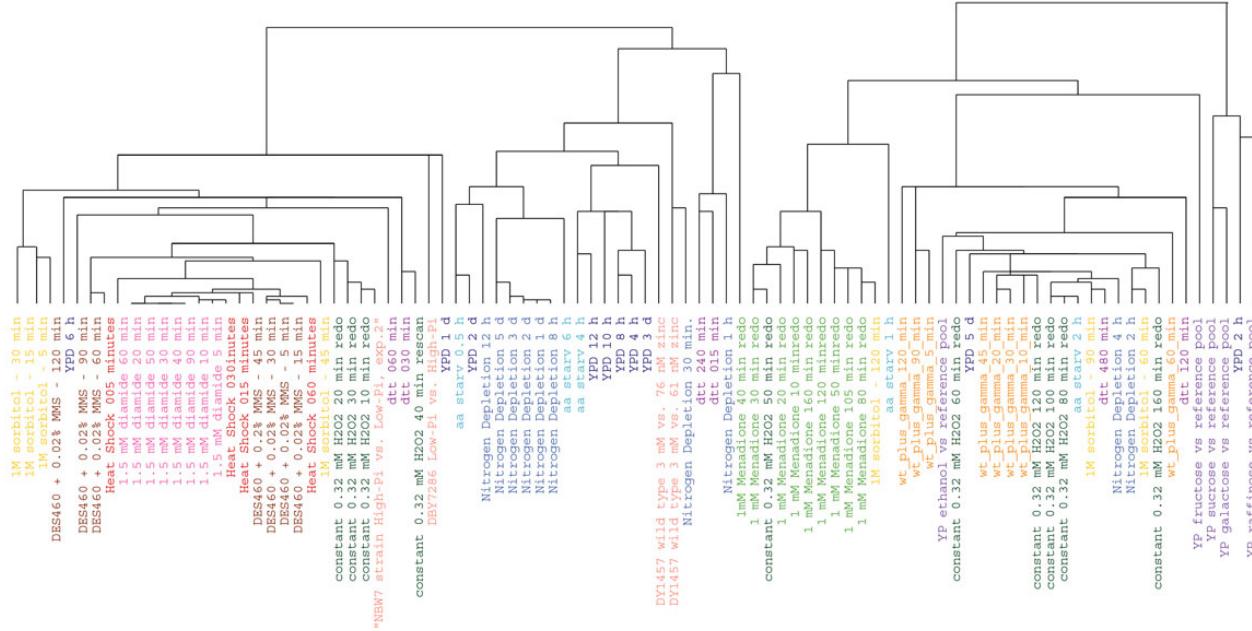
Dendrogram



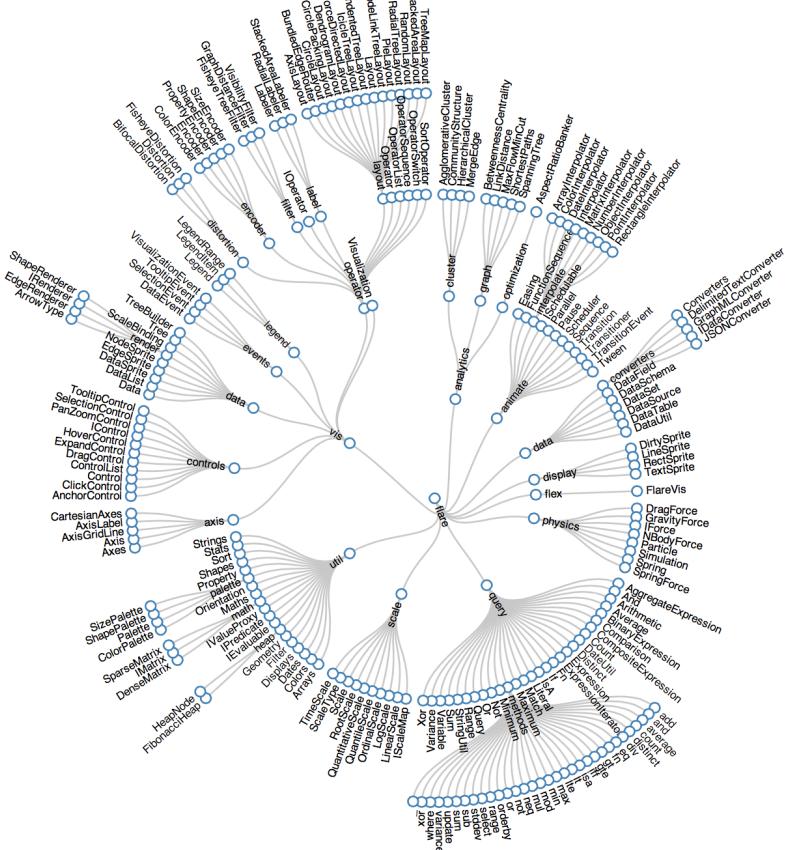
<http://mbostock.github.io/protovis/ex/dendrogram.html>

Dendrogram

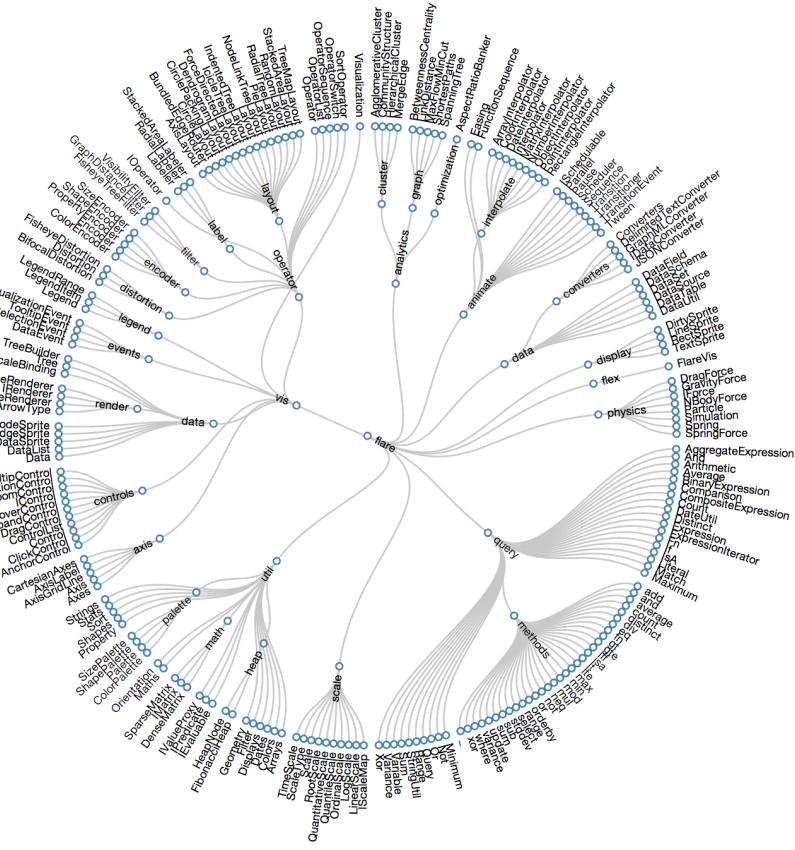
Cluster 11: protein folding chaperones



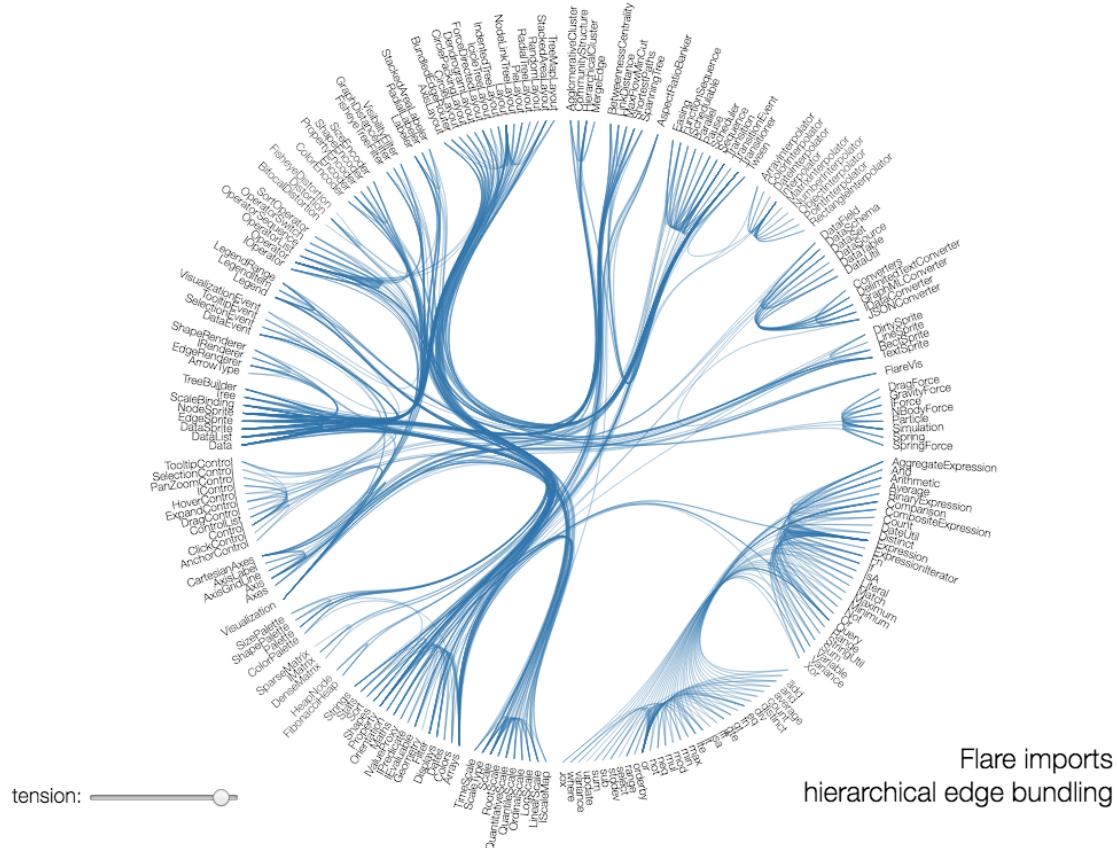
http://www.eisenlab.org/FuzzyK/images/Cluster11_atr.jpg



<http://bl.ocks.org/mbostock/4063550>

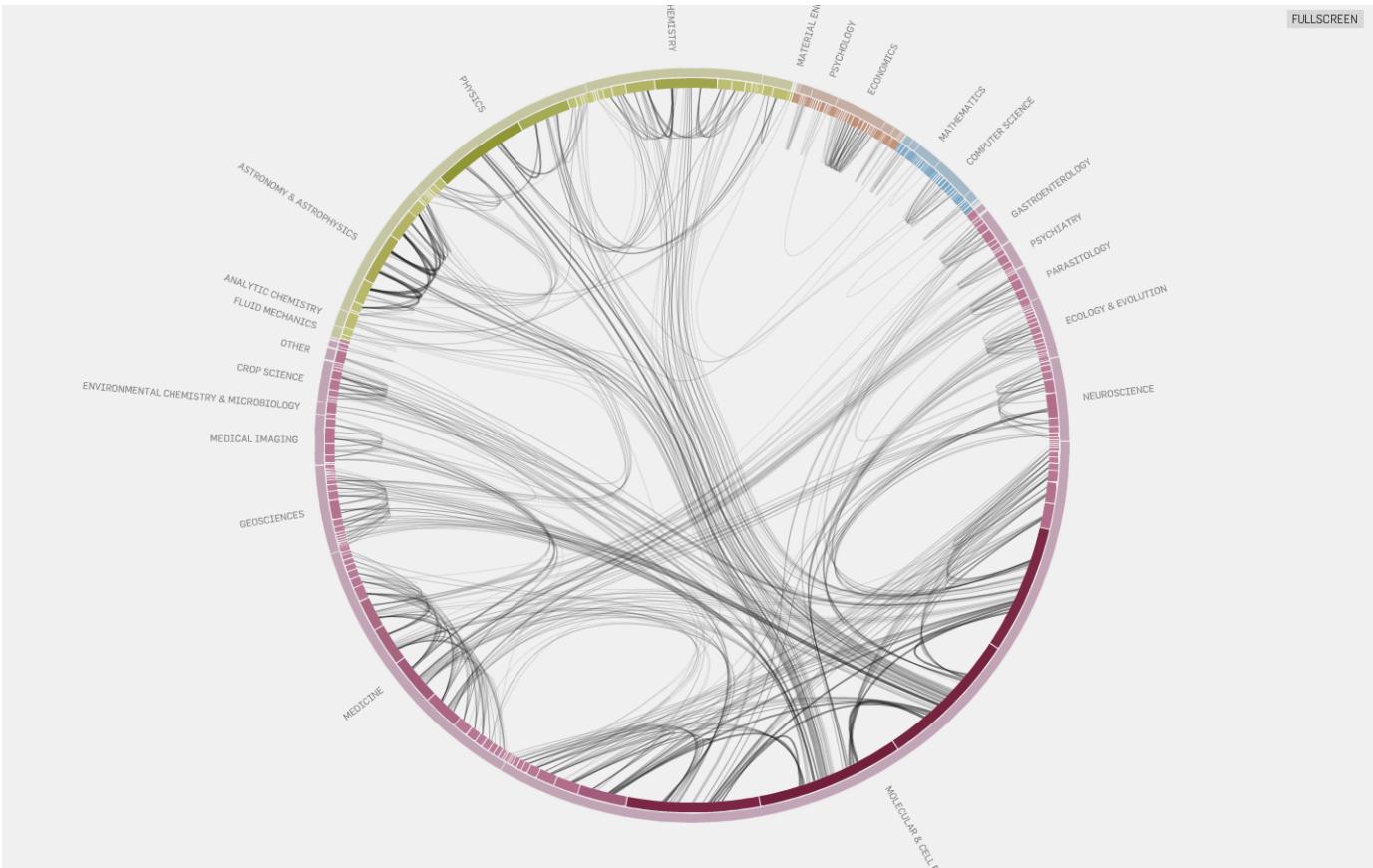


<http://mbostock.github.io/d3/talk/20111018/cluster.html>



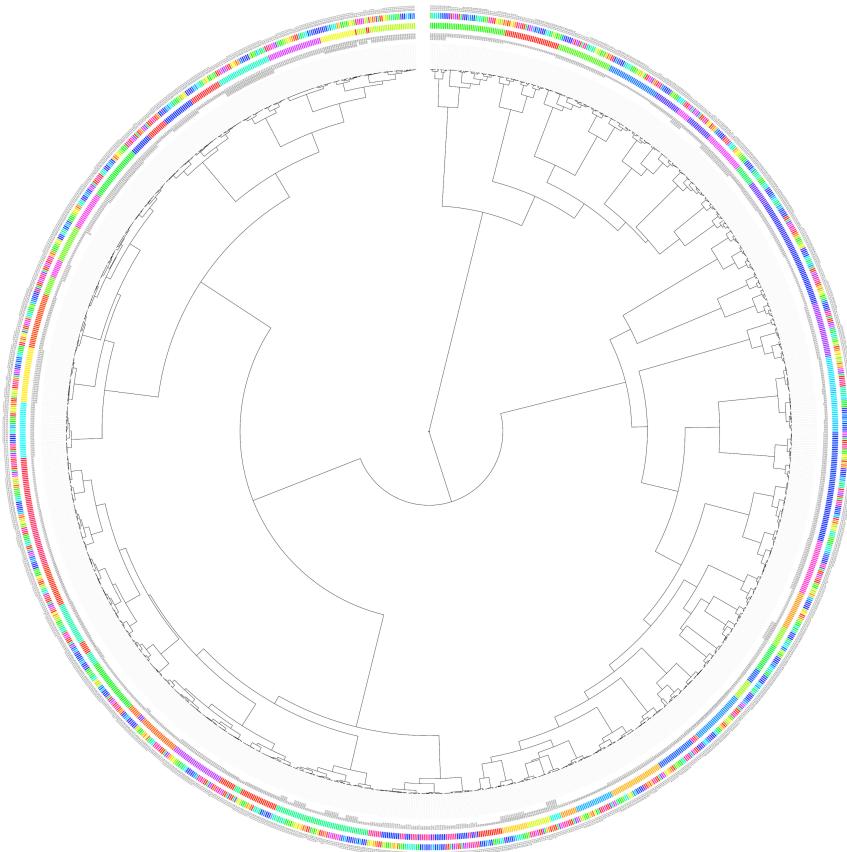
<http://mbostock.github.io/d3/talk/20111116/bundle.html>

FULLSCREEN



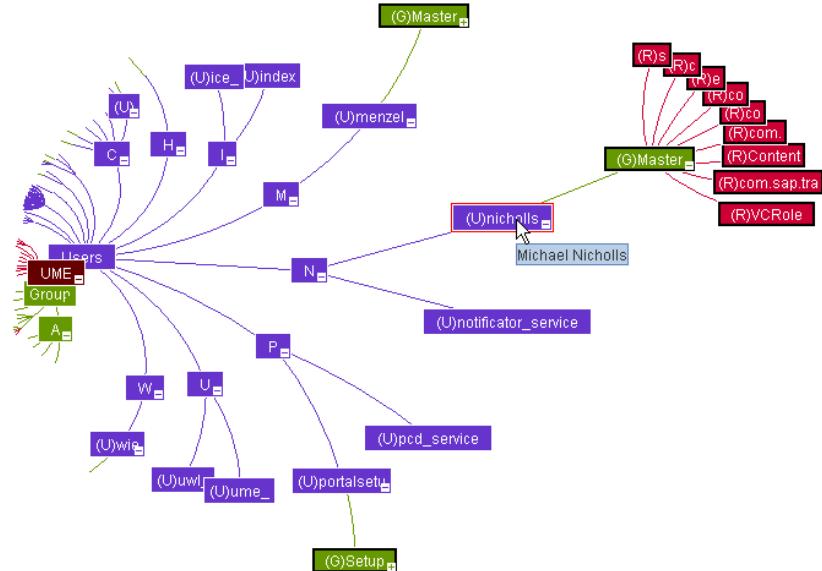
<http://www.eigenfactor.org/projects/well-formed/radial.html>



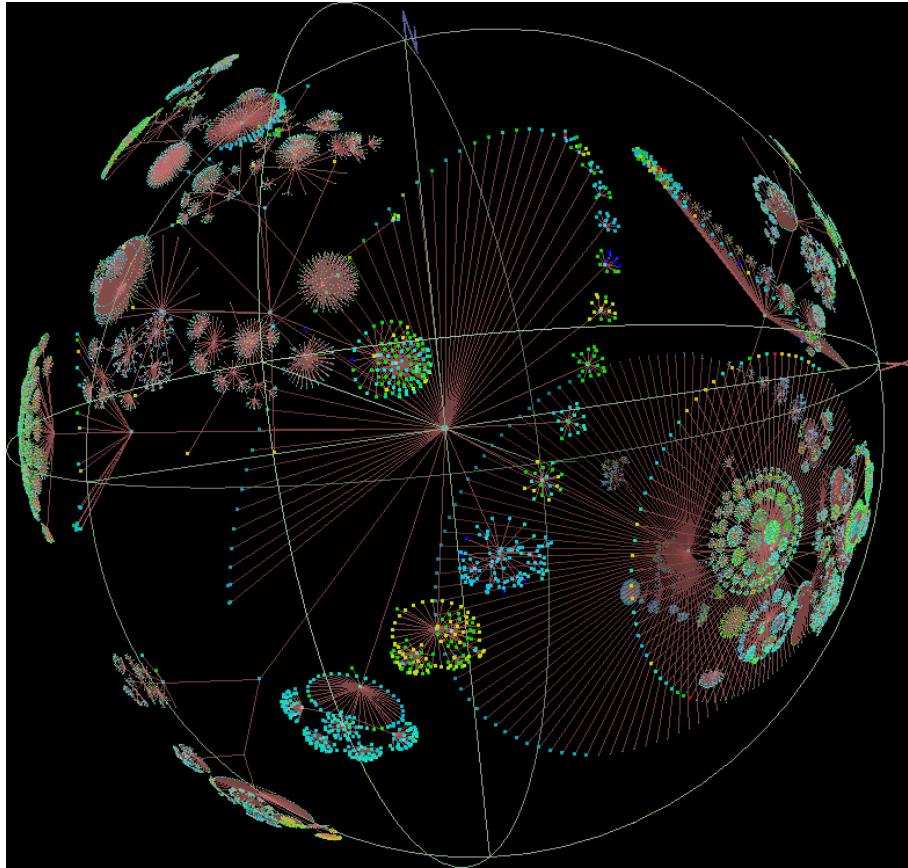


<http://cs.jhu.edu/~razvanm/fs-expedition/2.6.x.html>

Hyperbolic Tree



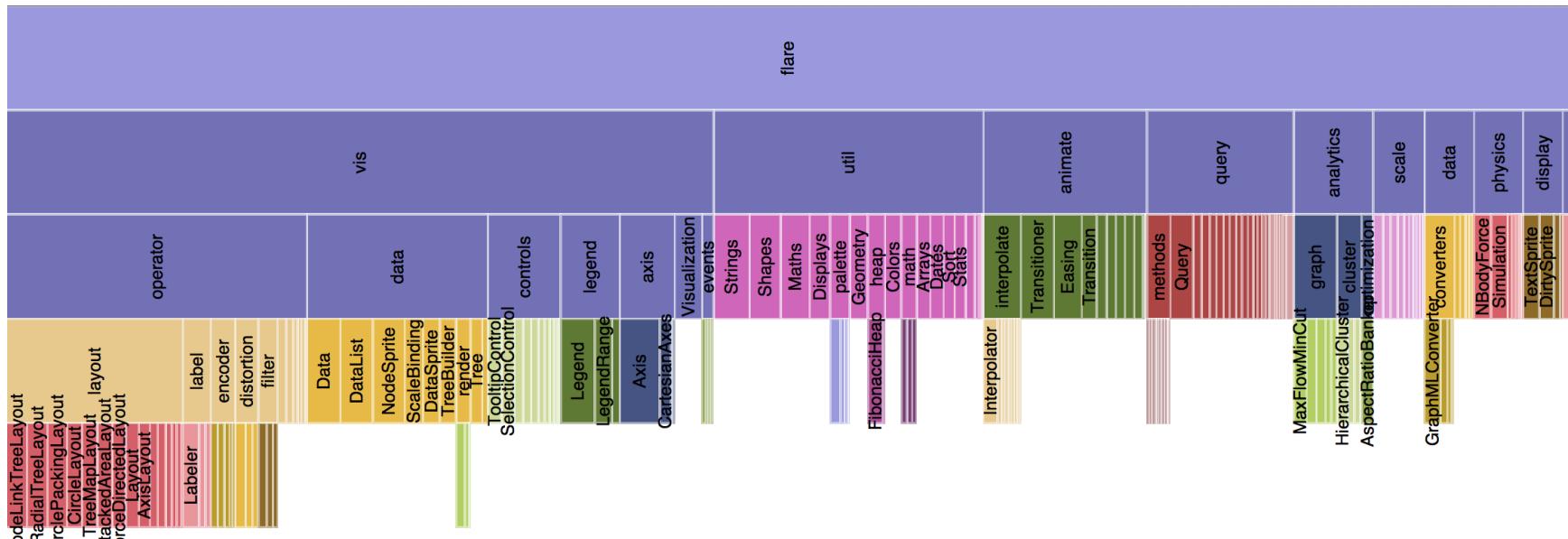
<http://wiki.sdn.sap.com/wiki/display/EmTech/StarTree+examples>



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

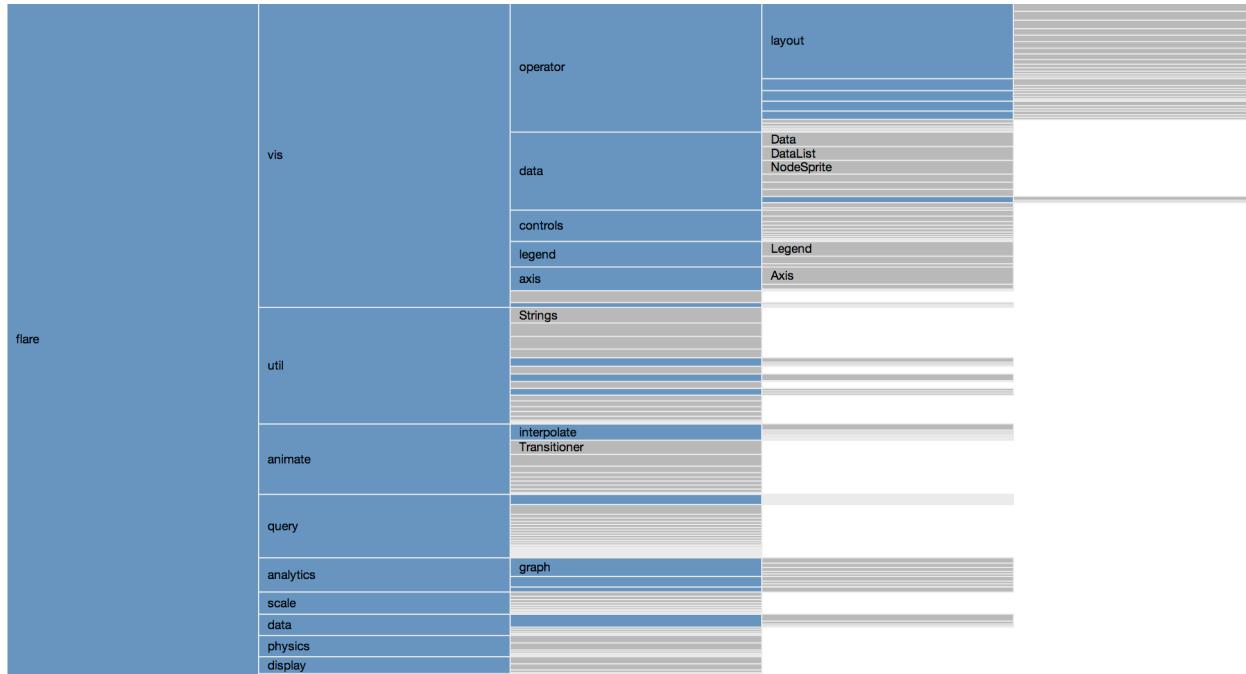
SPACE-FILLING DIAGRAMS

Icicle Diagram



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

Icicle Diagram



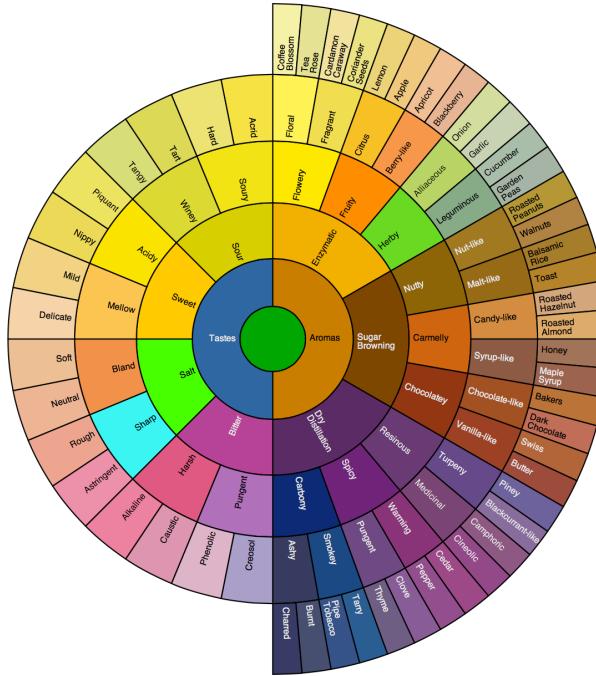
<http://mbostock.github.io/d3/talk/20111018/partition.html>

Sunburst Diagram



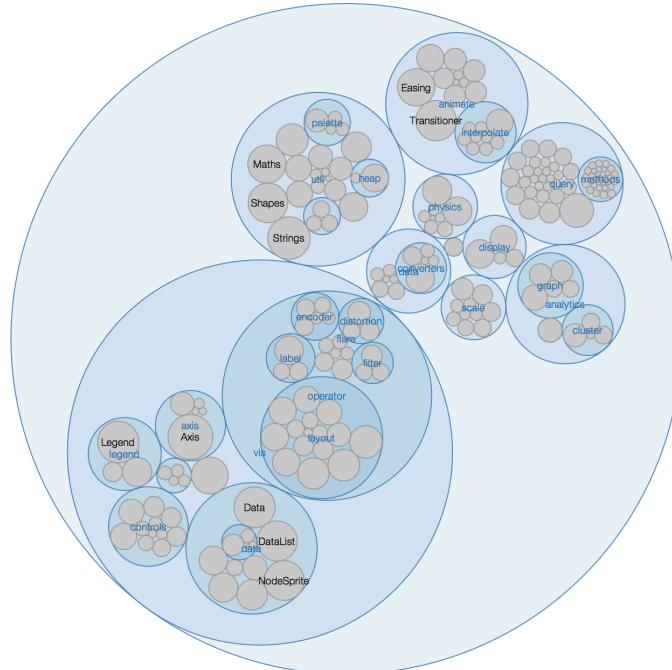
<http://bl.ocks.org/mbostock/4063423>

Sunburst Diagram



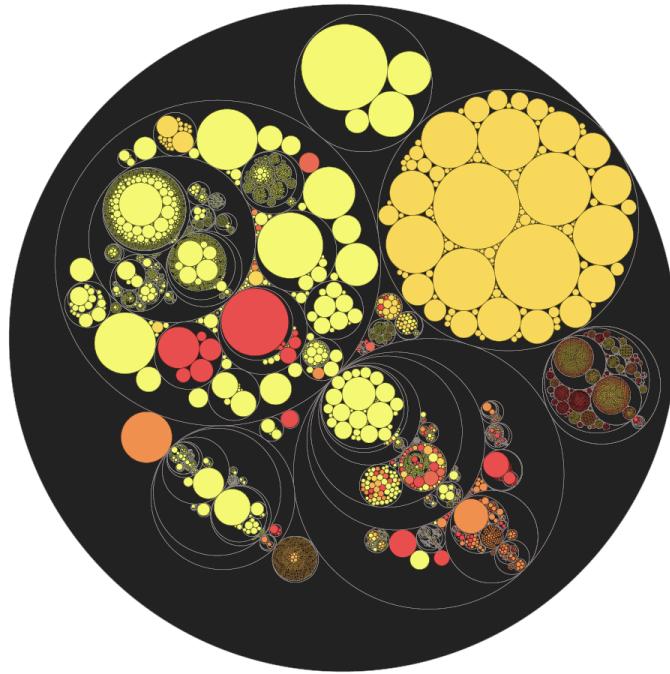
<http://www.jasondavies.com/coffee-wheel/>

Circle Packing

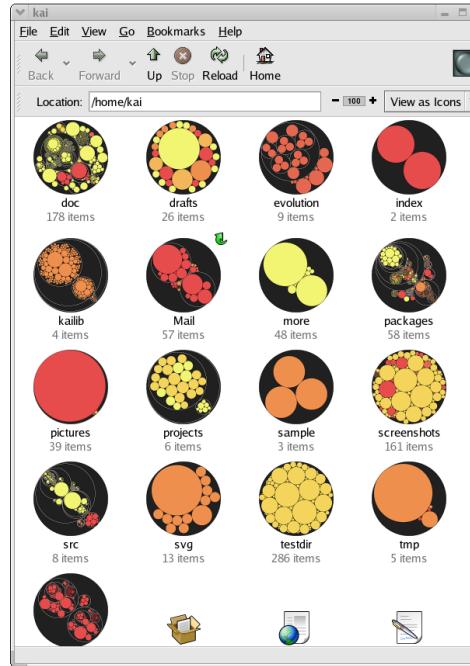


<http://mbostock.github.io/d3/talk/20111116/pack-hierarchy.html>

Pebbles File Manager



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



PRTG Network Monitor



https://prtg.paessler.com/help/general_layout.htm



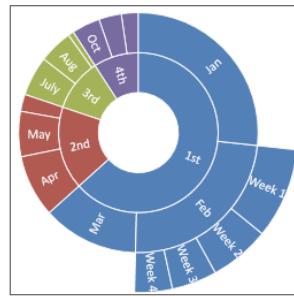
Mainstream* Adoption?

Create a sunburst chart in Office 2016

APPLIES TO: Excel 2016, Word 2016, Outlook 2016, PowerPoint 2016

Which version do I have?

The sunburst chart is ideal for displaying hierarchical data. Each level of the hierarchy is represented by one ring or circle with the innermost circle as the top of the hierarchy. A sunburst chart without any hierarchical data (one level of categories), looks similar to a donut chart. However, a sunburst chart with multiple levels of categories shows how the outer rings relate to the inner rings. The sunburst chart is most effective at showing how one ring is broken into its contributing pieces, while another type of hierarchical chart, the treemap chart, is ideal for comparing relative sizes.



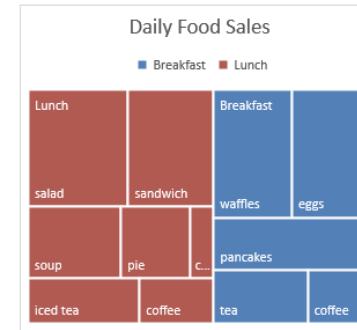
Create a treemap chart in Office 2016

APPLIES TO: Excel 2016, Word 2016, Outlook 2016, PowerPoint 2016

Which version do I have?

A treemap chart provides a hierarchical view of your data and makes it easy to spot patterns, such as which items are a store's best sellers. The tree branches are represented by rectangles and each sub-branch is shown as a smaller rectangle. The treemap chart displays categories by color and proximity and can easily show lots of data which would be difficult with other chart types.

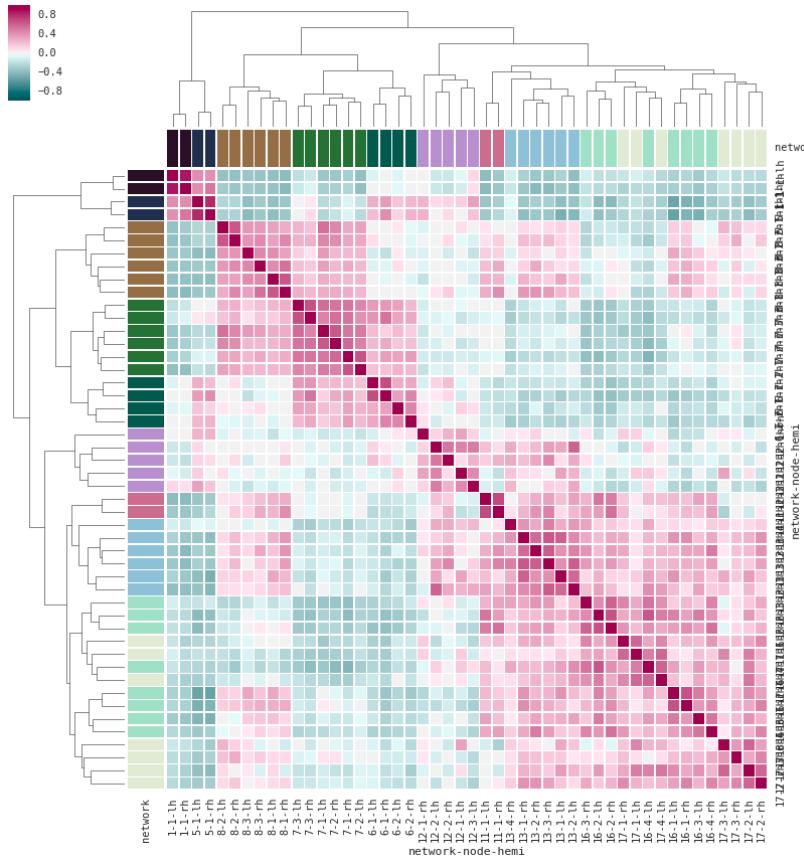
Treemap charts are good for comparing proportions within the hierarchy, however, treemap charts aren't great at showing hierarchical levels between the largest categories and each data point. A sunburst chart is a much better visual chart for showing that.



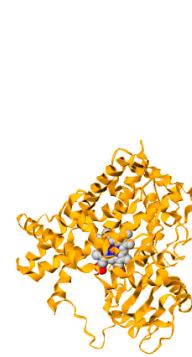
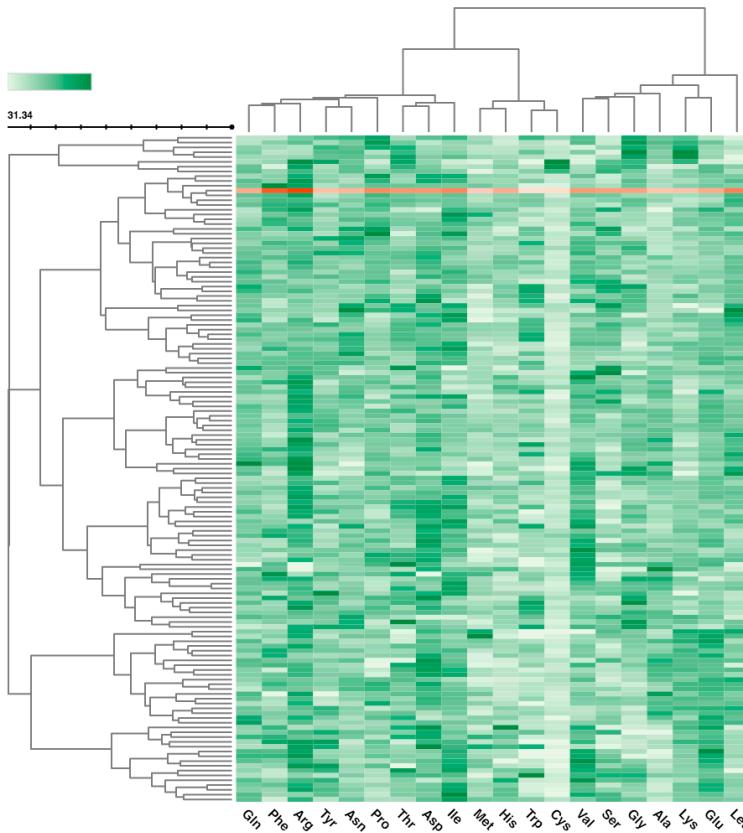
<https://blogs.office.com/2015/07/02/introducing-new-and-modern-chart-types-now-available-in-office-2016-preview/>

CLUSTER HEATMAPS

Juxtaposed Techniques



http://seaborn.pydata.org/examples/structured_heatmap.html

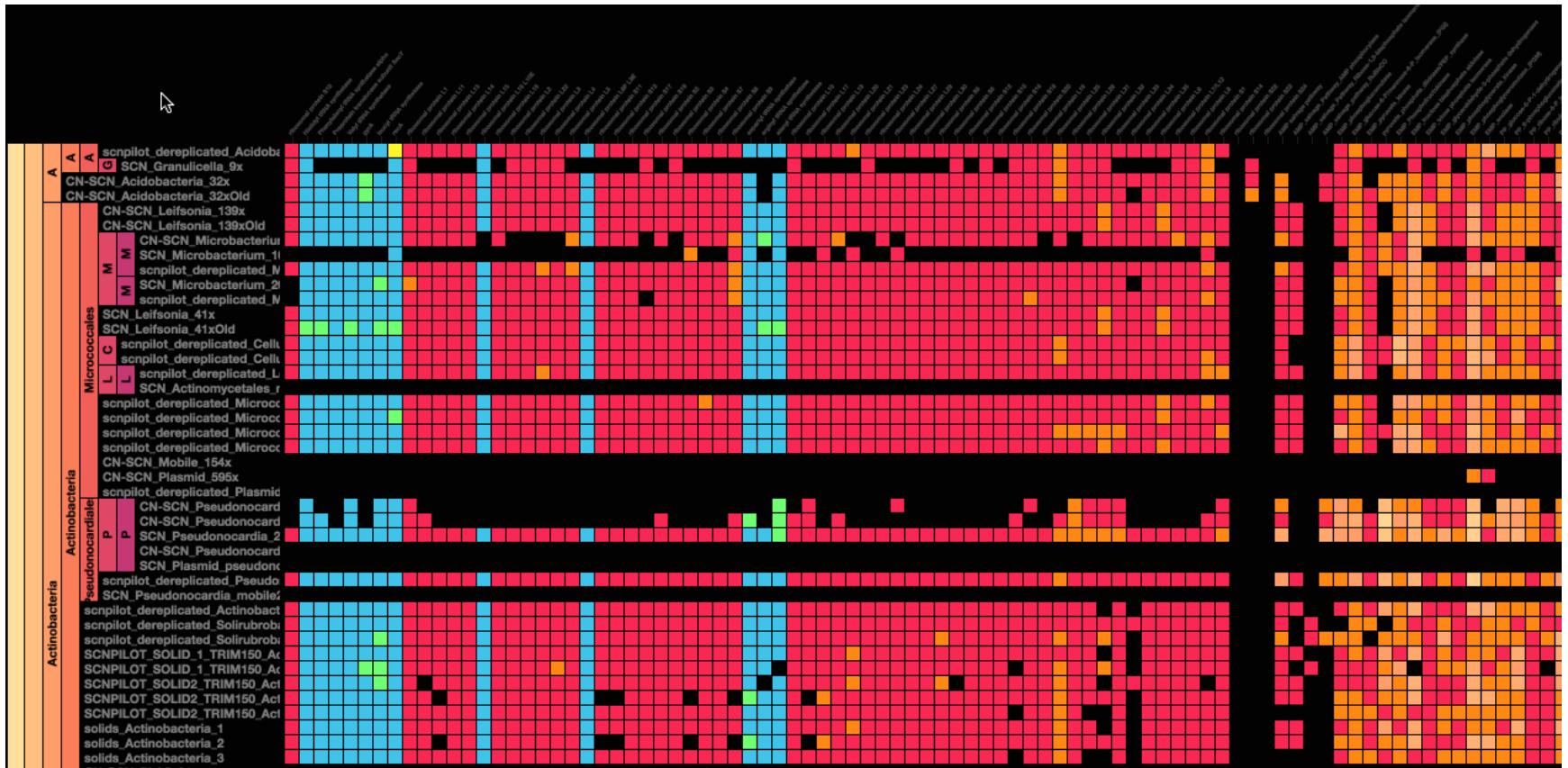


PDB ID	1P05
Structure Title	Structure of mammalian cytochrome P450 2B4
Chain Length	476 residues
Resolution [Å]	1.6
Classification	oxidoreductase
Biological Process	oxidation-reduction process
Cellular Component	endoplasmic reticulum
Molecular Function	monooxygenase activity
Primary citation	
PubMed ID	14563924
DOI	10.1073/pnas.2133986100

<http://www.openscreen.cz/software/inchlib/home/>



<https://bmcbioinformatics.biomedcentral.com/articles/10.1186/s12859-016-1442-6>



<https://stamen.com/work/banfield/>

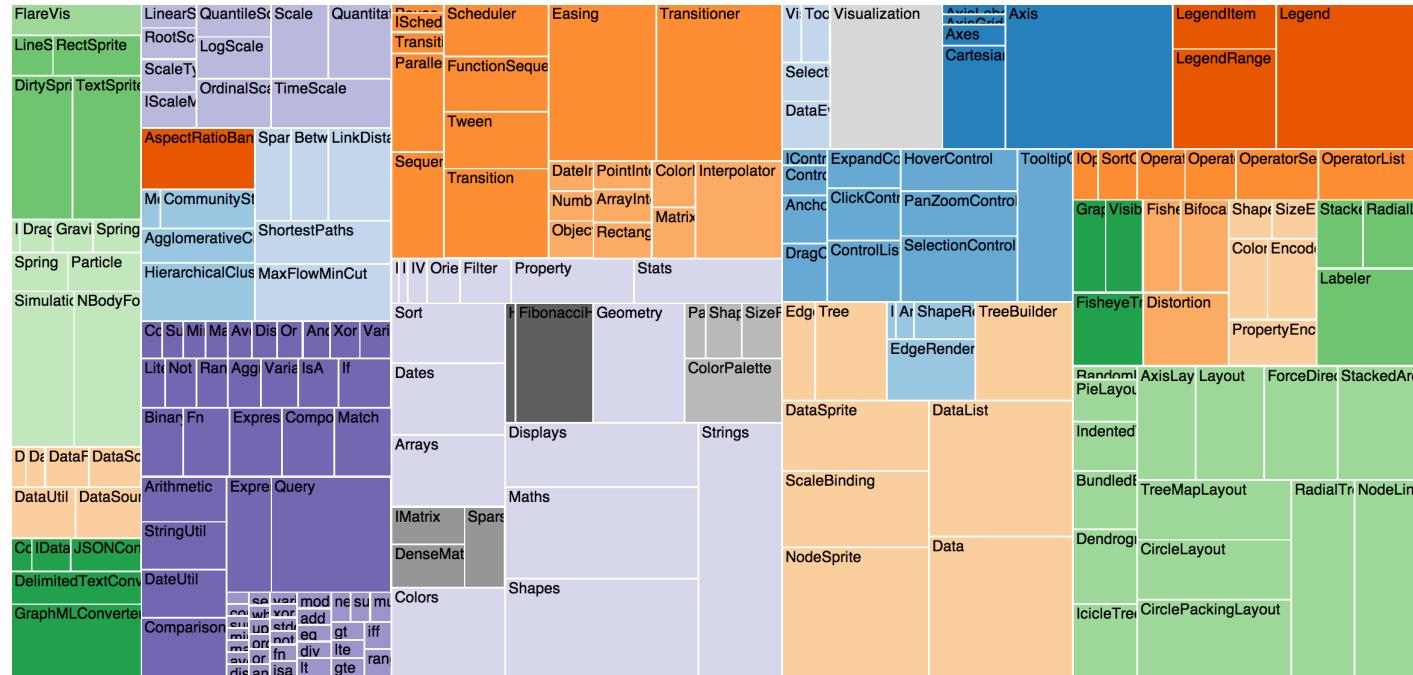
TREEMAPS

Treemaps

- Root is entire rectangle
- Recursively divide rectangles to show levels
- Two common visualization tasks
 - Promote comparison, visualize hierarchy
- Task affects encoding (color, outlines, shading, etc.)

<http://www.cs.umd.edu/hcil/treemap-history/>

Treemaps



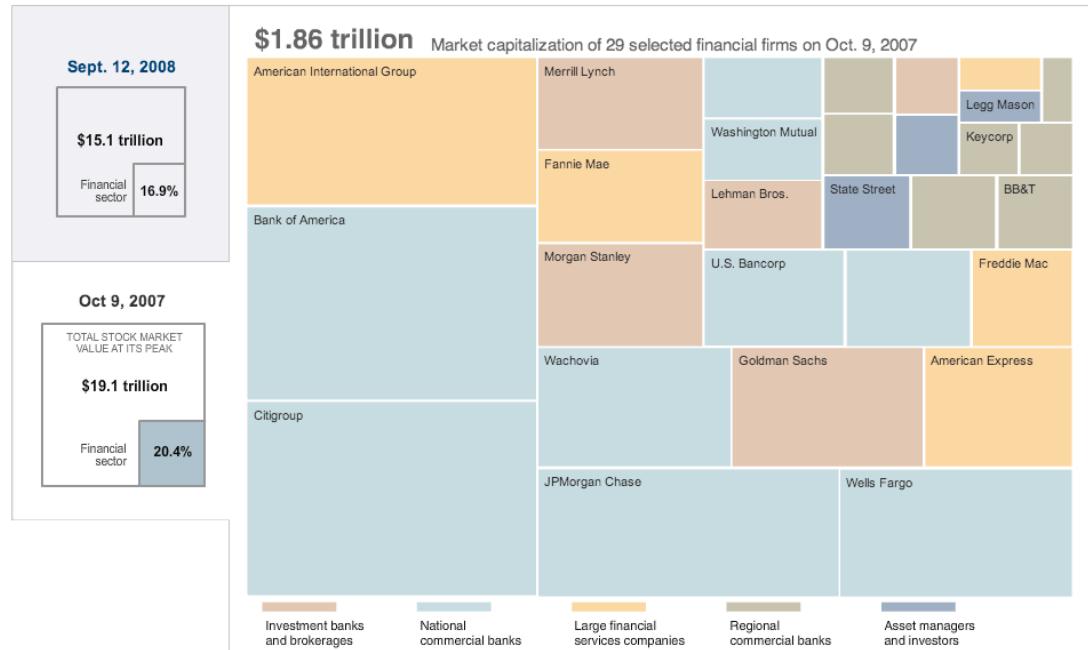
<http://bl.ocks.org/mbostock/4063582>

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.

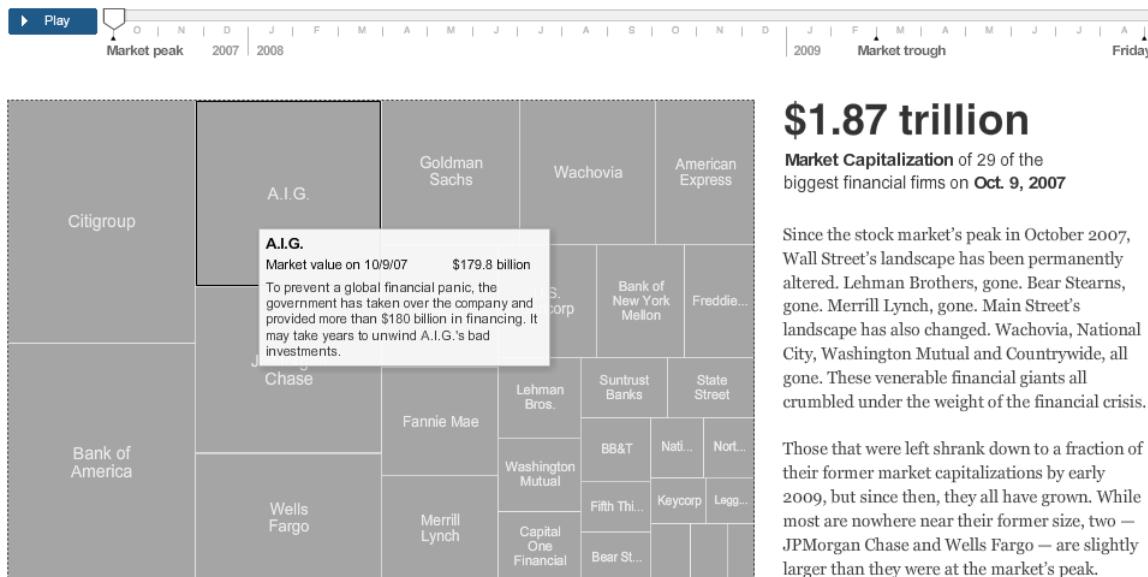
Source: Wilshire Associates

Kevin Quealy and Dylan Loeb McClain / The New York Times

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

Published: September 12, 2009

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

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, misstated 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>

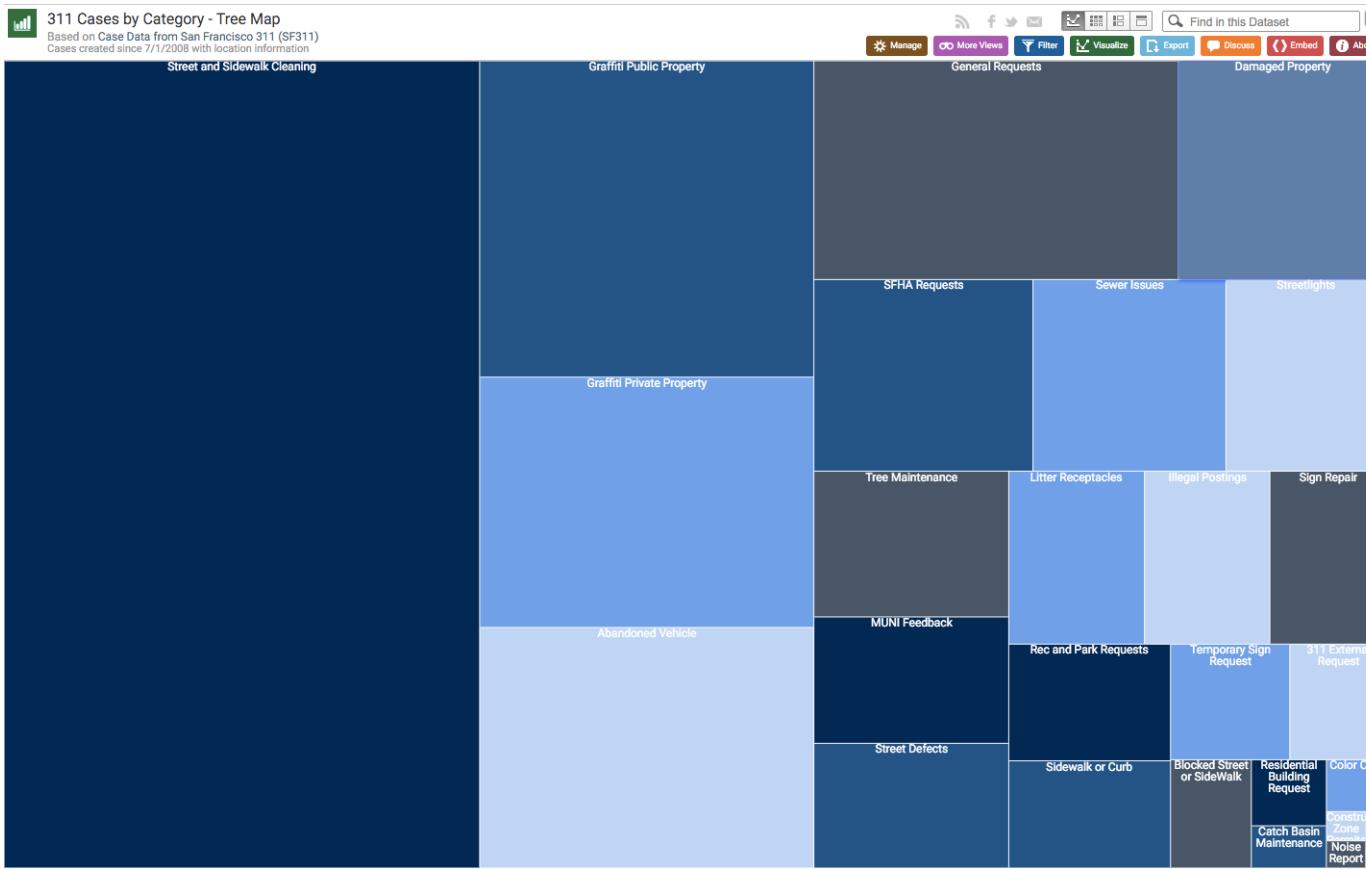




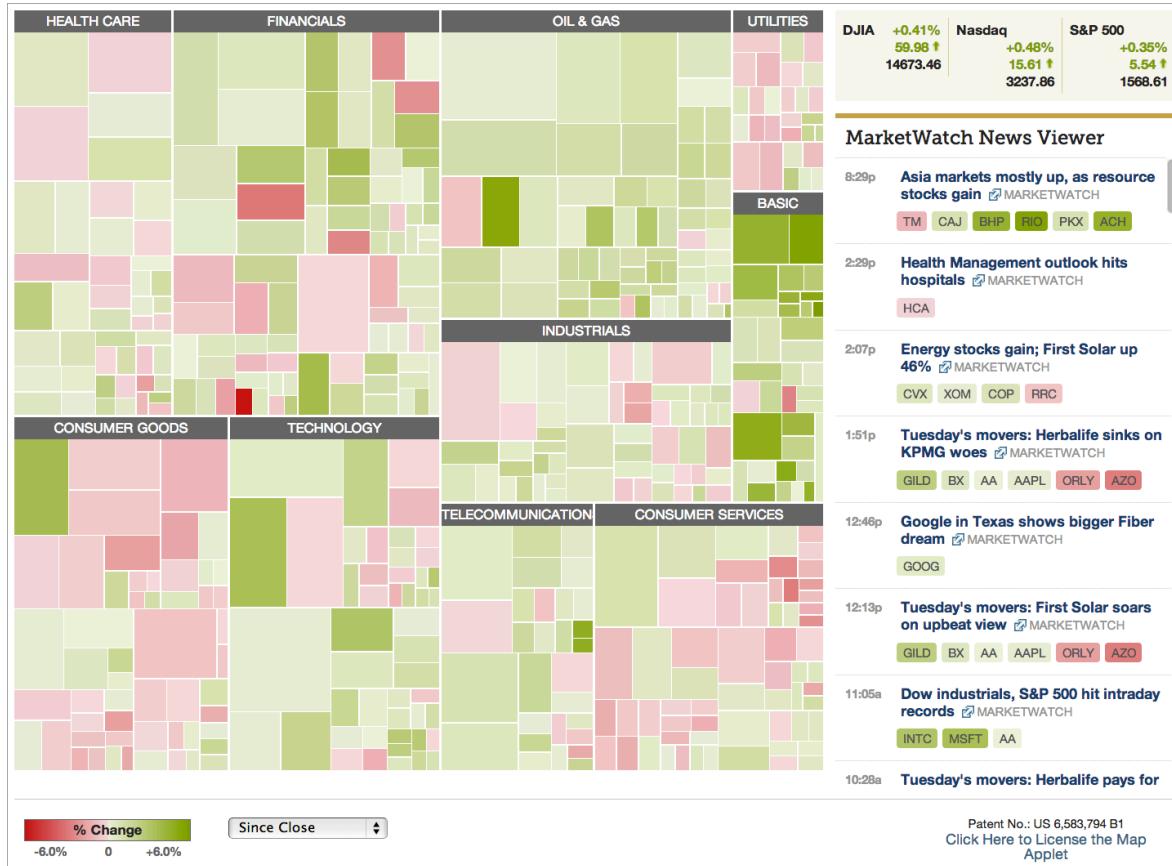
<http://www.informationisbeautiful.net/visualizations/the-billion-dollar-o-gram-2009/>

\$11,900 Worldwide cost of financial crisis

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



<https://data.sfgov.org/City-Infrastructure/311-Cases-by-Category-Tree-Map/bf6q-9qjw>



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

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'

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 ...

Ariana Grande Planning Surprises for Her Fiancé on Their Wedding Day

Alec Baldwin in Talks to Join NBC's Late-Night Lineup: 'There Have Been ...'

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

Lauder donates billion-dollar collection to Met

AMC Actually Considering a Saul-based Breaking Bad Spinoff

13th Annual Game of Thrones Awards Airs April 6

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

GM Returns To Formula 1, Will Super Bowl Be Next?

Twitter Authorizes Ready to Microsoft Accounts

Apple iPhone 5S Signs Off For Gray Scale Screen

SharePoint 2013 Offers New Features for Modern Work

Barnes & Noble launches new publishing platform

LinkedIn Acquires Jobster

Facebook's News Feed Algorithm

Finances may soon be covered by prescription medication use

In Photos, Alzheimer's Study Finds Some Variant Genes in White

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

Rockets' James Harden hits game-winner thanks to goalie from Suns' Jermaine ...

Judge breaks down arguments in concussion-related suit

Westbrook, Durant lead Thunder over Jazz 90-80

Bump in Ratings for Men's College Basketball Final

Nabokov backstops Islanders to win against Flyers

McLemore may have left KU after one season, but his journey has just begun

Matto Not Cleared to Throw, Might Need Surgery

Smith Leaving for NBA, Father Says

Nets Cruise Toward Playoffs Facing a Future Without Jay-Z

Hawks sign Brady Quinn, per report

Kovalchuk Returns From Injury to Play Practice

Jimmie & Chandra Johnson Baby On The Way

Jazz: Kanter will undergo surgery, season is over

Miami Heat ties franchise record with win over Milwaukee Bucks

The Blue Jays are off to a slow start, and their road is getting tougher

Student charged after 14 wounded in mass stabbing at Texas college

GOP Senators Signal Possible Breakthrough in Gun Debate

Navy's aerobatic team Blue Angels cancelling air shows amid federal budget cuts

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

Gf1 audio released from fugitive ex-LA cop manhunt

New Guidelines Call for Broad Changes in Science Education

American Eagle pilot charged with attempting to fly while intoxicated

Democrats' uncertain declare victory in 'Mony' McMichael

Roger Ebert: A Hero, A Teacher, An Inspiration

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

China Posts Trade Deficit

Virgin America enters Newark Airport with a party

Hostess Gets OK for Drake's, Bread Brands Sale

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

3 jobless Americans for every opening

FBI takes lead in London's May Day Mayhem

London United for Democracy Tax

Scott London: Tipping Began at Golf Club

Marilyn Tavenner soars through Senate Finance hearing

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

Top admiral: US can intercept a North Korean missile

Cuba to turn over Florida couple who allegedly kidnapped children

Japan readies defenses for possible missile test by North Korea

North Korea closes China border to tourists

Saudi Arabia Says Paralysis Sentence Is False

Bullying blamed in death of Nova Scotia teen

Armenia International Credit Card Trends

SharePoint 2013 offers new features for modern work

Barnes & Noble launches new publishing platform

Microsoft acquires LinkedIn

Finances may soon be covered by prescription medication use

http://newsmap.jp/



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

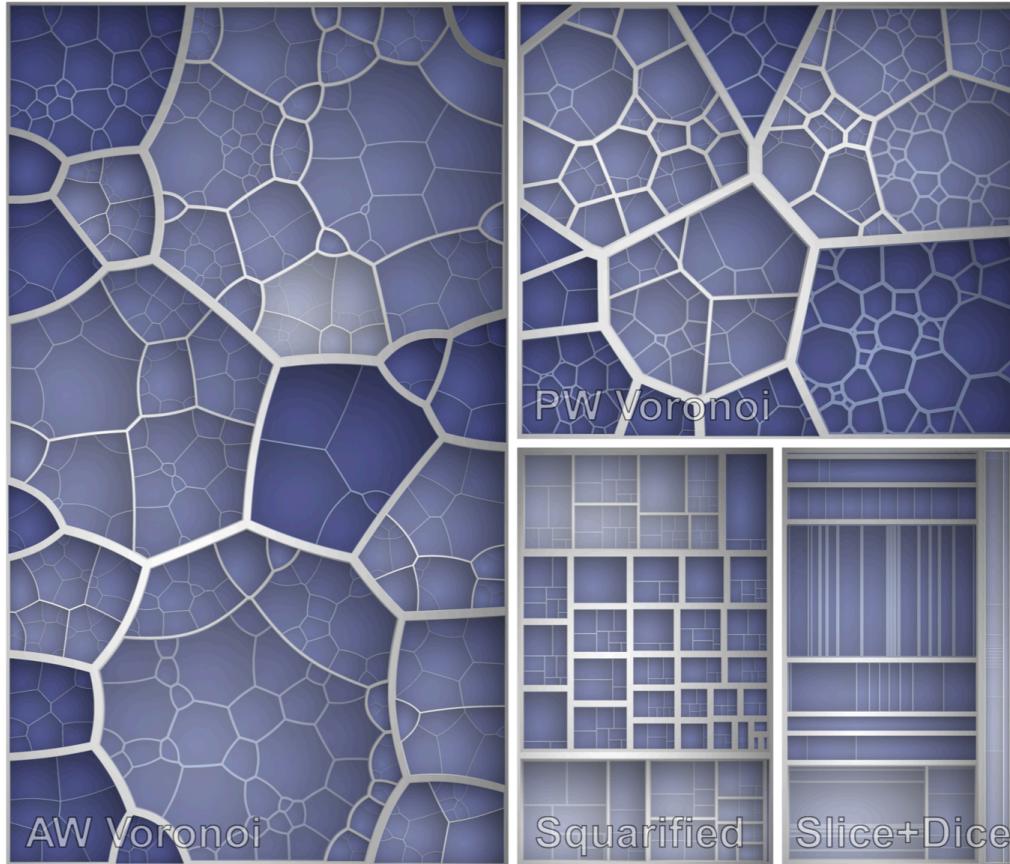
SliceAndDice

[Go to Parent](#)

[See the Example Code](#)

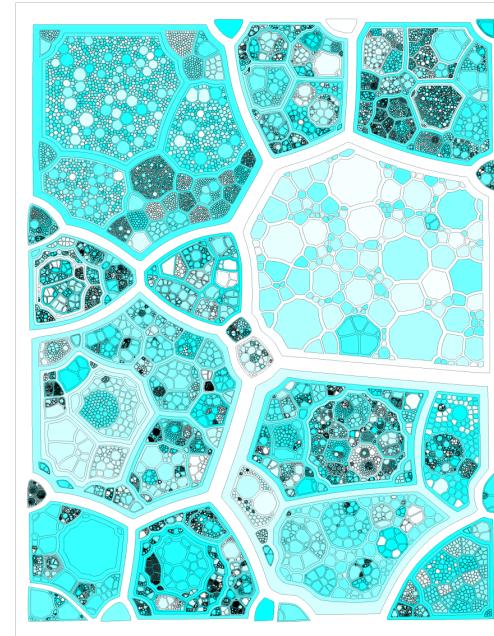
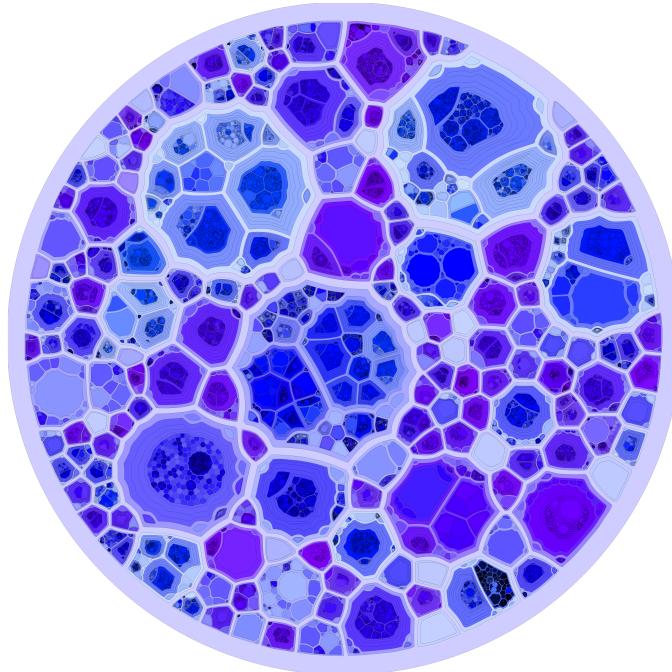


<http://philobg.github.io/jit/static/v20/Jit/Examples/Treemap/example3.html>



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

Voronoi Treemaps



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



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

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%

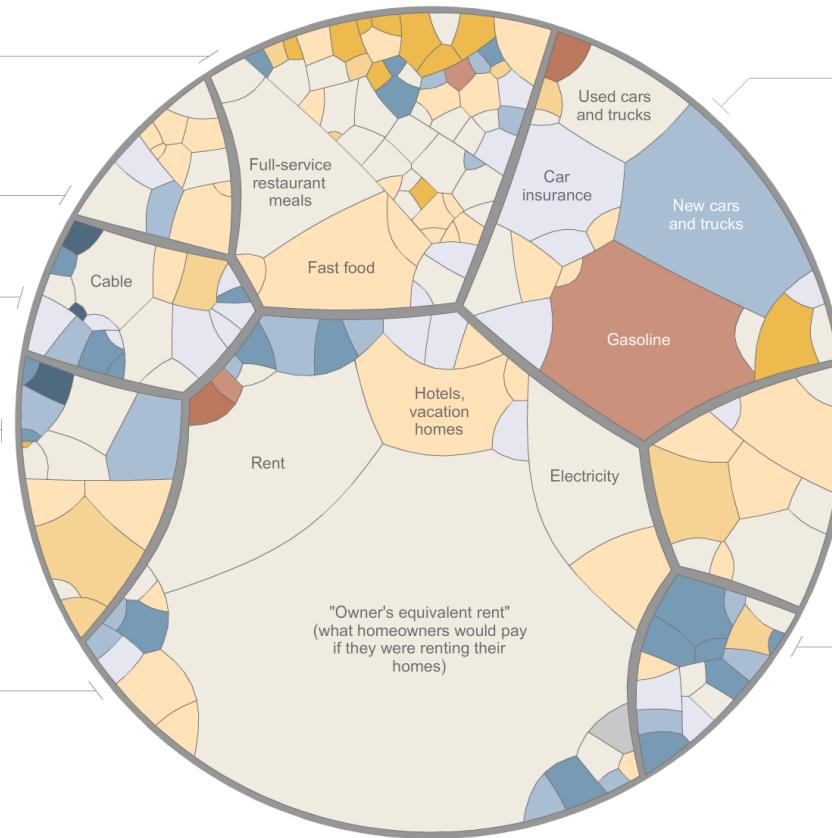
Recreation 6%

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.

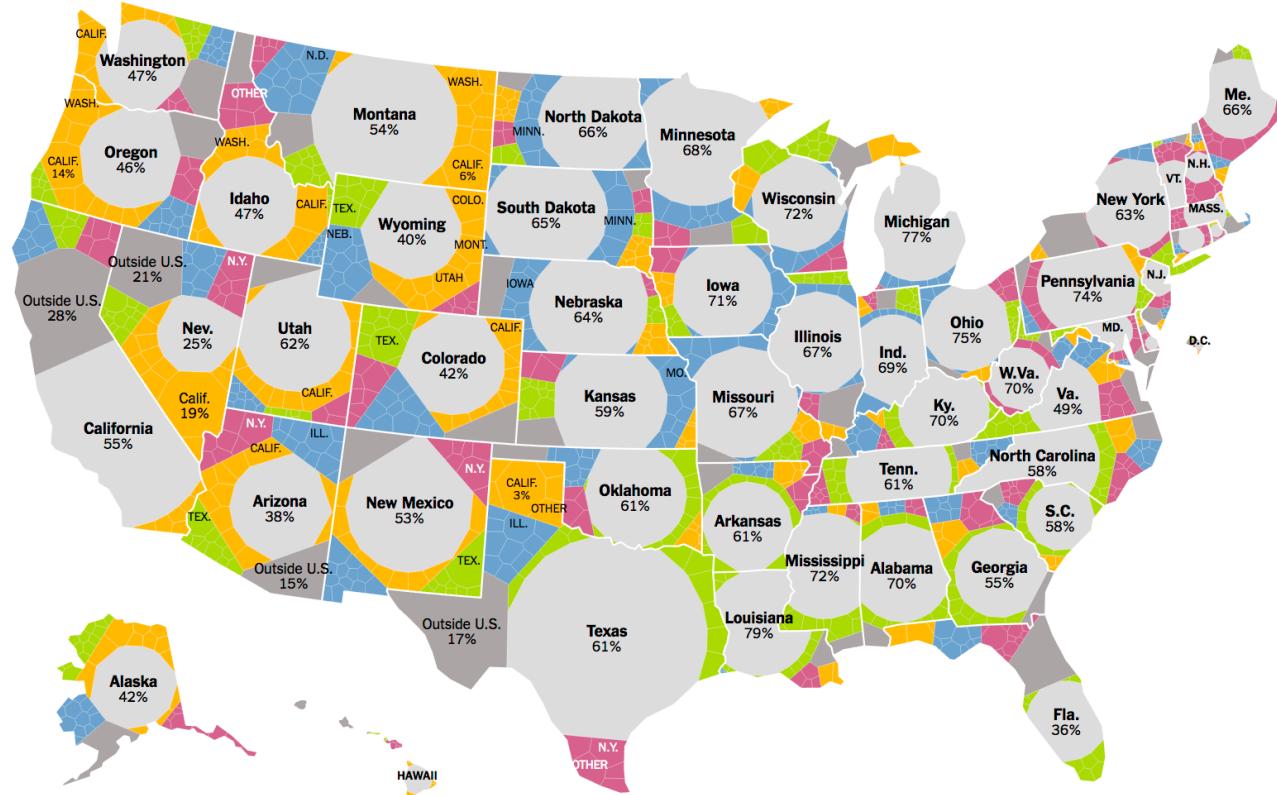
Apparel 4%

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



Northeast South Midwest West Outside the U.S.*



<https://www.nytimes.com/2014/08/16/upshot/mapping-migration-in-the-united-states-since-1900.html>

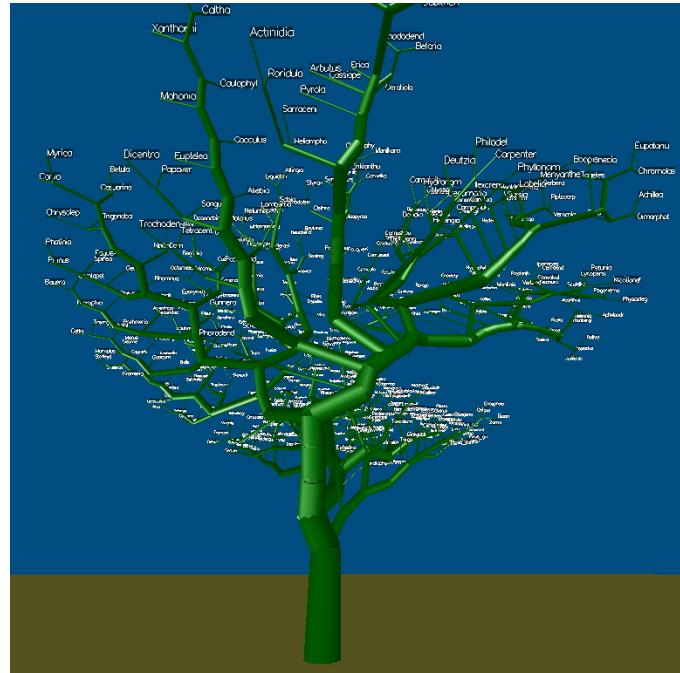
TREE OF LIFE

Case Study

Tree of Life

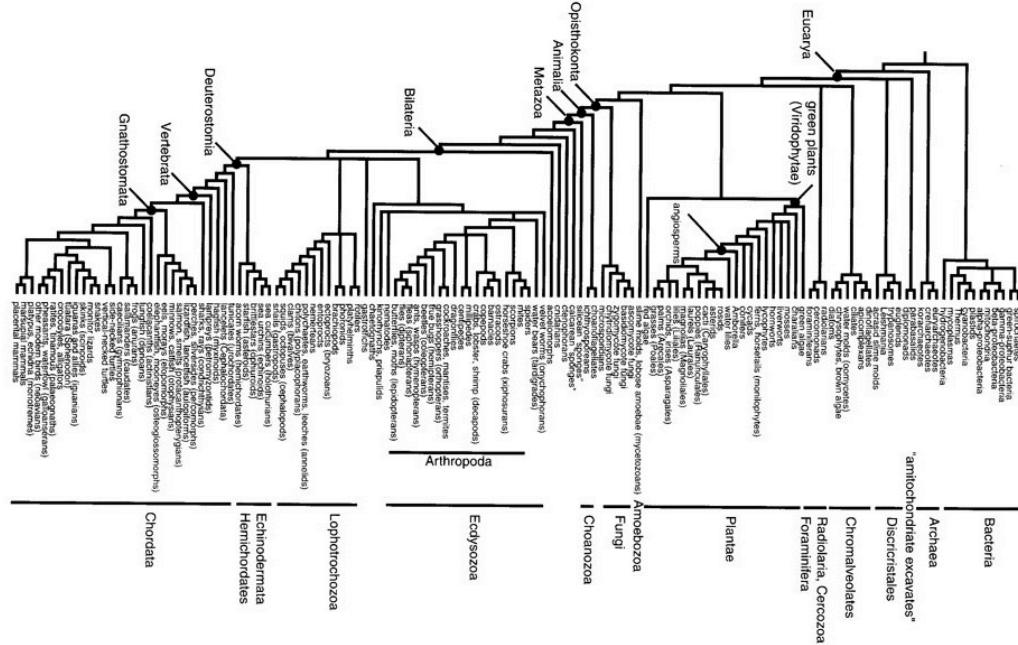
- Specifically **phylogenetic** tree of life
 - Evolutionary tree, showing where species branch
- Can be thousands to tens of thousands of nodes
- Many tools for the ToL exist using different visualization techniques
- See <http://tolweb.org/tree/phylogeny.html>

Paloverde



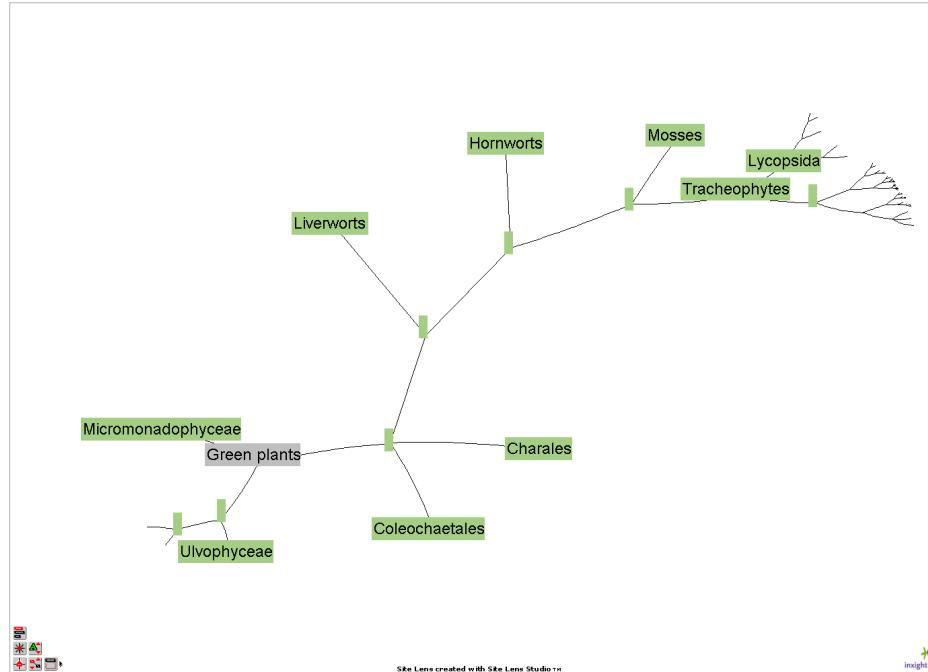
<http://loco.biosci.arizona.edu/paloverde/paloverde.html>

Teachable ToL



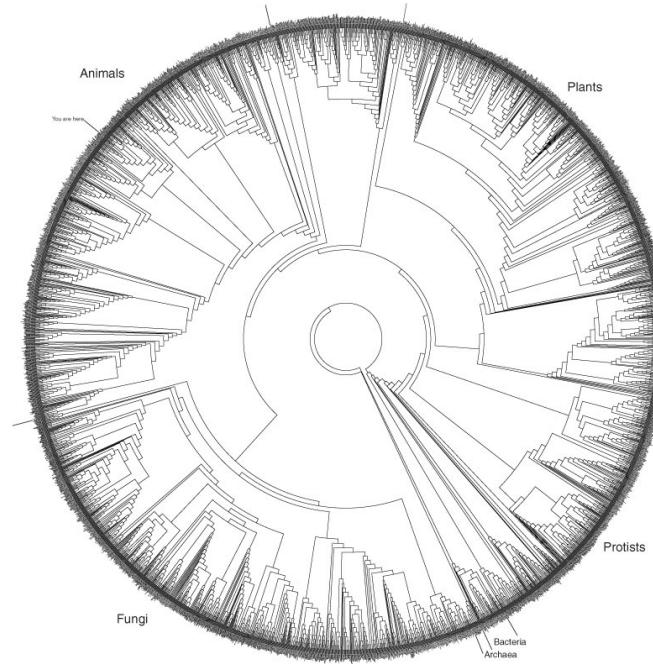
<http://www.rebeccashapley.com/cipres/telescoping.htm>

Hyperbolic ToL (Plants Only)



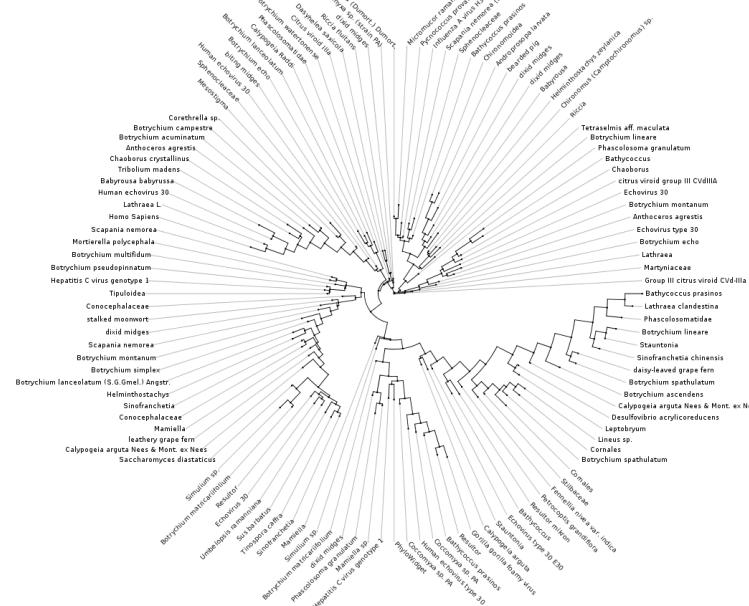
<http://ucjeps.berkeley.edu/TreeofLife/hyperbolic.php>

Subset of 3,000 Species



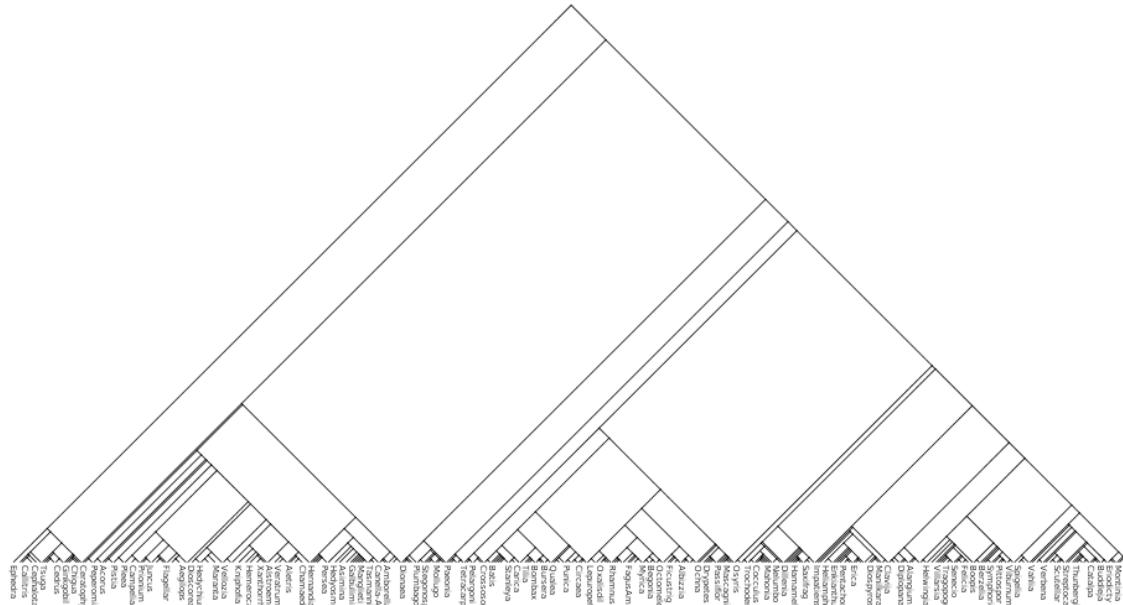
<http://www.zo.utexas.edu/faculty/antisense/DownloadfilesToL.html>

PhyloWidget



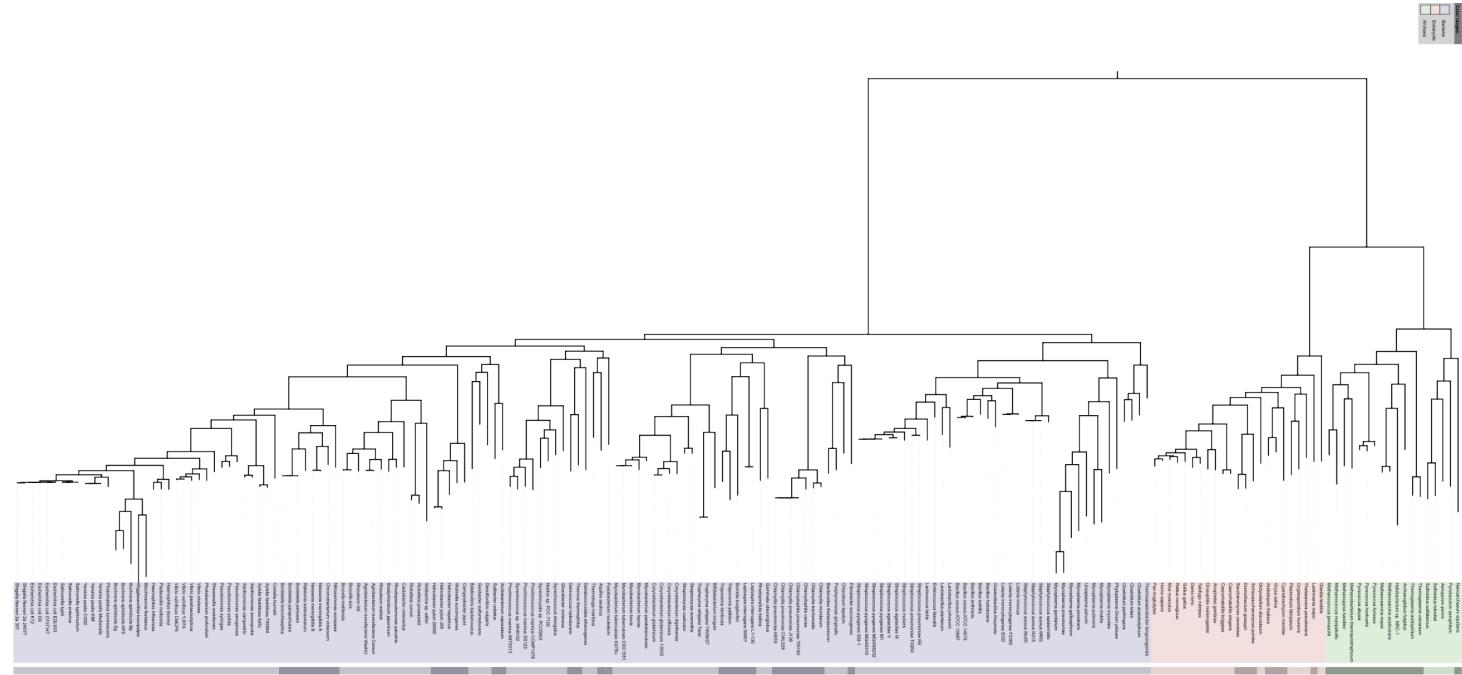
<http://www.phylowidget.org/>

PhyloWidget



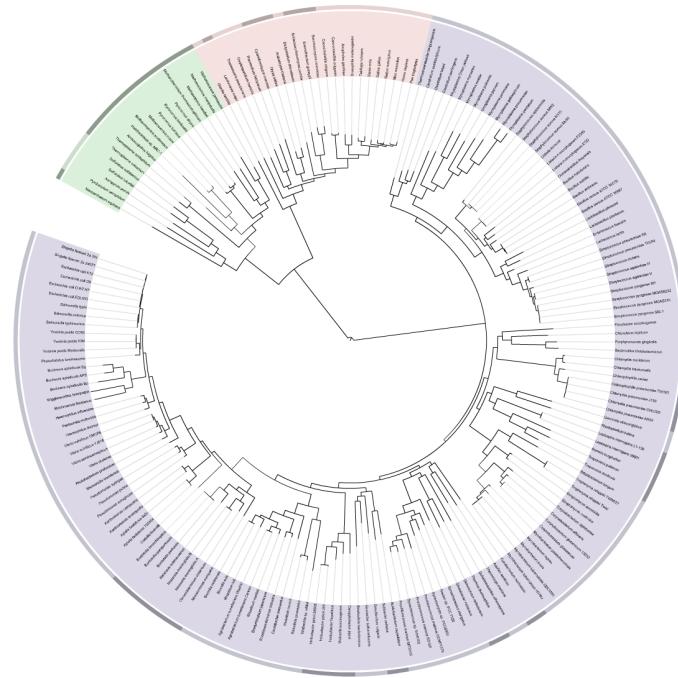
<http://www.phylowidget.org/>

Interactive ToL



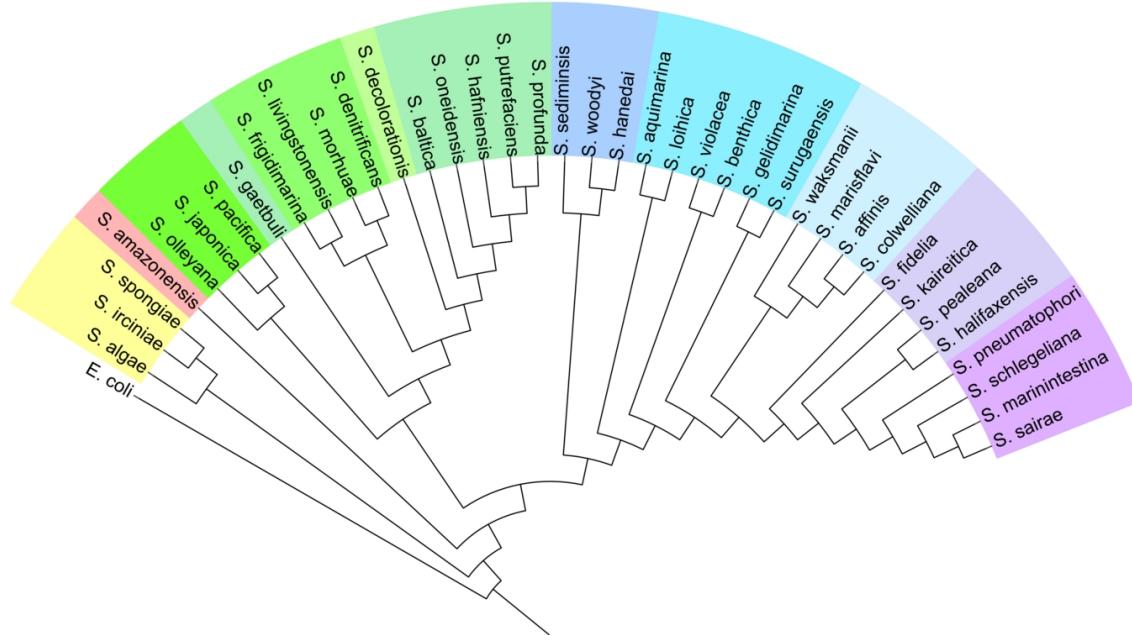
<http://itol.embl.de/>

Interactive ToL



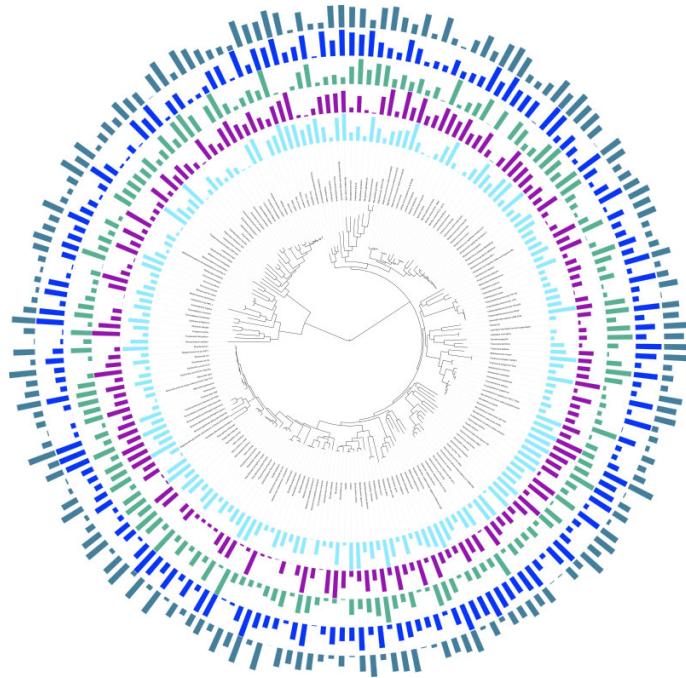
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Interactive ToL



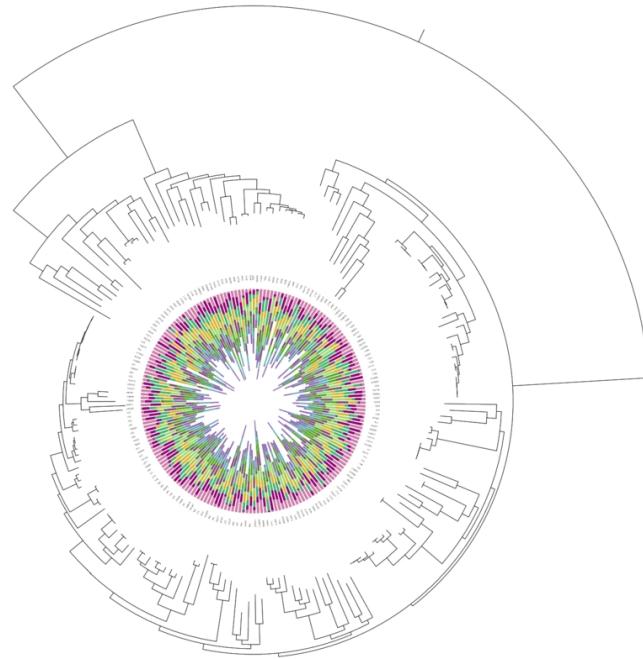
<http://itol.embl.de/>

Interactive ToL



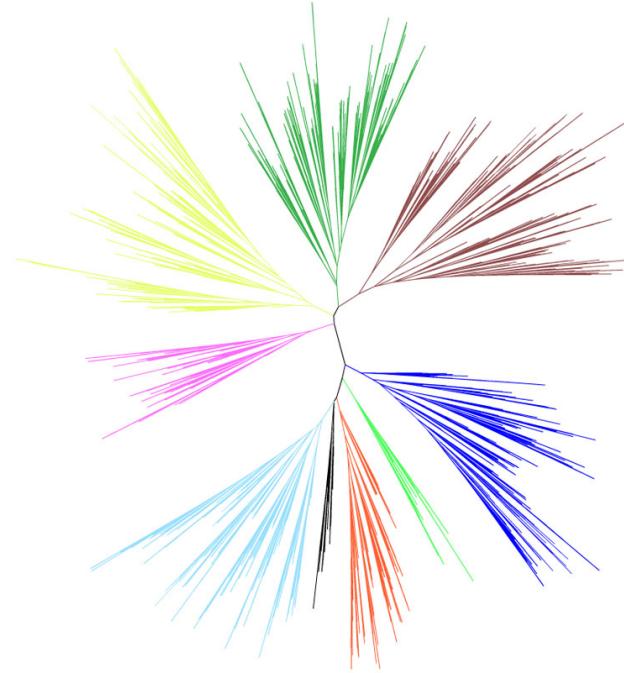
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Interactive ToL



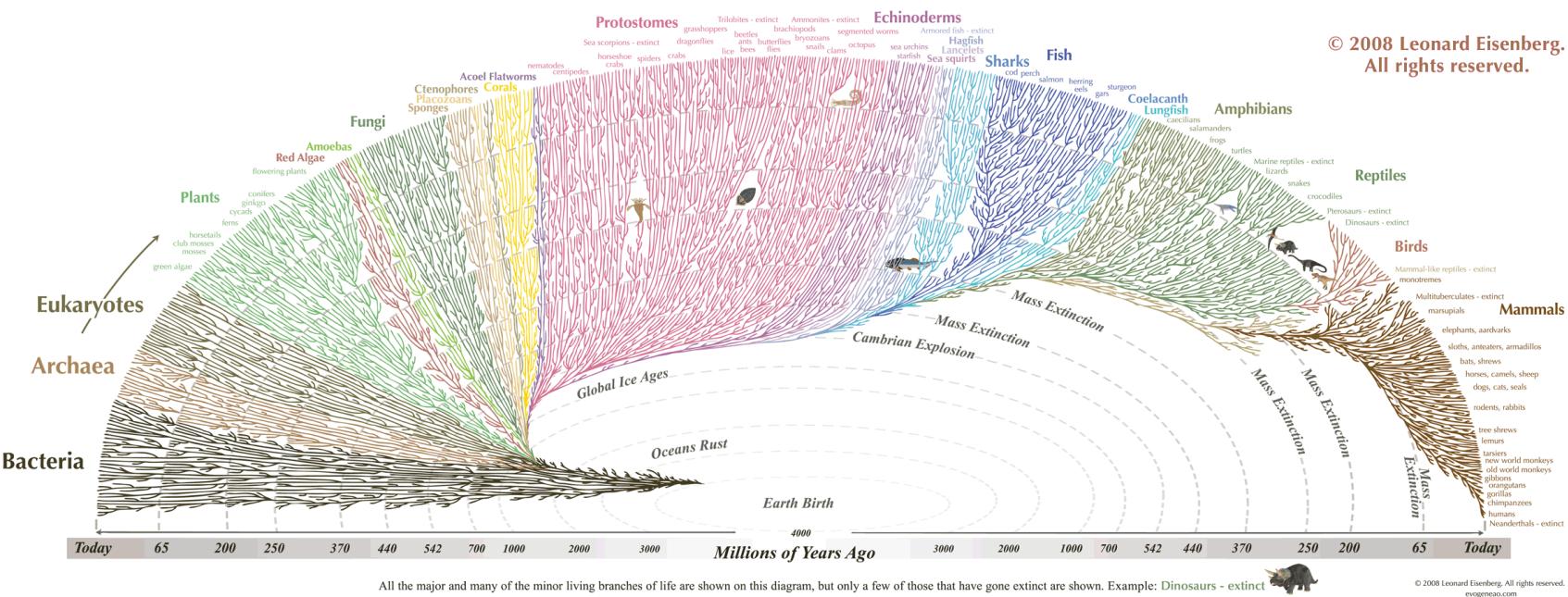
<http://itol.embl.de/>

Interactive ToL



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

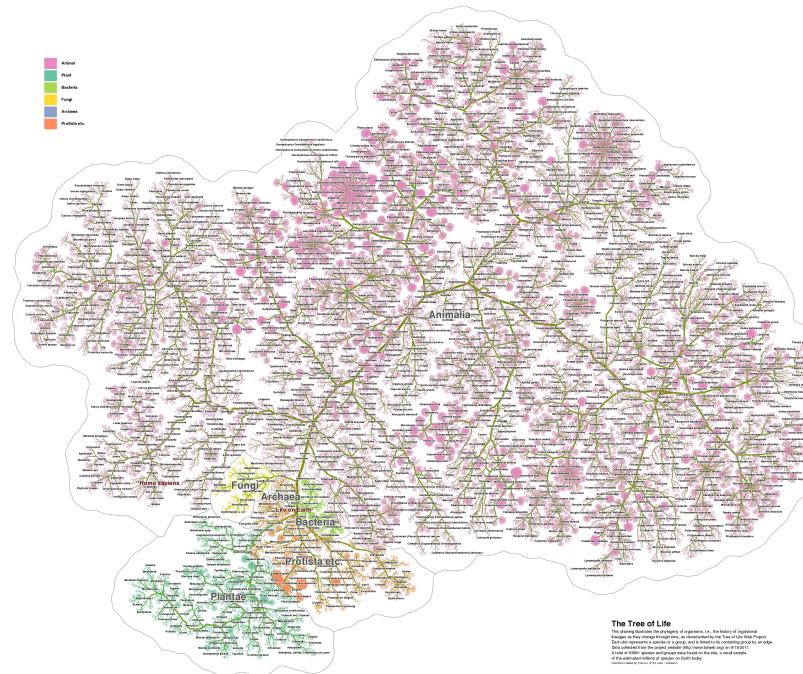
Illustration



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evogeneao.com

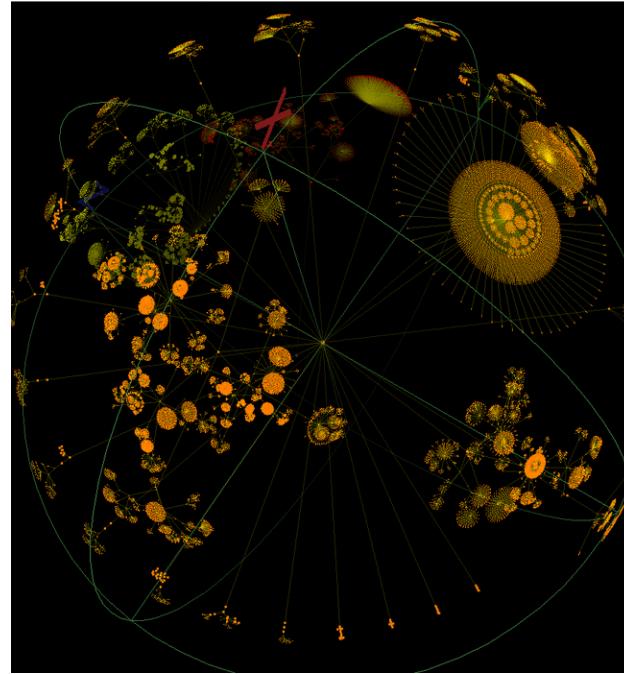
<http://www.evogeneao.com/>

Interactive ToL (2)

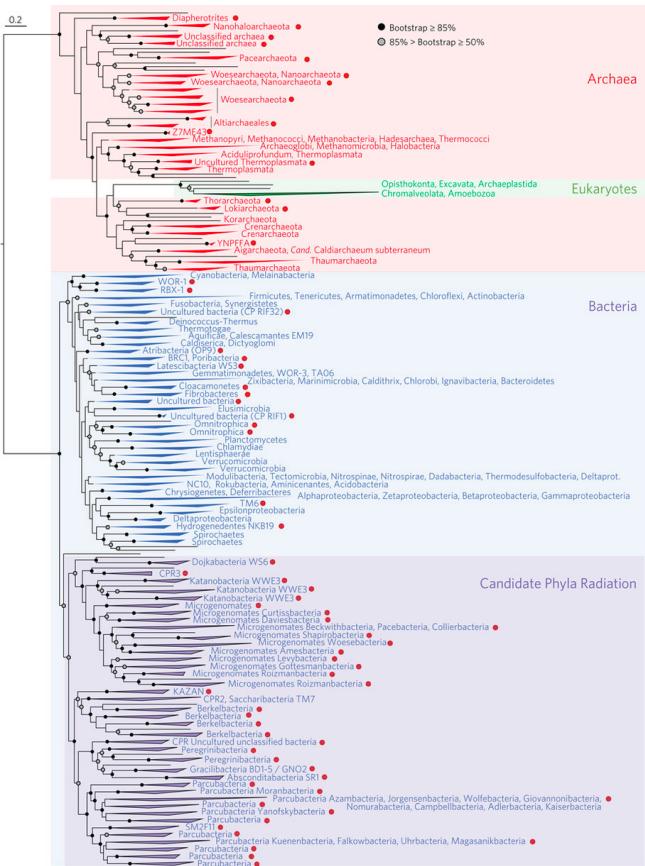
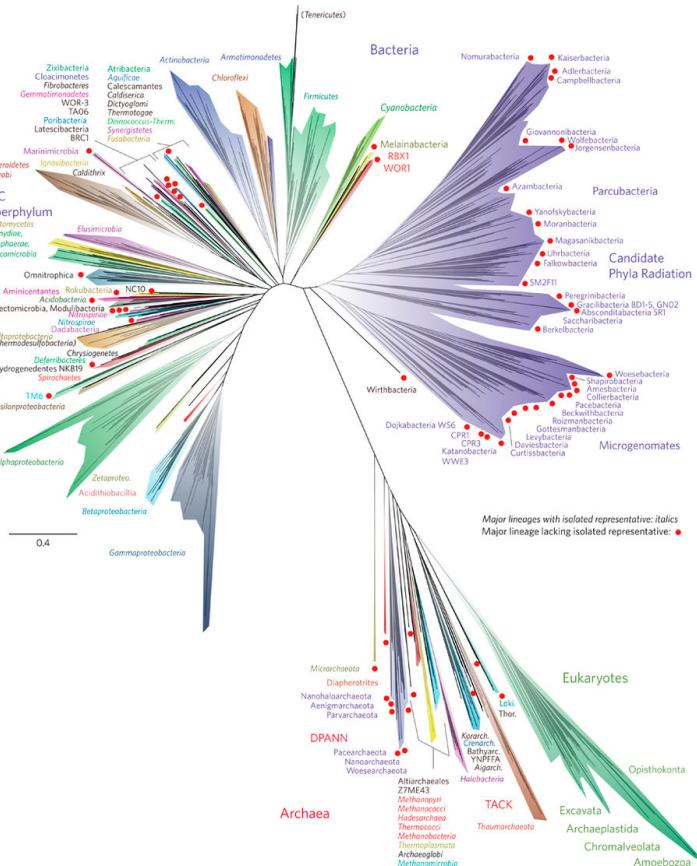


<http://www2.research.att.com/~yifanhu/TOL/>

ToL Using Walrus



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



<https://www.nature.com/articles/nmicrobiol201648>



CHANGE THE WORLD FROM HERE