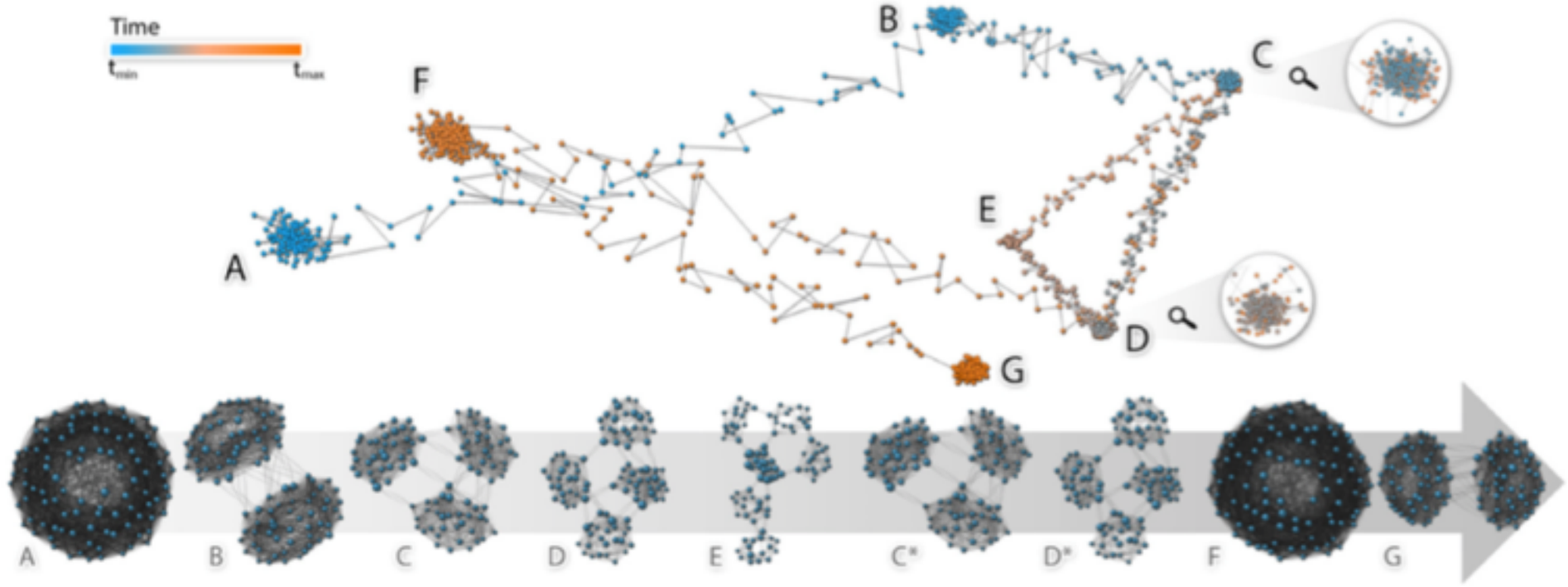
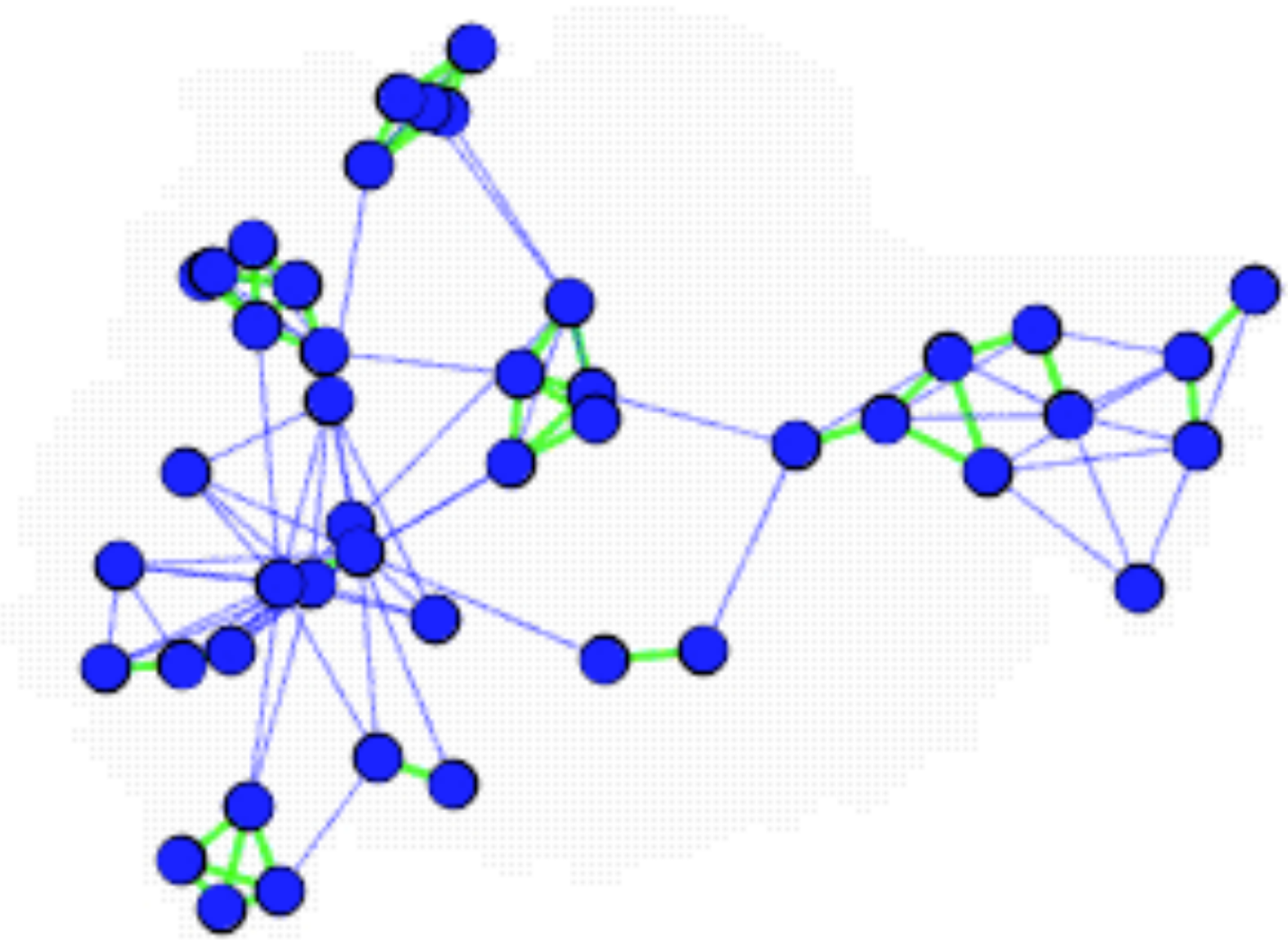
Reducing Snapshots to points

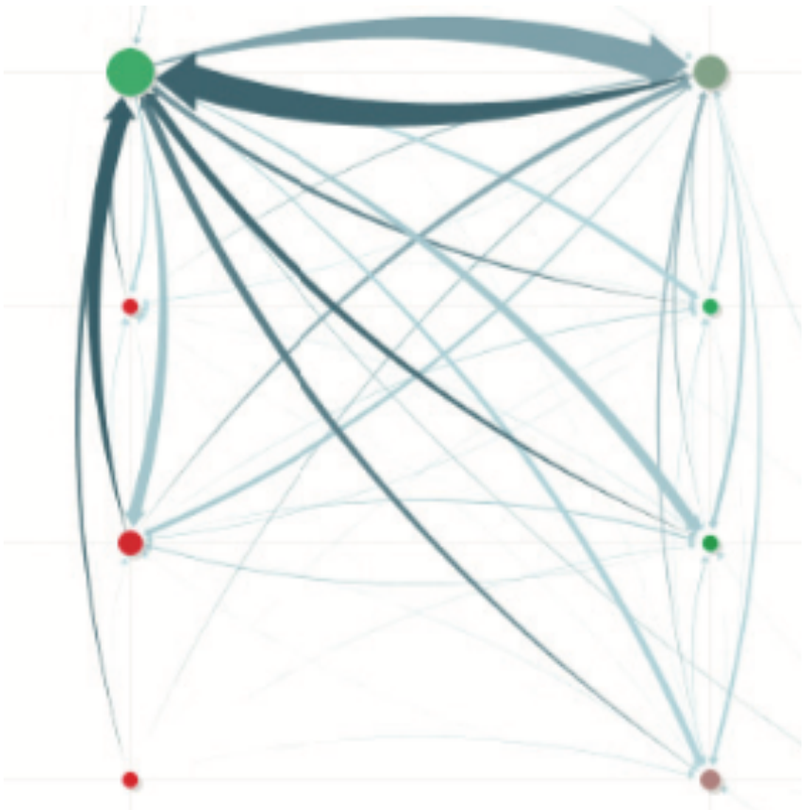
A visual analytics approach to Dynamic Exploration

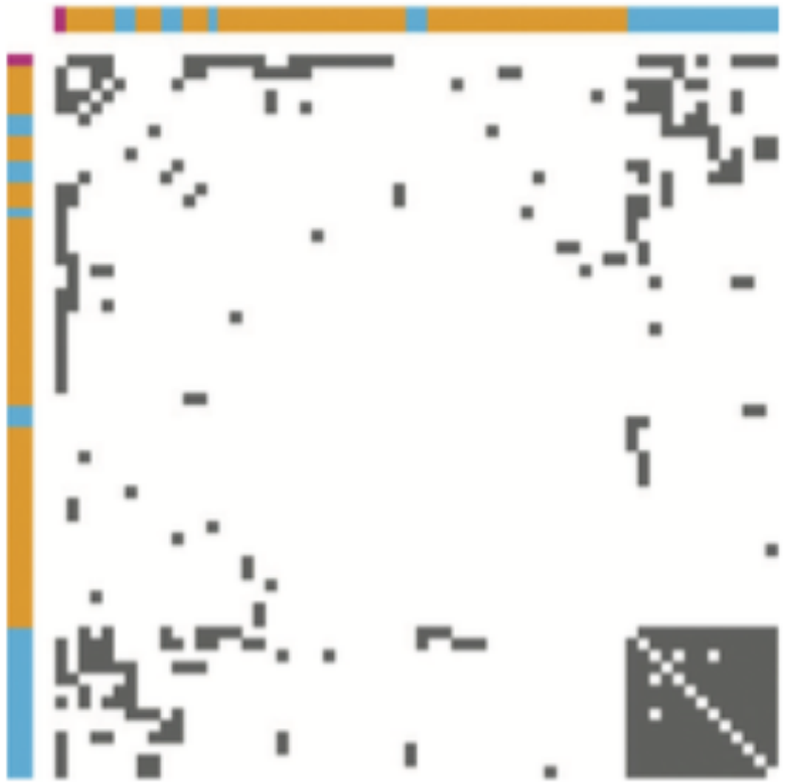


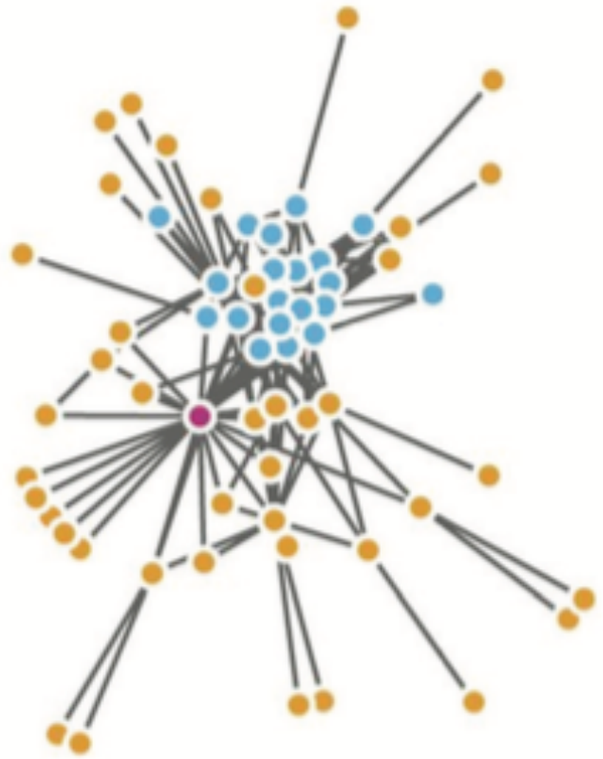
What: Understand the evolution of dynamic networks.



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

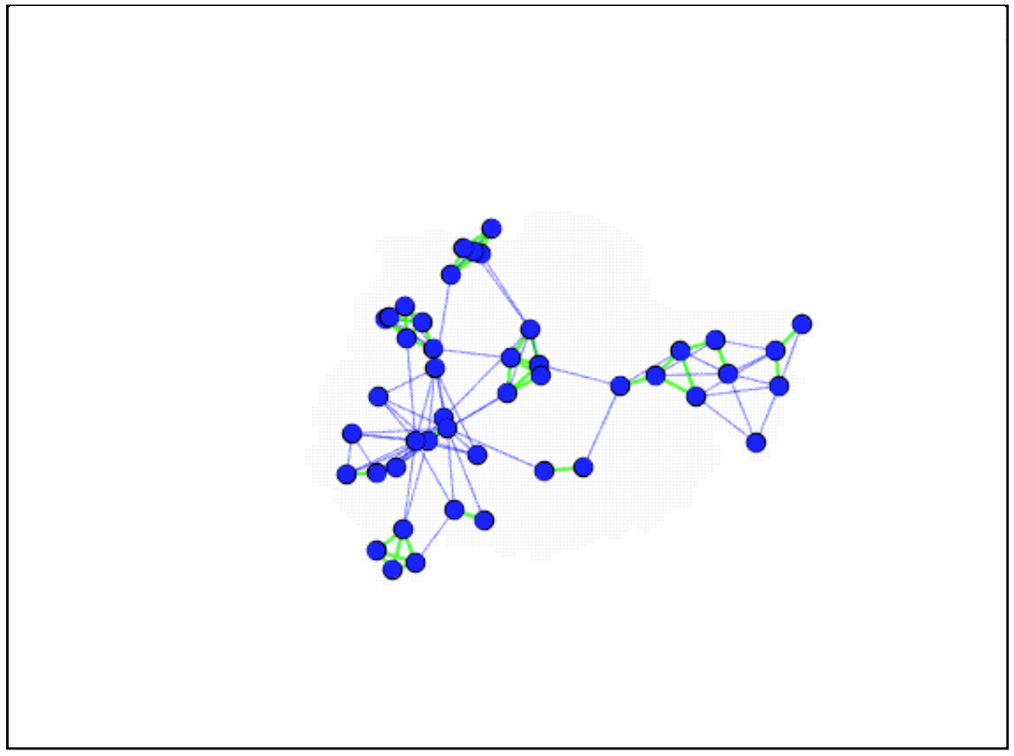


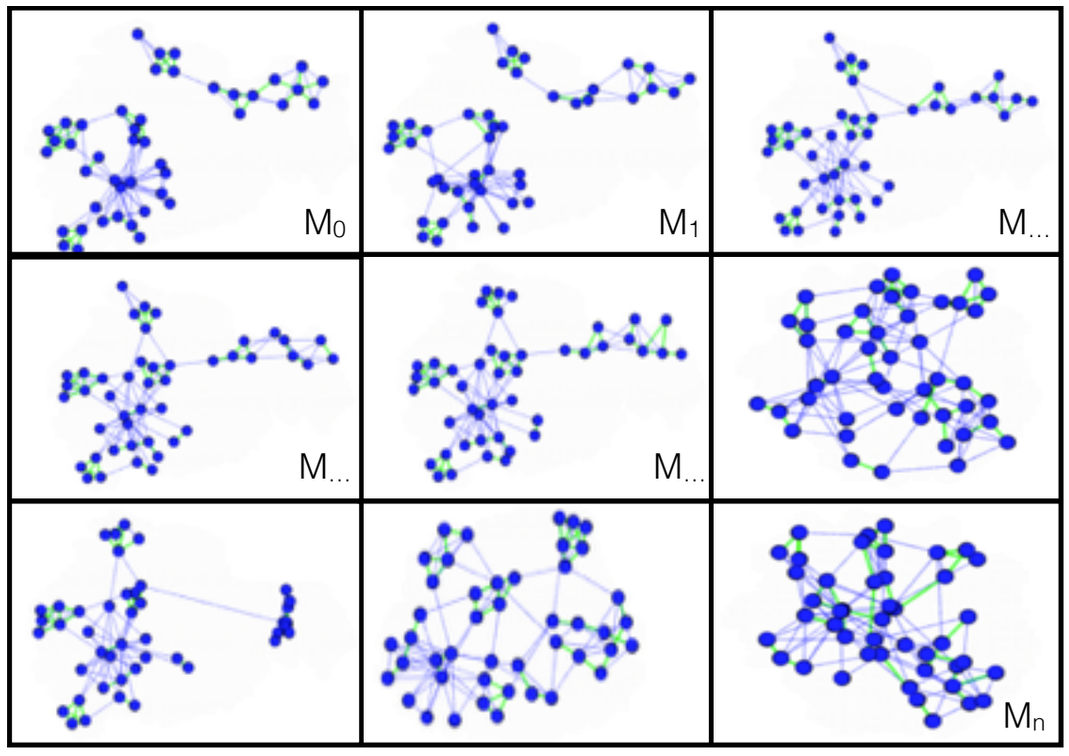




- …but fewer methods for analyzing dynamic networks

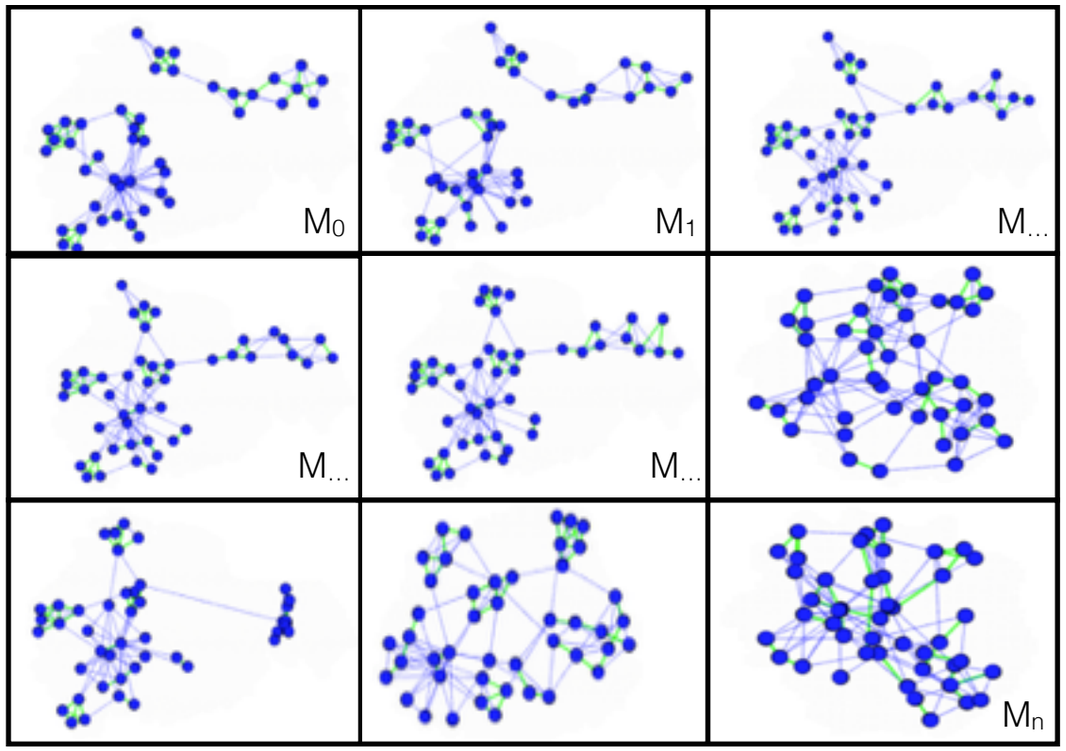
- Two common approaches are *“animation”* and *“small multiples”*

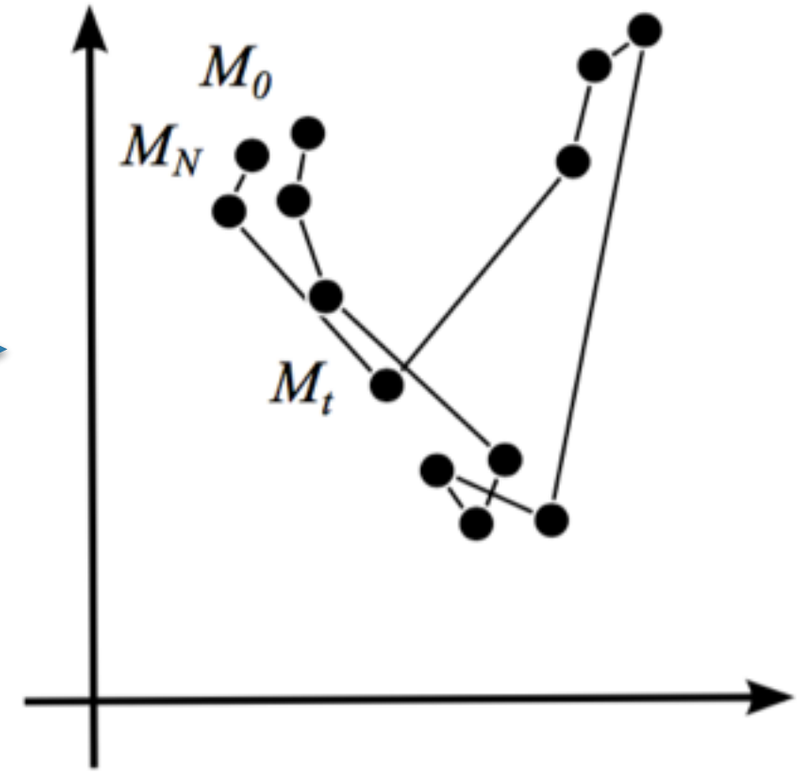




- **Their approach**: Reduce each “snapshot” to a 2D point and show the evolution of these points.

- Allow users to select a point to see snapshot



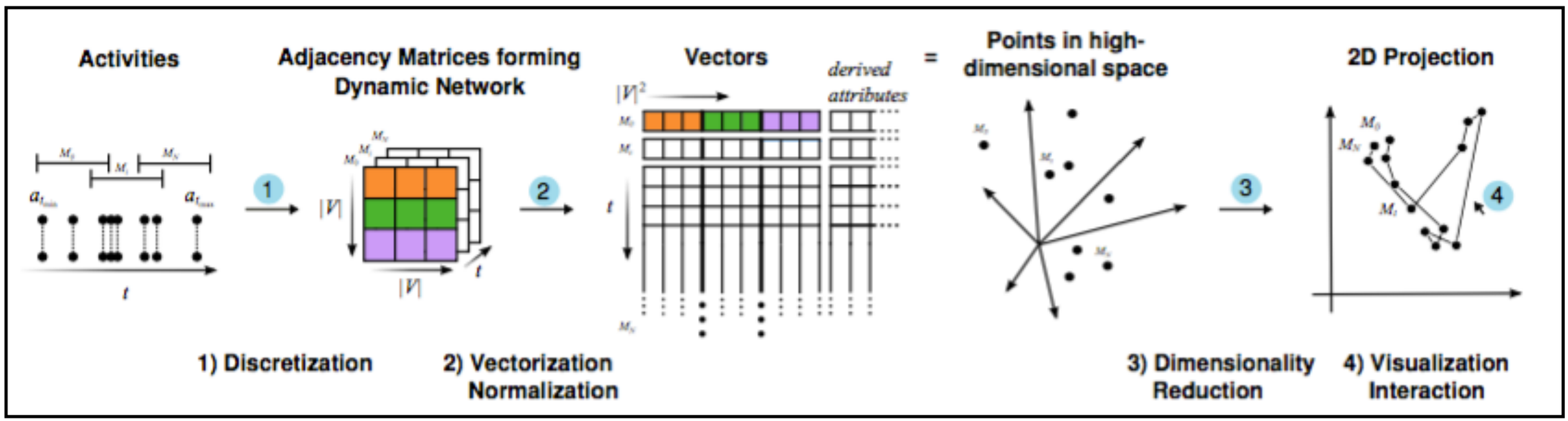


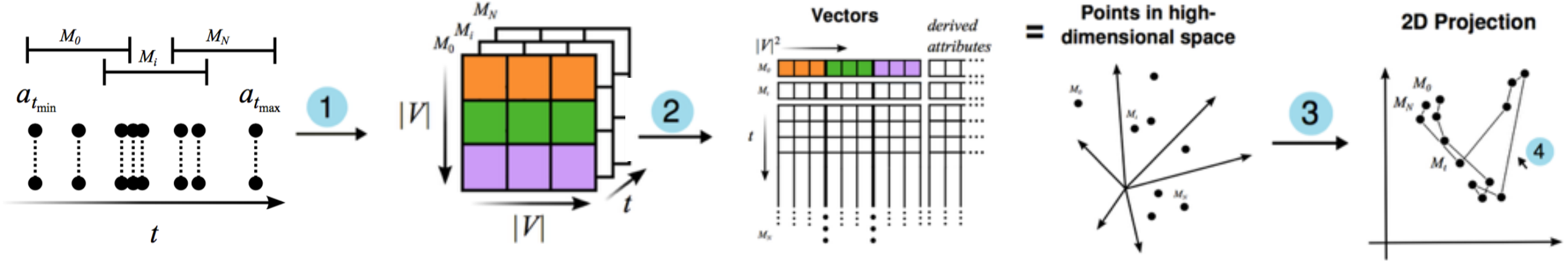
- **Why**: "*The identification of stable states, recurring states, outlier states, and transitions between these states helps in understanding the network.*"

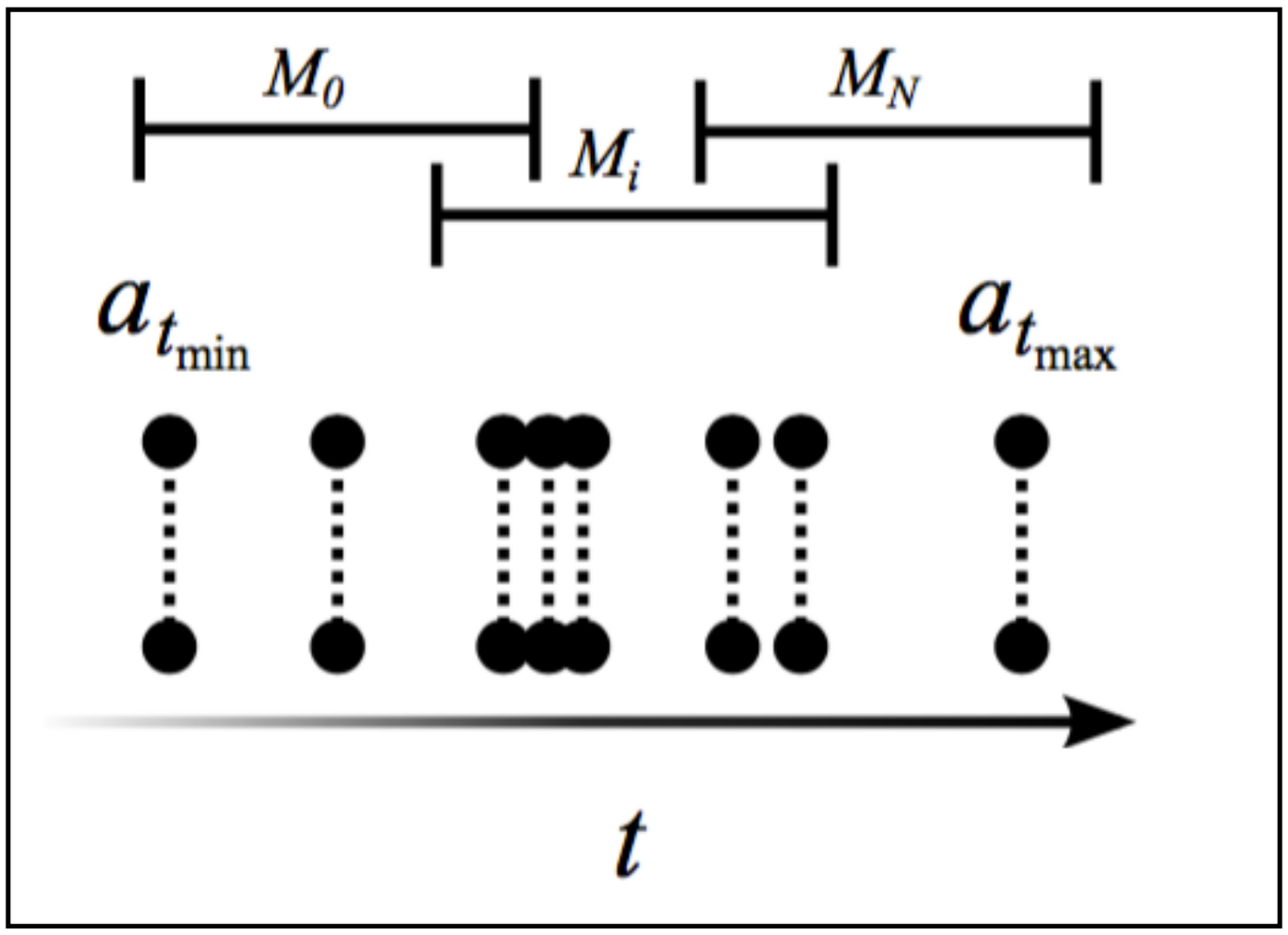
- Examples of dynamic networks include: (tele-)communication networks, social networks, financial networks, and transportation networks.

- **How**: Four Step Process:

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





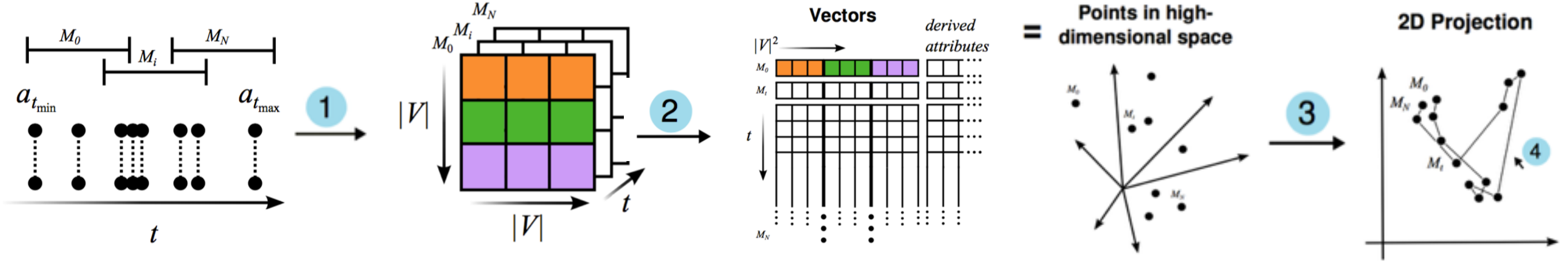


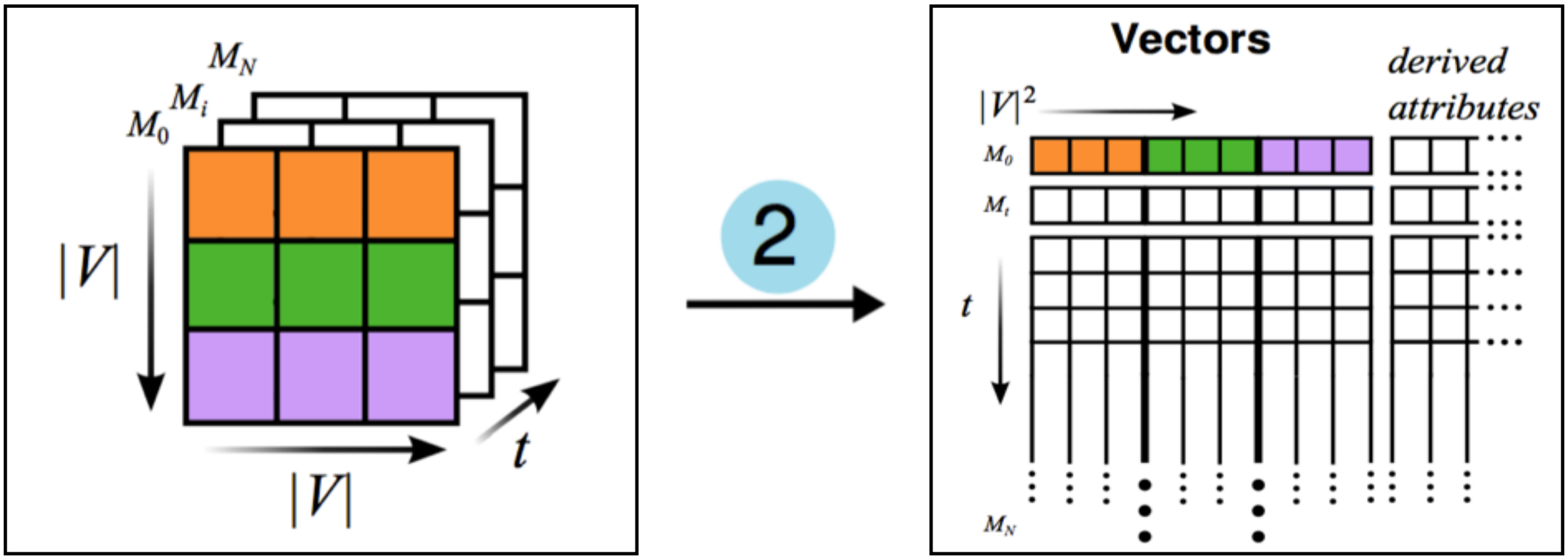
1) Discretization

What?

Why?

How?



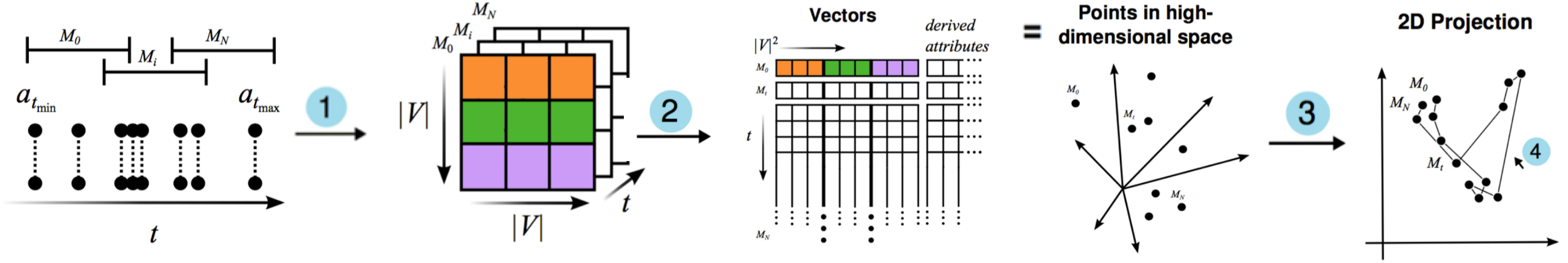


2) Vector Normalization

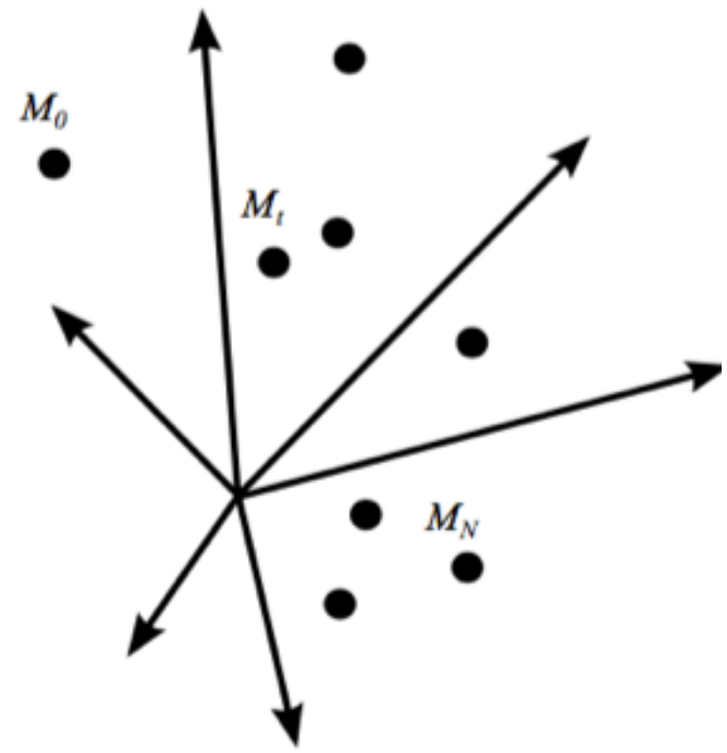
What?

Why?

How?

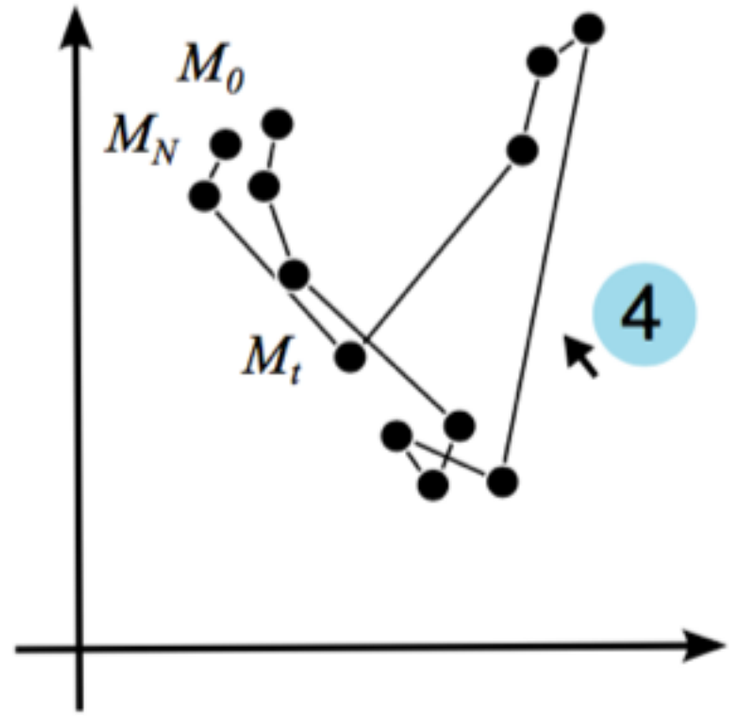


Points in high-dimensional space



3

2D Projection

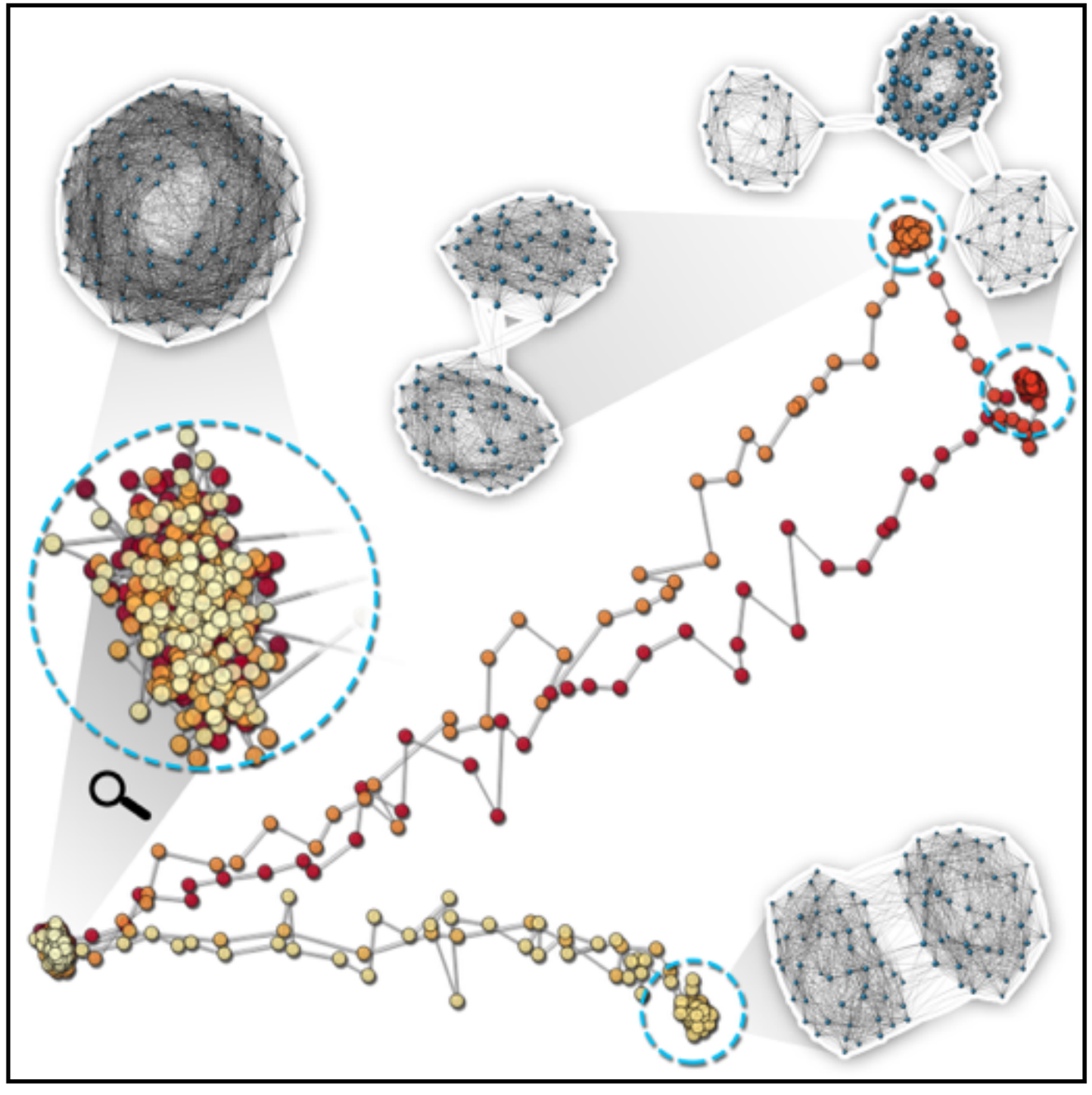


3) Dimensionality Reduction

4) Visualization interaction

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

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

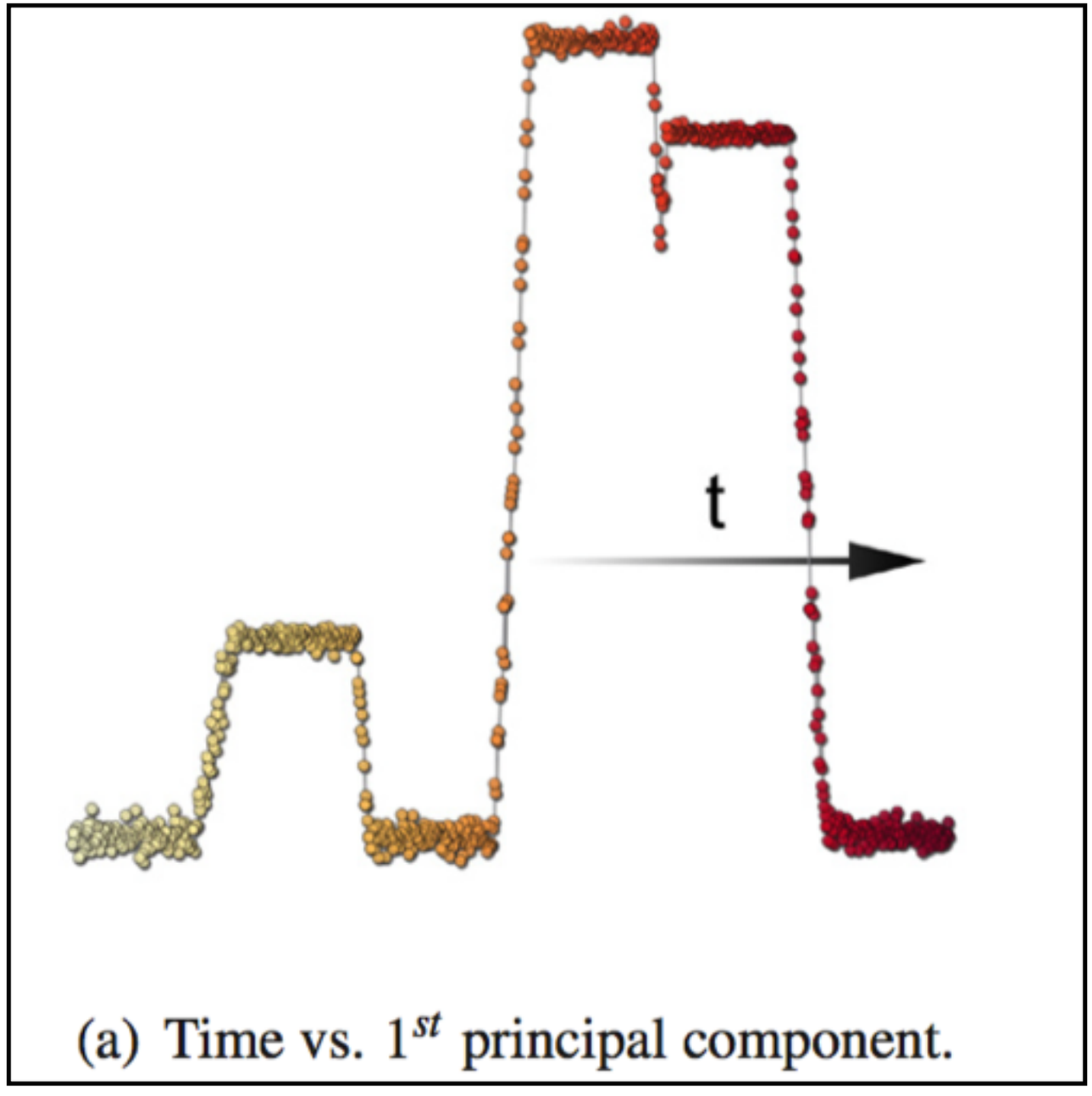


2D Snapshot Reduction

- Alternative view plots time along x axis

- Four stable states

- One reoccurring state (lowest tier)



(a) Time vs. 1^{st} principal component.

A Case Study

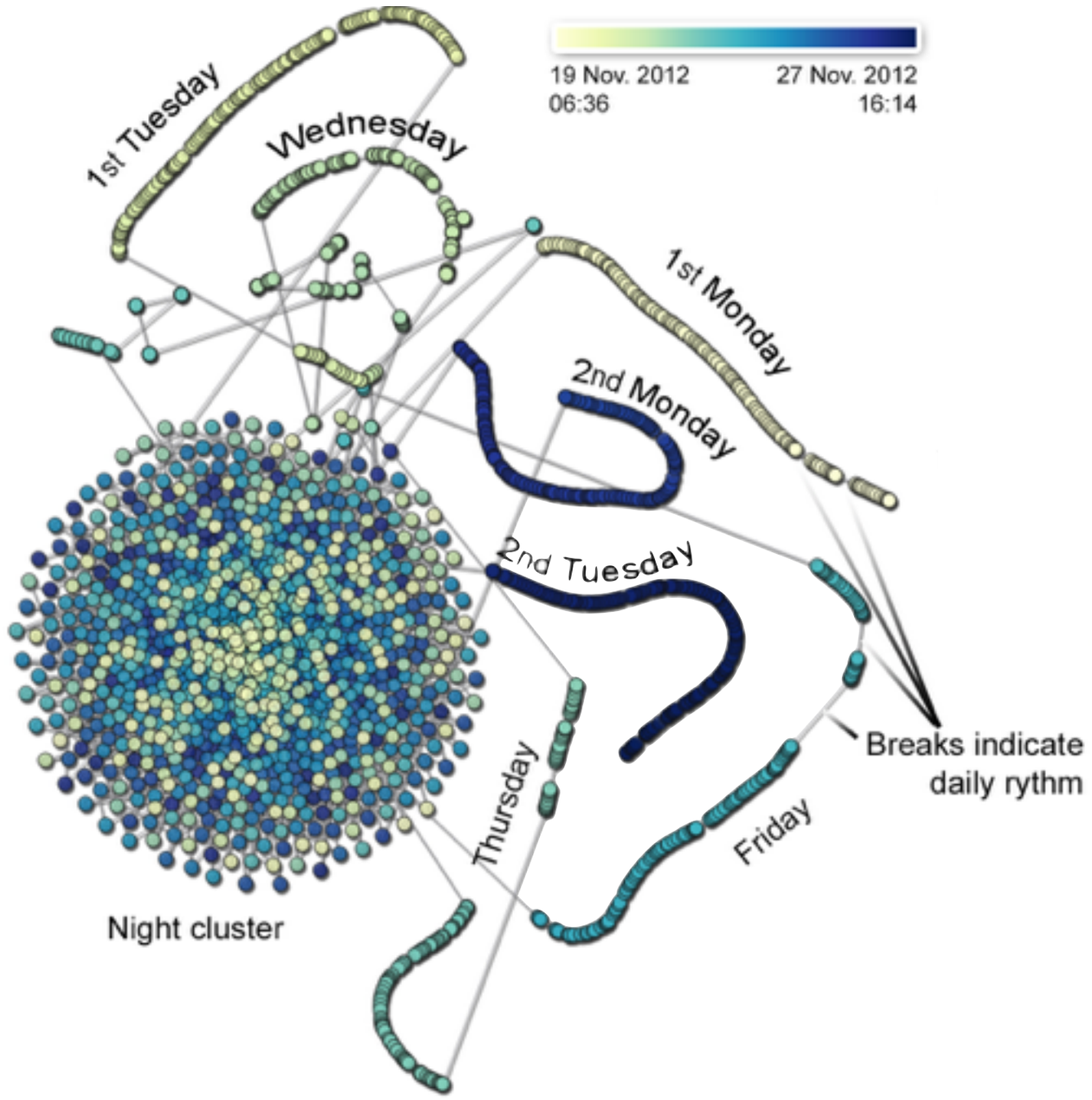
A Case Study

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

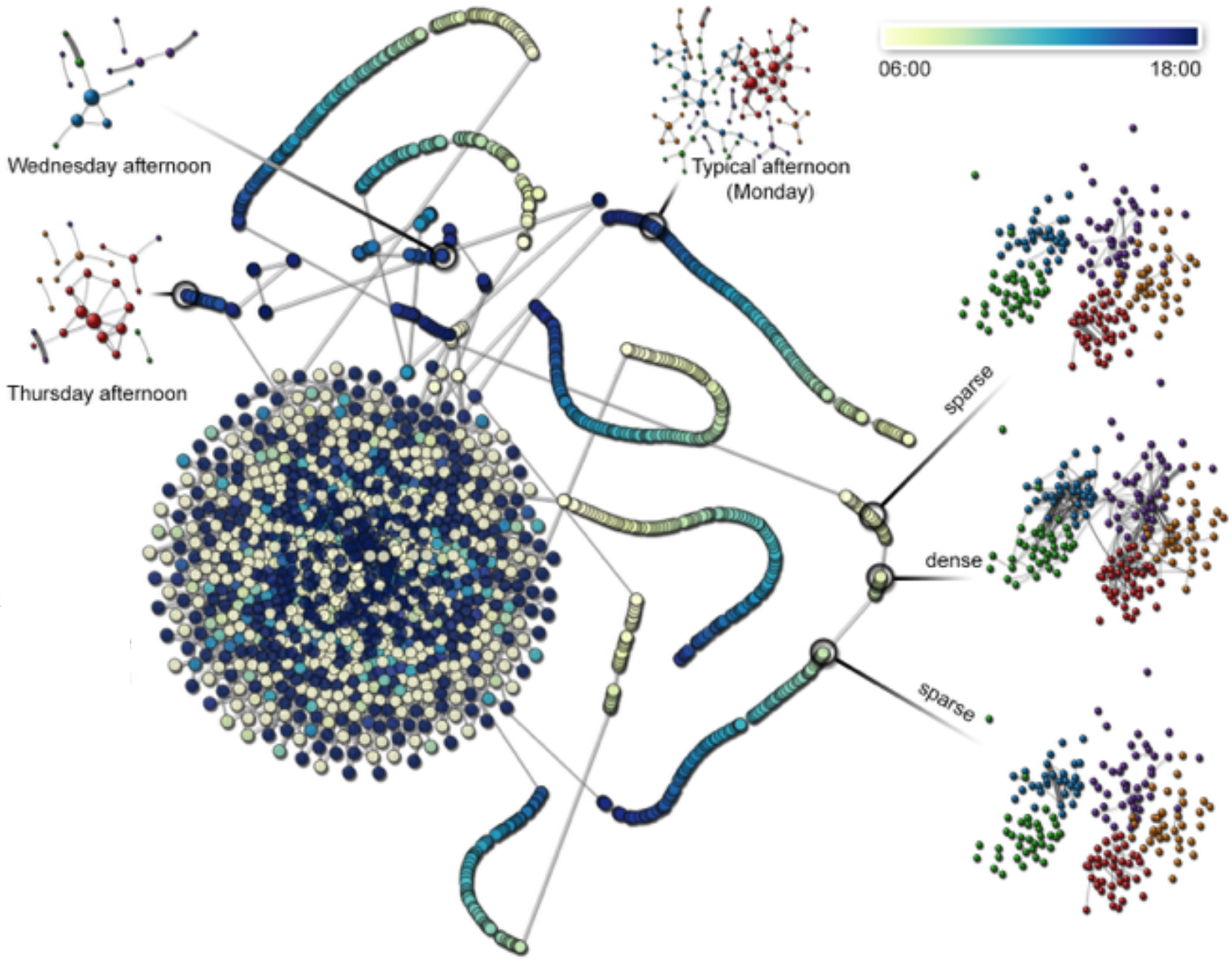
- Dataset is 7 days of face-to-face contact between high school students for 7 school days (MTWTFMT)

- 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



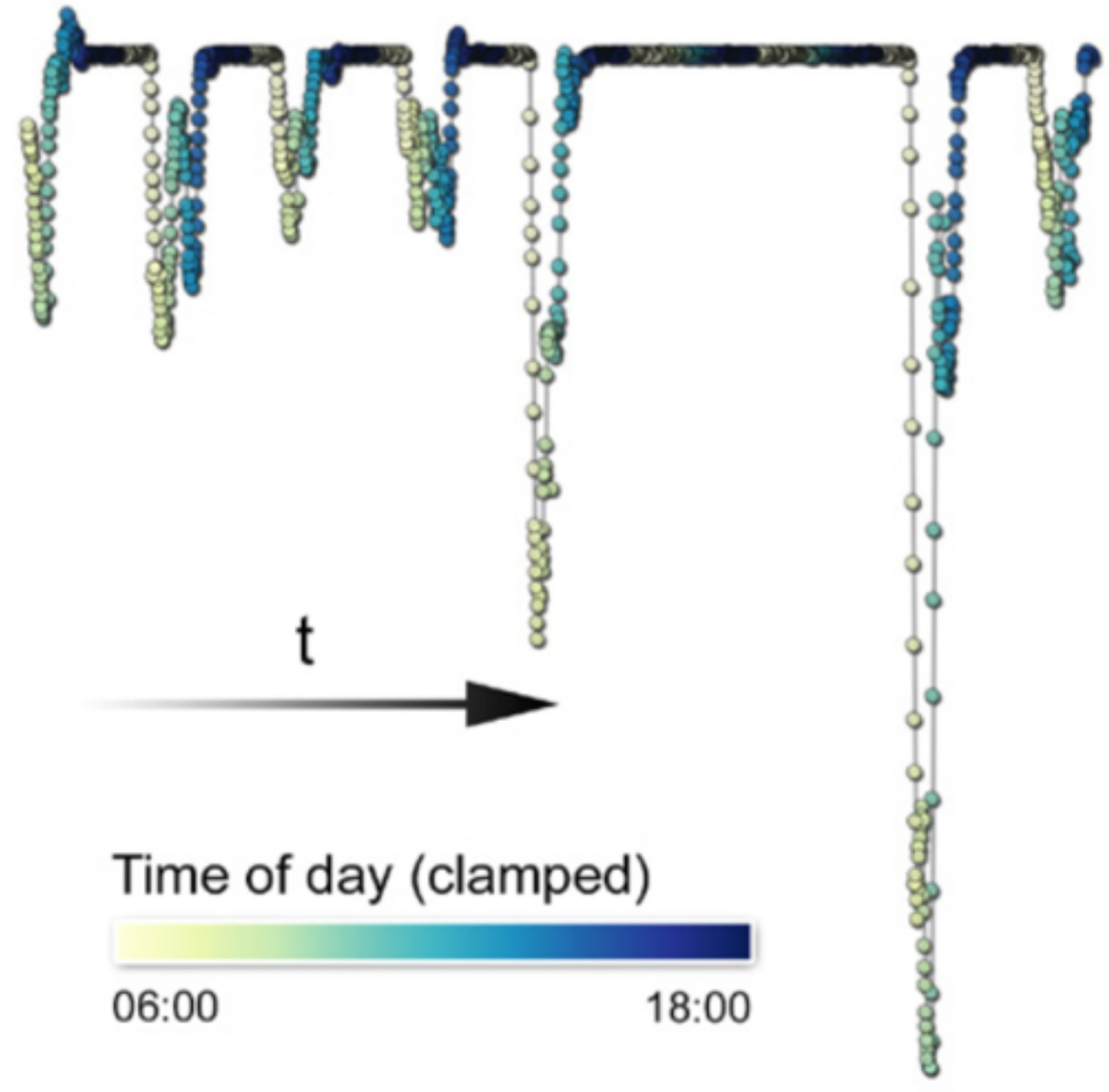
- Colour spans each day
- Network structure shown for each day
- Colour indicates that breaks happen at same time each day
- Wednesday more sparse than other days



- 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

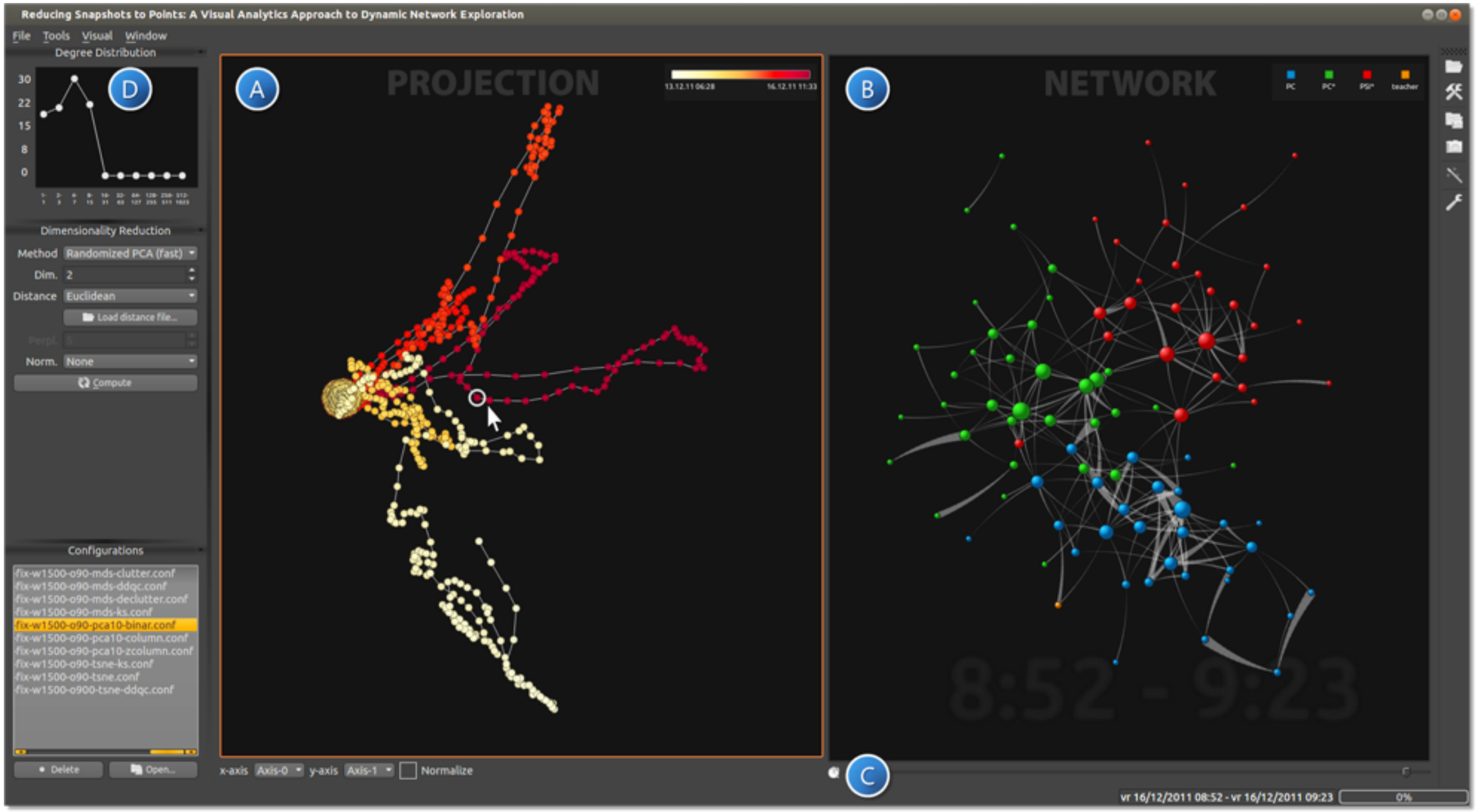
- **How?** Four step process: *discretization, vectorization, dimensionality reduction, and visualization*

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


Reducing Snapshots to Points: A Visual Analytics Approach to Dynamic Network Exploration
File Tools Visual Window
Degree Distribution
30
22
15
8
0
D
Dimensionality Reduction
Method Randomized PCA (fast)
Dim. 2
Distance Euclidean
Load distance file...
Perpl. 5
Norm. None
Compute
Configurations
fix-w1500-o90-mds-clutter.conf
fix-w1500-o90-mds-ddqc.conf
fix-w1500-o90-mds-declutter.conf
fix-w1500-o90-mds-ks.conf
fix-w1500-o90-pca10-binar.conf
fix-w1500-o90-pca10-column.conf
fix-w1500-o90-pca10-zcolumn.conf
fix-w1500-o90-tsne-ks.conf
fix-w1500-o90-tsne.conf
fix-w1500-o900-tsne-ddqc.conf
Delete
Open...
A
PROJECTION
13.12.11 06:28
16.12.11 11:33
x-axis Axis-0 y-axis Axis-1 Normalize
B
NETWORK
PC
PC*
PS*
teacher
8:52 - 9:23
C
vr 16/12/2011 08:52 - vr 16/12/2011 09:23
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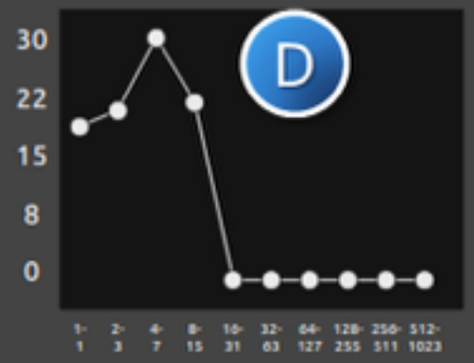
File Tools Visual Window

Degree Distribution



Dimensionality Reduction

Method: Randomized PCA (fast)

Dim.: 2

Distance: Euclidean

Load distance file...

Perpl.: 5

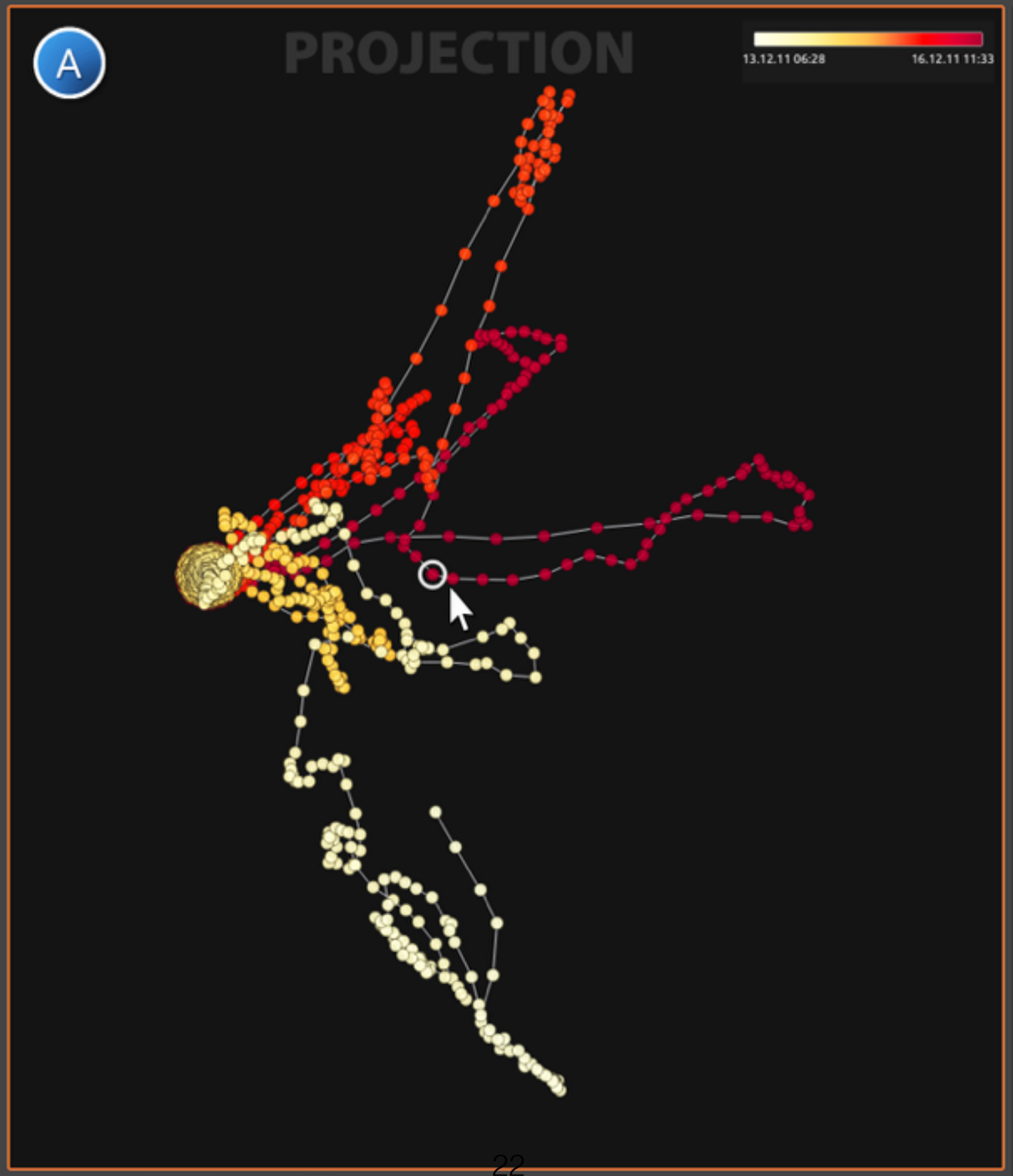
Norm.: None

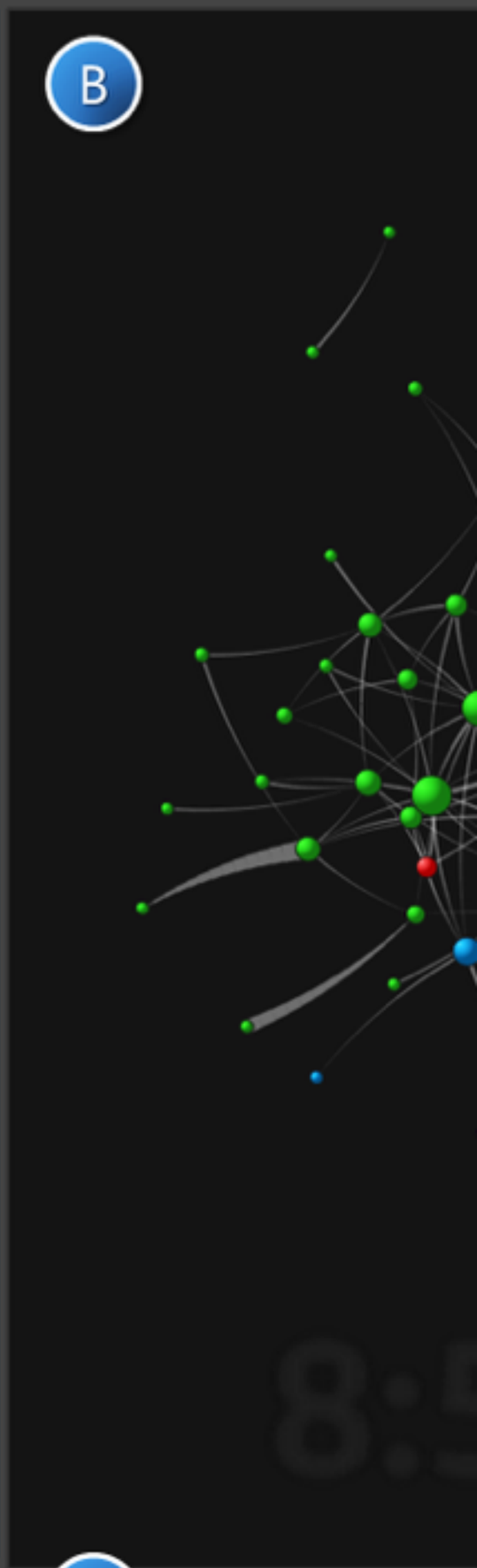
Compute

Configurations

- fix-w1500-o90-mds-clutter.conf
- fix-w1500-o90-mds-ddqc.conf
- fix-w1500-o90-mds-declutter.conf
- fix-w1500-o90-mds-ks.conf
- fix-w1500-o90-pca10-binar.conf
- fix-w1500-o90-pca10-column.conf
- fix-w1500-o90-pca10-zcolumn.conf
- fix-w1500-o90-tsne-ks.conf
- fix-w1500-o90-tsne.conf
- fix-w1500-o900-tsne-ddqc.conf

Delete Open...





x-axis Axis-0 y-axis Axis-1 Normalize

twork Exploration

OJECTION

13.12.11 06:28 — 16.12.11 11:33

B

NETWORK

PC PC* PSI* teacher

8:52 - 9:23

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