CptS 591: Elements of Network Science
Syllabus

Course Information

Semester: Spring 2020
Meeting times and location: TuTh 9:10–10:25, Sloan 161

The course website will be used to post relevant course material, including this syllabus, and course related resources. Additionally, the course management platform OSBLE+ will be used for posting lecture material, assignments, announcements, and messages, and for handling student submissions and instructor feedbacks.

Instructor Information

Instructor: Assefaw Gebremedhin
Office: EME B43
Email: assefaw DOT gebremedhin AT wsu DOT edu
Homepage: http://www.eecs.wsu.edu/~assefaw

Office Hours: Thursdays 10:30am–12pm, or by appointment.

Course Description

This 3 credit, graduate-level course introduces fundamental elements of the emerging science of complex networks, with emphasis on social and information networks. Students will learn about mathematical and computational methods used to analyze networks, models used to understand and predict behavior of networked systems, and theories used to reason about network dynamics. Students will also be exposed to current research in the field, and they will be given an opportunity to explore a chosen topic through a semester project.

Topics to be covered include:

- **Network structure, modeling and algorithms:**
  - Graph theory essentials; Basic network properties; Random graphs; Spectral graph theory; Centrality; PageRank; Hubs and Authorities; Graph similarity; Community detection
- **Graph embeddings:**
  - Graph embeddings; representation learning
- **Network dynamics:**
  - Cascading behaviors; Information diffusion; Epidemic models; Influence maximization.
- **Temporal networks:**
  - Models and algorithms for analysis of time-varying networks.

Learning Outcomes

At the conclusion of the course students should be able to:

- Explain basic metrics and measures used to characterize networks
- Analyze a network using the various measures and a suitable network analysis software tool
- Discuss the strengths and weaknesses of random graph models
- Understand and apply key algorithms for node ranking, network comparison, and community detection
- Understand and apply models and theories used to reason about cascading behaviors, information diffusion, contagion, and decentralized navigation in networks
- Understand and explain the interdisciplinary nature of the area of network science
- Critique research papers in the area
- Apply knowledge gained in the course to carry out a project and write a scientific report
Audience
The course is suitable for graduate students in computer science, engineering, epidemiology, sociology, economics, mathematics, physics, and related fields.

Prerequisites
Students are expected to have basic knowledge of algorithms (equivalent to completing an undergraduate algorithms course such as CptS 350), some programming experience (e.g. in Python, R, or C), and familiarity with basic linear algebra (e.g. solution of linear systems and eigenvalue/vector computation) and basic probability and statistics.

Course Work
The course consists of lectures (twice a week, 75 min each) and involves in-class quizzes, a set of assignments, one exam, and a semester project.

- **Assignments (30%)**. There will be three assignments mostly spread through the first half of the semester. Assignments are to be completed and submitted individually.

- **Semester Project (45%)**. Working in teams of two or three, students will complete a semester project. A semester project could take one of several forms: analysis of an interesting dataset using existing methods and software; comparison of existing methods and software tools in the context of a specific application; implementation of a new method; exploration of a chosen research topic.

Each project will have required submissions at three different stages—the submissions are called *Reaction Paper, Project Proposal* and *Final Report*—and will culminate with an oral presentation in class.

For the Reaction Paper part students will get to pick and read two closely related papers out of a list of papers the instructor provides and write a short reaction paper summarizing and critiquing the two papers and identifying opportunities for further work. Project Proposal is a short document (2 or 3 pages long) that describes the proposed project and the tentative plan to carry it out. Ideally it is an outgrowth of the Reaction Paper component, but can also deviate from it. The outcome of the project will be a final report of about 8 to 12 pages long. Guidelines for writing the proposal and the final report will be provided at an appropriate time during the semester. A more complete project description detailing the various components will also be provided.

The 45% weight of the semester project towards final grade is further broken down into its components as follows: Reaction Paper 5%, Project Proposal 5%, Presentation 7%, Final Report 28%.

- **Exam (20%)**. There will be one mid-term exam.

- **Class Participation (5%)**. Students are expected to actively participate in class discussions, in-class exercises and thought experiments.

Expectations for Student Effort
For each hour of lecture equivalent, students should expect to have a minimum of two hours of work outside class.

Grading
Letter grades will be given according to the following ranges:

A (93–100%), A- (90–92.99%), B+ (87–89.99%), B (83–86.99%), B- (80–82.99%), C+ (77–79.99%), C (70–76.99%), C- (67–69.99%), D (60–66.99%), F (less than 60%).
Books and Course Material

There is no required textbook for the course. Lecture notes, readings and related resources will be posted at the course website or the OSBLE page of the course as the course proceeds.

The following book will be used as a frequent reference:


Other related references include:


Software

The graph analysis package igraph will be used as the primary software resource. The package igraph is open-source and free.

Tentative Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Assignments</th>
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</thead>
<tbody>
<tr>
<td>01 (Jan 14/16)</td>
<td>Introduction, Graph theory</td>
<td>Survey out</td>
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<tr>
<td>02 (Jan 21/23)</td>
<td>Network properties</td>
<td>Survey due</td>
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<tr>
<td>03 (Jan 28/30)</td>
<td>Intro to igraph</td>
<td>Assignment 1 out</td>
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<tr>
<td>04 (Jan 04/06)</td>
<td>Random graphs</td>
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<tr>
<td>05 (Feb 11/13)</td>
<td>Spectral graph theory</td>
<td>Assignment 1 due</td>
</tr>
<tr>
<td>06 (Feb 18/20)</td>
<td>Centrality</td>
<td>Assignment 2 out</td>
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<tr>
<td>07 (Feb 25/27)</td>
<td>PageRank, Hubs &amp; Authorities</td>
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</tr>
<tr>
<td>08 (Feb 03/05)</td>
<td>Graph embeddings and representation learning</td>
<td>Assignment 2 due</td>
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<tr>
<td>09 (Mar 10/12)</td>
<td>Community detection, Project discussion</td>
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<tr>
<td>10 (Mar 17/19)</td>
<td><strong>Spring Break</strong></td>
<td></td>
</tr>
<tr>
<td>11 (Mar 24/26)</td>
<td>Graph similarity, Signed networks</td>
<td>Reaction Paper due</td>
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<tr>
<td>12 (Mar 31/Apr 02)</td>
<td>Cascading behaviors</td>
<td>Project proposal due</td>
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<tr>
<td>13 (Apr 07/09)</td>
<td>Influence maximization, Epidemic models</td>
<td>Assignment 3 out</td>
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<tr>
<td>14 (Apr 14/16)</td>
<td>Temporal networks</td>
<td>Assignment 3 due</td>
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<tr>
<td>15 (Apr 21/23)</td>
<td>Wrap-up, Project presentations</td>
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<tr>
<td>16 (Apr 28/30)</td>
<td>Project presentations</td>
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<tr>
<td>17</td>
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<td>Final project report due May 1</td>
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Policies

Conduct

Students are expected to maintain a professional and respectful classroom environment. In particular, this includes:

- silencing personal electronics
- arriving on time and remaining throughout the class.

Correspondence

All class related correspondence with the instructor will be made via OSBLE+.
Attendance

Regular attendance is required. While students may miss class for urgent reasons, repeated absences that are not cleared with the instructor will factor into the Class Participation portion of the semester grade.

Missing or Late Work

Submissions will be handled via the OSBLE page of the course. Students are expected to submit assignments and reports by the specified due date and time. Submissions turned in up to 24 hours late will be accepted with a 10% grade penalty per 12 hours late. Except by prior arrangement, missing or work late by more than 24 hours will be counted as zero.

Academic Integrity

Academic integrity is at the heart of all higher education philosophies. Adhering to academic integrity policies ensures that you provide yourself with the best education possible. Maintaining academic integrity assures you receive the credit you deserve for your ideas.

You are expected to know and understand Washington State University Academic Integrity Policies. Copying and plagiarism of other sources will result in an automatic 0 or F on the assignment. For a second offense, the student will receive an F as a final grade in this course, will not have the option to withdraw from the course and will be reported to the Office of Student Standards and Accountability. Cheating is defined in the Standards for Student Conduct WAC 504-26-010 (3). You can learn more about Academic Integrity on the WSU campus at http://academicintegrity.wsu.edu. Please also read this link carefully http://www.eecs.wsu.edu/~schneidj/Misc/academic-integrity.html EECS Academic Integrity Policy. Use these resources to ensure that you do not inadvertently violate WSU’s standard of conduct.

WSU’s AWARE Network

As a student you have many responsibilities and obligations. One of the most important obligations that you may have is to your friends and peers at WSU. If you feel like one of your friends or peers is struggling with academics because of physical or mental health please inform the instructor and/or appropriate university personnel. For more information refer to http://aware.wsu.edu/.

WSU’s Campus Safety Plan

Washington State University is committed to enhancing the safety of the students, faculty, staff, and visitors. It is highly recommended that you review the Campus Safety Plan http://safetyplan.wsu.edu/ and visit the Office of Emergency Management website http://oem.wsu.edu/ for a comprehensive listing of university policies, procedures, statistics, and information related to campus safety, emergency management, and the health and welfare of the campus community.

WSU Classroom Safety

Classroom and campus safety are of paramount importance at Washington State University, and are the shared responsibility of the entire campus population. WSU urges students to follow the “Alert, Assess, Act” protocol for all types of emergencies and “Run, Hide, Fight” response for an active shooter incident. Remain ALERT (through direct observation or emergency notification), ASSESS your specific situation, and ACT in most appropriate way to assure your own safety (and the safety of others if you are able).

Please sign up for emergency alerts on your account at MyWSU. For more information on this subject, campus safety and related topics, please view the FBI’s Run, Hide, Fight video and visit the WSU safety portal.

Students with Disabilities

Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center
(Washington Building 217; 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information, consult the webpage http://accesscenter.wsu.edu/ or email at Access.Center@wsu.edu.

Important Dates and Deadlines

Students are encouraged to refer to the WSU academic calendar often to be aware of critical deadlines throughout the semester. The academic calendar can be found at http://registrar.wsu.edu/academic-calendar.

Weather Policy

For emergency weather closure policy, consult: http://alert.wsu.edu.

Changes

This syllabus is subject to change. Updates will be posted on the course website.