
Online Dynamic Graph Drawing. Yaniv Frishman and Ayellet Tal. Proc EuroVis 2007, p 75-82.

Further Readings


Hermann Survey

- true survey, won’t try to summarize here!

- nice abstraction work by authors themselves
  - derived data: skeletonization via Strahler numbers
  - encoding techniques:
    - ghosting = layering
    - hiding = elision
    - grouping = aggregation

Trees: Basic Node-Link Drawings

- task/data abstraction
  - understanding detailed topological structure of tree
- visual encoding: layered node-link view
  - vertical position: distance from root node in hops
  - horizontal position: (as much symmetry as possible)

[http://gravite.labri.fr/?Want_to_work_with_us?:Hiring_puzzles:Tidy_Tree_Layouts]
Trees: Basic Node-Link Drawings

- **algorithm level:**
  - Wetherell and Shannon 1978, Tidy Drawings of Trees
  - Reingold and Tilford 1981, Tidier Drawing of Trees
  - Walker 1990, A Node-positioning Algorithm for General Trees
  - Buchheim et al 2002, Improving Walker’s Algorithm to Run in Linear Time

[http://gravite.labri.fr/?Want_to_work_with_us_](http://gravite.labri.fr/?Want_to_work_with_us_)
Trees: Radial Node-Link Drawings

- data abstraction: data stream, not static file
- encoding technique: radial not rectilinear layout
- interaction technique: animated transitions from old to new layout

[Fig 3, 5. Yee et al. Animated Exploration of Graphs with Radial Layout. Proc InfoVis 2001.]
Trees: Radial Node-Link Drawings

- animation requirements identified:
  - avoid center collapse/clutter by interpolate polar not rectilinear

- maintain neighbor order to stabilize (note prefuse bug!)

[Fig 2. Yee et al. Animated Exploration of Graphs with Radial Layout. Proc InfoVis 2001.]
Trees: Treemaps

- Data abstraction: tree nodes have attributes
- Task abstraction: emphasize node attributes, not topological structure
- Visual encoding: use containment not connection

[Fig 1. van Wijk and van de Wetering. Cushion Treemaps. Proc InfoVis 1999, pp 73-78.]
Cushion Treemaps

- visual encoding: also show nesting/topo structure more clearly with shading cues
- interaction: scale parameter controls global vs. local

Scaling Up Treemaps: MillionVis

- visual encoding: treemaps, scatterplots
  - darkness shows nesting level
- algorithm: many GPU tricks for speed
  - dynamic queries through Z buffering

[Fig 1. Fekete and Plaisant. Interactive Information Visualization of a Million Items. Proc InfoVis 2002, p 117-124.]
Scaling Up Treemaps: MillionVis

- interaction: animated transitions
- visenc requirement: stable layout

[Fig 4a. Fekete and Plaisant. Interactive Information Visualization of a Million Items. Proc InfoVis 2002, p 117-124.]
Scaling Up Treemaps: MillionVis

- scalability requires care at visual encoding level
  - not just algorithm level!
  - to visually distinguish with fewer pixels, use shading not outline

[Fig 2. Fekete and Plaisant. Interactive Information Visualization of a Million Items. Proc InfoVis 2002, p 117-124.]
Graphs: Hierarchical Layout

- visual encoding
  - vertical position: distance from root
  - does not mean using containment

- algorithms
  - Gansner et al 1993, A Technique For Drawing Directed Graphs
  - Eiglsperger et al 2005, An efficient implementation of Sugiyama’s algorithm for layered graph drawing
Graphs: Circular Layout

- visual encoding
  - nodes on circle
  - edge crossings minimized

- algorithms
  - Six and Tollis 1999, A Framework for Circular Drawings of Networks
Graphs: Force-Directed Placement

- visual encoding
  - nondeterministic placement
- algorithm
  - spring forces pull together edges, repulsive forces pull apart nodes
  - optimization framework easy to extend, but tends to be brittle
- algorithms
  - Fruchterman and Reingold, 1991, Graph Drawing By Force-Directed Placement
  - Kamada and Kawai, 1989, An Algorithm For Drawing General Undirected Graphs
Online Dynamic Graph Drawing

- data abstraction: streaming data not static file
- task abstraction: dynamic stability (tradeoff)
  - minimize visual changes
  - stay true to current dataset structure

[Fig 1. Frishman and Tal. Online Dynamic Graph Drawing. Proc EuroVis 2007, p 75-82.]
Online Dynamic GD: Algorithm

- static graph layout algs unstable
  - small changes in input can have large changes in output
  - randomness, no constraints on maintaining geometric proximity

- dynamic online algorithm
  - first step: initialize, layout
  - later steps: merge, pin, layout, animate
  - acceleration: partition before GPU force-directed layout
Online Dynamic GD: Validation

- **algorithm level**
  - complexity analysis
  - benchmarks: running time for CPU and GPU versions

- **visual encoding level**
  - qualitative discussion of result images/video
  - quantitative metrics:
    - pairwise avg node displacement for stability
    - potential energy for quality
    - compare static, full dynamic, dynamic without pinning
Critique

**Strengths**
- Strong algorithmic contribution
- Previous work not scalable
- Very good validation, matches technique contribution
- Best paper award, EuroVis 2007

**Weaknesses**
- Using mesh datasets to test graph drawing claims
- Different topological characteristics than typical infovis case

[Fig 3a. Frishman and Tal. Online Dynamic Graph Drawing. Proc EuroVis 2007, p 75-82.]
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[Fig 3a. Frishman and Tal. Online Dynamic Graph Drawing. Proc EuroVis 2007, p 75-82.]
Multi-level Graphs

- data abstraction: create cluster hierarchy on top of original graph (coarsening)

Multi-level Graphs: GrouseFlocks

- visual encoding: containment
- interaction: expand/contract metanodes to change graph cut

Small-World Networks

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

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

[Fig 2. Auber et al. Multiscale Visualization of Small World Networks. Proc. InfoVis 2003, p 75-81.]
Small World: Nested Quotient Graphs

- visual encoding
  - containment: subgraph laid out within metanode

[Fig 3. Auber et al. Multiscale Visualization of Small World Networks. Proc. InfoVis 2003, p. 75-81.]
Small World: Nested Quotient Graphs

- pro: very evocative of structure
- con: does not scale past 2-3 levels of depth

[Fig 5. Auber et al. Multiscale Visualization of Small World Networks. Proc. InfoVis 2003, p 75-81.]
Topological Fisheye Views

- data abstraction
  - input is laid-out graph
  - construct multilevel hierarchy by coarsening graphs
- interaction: user controls focus point
- visual encoding: show hybrid view made from cut through several levels

Topological Fisheye Views

Topo Fisheye: 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

Topo Fisheye: Coarsening Requirements

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

find active nodes

Topo Fisheye: Distort For Uniform Density

- visual encoding
  - geometric distortion for uniform density
  - (colorcoded by depth in hierarchy to illustrate algorithm)

Critique

- Strengths:
  - Topologically sophisticated, not just geometric distortion
  - Rigorous approach

- Weaknesses (shared by many approaches):
  - What if mental model does not match coarsening strategy?
  - Again, meshes for evaluating InfoVis claims
Critique

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PivotGraph

- task abstraction: show relationship between node attributes and connections in multiattribute graph
- data abstraction: rollup and selection transformations

PivotGraph

- visual encoding: line (1D) or grid (2D), area proportional to attribute
  - grid nodes based on attribute count, not original graph node count!
- scalability through abstraction, not layout algorithms

Node and Link Diagram

PivotGraph Roll-up
PivotGraph

- visual encoding: line for 1D rollup, or grid for 2D case

interaction: changing rollup/selection choices, animated transitions between states

PivotGraph

- in general, more compact than matrix view

Presentation Topics

- see course page for your day/topic
- seed papers coming soon for Wed Nov 9 folks