UNSW Course Outline

ELEC9741 Electrical Engineering Data Science - 2024

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General Course Information

Course Code : ELEC9741
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Electrical Engineering & Telecommunications
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

It is safe to say big data has become mainstream. Industry is forging ahead in the use of data mining to uncover patterns and information from massive datasets and reap the associated rewards. However, the challenges are not simply an increase in the size of datasets, but that of

understanding the nature of the data being collected, the processes that underpin this data and the structure inherent in the data. In order to incorporate these aspects in the practice of data analyses, it is critical to bring techniques for signal analyses, filtering and dynamic modelling to bear on the problems and develop appropriate frameworks within which predictive systems can be engineered. These techniques from the fields of signal processing and control systems are traditionally learnt by Electrical Engineers and this course will give you a fairly unique perspective into the principles of Data Science from this perspective. In addition, in this course you will be able to apply your knowledge of signal processing, control, modelling, mathematics and computing to the practice of data modelling and machine learning.

Course Aims

This course provides an introduction to Data Science principles and practice from a Control and a Signal Processing point of view. It is designed to be an advanced elective for students with an Electrical Engineering background or any others who have prior exposure to Control Systems and Signal Processing. The course is intended for postgraduate students as well as final-year undergraduate students.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Suitably visualise data, applying fundamental principles of data visualisation to practice
CLO2 : Model data, including time-series data, by appropriately employing system identification techniques
CLO3 : Implement optimal linear filter models to analyse and process data
CLO4 : Design suitable signal processing based feature extraction front-ends to machine learning systems
CLO5 : Demonstrate an understanding of linear and non-linear machine learning models and the algorithms underpinning their use
CLO6 : Deduce the behaviour of previously unseen prediction systems and hypothesise about their merits

Course Learning Outcomes	Assessment Item
CLO1 : Suitably visualise data, applying fundamental principles of data visualisation to practice	• Homework 1 • Take Home Exam 1 • Homework 2 • Take Home Exam 2
CLO2 : Model data, including time-series data, by appropriately employing system identification techniques	• Homework 1 • Take Home Exam 1
CLO3 : Implement optimal linear filter models to analyse and process data	• Take Home Exam 1
CLO4 : Design suitable signal processing based feature extraction front-ends to machine learning systems	• Homework 2
CLO5 : Demonstrate an understanding of linear and non-linear machine learning models and the algorithms underpinning their use	• Take Home Exam 2
CLO6 : Deduce the behaviour of previously unseen prediction systems and hypothesise about their merits	• Homework 2 • Take Home Exam 2

Learning and Teaching Technologies

In-class lectures

Other Professional Outcomes

Engineers Australia (EA), Professional Engineer Stage 1 Competencies

The Course Learning Outcomes (CLOs) contribute to your development of the following EA competencies:

PE1: Knowledge and Skill Base:
PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals: CLO 1, 2, 5
PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing: CLO 1, 2, 5, 6
PE1.3 In-depth understanding of specialist bodies of knowledge: CLO 1, 2, 3, 4, 5, 6
PE1.4 Discernment of knowledge development and research directions: n/a
PE1.5 Knowledge of engineering design practice: CLO 3, 4, 6
PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice: n/a

PE2: Engineering Application Ability:
PE2.1 Application of established engineering methods to complex problem solving: CLO 1, 2, 3, 4, 5, 6
PE2.2 Fluent application of engineering techniques, tools and resources: CLO 2, 3, 4, 5
PE2.3 Application of systematic engineering synthesis and design processes: CLO 2, 3, 4, 5, 6
PE2.4 Application of systematic approaches to the conduct and management of engineering projects: n/a

PE3: Professional and Personal Attributes:
PE3.1 Ethical conduct and professional accountability: n/a
PE3.2 Effective oral and written communication (professional and lay domains): CLO 1, 5, 6
PE3.3 Creative, innovative and pro-active demeanour: CLO 1, 2, 4, 6
PE3.4 Professional use and management of information: CLO 1, 2, 3, 4, 5
PE3.5 Orderly management of self, and professional conduct: n/a
PE3.6 Effective team membership and team leadership: n/a

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Homework 1 Assessment Format: Individual	15%	
Take Home Exam 1 Assessment Format: Individual	35%	
Homework 2 Assessment Format: Individual	15%	
Take Home Exam 2 Assessment Format: Individual	35%	

Assessment Details

Homework 1

Assessment Overview

The homework will be released a fortnight in advance and due mid-term. It covers the topics lectured in the first 4 weeks including data visualisation, data modelling, and data processing. Students will be given a small set of questions that will require both analytical and programming work to complete. They will submit their answers in the form of a short report/document outlining both the analytical working and program/code outputs along with explanations. Feedback will be provided in the form of marks and notes about potential expected solutions.

Course Learning Outcomes

- CLO1 : Suitably visualise data, applying fundamental principles of data visualisation to practice
- CLO2 : Model data, including time-series data, by appropriately employing system identification techniques

Take Home Exam 1

Assessment Overview

This is the final exam for the first half of the course. It is an open-book exam spanning 2 weeks. It covers the topics lectured in the first 5 weeks including data visualisation, data modelling, and data processing. Students will be given a set of questions that will require both analytical and programming work to complete. Students will submit their answers in the form of a short report/ document outlining both the analytical working and program/code outputs along with explanations. Feedback will be provided in the form of marks and notes about potential expected

solutions.

Course Learning Outcomes

- CLO1 : Suitably visualise data, applying fundamental principles of data visualisation to practice
- CLO2 : Model data, including time-series data, by appropriately employing system identification techniques
- CLO3 : Implement optimal linear filter models to analyse and process data

Homework 2

Assessment Overview

The project will be released a fortnight in advance and due towards the end of the term. The students will be given two questions that will require both analytical and programming work to complete. One question will focus more on analytical work and the other will be a somewhat open-ended mini-project They will submit their answers in the form of a short report/document outlining both the analytical working and program/code outputs along with explanations.

Course Learning Outcomes

- CLO1 : Suitably visualise data, applying fundamental principles of data visualisation to practice
- CLO4 : Design suitable signal processing based feature extraction front-ends to machine learning systems
- CLO6 : Deduce the behaviour of previously unseen prediction systems and hypothesise about their merits

Take Home Exam 2

Assessment Overview

This open-book take-home exam will be released at the end of the term and students will have a fortnight to complete it. The students will be given a set of questions that will require both analytical and programming work to complete. Students will submit their answers in the form of a short report/document outlining both the analytical working and program/code outputs along with explanations. Additionally, the exam will include a small oral component where students will be asked to explain their solutions and answer questions. The oral assessment component will be around 15-20 minutes per student. The topics covered by the project include data analyses, feature extraction, development, and analyses of machine learning models. These topics will be covered in the lectures in the second half of the term. Feedback will be provided in the form of marks.

Course Learning Outcomes

- CLO1 : Suitably visualise data, applying fundamental principles of data visualisation to practice
- CLO5 : Demonstrate an understanding of linear and non-linear machine learning models and the algorithms underpinning their use
- CLO6 : Deduce the behaviour of previously unseen prediction systems and hypothesise about their merits

General Assessment Information

To pass, students must obtain a pass level in each part of the course

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 27 May - 2 June	Lecture	Introduction to Data Science; Matrix Review; Introduction to System Identification.
	Lecture	Review of Random Variables and Computational Linear Algebra; Introduction to regression estimation of finite impulse response systems.
Week 2 : 3 June - 9 June	Lecture	Information Visualization: Principles & Practice. Noise Models.
Week 3 : 10 June - 16 June	Lecture	Noise Modeling, partial correlation, spectrum.
Week 4 : 17 June - 23 June	Lecture	Stochastic Processes and Spectra in System Identification.
Week 5 : 24 June - 30 June	Lecture	Kalman Filter, Wiener Filter.
Week 6 : 1 July - 7 July	Lecture	Introduction to Machine Learning.
	Lecture	Feature Representations: e.g. speech and image features
Week 7 : 8 July - 14 July	Lecture	Linear Methods for Regression and Classification.
Week 8 : 15 July - 21 July	Lecture	Generative Models and Support Vector Machines.
Week 9 : 22 July - 28 July	Lecture	Deep Learning.
Week 10 : 29 July - 4 August	Lecture	Large Language Models.

Attendance Requirements

Please note that lecture recordings are not available for this course. Students are strongly encouraged to attend all classes and contact the Course Authority to make alternative arrangements for classes missed.

Course Resources

Recommended Resources

Part 1

Software: Matlab & R

Textbook: None

Reference: R. Shumway & D. Stoffer (2011), Time Series Analysis and itsApplications. 3rd. ed. Springer.

Part 2

Software: Matlab & Python

Textbook: None

Reference: (i) T. Hastie, R. Tibshirani, J. Friedman The Elements of StatisticalLearning, 2nd ed. Springer (2009); (ii) R.O. Duda, D.G. Stork, P.E.Hart (2001), Pattern Classication 2nd.ed., J. Wiley.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Prof. Victor Solo					No	Yes
	A/Prof. Vidhyasaharan Sethu					No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;

- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School-specific Information

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Use of AI for assessments

Your work must be your own. If you use AI in the writing of your assessment, you must acknowledge this and your submission must be substantially your own work. More information can be found on this website.

Workplace Health & Safety (WHS)

WHS for students and staff is of utmost priority. Most courses involve laboratory work. You must follow the rules about conduct in the laboratory. About COVID-19, advice can be found on this website.

School Contact Information

Consultations: Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. ALL email enquiries should be made from your student email address with ELEC/TELExxxx in the subject line; otherwise they will not be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

Student Support Enquiries

For enrolment and progression enquiries please contact Student Services

Web

Electrical Engineering Homepage