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University of British Columbia Okanagan
The Irving K. Barber School of Arts and Sciences
COSC 421/Data 421/521 - Network Science
Course Outline Winter Term 2, 2019/2020

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1. PROFESSOR

Dr Paramjit Gill
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Office: Science Building Room 112
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2. CLASSES: MWF 9:30 – 10:30, EME 1101

OFFICE HOURS: MWF 11:00 – 12:00, 2:00 – 3:00

3. TEXTBOOKS

3.1 *Networks: An Introduction* by Mark Newman: Oxford University Press
3.2 *Statistical Network Analysis with igraph* by Gábor Csárdi. Tamás Nepusz and Edoardo M. Airoldi:

Available from: https://sites.fas.harvard.edu/~airoldi/pub/books/BookDraft-CsardiNepuszAiroldi2016.pdf

4. OBJECTIVES: Network science, an emerging field of scientific research, studies the structural properties and the dynamic behavior of (large-scale) complex networks. Due to the sheer size and the inherent complexity of these networks, techniques and methodologies from a variety of disciplines, including Computer science, Mathematics, Statistics, Physics, Sociology, need to be used in order to understand the patterns. This course introduces visualization and fundamental quantitative models, graph-theoretic concepts, and algorithmic techniques for network analysis. Selected applications of these techniques will be included.

5. EXPECTED OUTCOMES: Upon successful completion of this course, students are expected to demonstrate the ability to:

(a) Understand the basic mathematical principles and analytic foundations of network science,
(b) Have a knowledge of quantitative approach to understand small and large-scale networks,
(c) Use the R software for the analysis and visualization of network data.

6. EXPECTATIONS:

6.1 Note that this course does not have any specific pre-requisites. However, moderate quantitative reasoning beyond first year Math and basic probability theory will be required. Some knowledge of elementary matrix theory and probability distributions will be helpful. Data handling (say using MS Excel spreadsheets) and computer skills will be required.

6.2 We will use the R software extensively. This software has powerful libraries and functions for network analysis. The second textbook has all the details that we will need. However, learning the basics of R can be painful. It is very important that you go through these pains during the first 10 days of the course if you are not familiar with R. The first week lab and assignment will cover some basics of R.

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6.3 Class Attendance: Enrolling in this course does not guarantee a passing grade. You may not be able to pass this course just by reading the course slides and skipping classes. If you are not able to come to the class, this course is not for you.

7. TOPICS and WEEKLY SCHEDULE

Weeks 1-2 (Jan 6– 17). Introduction; types of networks: social networks, information networks, technological networks, biological networks, affiliation networks; network data collection methods.

Labs start in the second week with introduction to R and igraph library.

Weeks 3-5 (Jan 20– Feb 7) Mathematical and graph-theoretic concepts: directed graphs, the adjacency matrix, acyclic directed networks, bipartite graphs, trees, degree, paths, geodesic paths.

Term Test 1: Monday, Feb 10

Weeks 6-9 (Feb 10 – Mar 6) Structural Characteristics and Measures of Networks: Degree centrality, eigenvalue centrality, Katz centrality, pagerank, hubs and authorities, closeness centrality, betweenness centrality, cliques and components, clustering coefficient, local clustering, reciprocity, signed networks, similarity and correlation, Computer algorithms implementation in R.

Weeks 10-11 (Mar 9 – Mar 20) Large-scale structure: Components, Small-world effects, Degree distributions, Power laws and scale-free networks, Community detection algorithms.

Term Test 2: Monday, March 16

Week 12-13 (Mar 23 – April 3) Network Models: Random graphs, Preferential attachment, Barabási-Albert model, Simulation of network formation using these models.

Week 14 (April 6 – 8) Graduate students' research project presentations

8. EVALUATION:

8.1 Assignments (20%): There will be homework assignments due almost every week. Students must submit hard copies before the deadline, late and email submissions will not be accepted. Some of these assignments may be group assignments. It is very important that students submit their own work. If assignments of two or more students are found to be similar, that will be considered as plagiarism with the consequence of all of those students receiving a mark of 0 in that assignment. Further, this may be reported to the Dean's office. It is assumed that students are familiar with the UBC Academic Integrity Policy (see item 9 below for details) and understand the consequences of violating this policy.

8.2 Midterm Tests: There will be two midterm tests at the following dates during the lecture hours, each worth 20% of the overall grade.
Test 1: Monday, Feb 10, 2020
Test 2: Monday, March 16, 2020

Missed Test: Please note that students must take the tests during the scheduled time. No arrangements will be made to write the tests at any other times for students who can't take the test for whatever reasons. The missed test marks will be transferred to the final exam.

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8.3 Research Project for DATA 521 Students (20%): Graduate students will be required to work on research projects involving a detailed analysis of a real world network dataset. Class presentation on the results will be part of the research project.

8.4 Final Exam (40% for COSC/DATA 421 and 20% for DATA 521 students). The final exam will be comprehensive covering all the course material.

9. ACADEMIC INTEGRITY

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the break down of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. **For example, incidences of plagiarism or cheating usually result in a failing grade or mark of zero on the assignment or in the course.** Careful records are kept to monitor and prevent recidivism. A more detailed description of academic integrity, including the policies and procedures, may be found at http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,54,111,959. If you have any questions about how academic integrity applies to this course, consult with the instructor.

10. DISABILITY ASSISTANCE

If you require disability-related accommodations to meet the course objectives, please contact the Diversity Advisor of Disability Resources located in the University Centre, Room 227. For more information about Disability Resources or academic accommodations, please visit the website at : http://students.ok.ubc.ca/drc/welcome.html

11. Equity, Human Rights, Discrimination and Harassment

UBC is a place where every student, staff and faculty member should be able to study and work in an environment that is free from human rights based discrimination and harassment. If you require assistance related to an issue of equity, discrimination or harassment, please contact the Equity Office, your administrative head of unit, and/or your unit's equity representative.
UBC Okanagan Equity Advisor: UNC 216, ph. 250-807-9291; email equity.ubco@ubc.ca
Web: http://equity.ok.ubc.ca/