Course: CS5891/CS3891 Special Topics: Network Analysis in Healthcare
Instructor: You Chen, Ph.D. (you.chen@vanderbilt.edu)
Semester: Fall 2021
Time: Monday & Wednesday, 3:30 – 5:00 pm
Location: Featheringill Hall, Room XXX
Website: http://www.ohpenlab.org/courses/
Office Hours: Upon Appointment

DESCRIPTION

Network analysis has enjoyed extensive applications in healthcare. It has become a widely applied method to extract meaningful information from abundant healthcare data. This course will survey recent work in network analysis in healthcare, especially from a data mining, machine learning, and statistical perspective. This course aims to present network analysis methods for exploring and analyzing large-scale healthcare data and measuring associations between network metrics and patient outcomes. The course will include models, measures, and applications. Tentative topics include i) network analysis to measure healthcare organization structures and care teams; ii) network analysis to predict patient outcomes (e.g., length of stay, mortality risk, type 2 diabetes); and iii) network analysis in biology studies, such as linking sleep disorders to metabolic dysregulation or measuring protein-protein interactions.

OBJECTIVES

After this course, students will be able to

i) understand and formulate research questions relevant to network analysis.
ii) use network analysis methodologies to perform investigations of healthcare data.
iii) examine network analysis using case studies.

PREREQUISITES

There is no official prerequisite for this course. However, Students are expected to

i) have proficiency in designing and writing software programs (Python or any language of their preference) (CS 3270: Programming Languages); and
ii) have basic knowledge of statistical analysis (MATH 2820/5820: Introduction to Probability and Mathematical Statistics).

GRADING

Criteria		Percent of Grade
Project	Initial Proposal, Due in Week 4	10%

	Status Report, Due Week 10	15%
	Final Report & Presentation, Due Week 15	45%
Reading Summaries		20%
Class Participation		10%

Required Reading Assignments: There is no primary textbook for this course. Reading assignments will be selected from various periodicals. Students will be required to read and submit brief summaries of assigned readings. Your summaries should be no longer than one page in length. Your summaries will be graded on a scale ranging from 1 point to 3 points.

- **1 point:** You skimmed the assigned reading and barely understood, or summarized, its meaning and implications.
- **2 points:** You demonstrated that you read the material by providing a reasonable account of its contents, its strengths, and its weaknesses.
- **3 points:** You provided a critical assessment of the reading and show insight regarding the reading's topic.

These summaries constitute a total of 20% of your final grade. An average score of 2 points will provide the student with the full 20%. An average score greater than 2 points will entitle the student to "extra" credit, with a maximum of 5 additional percentage points on their final grade. You must email your summaries to you.chen@vanderbilt.edu before the due date.

Project: In lieu of a final exam, each student must complete an independent project on network analysis. Projects should investigate a topic of interest to the student and must demonstrate analysis and critical thinking in network analysis. The project will require a significant commitment and contribute to a substantial part of the final grade.

TOPIC AND SCHEDULE OVERVIEW (*Tentative and Subject to Change*)

Part 1 (Three classes): Course Overview, Introduction, and Overview of Network Analysis Models

In the first class, we'll go over ground rules for the course, review the syllabus, and learn basic sociometric (e.g., degree, betweenness centrality, cluster coefficient) used in network analysis. We will investigate how to build networks from data, introduce random networks and scale-free networks, and analyze the networks using node degree distribution, shortest paths, clustering coefficient, betweenness centrality, closeness centrality, and diameter. We will also discuss the small word phenomenon (the alpha-model and the beta-model), random walks, weak ties' strength, and centrality balance and homophily.

In this second class, we'll focus on generative network models, including random graphs, preferential attachment models, Kronecker graphs, and stochastic blockmodels.

In the third class, we will introduce models of information diffusion, spread, transmission, and contagion.

Part 2 (four classes): Network Analysis to Measure Healthcare Organization Structures, Care Teams, and Clinical Workflows

This section of the course will investigate healthcare data that can be used to measure healthcare professional relationships and introduce how network analysis can measure healthcare organization structures, collaboration networks, and clinical workflows.

Part 3 (two classes): Network Analysis to Detect Anomalous Insiders in Health Information Systems

In this section of the course, we'll focus on the application of network analysis in healthcare data security and privacy.

Initial proposal (one class)

This day will be dedicated to student projects. Students will write a short summary of their problem statement, initial research design.

Part 4 (three classes): Network Analysis to Predict Patient Morbidity and Mortality

This part will introduce node embedding, node similarity, node classification, and link prediction. We will focus on applications of network analysis in predicting patient morbidity and mortality, and length of hospital stay.

Part 5 (three classes – guest lecturer): Network Analysis in Drug Repurposing

This section of the course will investigate how network analysis is applied to discover new functions of existing used drugs.

Part 6 (three classes) Network Analysis to Measure Associations between Sleep Disorders and Metabolic Dysregulation

This section of the course will introduce the application of network analysis linking sleep disorders to metabolic dysregulation.

Project Status Report Presentations (one class)

This day will be dedicated to student projects. Students will make a short presentation on the status of their projects for an in-class evaluation.

Part 7 (two classes): Gaussian Graphic Model and Its Application in Building Networks of Metabolites

We will investigate how to build a network of metabolites, which can be used to predict type 2 diabetes.

Part 8 (one class): Network Analysis to the Examination of Interruptions in Healthcare

We will learn how to measure interdependencies between healthcare professional roles that result in interruptions in healthcare settings. Also, we will show how network analysis can identify targeted systems-based interventions that may reduce unnecessary interruptions while avoiding unintended consequences that impose an additional burden on healthcare professionals.

Part 9 (two classes) Community Structure in Healthcare Forums

We will learn how to infer meaningful community structures from implicit networks of peer interaction in online healthcare forums.

Part 10 (two classes): Student Final Presentations

The final lecture will be dedicated to students' presentations on their final project.