ACE Network Subject Information Guide

Convex Optimisation

Semester 1, 2021

Administration and contact details

Host department	School of Mathematics and Statistics
Host institution	University of Melbourne
Name of lecturer	Matthew Tam
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Name of honours coordinator	n/a
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Subject details

Handbook entry URL	n/a
Subject homepage URL	n/a
Honours student hand-out URL	TBA
Start date:	March 4th, 2021
End date:	May 27th, 2021
Contact hours per week:	**2**
Lecture day(s) and time(s):	Thursdays, 1-3pm
Description of electronic access arrangements for students (for example, WebCT)	Lecture notes and assignments will be distributed via email and via the lecturer's webpage

Subject content

1. Subject content description

In much of applied mathematics, the dominant distinct between "easy" problems and "hard" problems revolves around questions of linearity or lack thereof. Before the so-called interior-point revolution of the 1980s, the same was true in optimisation: linear programming was considered "easy" whereas nonlinear programming was considered "hard". Nowadays however, it is now more or less agreed that, for the purposes of optimisation, the notion of convexity rather than linearity distinguish easy from hard, both in theory and practice.

This course provides an introduction to the field of convex optimisation. It will cover the mathematical foundations in convex analysis as well as iterative algorithms for solving convex optimisation problems. After completing this course, students will be able to model, mathematically analyse and solve convex optimisation problems. It is expected that the course will provide a working knowledge of the tools of convex optimisation as well as the theoretical foundations for further study in optimisation.

2. Week-by-week topic overview

Week 1: Introduction and Euclidean Spaces
Week 2: Convexity
Week 3: Differentiability of convex functions
Week 4: The proximity operator
Week 5: Separation Theorems
Week 6: Subgradients of convex functions
Week 7: The Frank-Wolfe algorithm
Week 8: Proximal gradient descent
Week 9: Nesterov acceleration
Week 10: The subgradient method
Week 11: Douglas-Rachford splitting
Week 12: Stochastic gradient descent

3. Assumed prerequisite knowledge and capabilities

linear algebra and calculus

4. Learning outcomes and objectives

On completion of this course, students should be able to:

- Identity convex sets and convex functions, and formulate convex optimisation problems.
- Understand the role of convexity and other mathematical properties in optimisation.
- Understand standard arguments used in convex analysis and convex optimisation.
- Select and apply appropriate iterative algorithms for solving convex optimisation problems, depending on the mathematical properties of the problem.

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

AQF Program Learning Outcomes addressed in this subject	**Associated AQF Learning Outcome Descriptors for this subject**
Insert Program Learning Outcome here	Choose from list below
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Insert Program Learning Outcome here	Choose from list below
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Learning Outcome Descriptors at AQF Level 8

Knowledge

K1: coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines

K2: knowledge of research principles and methods

Skills

S1: cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problem with intellectual independence

S2: cognitive and technical skills to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas

S3: cognitive skills to exercise critical thinking and judgement in developing new understanding

S4: technical skills to design and use in a research project

S5: communication skills to present clear and coherent exposition of knowledge and ideas to a variety of audiences

Application of Knowledge and Skills

A1: with initiative and judgement in professional practice and/or scholarship

A2: to adapt knowledge and skills in diverse contexts

A3: with responsibility and accountability for own learning and practice and in collaboration with others within broad parameters

A4: to plan and execute project work and/or a piece of research and scholarship with some independence

5. Learning resources

Lecture notes will be provided to students by the lecturer.

Recommend supplementary resources include:

- Beck, Amir. First-order methods in optimization. Society for Industrial and Applied Mathematics, 2017.
- Borwein, Jonathan, and Adrian S. Lewis. Convex analysis and nonlinear optimization: theory and examples. Springer Science & Business Media, 2010.
- Borwein, Jonathan M., and Jon D. Vanderwerff. Convex functions: constructions, characterizations and counterexamples. Vol. 172. Cambridge: Cambridge University Press, 2010.
- Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.
- Rockafellar, R. Tyrrell. Convex analysis. Vol. 36. Princeton university press, 1970.

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6. Assessment

Exam/assignment/classwork breakdown					
Exam	0%	**Assignment**	100%	**Class work**	0%
Assignment due dates		March 18th (Week 3)	April 15th (Week 6)	May 13th (Week 10)	June 3rd (Week 13)
Approximate exam date				n/a	

Institution honours program details

Weight of subject in total honours assessment at host department	n/a
Thesis/subject split at host department	
Honours grade ranges at host department	
H1	
H2a	
H2b	
H3	

Institution masters program details

Weight of subject in total masters assessment at host department	n/a
Thesis/subject split at host department	
Masters grade ranges at host department	
H1	
H2a	
H2b	
H3	