

STAT 695 – FRONTIERS IN STATISTICAL RESEARCH: STATISTICAL INFERENCE FOR NETWORK DATA

Spring 2023

Course description

This course provides an overview on recent models, methods and theory for network data analysis. Particular focus will be given to low-rank network models, including stochastic block models and random dot product graphs. Applications of these methodologies to different disciplines will be discussed.

Logistics

- **Instructor:** Jesús Arroyo (jarroyo@stat.tamu.edu), Blocker 436.
- **Lecture:** Tue 12:45pm - 2:00pm, Blocker 411
- **Office hours:** TBD
- **Credits:** 1
- **Dates:** 01/17/2023 - 05/09/2023

Prerequisites

Linear algebra, mathematical statistics and some basic programming experience with R. Graduate classification in the Department of Statistics or approval of instructor.

Course outline

1. *Introduction:* networks and graphs, motivation and background.
2. *Statistical models for networks:* generative models, exponential random graphs, stochastic block models, latent position graph models, random dot product graphs.
3. *Estimation and inference in low-rank network models:* community detection; adjacency spectral embedding; matrix concentration inequalities and subspace perturbation analysis; consistency and distributional properties of spectral methods; applications to inference tasks.
4. *Statistical methods for multiple networks:* models for multiple graphs; multiple network embeddings; clustering and prediction with multiple network data; time series of graphs; graph matching.

Course evaluation

The grade will be based on the following two items:

- *Lecture scribing:* each student will be assigned to scribe one lecture. Scribes should be in LaTeX, and need to be delivered one week after the class.
- *Paper presentation:* each student will choose (with the instructor's help) a research article to give a short presentation during class at the end of the semester. More details will be announced at the beginning of the course.

Main References

- Athreya, A., Fishkind, D.E., Tang, M., Priebe, C.E., Park, Y., Vogelstein, J.T., Levin, K., Lyzinski, V. and Qin, Y., 2017. *Statistical inference on random dot product graphs: a survey*. The Journal of Machine Learning Research, 18(1), pp.8393-8484.
- Kolaczyk, E.D. and Csárdi, G., 2014. *Statistical analysis of network data with R* (Vol. 65). New York: Springer.