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Comparing Network Centrality Measures of Non-Traditional Students in an Introductory Physics Class


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



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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].

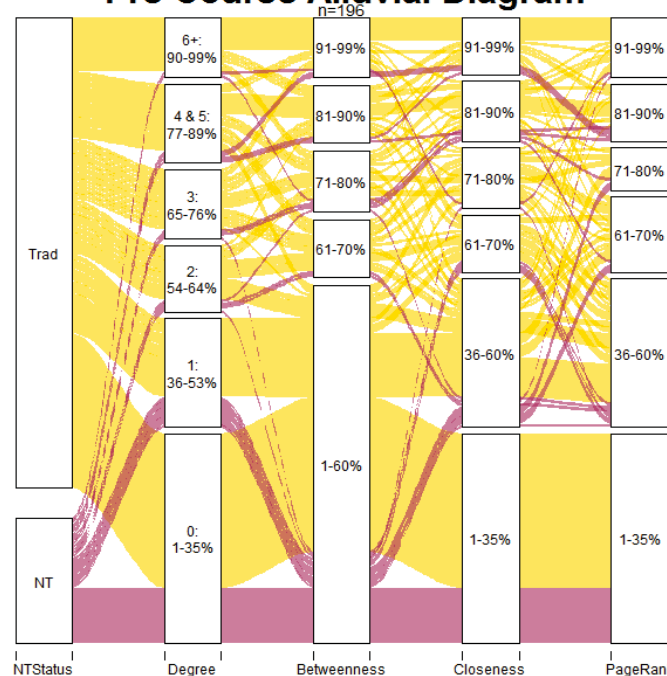
Network representation:

- 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]: $C_C(i) = [\sum_{j=1}^n d_{ij}]^{-1}, i \neq j$
 - 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

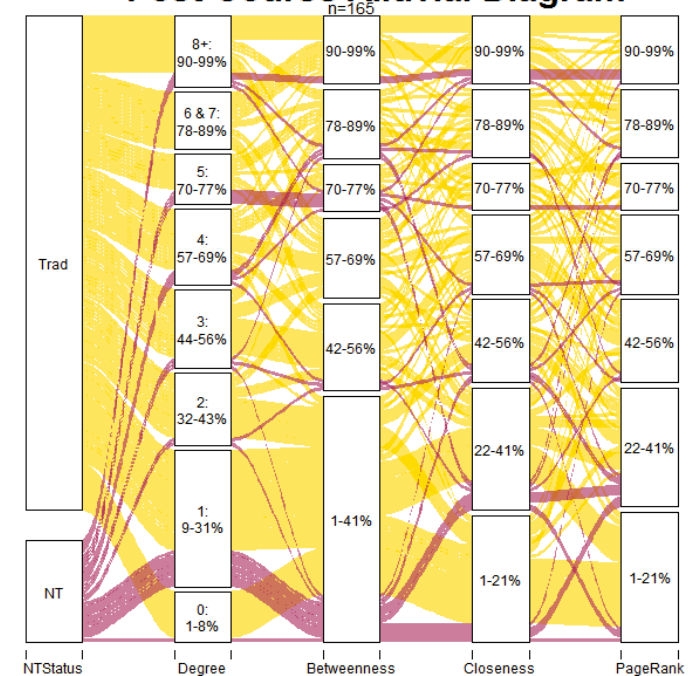
Preliminary results

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.

Pre-Course Alluvial Diagram



Post-Course Alluvial Diagram



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?

[1] Kolaczyk, E. D., & Csárdi, G. (2014). *Statistical analysis of network data with R* (pp. 1-5). New York, NY: Springer.

[2] Gilardi, S., & Guglielmetti, C. (2011). University life of non-traditional students: Engagement styles and impact on attrition. *The Journal of Higher Education*, 82(1), 33-53.

[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.