Special Topics in Network Data Analysis (STAT 689)

Spring 2024

Course information
Section: 602
Time: Tue-Thu 11:10 am-12:25 pm
Location: BLOC 411
Credit Hours: 3

Instructor details
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Course description
This course provides a foundation in statistical and computational tools for analyzing network data. At the end of the course, students will be able to conduct exploratory and visualization analyses, formulate probabilistic models for graphs, perform statistical inference and computational methods, understand fundamental theoretical concepts, and resolve applications to challenges arising in real data problems.

Course Prerequisites
Familiarity with linear algebra, probability, and mathematical statistics at an upper undergraduate level, and programming experience. Graduate classification in the Department of Statistics or instructor approval.

Course Learning Outcomes
By the end of the semester, students will be able to

- perform visualization and exploratory analysis from network data;
- formulate statistical models to describe different aspects of networks;
- understand and develop statistical and computational methodologies for analyzing network datasets;
- understand fundamental theoretical aspects behind the methodologies;
- apply the techniques to relevant problems in different domains.

Grading policy
The grade will be based on the following items:

- *Homework*: tentatively 2-3 homework assignments.
- *Lecture scribing*
- *Final project*: team projects (2-3 people per team) will be evaluated as follows:
  - Project proposal: due by the middle of the semester (TBD).
  - Project presentation: scheduled at the end of the semester.
  - Project outcome: a final report needs to be submitted by the final exam assigned date.

Course outline

1. *Introduction:* networks and graphs, motivation and background.
2. *Visualization and exploratory analysis:* network summary statistics, centrality measures, methodologies.
3. *Network data modeling:* Graph theory review, random graph models, preferential attachment, small world networks, exponential random graphs, latent space models.
4. *Spectral methods for networks:* Low-rank models for networks, stochastic block-models, spectral embeddings, theory for spectral methods, applications.
5. *Miscellaneous topics:* graph matching, multilayer network data, graph machine learning.

Suggested Resource Materials

There is no mandatory textbook for the class. Some useful references are listed below.

- 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.
- Crane, H. (2018). Probabilistic foundations of statistical network analysis. CRC Press.
- Kolaczyk, E.D. and Csárdi, G., 2014. Statistical analysis of network data with R (Vol. 65). New York: Springer.
- Menczer, F., Fortunato, S., & Davis, C. A. (2020). A first course in network science. Cambridge University Press.
- Newman, M. (2018). Networks. Oxford University Press.

University Policies

Attendance Policy
The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments. Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy
Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.
"Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" (Student Rule 7, Section 7.4.1).
"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement
"An Aggie does not lie, cheat or steal, or tolerate those who do."
"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at `aggiehonor.tamu.edu`.

Americans with Disabilities Act (ADA) Policy
Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit `disability.tamu.edu`. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality
Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking. With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention —- including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need. Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS). Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

Statement on Mental Health and Wellness
Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care by utilizing available resources and services on your campus Students who need someone to talk to can contact Counseling and Psychological Services (CAPS) or call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m.

weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

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