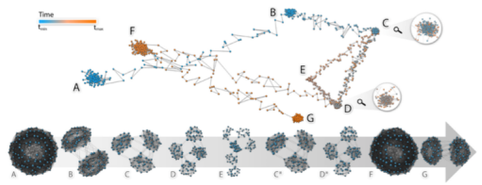
Reducing Snapshots to points

A visual analytics approach to Dynamic Exploration



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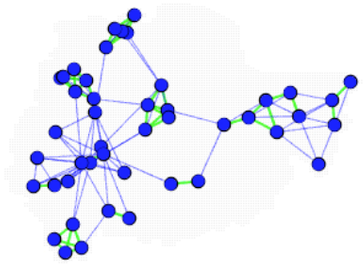
What: Understand the evolution of dynamic networks.



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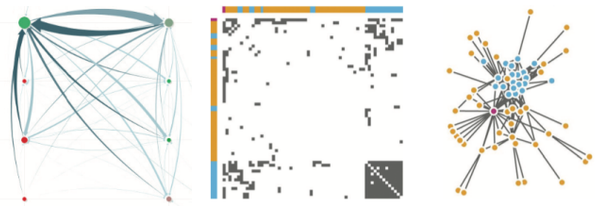
- Many methods for analyzing a static network (or a "*snapshot*")



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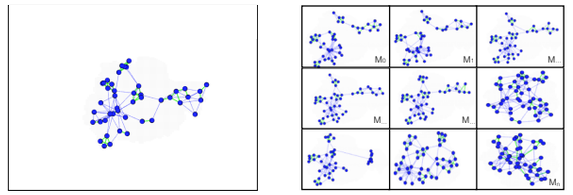
- …but fewer methods for analyzing dynamic networks
- Two common approaches are *"animation"* and *"small multiples"*



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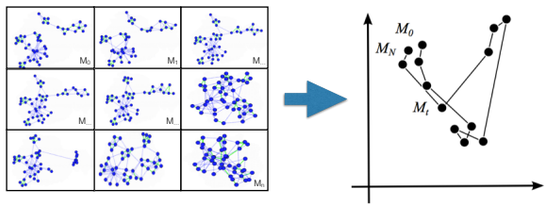
- **Their approach**: Reduce each "snapshot" to a 2D point and show the evolution of these points.
- Allow users to select a point to see snapshot



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- **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.

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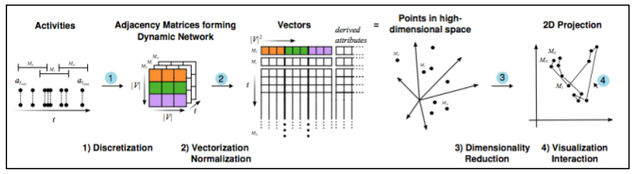
- **How**: Four Step Process:
  1. Discretization
  2. Vector Normalization
  3. Dimensionality Reduction
  4. Visualization interaction



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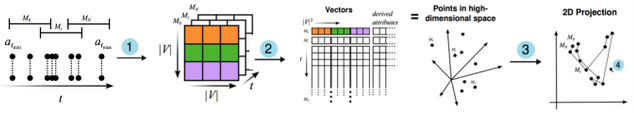

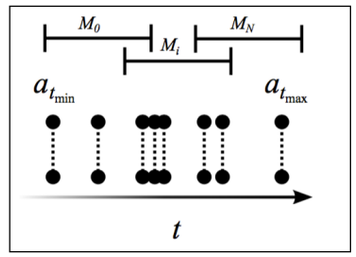

1) Discretization

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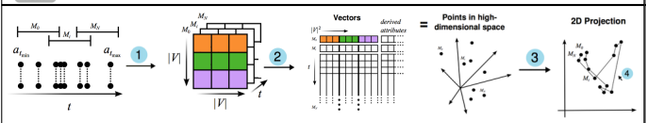

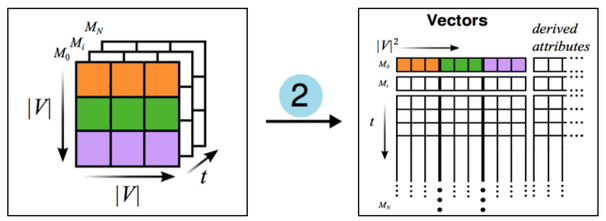

2) Vector Normalization

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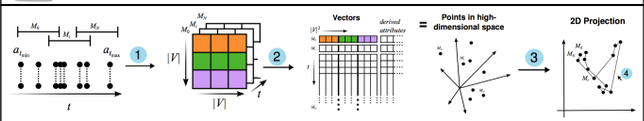
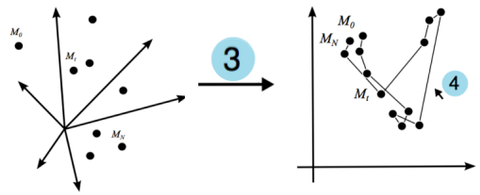


Points in high-dimensional space

2D Projection



3) Dimensionality Reduction

4) Visualization interaction

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What: Data	Dynamic Network
What: Derived	Snapshots of network reduced to 2D points
Why: Tasks	Identify stable states, reoccurring states, outlier states and transitions between those states
How: Reduce	Dimensionality Reduction
How: Encode	Node colour encoded with attribute
How: Facet	Snapshot view as context, network view as focus
How: Manipulate	Zoom and pan
Scale:	Original Attributes: Hundreds Reduced attributes: 2 Nodes: 180 Edges: 10104 Timestep: 2015

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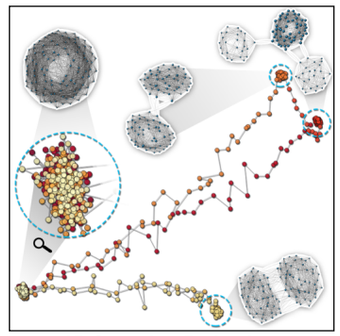
- Reduction shows four stable states and transitions between
- One reoccurring state
- Colour encodes time
- Grey insets show representative snapshots.



2D Snapshot Reduction

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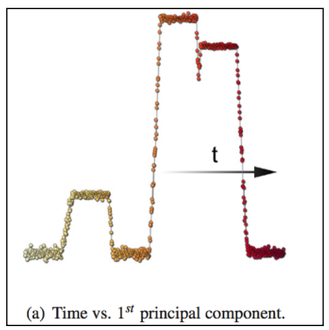
- Alternative view plots time along x axis
- Four stable states
- One reoccurring state (lowest tier)



(a) Time vs. 1st principal component.

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A Case Study

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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.

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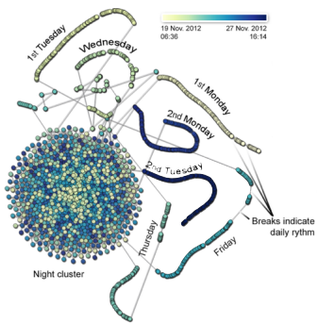
- Colour spans full seven days
- t-SNE reduction
- Central cluster showing reoccurring state (nighttime, no face-to-face interaction)
- Breaks indicate school day rhythm



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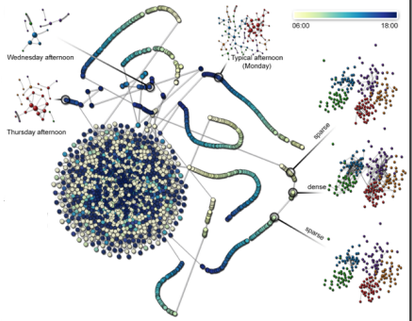
- Colour spans each day
- Network structure shown for each day
- Colour indicates that breaks happen at same time each day
- Wednesday more sparse than other days



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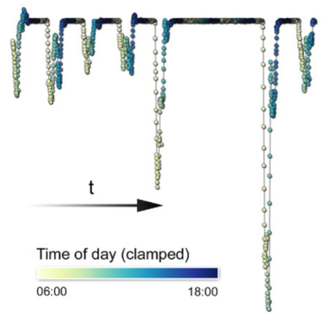
- Time vs. 1st principal component view
- One reoccurring stable state
- Multiple days visible over weekend



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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*

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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

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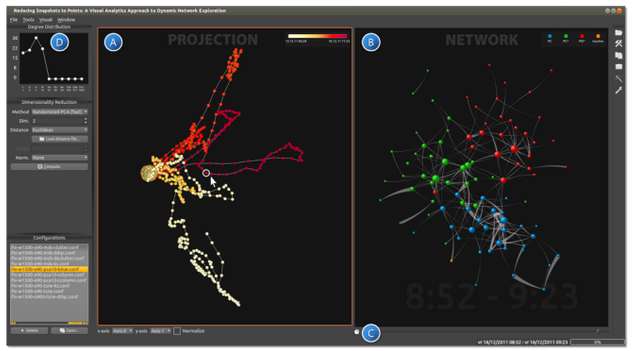

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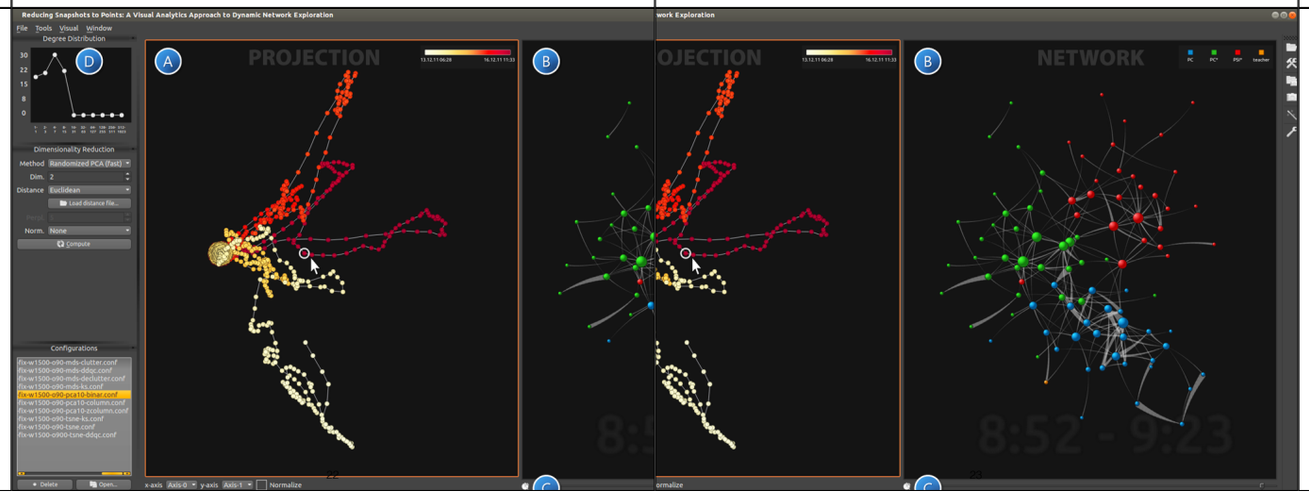

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