Reducing Snapshots to points

A visual analytics approach to Dynamic Exploration
**What:** Understand the evolution of dynamic networks.
• Many methods for analyzing a static network (or a “snapshot”)
• ...but fewer methods for analyzing dynamic networks

• Two common approaches are “animation” and “small multiples”
• **Their approach**: Reduce each “snapshot” to a 2D point and show the evolution of these points.

• Allow users to select a point to see snapshot
Why: “The identification of stable states, recurring states, outlier states, and transitions between these states helps in understanding the network.”

Examples of dynamic networks include: (tele-)communication networks, social networks, financial networks, and transportation networks.
• **How**: Four Step Process:

1. Discretization
2. Vector Normalization
3. Dimensionality Reduction
4. Visualization interaction

![Diagram showing the four steps of the process](image)
1) Discretization
2) Vector Normalization
3) Dimensionality Reduction

4) Visualization interaction
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<th>Dynamic Network</th>
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<td>Snapshots of network reduced to 2D points</td>
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<td>Identify stable states, reoccurring states, outlier states and transitions between those states</td>
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Scale:
- Original Attributes: Hundreds
- Reduced attributes: 2
- Nodes: 180
- Edges: 10104
- Timestep: 2015
• Reduction shows four stable states and transitions between
• One reoccurring state
• Colour encodes time
• Grey insets show representative snapshots.
• Alternative view plots time along x axis

• Four stable states

• One reoccurring state (lowest tier)

(a) Time vs. 1st principal component.
A Case Study
A Case Study

• Interested in tracking face-to-face contact between persons in context of determining how infectious diseases spread within a population.

• Dataset is 7 days of face-to-face contact between high school students for 7 school days (MTWTFMT)

• The dynamic network consists of 180 nodes (students), 45047 contacts, and 10,104 unique edges.
• Colour spans full seven days
• t-SNE reduction
• Central cluster showing reoccurring state (nighttime, no face-to-face interaction)
• Breaks indicate school day rhythm
• Colour spans each day

• Network structure shown for each day

• Colour indicates that breaks happen at same time each day

• Wednesday more sparse than other days
• Time vs. 1st principal component view

• One reoccurring stable state

• Multiple days visible over weekend
Conclusion

• **What?** Dynamic network visualization by reducing snapshots to points

• **Why?** To identify stable, reoccurring and outlier states and transitions between these states

• **How?** Four step process: *discretization, vectorization, dimensionality reduction, and visualization*
Comments

• Not convinced this is better than animation or small multiples in detecting states

• Simple concept but computationally expensive - PCA is $O(n^2v^2)$

• Perhaps difficult to understand for non-technical users