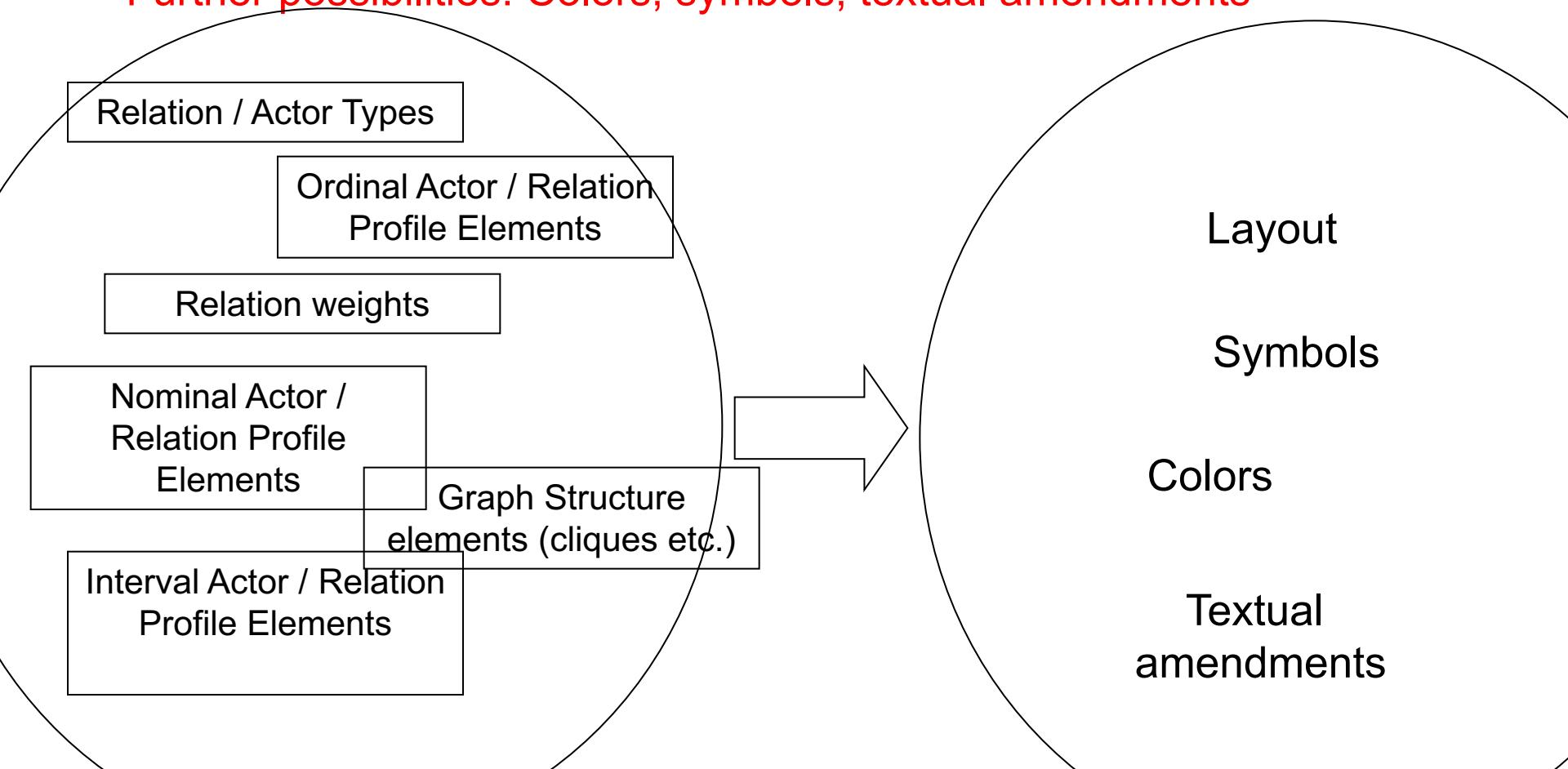

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

- What we saw **so far**: How to draw a graph so that certain “quality criteria” are met; **Concentration on layout**
- **Further possibilities:** Colors, symbols, textual amendments



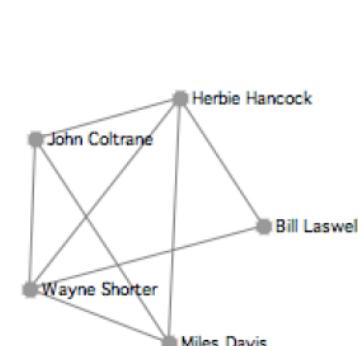
Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

- Layout: Examples:

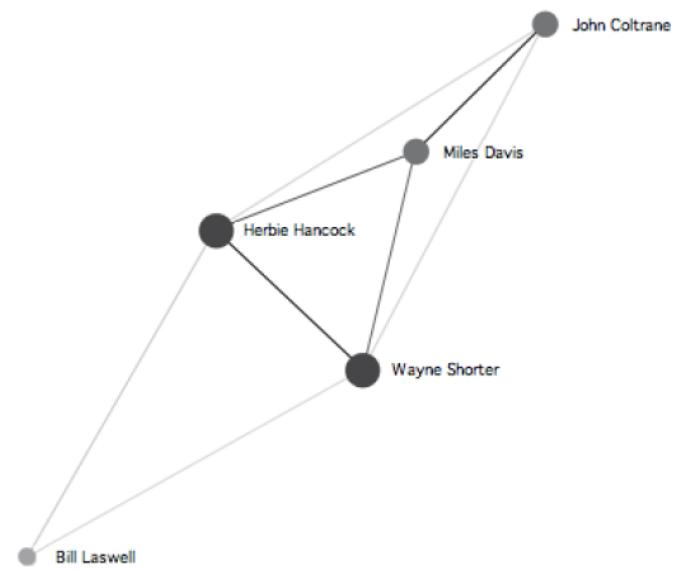
Kamada Kawai

Planar Graph drawing

Fruchterman Reingold



(a) Unweighted edges & nodes.



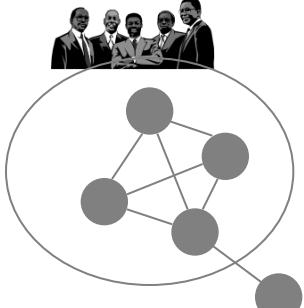
Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

- Symbols: Examples:

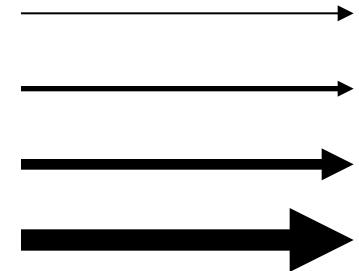
node symbols / design:



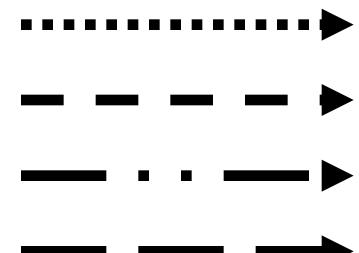
node / graph structure symbols / design:



edge thickness:



edge patterns:



edge symbols / design:



Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

- Color: Examples:
 - (Continuous) **Color Temperature**: E.g. Use Hot Colors for active edges (that are often “instantiated”), edges with high weight, active actors etc. and cold colors for inactive edges or actors or low weight edges etc.
 - Use a **distinct set of n colors** for different actor / relation types.
Problem: Maximize color difference → In 3 valued color spaces (RGB etc.) or 4 valued color spaces (CMYK, RGBA etc.): Find n vectors on unit spheres of corresponding dimension so that angles are maximized → interesting combinatorial / abstract mathematical problem; very complex aspects (see [2]) → use numerical approach (→ e.g. charged particles)

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Further possibilities:

- Interactive SN visualizations:
 - Zooming
 - Change Projection (3D)
 - Click on / Point to Actor / Relation to get further information
 - Click on / Point to Actor / Relation to invoke service (e.g. instantiate communication channel)
- SN visualizations with hierarchical graphs: E.g. for every clique introduce “supernode”
- SN visualizations with multigraphs: Two nodes can be connected by more than one edge (e.g. of different types)
- SN visualizations with hypergraphs: An edge can connect more than one node (e.g. have cliques connected by special “clique edge”)

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

- **Goal** of dynamic social network visualization: Visualize not only structure of a SN “as it is” but: **Visualize dynamics** of a social network:
 - **edges** appear / disappear, change weights, change type;
 - **nodes** appear / disappear, change profile etc.
- Either **animated** / unanimated sequence of graphs (each graph corresponding to a time slice t_i or a “**stacked**” view of the graph at the current time slice and the time slices before). (Examples later).
- Main goal / Quality criterion:
Preserving the mental map \leftrightarrow How long does it take to re-familiarize oneself with new graph layout by re-identifying important nodes and most important structural features of graph.
“**Communicate the changes**”[15]

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Quality criteria: more detailed (see [15])

- Movements of nodes and edges should be easy to follow
- Movements of / in the graph should be structured (Uniform movement, symmetric movement, 2D Proj of 3D structure...)
- Smooth transitions
- No display of non-existing structures
- Individual frames should satisfy the classical criteria for good graph drawings (see chapter 3)
- Minimize temporary edge crossings.
- Minimize the length of the movement path of a node

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Software Packages for Graph Drawing and Social Network Visualization

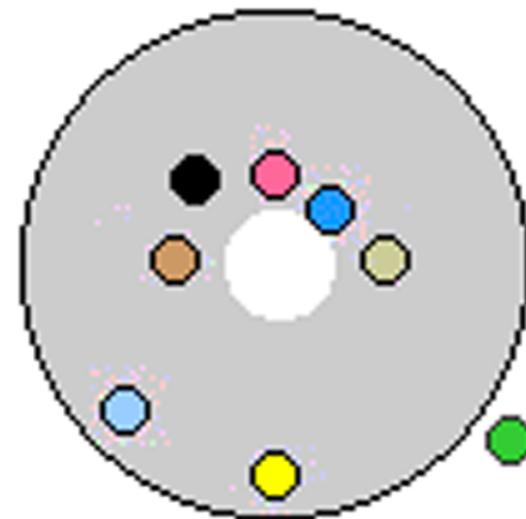
- We will investigate **software packages** for general visualization of SN in the context of the general discussion on general purpose software (tool sets) for social network analysis in a **later chapter** of the lecture
- We will now take a look at specific “solutions” (**original papers**) on dynamic social network visualization

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic viz. of “activity” while using social media:

Examples: Babble + PeopleGarden

- Both not viz. of dynamic SN in the narrower sense but: Dynamic “Activity” may be an **indirect hint** for dynamic network centrality; also: two users being both active at a given time interval may also have a higher probability of interacting in that interval (\rightarrow **indirect hint for dyn. SN edge**)
- Babble [3]: **Viz. of activity in a chat: Distance to center \rightarrow Activity; Compare Milgram’s crowd metaphor [4] (center & fringe)**



Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic viz. of “activity” while using social media:
Examples: Babble + PeopleGarden

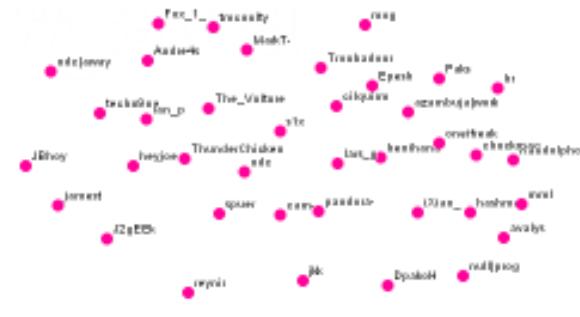
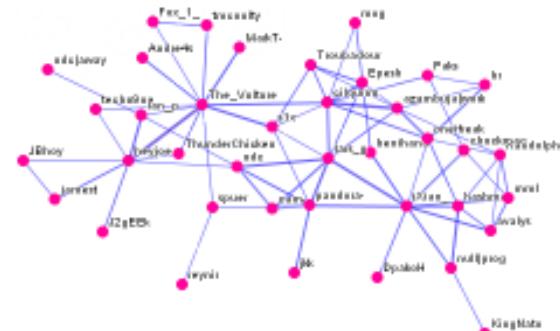
- PeopleGarden [5]: Viz. of activity in communities (discussion boards etc.): Flower paradigm
- Height of flower: Time of first posting (\rightarrow how long “member”)
- Bloom / blossom:
 - number of petals \leftrightarrow number of postings;
 - color saturation: age of postings;
 - color: post or reply



Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN viz. Examples

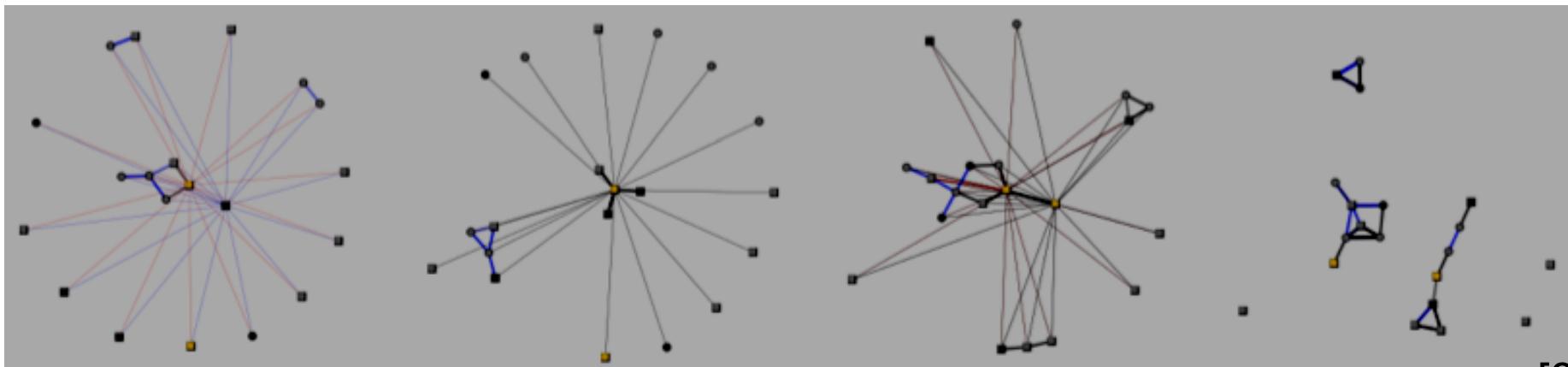
- PieSpy [6]: Viz. dyn SN inferred from IRC channels
 - Series of SN drawings at given time interval; no animation → some abrupt changes (→ sometimes no preserving of mental map)
 - Fruchterman-Reingold based drawing; disconnected components hindered of drifting too far away by repelling force cutoff
 - Ability to suppress edges → better “readability” (only proximity of nodes)



Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN viz. Examples

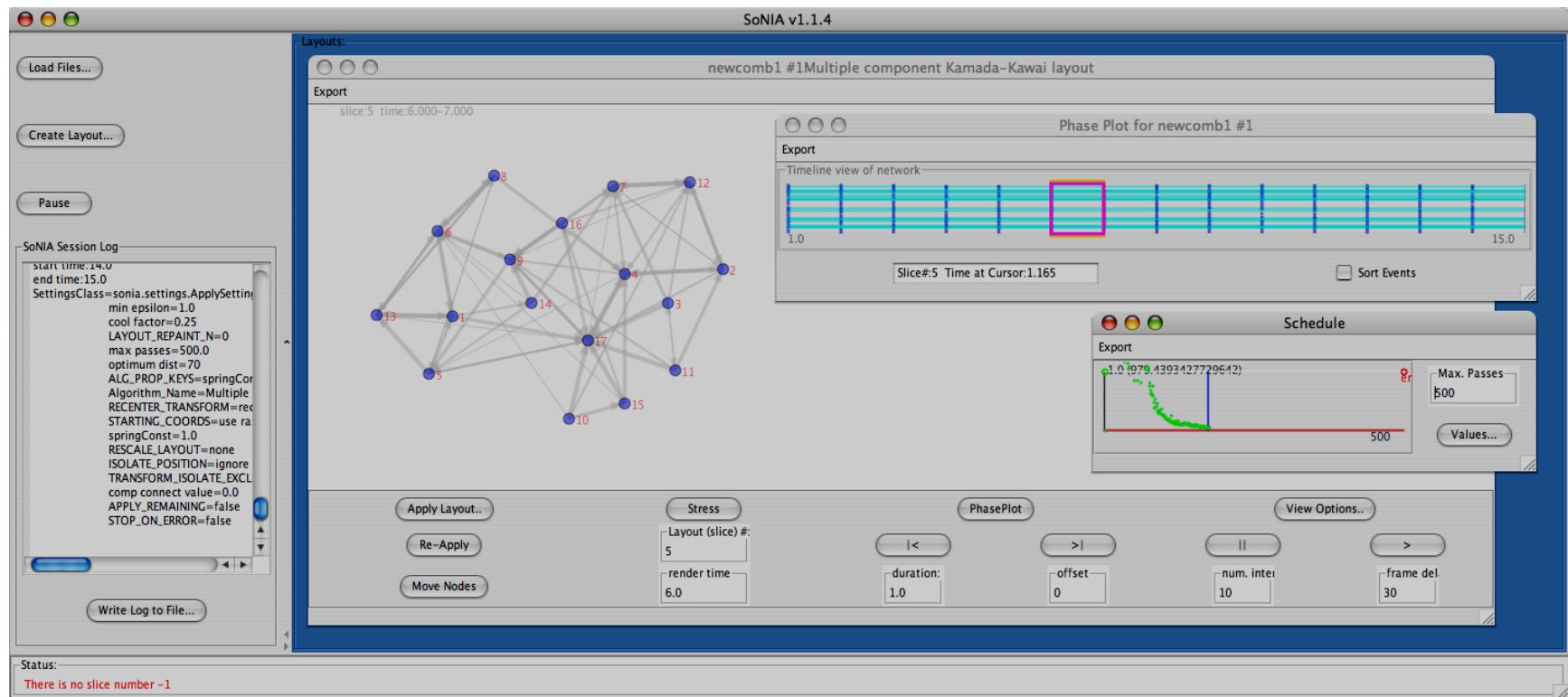
- SoNIA [7,8,9] (Social Network Image Animator): General purpose dynamic SN visualizer
- In each time slice: **relational events** → aggregated into SN; smooth transition animation between slices
- Various **options**: Layout alg (FR, KK, etc.); initial node positioning (random, circular, previous slice etc.); **centering of layout** (canvas center, barycenter); **max. number of iterations** for layout alg. **etc.**; Works together with standard SN software (eg. Pajek)



Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN viz. Examples

- SoNIA [7,8,9] (Social Network Image Animator): General purpose dynamic SN visualizer



[7,1]

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN viz. Examples

- SoNIA [7,8,9] (Social Network Image Animator): General purpose dynamic SN visualizer: Problem of choosing the right time slice

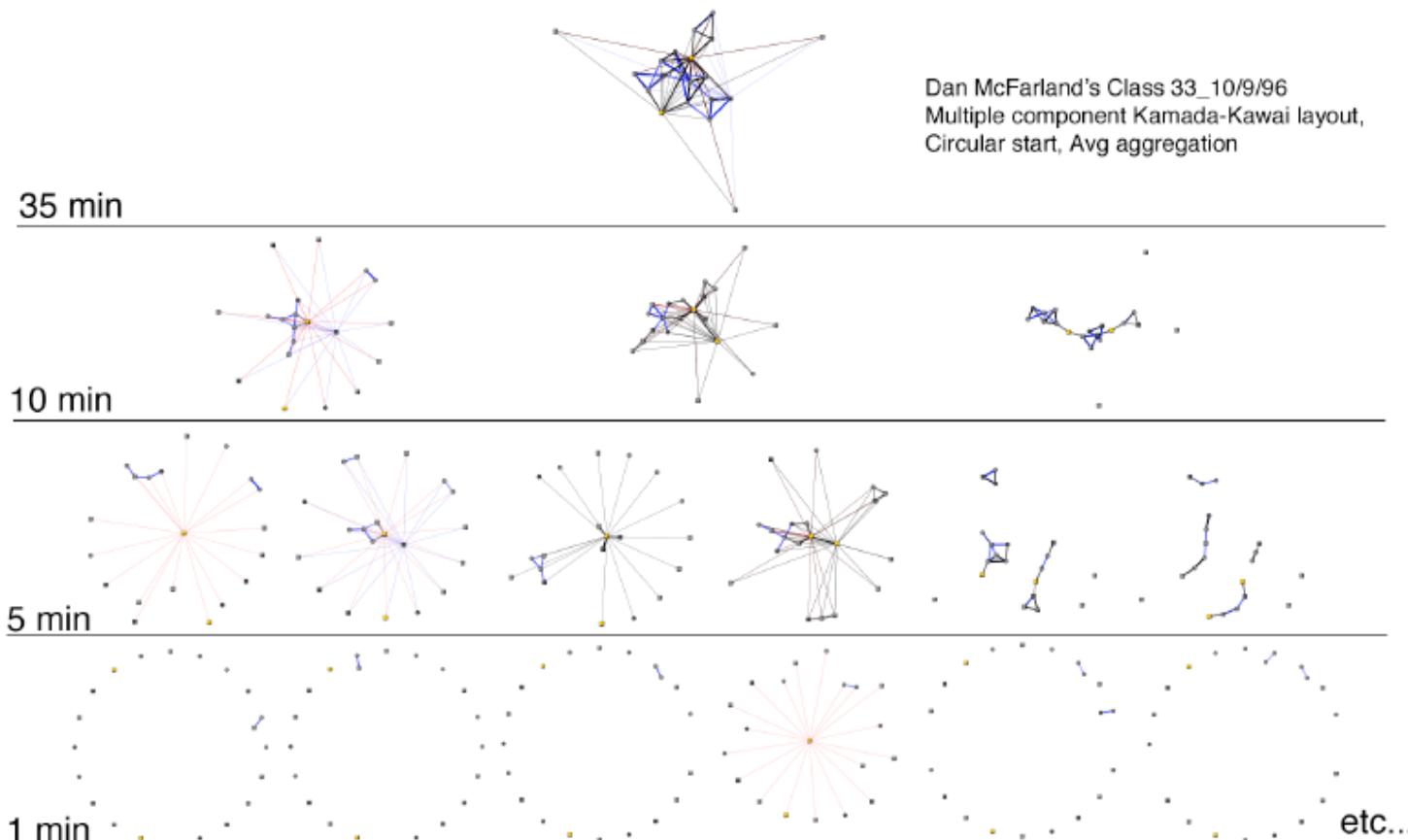
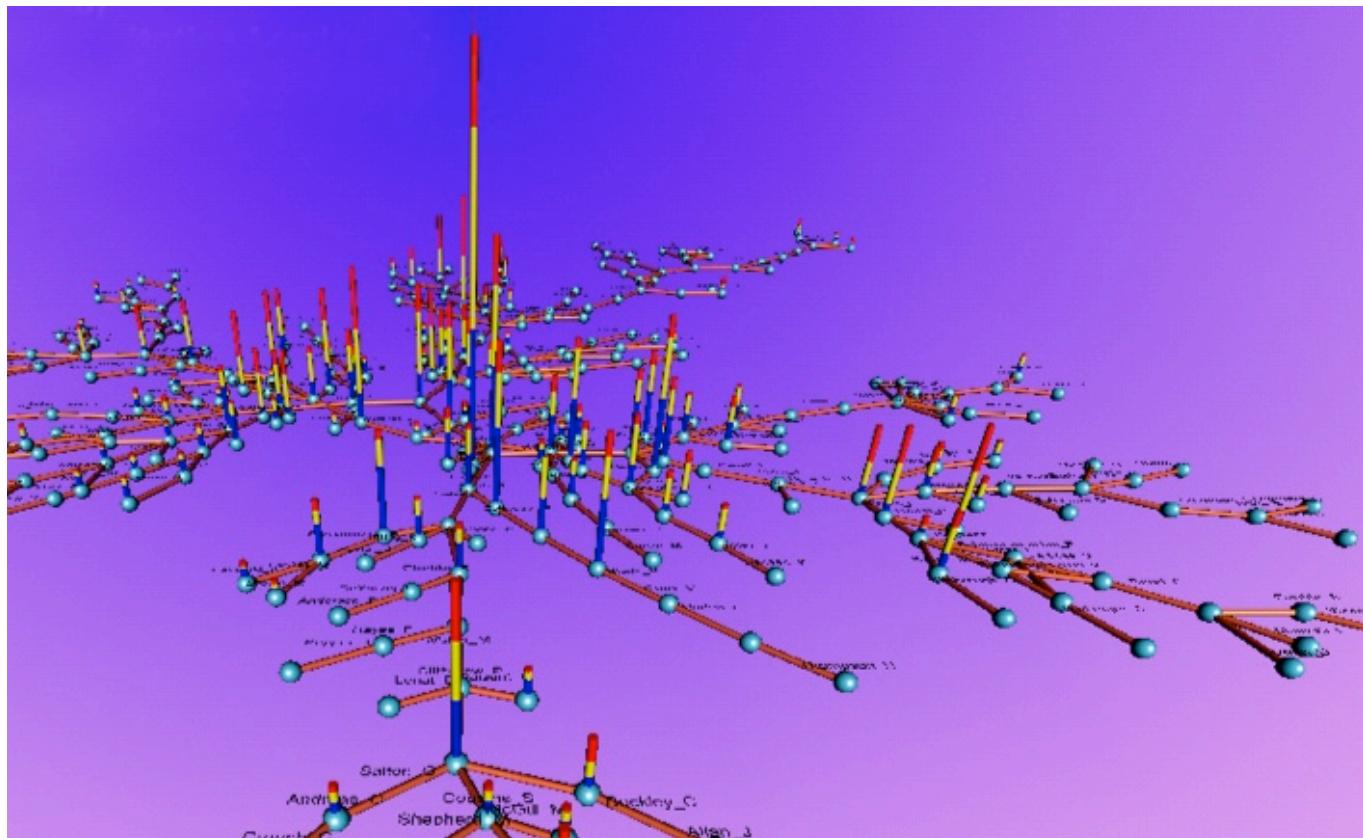


Figure 1. Interaction data from McFarland's classroom observations viewed at various levels of time aggregation from 35 minutes (one entire class period) to 1 minute (two to three turns of interaction).

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN viz. Examples

- Chen & Carr [10,11] Co-citation dynamic network visualization
- co-citation network with stacked bars that indicate citations of an author → frequency of co-citation events

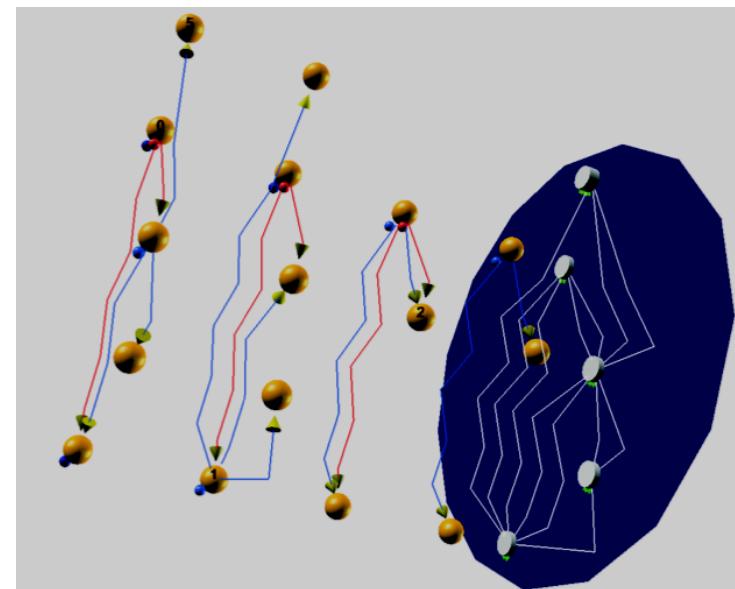


Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN viz. Examples

Forsighted layout [13] / Graphs they are changing [12]

- Visualize Dynamic graph where nodes and edges appear from slice to slice
- Idea: Draw **Supergraph** where all edges and nodes of all times are contained; In each slice: draw subgraph
- nodes and edges do **not change positions** / curvature between slices
- Nodes / Edges existing at disjoint slices only may be **grouped and positioned at similar positions** of subsequent time slices
- In [12] **movement tolerance** of nodes is introduced to make layout more compact; several other variations of static placement are introduced



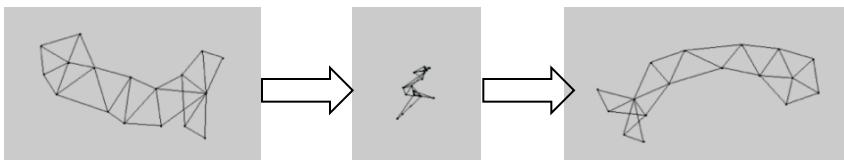
[13]

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

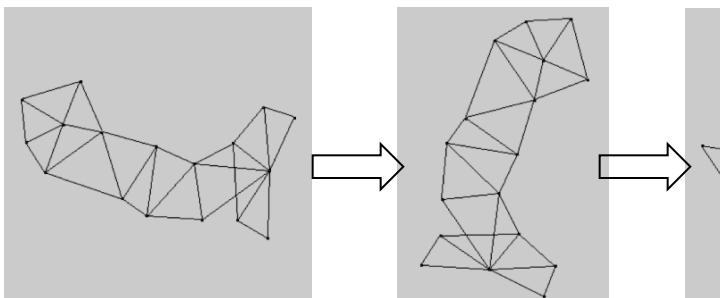
Dynamic SN viz. Examples

Graph Drawing in Motion [15] : Preserving the Mental Map in Dyn.
Graph Drawing by:

- minimize changes or animate transitions between time slices
- Further methods: avoid temporary edge crossings, maintain minimal dist. betw. nodes (if poss.); maintain symmetry of structures, move graphs “like rigid objects”;



bad animation (linear interpolation)



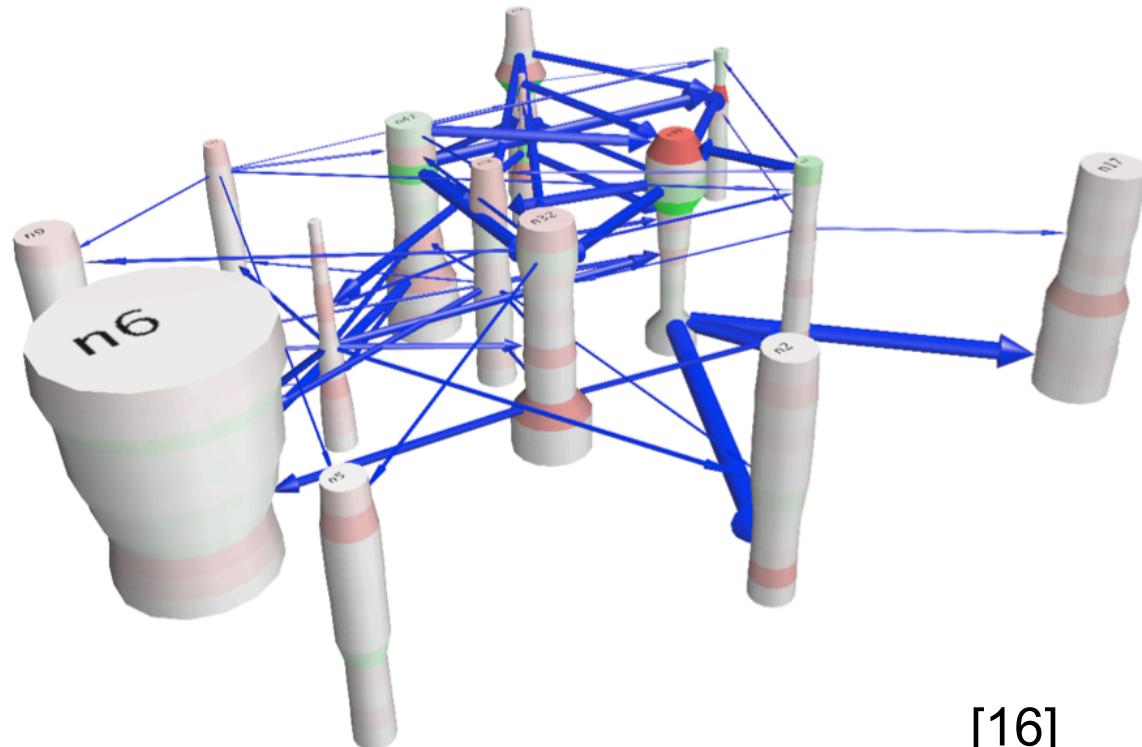
better animation

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic Data Viz. Examples with Graphs

Fund Manager Flow Graph [16,17]

- “Movement” ($B \rightarrow A$: Transaction: Buying shares of company A and Selling shares from B) of fund managers between company shares
- 2,5D: Time is z-axis;
Movement: edge; Edge-weight (thickness): Value of transferred shares; Radius of company-cylinder: Value of current share (red: loss, green: gain)
- Graph layout: Force directed alg. (Frick)
- Click on edge: Information on fund manager that initiated the transaction



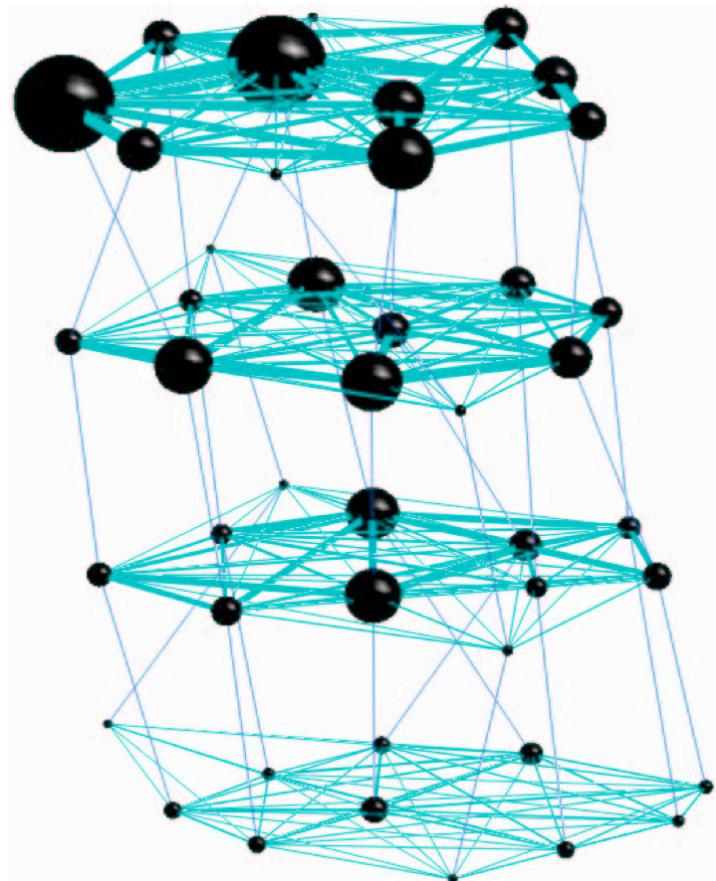
[16]

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN Viz. Example:

GraphAEL [18,19]

- 2.5D co-citation network; Node weight (diameter): “Productivity” of author; Edge weight (thickness) : “Intensity” of collaboration
- Intertemporal edges:
Identify corresp. nodes
- Each time slice: force directed layout (modified KK)

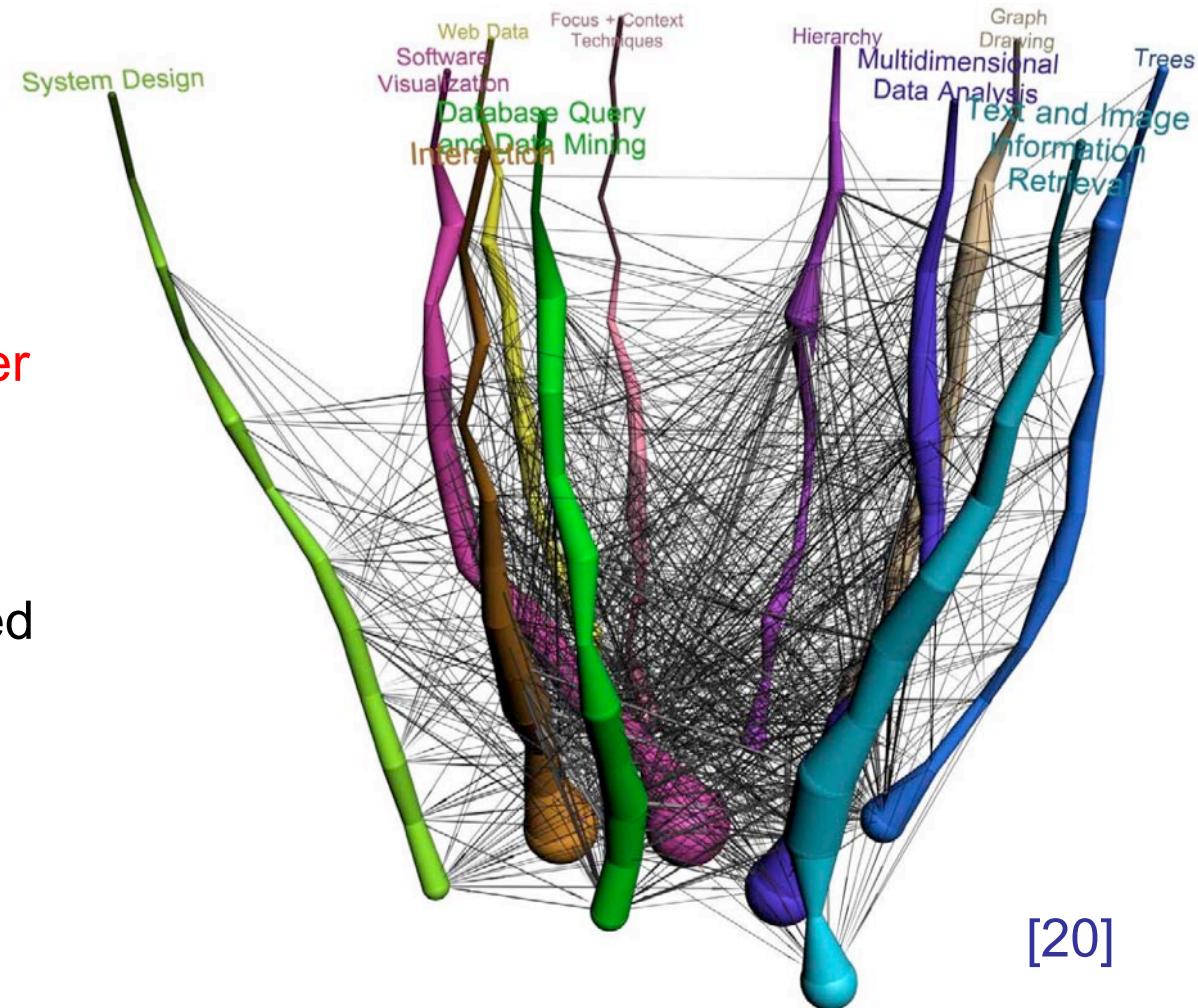


[18]

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic Temporal Data Viz. Example: Research Area Evolution Network [20]

- 2.5D citation network
Nodes: All Papers of a particular research area;
Edges: Citations; Node weight (diameter): number of citations or research area; No Edge weight



Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN Viz. Example:

Dyson [1]

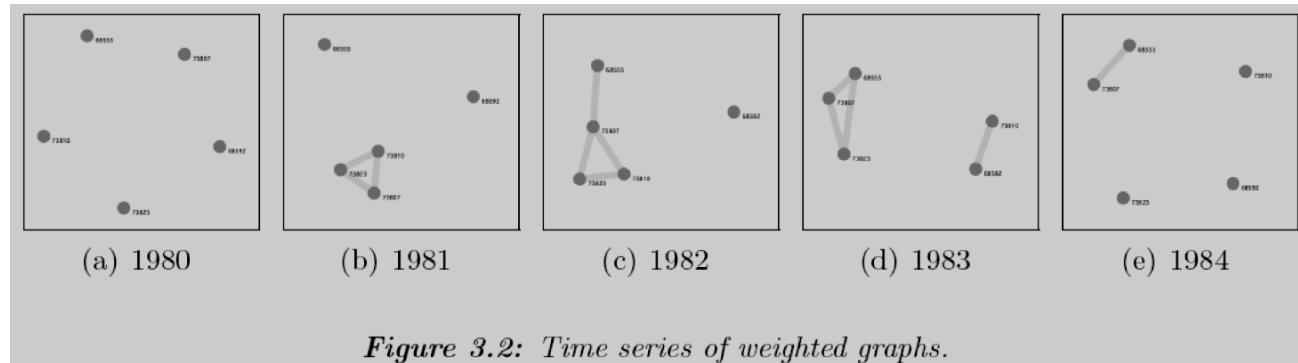
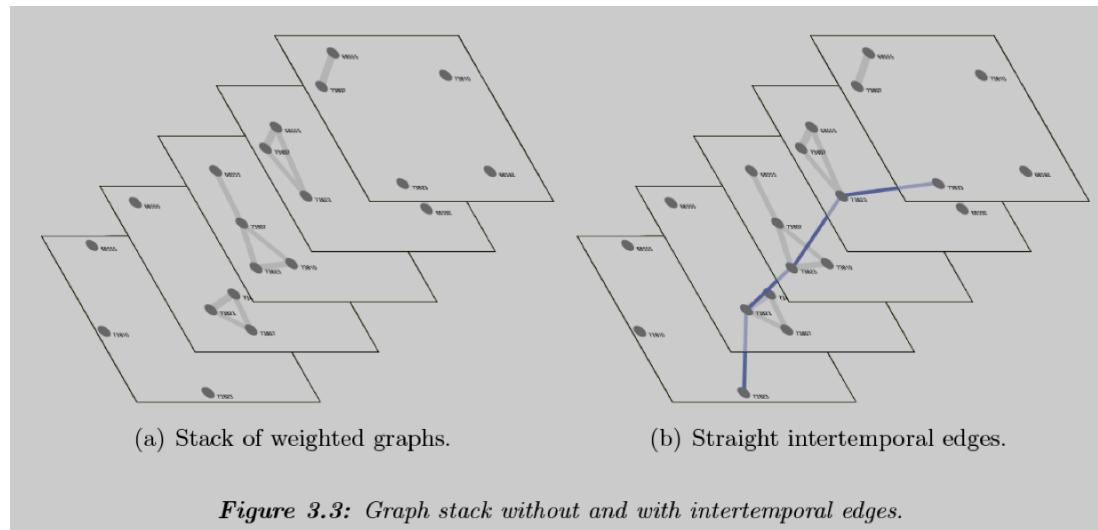


Figure 3.2: Time series of weighted graphs.

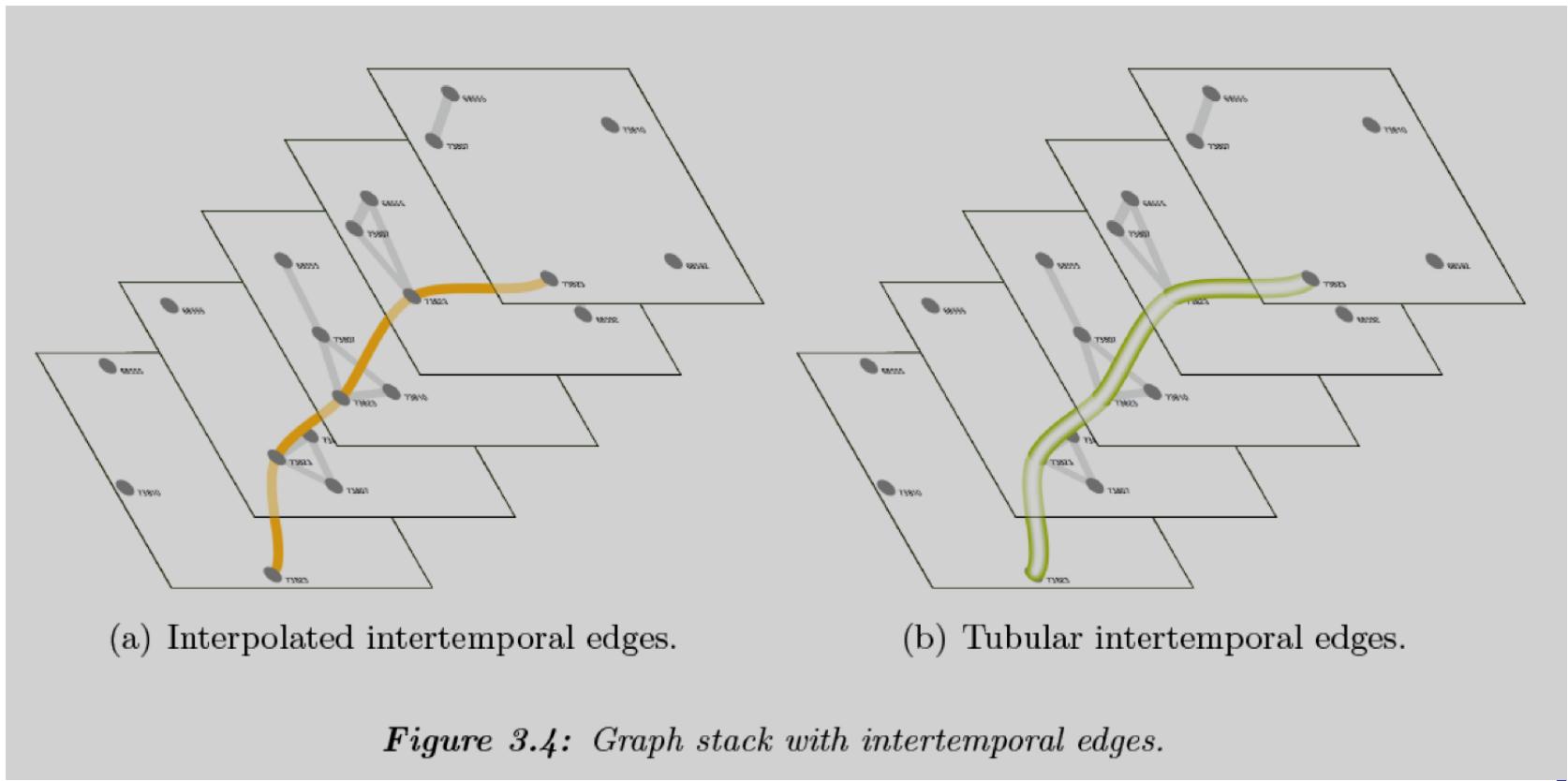
[1]



Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN Viz. Example:

Dyson [1]

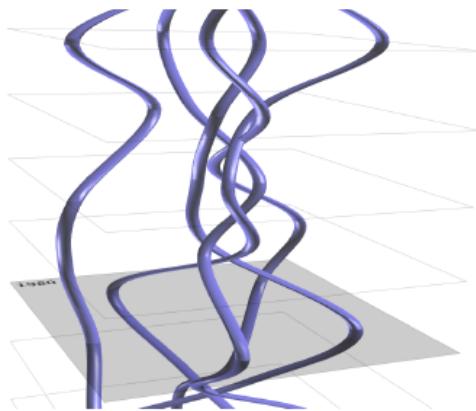


[1]

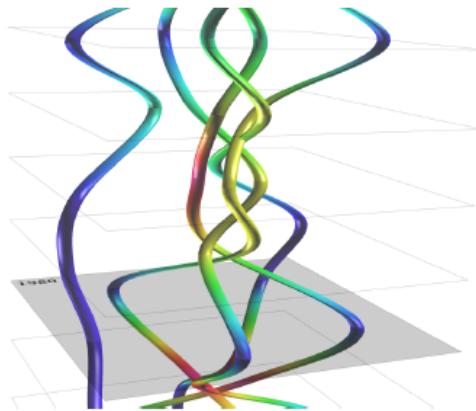
Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN Viz. Example:

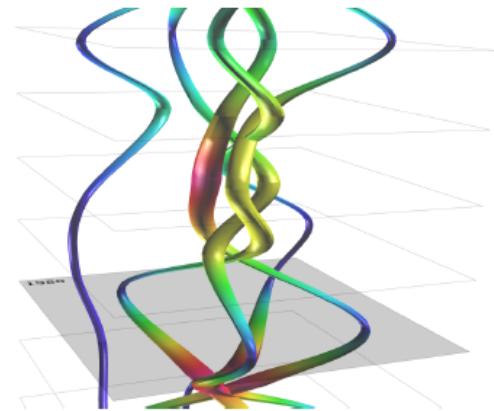
Dyson [1]



(a) Tube-only display



(b) Color mapping



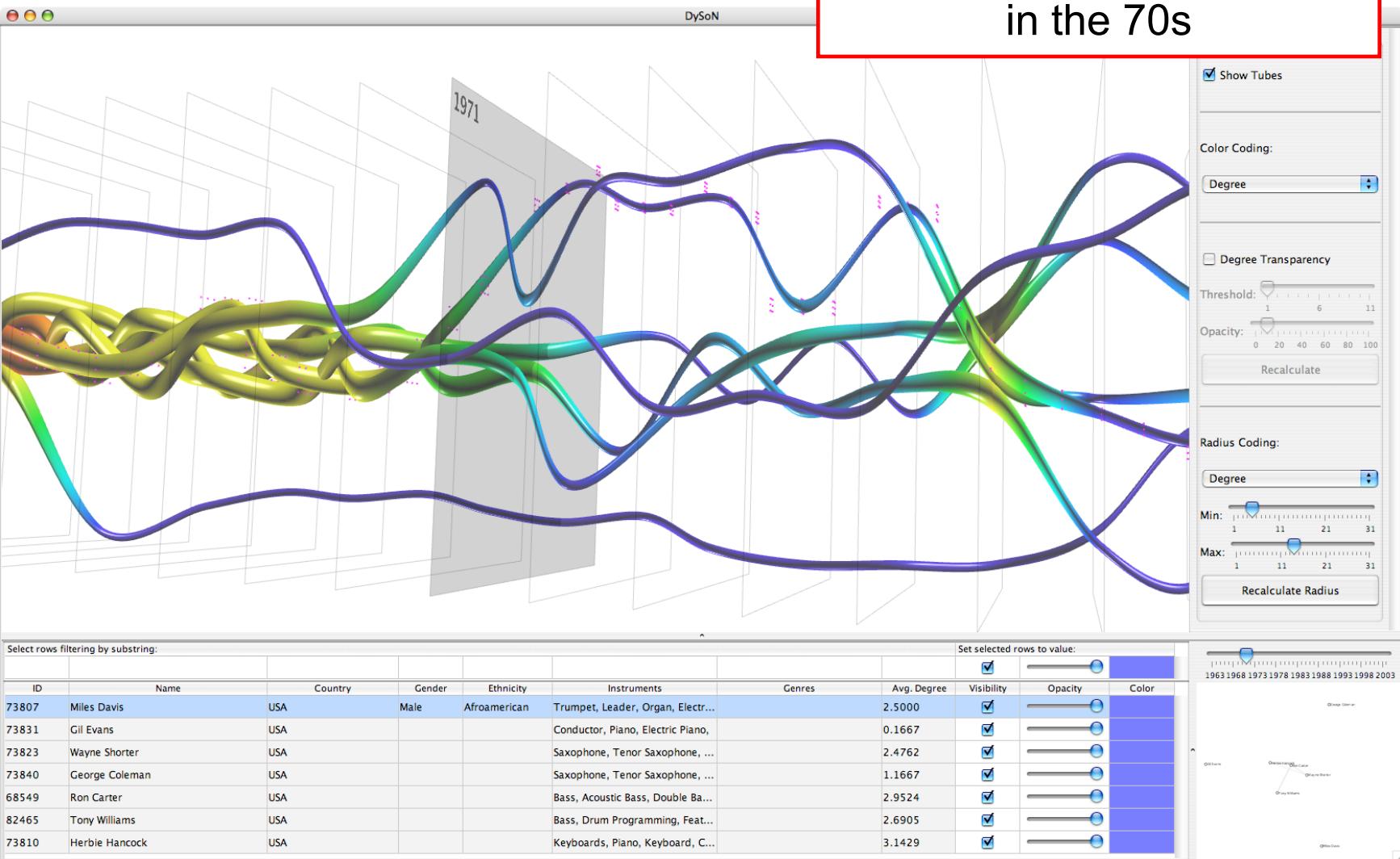
(c) Color and radius mapping

Figure 3.5: Tube-only model without and with mapping of degree centrality onto temporal axis.

[1]

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN Viz. Example: Dyson [1]



Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN Viz. Example:

Dyson [1]

- Each time-slice layout: modified FR algorithm: Attractive forces:

$$\frac{\delta^2}{k} \rightarrow \frac{\delta^2}{k} w(e_i)$$

- Gravitational force to center
- Preserving the Mental Map: Use final layout of slice t_i as initial layout of slice t_{i+1} ; Introduce spring forces between node position and initial node position. (force is inverse proportional to degree change of node (compared to previous timeslice) \rightarrow nodes with no changes in degree move less).

Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

Dynamic SN Viz. Example:

Dyson [1]

- Modify gravitational forces further: **emphasize node (degree) centrality**

$$F_{grav}(v) \rightarrow F_{grav}(v) (\deg(v) + c)$$

→ nodes with high centrality move to center

- depict node “activity” (number of social “events” in current slice) by **color temperature**: hot colors → high activity
- depict further node profile element (or also “activity”) as **node diameter**
- interpolate node’s layout locations & diameters in different time slices → **tube metaphor**

Recommended Readings

- Select two papers from the shown example systems;
- Especially Recommended are: [9] (Excellent overview), [6], [15]

Citations

- (1) Holger Hanstein: "Interactive visualization of dynamic social networks" Master's Thesis, TU-München, Falultät für Informatik, LS Prof. Schlichter, Betreuer: G.Groh, 2007
- (2) <http://www.maths.unsw.edu.au/school/articles/me100.html> (URL May 2008)
- (3) Erin Bradner, Wendy A. Kellogg, and Thomas Erickson. The adoption and use of BABBLE: a field study of chat in the workplace. In Proceedings of the Sixth European conference on Computer supported cooperative work, pages 139–158, Norwell, MA, USA, 1999. Kluwer Academic Publishers. www.research.ibm.com/SocialComputing/Papers/AdoptionOfBabble.htm (URL May 2008)
- (4) Stanley Milgram. The individual in a social world - Essays and Experiments. Series in social psychology. Addison-Wesley, Reading, Massachusetts, 1977.
- (5) Rebecca Xiong and Judith Donath. Peoplegarden: creating data portraits for users. In UIST '99: Proceedings of the 12th annual ACM symposium on User interface software and technology, pages 37–44, New York, NY, USA, 1999. ACM Press. <http://doi.acm.org/10.1145/320719.322581>
- (6) Paul Mutton. Piespy social network bot – inferring and visualizing social networks on irc, 2006. <http://www.jibble.org/piespy/>
- (7) Daniel A. McFarland and Skye Bender-deMoll. SoNIA (Social Network Image Animator), 2007. <http://sonia.stanford.edu>
- (8) Skye Bender-deMoll and Daniel A. McFarland. Interaction, time, and motion: Animating social networks with sonia, 2004. www.stanford.edu/group/sonia/papers/PiranVizTalk.pdf
- (9) Skye Bender-deMoll and Daniel A. McFarland. The art and science of dynamic network visualization. Journal of Social Structure, 7(2), 2006. www.cmu.edu/joss/content/articles/volume7/deMollMcFarland/

Citations

- (10) Chaomei Chen and Leslie Carr. Visualizing the evolution of a subject domain: a case study. In VIS '99: Proceedings of the conference on Visualization '99, pages 449–452, Los Alamitos, CA, USA, 1999. IEEE Computer Society Press.
- (11) Ed H. Chi. Web analysis visualization spreadsheet. Technical report, Xerox Palo Alto Research Center, Palo Alto, CA 94304, 1999. <http://www2.parc.com/istl/groups/uir/publications/items/UIR-1999-08-Chi-WOWS99-WAVS.pdf> (URL May 2008)
- (12) Stephan Diehl and Carsten Görg. Graphs, they are changing – dynamic graph drawing for a sequence of graphs. In Graph Drawing: 10th International Symposium, GD 2002, Irvine, CA, USA, August 26-28, 2002. Revised Papers, volume 2528/2002 of Lecture Notes in Computer Science, pages 23–30. Springer-Link, 2002. www.springerlink.com/content/dklm0erkw0bftwh8 (URL May 2008)
- (13) Stephan Diehl, Carsten Görg, and Andreas Kerren. Preserving the mental map using foresighted layout. In Proceedings of the Joint Eurographics-IEEE TVCG Symposium on Visualization, VisSym, pages 175–184. Springer Verlag, Wien, New York, 2001.
<http://citeseer.ist.psu.edu/diehl01preserving.html> (URL May 2008)
- (14) Jürgen Branke. Dynamic graph drawing. Lecture Notes In Computer Science, pages 228–246, 2001. <http://portal.acm.org/citation.cfm?id=376953>
- (15) Carsten Friedrich and Peter Eades. Graph drawing in motion. Journal of Graph Algorithms and Applications, 6(3):353–370, February 2002.
<http://jgaa.info/accepted/2002/FriedrichEades2002.6.3.pdf>
- (16) Tim Dwyer. A scalable method for visualising changes in portfolio data. In APVis '03: Proceedings of the Asia-Pacific symposium on Information visualisation, pages 17–25, Darlinghurst, Australia, Australia, 2003. Australian Computer Society, Inc. <http://portal.acm.org/citation.cfm?id=857083>.
- (17) Tim Dwyer. Two and a Half Dimensional Visualisation of Relational Networks. PhD thesis, University of Sydney, 2005. www.cs.usyd.edu.au/dwyer/thesis_20050609.pdf

Citations

- (18) Cesim Erten, Philip J. Harding, Stephen G. Kobourov, Kevin Wampler, and Gary Yee. Exploring the computing literature using temporal graph visualization, 2003.
<http://citeseer.ist.psu.edu/erten03exploring.html>
- (19) Cesim Erten, Philip J. Harding, Stephen G. Kobourov, Kevin Wampler, and Gary V. Yee. Graphael: Graph animations with evolving layouts. In Graph Drawing, volume 2912 of Lecture Notes in Computer Science, pages 98–110. Springer Verlag, 2004.
www.springerlink.com/content/4pt8gbhu8eqyyk7e
- (20) Adel Ahmed, Tim Dwyer, Colin Murray, Le Song, and Ying Xin Wu. Wilmascope graph visualisation. In INFOVIS '04: Proceedings of the IEEE Symposium on Information Visualization (INFOVIS'04), page 216.4, Washington, DC, USA, 2004. IEEE Computer Society.
<http://dx.doi.org/10.1109/INFOVIS2004>