ACE Network Subject Information Guide

DATA5441: Networks and High-dimensional Inference

Semester 1, 2021

Administration and contact details

Host department	**School of Mathematics and Statistics**
Host institution	**The University of Sydney**
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Subject details

Handbook entry URL	
Subject homepage URL	**https://www.maths.usyd.edu.au/u/PG/DATA5441/**

Honours student hand-out URL	**https://www.maths.usyd.edu.au/u/PG/DATA5441/**
Start date:	**1 March 2021**
End date:	**4 June 2021**
Contact hours per week:	**1 HOUR**
Lecture day(s) and time(s):	**Tuesdays/Wednesdays 9-11am**
Description of electronic access arrangements for students (for example, WebCT)	**Forum, Notebooks, lectures tutorials will be all posted in Canvas and https://edstem.org/**

Subject content

1. Subject content description

In our interconnected world, networks are an increasingly important representation of datasets and systems. This unit will investigate how this network approach to problems can be pursued through the combination of mathematical models and datasets. You will learn different mathematical models of networks and understand how these models explain non-intuitive phenomena, such as the small world phenomenon (short paths between nodes despite clustering), the friendship paradox (our friends typically have more friends than we have), and the sudden appearance of epidemic-like processes spreading through networks. You will learn computational techniques needed to infer information about the mathematical models from data and, finally, you will learn how to combine mathematical models, computational techniques, and real-world data to draw conclusions about problems. More generally, network data is a paradigm for high-dimensional interdependent data, the typical problem in data science. By doing this unit you will develop computational and mathematical skills of wide applicability in studies of networks, data science, complex systems, and statistical physics.

2. Week-by-week topic overview

Weeks 1-2: Basic Network concepts

Weeks 3-5: Network models

Weeks 6-9: High dimensional inference and communities

Weeks 10-12: Dynamics of and on Networks

Week 13: Projects

3. Assumed prerequisite knowledge and capabilities

Linear algebra, introduction to statistics, and basic coding skills.

4. Learning outcomes and objectives

Develop analytical, numerical, and modeling skills that help to connect abstract mathematical ideas to real-world systems represented as networks.

LO1	provide solutions to problems through the application of abstract mathematical theory and computational methods.
LO2	transmit information and skills to others through collaborative computing projects.
LO3	summarize, interpret, and differentiate mathematical and computational models in network science.
LO4	evaluate critically the applicability of mathematical models to a given network data.
LO5	create new computational and mathematical models for networks.
LO6	develop new strategies to communicate research results to specialist and non-specialist audiences.
LO7	synthetise and apply mathematical and computational models to problems and data in new contexts.

AQF specific Program Learning Outcomes and Learning Outcome Descriptors (if available):

Learning taxonomy Blooms

#	LO1	LO2	LO3	LO4	LO5	LO6	LO7
T1							
T2							
T3	Y	Y					
T4			Y				
T5				Y			Y
T6					Y	Y	

Learning taxonomy Reference Blooms

#	Taxonomy description	Taxonomy component
T1	Remembering	Level of Thinking - Cognitive
T2	Comprehending	Level of Thinking - Cognitive
T3	Applying	Level of Thinking - Cognitive
T4	Analysing	Level of Thinking - Cognitive
T5	Evaluating	Level of Thinking - Cognitive
T6	Creating	Level of Thinking - Cognitive

5. Learning resources

References:

Networks: An Introduction, Mark Newman, Oxford Univ Press, 2010.

Network Science book, L. Barabasi, 2017 http://barabasi.com/networksciencebook/

Dynamical Processes on Complex Networks, A. Barrat, M. Barthélemy, A. Vespignani, Cambridge University Press, 2012

Statistical mechanics of complex networks, R. Albert & A. Barabasi, Rev. Mod. Phys. 2002.

The Structure and Function of Complex Networks, M. Newman, SIAM Review, 2002.

References:

Networkx: https://networkx.github.io

graphtool: https://graph-tool.skewed.de

igraph: http://igraph.org

Pajek: http://vlado.fmf.uni-lj.si/pub/networks/pajek/

Jupyter Notebooks: http://jupyter.org

Further resources at the UoS webpage.

6. Assessment

Exam/assignment/classwork breakdown					
Exam	**40%**	**Assignment**	**30%**	**Class work**	**30%**
Assignment due dates		**There will be assignments every one or two weeks**	**There will be assignments every one or two weeks**	**There will be assignments every one or two weeks**	**There will be assignments every one or two weeks**
Approximate exam date				**15-26 June 2021**	

7.

Institution honours program details

Weight of subject in total honours assessment at host department	6 CP of a total of 24 CP for an Honours program
Thesis/subject split at host department	50/50
Honours grade ranges at host department	
H1	80 - 100
H2a	75-79
H2b	**70-74**
H3	**65-69**

Institution masters program details

Weight of subject in total masters assessment at host department	Click here to enter text.
Thesis/subject split at host department	Click here to enter text.
Masters grade ranges at host department	
H1	Enter range %
H2a	Enter range %
H2b	Enter range %
H3	Enter range %