Lecture 12: Graphs and Trees

Information Visualization
CPSC 533C, Fall 2007

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Proposal Writeup Expectations

- project title (not just “533 Proposal”)
- names of all people on team
- description of the domain, task, and dataset
- personal expertise/background in area
- proposed infovis solution
- scenario of use
- mockup/illustration of proposed interface
- implementation ideas
- milestones and timeline
- previous work

http://www.cs.ubc.ca/~tmm/courses/533/projectdesc.html

Presentations

- I have posted topics/times
- I will soon post list of papers for each topic
  - pick at least two of your four papers from list
- timing
  - 30 min present
  - 8 min questions

Readings Covered

Graph Visualisation in Information Visualisation: a Survey. Ivan Herman, Guy Melancon, M. Scott Marshall. IEEE Transactions on Visualization and Computer Graphics, 6(1), pp. 24-44, 2000. http://citeseer.nj.nec.com/herman00graph.html

Cushion Treemaps. Jack J. van Wijk and Huub van de Wetering, Proc InfoVis 1999, pp 73-78. http://www.win.tue.nl/~vanwijk/ctm.pdf

Multiscale Visualization of Small World Networks. David Auber, Yves Chiricota, Fabien Jourdan, Guy Melancon, Proc. InfoVis 2003. http://dept-info.labri.fr/~auber/documents/publi/auberIV03Seattle.pdf

Topological Fisheye Views for Visualizing Large Graphs. Emden Gansner, Yehuda Koren and Stephen North, IEEE TVCG 11(4), p 457-468, 2005. http://www.research.att.com/areas/visualization/papers_videos/pdf/DBLP-conf-infovis-GansnerKN04.pdf

IPSep-CoLa: An Incremental Procedure for Separation Constraint Layout of Graphs. Tim Dwyer, Kim Marriott, and Yehuda Koren. Proc. InfoVis 2006, published as IEEE TVCG 12(5), Sep 2006, p 821-828. http://www.research.att.com/~yehuda/pubs/dwyer.pdf

Further Readings

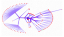
Online Dynamic Graph Drawing. Yaniv Frishman and Ayellet Tal. Proc EuroVis 2007, p 75-82. http://www.ee.technion.ac.il/ ayellet/Ps/OnlineGD.pdf

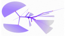
Animated Exploration of Graphs with Radial Layout. Ka-Ping Yee, Danyel Fisher, Rachna Dhamija, and Marti Hearst, Proc InfoVis 2001. http://bailando.sims.berkeley.edu/papers/infovis01.htm

Interactive Information Visualization of a Million Items Jean-Daniel Fekete and Catherine Plaisant, Proc InfoVis 2002. [http://www.cs.umd.edu/local-cgi-bin/hcil/rr.pl?number=2002-01]

Hermann survey

- true survey, won’t try to summarize here
- nice abstraction work by authors
  - Strahler skeletonization
  - ghosting, hiding, grouping



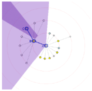
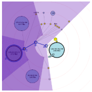


Dynamic Graph Layout

- static radial layouts: known algorithm
- dynamic: recent progress
  - minimize visual changes
  - stay true to current dataset structure
- Online Dynamic Graph Drawing: Frishman and Tal, EuroVis 2007 [video]

Animated Radial Layouts

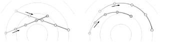
- video

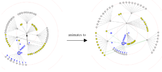
[Animated Exploration of Graphs with Radial Layout. Ka-Ping Yee, Danyel Fisher, Rachna Dhamija, and Marti Hearst, Proc InfoVis 2001. http://bailando.sims.berkeley.edu/papers/infovis01.htm]

Animation

- polar interpolation



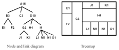
- maintain neighbor order (note prefuse bug!)

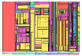


[Animated Exploration of Graphs with Radial Layout. Ka-Ping Yee, Danyel Fisher, Rachna Dhamija, and Marti Hearst, Proc InfoVis 2001.]

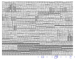
Treemaps

- containment not connection
  - emphasize node attributes, not topological structure



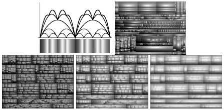


- difficulties reading

Cushion Treemaps

- show structure with shading
  - scale parameter controls global vs. local



Critique

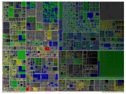
- good: use shading to free color for other encodings
- good: cushions do help show more internal hierarchical structure
- limitations: fundamental strength is unchanged
  - still best when focus is node attributes not topological structure

Treemap Applications

- cushion treemaps
  - SequoiaView, Windows app
  - hard drive usage
  - http://www.win.tue.nl/sequoiaview/
- one of the infovis tech-transfer success stories
  - http://www.cs.umd.edu/hcil/treemap-history/

Scaling Up Treemaps: MillionVis

- shading not outline to visually distinguish with less pixels
- more GPU tricks, animation for transitions



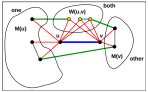
[Interactive Information Visualization of a Million Items. Jean-Daniel Fekete and Catherine Plaisant, Proc InfoVis 2002.]

Small-World Networks

- high clustering, small path length
  - vs. random uniform distribution
- examples
  - social networks
  - movie actors
  - Web
  - software reverse engineering
- multiscale small-world networks
  - exploit these properties for better layout

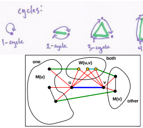
Strength Metric

- strength: contribution to neighborhood cohesion
- calculate for each edge based on
  - edge’s POV partition of graph: one, other, both



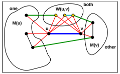
Strength via Cycles

- 3-cycles through (u,v) + 4-cycles through (u,v)



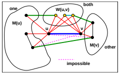
Cycles: Cohesion Measure

- 3-cycles through u/v
- blue + 2 red edges == yellow nodes in both



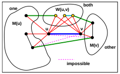
Cycles: Cohesion Measure

- 3-cycles through u/v
  - blue + 2 red edges == yellow nodes in both
- all other 3-cycles don't contain blue u/v edge
  - magenta edges impossible
  - black, red/green, red/black, etc



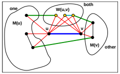
Cycles: Cohesion Measure

- 3-cycles through u/v
  - blue + 2 red edges == yellow nodes in both
- $\frac{\text{existing}}{\text{all possible}} = \frac{\text{yellow nodes}}{\text{all nodes}}$



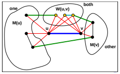
Cycles: Cohesion Measure

- 4-cycles through u/v
  - blue + 2 red + 1 green
  - blue + 2 red + 1 cyan
- $s(A,B) = \frac{\text{existing edges between sets}}{\text{all possible edges between sets}}$



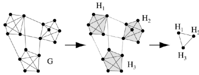
Strength

- 4-cycles [green edges]
  - one-both, other-both, one-other
  - s(M(u),W(u,v))+s(M(v),W(u,v))+s(M(u),M(v))
- 4-cycles [cyan edges]
  - both-both
  - s(W(u,v))
- 3-cycles [yellow nodes in both]
  - $|W(u,v)|/(|M(u)|+|M(v)|+|W(u,v)|)$



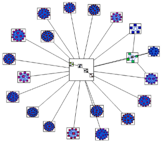
Hierarchical Decomposition

- remove low-strength edges
- maximal disconnected subgraphs
- quotient graph: subgraph = higher-level node



[Multiscale Visualization of Small World Networks. Auber, Chiricota, Jourdan, and Melancon. Proc. InfoVis 2003]

Nested Quotient Graphs



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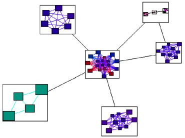
Nested Quotient Graphs



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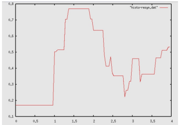
Clustering Quality Metric

- automatically determine how many clusters



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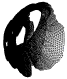
Critique

- pros
  - exploit structure of data
  - hierarchical structure shown visually
  - automatically determine number of clusters
  - nifty math
- cons
  - information density could be better
  - what if mental model doesn't match clustering metric?

Topological Fisheye Views

- input is laid-out graph
- preprocess: construct multilevel hierarchy by coarsening graphs
- user interactively controls focus point
- show hybrids made from several levels



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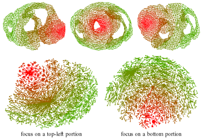
Topological Fisheye Views



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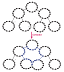
Coarsening Strategy

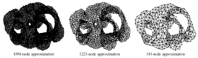
- must preserve graph-theoretic properties
  - topological distance (hops away), cycles
  - cannot just use geometric proximity alone
  - cannot just contract nodes/edges
  - exploit geometric information with proximity graph



[Topological Fisheye Views for Visualizing Large Graphs. Gansner, Koren and North, IEEE TVCG 11(4), p 457-468, 2005.]

Coarsening Requirements

- uniform cluster/metanode size
- match coarse and fine layout geometries
- scalable



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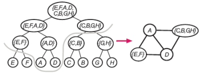
Hybrid Graph

- find active nodes



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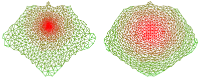
Distort For Uniform Density



(b) default layout of hybrid graph (c) distorted layout of hybrid graph

[Topological Fisheye Views for Visualizing Large Graphs. Gansner, Koren and North, IEEE TVCG 11(4), p 457-468, 2005.]

Critique

- topologically sophisticated, not just geometric distortion
- rigorous approach

IPSep-Cola

- use Dwyer's own talk slides for the great animations