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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, 2018/2019

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1. PROFESSOR

Dr Paramjit Gill
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Office: Science Building Room 112
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2. CLASSES: Thursday 2:00 – 5:00 (Lecture 2:00 – 3:20 in Art 202 and lab 3:30 – 5:00 in Science 126).

Lab: Friday 8:30 – 10:30 (EME 2205). First hour will be lecture and the second hour will be lab.

OFFICE HOURS: Mon, Wed 9:00 – 10:15; Thursday 11:00 – 12:00

3. TEXTBOOKS

3.1 Networks: An Introduction by Mark Newman: Oxford University Press, 2010.
3.2 Statistical Analysis of Network Data with R by Eric D. Kolaczyk and Gábor Csárdi: Springer, 2014
This book is available as a pdf through UBC Library and will be out R manual.

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. COURSE ORGANIZATION: The course will be delivered via lectures, laboratory exercises and in-class group exercises. There will be home work assignments almost every week, some of which may be done in groups of two students. Students will be required to complete a research project on some real-world networks data.

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

(a) Understand the basic principles and analytic foundation 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.

7. TOPICS and WEEKLY SCHEDULE

Weeks 1-2 (Jan 1– 11). Introduction; types of networks: social networks, information networks, technological networks, biological networks, affiliation networks; network data collection methods.

Labs start first week: Introduction to R, igraph library and networks visualization.

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Weeks 3-5 (Jan 14– Feb 1) Mathematical and graph-theoretic concepts: directed graphs, the adjacency matrix, acyclic directed networks, bipartite graphs, trees, degree, paths, geodesic paths.

Weeks 6-9 (Feb 4 – Mar 1) 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.

Week 8 is reading break
Midterm exam: Thursday, Feb 28, 2019

Weeks 10-11 (Mar 4 – Mar 15) Large-scale structure: Components, Small-world effects, Degree distributions, Power laws and scale-free networks, Community detection algorithms.

Week 12-13 (Mar 18 – Mar 29) Network Models: Random graphs, Preferrential attachment, Barabási-Albert model, Simulation of network formation using these models.

8. EVALUATION:

8.1 Assignments (25%): There will be home work 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 will be group assignments.

8.2 Class Exercises (15%): Class exercises will be conducted during the lectures or labs without any prior announcement. These will be short quizzes to monitor the understanding of key theoretical concepts and computer coding and data handling.

8.3 Midterm Exam (30%): Midterm exam will be on Thursday, Feb 21, 2019. This exam will have two parts, closed book written part and open book computation part.

8.4 Research Project (30%): All students will be required to work on a research project. Students will work in groups of 2 or 3 students. Undergraduate students' projects will involve a detailed analysis of a large real world network dataset using the analytical and graphical methods from this course. Graduate students' projects will involve implementation of a new methodology (for example, an algorithm) from a recent research paper for analysis of a real life complex network dataset. Class presentation on the results will be part of the research project.

9. EXPECTATIONS:

9.1 Note that this course does not have any specific pre-requisites. However, moderate quantitative reasoning (beyond first year Math and basic probability theory), data handling (say using MS Excel spreadsheets) and computer coding skills will be required.

9.2 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.

9.3 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 Friday 8:30 AM lab or don't like 3 hours long classes, this course is not for you.

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10. 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.

11. 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

12. 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/