CSC 495: Social Network Analysis

Professor Robin Burke
Spring 2015, Sections 901/910, CDM 214
Th 5:45 — 9:00 pm

Office: CS&T 849
Office hours: Tuesdays 10:00 – 11:30 am (Loop, CS&T 847), 2:30 – 4:00 pm (Lincoln Park, 990 W. Fullerton, Suite 3100) and by appointment.
Course web site: http://d2l.depaul.edu/
Phone: (Loop) 312-362-5910 / (Lincoln Park) 773-325-4910
Email (preferred): rburke@cs.depaul.edu
Piazza (best): https://piazza.com/class/i7c9ah0lnwi2wr

Description

This course is an introduction to the concepts and methods of social network analysis. Students will learn to extract and manage data about network structure and dynamics, and to analyze, model and visualize such data. Students will use software tools to model and visualize network structure and dynamics. Specific network applications to be discussed include online social networks, collaboration networks, and communication networks. PREREQUISITE(S): CSC 423 or CSC 400 or SOC 412

Textbook: Kolaczyk, E. and Csardi, G. *Statistical Analysis of Network Data with R*. Springer. ISBN: 978-1-4939-0982-7.
Other readings online as assigned.

Learning Objectives

After taking this class, students will be able to:

- Define key concepts in networks such as node, edges, path, geodesic, weighted and directed networks.
- Define and calculate key metrics such as degree, degree distribution, diameter, density, closeness, betweenness, local and global clustering.
- Interpret the results of computing various forms of centrality including Katz, Bonacich, eigenvector, and PageRank.
- Explain and distinguish between several key network models: random, growing random, Watts-Strogatz, preferential attachment, strategic formation, and exponential random graph.
- Analyze different types of networks to identify important actors, significant structural features such as communities, and overall network characteristics.
- Describe the consequences of different network structures for network processes including contagion and social influence.
- Use R to load, process, filter, manipulate, and compute metrics over a variety of networks.
- Apply QAP regression and exponential random graph modeling to test hypotheses about graph formation.
- Create effective network visualizations that communicate analytic findings about a network.

Assessment

Students will be assessed on the basis of 5 homework assignments, 4 labs, a midterm and a final project.

Homework (5): 30%
Midterm: 25%
Labs (4): 15%
Final project: 30%

Homeworks are due weekly by class time and cannot be submitted late. This enables us to discuss homework solutions in class.

Attendance at labs is optional, and lab assignments will be due the following week. Lab sessions will be recorded so on-line students can follow along to complete each exercise.

The final project is a group project (2 – 3 students) will involve the creation of a network analysis using a data set of the team's choice. There are four milestones for this project:

5/7: Project proposal
5/21: Project data
5/28: Draft visualizations
6/11: Project due

Tentative Schedule

(SAND = Statistical Analysis of Network Data in R)

4/2: Introduction

Introduction to the class. Syllabus and expectations. Steps in social network analysis: network definition, manipulation, calculation, visualization. Graph terminology and definitions. Representing networks: Adjacency matrix and properties. Weighted, directed, bipartite networks. Trees. Paths, walks, cycles. Some sample networks.
Reading: SAND, Ch. 1 and 2

4/9: Defining and Gathering Network Data / Lab

Defining nodes and ties. Defining network boundaries. Gathering network data: snowball sampling, egocentric networks, other sampling techniques. Lab: Loading, manipulating, visualizing and saving network data in R.
Reading: Hanneman and Riddle, *Introduction to social network methods*. Ch. 1. Social network data. Available online at: http://faculty.ucr.edu/~hanneman/nettext/C1_Social_Network_Data.html
Due: Homework 1

4/16: Linear Algebra / Descriptive Analysis

Eigenvectors and eigenvalues. Graph Laplacian. Markov matrices. Degree, density. Degree distribution. Diameter, average path length. Average and local clustering. Centrality measures: degree, betweenness, closeness, Katz, Bonacich.
Reading: SAND, Ch. 4.1 and 4.2
Due: Homework 2

4/23: Network Visualization / Lab

Challenges for graph visualization. Physics-based layout. Attaching visual elements to graph nodes and edges. Grouping and summarizing large networks. Lab: Loading, manipulating, visualizing and saving network data in Gephi.
Reading: SAND, Ch. 3, Gephi tutorials
Due: Homework 3

4/30: Midterm / Project Discussion

5/7: Clustering / Lab
Graph partitioning. Random walks. Spectral partitioning. Modularity and modularity maximization. Betweenness clustering. Non-exclusive clustering. Assortativity. Lab: Calculating and comparing clustering approaches.
Reading: SAND, Ch. 4.4 – 4.6.
Due: Project proposal

5/14: Mathematical Models of Networks
Poisson random graphs. Growing random networks. Preferential attachment. Properties and phase transitions. Degree distributions. Model fitting: power-law techniques, matching techniques, QAP regression.
Reading: SAND, Ch. 5
Due: Homework 4

5/21: Statistical Models of Networks / Lab
Fitting networks to data. Exponential random graph models. Computational considerations. Interpreting results. Problems with ERGM analysis. Lab: ERGM analysis in R.
Reading: SAND, Ch. 6.1 – 6.3
Due: Project data

5/28: Link Prediction / Processes on Networks
Network topology inference. Link prediction. Random walk methods and similarity-based methods. Processes on networks. SIS and SIR infection models and predictions.
Reading: SAND, Ch. 7.1, 7.2 and 8.1, 8.5
Due: Draft visualizations

6/4: Games and Networks
Game theory basics: players, moves, payoffs. Nash equilibrium. Efficiency and optimality. Examples. Network formation as a game. Pairwise stability. Positive and negative externalities. Networked adoption games.
Reading: TBA
Due: Homework 5

6/11: Final project

Class Policies

Attendance
Students are expected to attend all classes and participate in in-class exercises. Class will start promptly. Students are individually responsible for material they may have missed due to absence or tardiness.

Assignments (except for designated group assignments) must represent a student's individual effort. While students are permitted to discuss assignments at the conceptual level, under no circumstances should students share code (electronically or otherwise). Use of sources without attribution constitutes plagiarism, a serious violation of academic integrity. Consult the assignment handouts or the instructor if you have questions about how or what to document. The bottom line: do all of your own original work and do not copy from fellow students or past assignments.

Attitude
A professional and academic attitude is expected throughout this course. Measurable examples of non-academic or unprofessional attitude include but are not limited to: talking to others when the instructor is speaking, mocking another's opinion, cell phones ringing, emailing, texting or using the Internet whether on a phone or computer. If any issues arise a student may be asked to leave the classroom. The professor will work with the Dean of Students Office to navigate such student issues.

Civil Discourse
DePaul University is a community that thrives on open discourse that challenges students, both intellectually and personally, to be socially responsible leaders. It is the expectation that all dialogue in this course is civil and respectful of the dignity of each student. Any instances of disrespect or hostility can jeopardize a student's ability to be successful in the course. The professor will partner with the Dean of Students Office to assist in managing such issues.

Cell Phones/On Call
If you bring a cell phone to class, it must be off or set to a silent mode. Should you need to answer a call during class, students must leave the room in an undisruptive manner. Out of respect to fellow students and the professor, texting is never allowable in class. If you are required to be on call as part of your job, please advise me at the start of the course.

University Policies

Changes to Syllabus
This syllabus is subject to change as necessary during the quarter. If a change occurs, it will be thoroughly addressed during class, posted under Announcements in D2L and sent via email.

Online Course Evaluations
Instructor and course evaluations provide valuable feedback that can improve teaching and learning. The greater the level of participation, the more useful the results. As students, you are in the unique position to view the instructor over time. Your comments about what works and what doesn't can help faculty build on the elements of the course that are strong and improve those that are weak. Isolated comments from students and instructors' peers may also be helpful, but evaluation results based on high response rates may be statistically reliable (believable). As you experience this course and material, think about how your learning is impacted. Your honest opinions about your experience in and commitment to the course and your learning may help improve some components of the course for the next group of students. Positive comments also show the department chairs and college deans the commitment of instructors to the university and teaching evaluation results are one component used in annual performance reviews (including salary raises and promotion/tenure). The evaluation of the instructor and course provides you an opportunity to make your voice heard on an important issue – the quality of teaching at DePaul. Don't miss this opportunity to provide feedback!

Academic Integrity and Plagiarism
This course will be subject to the academic integrity policy passed by faculty. More information can be found at http://academicintegrity.depaul.edu/.
The university and school policy on plagiarism can be summarized as follows: Students in this course should be aware of the strong sanctions that can be imposed against someone guilty of plagiarism. If proven, a charge of plagiarism could result in an automatic F in the course and possible expulsion. The strongest of sanctions will be imposed on anyone who submits as his/her own work any assignment which has been prepared by someone else. If you have any questions or doubts about what plagiarism entails be sure to consult the instructor. While students are permitted to discuss assignments at the conceptual level, under no circumstances should students share specific answers (electronically or otherwise).

Withdrawal
Students who withdraw from the course do so by using the Campus Connection system (http://campusconnect.depaul.edu. Withdrawals processed via this system are effective the day on which they are made. Simply ceasing to attend, or notifying the instructor, or nonpayment of tuition, does not constitute an official withdrawal from class and will result in academic as well as financial penalty.

Retroactive Withdrawal
This policy exists to assist students for whom extenuating circumstances prevented them from meeting the withdrawal deadline. During their college career students may be allowed one medical/personal administrative withdrawal and one college office administrative withdrawal, each for one or more courses

in a single term. Repeated requests will not be considered. Submitting an appeal for retroactive withdrawal does not guarantee approval. College office appeals for CDM students must be submitted online via MyCDM. The deadlines for submitting appeals for this quarter is the last day of the last final exam of Winter Quarter 2016.

Excused Absence
In order to petition for an excused absence, students who miss class due to illness or significant personal circumstances should complete the Absence Notification process through the Dean of Students office. The form can be accessed at http://studentaffairs.depaul.edu/dos/forms.html. Students must submit supporting documentation alongside the form. The professor reserves the sole right whether to offer an excused absence and/or academic accommodations for an excused absence.

Exceptions to the late assignment policy and requests for makeup exams will only be permitted if the Absence Notification protocol is followed.

Incomplete
An incomplete grade is a special, temporary grade that may be assigned by an instructor when unforeseeable circumstances prevent a student from completing course requirements by the end of the term and when otherwise the student had a record of satisfactory progress in the course. CDM policy requires the student to initiate the request for incomplete grade before the end of the term in which the course is taken. Prior to submitting the incomplete request, the student must discuss the circumstances with the instructor. Students may initiate the incomplete request process in MyCDM.

- All incomplete requests must be approved by the instructor of the course and a CDM Associate Dean. Only exceptional cases will receive such approval.
- If approved, students are required to complete all remaining course requirement independently in consultation with the instructor by the deadline indicated on the incomplete request form.
- By default, an incomplete grade will automatically change to a grade of F after two quarters have elapsed (excluding summer) unless another grade is recorded by the instructor.
- An incomplete grade does NOT grant the student permission to attend the same course in a future quarter.

Students with Disabilities
Students who feel they may need an accommodation based on the impact of a disability should contact the instructor privately to discuss their specific needs. All discussions will remain confidential.
To ensure that you receive the most appropriate accommodation based on your needs, contact the instructor as early as possible in the quarter (preferably within the first week of class), and make sure that you have contacted the Center for Students with Disabilities (CSD) at: Student Center, LPC, Suite #370 Phone number: (773)325.1677 Fax: (773)325.3720 TTY: (773)325.7296

Quarter at a Glance

Week	Date	Reading	Topic	Due
1	4/2	SAND, Ch. 1 and 2	Introduction	
2	4/9	Hanneman and Riddle, *Introduction to social network methods*. Ch. 1	Defining and Gathering Network Data / Lab	Homework 1
3	4/16	SAND, Ch. 4.1 and 4.2	Linear Algebra / Descriptive Analysis	Homework 2
4	4/23	SAND, Ch. 3. Gephi tutorials.	Network Visualization / Lab	Homework 3
5	4/30		Midterm / Project Discussion	
6	5/7	SAND, Ch. 4.4 – 4.6	Clustering / Lab	Project proposal
7	5/14	SAND, Ch. 5	Mathematical Models / Lab	Homework 4
8	5/21	SAND, Ch. 6.1 – 6.3	Statistical Models / Lab	Project data
9	5/28	SAND, Ch. 7.1, 7.2 and 8.1, 8.5	Link Prediction / Processes on Networks	Draft visualizations
10	6/4	TBA	Games and Networks	Homework 5
Finals	6/11			Final Project