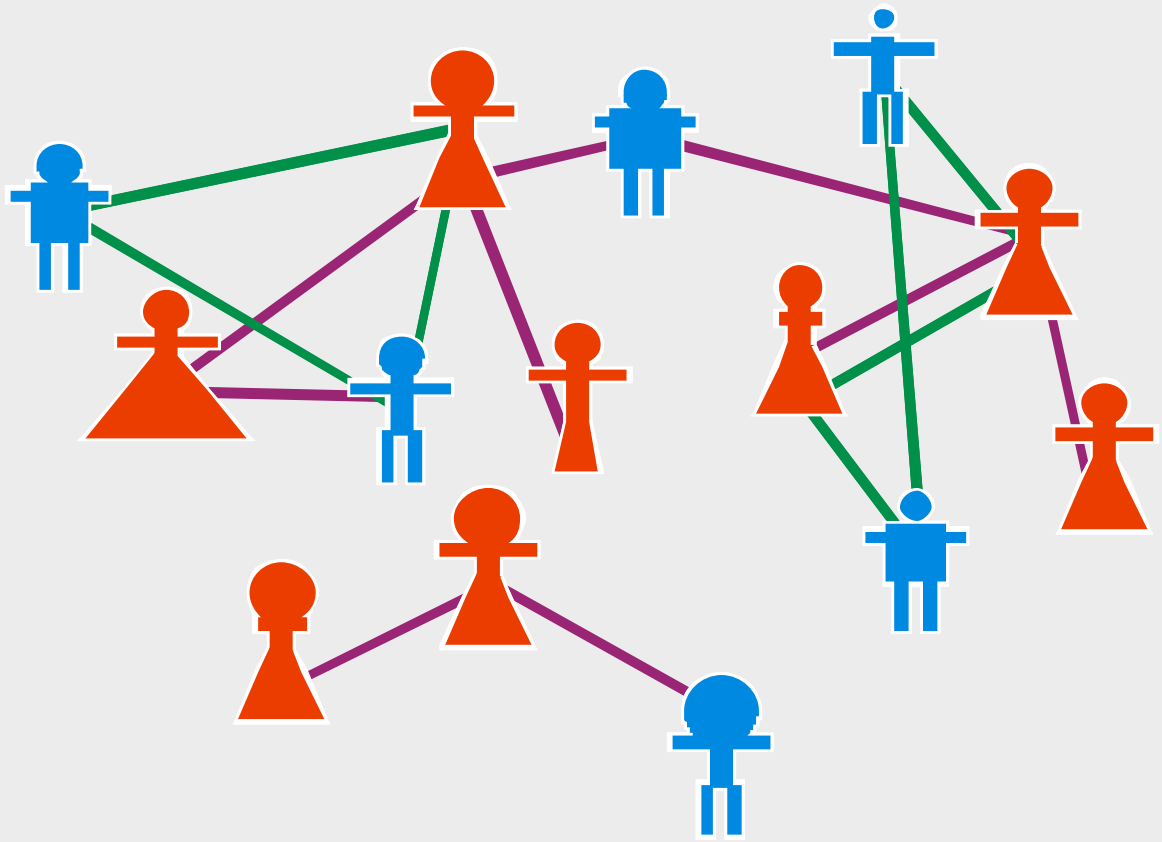
RELATIONS AND NETWORKS

INTRODUCTION

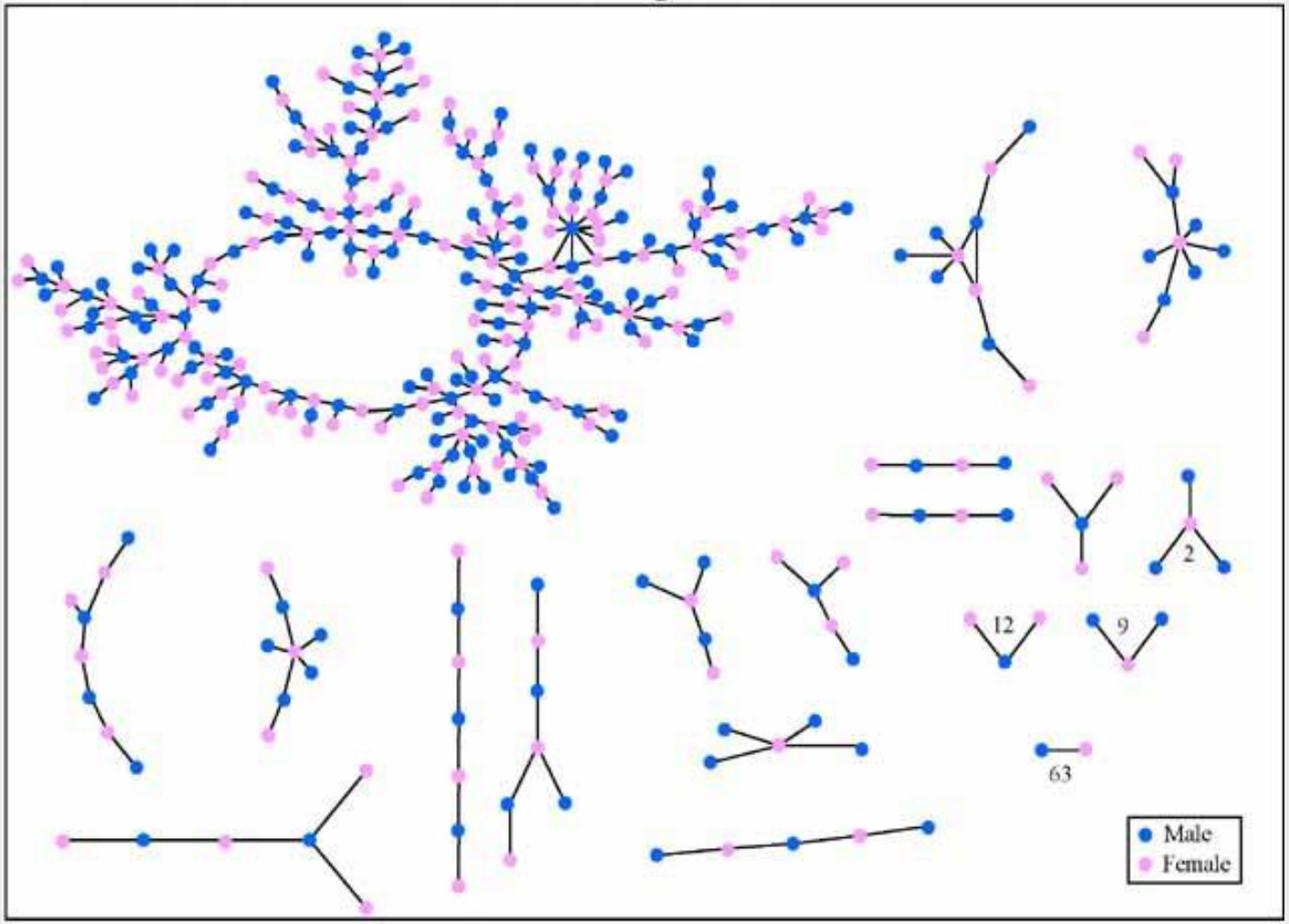
SO FAR THE DATA CONTAINED ONLY ENTITIES



RELATIONS BETWEEN ENTITIES ARE RELEVANT

MOTIVATION

The Structure of Romantic Relations at "Jefferson High School"



Each circle represents a student and lines connecting students represent romantic relations occuring within the 6 months preceding the interview. Numbers under the figure count the number of times that pattern was observed (i.e. we found 63 pairs unconnected to anyone else).

APPLICATIONS:

SOCIAL SCIENCES

COMMUNICATION NETWORKS
Intrusions, load balance

SECURITY
Financial transactions
E-mails...

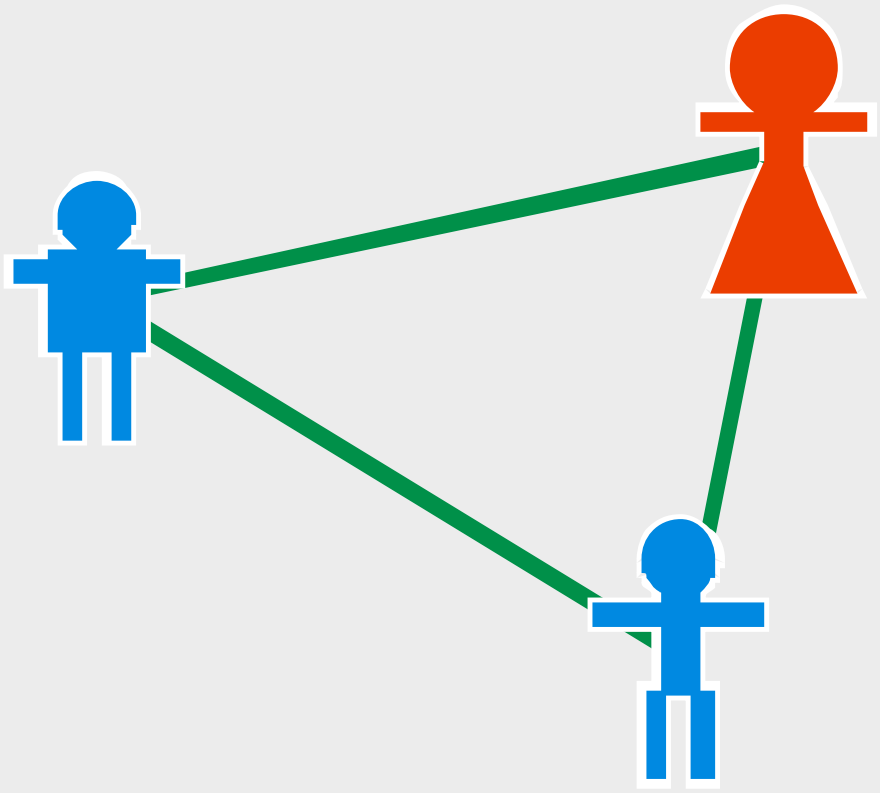
ENGINEERING & IT
Production process
Source code

RELATIONAL INFORMATION

ENTITIES
Entity attributes

RELATIONS
Relation attributes

- type of relation
- orientation
- other



TYPES OF RELATIONS

SYMMETRY

Symmetric (directed)	*colleagues*
Asymmetric (undirected)	*parent-child*

TRANSITIVITY

Transitive	*family*
Intransitive	*email*

CARDINALITY

One-to-many	*email*
One-to-one	*phone call*
Many-to-many	*P2P network*

BASICS OF RELATION VISUALIZATION

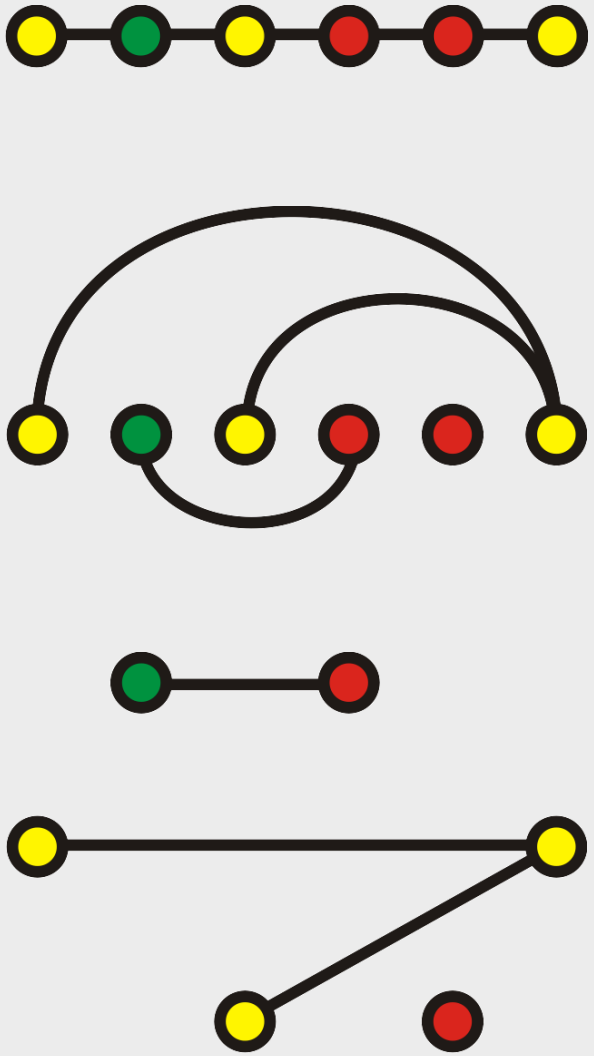
NODE-LINK DIAGRAMS

ENTITIES → NODES
RELATIONS → LINKS

IMPORTANT:

LAYOUT OF NODES
Groups, structures

SHAPE OF LINKS
Emphasize link orientation

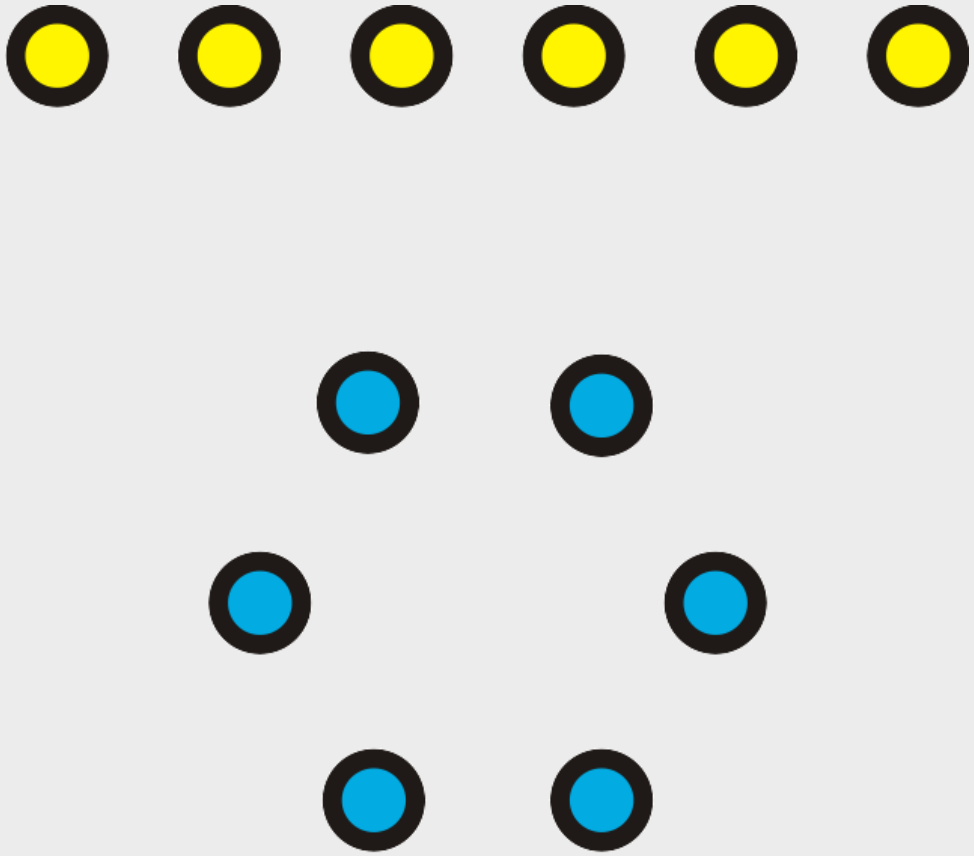


NODE LAYOUTS – STRUCTURED

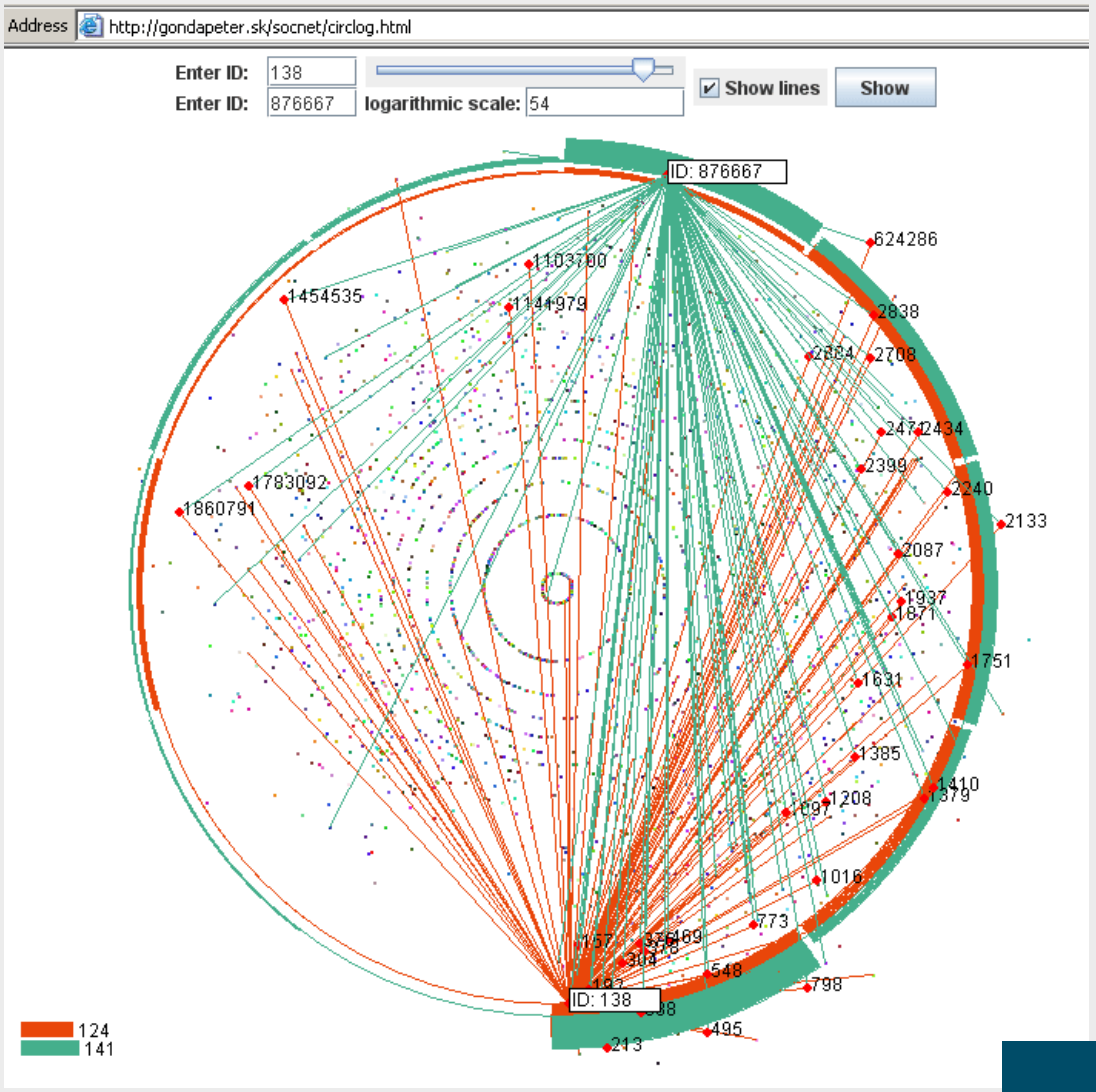
ORDERED NODES

Linear
Multi-linear
Circular
Radial

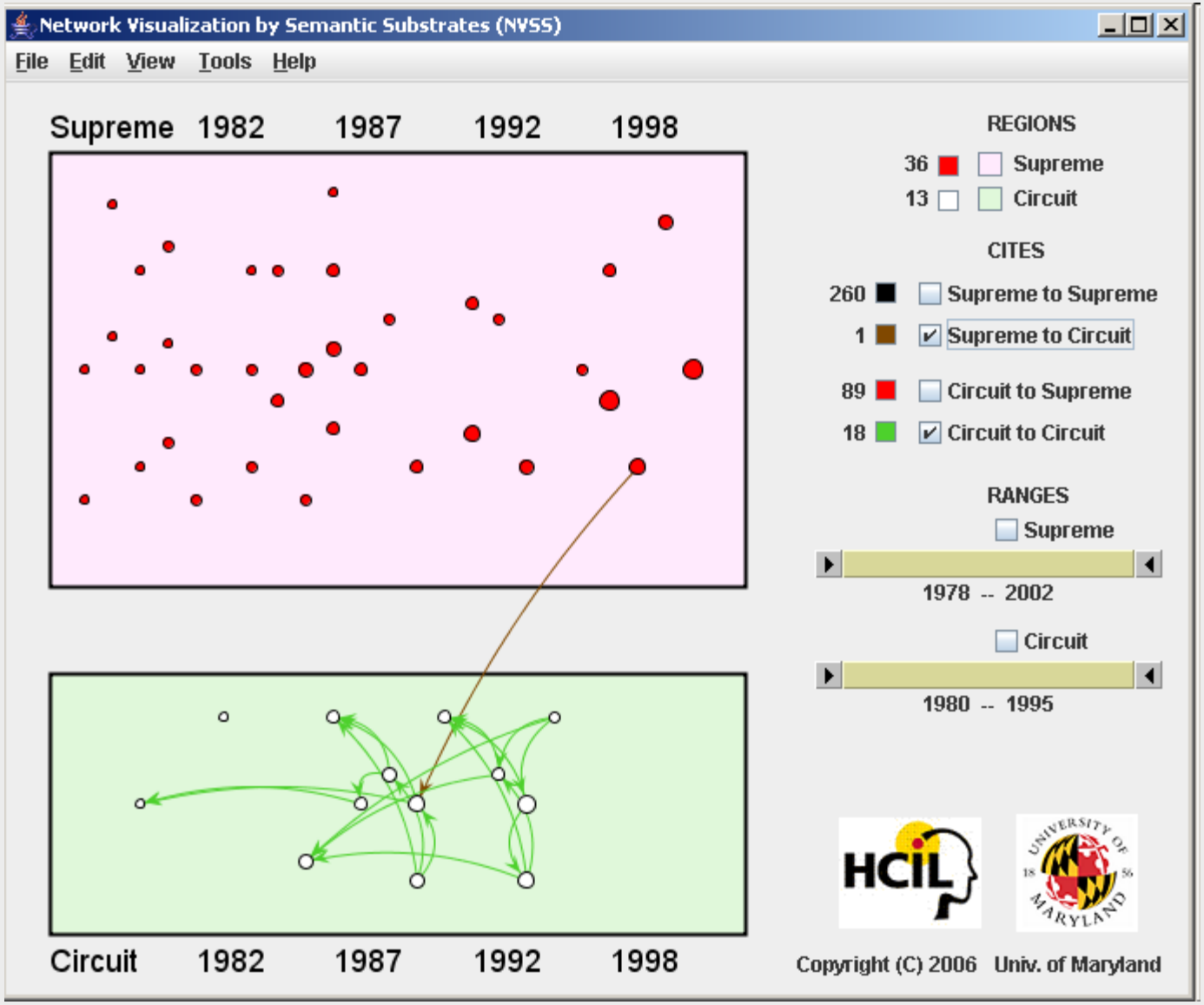
TOP-TO-BOTTOM LAYOUT



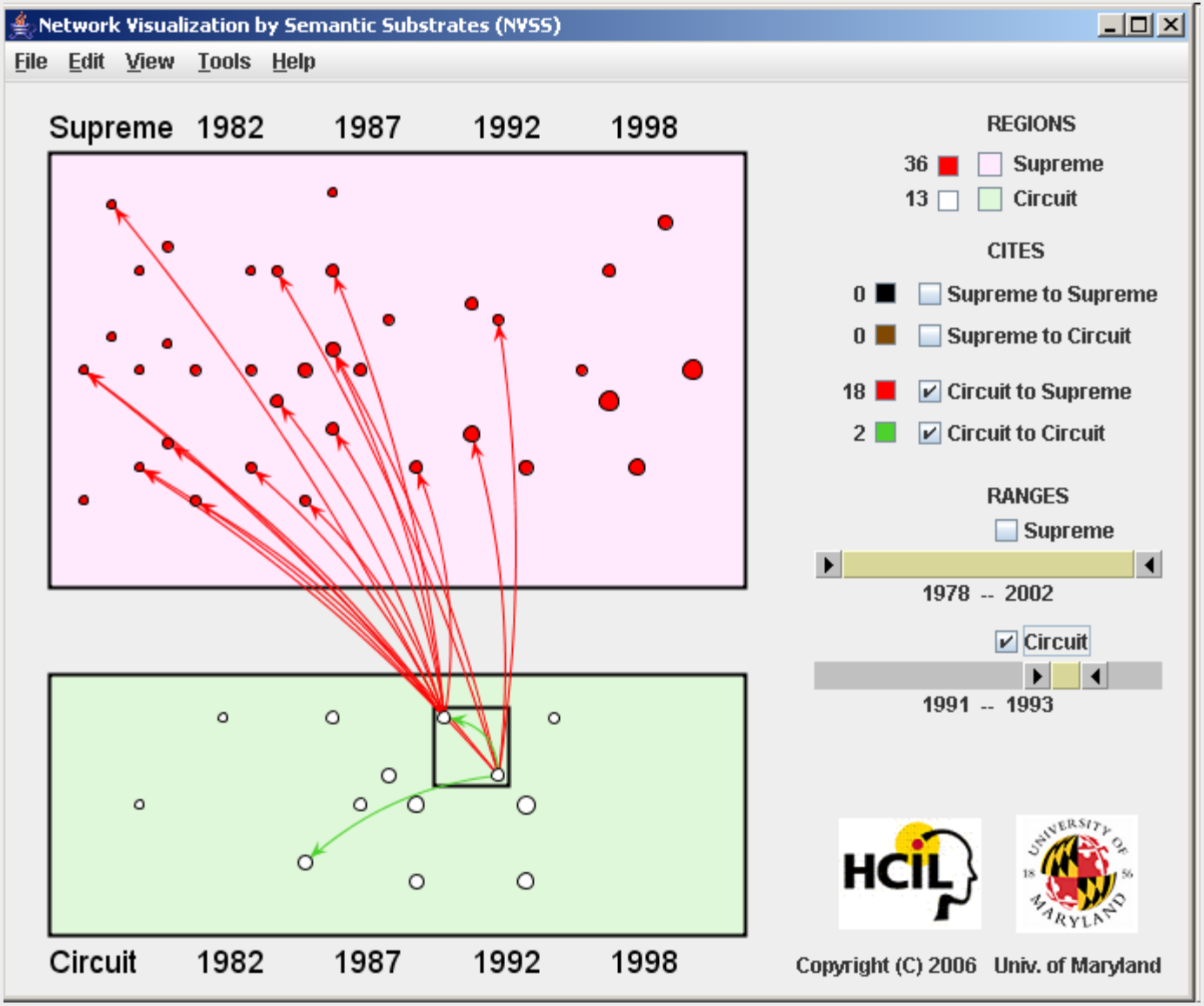
NODE LAYOUTS – ORDERED



NODE LAYOUTS – ORDERED



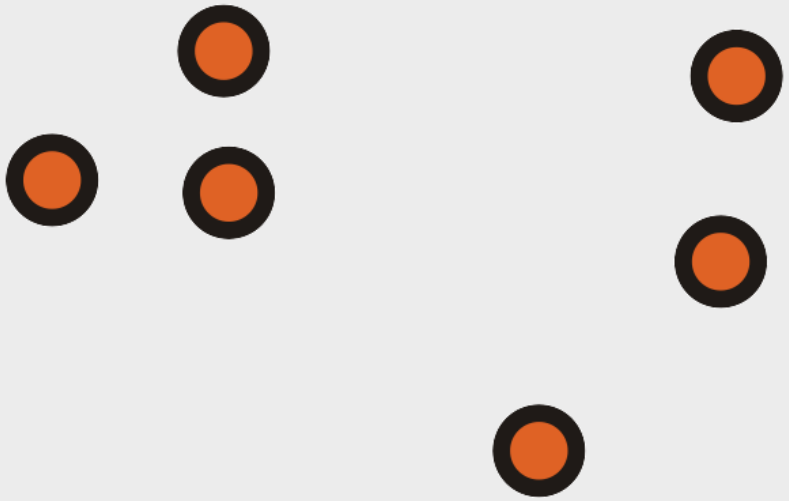
NODE LAYOUTS – ORDERED



NODE LAYOUTS – UNSTRUCTURED

UNORDERED NODES

Force-directed
Clustering
Random scattering

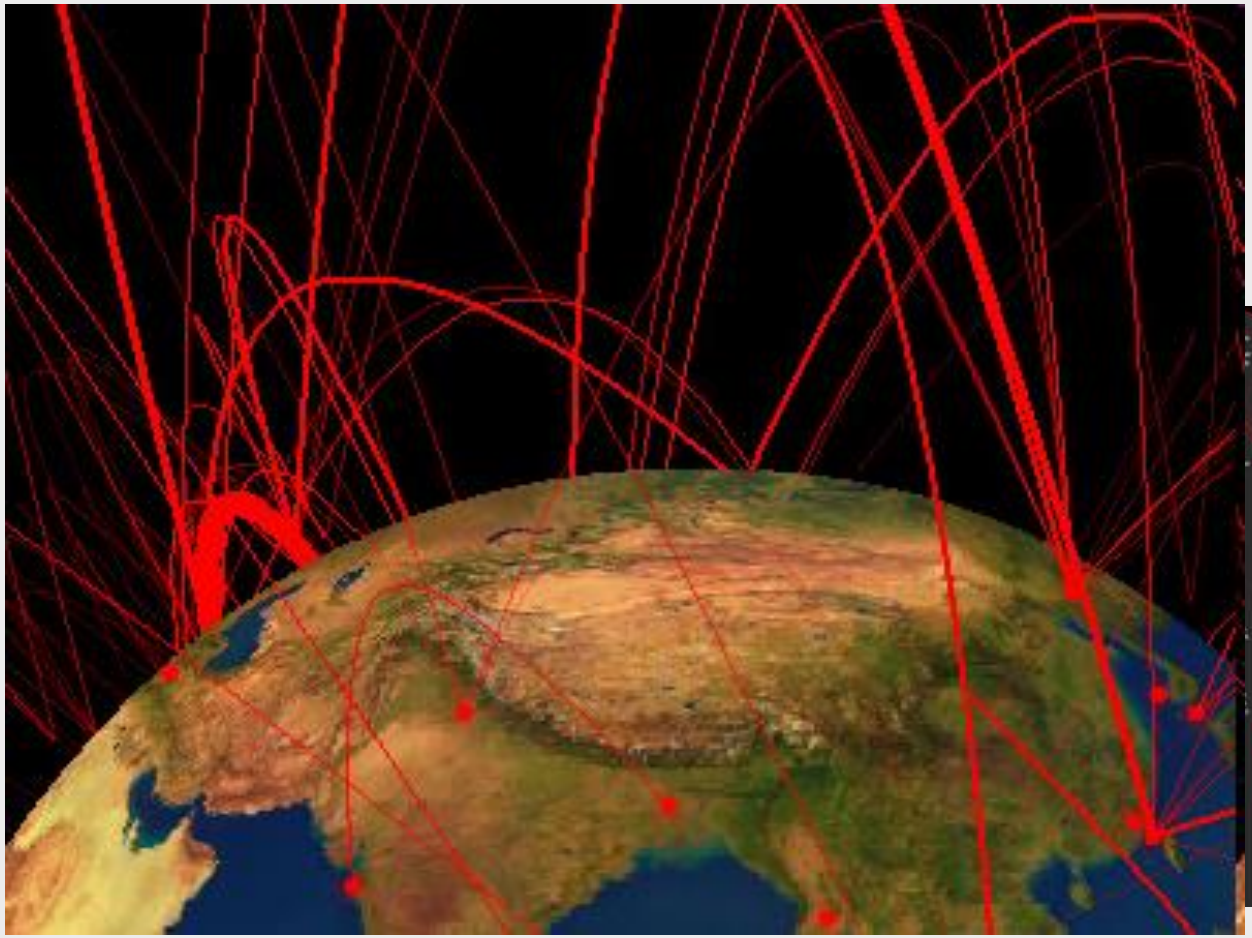


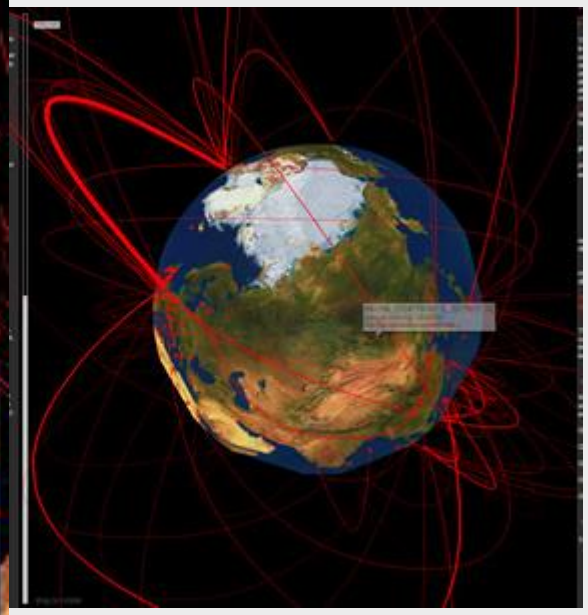
BOTTOM-TO-TOP LAYOUT

GEOGRAPHIC

Ordered & unstructured

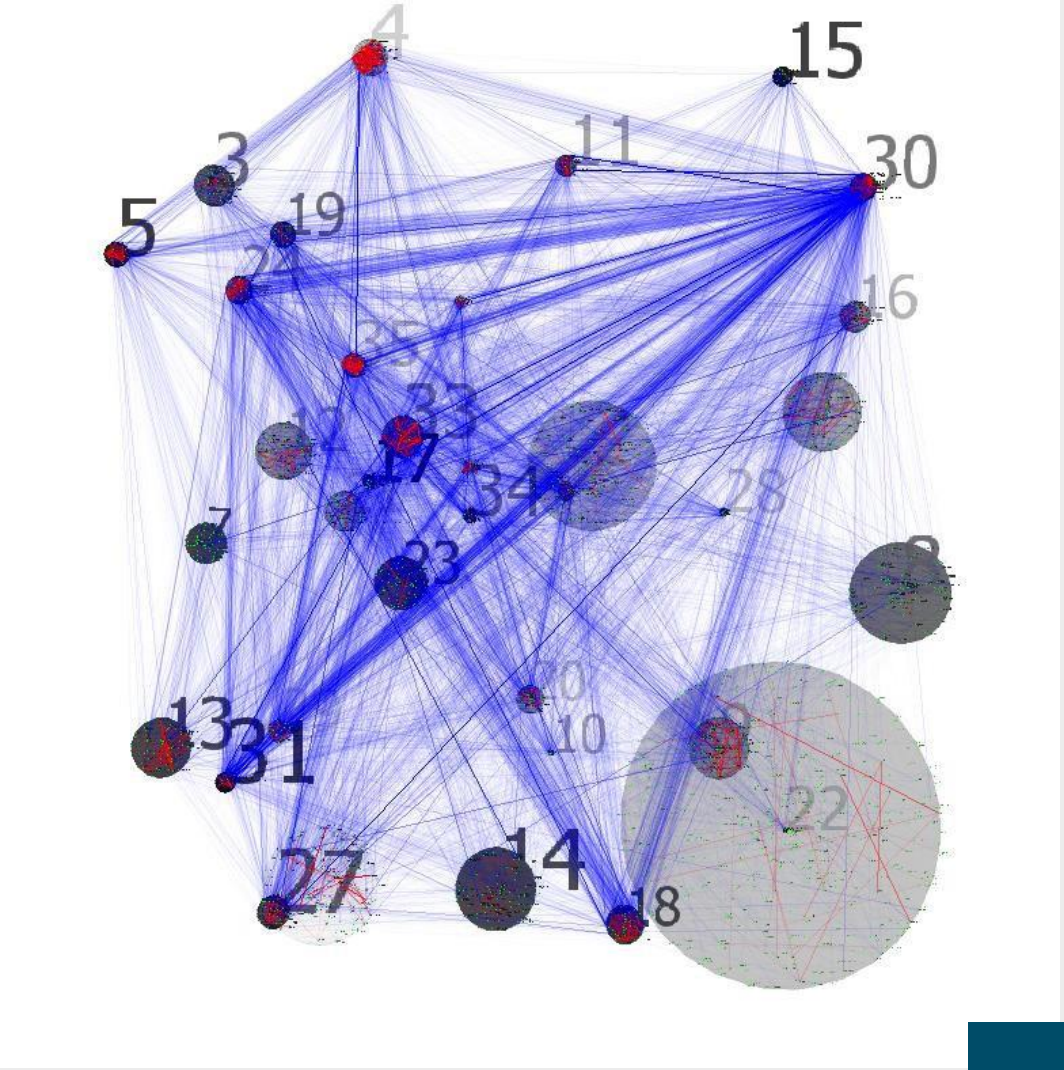
NODE LAYOUTS – GEOGRAPHIC





http://bestiario.org/research/citydistances/

NODE LAYOUTS – CLUSTERS

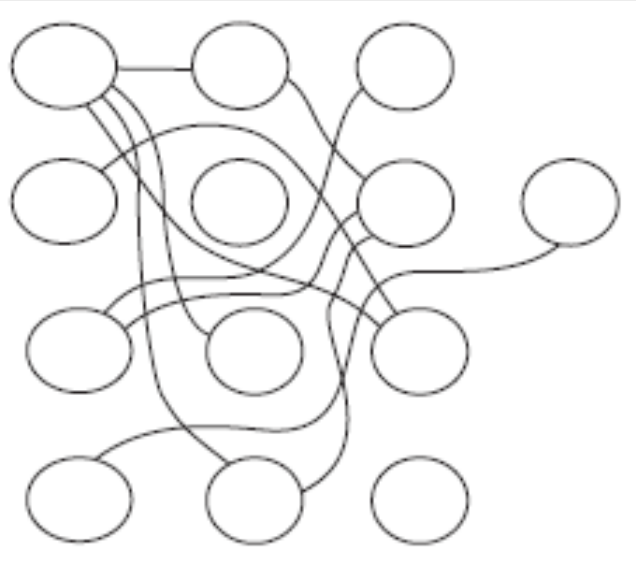


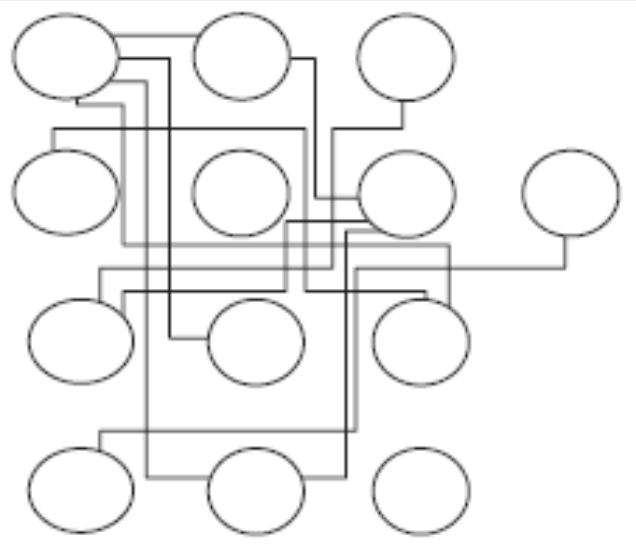
LINK SHAPES

LINES
Color
Thickness
Variations along path

CURVES
Curvature
Start/end tangent
Clockwise orientation (+,-)

POLYGONAL LINES

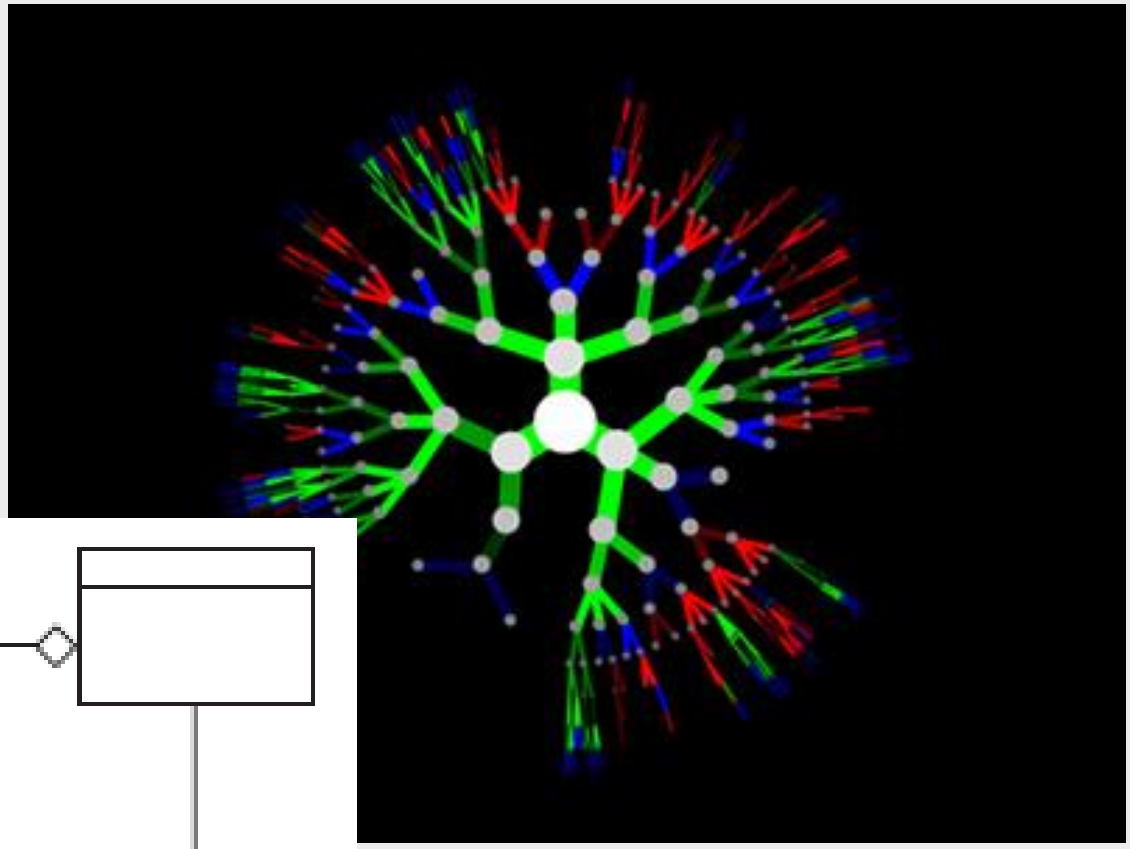


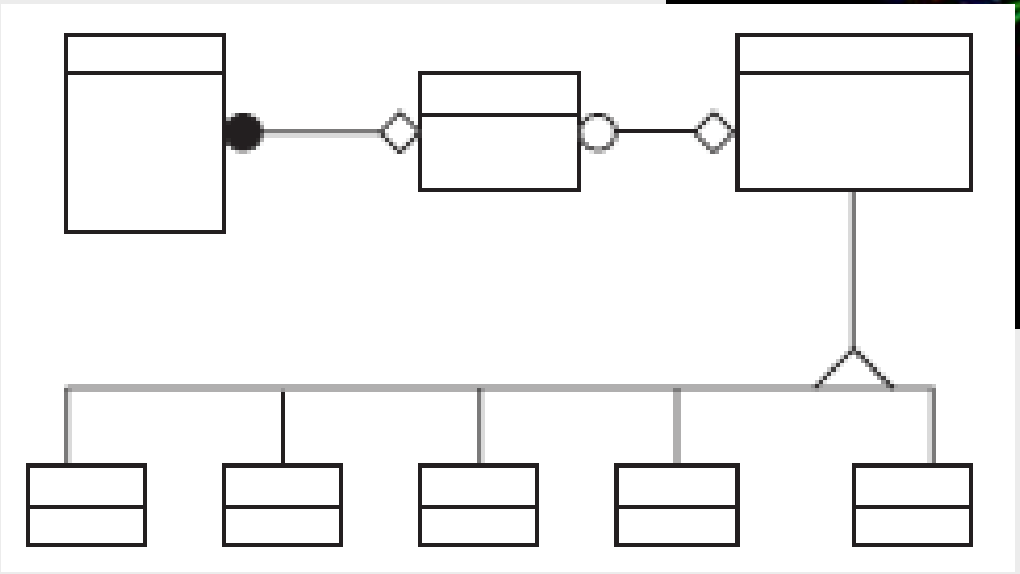


EXAMPLES OF LINK TYPES

RELATION TYPE

Line shape
Symbols
Line color



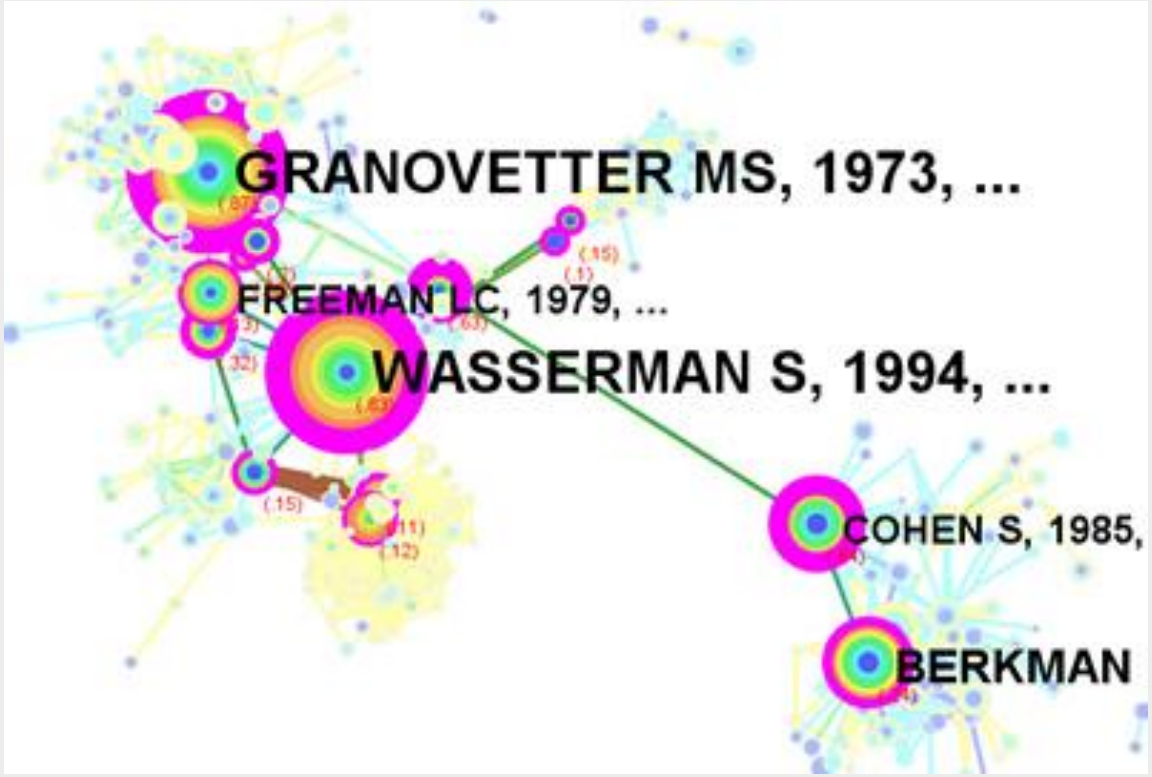


USING NODES TO ADD INFORMATION

COLORS

SHAPES

GLYPHS



EVEN RELATIONS (SETS, CLUSTERS) CAN BE DISPLAYED USING NODES INSTEAD OF LINKS

Relation → group → entity attribute

ADJACENCY MATRICES

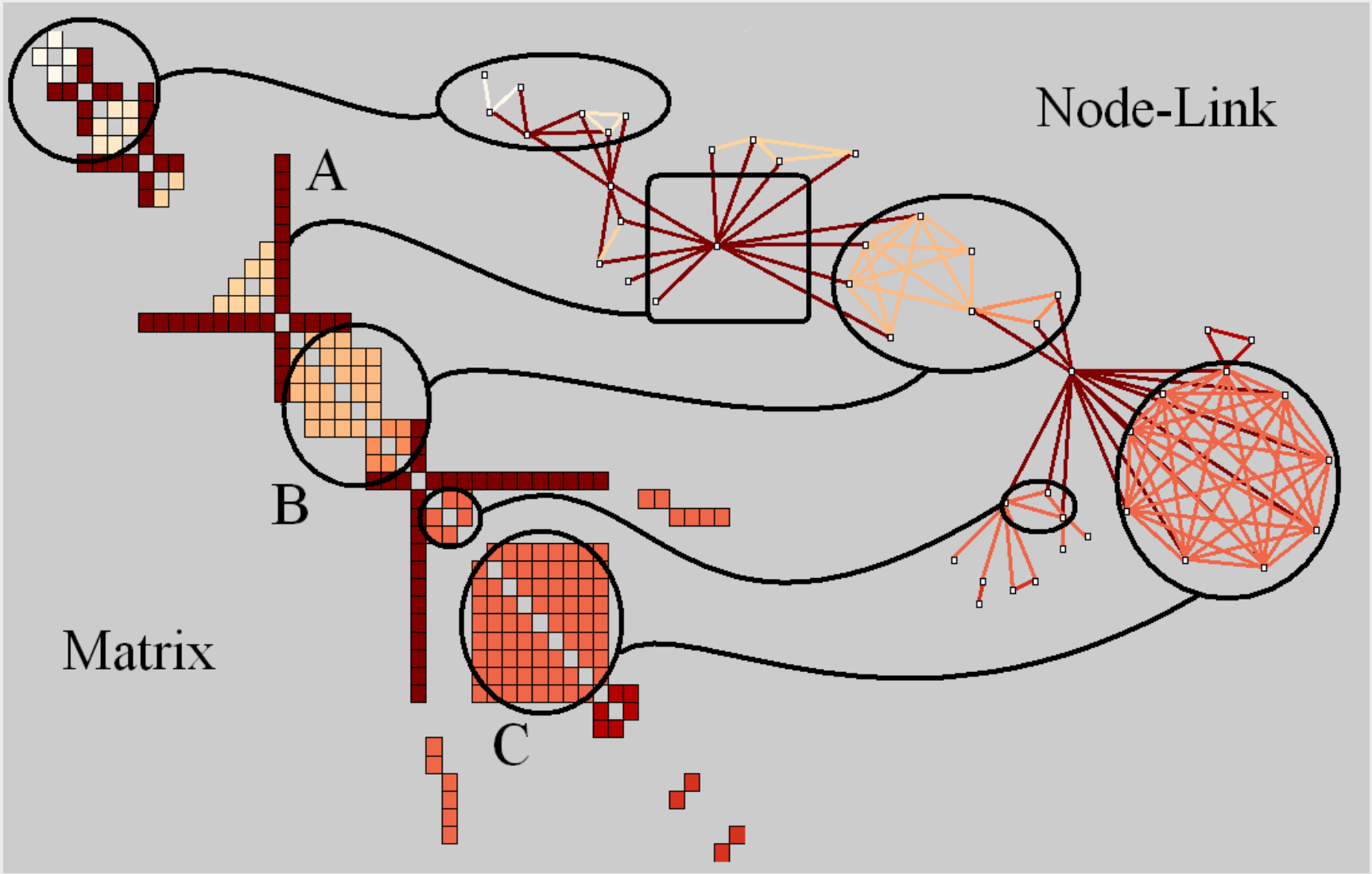
ALTERNATIVE TO NODE-LINK DIAGRAMS

ROW/COLUMN ORDERING IS ESSENTIAL

PATTERNS FOR VARIOUS RELATIONS

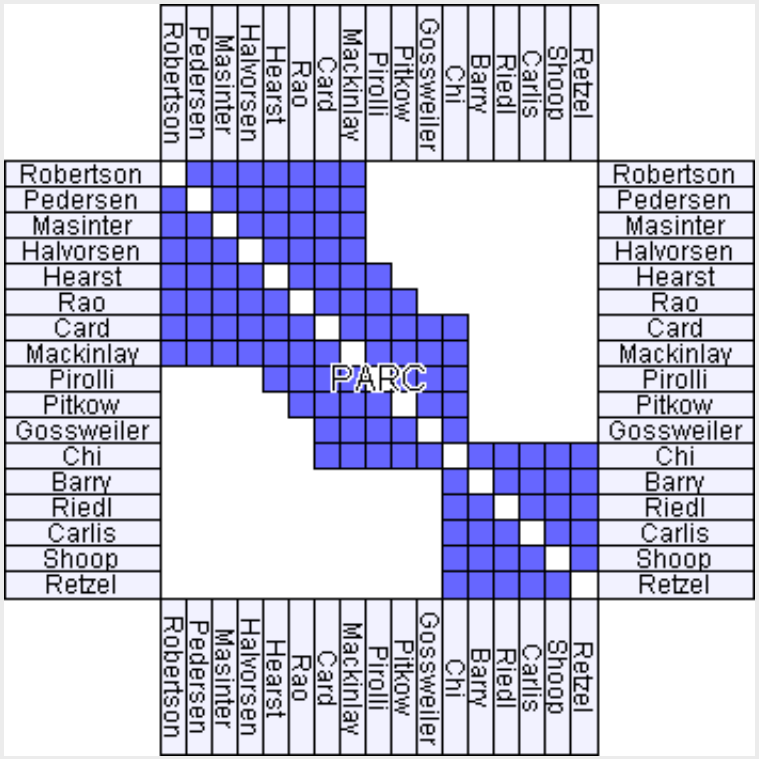
One to one
One to many
Many to one
Many to many

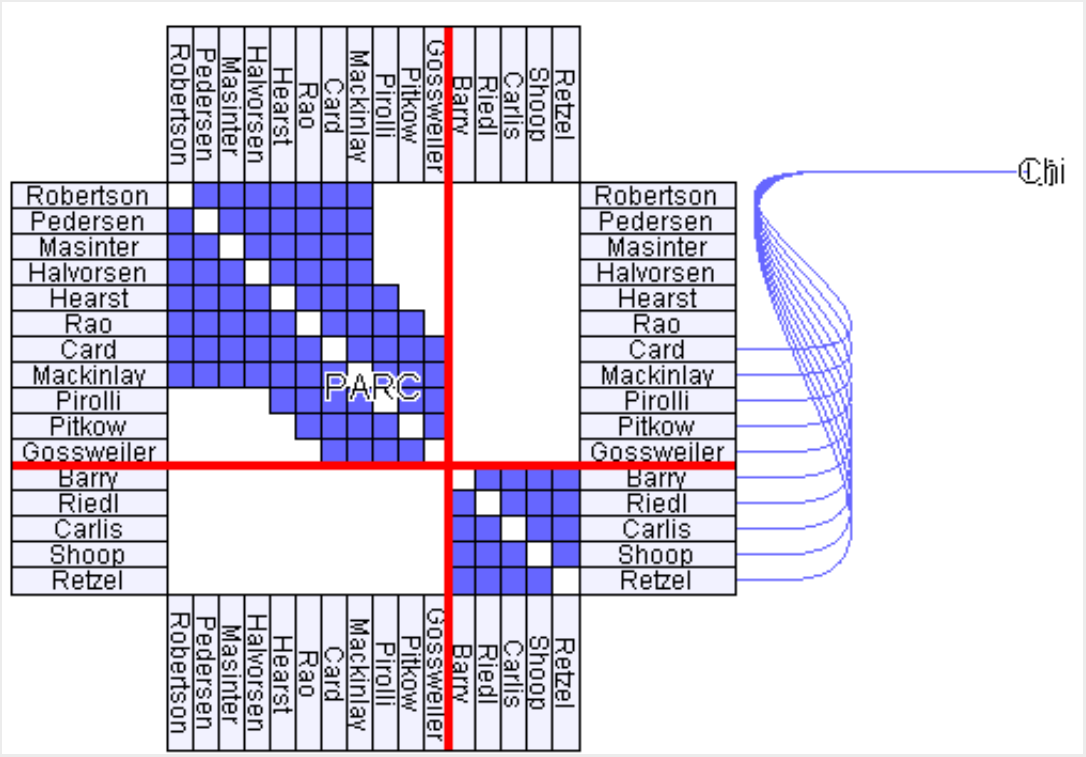
MATRIX VISUALIZATION PATTERNS



MATRIX VISUALIZATION PATTERNS

E.G. BRIDGE BETWEEN COMMUNITIES





NodeTrix: http://www.lri.fr/~nhenry/PhD.html

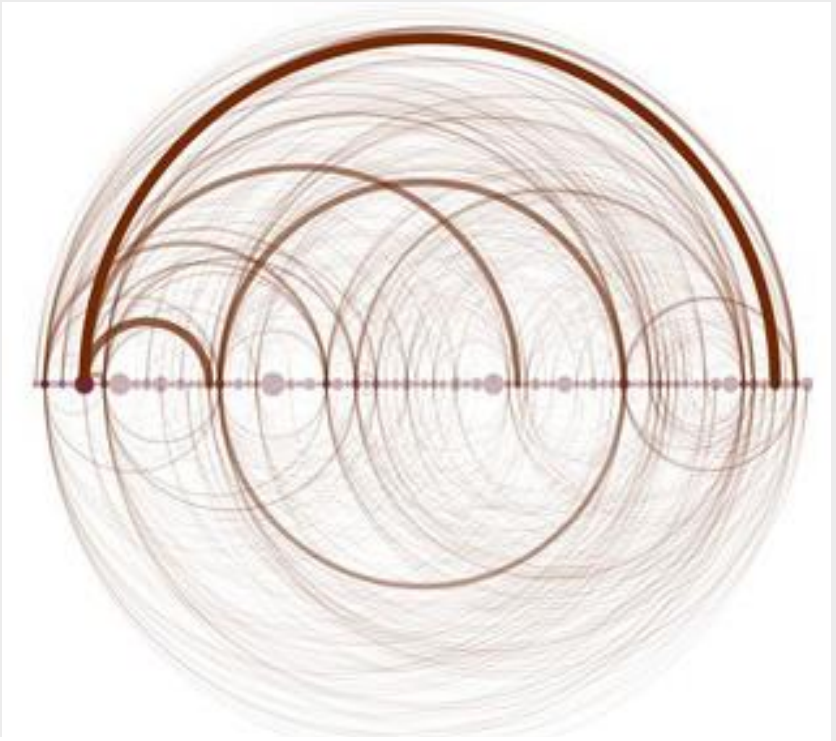
EXAMPLES OF TECHNIQUES

ARC DIAGRAMS

LINEAR ORDER

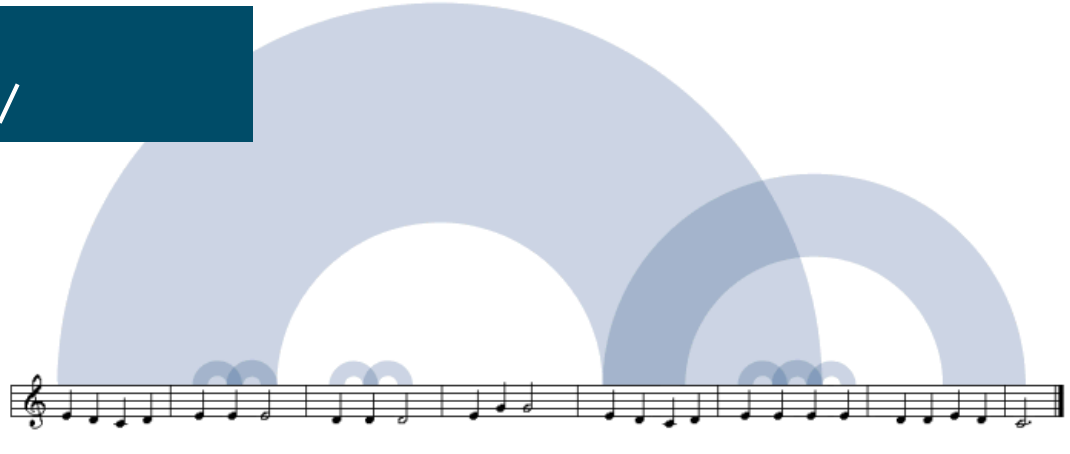
LINK ORIENTATION

Bottom/top arc

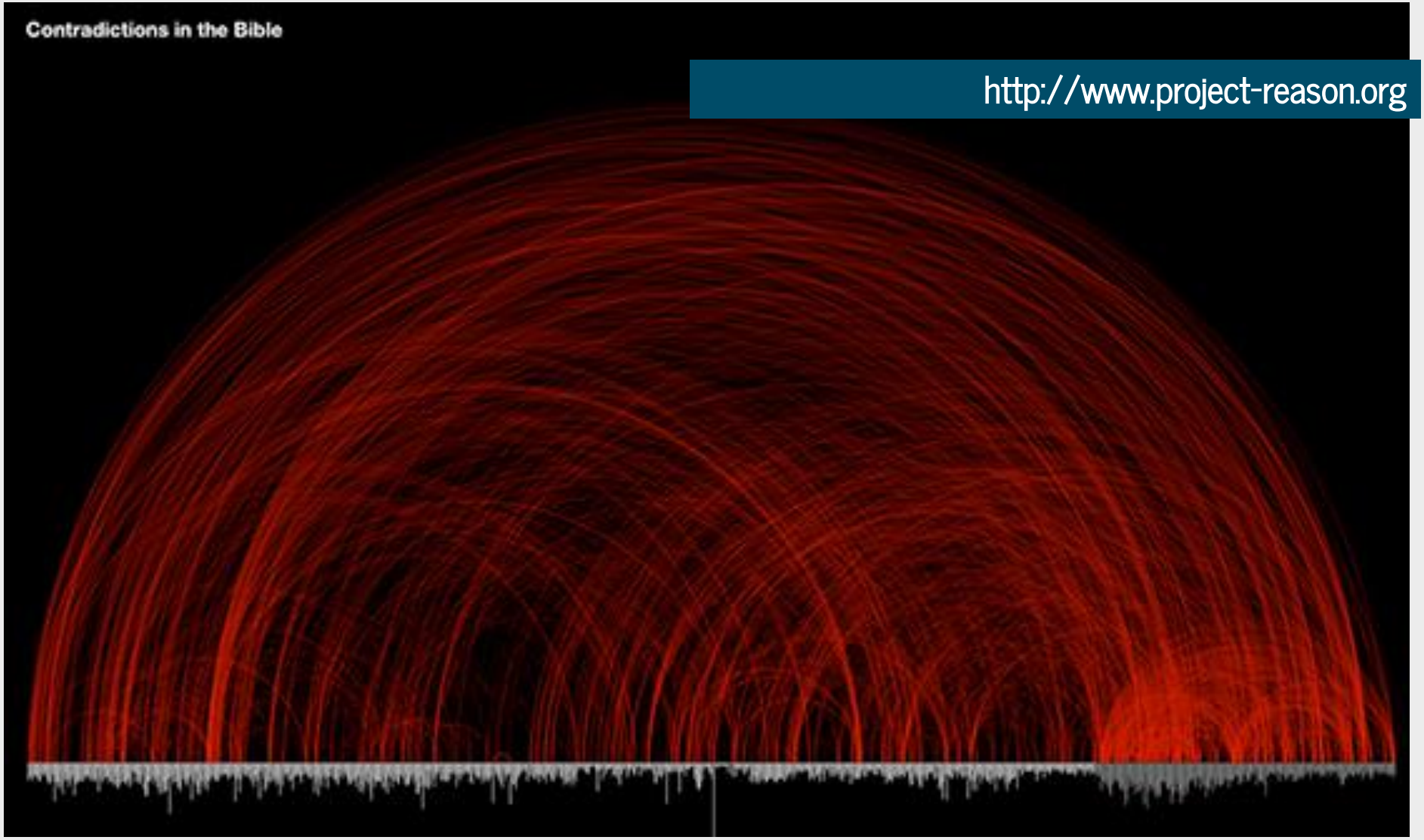


INTERVALS

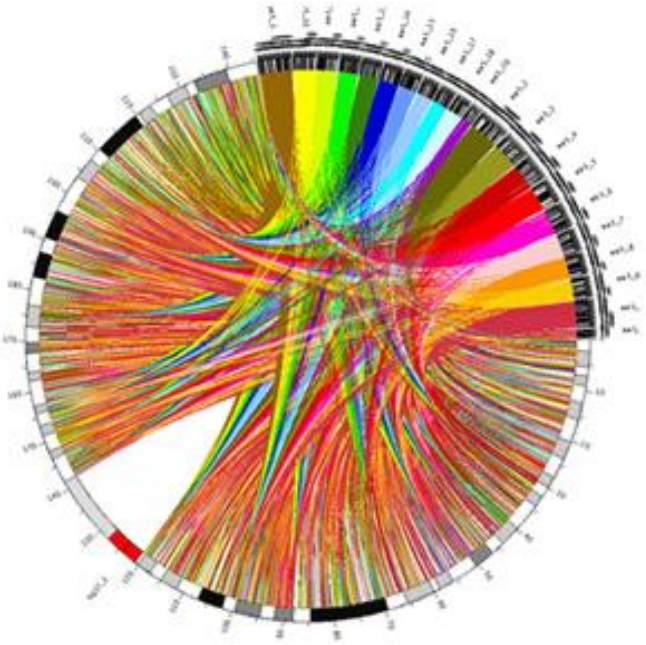
Martin Wattenberg: The shape of song
http://www.turbulence.org/Works/song/

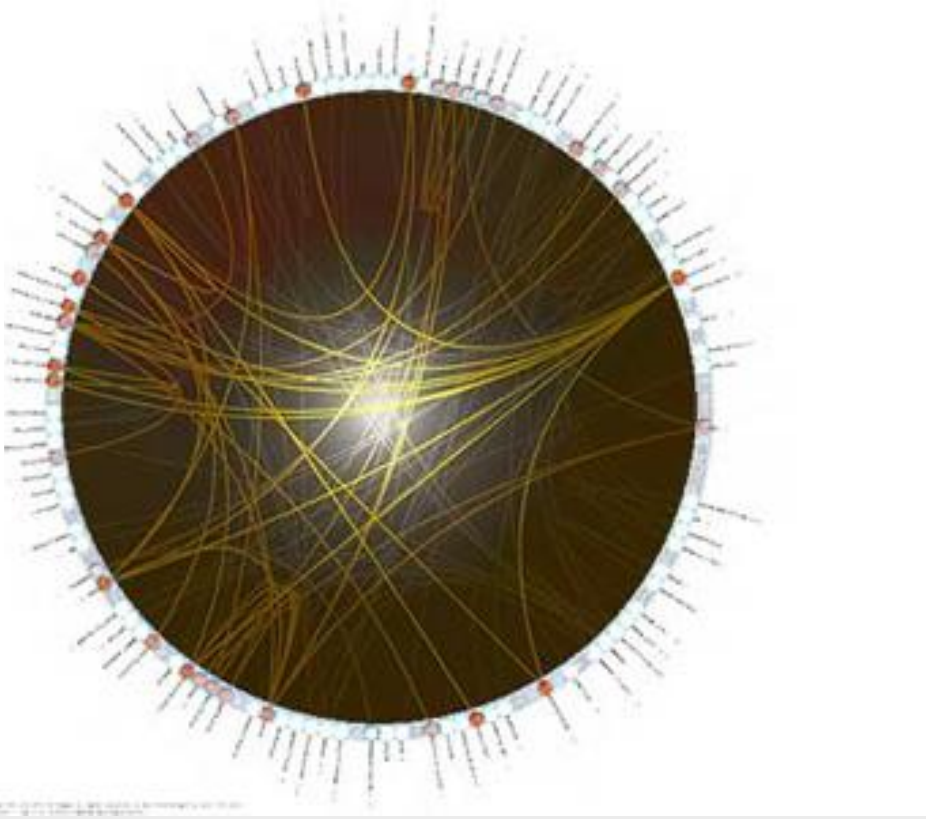


ARC DIAGRAM – BIBLE CONTRADICTIONS

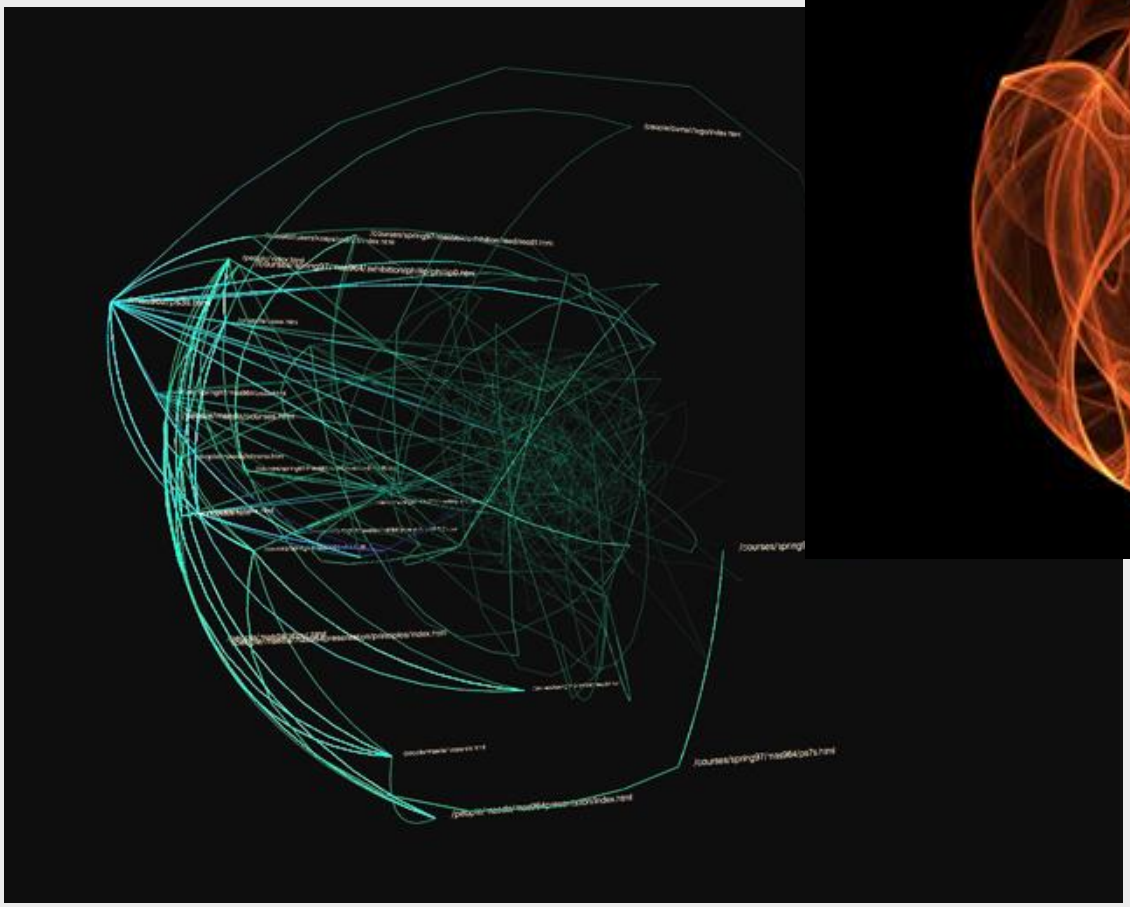


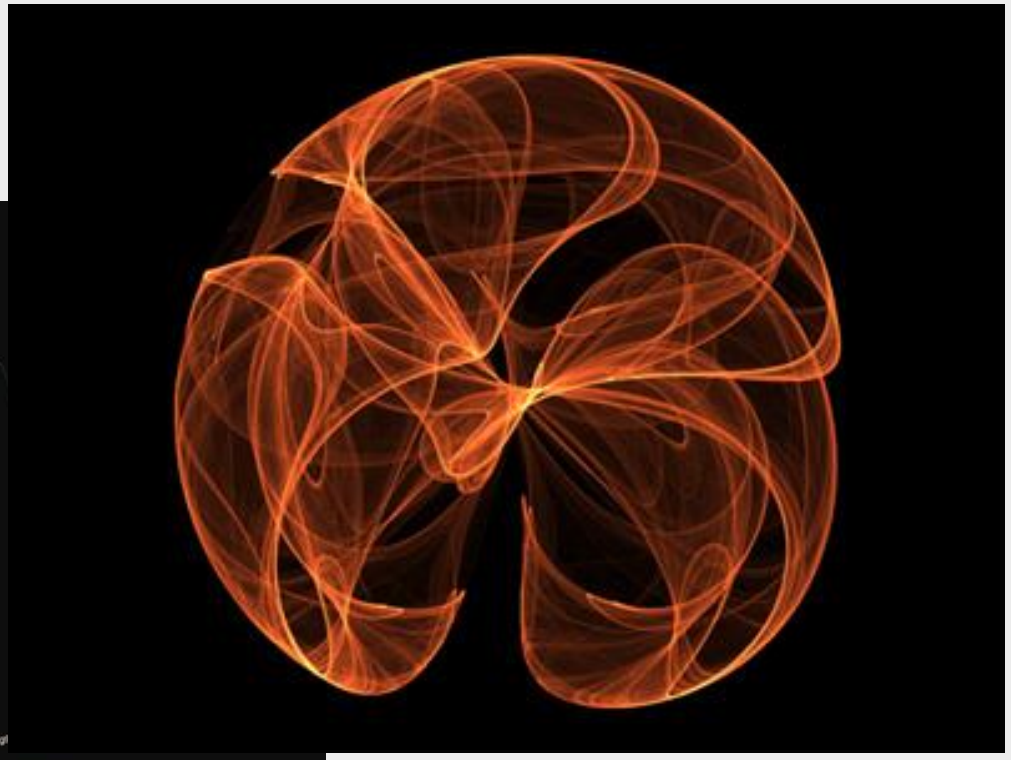
RADIAL CONVERGENCE



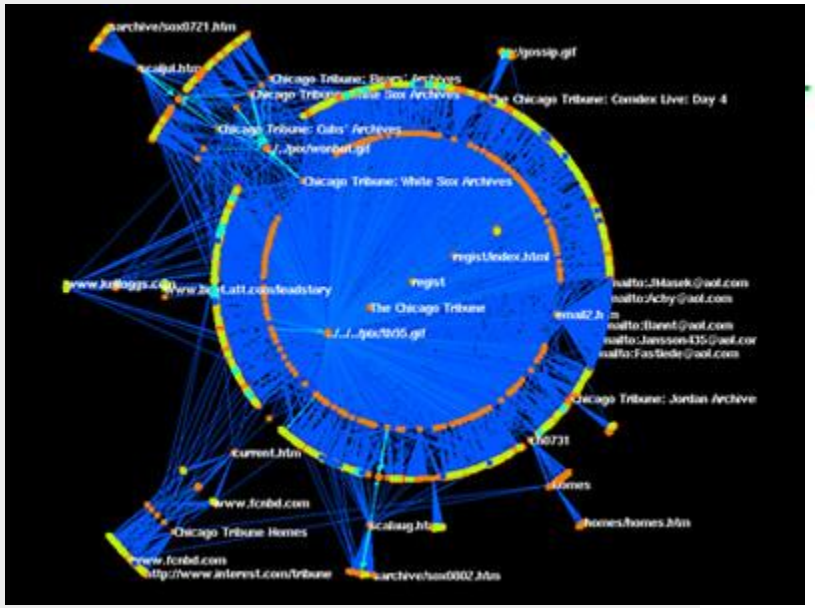


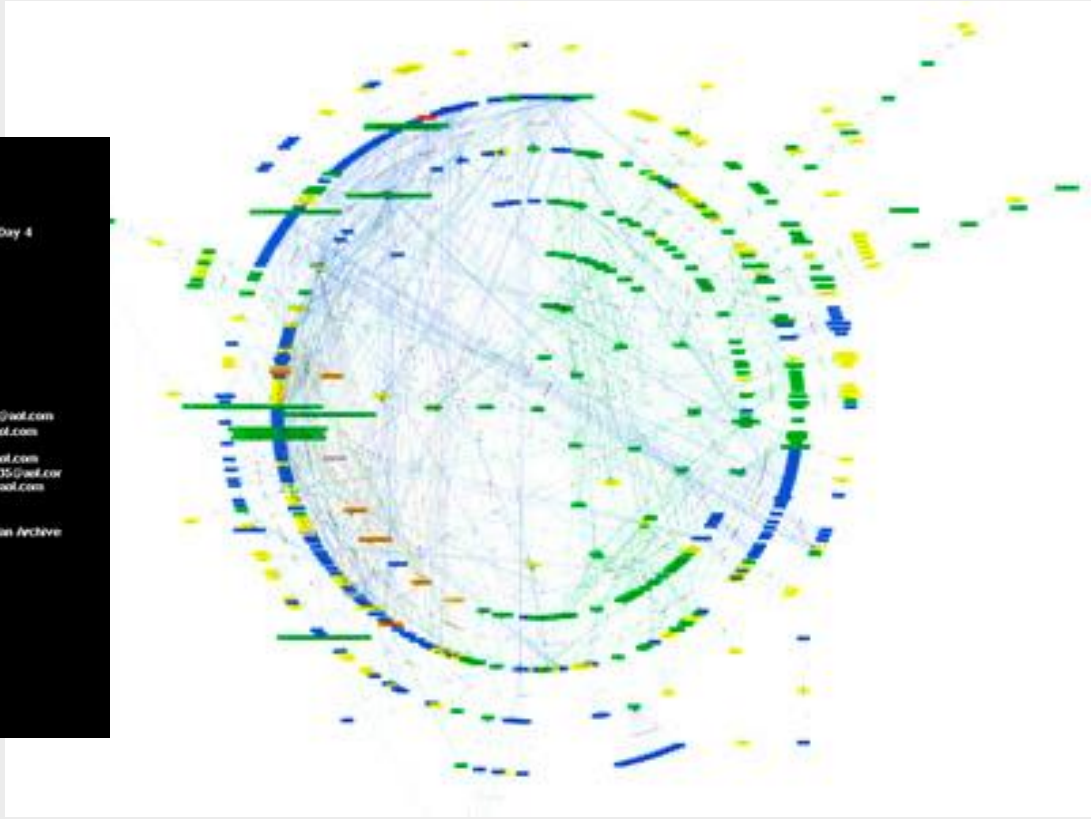
GLOBES





RADIAL GROUPING





SUMMARY

INFORMATION:
Relations
Groups
Society patterns

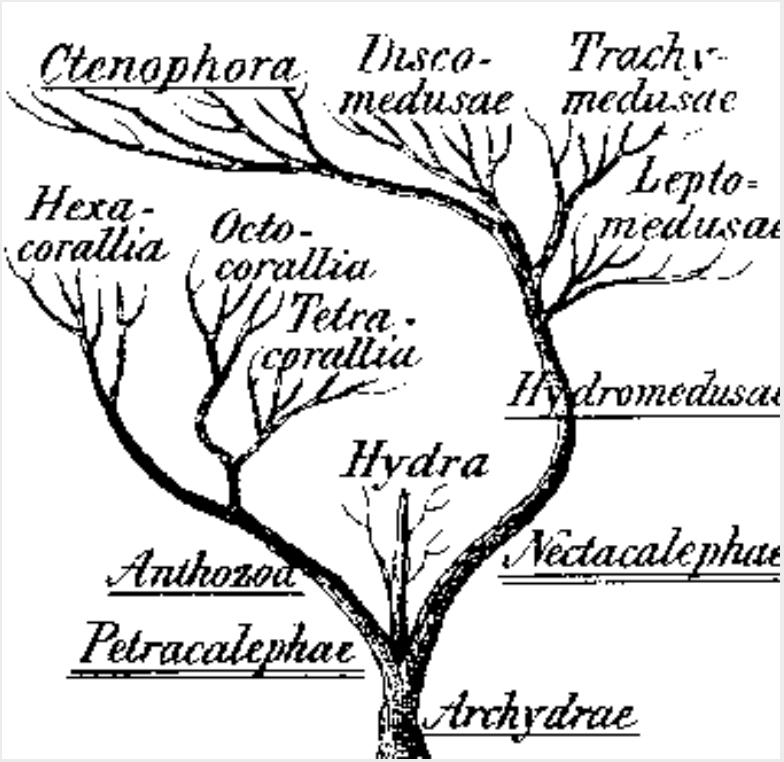
NODE-LINK DIAGRAMS
Node - shape, color, position
Link - shape, color, orientation

LAYOUTS
MATRICES

TREES AND HIERARCHIES

TREES

NO CYCLES => DISTANCE
DISTANCES => ORDERING
ORDERING => LAYOUT



SPECIFICS OF TREES

leaves vs. root vs. nodes

HIERARCHIES

parent-child relation important

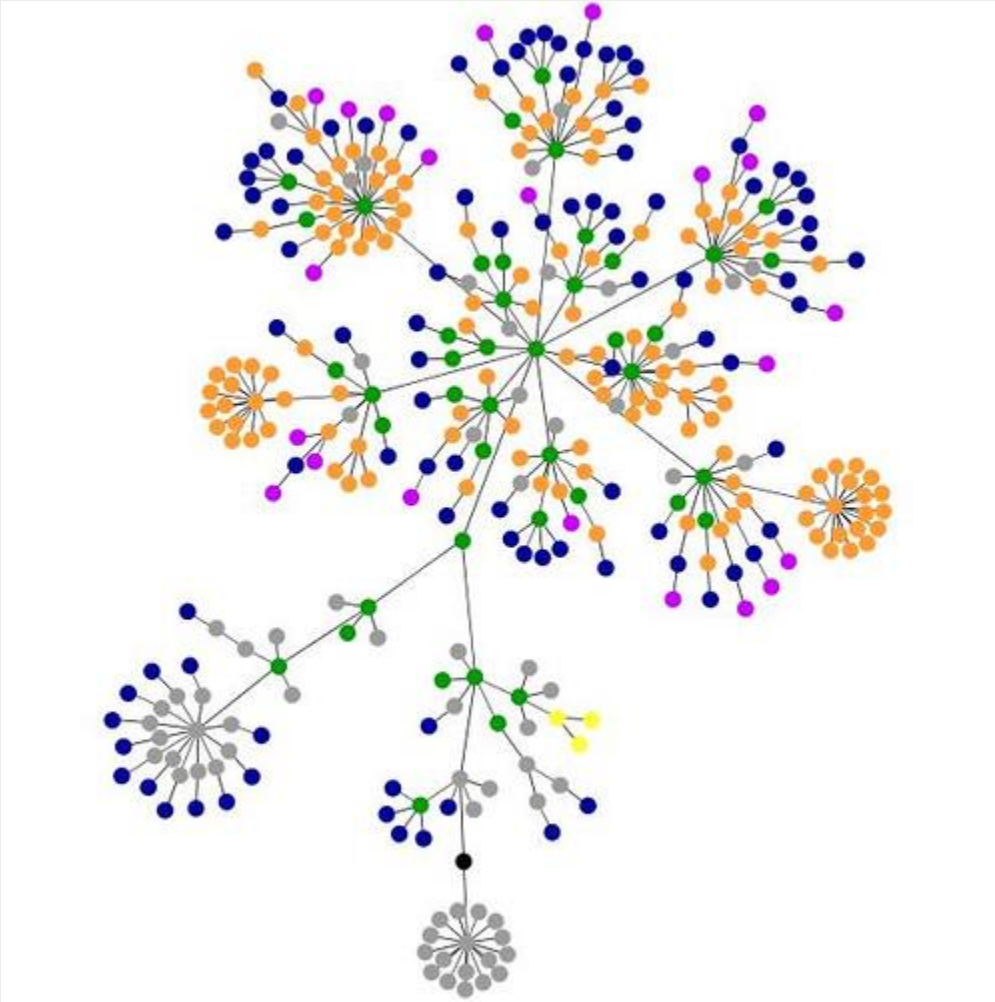
TREES CONTINUED

TREES ARE SPECIAL SUBSET OF GRAPHS

=>

GRAPH VISUALIZATION TECHNIQUES

NODE-LINK DIAGRAMS

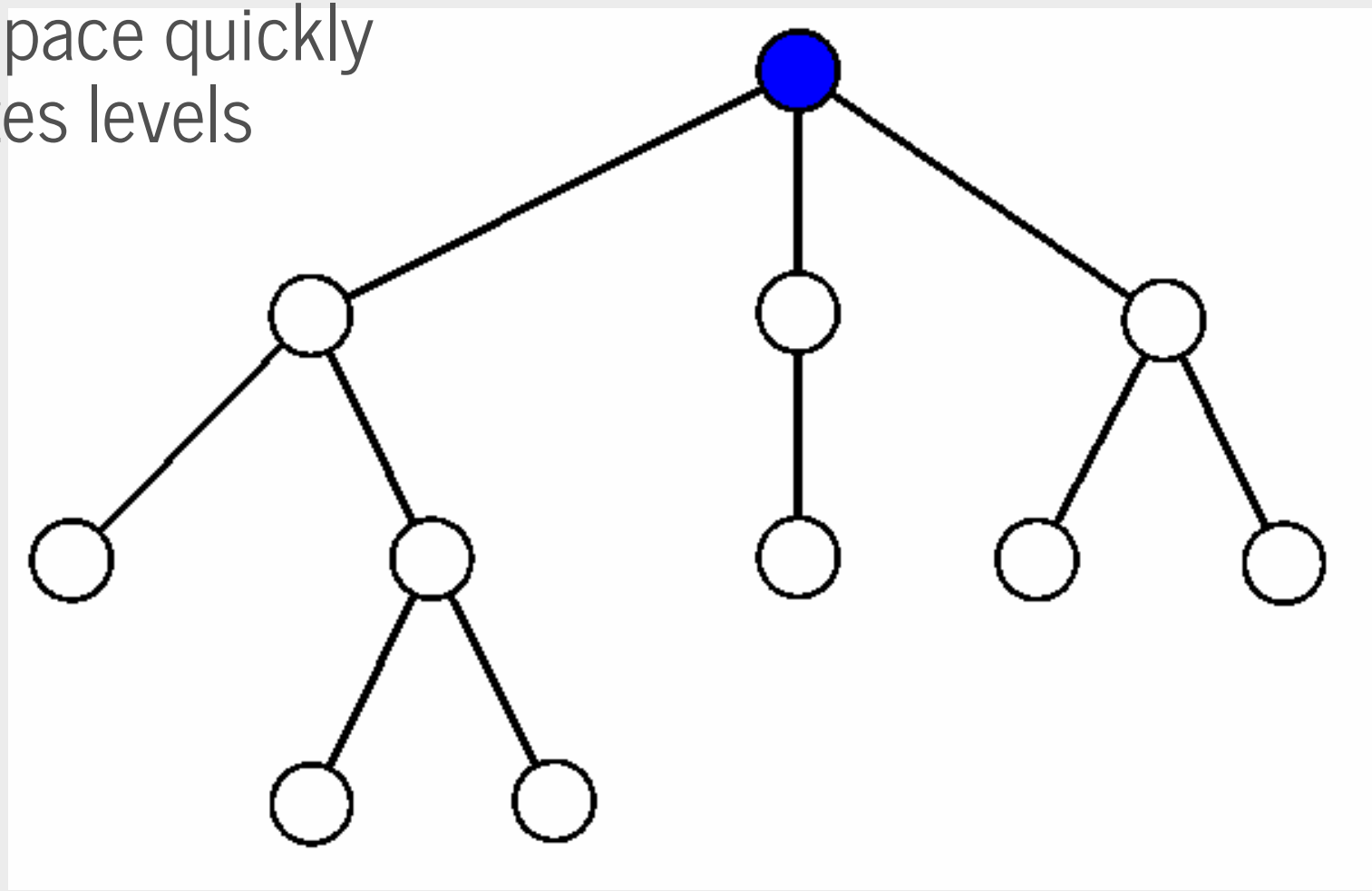


TREE LAYOUTS – ROOTED TREE

ROOTED TREE

Uses up space quickly

Emphasizes levels

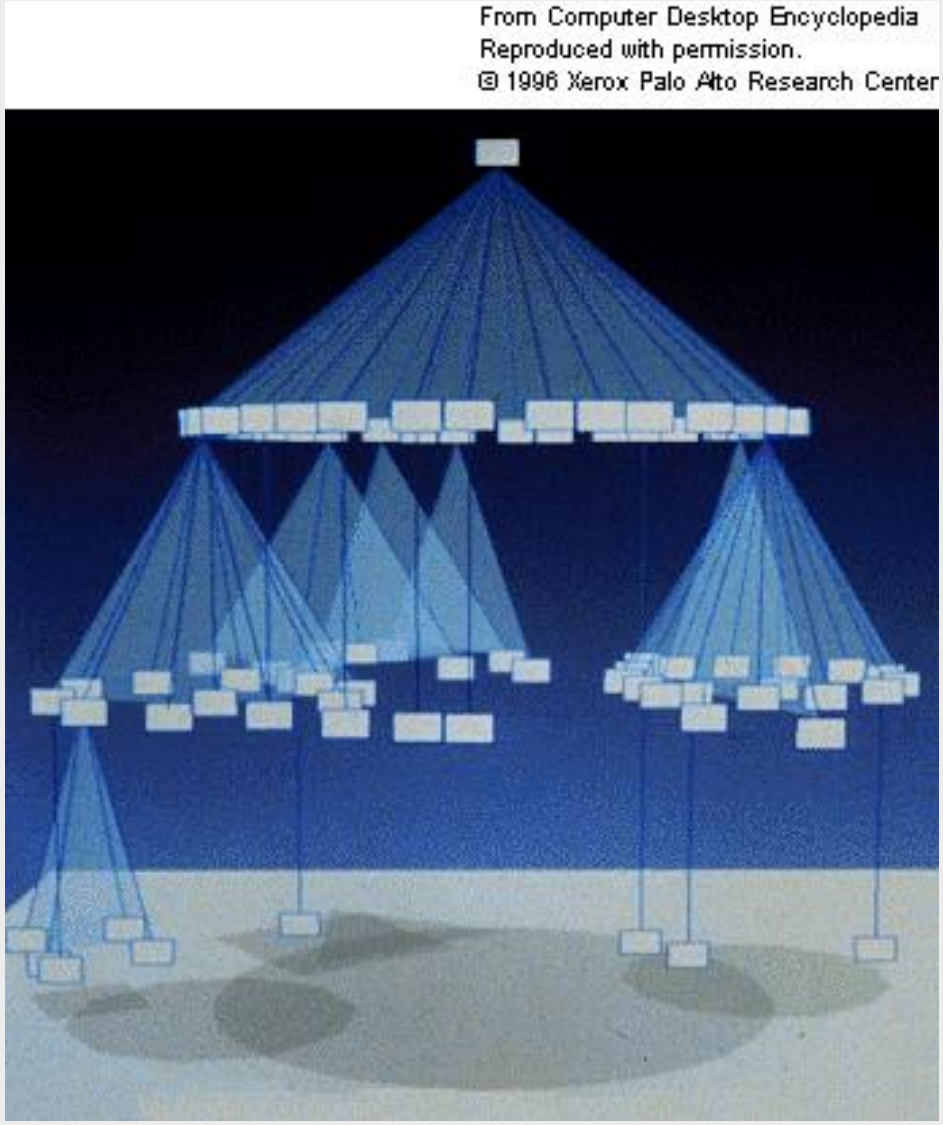


TREE LAYOUTS – CONE TREE

ROOTED TREE IN 3D

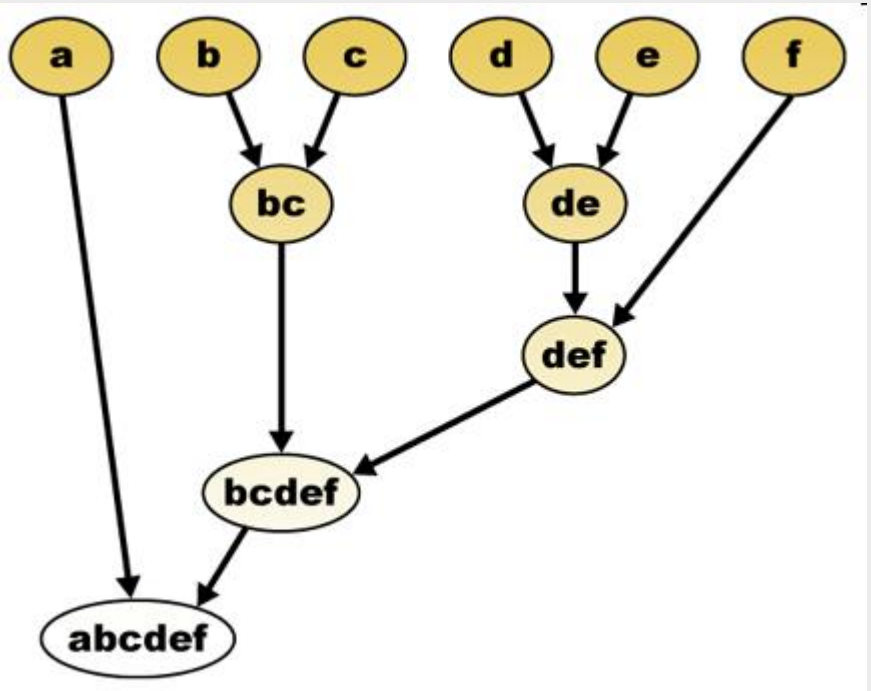
POPULAR EXAMPLE

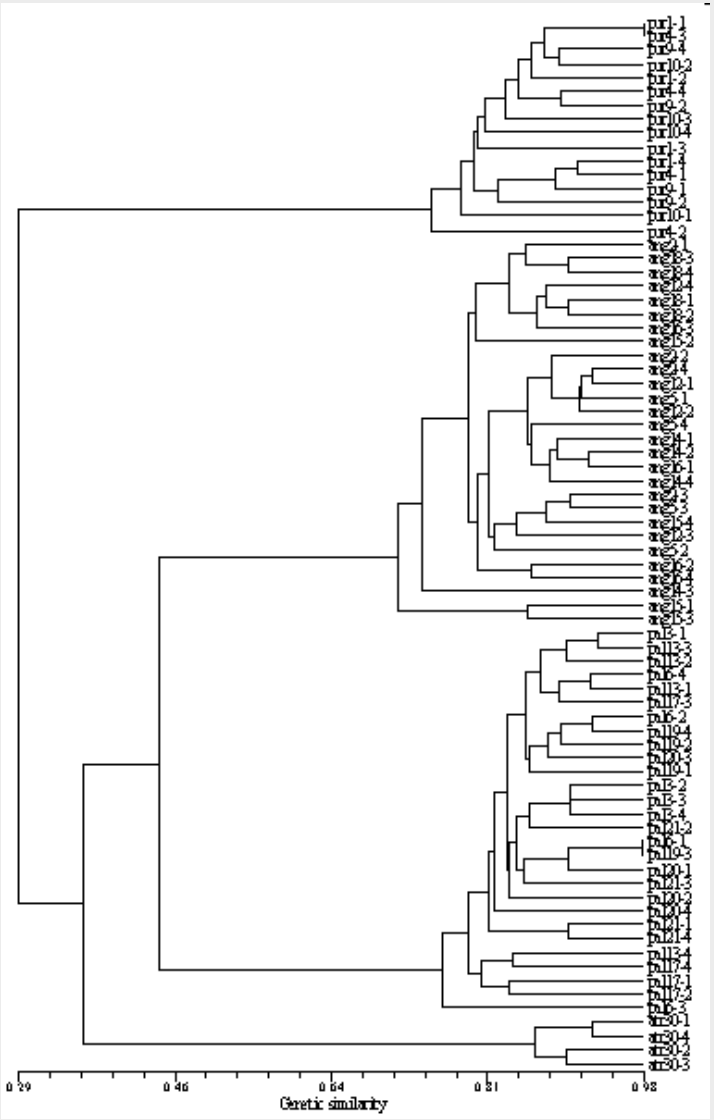
NOT SO POPULAR TECHNIQUE



DENDROGRAM

HIERARCHICAL CLUSTERS
NESTED SETS



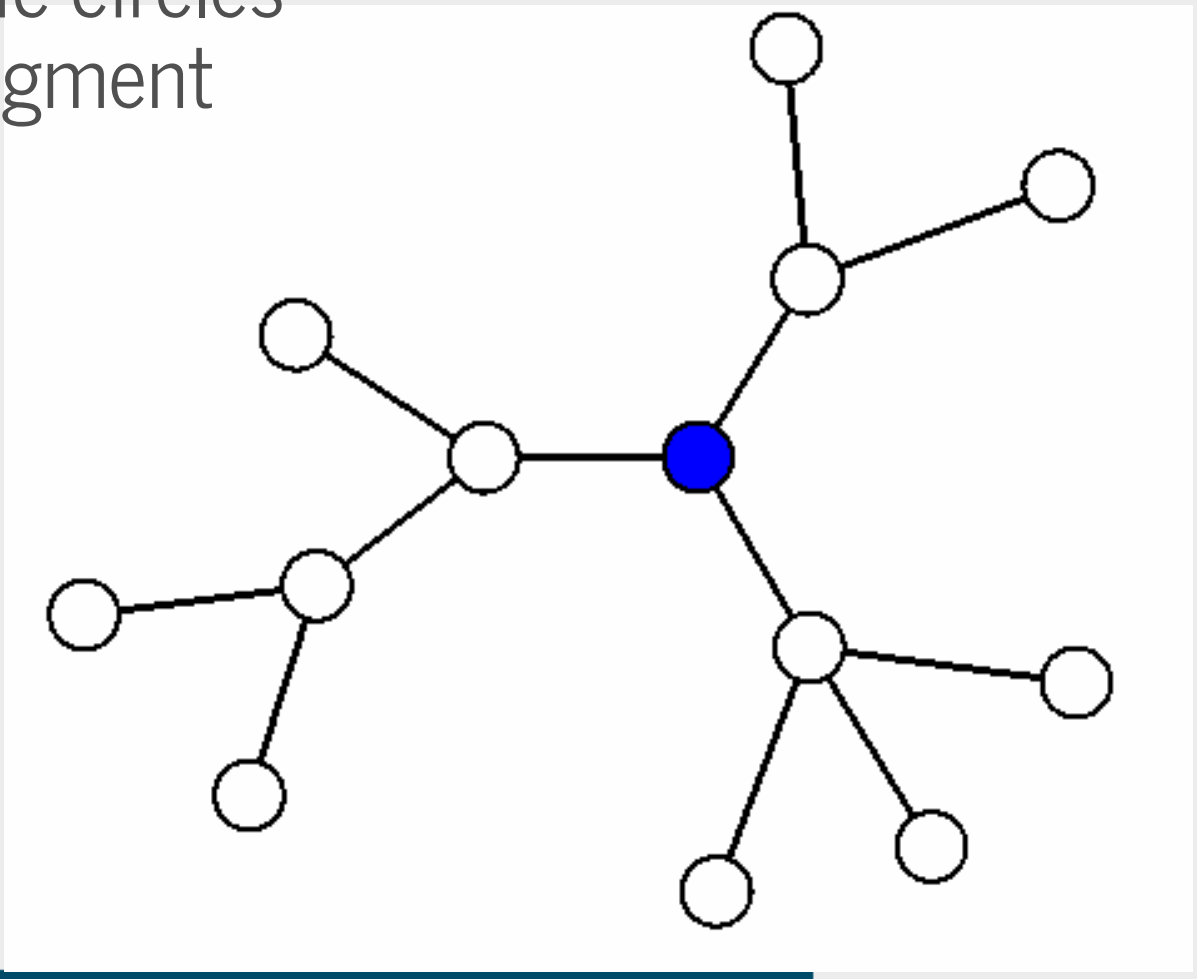


TREE LAYOUTS – RADIAL TREE

RADIAL TREE

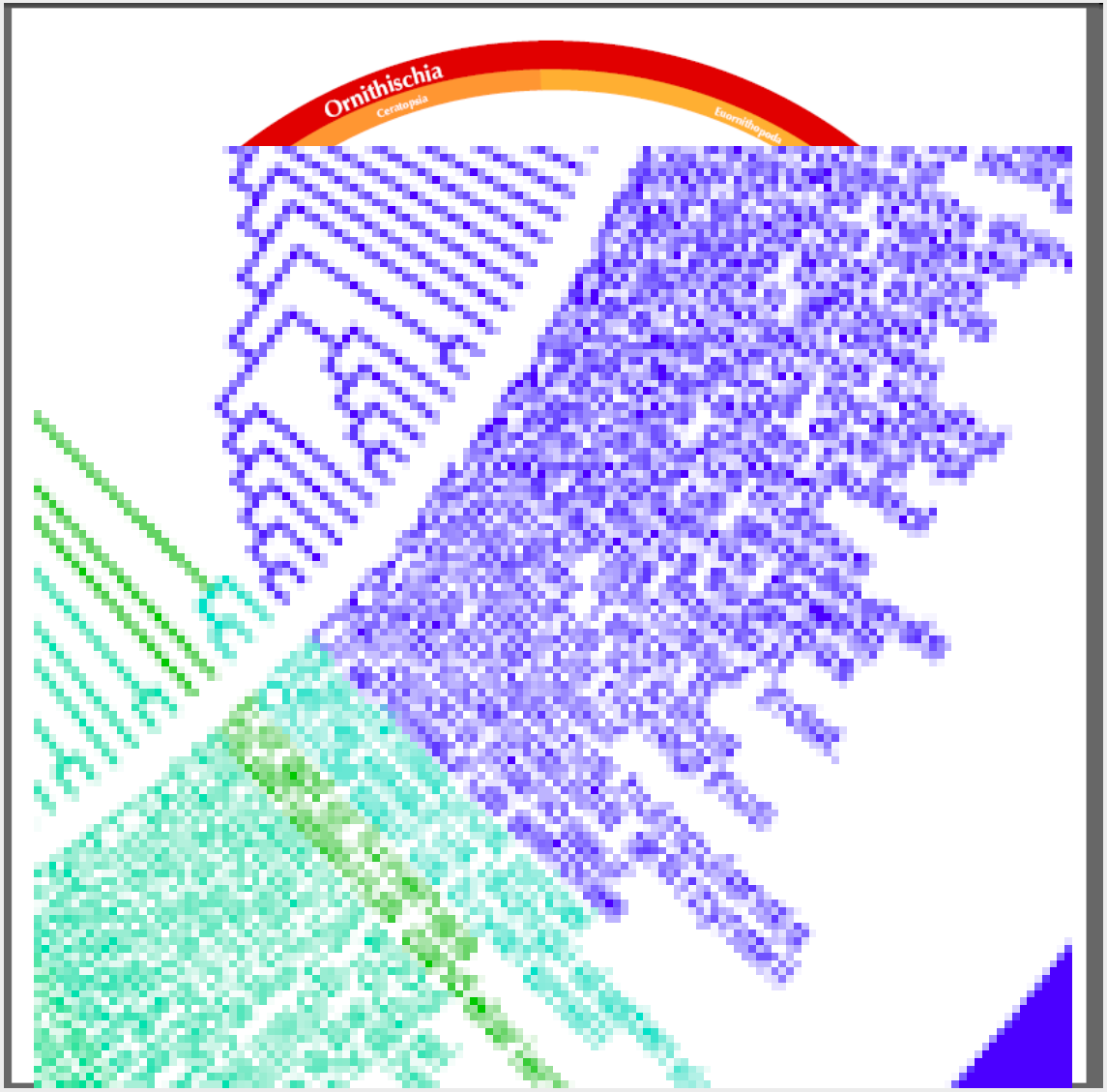
Levels on concentric circles

Subtree in circle segment



EXAMPLE RADIAL TREE

DINOSAUR FAMILY

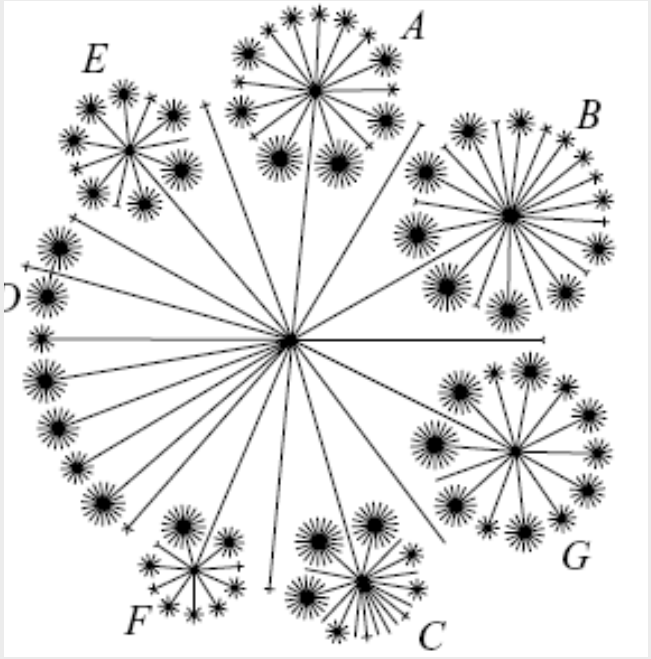


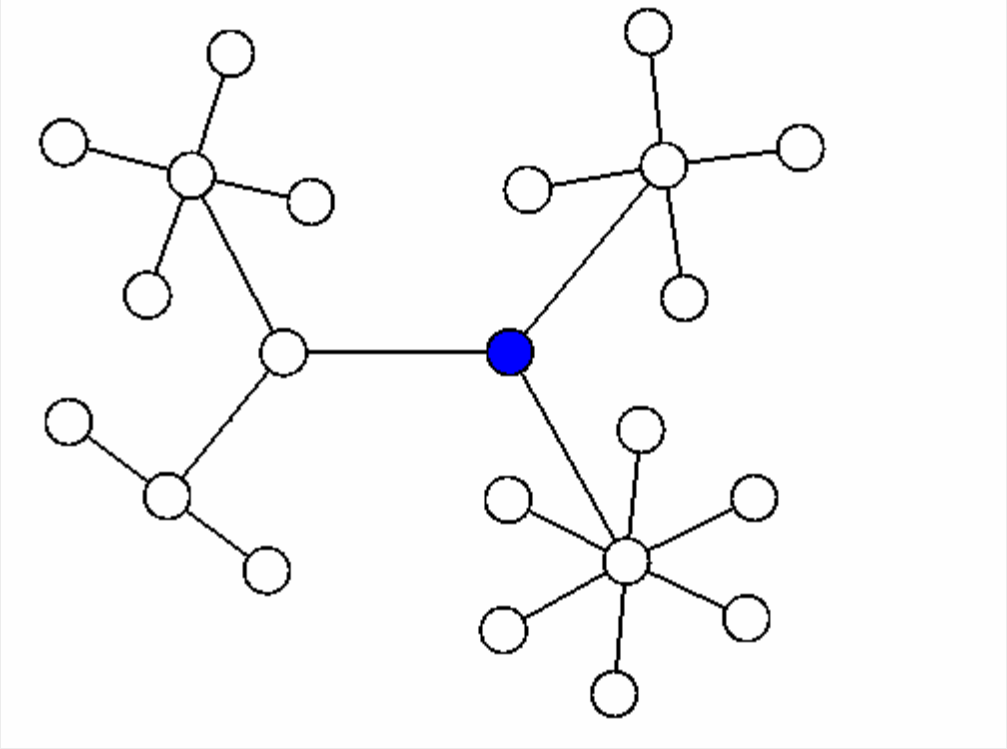
TREE LAYOUTS – BALLOON TREE

BALLOON TREE

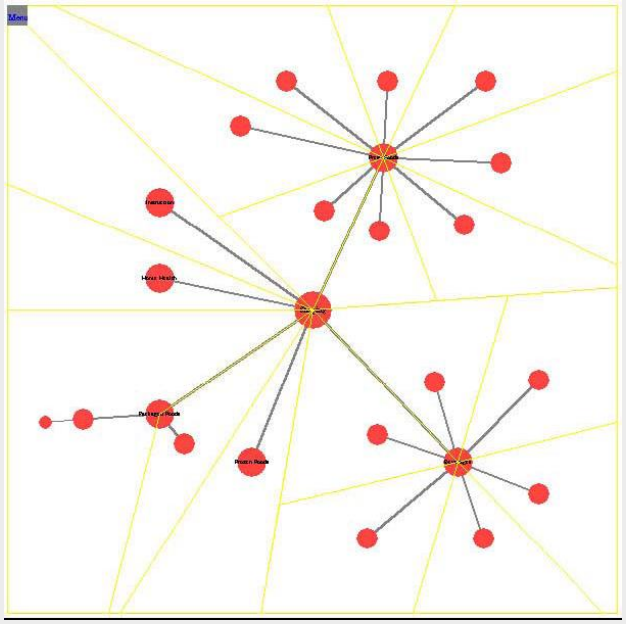
Focus on subtrees in smaller circles

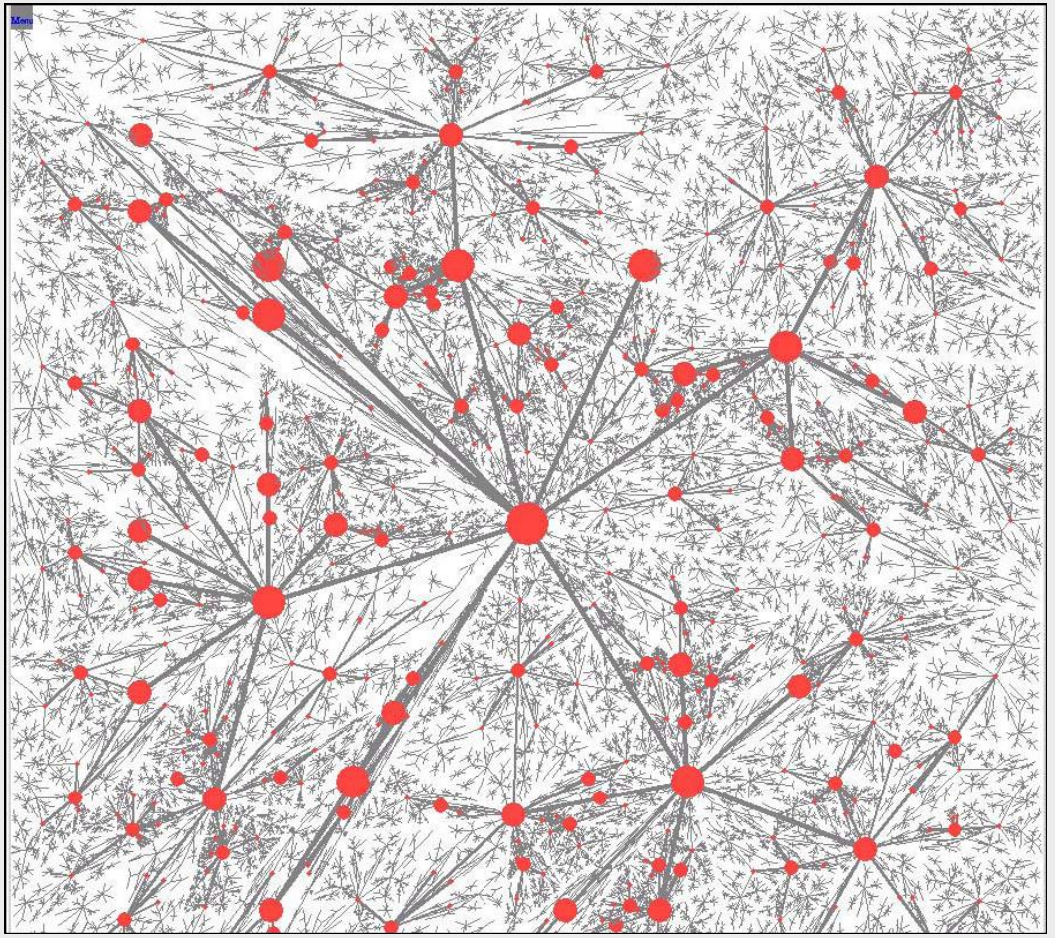
Recursive space subdivision



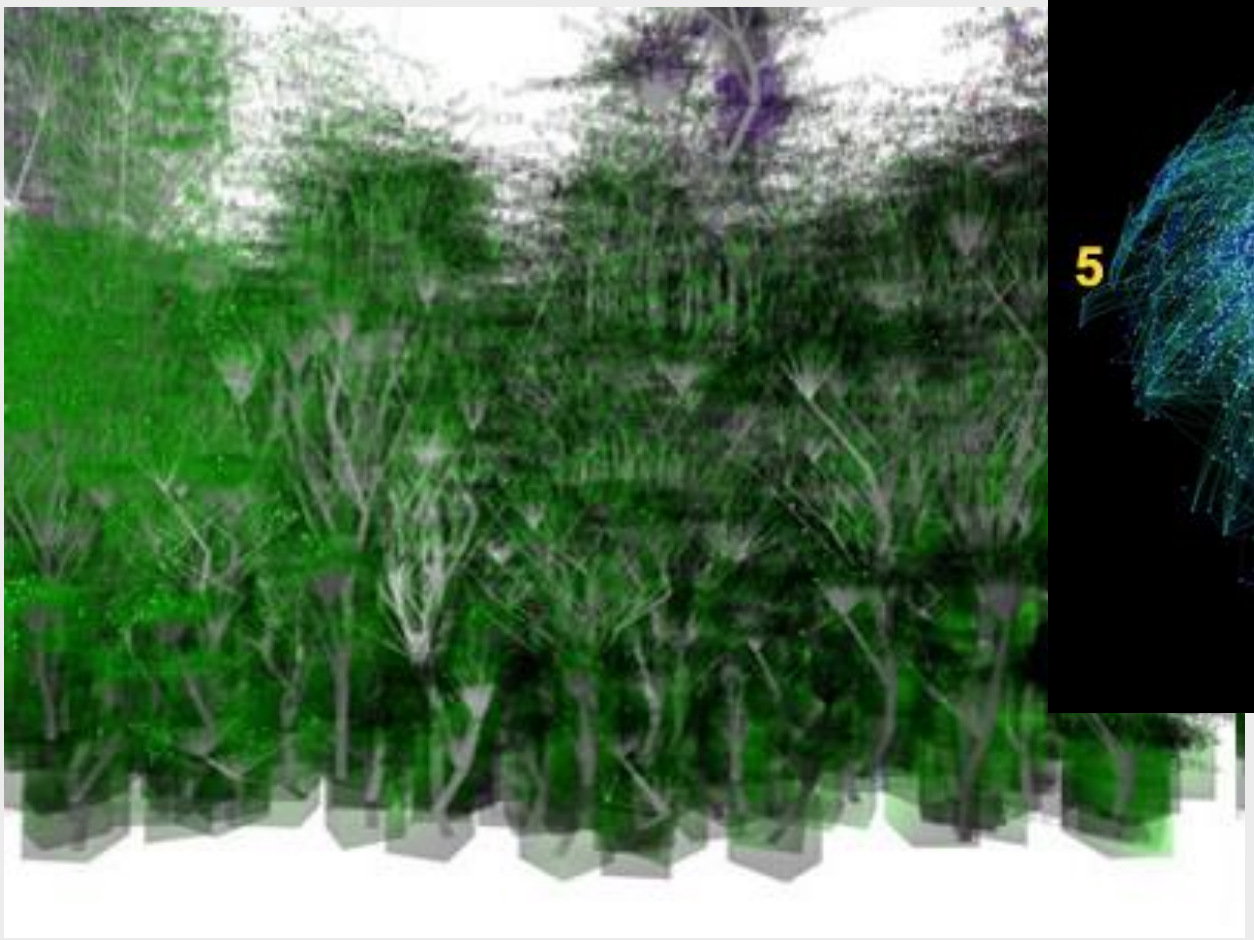


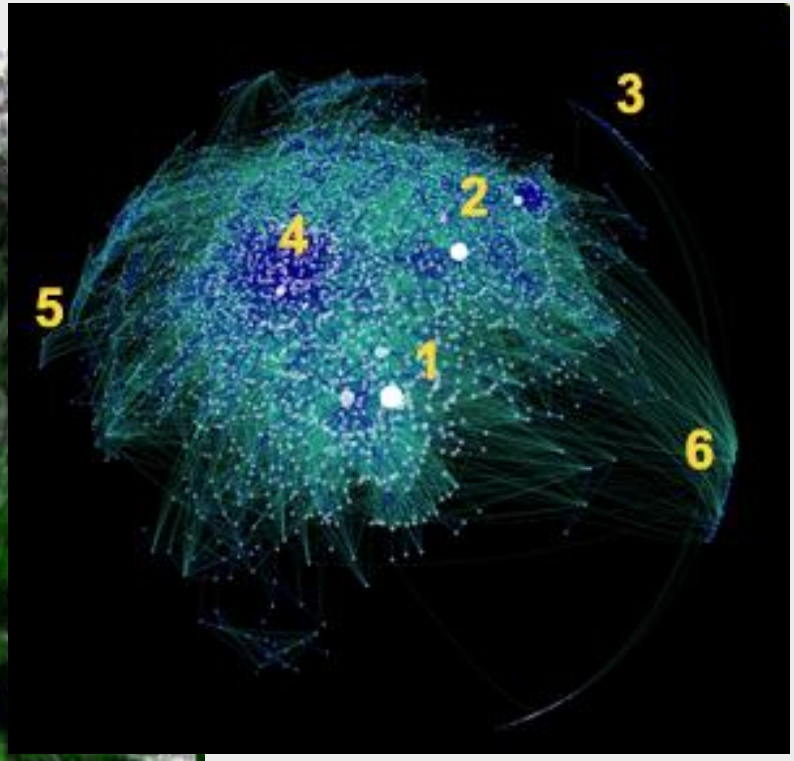
TREE LAYOUTS – SPACE FILLING





SPACE FILLING – GOAL OR ISSUE?

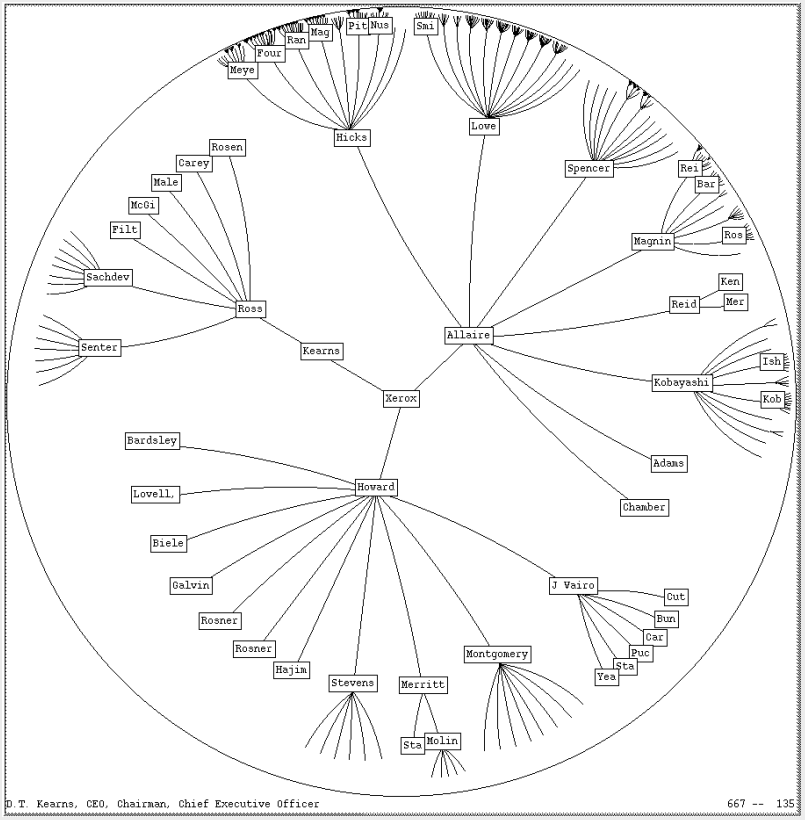


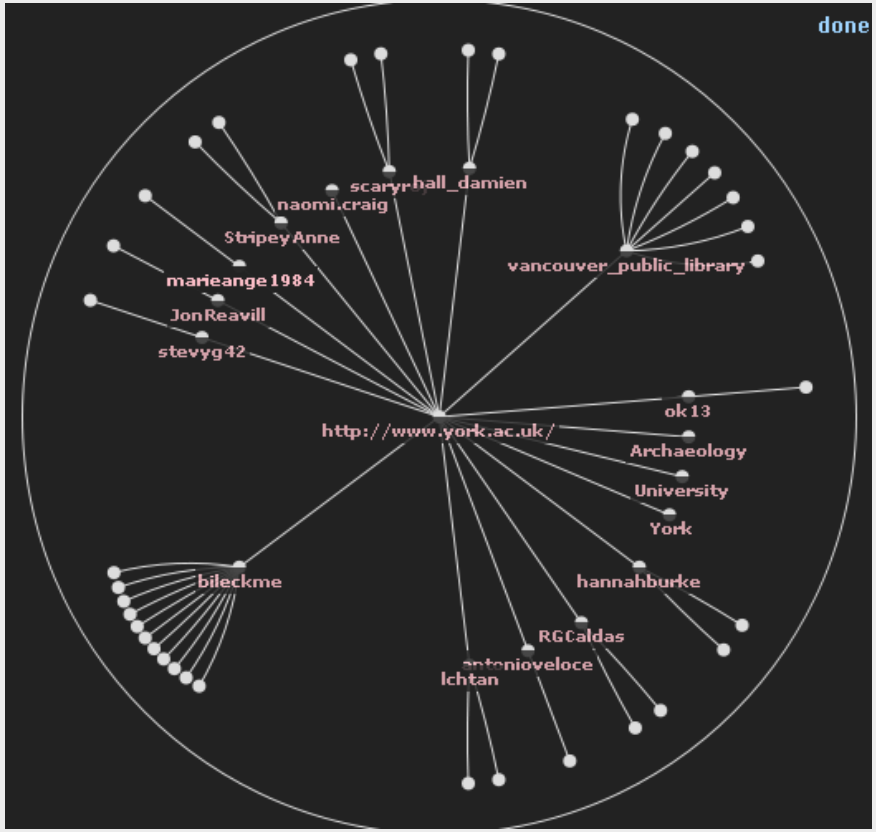


http://www.texone.org/tree/tree.php?id=applet

HYPERBOLIC TREE BROWSER

LAMPING & RAO, 96



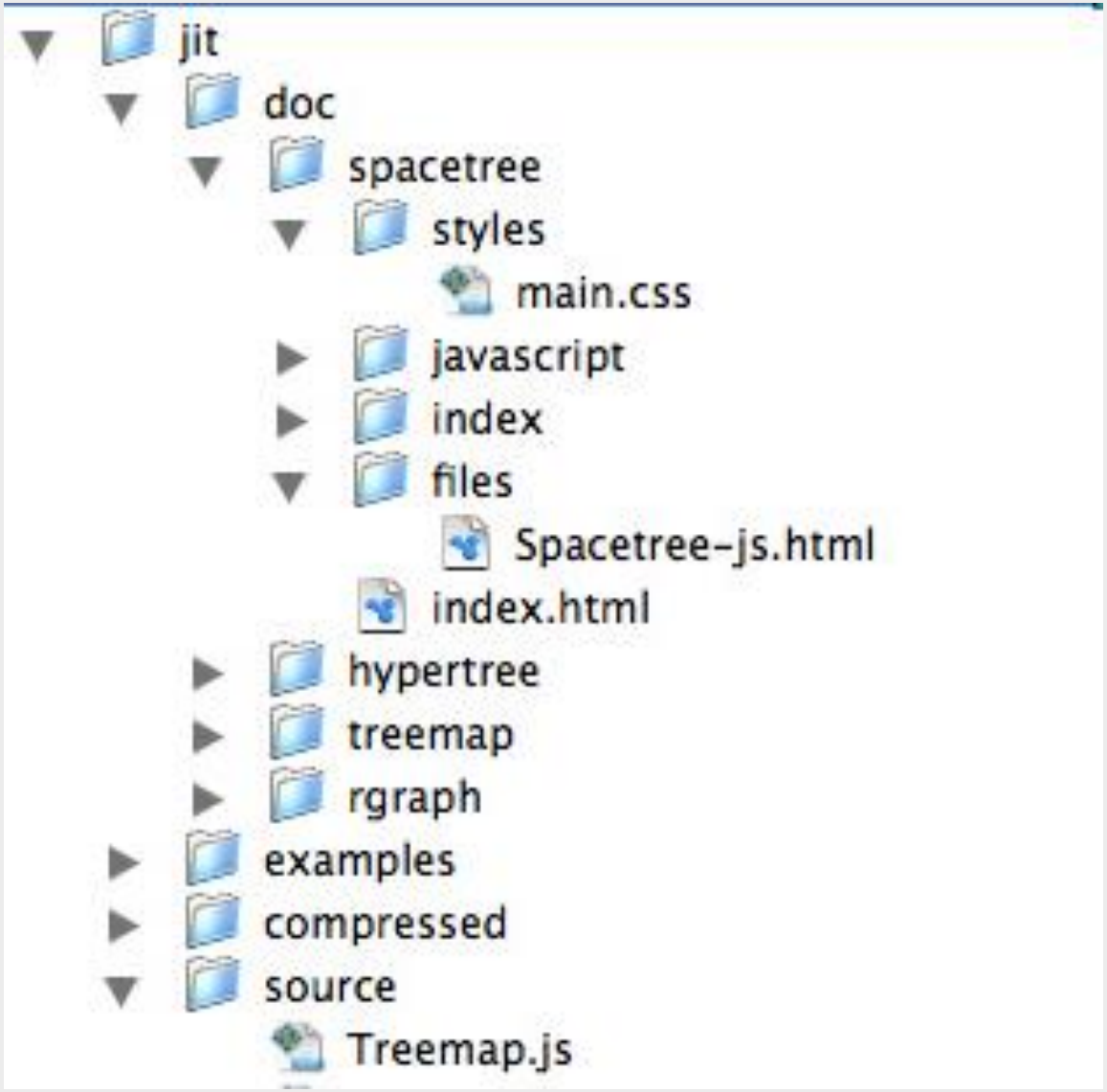


FOCUS+CONTEXT VISUALIZATION

ONE STEP FROM NODES AND LINKS

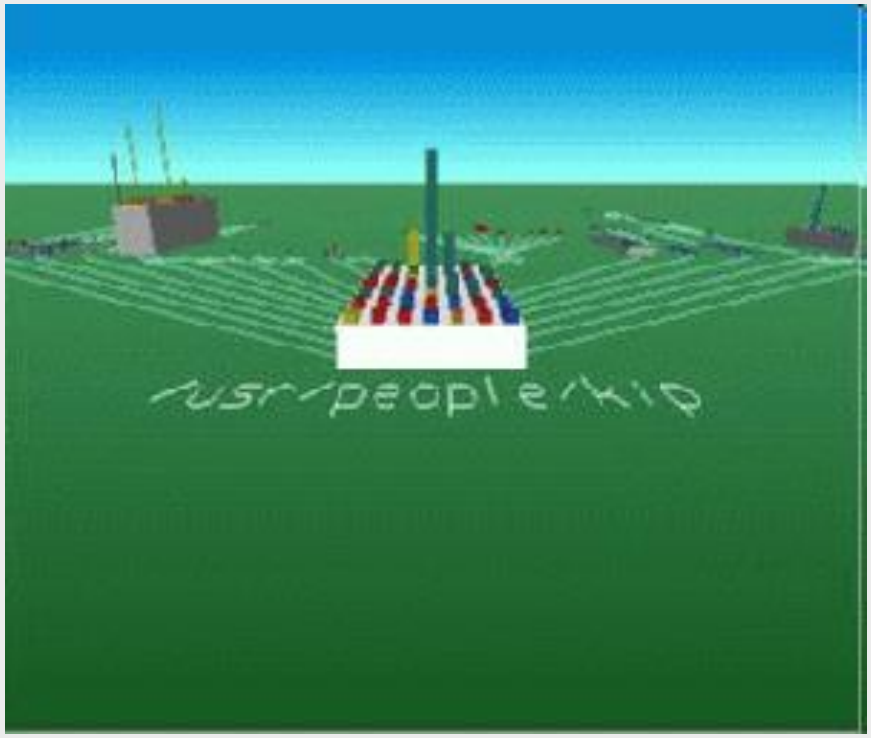
FILE BROWSER

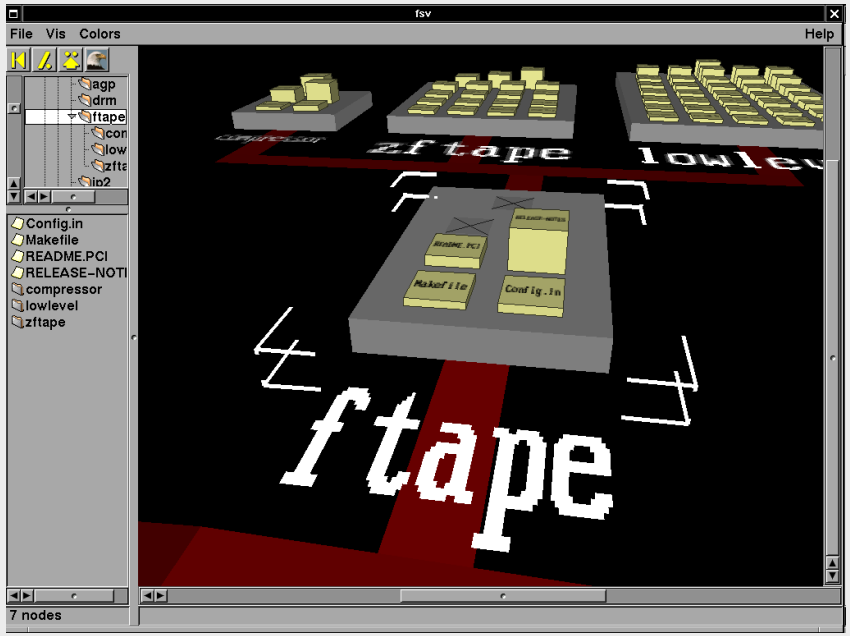
PROS/CONS?



FILE SYSTEM NAVIGATION

SGI FILE SYSTEM NAVIGATOR





http://fsv.sourceforge.net/

ESCAPING NODES AND LINKS

TREE MAPS

Ben Shneiderman

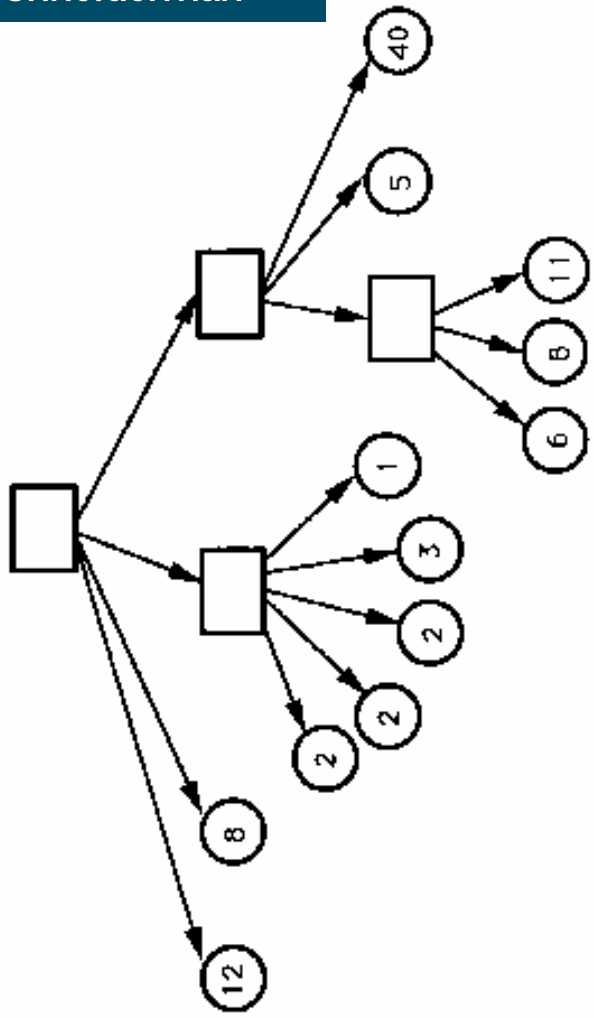


Figure 1: Typical 3-level tree structure with numbers indicating size of each leaf node

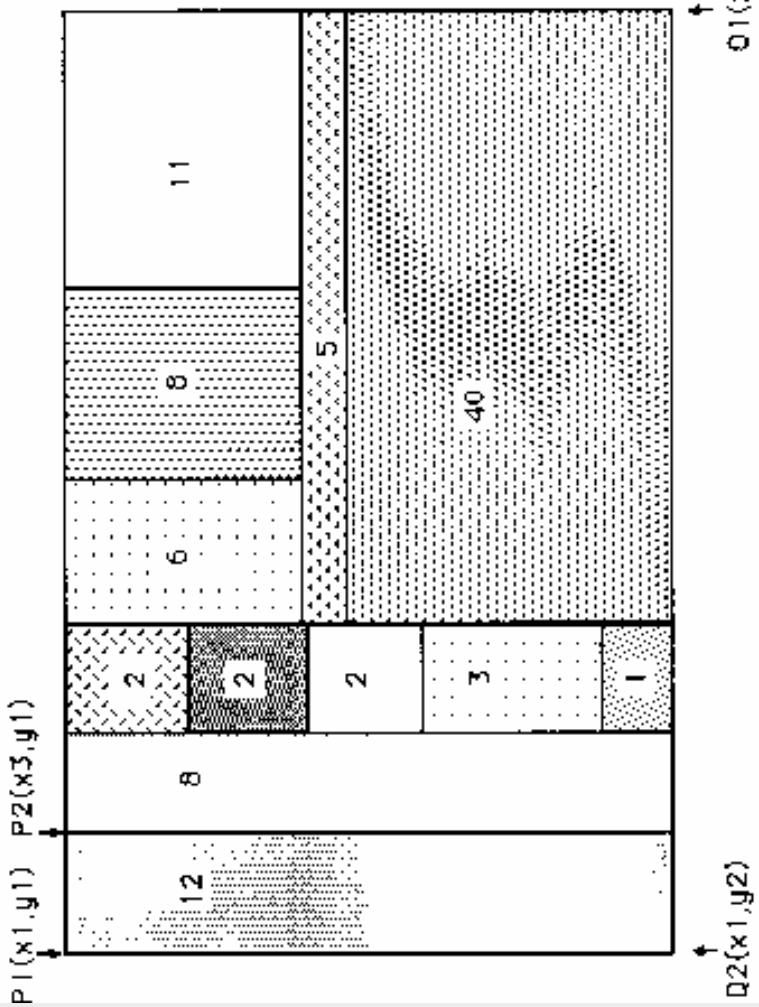
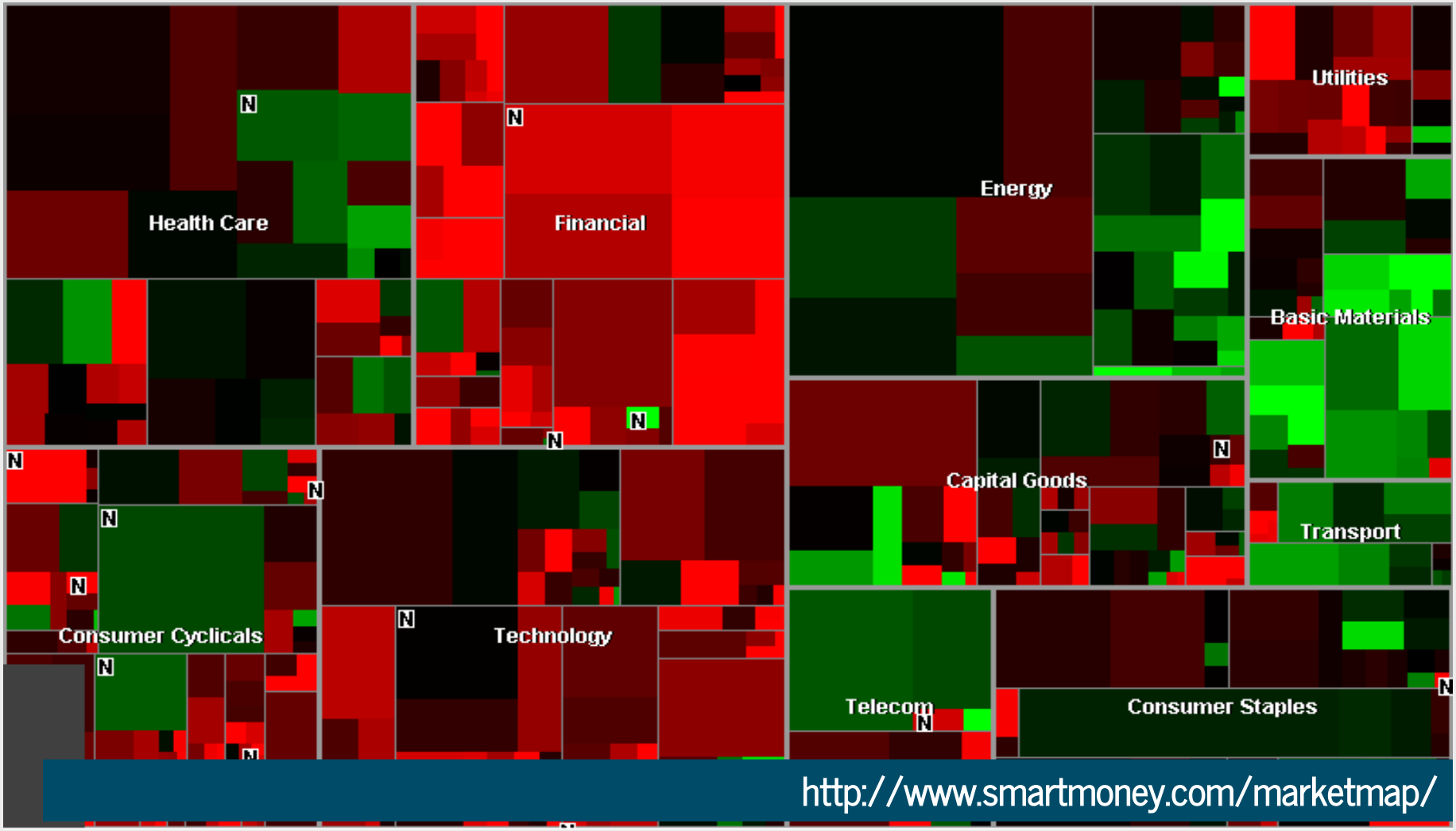


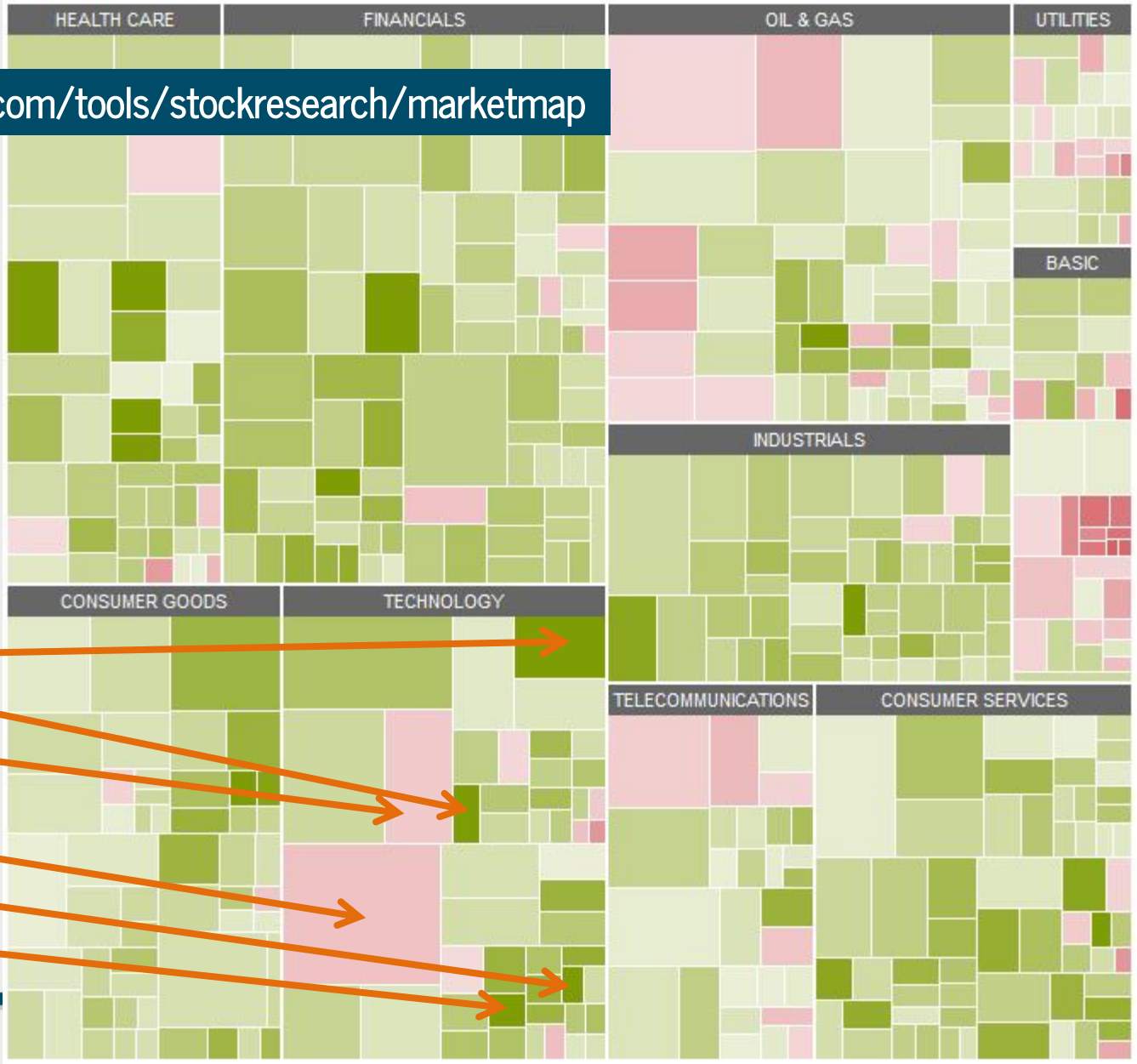
Figure 2: Tree-map of figure 1

TREEMAPS – MAP OF THE MARKET



MAP OF THE MARKET TODAY

http://www.marketwatch.com/tools/stockresearch/marketmap

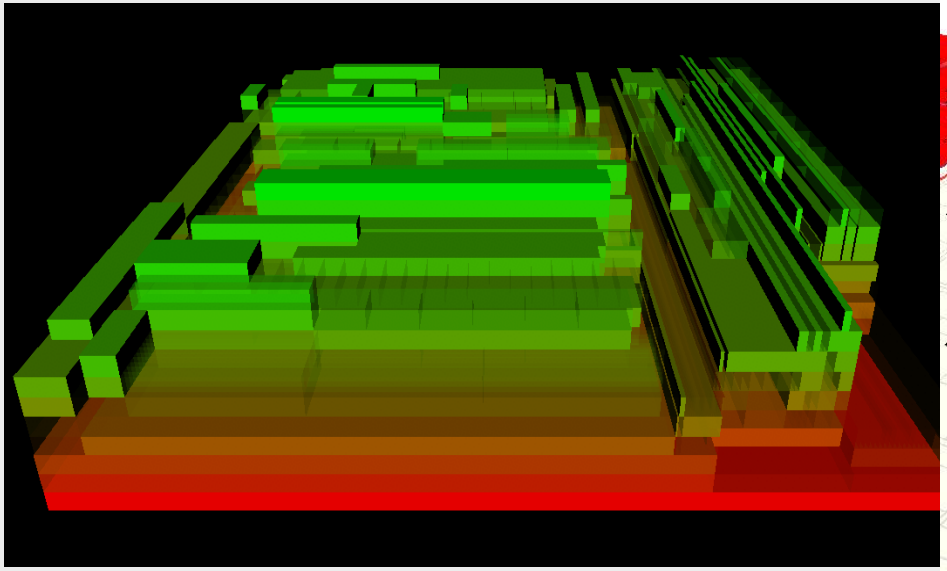


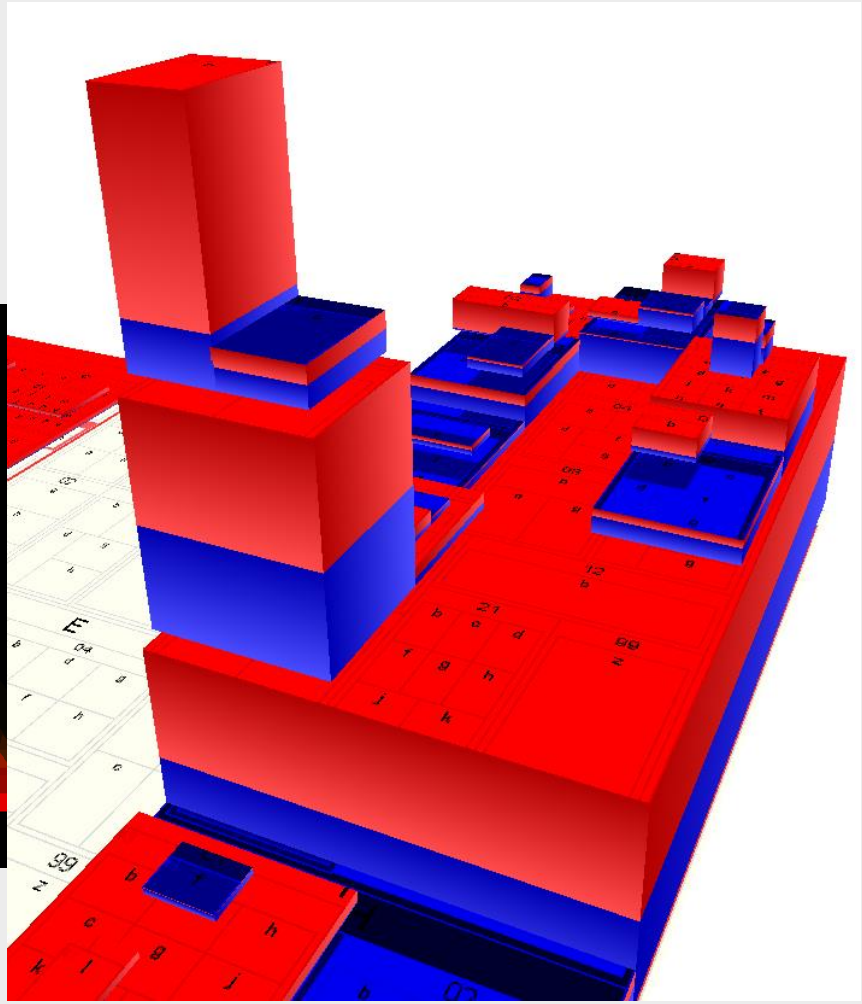
FACEBOOK
YAHOO
IBM

APPLE
WD
NOKIA

TREEMAPS IN 3D

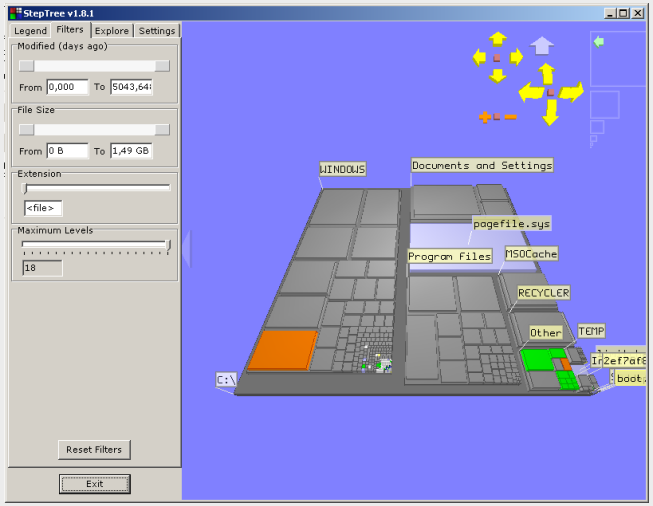
RATHER EXOTIC ☺

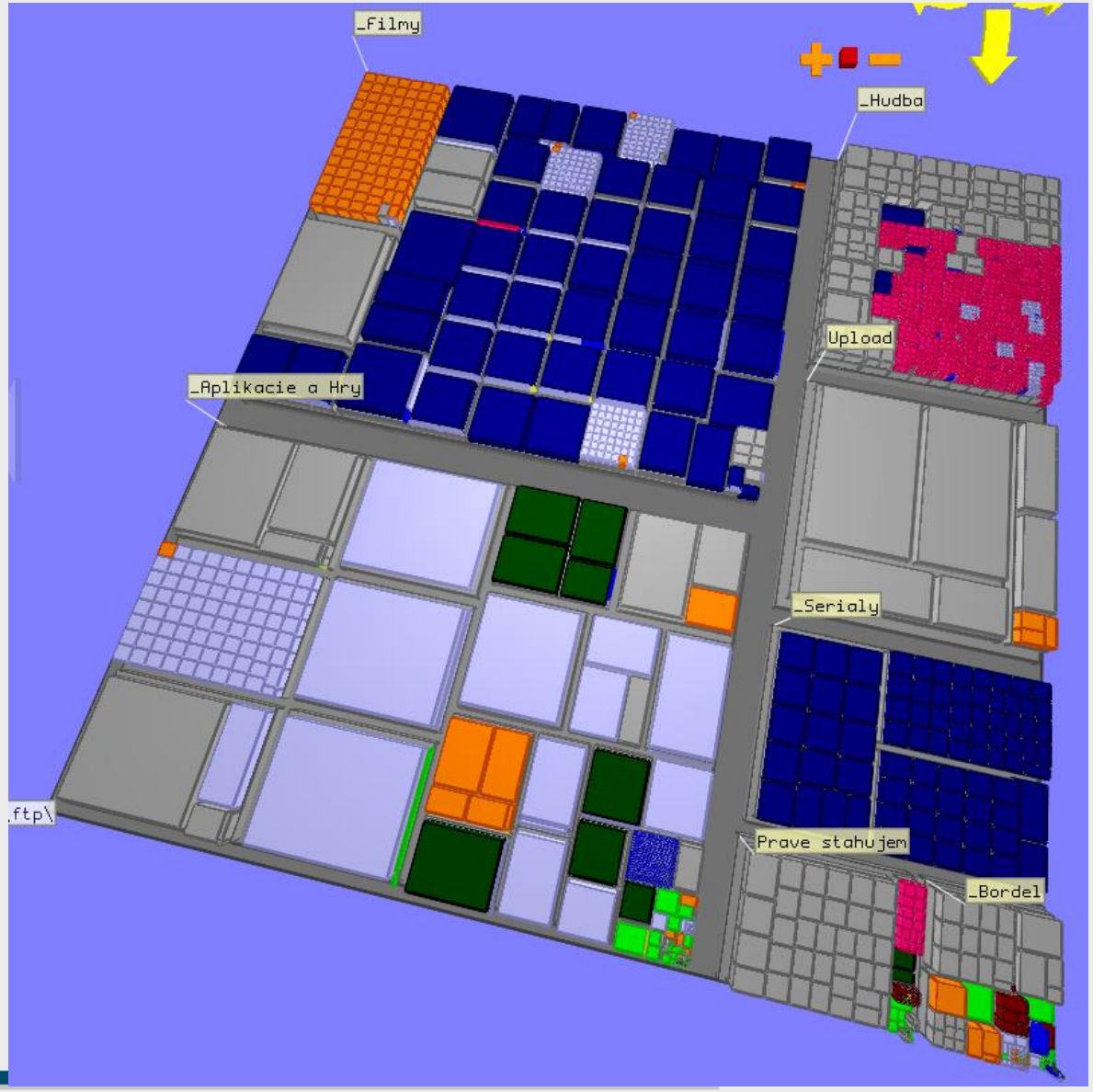




STEPTREE

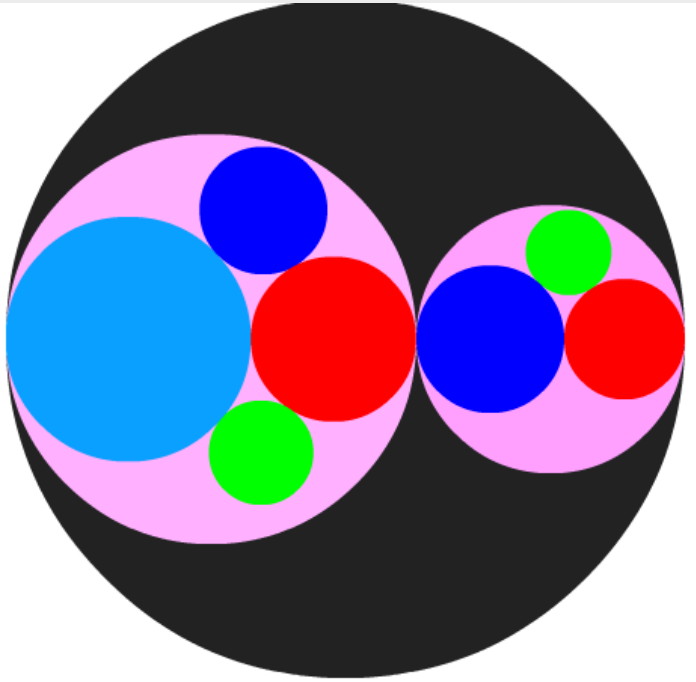
THOMAS BLADH
Master thesis

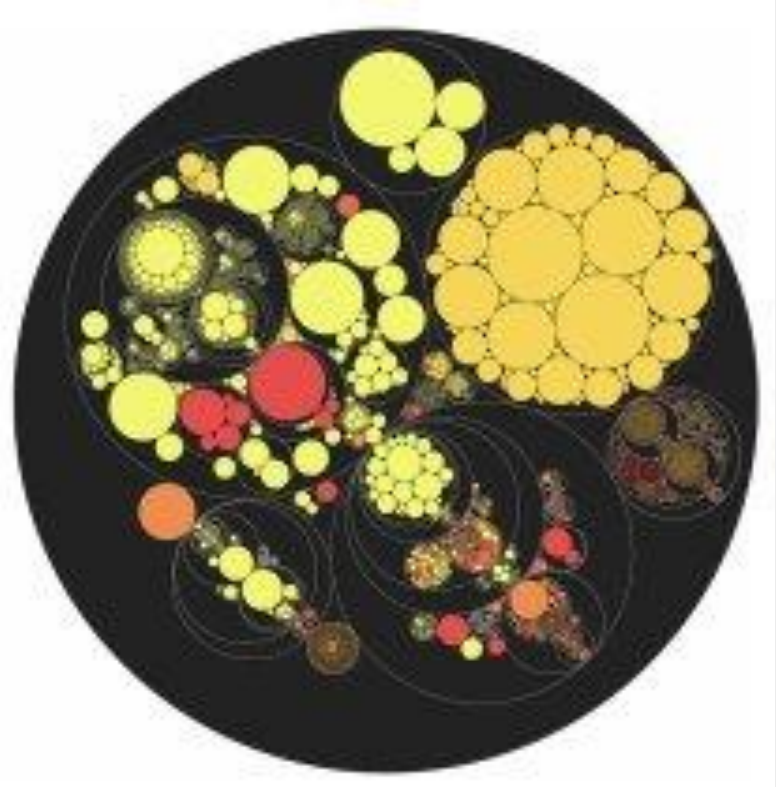




CIRCULAR TREEMAPS

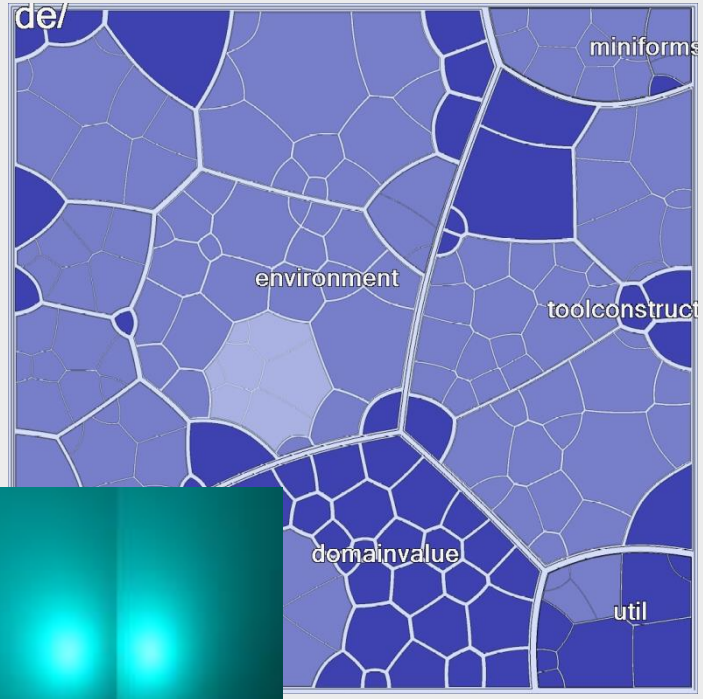
UNUSED SPACE?





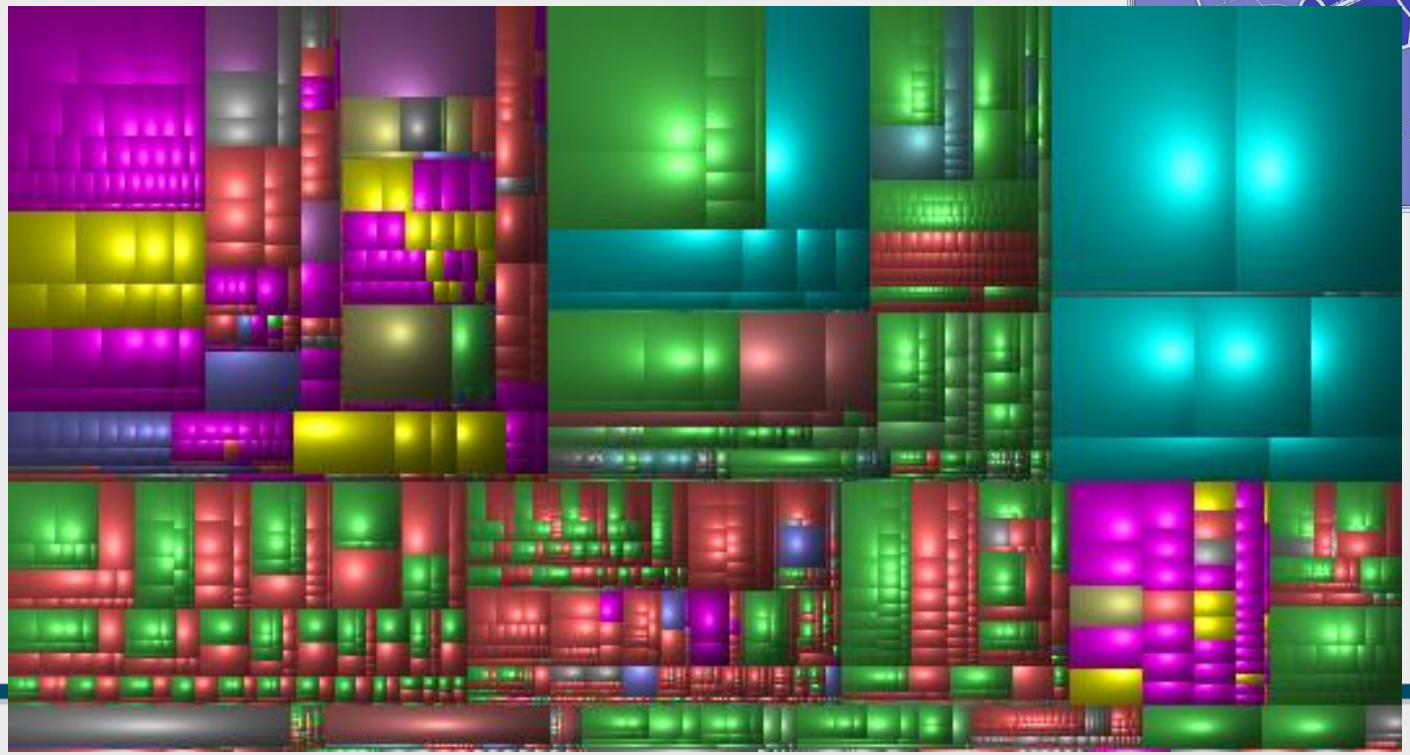
OTHER MODIFICATIONS

VORONOI TREEMAPS

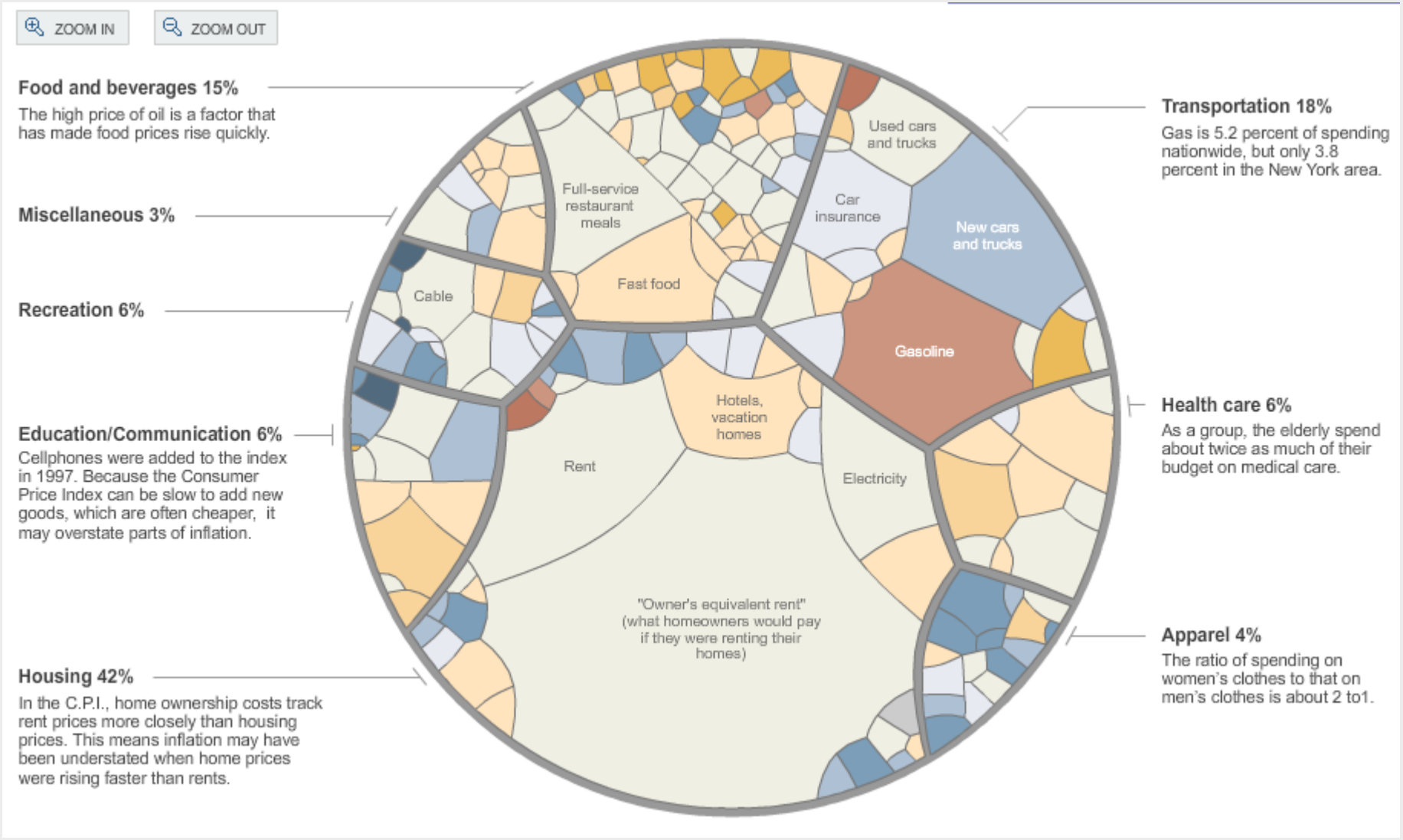


CUSHION TREEMAPS

Perception of siblings



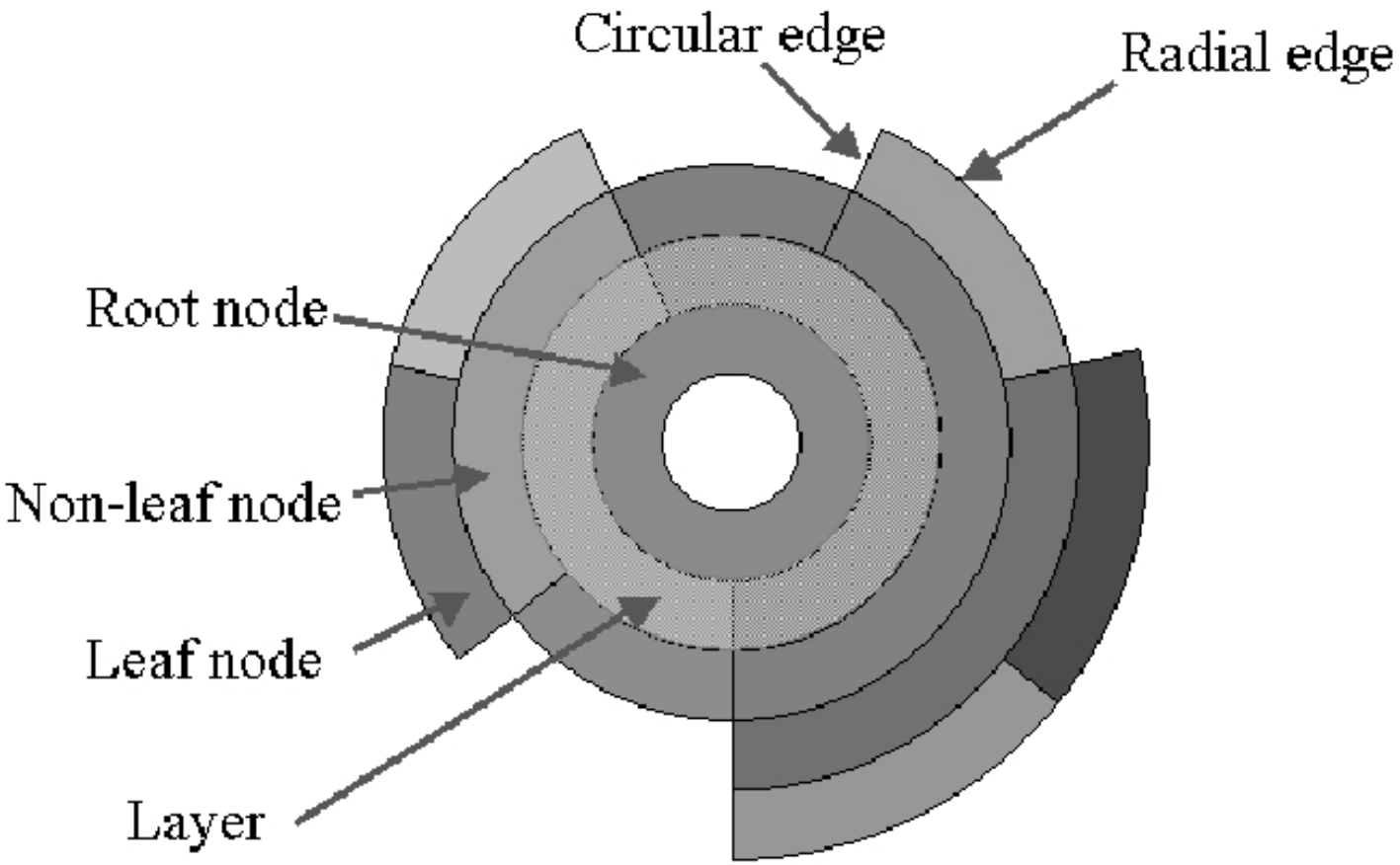
VORONOI TREEMAPS



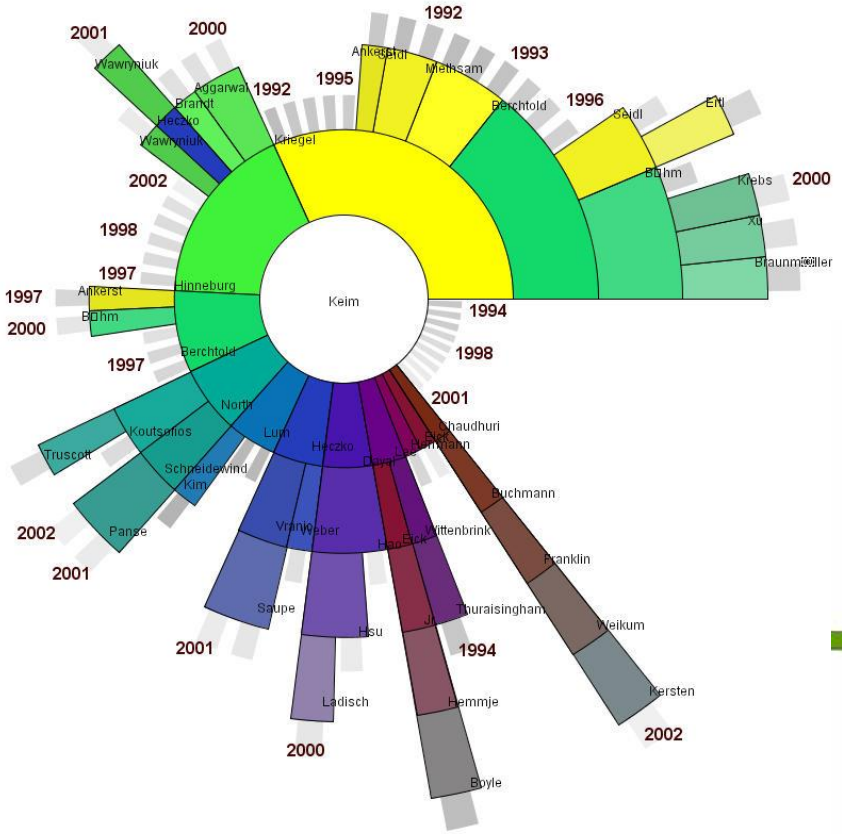
http://www.nytimes.com/interactive/2008/05/03/business/20080403_SPENDING_GRAPHIC.html

INTERRING

YANG, WARD & RUNDENSTEINER



INTERRING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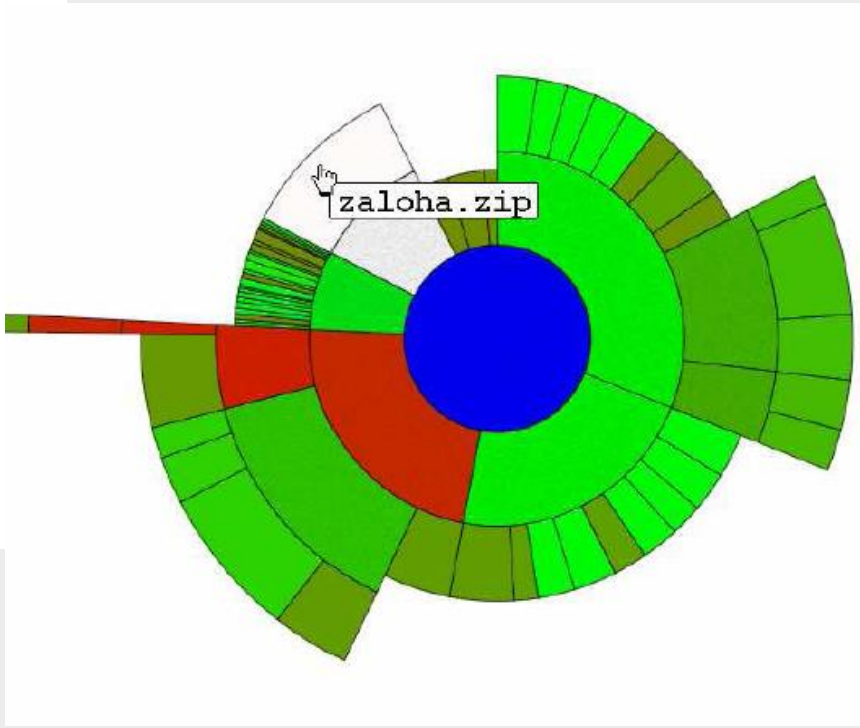
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INTERRING – EVOLUTION OF LANGUAGES