UNSW Course Outline

COMP9444 Neural Networks and Deep Learning - 2024

Published on the 21 May 2024

General Course Information

Course Code : COMP9444
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Computer Science and Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate, Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Neural networks and deep learning play a critical role in pushing the boundaries of what AI can achieve, making them indispensable for various industries and applications. Their ability to learn and adapt from data has revolutionised many fields and opened up new opportunities for solving

complex problems. This course provides an introduction to and deep exploration of neural networks and deep learning principles and practice.

Topics chosen from: perceptrons, feedforward neural networks, backpropagation, deep convolutional networks, image processing; geometric analysis of trained networks; recurrent networks, language processing, semantic analysis, long short term memory; deep reinforcement learning; autoencoders, generative models, adversarial training; designing successful applications of neural networks; recent developments in neural networks and deep learning.

Course Aims

This course aims to introduce students to the main topics and methods in the field of neural networks and deep learning, ranging from traditional neural network models to the latest research and applications of deep learning.

It is an elective in the Artificial Intelligence majors for both undergraduate and postgraduate.

Relationship to Other Courses

Following are the related courses that are run by School of Computer Science and Engineering at UNSW Sydney:

- COMP3411/9414: Artificial Intelligence
- COMP9417: Machine Learning and Data Mining
- COMP9418: Advanced Topics in Statistical Machine Learning
- COMP4418: Knowledge Representation and Reasoning
- COMP9491: Applied Artificial Intelligence
- COMP9517: Computer Vision
- COMP3431: Robotic Software Architecture
- COMP9727: Recommender Systems
- COMP6713: Natural Language Processing

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Discuss the social, intellectual, and neurobiological context of neural networks and deep learning
CLO2 : Describe a variety of NN and DL techniques - including fully connected, convolutional and recurrent networks, deep reinforcement learning, generative models and adversarial training
CLO3 : Analyse a problem and devise a suitable neural network solution
CLO4 : Use a Python module or simulation package to implement neural networks for a range of tasks, including image and language processing, reinforcement learning, and unsupervised learning

Course Learning Outcomes	Assessment Item
CLO1 : Discuss the social, intellectual, and neurobiological context of neural networks and deep learning	• Group Project • Final Exam
CLO2 : Describe a variety of NN and DL techniques - including fully connected, convolutional and recurrent networks, deep reinforcement learning, generative models and adversarial training	• Group Project • Final Exam
CLO3 : Analyse a problem and devise a suitable neural network solution	• Assignment • Group Project • Final Exam
CLO4 : Use a Python module or simulation package to implement neural networks for a range of tasks, including image and language processing, reinforcement learning, and unsupervised learning	• Assignment • Group Project • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System | EdStem | Echo 360 | Zoom | Microsoft Teams

Learning and Teaching in this course

This course will include Lectures (Weeks 1-5, 7-10); Tutorials (Weeks 1-5) and Project Mentoring Sessions (Week 6-10).

All the course materials will be delivered through the course Ed page. This includes course content in the form of text, images, and embedded videos, online discussion forums, quizzes, coding exercises using Jupyter Notebooks, as well as links to the Tutorial questions.

Students are encouraged to read through the materials on Ed before each lecture.

Tutorials will be used in Week 1 to 5, to discuss worked examples and develop a deeper understanding of fundamental topics.

Project Mentoring Sessions will be used in Week 6 to 10, to assist with the Group Project.

You are expected to:

- review the course materials before and after each scheduled class
- attempt the tutorial questions ahead of time and be ready to ask questions in the tutorial
- complete relevant quizzes, coding exercises, assignment and group project

- discuss the material with your fellow students
- consider exploring topics of particular interest by writing and running your own programs
- ask questions and contribute to the discussion in the online forums.

Students are expected to form themselves into groups of 5 (max) for the Group Project, by the end of Week 3. Each group will be assigned a Mentor. More details about group formation and mentoring will be provided at the beginning of Week 1.

The assignment will involve writing code in PyTorch. These are the versions of modules currently installed on the CSE lab machines. Please try to install equal or later versions on your own laptop.

- python3 3.11.2
- torch 1.13.0
- numpy 1.24.2
- sklearn 1.2.1

The Final Exam will be on campus, and invigilated during the standard UNSW Exam Period.

Other Professional Outcomes

https://www.unsw.edu.au/engineering/student-life/student-resources/program-design

Additional Course Information

The course will assume knowledge of the following mathematical topics:

- Linear Algebra (2.1-2.8)
- Probability (3.1-3.14)
- Calculus and Chain Rule (6.5.2)

Students should study the relevant sections of the textbook (shown in brackets) and, if necessary, try to revise these topics on their own during the first few weeks of the course.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment Assessment Format: Individual	20%	Start Date: Week 3 Due Date: Week 6
Group Project Assessment Format: Group	35%	Start Date: Week 4 Due Date: Week 10
Final Exam Assessment Format: Individual	45%	Start Date: UNSW Exam Period Due Date: UNSW Exam Period

Assessment Details

Assignment

Assessment Overview

The assignment involves solving problems using neural networks implemented in Python and analysing the properties of the trained networks.

Students submit their programs and analysis online. Tutors mark the programs and analysis using a rubric described in the assignment specification, and provide feedback to students.

Course Learning Outcomes

- CLO3 : Analyse a problem and devise a suitable neural network solution
- CLO4 : Use a Python module or simulation package to implement neural networks for a range of tasks, including image and language processing, reinforcement learning, and unsupervised learning

Group Project

Assessment Overview

Students are expected to form themselves into groups of 5 for the Group Project, by the end of Week 4. Each group is assigned a Mentor.

Groups choose a specific problem to be solved using a neural network. They must (a) submit their codebase in the form of a Jupyter Notebook, (b) submit a project report describing and analysing their solution, and (c) give a presentation on their project work.

The Mentor assesses the group's work and provides feedback throughout the term.

The allocation of 35 marks includes 30 marks for group work plus 5 marks of individual component (based on each student's contribution to the final presentation).

Course Learning Outcomes

- CLO1 : Discuss the social, intellectual, and neurobiological context of neural networks and deep learning
- CLO2 : Describe a variety of NN and DL techniques - including fully connected, convolutional and recurrent networks, deep reinforcement learning, generative models and adversarial training
- CLO3 : Analyse a problem and devise a suitable neural network solution
- CLO4 : Use a Python module or simulation package to implement neural networks for a range of tasks, including image and language processing, reinforcement learning, and unsupervised learning

Final Exam

Assessment Overview

The Final Exam is a 2-hour written examination designed to test the student's understanding of the theory and practice of neural network architectures and algorithms. It consists of multiple choice questions, plus questions requiring the student to compute numerical answers and type them into a text box.

Course Learning Outcomes

- CLO1 : Discuss the social, intellectual, and neurobiological context of neural networks and deep learning
- CLO2 : Describe a variety of NN and DL techniques - including fully connected, convolutional and recurrent networks, deep reinforcement learning, generative models and adversarial training
- CLO3 : Analyse a problem and devise a suitable neural network solution
- CLO4 : Use a Python module or simulation package to implement neural networks for a range of tasks, including image and language processing, reinforcement learning, and unsupervised learning

Assessment Length

2 Hours

Assessment information

https://www.student.unsw.edu.au/calendar

General Assessment Information

Grading Basis

Standard

Requirements to pass course

In order to pass the course, you must:

- achieve a total mark of at least 50;
- meet any additional requirements of the assessment tasks.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 0 : 20 May - 26 May	Reading	Introduction to the course • Python Refresher • Numpy Refresher • Matplotlib Refresher • Google Colab Refresher
Week 1 : 27 May - 2 June	Lecture	Perceptrons and Backpropagation • Neuroanatomy and Perceptrons • Multi-Layer Networks and Backpropagation Tutorial: • Perceptrons and Multi-Layer Networks
Week 2 : 3 June - 9 June	Lecture	Probability, Generalization and Overfitting • Probability, Generalization and Overfitting • PyTorch Tutorial • Backpropagation
Week 3 : 10 June - 16 June	Lecture	Backprop Variations, Hidden Unit Dynamics • Cross Entropy, Softmax and Weight Decay • Hidden Unit Dynamics Tutorial • Probability and Backprop variations
Week 4 : 17 June - 23 June	Lecture	Convolution and Image Processing • Convolution • Image Processing Tutorial • Softmax, Hidden Unit Dynamics
Week 5 : 24 June - 30 June	Lecture	Recurrent Networks and LSTM • Recurrent Neural Networks • Long Short-Term Memory Tutorial • Convolutional Neural Networks
Week 6 : 1 July - 7 July	Other	Flexibility Week: No Lectures in this week Project Mentoring • Attend respective mentoring session as a team
Week 7 : 8 July - 14 July	Lecture	Word Vectors and Language Processing • Word Vectors • Natural Language Processing Project Mentoring • Attend respective mentoring session as a team
Week 8 : 15 July - 21 July	Lecture	Reinforcement Learning • Reinforcement Learning • TD-Learning and Q-Learning • Policy Learning and Deep RL Project Mentoring • Attend respective mentoring session as a team
Week 9 : 22 July - 28 July	Lecture	Unsupervised and Multimodal Learning • Autoencoders and Adversarial Training • Generative Adversarial Networks • Vision and Language Learning Project Mentoring • Attend respective mentoring session as a team
Week 10 : 29 July - 4 August	Lecture	Generative AI • Generative Artificial Intelligence • Recent Advances in Deep Learning Project Demonstrations • Demonstration of project work

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

Lectures are scheduled as follows:

- Tuesday; 14:00 - 16:00; Science Theatre (K-F13-G09)
- Wednesday; 11:00 - 13:00; Science Theatre (K-F13-G09)

You can check schedule of Lectures and your tutorials from the timetable page (see link below)

https://timetable.unsw.edu.au/2024/COMP9444.html#S2-4290

Course Resources

Recommended Resources

- Deep Learning by Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016
- Understanding Deep Learning by Simon J.D. Prince, MIT Press, 2023

Course Evaluation and Development

Every term, student feedback is requested in a survey using UNSW's myExperience online survey system where the feedback will be used to make improvements to the course. Students are also encouraged to provide informal feedback during the session, and to let course staff know of any problems as soon as they arise. Suggestions will be listened to openly, positively, constructively, and thankfully, and every reasonable effort will be made to address them.

Changes made in response to feedback from previous offerings include: migration of the course content to an online platform with expanded text, clickable references, coding exercises and online discussion forums; introduction of a group project, and, most recently, introduction of scheduled tutorials. We hope these changes will help to make this course a rewarding and enjoyable experience.

Based on the feedback from 2023 offerings, we have now scheduled tutorial from Week 1 so that students will get more time to have deeper discussion with their tutors and should be able to go through most of the tutorial questions within the tutorial time.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Sonit Singh		K17 405		cs9444@cse.unsw.edu.au	Yes	No
Lecturer	Alan Blair		K17 412C		cs9444@cse.unsw.edu.au	Yes	No
	COMP9444 Course Email		cs9444@cse.unsw.edu.au			No	Yes

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 Contact Information

CSE Help! - on the Ground Floor of K17

- For assistance with coursework assessments.

The Nucleus Student Hub - https://nucleus.unsw.edu.au/en/contact-us

- Course enrolment queries.

Grievance Officer - grievance-officer@cse.unsw.edu.au

- If the course convenor gives an inadequate response to a query or when the courses convenor does not respond to a query about assessment.

Student Reps - stureps@cse.unsw.edu.au

- If some aspect of a course needs urgent improvement. (e.g. Nobody responding to forum queries, cannot understand the lecturer)

You should **never** contact any of the following people directly:

- Vice Chancellor

- Pro-vice Chancellor Education (PVCE)

- Head of School

- CSE administrative staff

- CSE teaching support staff

They will simply bounce the email to one of the above, thereby creating an unnecessary level of indirection and a delay in the response.