Diffusion on Dynamic Networks

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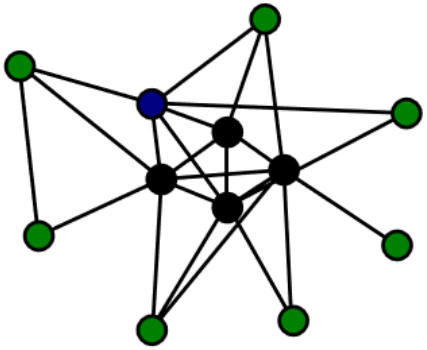
March 6, 2020

Nodes and Edges

Social networks can simulate many types of interaction, including but not limited to interactions between people in a society, organisms in a species, cells in a body, and avatars on a social media platform.

Nodes represent actors: e.g. individual organisms, cells, etc.

Edges represent ties that connect the nodes: e.g. meerkats that groom one another



Affiliation Measures

Degree Affiliation

Degree Affiliation is the most obvious affiliation measure, quantified by the proportion of connections in the graph attached to the node v_i:

$$P(v_i) = \frac{d_{in}(v_i)}{n-1}$$

It is calculated by dividing the number of indegrees of node v_i by $n-1$, the number of nodes in the network excluding v_i.

Affiliation Measures

Closeness

Closeness is related to the average distance of a node to all other nodes:

$$C(v_i) = \frac{n-1}{\sum d(v_i, v_j)}$$

It is calculated for node v_i by dividing $n-1$ (the number of nodes in the network excluding v_i) by the sum of the distances between node v_i and all other nodes v_j.

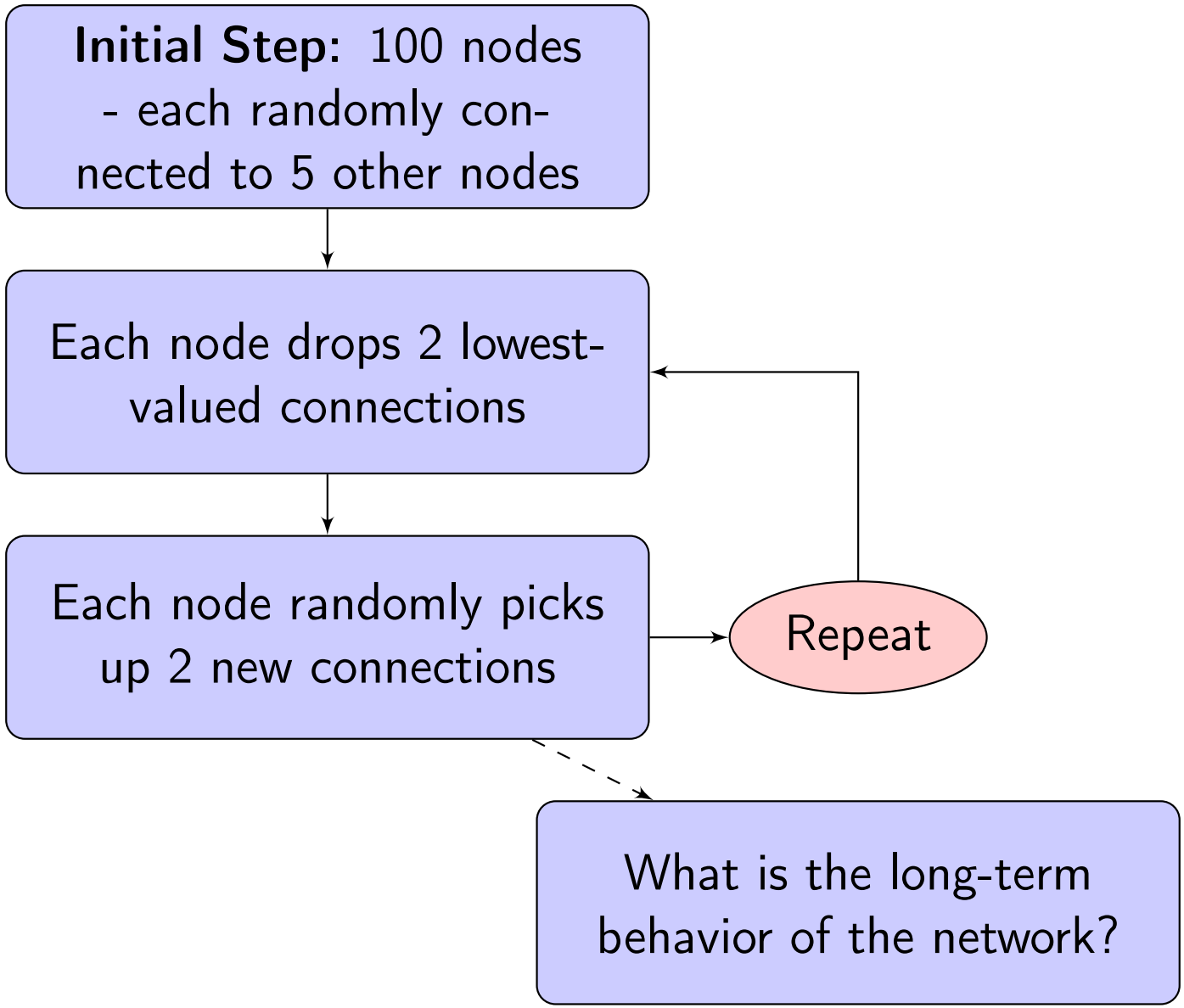
Affiliation Measures

Betweenness

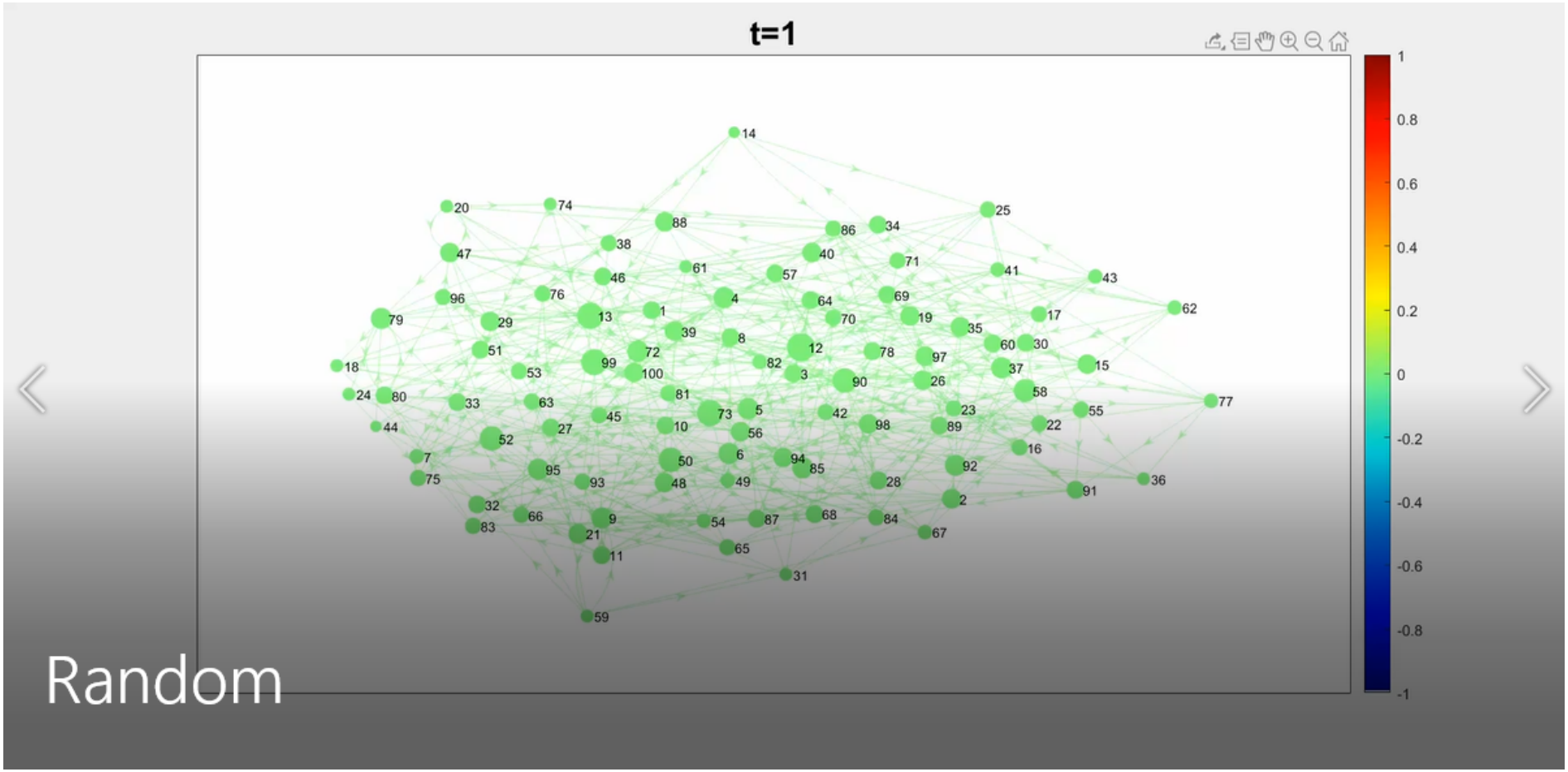
Betweenness quantifies to what degree a node serves as an intermediary between nodes. In the equation below, count(v_i) represents the number of shortest paths that passes through the node v_i:

$$B(v_i) = \frac{2count(v_i)}{(n-1)(n-2)}$$

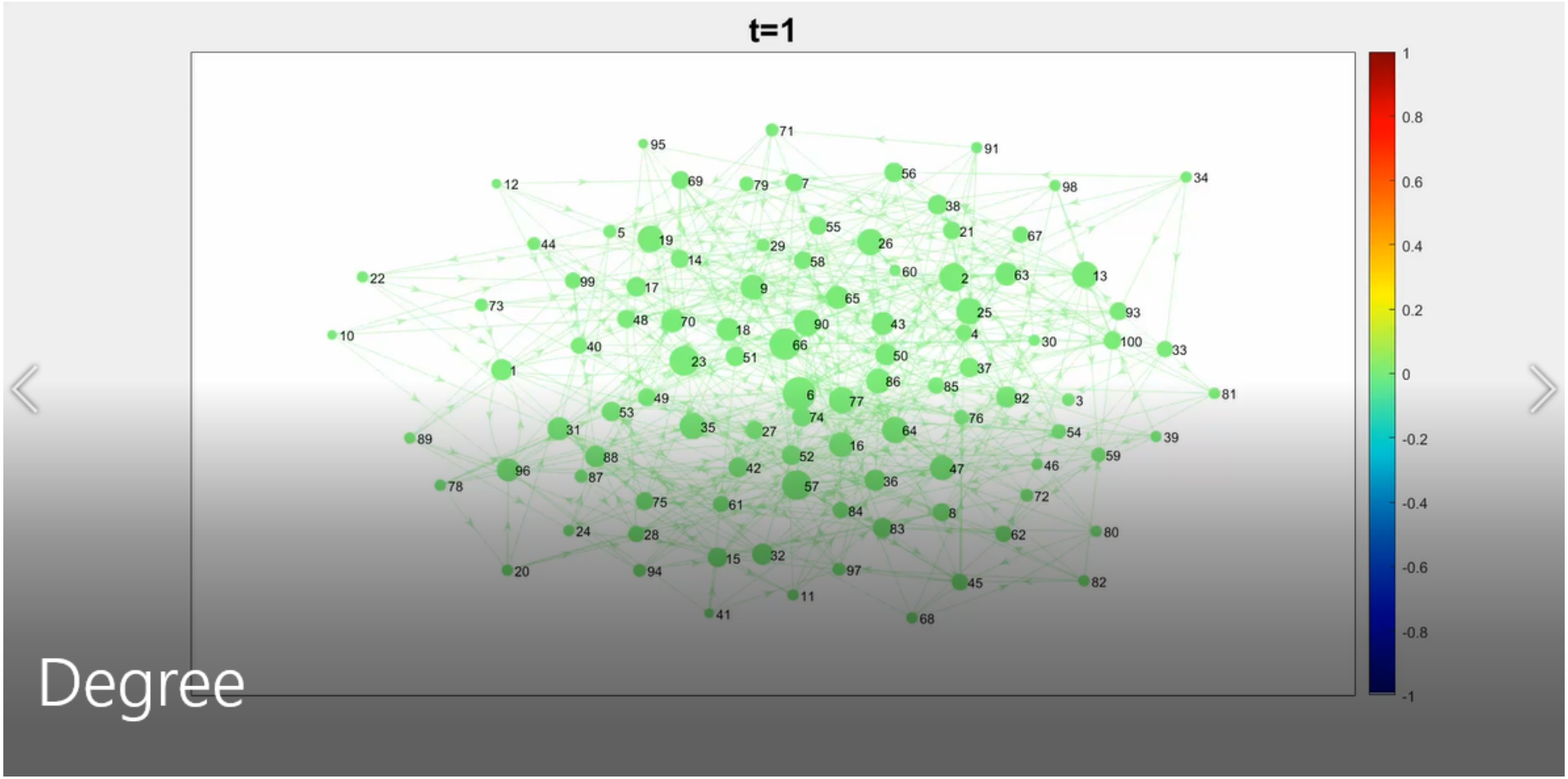
Exploring Network Evolution



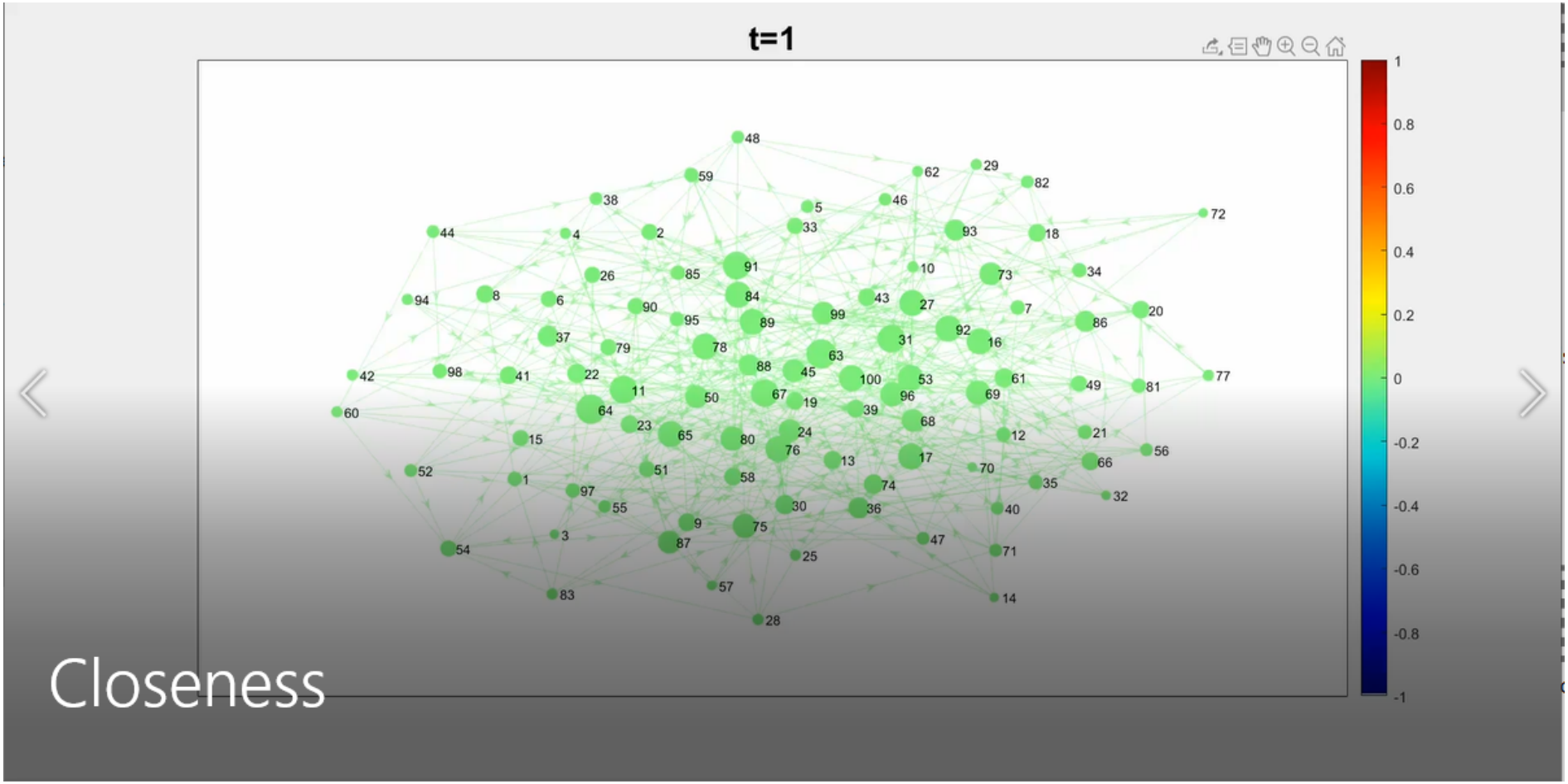
Exploring Network Evolution - No Preference



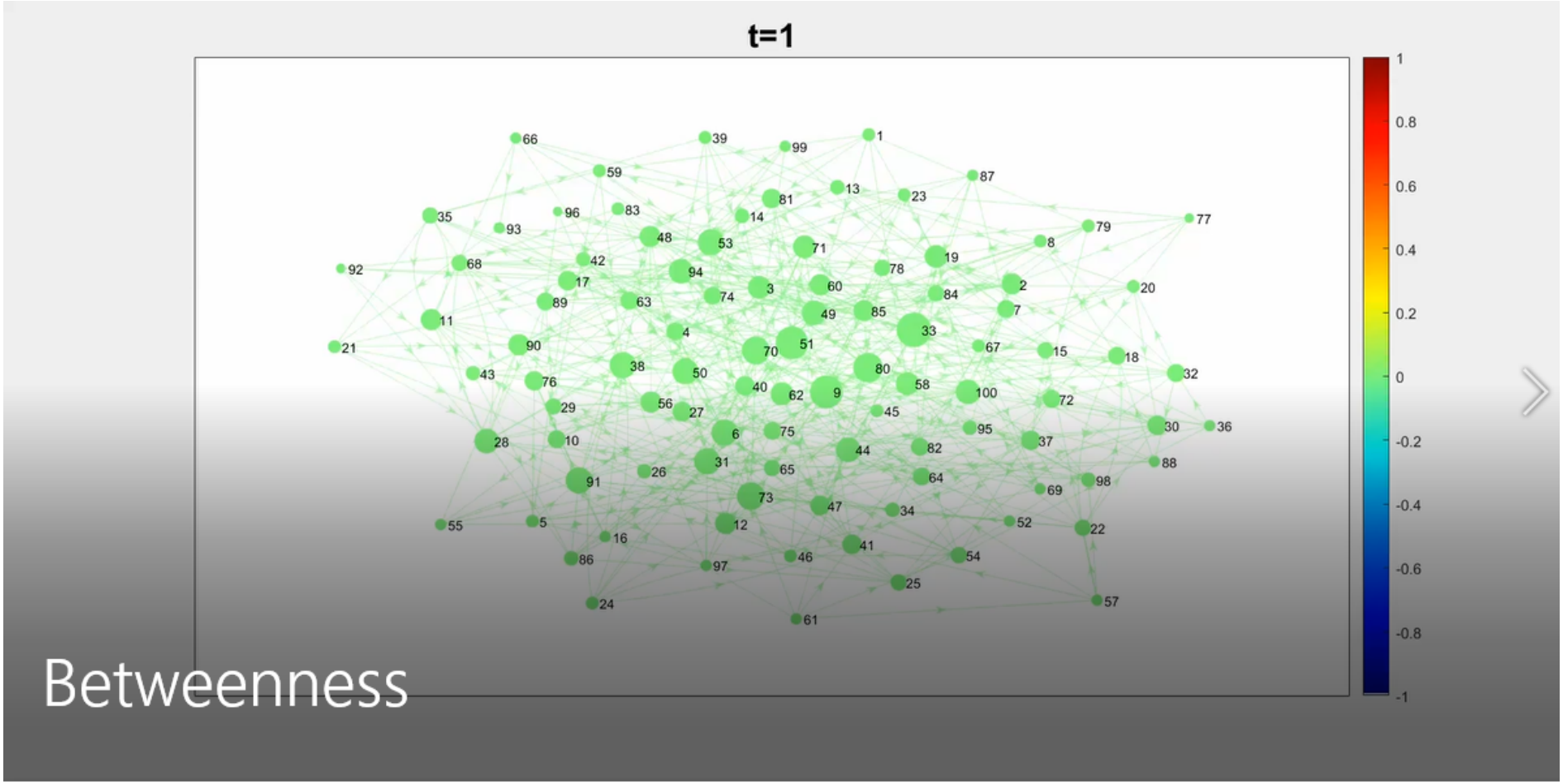
Exploring Network Evolution - Degree Affiliation



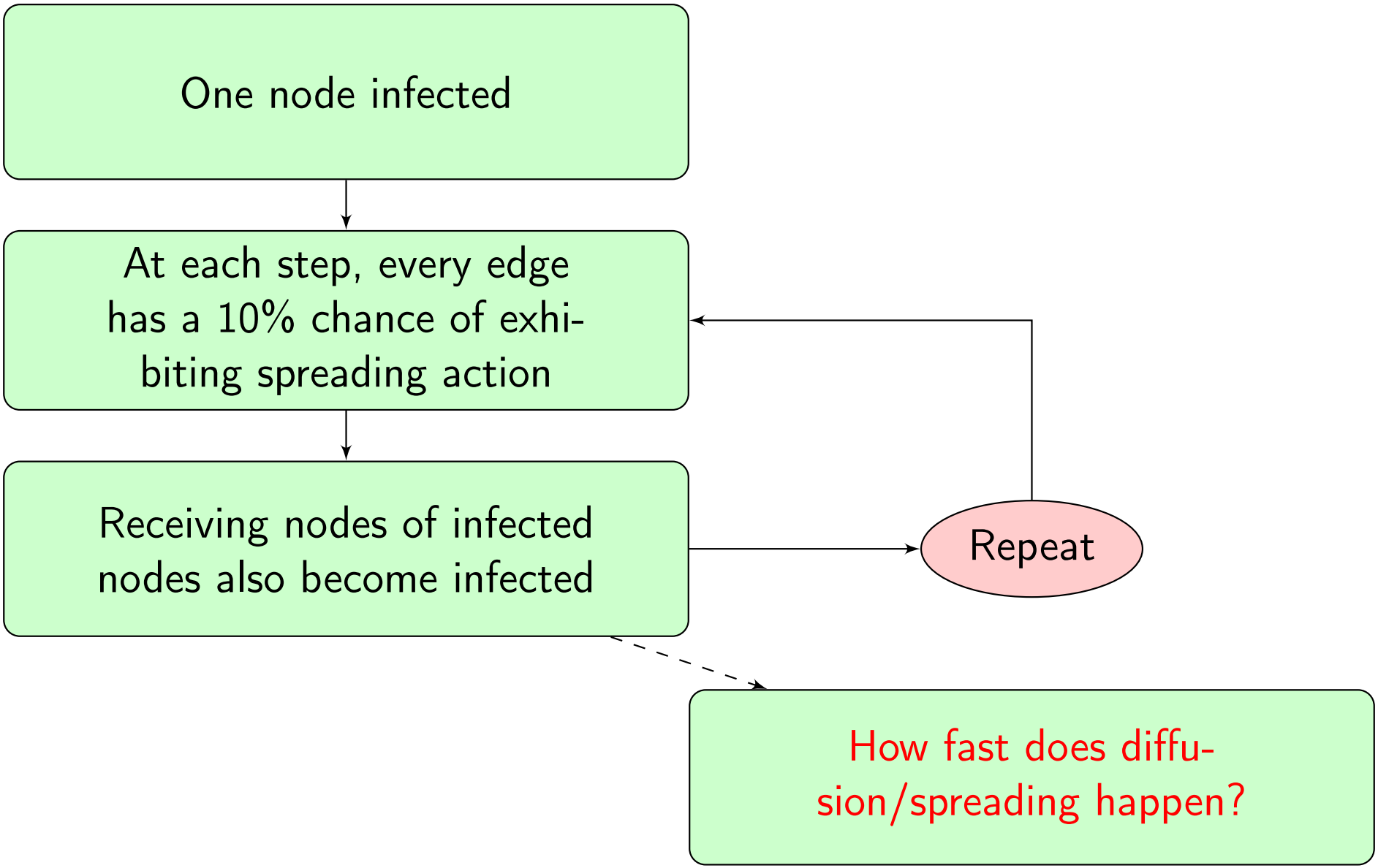
Exploring Network Evolution - Closeness



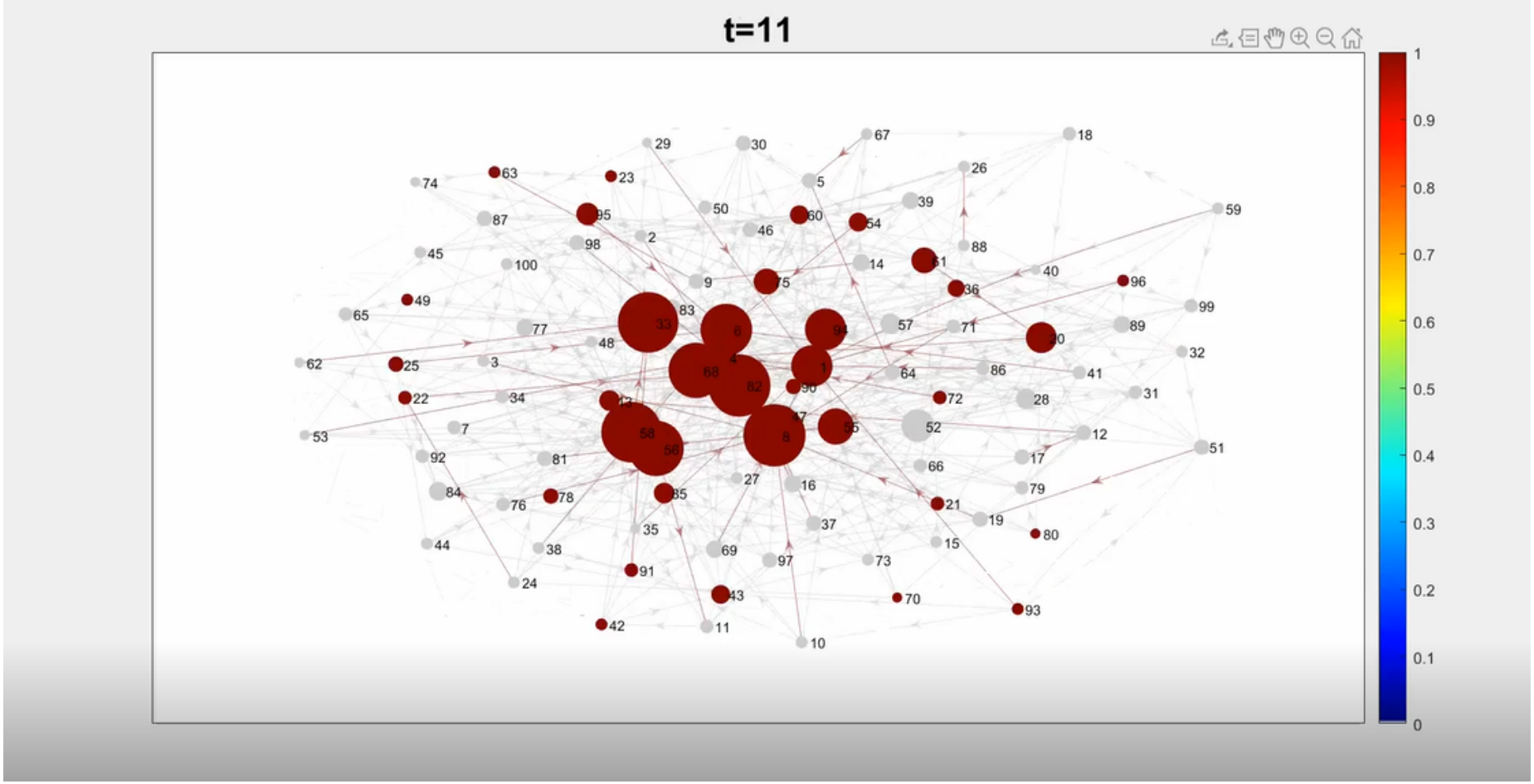
Exploring Network Evolution - Betweenness



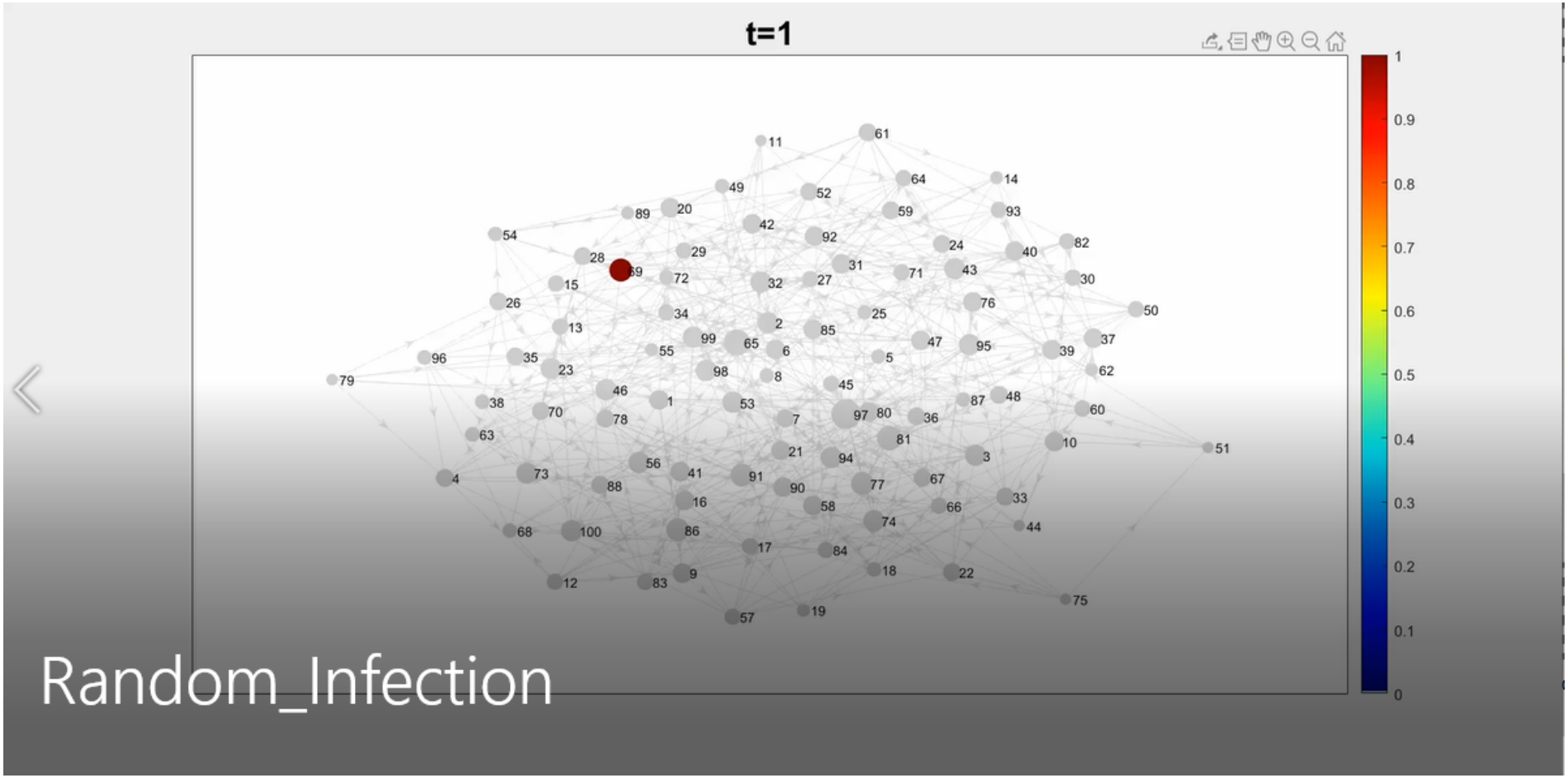
The Diffusion Process



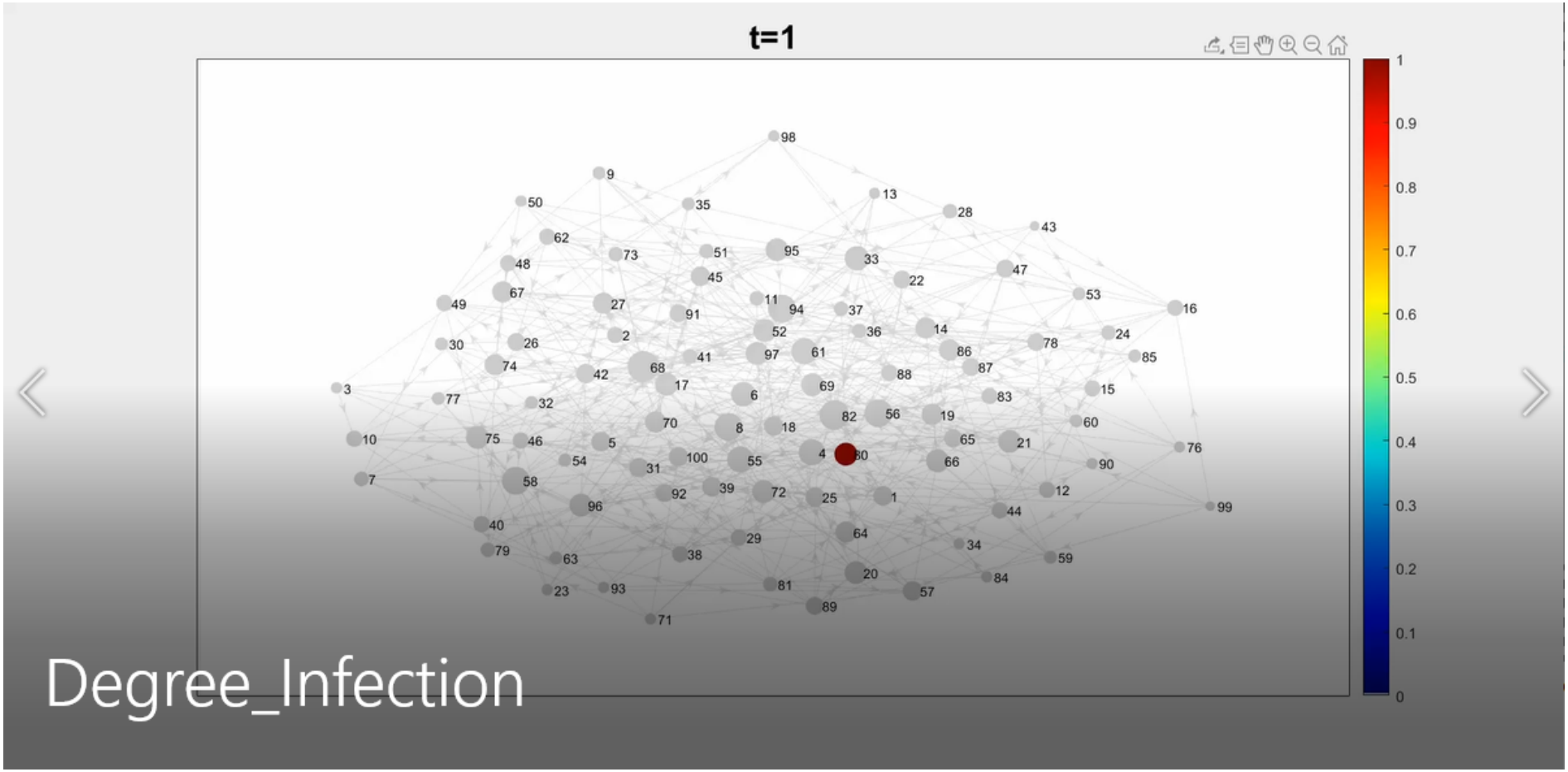
The Diffusion Process



The Diffusion Process - Randomly Evolving Network

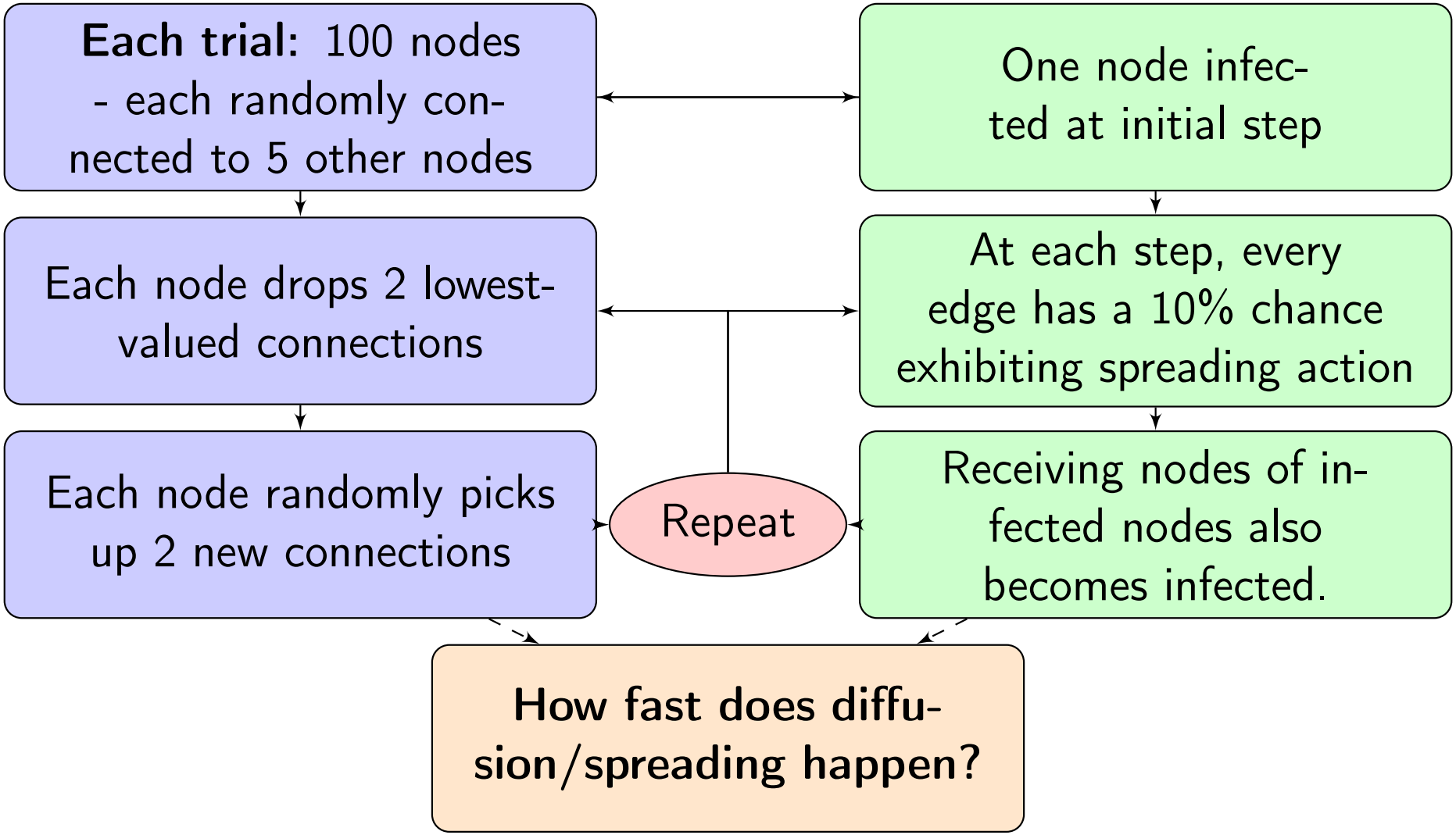


The Diffusion Process - Degree Centrality



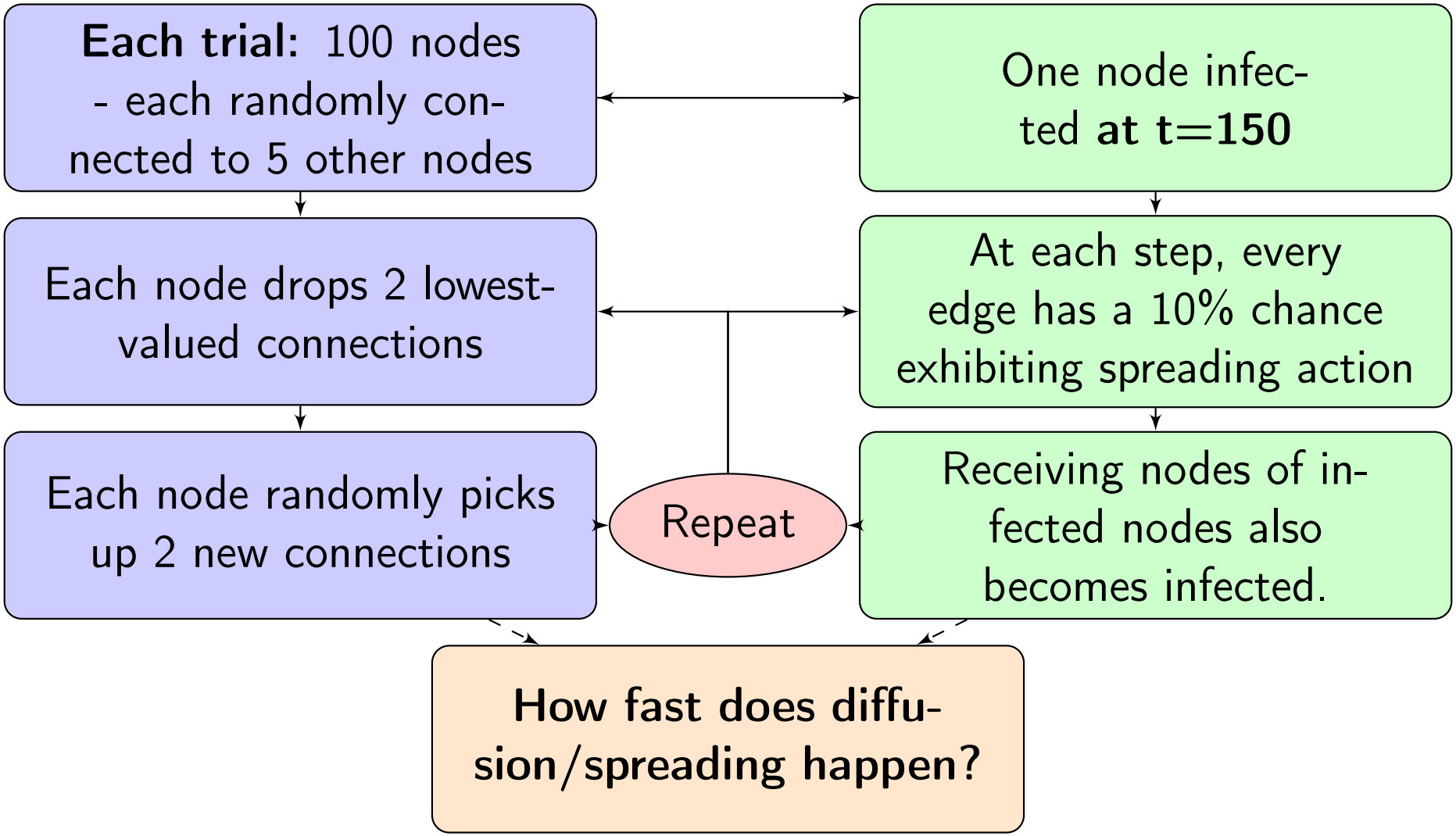
The Diffusion Process - Experiments 1-4

We run **50 trials** each for Degree, Closeness, Betweenness, and Randomness (Control):

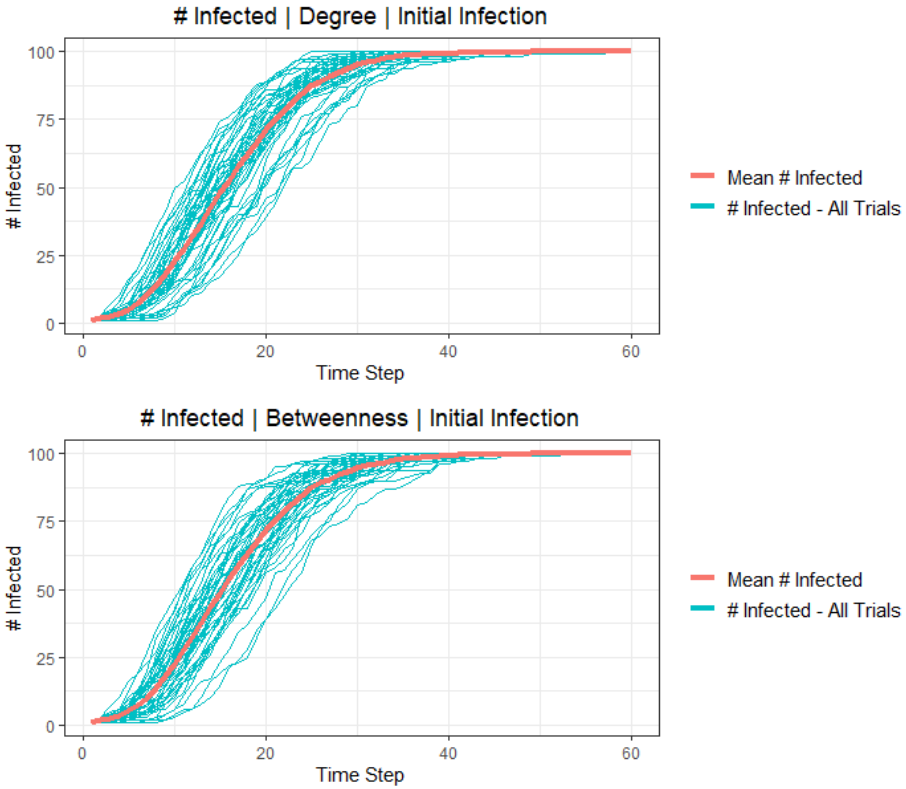


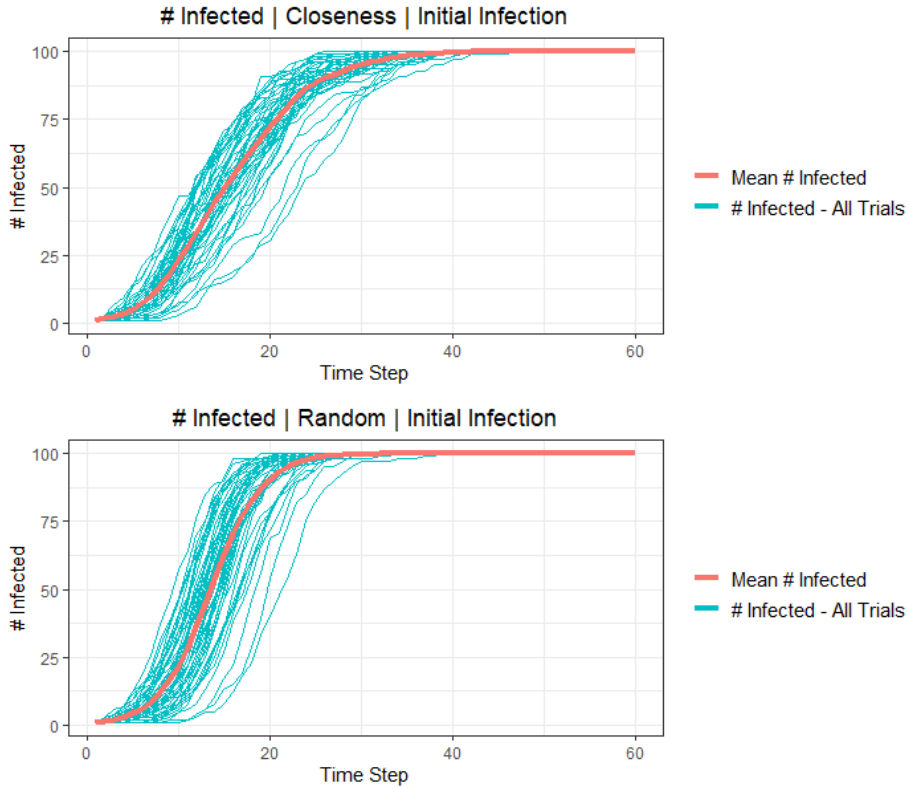
The Diffusion Process - Experiments 1-4

We run **50 trials** for each metric again, **but begin spreading at t=150**, when cores have had more time to evolve:

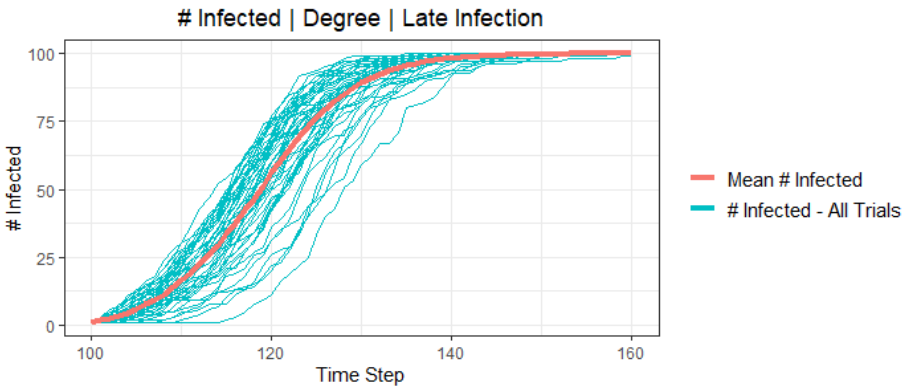


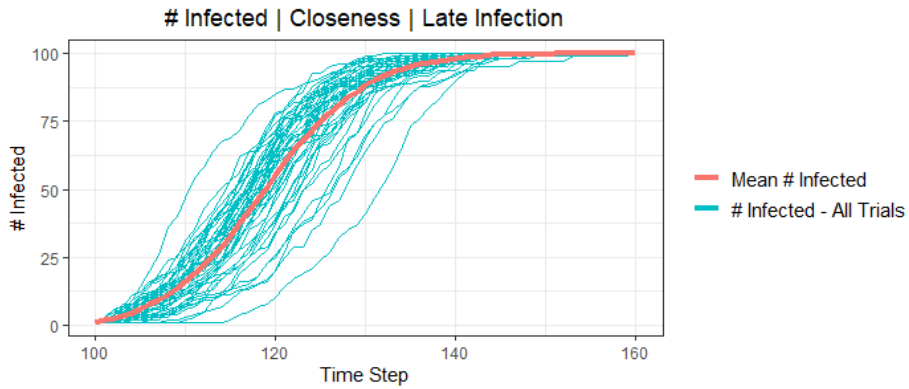
The Diffusion Process - Results: Initial Infection

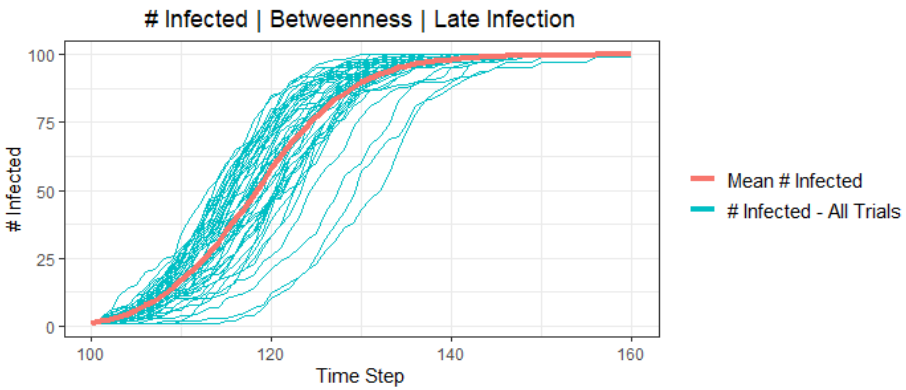


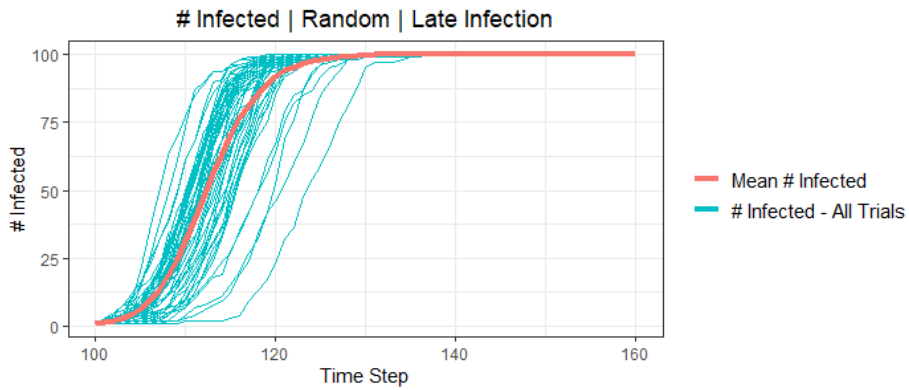


The Diffusion Process - Results: Late Infection

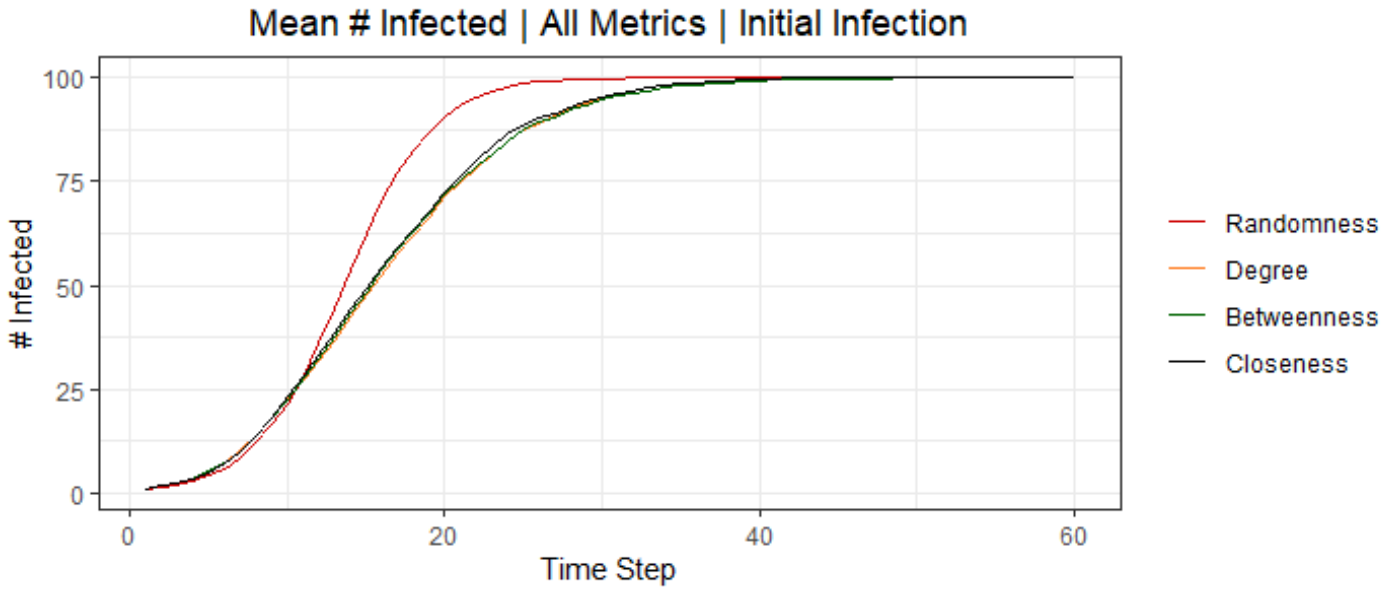


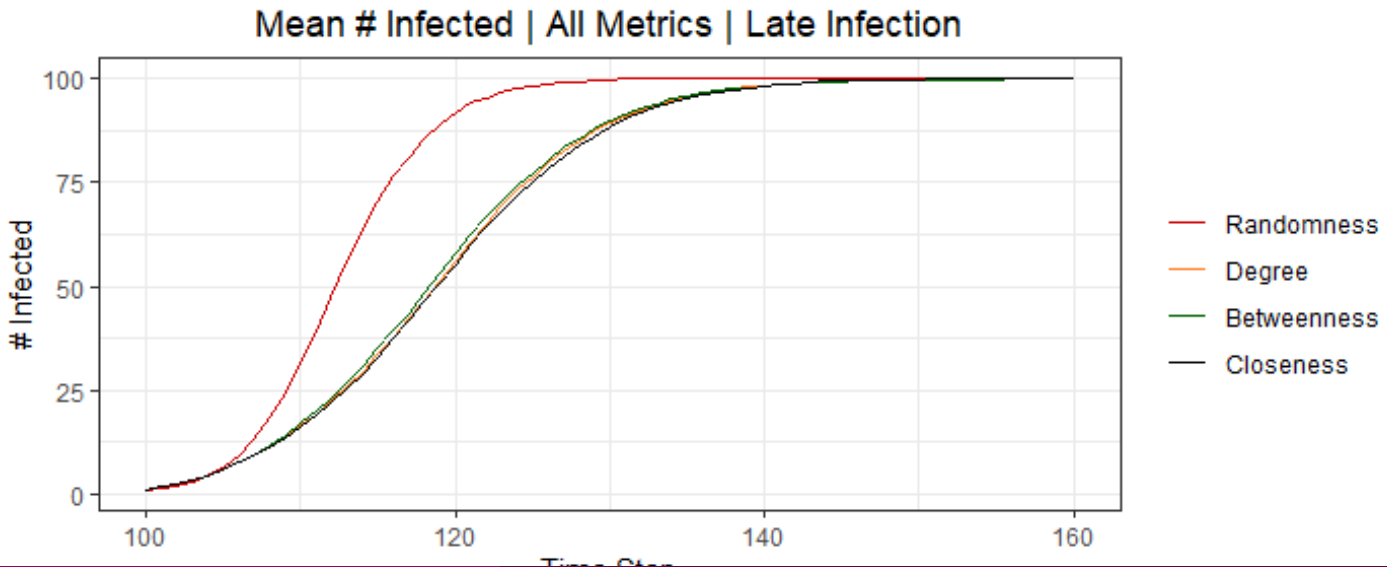




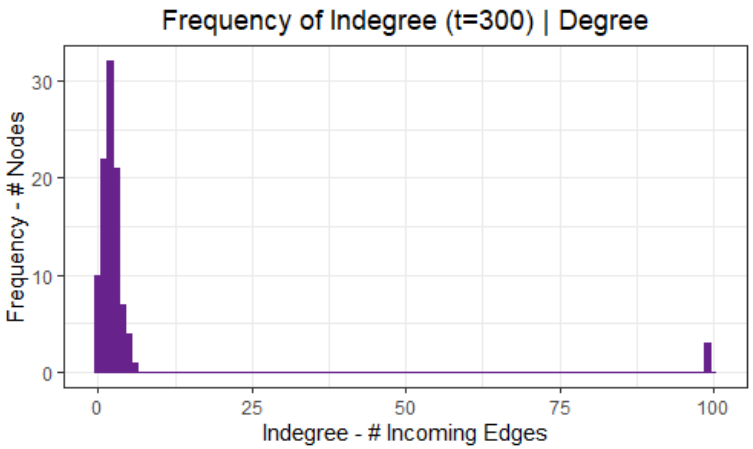


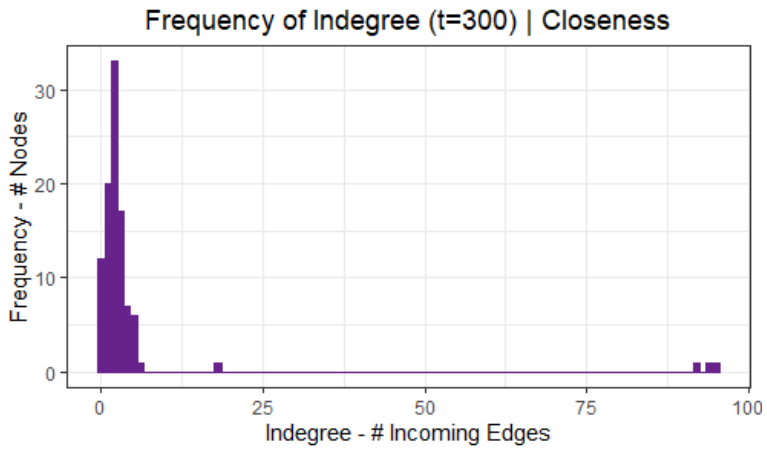
The Diffusion Process - Results: Comparing Initial & Late Infection

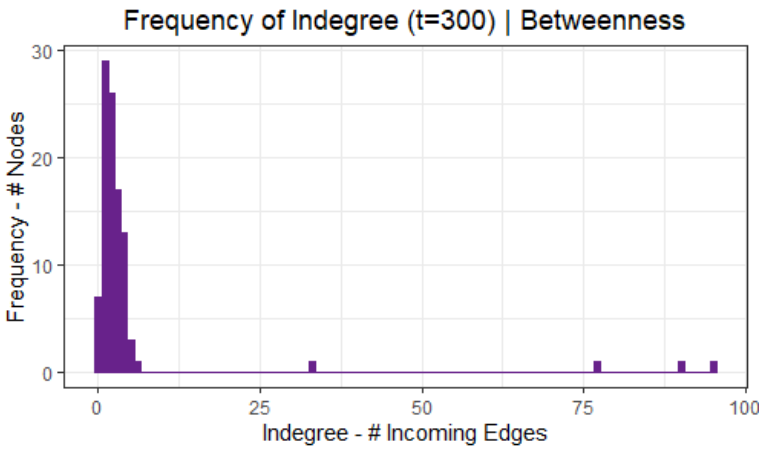


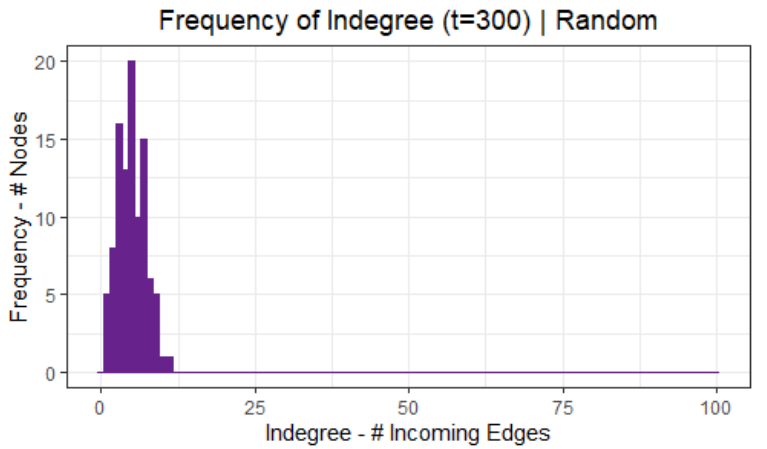


The Diffusion Process - Results









The Diffusion Process - Conclusion & Next Steps

Summary of Findings

- Diffusion on networks that evolved based on degree, closeness, and betweenness occurs slower than on non-dynamic (random) networks
- More evolved dynamic networks exhibit slower diffusion
- Despite how different the core of each dynamic network looks, diffusion rates are similar

Next Steps

- Conjecture as to why dynamic networks exhibit slower diffusion than random networks - Is the core responsible?
- Examine why diffusion rates on dynamic networks are similar despite different attributes of cores

Thank you!

Special thanks to Dr. Radunskaya & Hohn