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

(Repitition)

- Ultimate goal of (empirical) Analysis & (mathematical) Modeling of Social Networks in Computer Science: Constructing useful services for users; Establish & further develop Social Networking (Model of network + bundle of services that operate on that model) as Social Medium

- In Social Computing: Services are ultimately Communication Services: Information is transferred between individuals

- More fine grained subdivision: Awareness Services, Communication Services (per se), Information Services; (subdivision is only coarse: every communication act transfers information and requires awareness about state of receiver; every use of an information service is ultimately a communication act)

(Repitition)

- Awareness-Services: Inform Users about the activities or general state of other users

- Communication-Service (per se): Establish channels for all kinds of communication acts: (synchronous vs. asynchronous, direct vs. indirect, 1:1 vs n:m, textual, audio-visual, symbolical etc.)

- Information Service: Allow users to manage information spaces and other users to access those information spaces

(Repitition)

- Most basic Awareness-Service in Social Networking: Visualize the social network
- Purposes of social network visualizations:
  - Get an overview about a particular social network
  - Perceive structures (clusters etc.) in the SN via human visual system
  - Show dynamic changes in a network

(Repitition)

- We model SN as graphs → Investigate discipline of graph drawing

(1) Theoretical Background;
Drawing of static graphs

(2) Drawing of dynamic graphs; SN visualization applications

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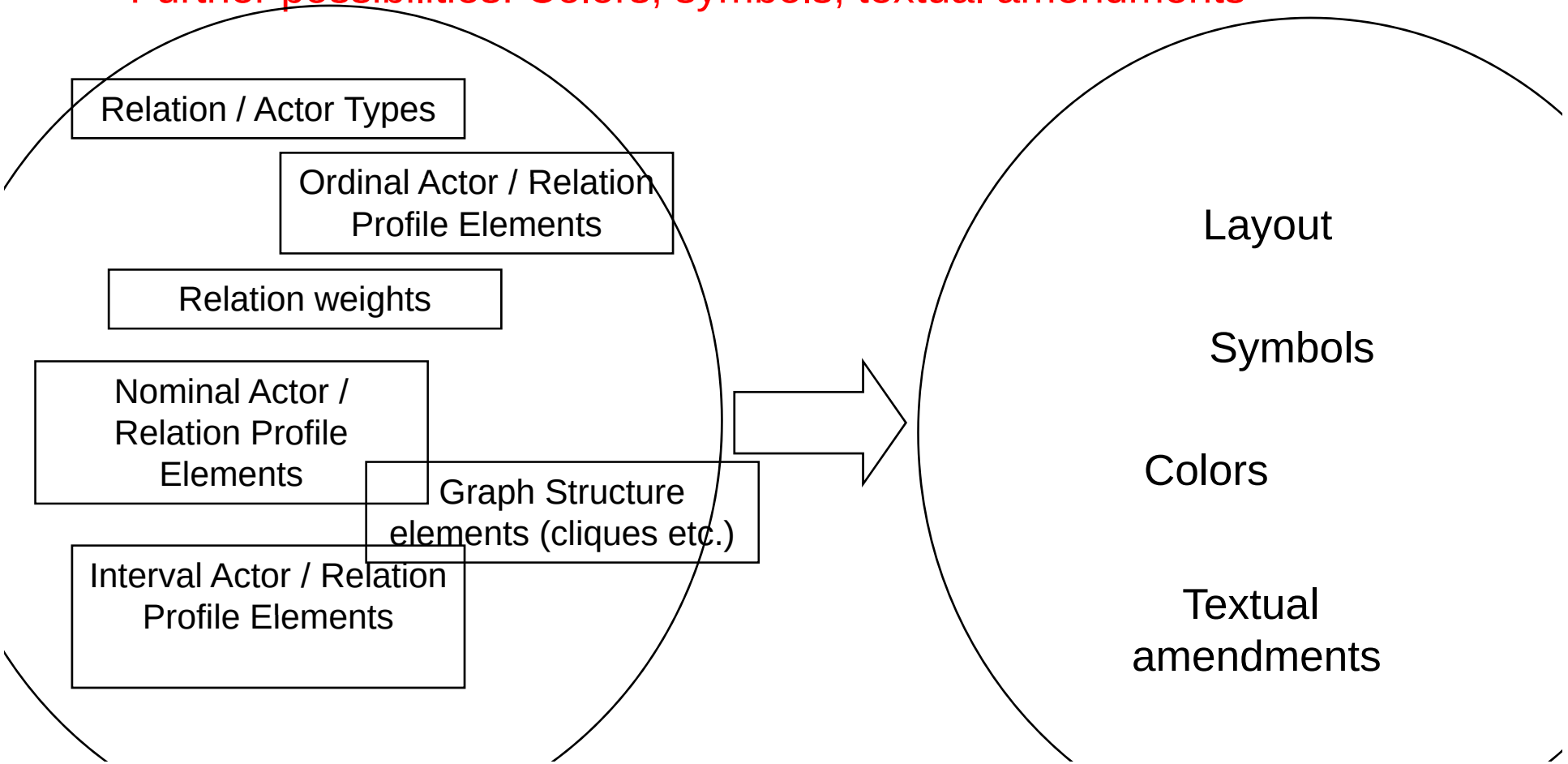
- What we saw so far: How to draw a graph so that certain “quality criteria” are met; Concentration on layout

- Further possibilities: Colors, symbols, textual amendments



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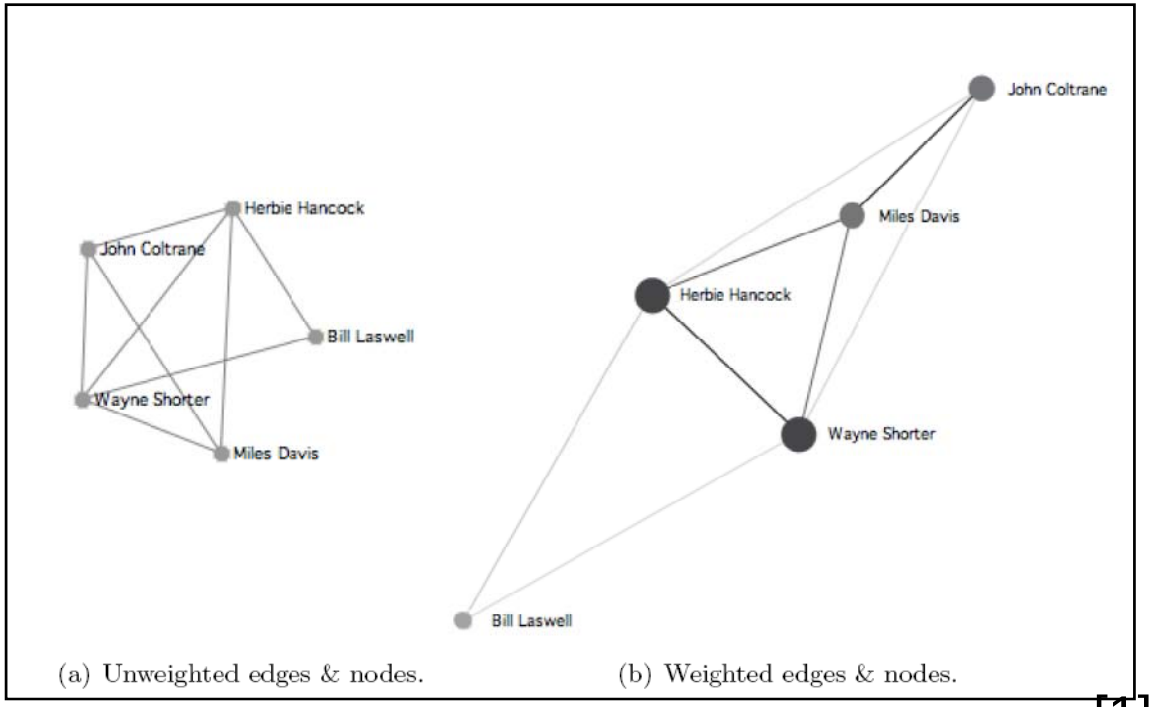
- Layout: Examples:

Kamada Kawai

Planar Graph drawing

Fruchterman Reingold



(a) Unweighted edges & nodes. (b) Weighted edges & nodes.

[1]

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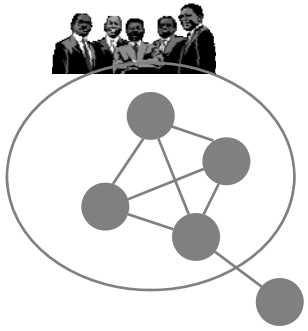
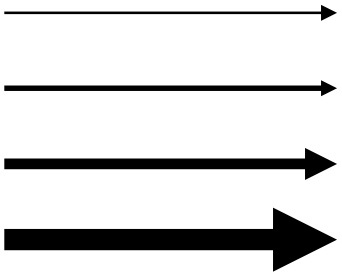
- Symbols: Examples:

node symbols / design:

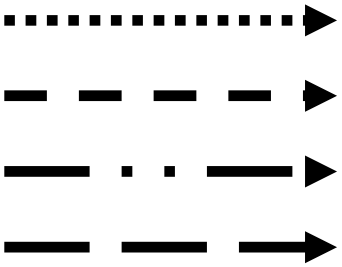
node / graph structure symbols / design:



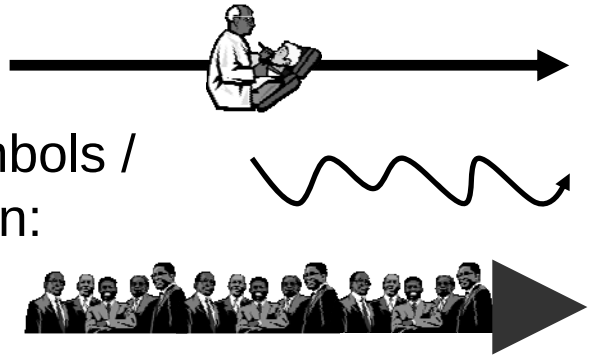
edge thickness:



edge patterns:



edge symbols / design:



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- 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)

4: 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”)

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- 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 ti 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 ←→ 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]

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

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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

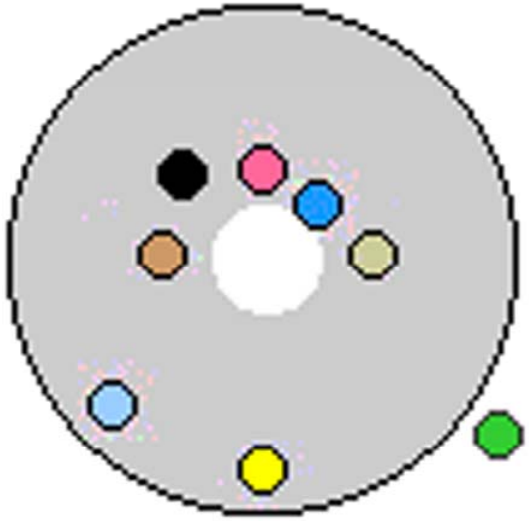
- We will now take a look at specific “solutions” (original papers) on dynamic social network visualization

4: 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 (→ indirect hint for dyn. SN edge)

- Babble [3]: Viz. of activity in a chat: Distance to center → Activity; Compare Milgram’s crowd metaphor [4] (center & fringe)



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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 (→ how long “member”)

- Bloom / blossom:
  - number of petals ←→ number of postings;
  - color saturation: age of postings;
  - color: post or reply

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Dynamic SN viz. Examples

- PieSpy [6]: Viz. dyn SN inferred from IRC channels

- Series of SN drawings at given time interval; no animation → some aprupt 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)

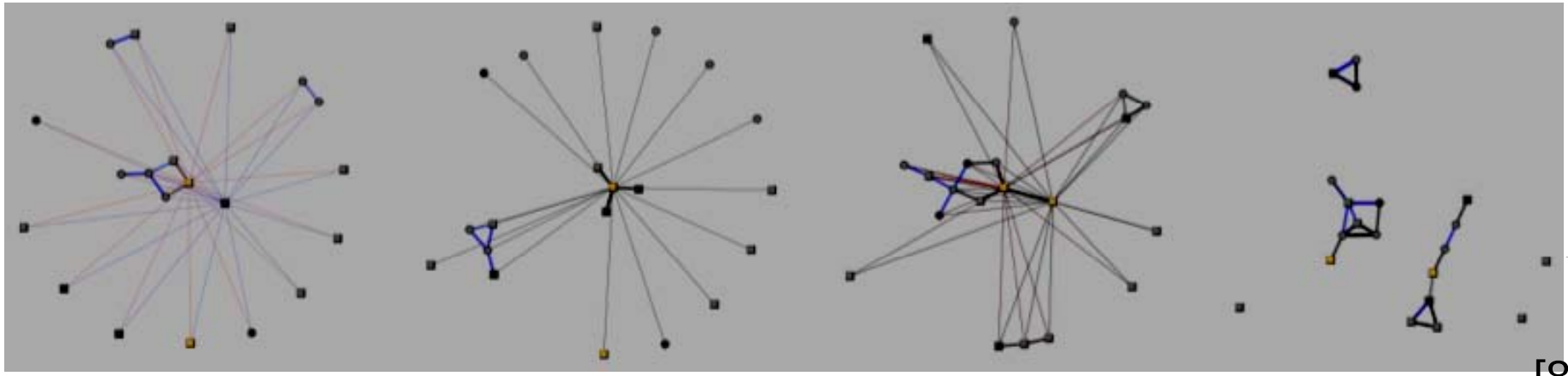
4: Social Network Visualization: Dynamic Graph Drawing & Social Networking Visualization Application Examples

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)



[8]

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Dynamic SN viz. Examples

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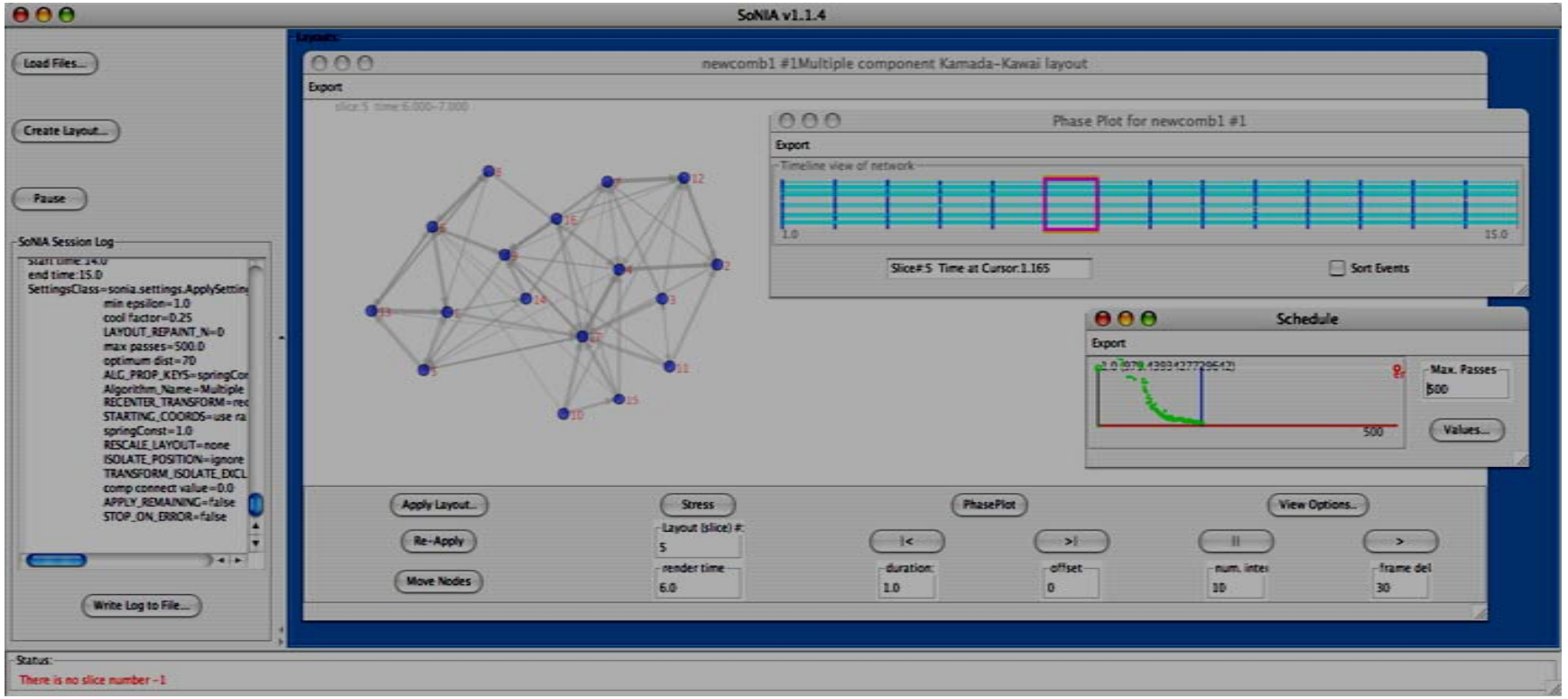


[7,1]

Dynamic SN viz. Examples

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

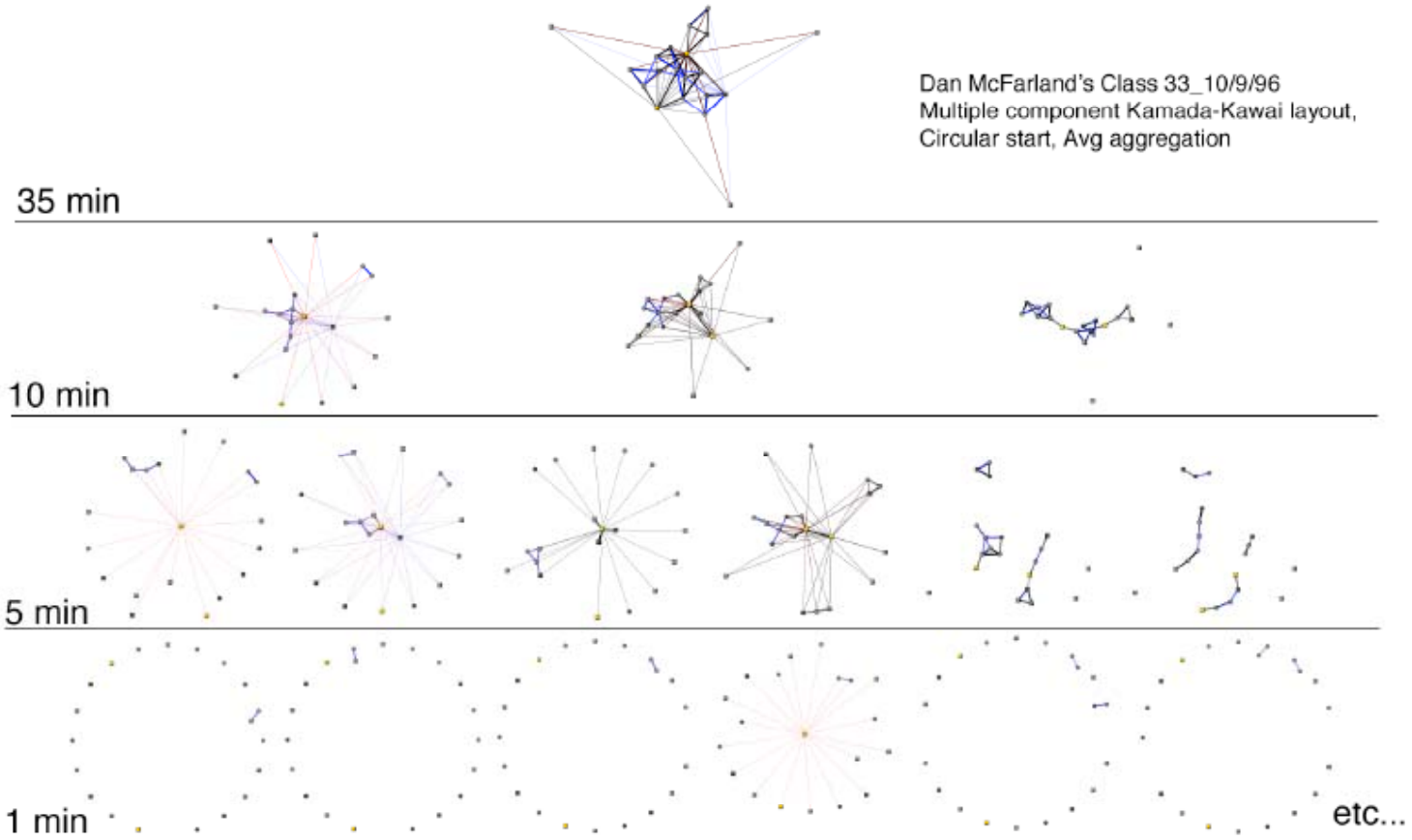


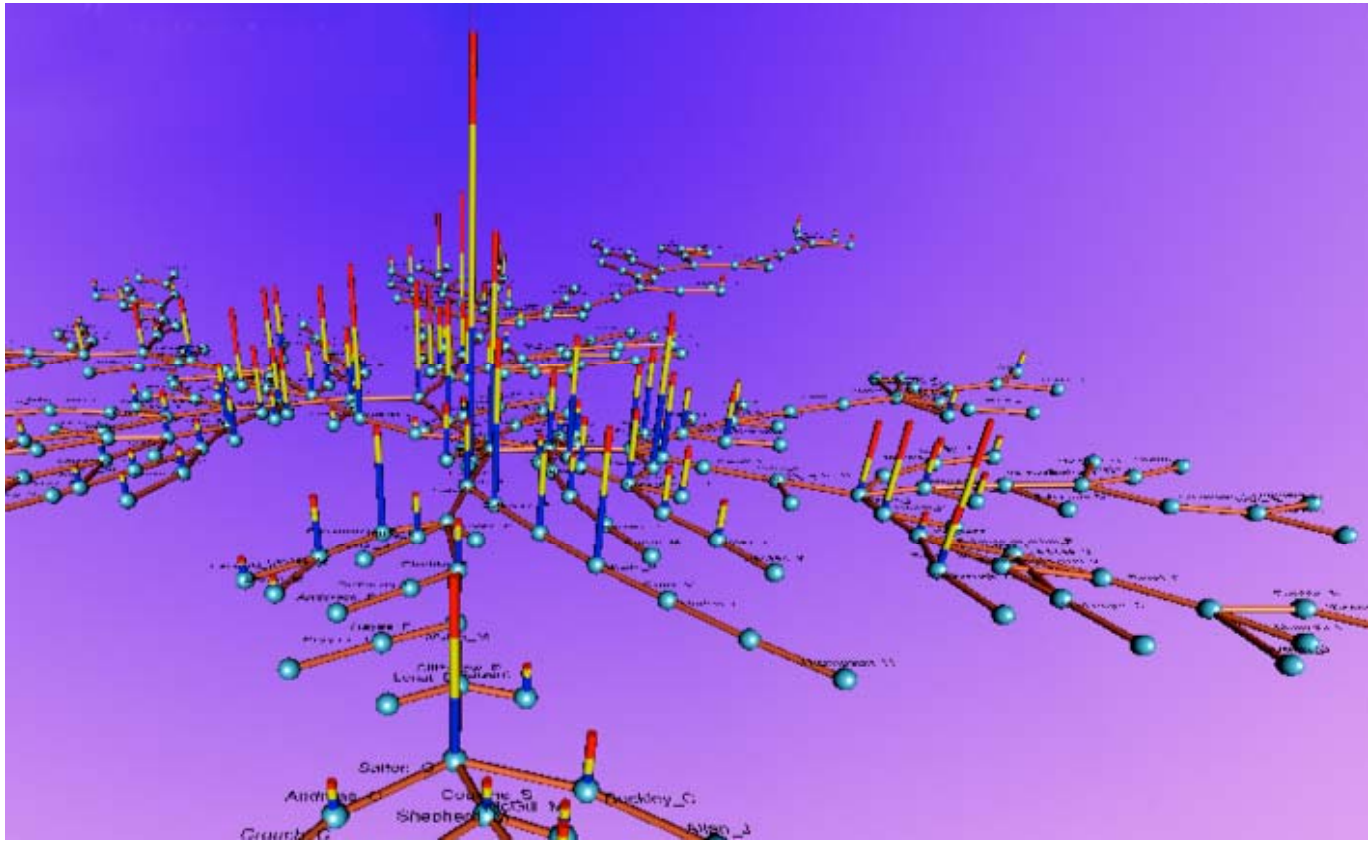
Figure 1. Interaction data from McFarland's classroom observations viewed at various levels of time aggregation from 35 minutes (one entire class period) to 1 minute (two to three turns of interaction).

[9]

4: 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 frequency of co-citation events



[10]

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

Dynamic SN viz. Examples

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

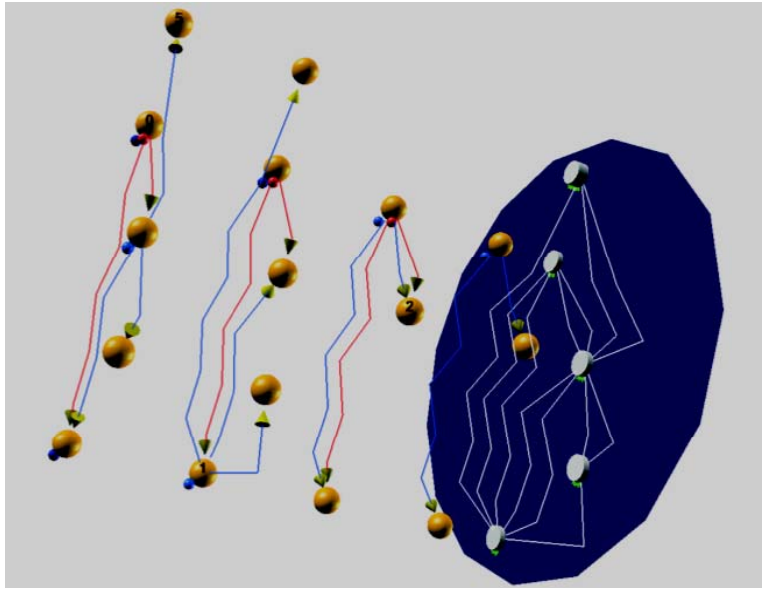
- Visualize Dynamic graph where nodes and edges appear from slice to slice

- 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

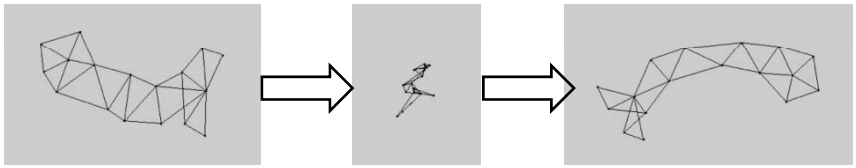


[13]

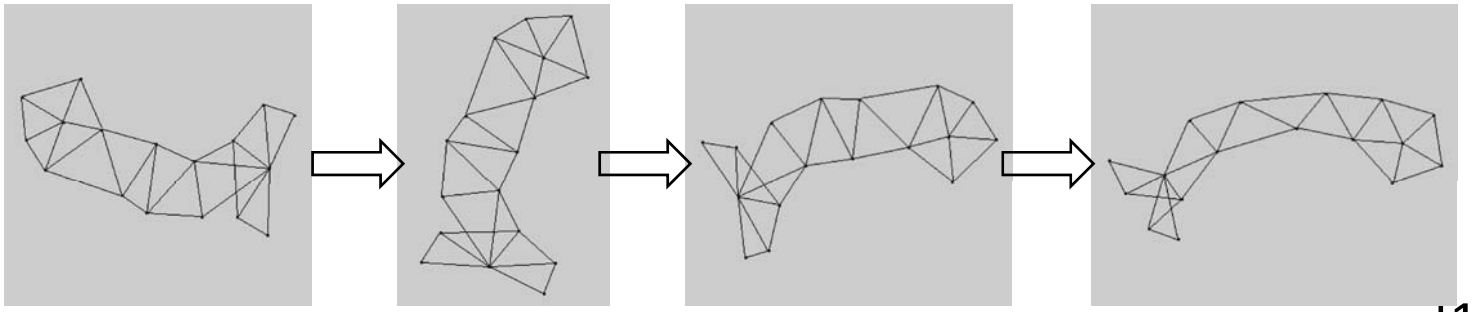
Dynamic SN viz. Examples

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

[12]

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

Dynamic Data Viz. Examples with Graphs

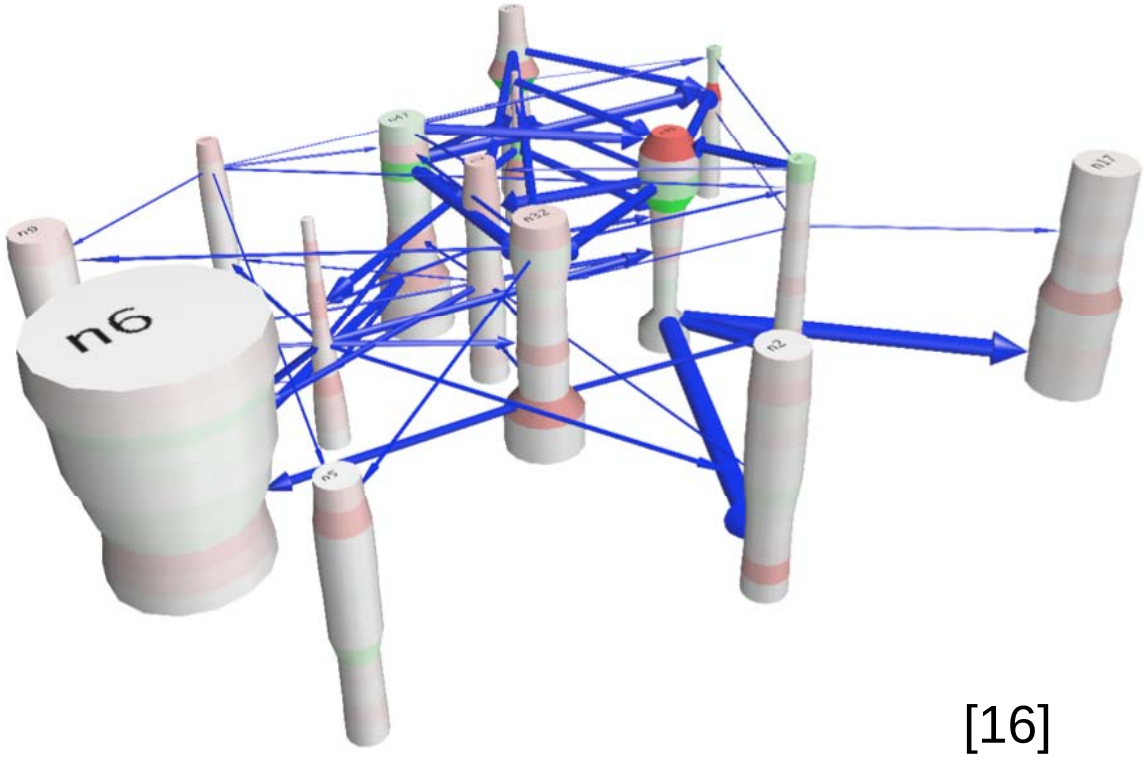
Fund Manager Flow Graph [16,17]

- "Movement" (B→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]

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

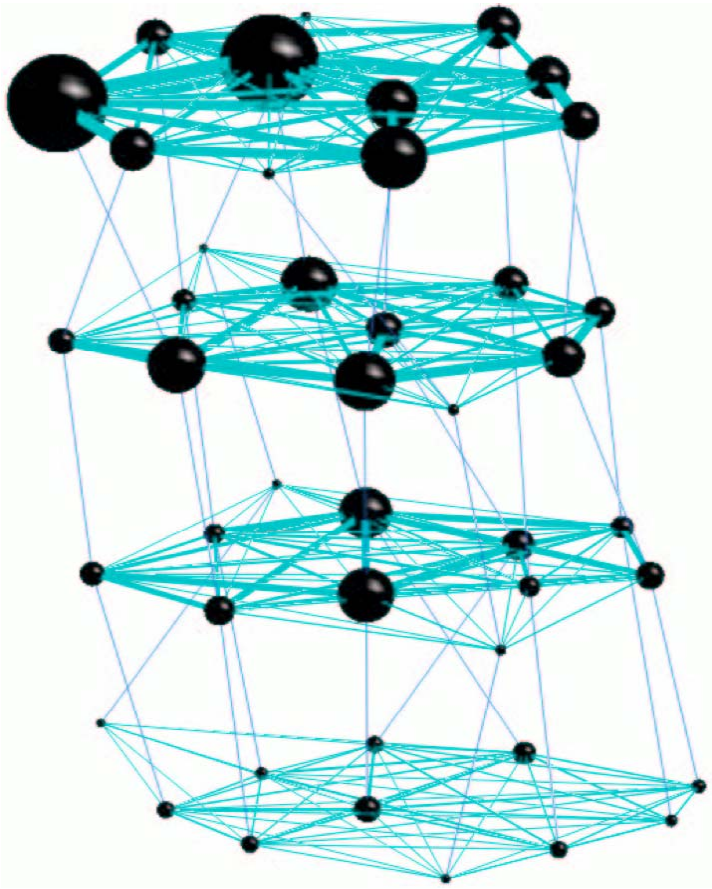
Dynamic SN Viz. Example:

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]

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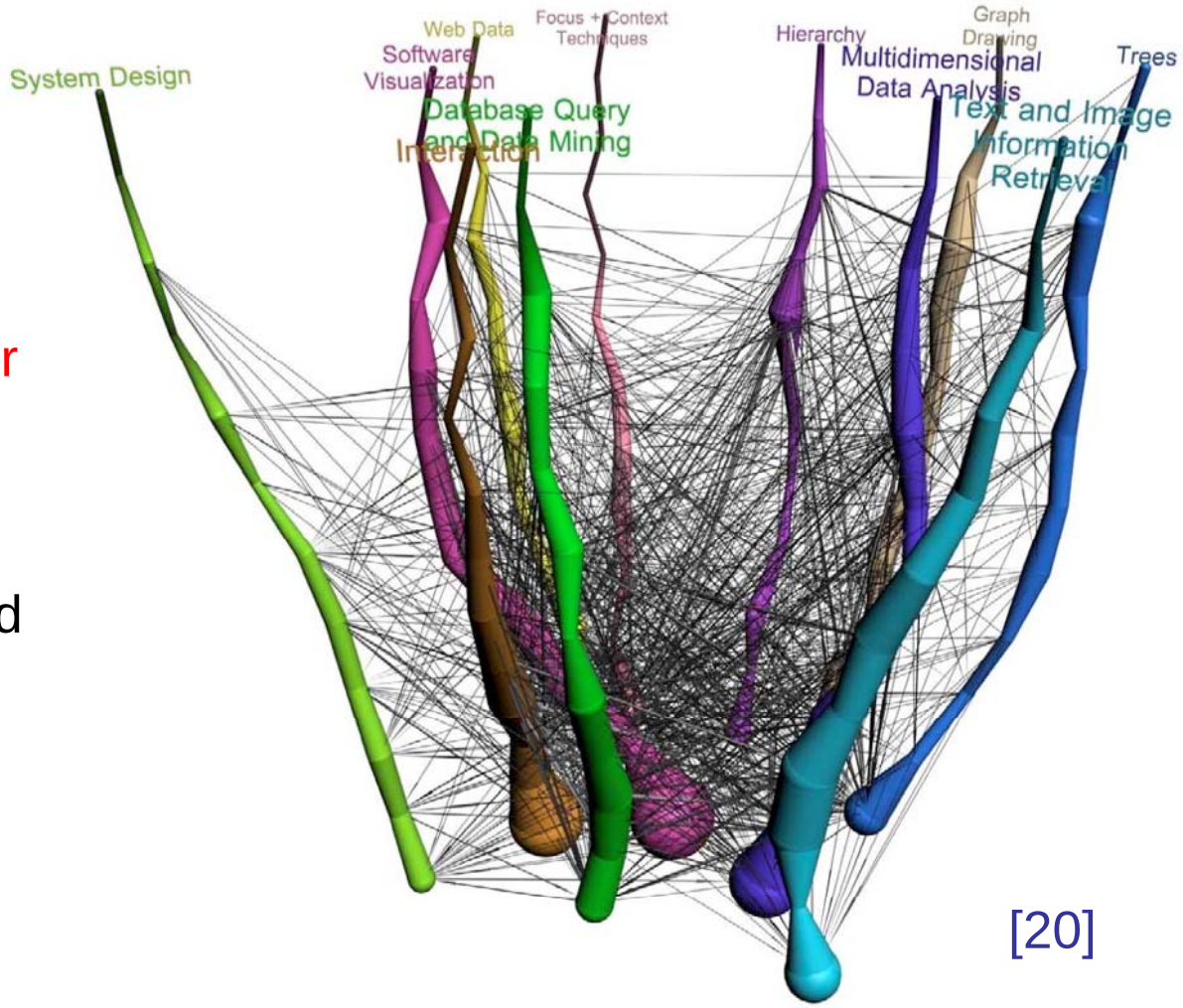
Dynamic Temporal Data Viz. Example:

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

- Each time slice: Modified force directed layout: Hot research topics move to center

- Intertemporal edges: “worm tubes”



[20]

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Dynamic SN Viz. Example:

Dyson [1]

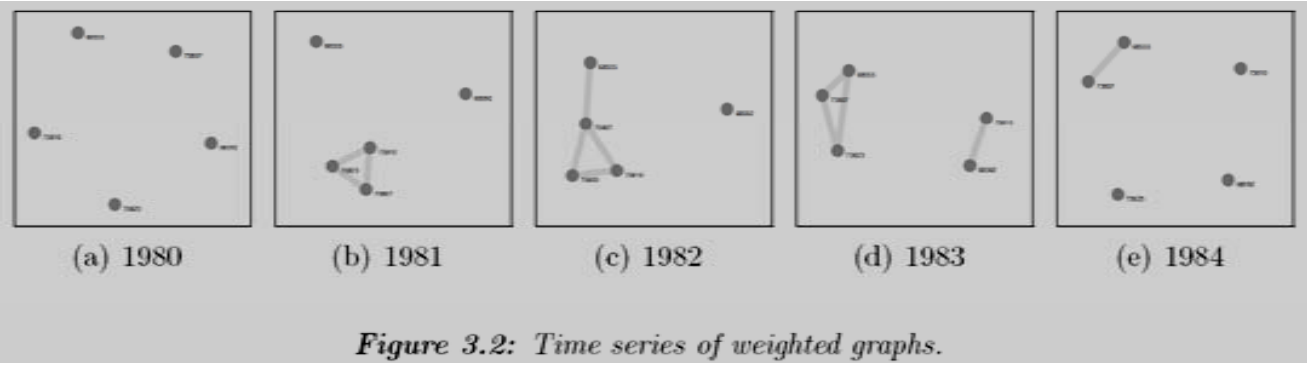

Figure 3.2: *Time series of weighted graphs.*

[1]

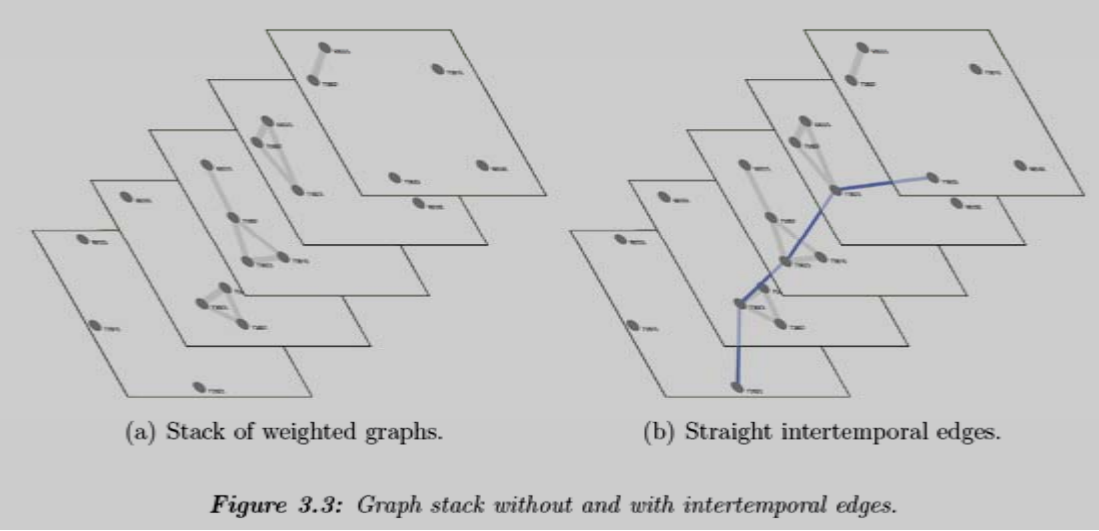

Figure 3.3: *Graph stack without and with intertemporal edges.*

[1]

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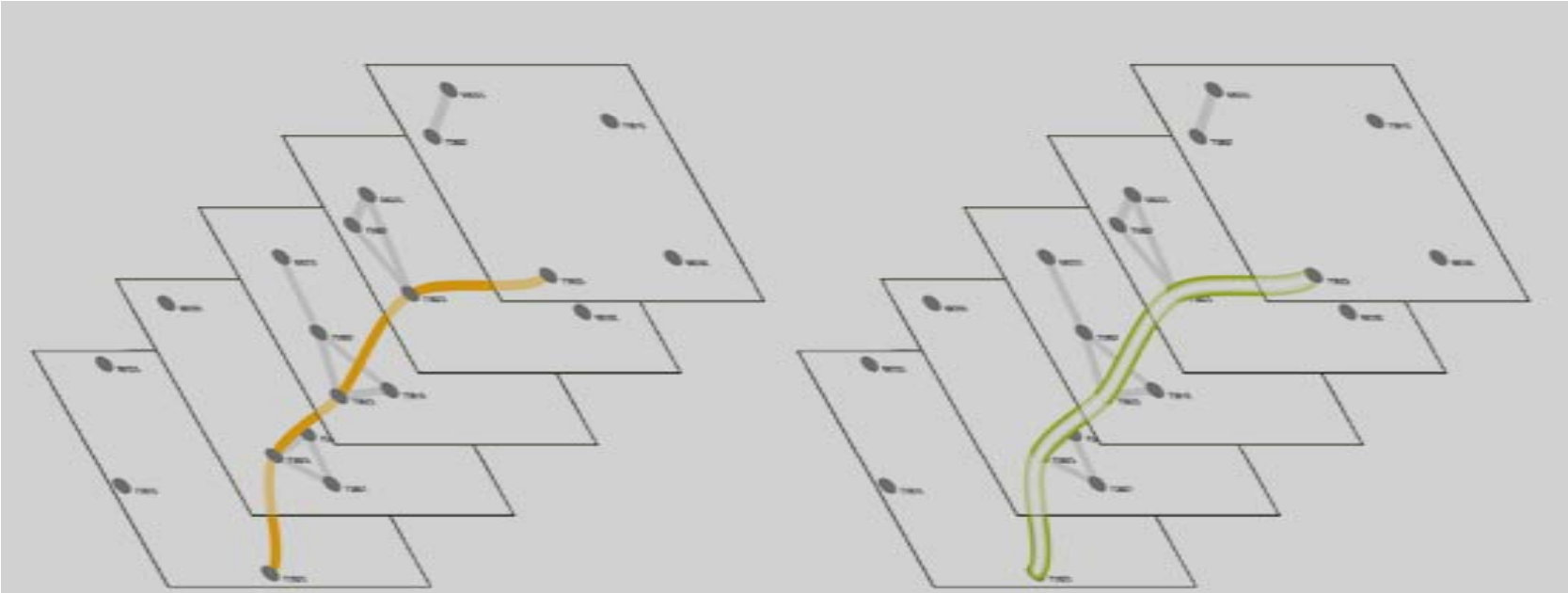
Dynamic SN Viz. Example:

Dyson [1]



(a) Interpolated intertemporal edges.

(b) Tubular intertemporal edges.

Figure 3.4: *Graph stack with intertemporal edges.*

[1]

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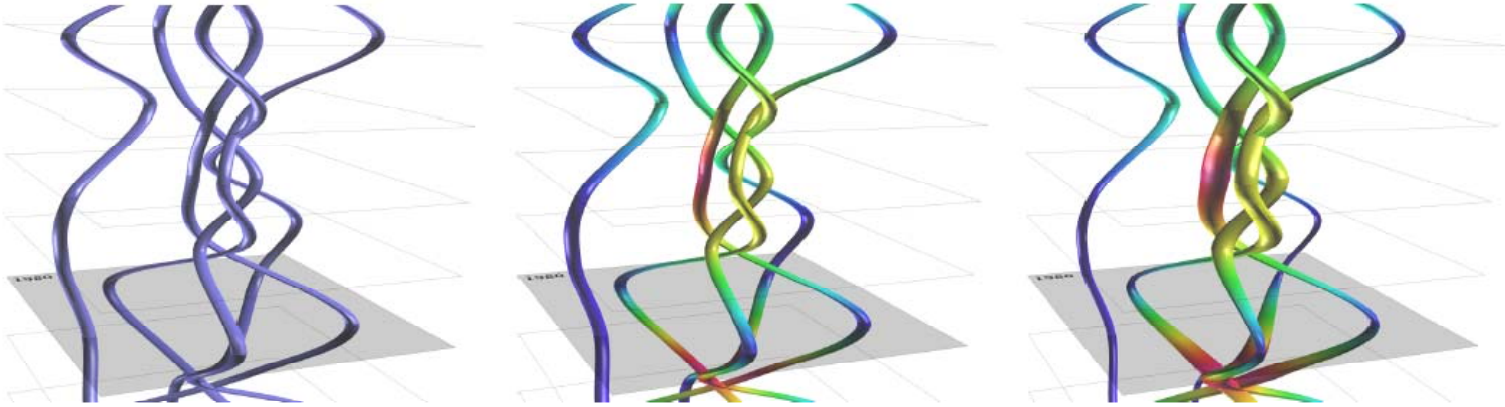
Dynamic SN Viz. Example:

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]

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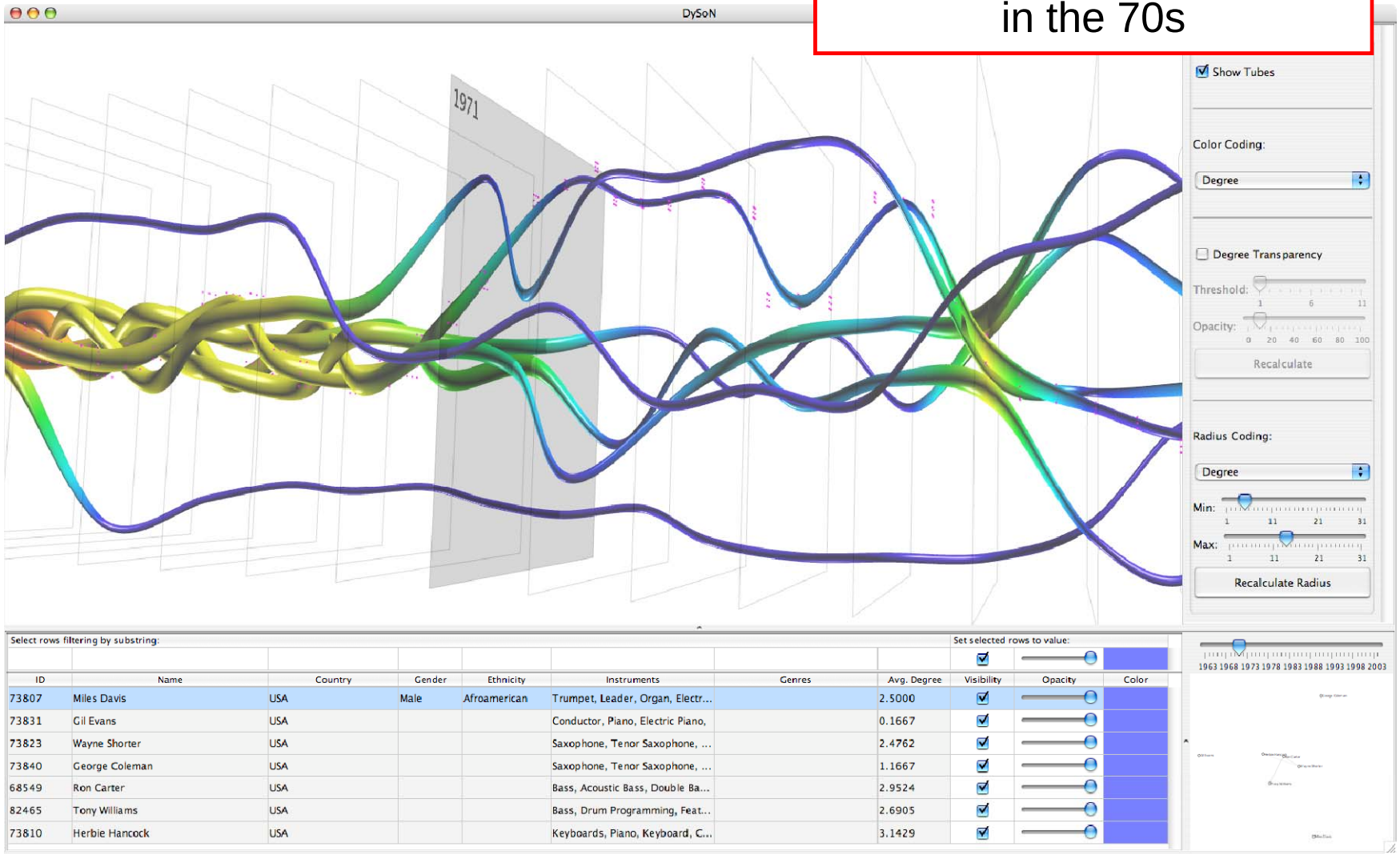
Dynamic SN Viz. Example: Dyson [1]

Decay of Miles Davis band in the 70s



ID	Name	Country	Gender	Ethnicity	Instruments	Genres	Avg. Degree	Visibility	Opacity	Color
73807	Miles Davis	USA	Male	Afroamerican	Trumpet, Leader, Organ, Electr...		2.5000	☑		
73831	Gil Evans	USA			Conductor, Piano, Electric Piano,		0.1667	☑		
73823	Wayne Shorter	USA			Saxophone, Tenor Saxophone, ...		2.4762	☑		
73840	George Coleman	USA			Saxophone, Tenor Saxophone, ...		1.1667	☑		
68549	Ron Carter	USA			Bass, Acoustic Bass, Double Ba...		2.9524	☑		
82465	Tony Williams	USA			Bass, Drum Programming, Feat...		2.6905	☑		
73810	Herbie Hancock	USA			Keyboards, Piano, Keyboard, C...		3.1429	☑		

[1]

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 ti as initial layout of slice ti+1; Introduce spring forces between node position and initial node position. (force is inverse proportional to degree change of node (compared to previous timeslice) → nodes with no changes in degree move less).

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]

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