Course Syllabus

Program and Course Code	Computing and Information Science CIS614
Course Title	**Topics in Computational Social Science**
Credit Hours	3
Instructor	Iyad Rahwan
Contact Information	Email: irahwan@masdar.ac.ae
Office Hours	
Bulletin Course Description	Computational Social Science is an emerging field that uses techniques from computing and information science to model, understand and predict social phenomena. This understanding can inform how we address challenges in health, sustainability, security, innovation and social adaptation. The importance of this emerging field has been recognized in MIT's interdisciplinary "Connection Science & Engineering" initiative. This seminar-based course will cover two aspects: (1) the use of computational techniques (simulation) to model social phenomena; (2) the use of data analytics to learn models of (and to predict) social phenomena using real data. First, students obtain proficiency in the mathematical modeling of social networks and manipulating their data (around 50% of the course). Students will then read recent papers published in this area and present them in class, with topics rotating in each offering. Students will also be required to complete a major project, which involves substantial use of mathematical modeling combined with computational simulation or data analysis/mining (e.g. from mobile phones or social media), and writing up the results in a short article. Note: Enrollment in this course will be limited to facilitate seminar-style discussion of papers. Preference will be given to students with the strongest background.
Pre-requisites	Both "CIS507 Design and Analysis of Algorithms" and "CIS501 Data Mining: Finding the Data and Models that Create Value" Or permission from the instructor.
Co-requisites	None
Course Objectives (Learning Outcomes of the Course)	1. Use mathematical techniques to model and analyze structural and dynamical properties of social networks. 2. Conduct in-depth discussion of the latest literature in a specific area of computational social science. 3. Identify the pros and cons of different simulation and data mining techniques for modeling a given social phenomena, along with their underlying assumptions. 4. Implement and apply simulation and/or data mining

	methods and algorithms to investigate a particular social phenomenon. 5. Communicate scientific and technical issues.

Week	Course Topics and Contents	Readings
1	Modeling Social Networks (graph theory, statistical properties of social networks) *Lab: Command line data manipulation*	Easley & Kleinberg, Ch 1-3 Barabasi, Ch 1
2	Graph models (random graph theory, matrix computations of properties) *Lab: Data visualization and analysis*	Barabasi Ch 2-3
3	Structural Balance, similarity (power laws, preferential attachment dynamics) *Lab: Software for network analysis*	Easley & Kleinberg, Ch 4-5
4	Information Networks and the Web (Eigenvector centrality, random walks) *Lab: Simulating processes on networks*	Easley & Kleinberg, Ch 13-14
5	Network Dynamics: Population Models (Bayesian decision theory, cascades) *Lab: Simulation on NetworkX: SI, SIR*	Easley & Kleinberg, Ch 16-18
6	Network Dynamics: Structural Models (epidemic models, branching processes) *Lab: Fitting power laws + other topics*	Easley & Kleinberg, Ch 19-21
7	Literature: Coordination & Cooperation	Selected research papers
8	**Mid-semester break**	
9	Literature: Search in Networks	Selected research papers
10	Literature: Influence in Networks	Selected research papers
11	Literature: Crowdsourcing	Selected research papers
12	Literature: Friendship & Mobility	Selected research papers
13	Literature: Opinions and sentiments	Selected research papers
14	Literature: Behavioral Contagion	Selected research papers
15	Literature: Tolerance of Networks	Selected research papers
16	**Final Exam + Project Presentation**	

Relationship of course objectives to program outcomes	
Program Outcome 1	Demonstrate appropriate depth and breadth of knowledge that is at the frontier of their disciplines
Program Outcome 2	Use skills of interdisciplinary scholarship and research to integrate multiple perspectives
Program Outcome 4	Work effectively in a multidisciplinary collaborative environment using highly developed cognitive and creative expert skills and intellectual independence.
Program Outcome 5	Communicate effectively, in written and oral forms, their research results and/or critique highly complex

	and diverse matters to diverse audiences.

Course Grading	
Homework 1	10% Covers data anlaysis exercise Out: week 3, Due: week 6
Homework 2	10% Covers a simulation exercise Out: week 6, Due: week 8
Final Exam	30% Covers lectures + all papers discussed
Project + Report	50% Projects are individual-based, and must include substantial independent work and literature review.

Class/Laboratory schedule and Methodology	
Class	Class meets 14 weeks, 2 sessions per week, 75 minutes each.
Laboratory	In the first few weeks, some sessions will be hands-on, giving students hands-on practice in tools such as: • Python NetworkX (simulating networks) • R (data analysis and visualization, with application to social networks)
Teaching and learning methodologies	This is primarily a seminar course, with most time dedicated to reading and discussing research papers. However, the first few classes will include lectures on some important background material on social networks mathematics and some analysis tools. Subsequently, students are expected to participate in class discussion, present one or more papers, and write a final course paper based on a substantial project. Students must read the papers in advance, submit short summaries and questions before class, participate in class discussion, and present and lead discussion on one or two sets of papers.

Course Materials	
Textbooks	• D. Easley, J. Kleinberg. Networks, Crowds, and Markets: Reasoning About a Highly Connected World. Cambridge University Press, 2010 Free PDF version: www.cs.cornell.edu/home/kleinber/networks-book/ • Philipp K. Janert. Data Analysis with Open Source Tools. O'Reilly Media, 2010. • A.-L. Barabasi. Network Science. Free online book: http://barabasilab.neu.edu/networksciencebook/
Sample Reading Collection	Course readings will be composed of research articles from leading journals, conferences and edited volumes. As the course aims to include the latest research directions, the

	list below provides only a typical sample. Overviews: • D. Lazer, et. al. Computational Social Science. Science 6 February 2009: 721-723. • T. Mitchell. Mining Our Reality. Science 18 December 2009: 1644-1645. • J. Kleinberg. The Convergence of Social and Technological Networks. Communications of the ACM. Volume 51 , Issue 11 Information Flow: • J. Kleinberg. Cascading Behavior in Networks: Algorithmic and Economic Issues. In Algorithmic Game Theory (N. Nisan, T. Roughgarden, E. Tardos, V. Vazirani, eds.), Cambridge University Press, 2007 • D. Liben-Nowell, J. Kleinberg. Tracing Information Flow on a Global Scale Using Internet Chain-Letter Data. Proc. National Academy of Sciences, 105(12):4633–4638, 25 March 2008 Mobility: • N. Eagle, A. Pentland, and D. Lazer. Inferring friendship network structure by using mobile phone data. PNAS 106, 15274-1527 • E. Cho, S. A. Myers, J. Leskovec. Friendship and Mobility: User Movement In Location-Based Social Networks. ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD), 2011 • D. Crandall, L. Backstrom, D. Cosley, S. Suri, D. Huttenlocher, J. Kleinberg. Inferring Social Ties from Geographic Coincidences. Proc. National Academy of Sciences 107(52) 22436-22441, 28 December 2010. Opinions and sentiments: • J. Leskovec, D. Huttenlocher, J. Kleinberg. Signed Networks in Social Media. Proc. 28th ACM SIGCHI Conf. on Human Factors in Computing Systems (CHI), 2010. • J. Leskovec, L. Backstrom, J. Kleinberg. Meme-tracking and the dynamics of the news cycle. Proc. 15th ACM SIGKDD Intl. Conf. on Knowledge Discovery and Data Mining, 2009. • Jan Lorenza et al. How social influence can undermine the wisdom of crowd effect. PNAS, May 16, 2011 Coordination: • M. Kearns, S. Judd, J. Tan and J. Wortman. Behavioral Experiments on Biased Voting in Networks. PNAS, January 2009. • M. Kearns, S. Suri and N. Montfort. An Experimental Study of the Coloring Problem on Human Subject Networks. Science 313(5788), 2006, pp. 824-827 Learning and Adaptation: • W. Mason and D. J. Watts. Collaborative learning in

	networks. PNAS 2011 • D.G. Rand, S. Arbesman, and N.A. Christakis, Dynamic Social Networks Promote Cooperation in Experiments with Humans, PNAS, October 2011 • Arlette van Wissen, Ya'akov Gal, Bart Kamphorst, Virginia Dignum. Human-Agent Team Formation in Dynamic Environments. Computers in Human Behavior 28:23-33, 2012 Health Behavior Sensing: • N.A. Christakis and J.H. Fowler, "Social Network Sensors for Early Detection of Contagious Outbreaks," PLoS One, 5(9) • Sensing the health state of a community, A. Madan, M. Cebrian, S. Moturu, K. Farrahi, and A. Pentland, IEEE Pervasive Computing Magazine (in press)
Instructional material and resources	This course will make use of significant open source software. Students must have Ubuntu Linux installed on their machines.