

Student Collaboration Models Using Random Graphs

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Context

Student collaboration networks

- Introductory Physics (Calc based)
- Self-reported networks
- During group exams (with open collaboration) ⁽¹⁾

Goal: Model collaboration to describe student behavior.

Methods

(Social) Network Analysis (SNA) tools to describe collaboration networks: ⁽²⁾

Nodes Students

Edges (Directional) collaborations between students

SNA parameters for describing these networks:

Plot Degree Number of collaborators

Betweenness number of connections

Plot Transitivity Number of mutual collaborators in a triad

Plot Reciprocity Probability for vertices to be linked in a directed network

StuNet model parameters

pGroup probability of nodes connecting within a group

pOther probability of nodes connecting outside a group

clump average group size

Comparison metric

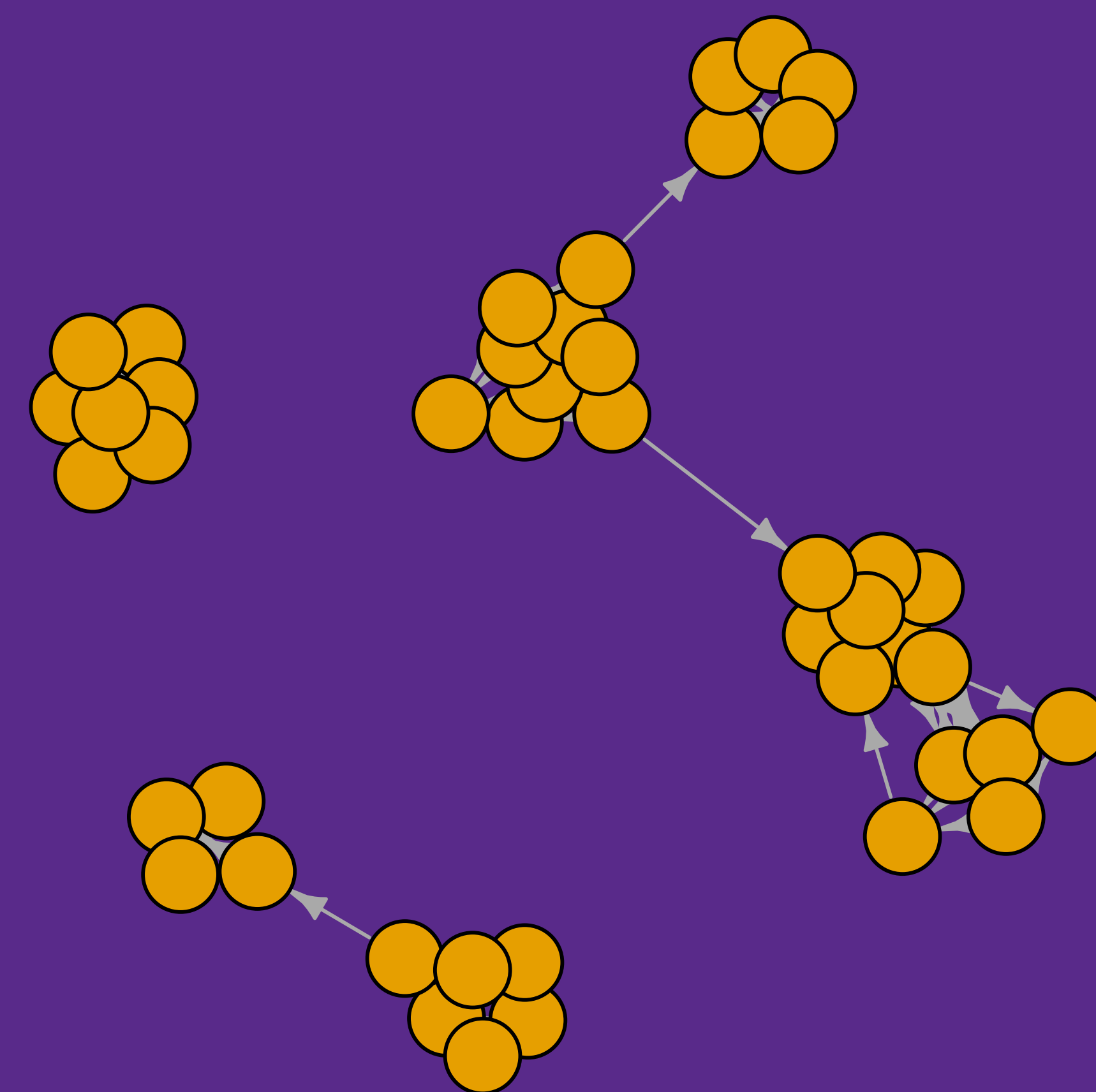
Dissimilarity: The overall differences between the model and the class network

$$D = \langle KS_{\text{degree}} \rangle + \langle KS_{\text{betweenness}} \rangle + |Z_{\text{transitivity}}| + |Z_{\text{reciprocity}}|$$

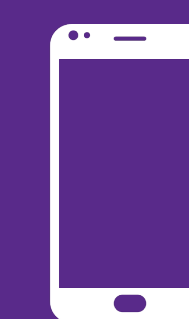
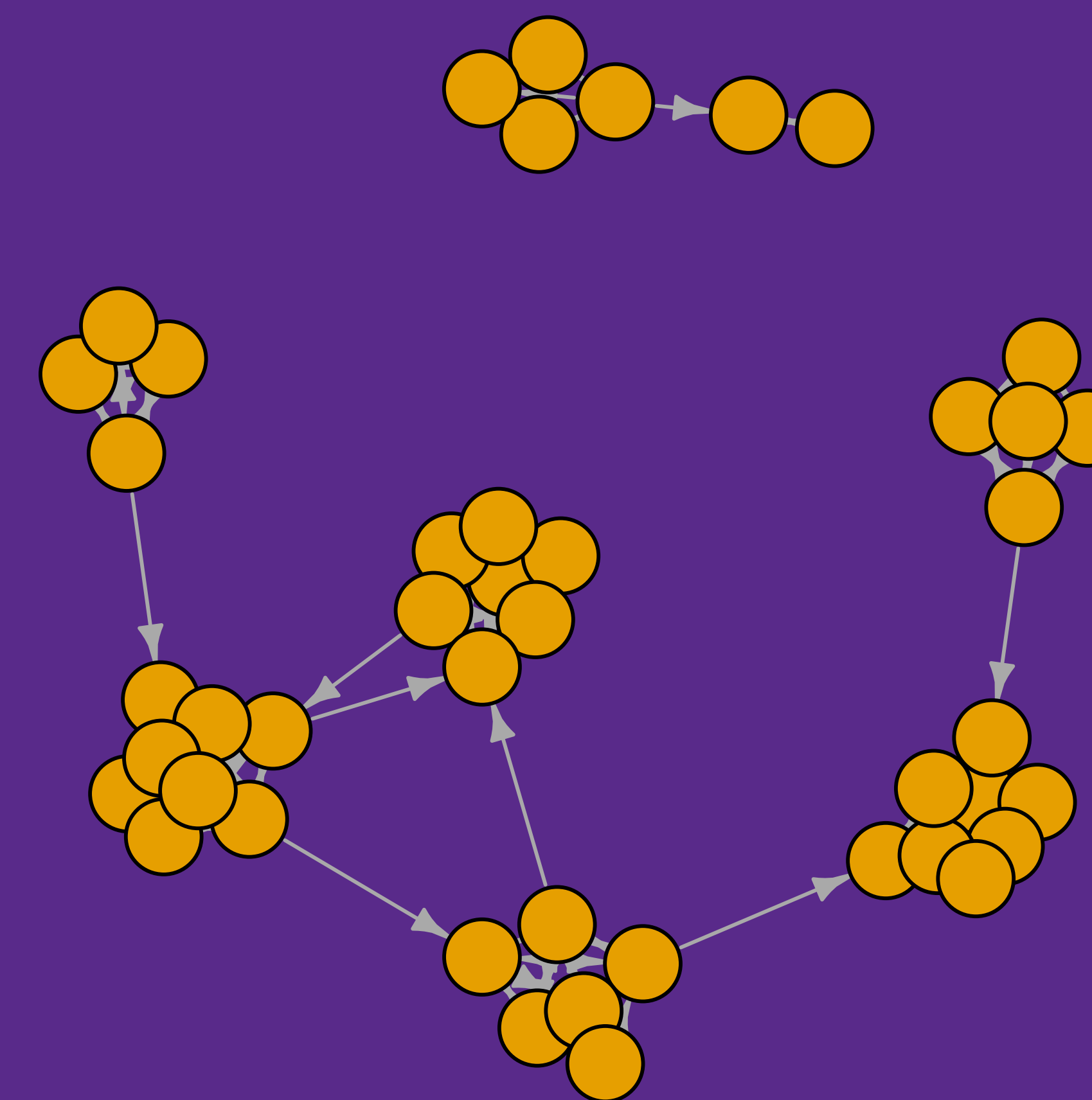
KS is the KS-statistic (kolmogorov smirnov)

We developed and optimized a model describing the social network of a collaborative classroom.

Classroom Network



Simulated Network



Take a picture to learn more

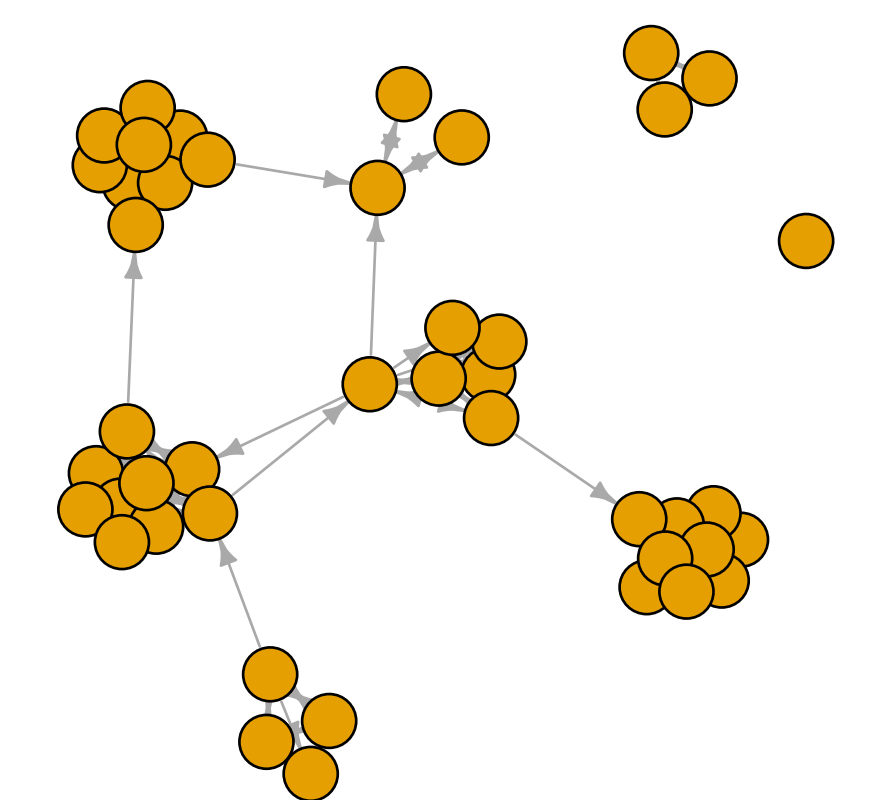
Optimization

- We used `optimr` to optimize our model
- A logit transformation was applied to conduct an unconstrained optimization, specifically on `pGroup` and `pOther` as their probability is between 0 and 1
- $\text{logit}(P) = \log\left(\frac{P}{1-P}\right)$

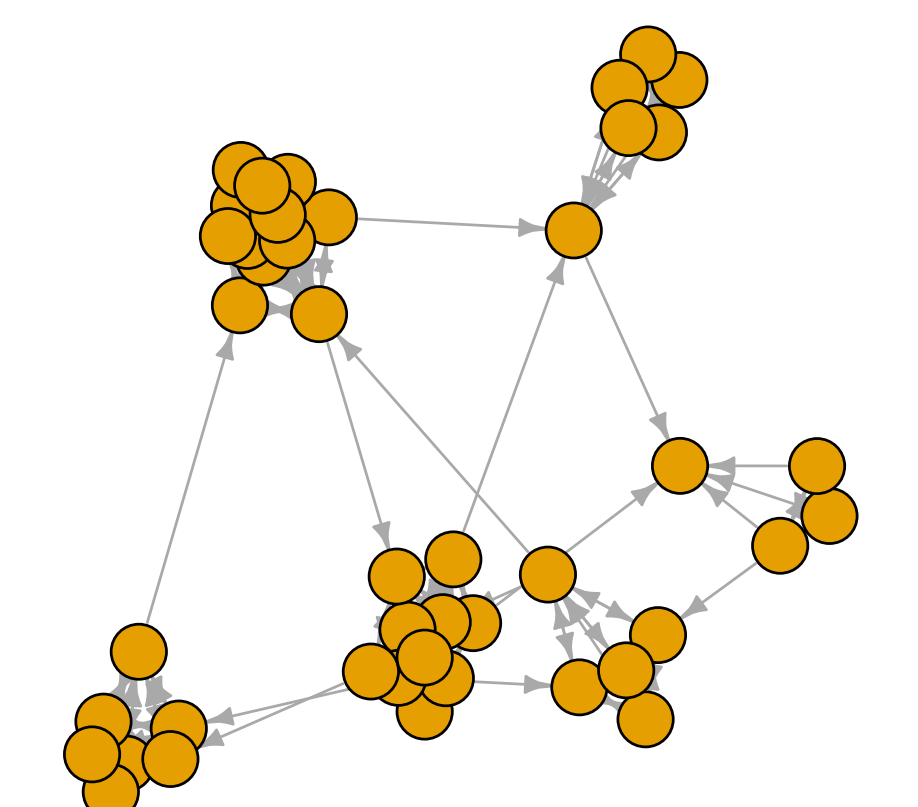
More Networks

Here are a couple more simulations using the same data!!

Simulated Network



Simulated Network



Future Directions

- Optimize more exams and compare student trends between exams
- Test the assumption that students connect depending on their position in a group or outside a group.
 - Are we *Fermions* or are we *Bosons*
- Add more detailed information about the students, such as gender and major

References

⁽¹⁾ Wolf, Steven & Blakeney, Cody & Close, Hunter. (2016). Group Formation on Physics Exams. 400-403. 10.1119/perc.2016.pr.095.

⁽²⁾ Wolf, Steven & M. Sault, Timothy & Close, Hunter. (2018). Information flow in group exams. 444-447. 10.1119/perc.2017.pr.106.