ACE Network Subject Information Guide

Optimisation for Deep Learning

Semester 2, 2020

Administration and contact details

Host Department	Department of Mathematics
Host Institution	Swinburne University of Technology
Name of lecturer	Nadezda Sukhorukova
Phone number	(03)92148289, mob. 0403552127
Email Address	nsukhorukova@swin.edu.au
Homepage	**https://www.swinburne.edu.au/research/our-research/access-our-research/find-a-researcher-or-supervisor/researcher-profile/?id=nsukhorukova**
Name of Honours coordinator	Dr. Antony Edwards
Phone number	**03 9214 5393**
Email Address	**awedwards@swin.edu.au**

Subject details

Handbook entry URL	TBA
Subject homepage URL	The material will be available from MoCaO website (special interest group within AustMS)
Honours student hand-out URL	TBA
Start date:	August 2020
End date:	October 2020
Contact hours per week:	2 hours of lecture and 2 tutorial/lab/consultation
Lecture day and time:	TBA
Description of electronic access arrangements for students (for example, WebCT)	Zoom

Subject content

1. **Subject content description**

The aim of this unit is to introduce classical optimisation techniques that are essential for deep learning models. The structure includes lectures, tutorials and computer labs. The final assessment task is a (group) project.

2. Week-by-week topic overview

1. Introduction: Deep learning
2. Introduction: Optimisation
3. Linear Programming: duality and computational methods
4. Integer programming. Assignment 1 (start)
5. Convex optimisation
6. Duality, KKT and Computational Methods for convex optimisation.
7. Principal Component Analysis (PCA). Assignment 1 (due). Assignment 2 (start).
8. Nonconvex optimisation I
9. Nonconvex optimisation II
10. Sequential Quadratic Programming. Assignment 2 (due). Final project (start).
11. Optimisation as part of Deep learning. Comments on Assignment 2.
12. Other possibilities for activation functions. Comments on Final project

3. Assumed prerequisite knowledge and capabilities

Linear Algebra and Calculus (one semester each).

4. Learning outcomes and objectives

After taking this unit, the students will be able to:

- Formulate mathematical programming models for modern real-world applications of deep learning and data analysis given in a non-specialised description.
- Explain the difference between various optimisation problems
- Analyse optimisation problems and identify advantages and disadvantages of various formulations (approximate solutions.
- Apply cutting edge numerical tools to solve large scale optimisation problems and integrate them into machine learning software.

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
Formulate mathematical programming models for modern real-world applications	K1,S3,S4,A1

Analyse optimisation problems	K1,K2,S1-S5,A1
Apply cutting edge numerical tools to solve large scale optimisation problems and integrate them into machine learning software	K1,K2,S1-S3,A1

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 via MoCaO (Mathematics of Computation and Optimisation, Special Interest Group of the AustMS) web-site.

Python

6. Assessment

Exam/assignment/classwork breakdown					
Exam	70 %	**Assignment**	30 % (2 assignments)	**Class work**	Enter %
Assignment due dates		A1: September 2020.	A2: October 2020.	Click here to enter a date.	Click here to enter a date.

Approximate exam date	November 2020

Institution Honours program details

Weight of subject in total honours assessment at host department	12.5%
Thesis/subject split at host department	Thesis: 62.5%, courses 37.5%
Honours grade ranges at host department:	
H1	80-100%
H2a	70-79%
H2b	60-69%
H3	50-59%