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Comparing network centrality measures of non-traditional students in an introductory physics class

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WRIGHT STATE UNIVERSITY

Goals

- Compare different models of network influence for students
- Research questions:
  1. How do common centrality measures compare when ranking students' network influence?
  2. Do centrality values of non-traditional students show different trends than traditional students?

Motivation and background

- Social Network Analysis utilizes several different measures to describe a node's centrality position [1].
- Non-traditional students (age 22+) tend to have fewer on-campus connects and lower retention rates than traditional students [2].
- Social connections toward other students have consequences for long-term retention [3].

Methods

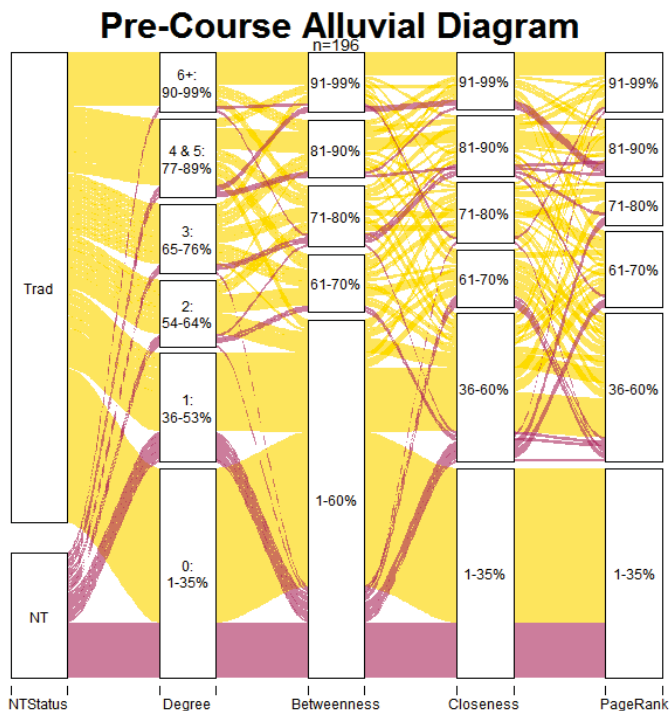
- Data: pre- and post-course survey question:
  - "Who do you work with to learn physics in this class?"
- Course: Calculus-based physics I, lecture format with use of peer instruction, approximately 220 students
- Alluvial diagrams are useful for depicting flow of students between variables [4].

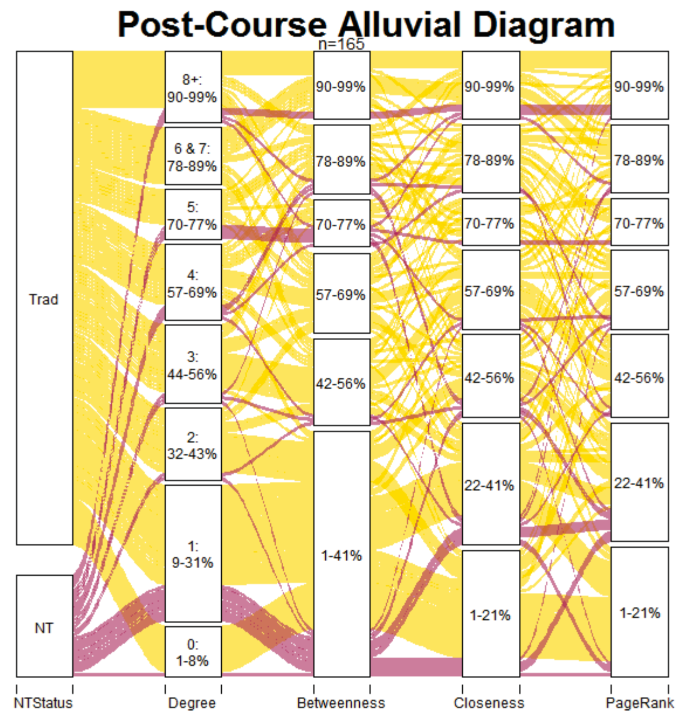
<u>Network representation:</u>

- Students are nodes (*i*,*j*,*k*).
- Undirected links (R_{ij}) between nodes indicate either student reported the pair as study partners.
- Geodesics (d_{ij}) are the shortest paths between nodes *i* and *j*.
- Links are connections used in centrality calculations:
  - Degree [5]: $C_D(i) = \sum_i^n R_{ij}\,, i \neq j$
    - total number of links connected to node *i*
  - Betweenness [5]: $C_B(i) = \sum_{j<k}^n \frac{d_{jk}(i)}{d_{ik}}, i \neq j$
    - number of times node *i* falls between pair of other nodes (*j* and *k*) on geodesic connecting nodes *j* and *k*
  - Closeness [5]: $C_C(i) = \left[\sum_{j=1}^n d_{ij}\right]^{-1}, i \neq j$
    - sum of geodesics from node *i* to all other nodes
  - PageRank [6]: $C_{PR}(i) = c\sum_j^n C_{PR}(j)\,, i \neq j$
    - indicates node *i*'s connections are well-connected

Preliminary results

Pre- and post-course alluvial diagrams of various centrality measures are below. Each diagram shows the shifts in student rankings between the different centrality models. Colors indicate non-traditional (age 22+) and traditional students. Percentiles are binned based on the data's natural breaking points for low centrality values.





Work in progress

- Determine if non-traditional students' centrality ranking behavior varies differently from traditional students' centrality behavior.
  - If so: Is this due to non-traditional students lower overall centrality at pre-course?
- What do the pre/post-course alluvial diagrams and associated centrality distributions look like for other instructors and course formats (smaller class size, SCALE-UP classrooms, etc.) and classes (calculus-based general physics II)?
- What are the implications of large variances for correlating network position with course outcomes?

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[3] Tinto, V. (1993). Leaving College: Rethinking the Causes and Cures of Student Attrition.
[4] Rosvall, M., & Bergstrom, C. T. (2010). Mapping change in large networks. *PloS one*, *5*(1), e8694.
[5] Freeman, L. C. (1978). Centrality in social networks conceptual clarification. *Social networks*, *1*(3), 215-239.
[6] Page, L., Brin, S., Motwani, R., & Winograd, T. (1999). The PageRank citation ranking: bringing order to the web.