Graphs and Networks 2

CS 4460 – Intro. to Information Visualization
November 8, 2017
John Stasko

Review

- Last time we looked at graph layout aesthetics and algorithms, as well as some example applications
- Today we look at more recent InfoVis network visualization systems & projects

Learning Objectives

- Understand how interaction can be used to assist network visualization
- Be able to explain concept of "attribute-based layout"
  - Provide examples of systems using technique
- List and define different network analysis metrics (eg., betweeness centrality)
- Describe and explain contribution of following network visualization systems
  - TreePlus, PivotGraph, Semantic Substrates, CiteVis, Social Action,

Interaction

- One of the key ways we move beyond graph layout to network visualization (InfoVis) is interaction with the graph

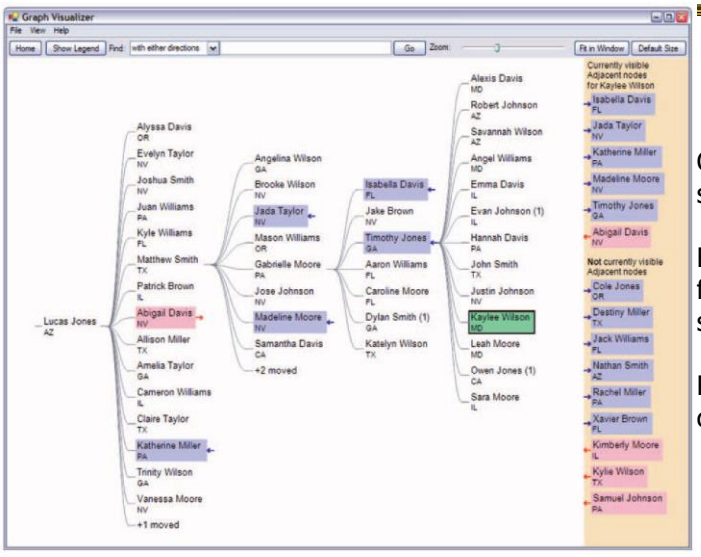
TreePlus

- Don't draw entire graph
- Have a focus vertex, then incrementally expand and show connections (min span tree) from there
- Interaction:
  - Single-click: show connections via highlight
  - Double-click: new focus vertex
  - Smooth animated change in focus
- "Plant a seed and watch it grow"

Lee et al *TVCG* '06

TreePlus

Video



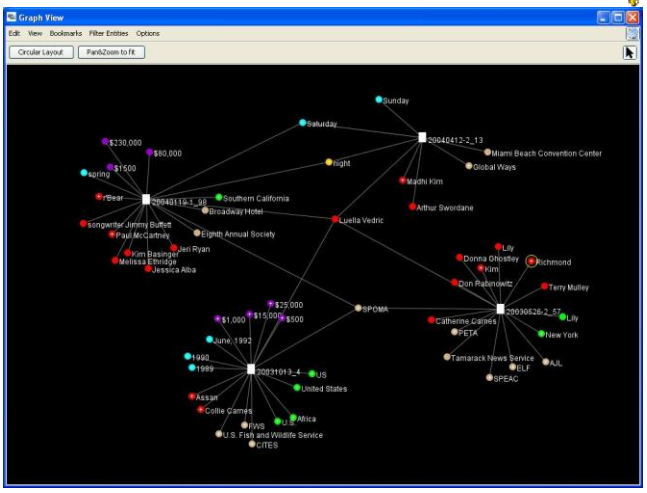
Green – current selection

Blue – vertices from current selection

Red – vertices to current selection

Jigsaw's Graph View

Don't draw everything, but allow the viewer to interactively explore (expand & compress) the graph



Stasko, Görg & Liu
Information Visualization '08

Demo

Recent Trends in GraphViz

- Attributes of nodes influence geometric positioning
  - Not just some arbitrary layout
- Utilize graph statistical analysis too

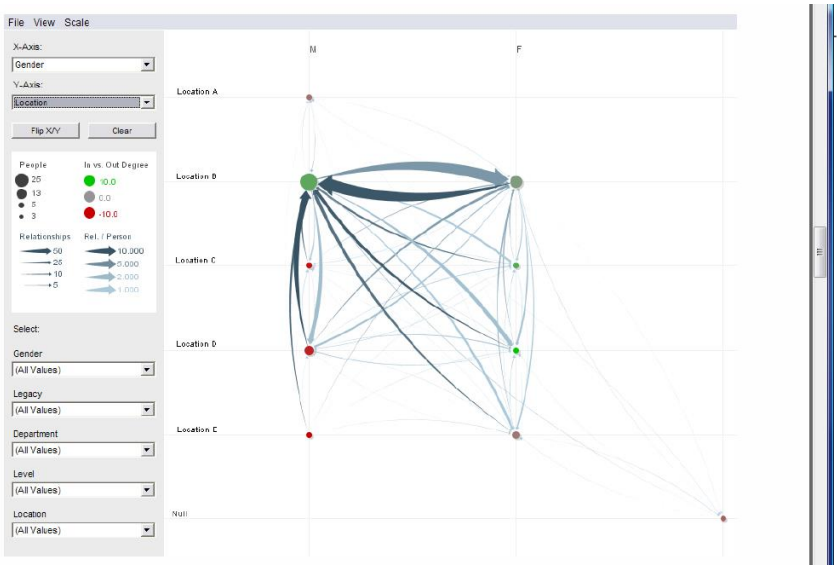
Attribute-based layout

- Largely driven by interest in social network analysis

PivotGraph

- Position nodes into a grid based on attributes
- Cluster on common node attributes
  - Put all A's together, all B's together, …
- "Roll up" nodes
  - Draw edge from A to B depending on how many edges from some A to some B

Wattenberg
CHI '06



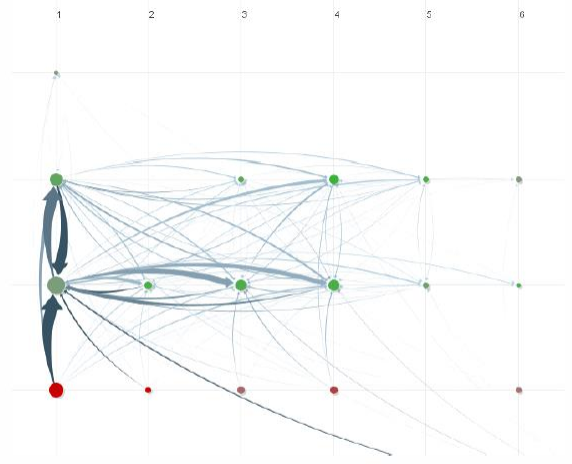


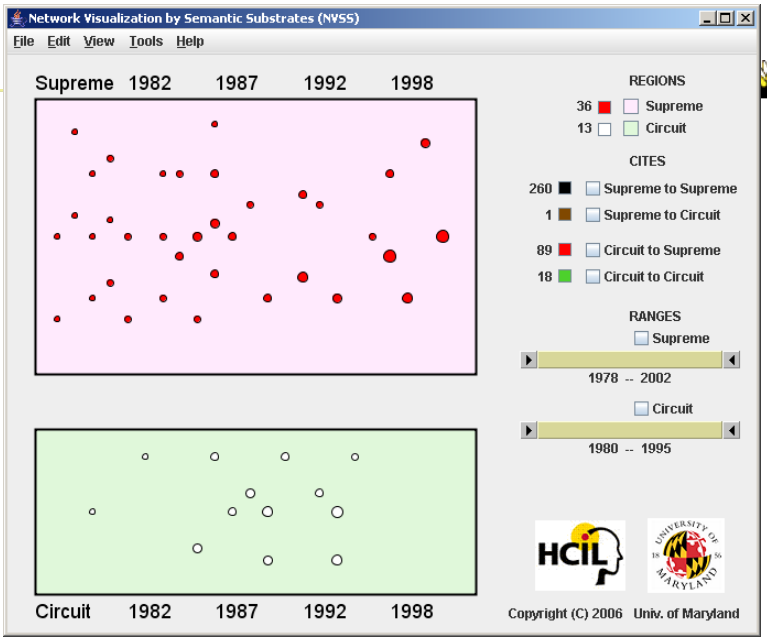
Figure 10. *Communication network of people in a large company. X-axis is division, y-axis is office geography. The division in the leftmost column has far more cross-location communication than the others.*

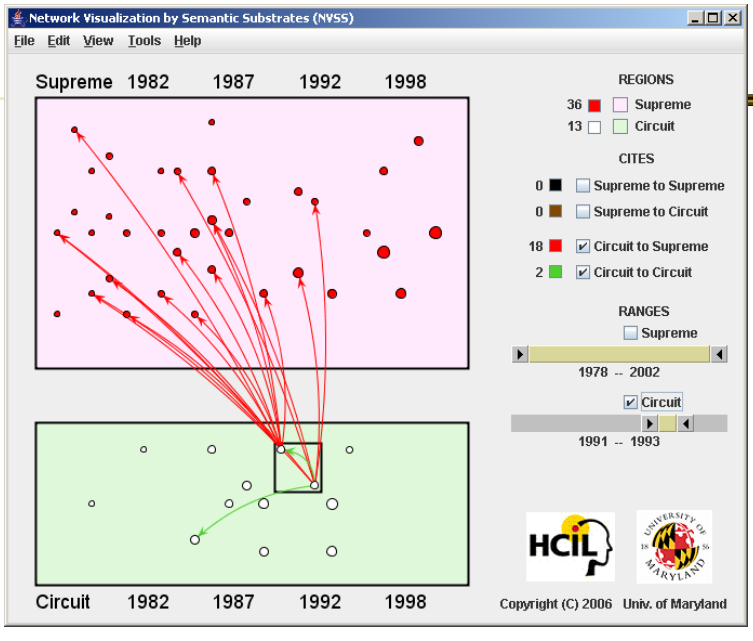
http://www.cs.umd.edu/hcil/nvss/

Semantic Substrates

- Group nodes into regions
  - According to an attribute
    - Categorical, ordinal, or binned numerical
- In each region:
  - Position nodes according to some other attribute(s)
- Give users control of link visibility

Shneiderman & Aris
TVCG (InfoVis) '06


Network Visualization by Semantic Substrates (NVSS)
File Edit View Tools Help
Supreme 1982 1987 1992 1998
Circuit 1982 1987 1992 1998
REGIONS
36 Supreme
13 Circuit
CITES
260 Supreme to Supreme
1 Supreme to Circuit
89 Circuit to Supreme
18 Circuit to Circuit
RANGES
Supreme
1978 -- 2002
Circuit
1980 -- 1995
HCIL
Copyright (C) 2006 Univ. of Maryland

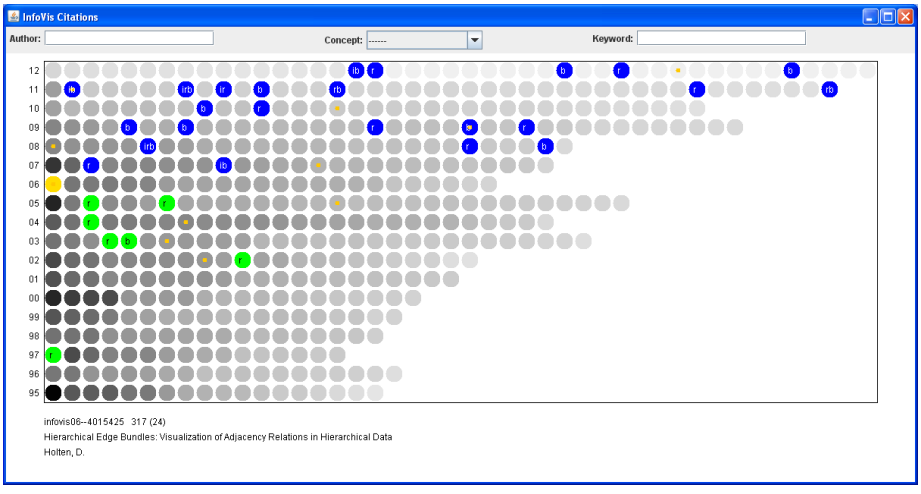

Network Visualization by Semantic Substrates (NVSS)
File Edit View Tools Help
Supreme 1982 1987 1992 1998
Circuit 1982 1987 1992 1998
REGIONS
36 Supreme
13 Circuit
CITES
0 Supreme to Supreme
0 Supreme to Circuit
18 Circuit to Supreme
2 Circuit to Circuit
RANGES
Supreme
1978 -- 2002
Circuit
1991 -- 1993
HCIL
Copyright (C) 2006 Univ. of Maryland

CiteVis

- Showing InfoVis Conference paper citation patterns
  - Papers are graph vertices
  - A cites B is graph edge
- Attribute-based layout
  - Year x Number of citations
- Uses color & interaction to show citations rather than drawn links

Stasko, Choo, Han, Hu, Pileggi, Sadana & Stolper
InfoVis poster '13

http://www.cc.gatech.edu/gvu/ii/citevis



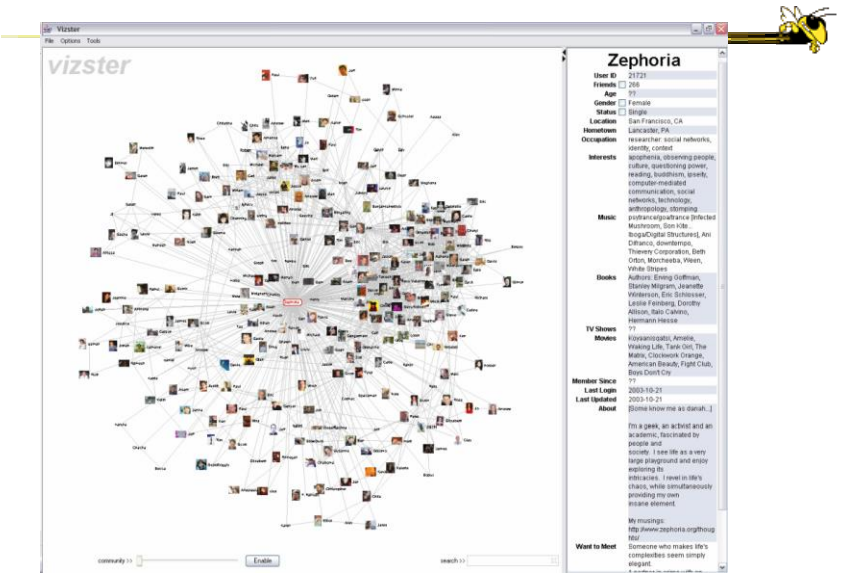
Demo

Vizster

- Visualize social networking sites like friendster, myspace, facebook
- Implementation
  - Crawled 1.5 million members (Winter 2003)
  - Written in Java using the *prefuse* tookit (http://prefuse.sourceforge.net)
- Oppose Shneiderman's mantra. Instead: "Start with what you know, then grow."

Heer & boyd
InfoVis '05

Visualization



Combining Features

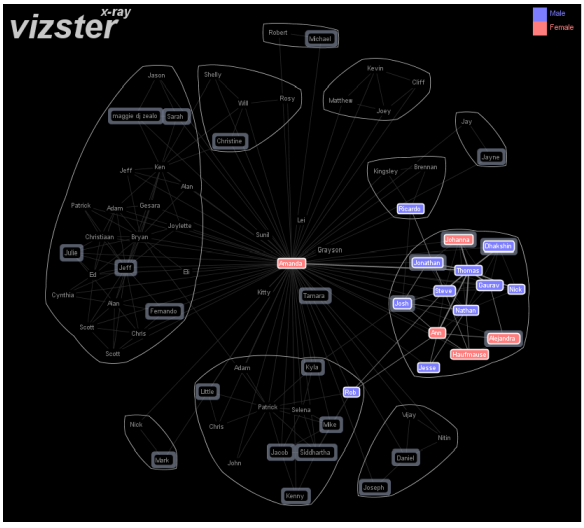
Video

Colors: Gender

Halo: Search for "student"

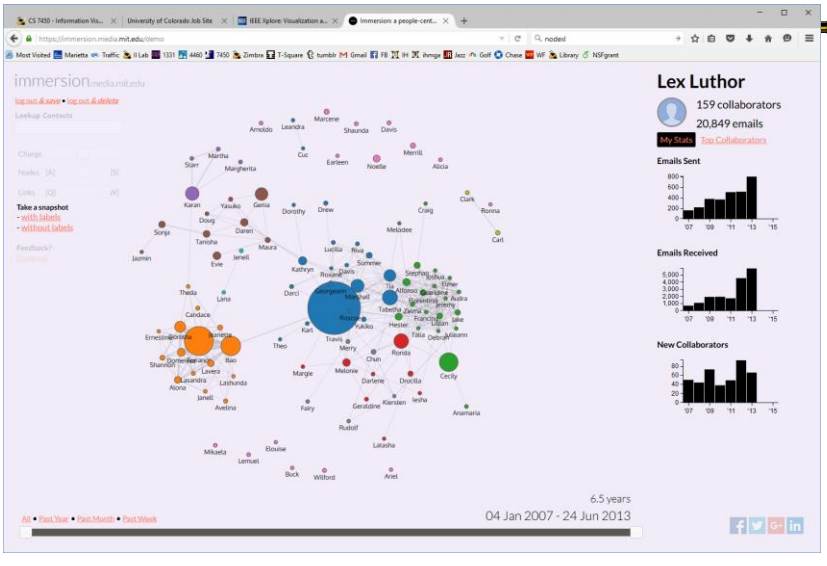
Highlight: Friends of selection

Blobs: Communities



https://immersion.media.mit.edu/

Immersion

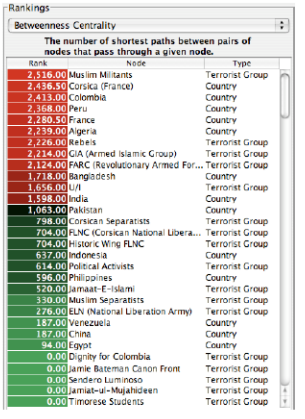


Demo

SocialAction

- Combines graph structural analysis (ranking) with interactive visual exploration
- Multiple coordinated views
  - Lists by ranking for analysis data
  - Basic force-directed layout for graph vis

Perer & Shneiderman
TVCG (InfoVis) '06



(a) Ordered list of 97 nodes in the largest connected component of the terrorism network in 1996. The nodes are ranked according to their betweenness centrality.

(b) Network visualization of the same 97 nodes, colored according to their ranking. The nodes with highest betweenness rankings, sometimes referred to as "gatekeepers", are painted red.

Figure 1.

Social Network Attributes

- **Bary center** – total shortest path of a node to all other nodes
- **Betweenness centrality** – how often a node appears on the shortest path between all other nodes
- **Closeness centrality** – how close a node is compared to all other nodes
- **Cut-points** – the subgraph becomes disconnected if the node is removed
- **Degree** – number of connections for node
- **HITs** – "hubs and authorities" measure
- **Power centrality** – how linked a node is to rest of network

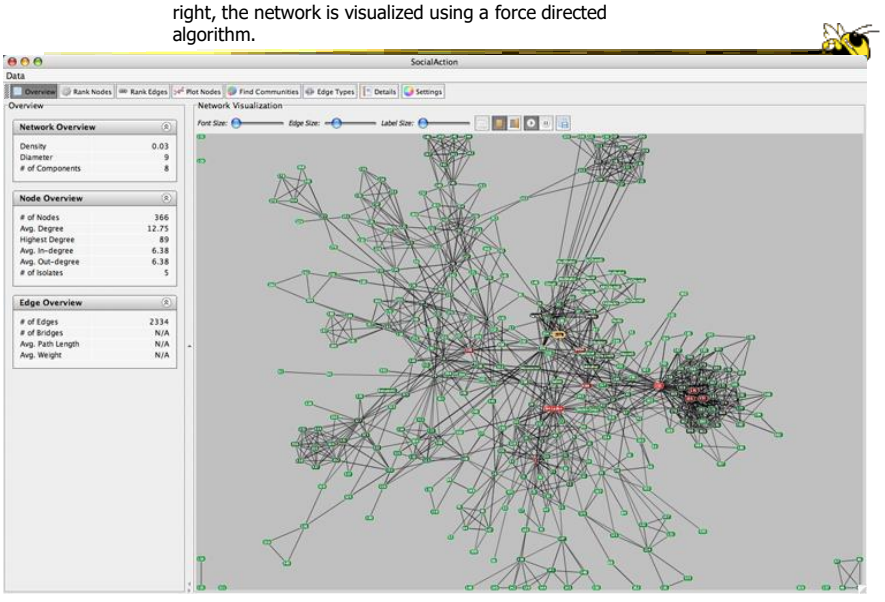
Attribute Ranking

- Run these measures on all nodes and rank them
- Sort the rankings and show in lists and scatterplots
- Allow user to filter based on rankings
- Can aggregate rankings for cohesive subgroups of nodes

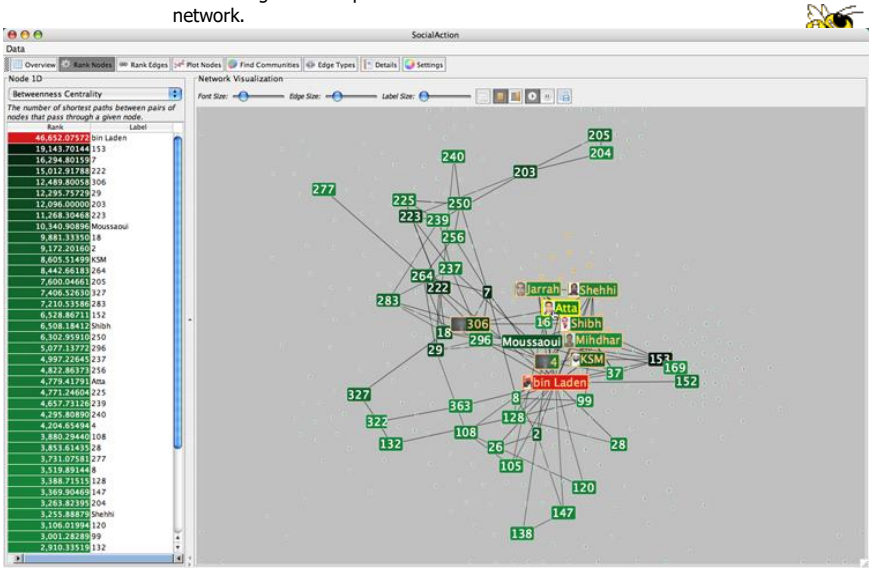
Graph Visualization

- Standard node-link
- Node positions remain constant across different metric views to promote comprehension
- Links can have types
- Coherent subgroups can be aggregated (like in Vizster)
  - Uses Newman's community identification algo

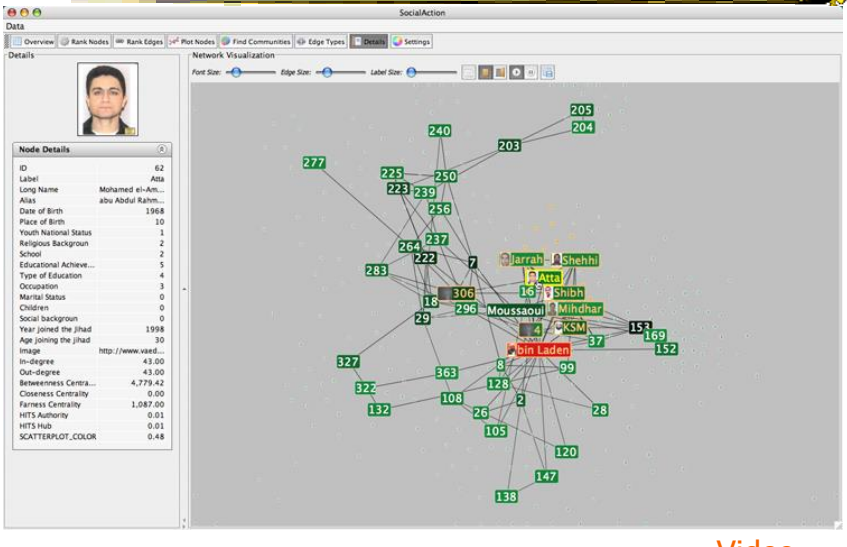
Users begin with an overview of the entire social network. On the left side, overview statistics that describe the overall structure are presented. On the right, the network is visualized using a force directed algorithm.



The gatekeepers are found using a statistical algorithm. Users filter out the unimportant nodes using a dynamic slider which simplifies the visualization while maintaining the node positions and structure of the network.



Labels are always given priority so users can understand what the data represents. When user selects a node, neighbors are highlighted and details appear on the left. In order to protect sensitive information, node labels have been anonymized except for those individuals publicly identified in the Zacarias Moussaoui trial.



Comments

- One of my favorite recent InfoVis papers
- Not too innovative on the vis technique side, but wonderful application and synthesis of useful capabilities
- Actually, a very nice *visual analytics* example
- Good subsequent paper on case studies evaluation of it (on our later Eval day)

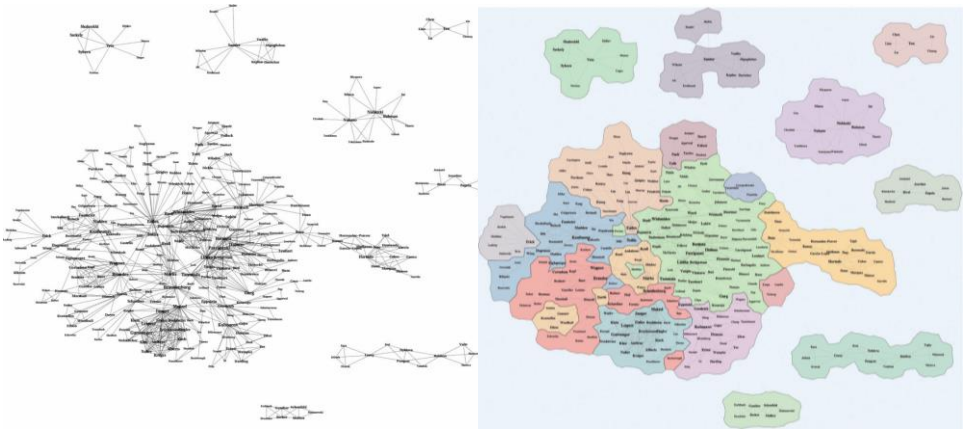
Graphs as Maps

- Represent a large graph as a map
- Maintain inherent structure and relationships between nodes
- Follow standard cartographic representations

Gansner, Hu & Kobourov
IEEE CG&A (PacificVis) '10

http://www2.research.att.com/~yifanhu/MAPS/imap.html

Both Representations

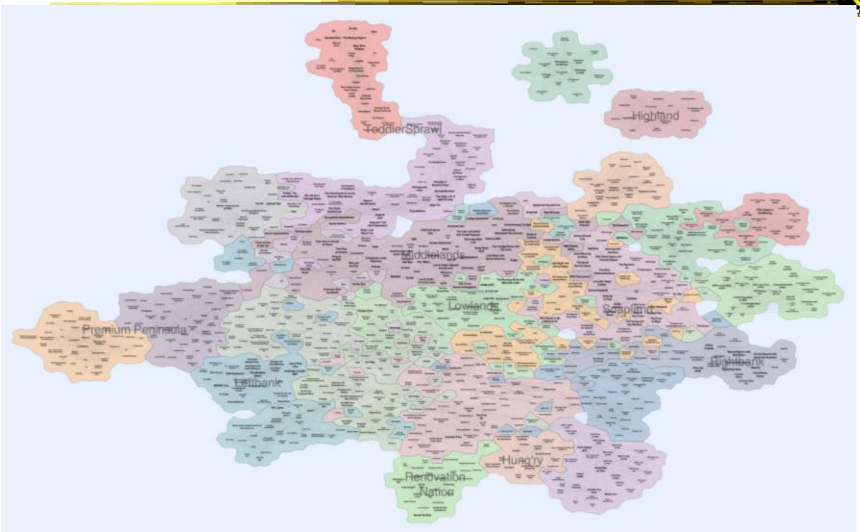


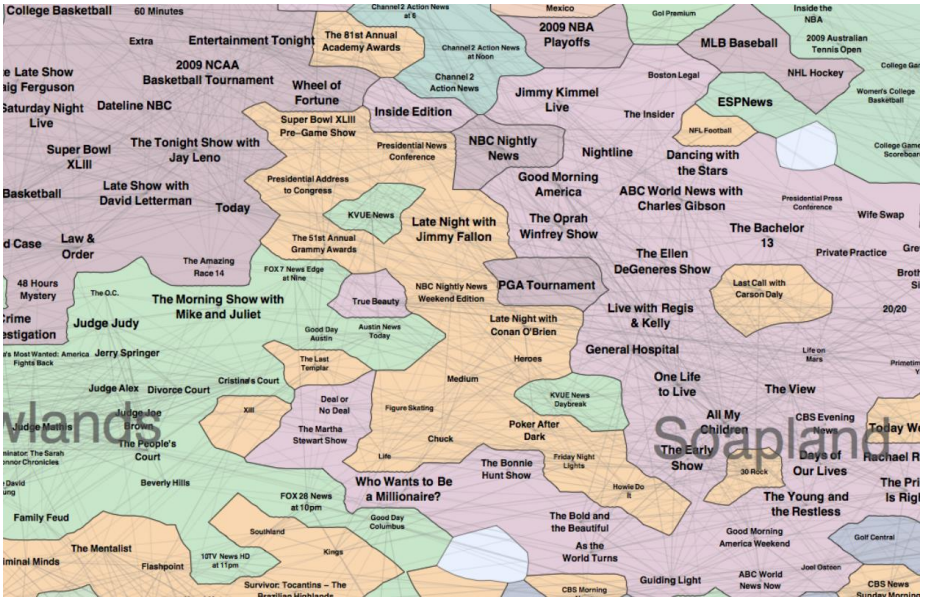
Node-link Map

Music Graph/Map

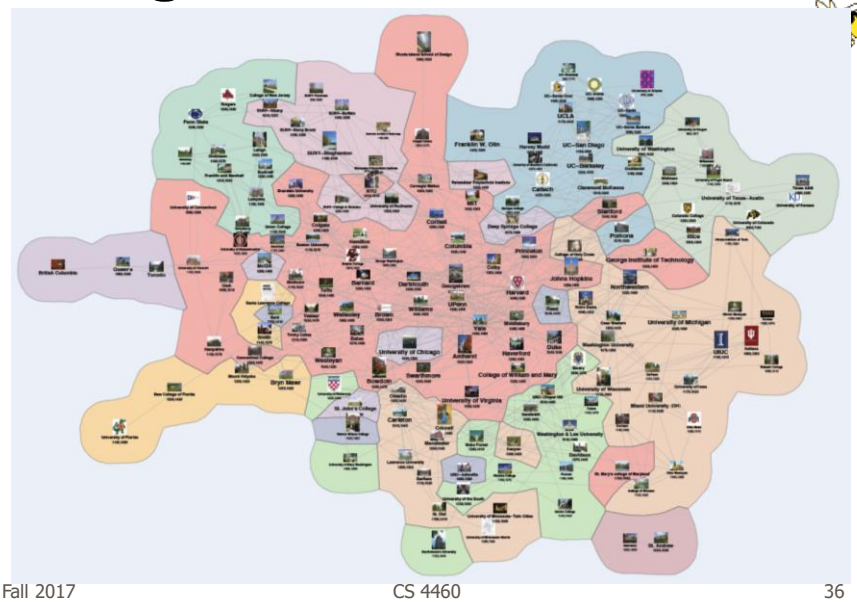

Joe Purdy
Fastball
Collective
Jeff Buckley
Jack Johnson
Counting Crows
Maroon 5
R.E.M.
Fort Minor
Avril Lavigne
The B-52's
Iggy Pop
Simple Minds
Blondie
Suzanne Vega
Tears for

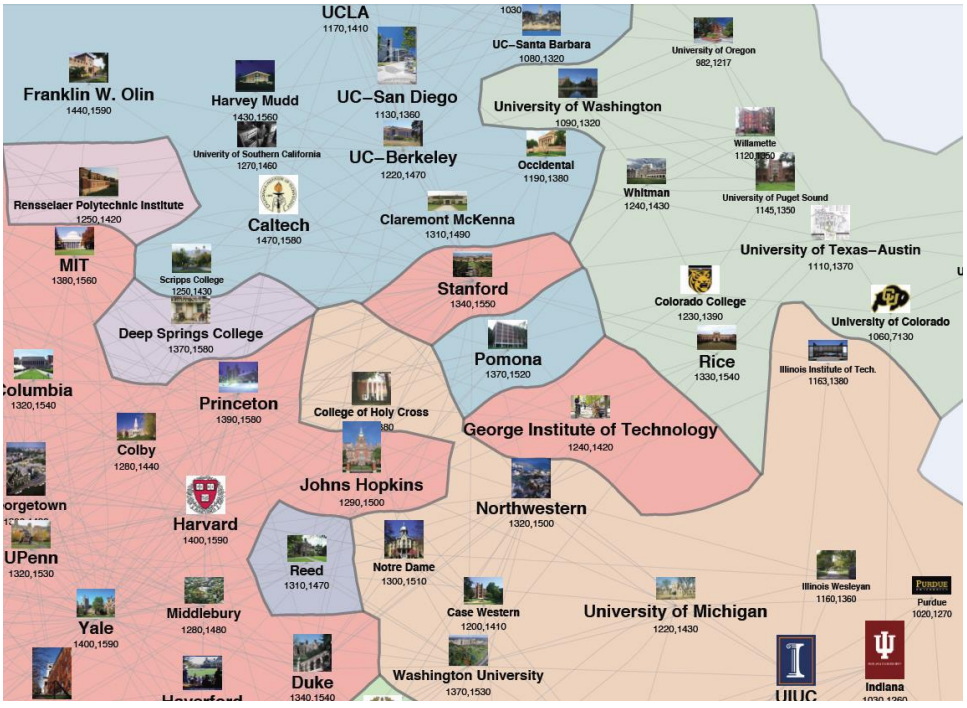
TV Shows


Highland
Lowlands
Premium Peninsula
Hungry


College Basketball
60 Minutes
Extra
Entertainment Tonight
The 81st Annual Academy Awards
2009 NBA Playoffs
MLB Baseball
2009 Australian Tennis Open
2009 NCAA Basketball Tournament
Wheel of Fortune
Jimmy Kimmel Live
NHL Hockey
Dateline NBC
Inside Edition
ESPNews
Super Bowl XLIII Pre-Game Show
The Insider
Super Bowl XLIII
The Tonight Show with Jay Leno
Presidential News Conference
NBC Nightly News
Nightline
Dancing with the Stars
Late Show with David Letterman
Presidential Address to Congress
Good Morning America
ABC World News with Charles Gibson
Basketball
Today
KVUE News
Late Night with Jimmy Fallon
The Oprah Winfrey Show
Wife Swap
Law & Order
The 51st Annual Grammy Awards
The Bachelor 13
The Amazing Race 14
The Ellen DeGeneres Show
Private Practice
48 Hours Mystery
The O.C.
The Morning Show with Mike and Juliet
NBC Nightly News Weekend Edition
PGA Tournament
Last Call with Carson Daly
True Beauty
Live with Regis & Kelly
20/20
Judge Judy
Late Night with Conan O'Brien
Jerry Springer
General Hospital
Heroes
Life on Mars
Judge Alex
Divorce Court
Cristina's Court
Medium
One Life to Live
The View
Deal or No Deal
KVUE News Daybreak
All My Children
CBS Evening News
Judge Mathis
Judge Joe Brown
The Martha Stewart Show
Poker After Dark
The People's Court
Chuck
The Early Show
Days of Our Lives
Life
The Bonnie Hunt Show
Friday Night Lights
Beverly Hills
Who Wants to Be a Millionaire?
Howie Do It
The Young and the Restless
FOX 26 News at 10pm
Family Feud
Good Day Columbus
The Bold and the Beautiful
Good Morning America Weekend
Southland
As the World Turns
The Mentalist
Kings
Criminal Minds
Flashpoint
10TV News HD at 11pm
Guiding Light
ABC World News Now
Survivor: Tocantins – The

Colleges





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- Describe and explain contribution of following network visualization systems
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Upcoming

- Lab 8: Interactivity 2
  - Prep: Murray chapter 10
- Text and Documents
  - Prep: Viegas & Wattenberg article