UNSW Course Outline

COMP4418 Knowledge Representation and Reasoning - 2024

Published on the 25 Aug 2024

General Course Information

Course Code : COMP4418
Year : 2024
Term : Term 3
Teaching Period : T3
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 : Postgraduate, Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

How can you timetable classes to fit everyone's schedule? Could tactical voting occur in

Australia? Can a single computer program play and solve both sudoku and minesweeper?

Knowledge Representation and Reasoning is at the core of Artificial Intelligence and the corresponding course, COMP4418, will equip you to answer the questions above and many other ones, so-called combinatorial problems. To do so, I will teach you “modeling”, that is the representation of a problem and its solutions in a way the computer can understand. You will learn a declarative programming language, a paradigm in which one only specifies what constitutes a solution to a problem and then leaves it to the computer to actually find the solution. With this new tool under your belt, you can effectively tackle most combinatorial problems coming your way, from planning and scheduling to digital circuit synthesis or some limited program verification.

Course Aims

This course provides an introduction to the important approach to symbolic Artificial Intelligence (AI) known is Knowledge Representation and Reasoning (KRR). KRR has a long and distinguished history of research in AI with a broad range of approaches. In this course we concentrate on formal approaches to KRR, in particular logic based approaches – propositional logic, first-order logic, non-monotonic logic – and how they can be used to solve difficult computational problems.

This course can be a starting point for further exploration of artificial intelligence. Further courses include COMP3431/COMP9431: Robotic Software Architecture, COMP9417: Machine Learning and Data Mining, COMP9444: Neural Networks and COMP9844: Extended Neural Networks.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Identify when a given situation can be formulated with a Knowledge Representation and Reasoning (KRR) approach
CLO2 : Implement a problem model in a KRR language and use existing KRR tools to identify a solution
CLO3 : Break down a task into its domain vocabulary and its combinatorial dimension
CLO4 : Solve new combinatorial problems using declarative programming

Course Learning Outcomes	Assessment Item
CLO1 : Identify when a given situation can be formulated with a Knowledge Representation and Reasoning (KRR) approach	• Assignment 1 • Exam
CLO2 : Implement a problem model in a KRR language and use existing KRR tools to identify a solution	• Assignment 2 • Exam
CLO3 : Break down a task into its domain vocabulary and its combinatorial dimension	• Assignment 3 • Exam
CLO4 : Solve new combinatorial problems using declarative programming	• Assignment 1 • Exam

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

The learing and teaching will be based on the weekly lectures. Every week, there will be 2 lectures of 2 hours each

Additional Course Information

In this edition of the course, the focus will be on game-theoretic foundations of knowledge representation, reasoning, and multi-agent systems.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Assignment 1 Assessment Format: Individual	15%	Start Date: Not Applicable Due Date: Week 4: 30 September - 06 October
Assignment 2 Assessment Format: Individual	15%	Start Date: Not Applicable Due Date: Week 7: 21 October - 27 October
Assignment 3 Assessment Format: Individual	15%	Start Date: Not Applicable Due Date: Week 10: 11 November - 17 November
Exam Assessment Format: Individual	55%	

Assessment Details

Assignment 1

Assessment Overview

This assignment requires students to solve problems in knowledge representation, formal logic and reasoning, and commonsense reasoning.

Assignments will be marked by tutors, who will also provide feedback on the work.

Course Learning Outcomes

- CLO1 : Identify when a given situation can be formulated with a Knowledge Representation and Reasoning (KRR) approach
- CLO4 : Solve new combinatorial problems using declarative programming

Detailed Assessment Description

This assignment will test concepts around game theory that provide the foundation for reasoning about multi-agent systems.

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

Simple Editing Assistance

In completing this assessment, you are permitted to use standard editing and referencing

functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other media, whether based on your own work or not.
If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
For more information on Generative AI and permitted use please see here.

Assignment 2

Assessment Overview

This assignment involves solving decision making problems.

Assignments will be marked by tutors, who will also provide feedback on the work.

Course Learning Outcomes

- CLO2 : Implement a problem model in a KRR language and use existing KRR tools to identify a solution

Detailed Assessment Description

This assignment will be on testing concepts related to matching and cooperative games applies to multi-agent systems and reasoning.

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

Planning/Design Assistance

You are permitted to use generative AI tools, software or services to generate initial ideas, structures, or outlines. However, you must develop or edit those ideas to such a significant extent that what is submitted is your own work, i.e., what is generated by the tool, software or service should not be a part of your final submission. You should keep copies of your iterations to show your Course Authority if there is any uncertainty about the originality of your work.
If your Convenor has concerns that your answer contains passages of AI-generated text or media that have not been sufficiently modified you may be asked to explain your work, but we recognise that you are permitted to use AI generated text and media as a starting point and some traces may remain. If you are unable to satisfactorily demonstrate your understanding of your

submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
For more information on Generative AI and permitted use please see here.

Assignment 3

Assessment Overview

This assignment involves solving problems in non-monotonic reasoning and reasoning about actions.

Assignments will be marked by tutors, who will also provide feedback on the work.

Course Learning Outcomes

- CLO3 : Break down a task into its domain vocabulary and its combinatorial dimension

Detailed Assessment Description

This assignment will test concepts related to fair decision making and allocation in multi-agent systems.

Assignment submission Turnitin type

Not Applicable

Generative AI Permission Level

Planning/Design Assistance

You are permitted to use generative AI tools, software or services to generate initial ideas, structures, or outlines. However, you must develop or edit those ideas to such a significant extent that what is submitted is your own work, i.e., what is generated by the tool, software or service should not be a part of your final submission. You should keep copies of your iterations to show your Course Authority if there is any uncertainty about the originality of your work.
If your Convenor has concerns that your answer contains passages of AI-generated text or media that have not been sufficiently modified you may be asked to explain your work, but we recognise that you are permitted to use AI generated text and media as a starting point and some traces may remain. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
For more information on Generative AI and permitted use please see here.

Exam

Assessment Overview

The final exam consists of 2 exercises covering the theoretical material of the course and 1 exercise covering the programming aspect of the course. The exercises will be of similar nature to those solved in the assignments. The final exam will take place online with modalities to be confirmed (presumably around 3 hours to complete the exam).

Course Learning Outcomes

- CLO1 : Identify when a given situation can be formulated with a Knowledge Representation and Reasoning (KRR) approach
- CLO2 : Implement a problem model in a KRR language and use existing KRR tools to identify a solution
- CLO3 : Break down a task into its domain vocabulary and its combinatorial dimension
- CLO4 : Solve new combinatorial problems using declarative programming

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 9 September - 15 September	Lecture	Noncooperative Games
Week 2 : 16 September - 22 September	Lecture	Noncooperative Games II
Week 3 : 23 September - 29 September	Lecture	Cooperative Games
Week 4 : 30 September - 6 October	Lecture	Matching
Week 5 : 7 October - 13 October	Lecture	Matching II
Week 6 : 14 October - 20 October	Activity	FLEXIBILITY WEEK
Week 7 : 21 October - 27 October	Lecture	Fair Allocation
Week 8 : 28 October - 3 November	Lecture	Fair Allocation II
Week 9 : 4 November - 10 November	Lecture	Social Choice
Week 10 : 11 November - 17 November	Lecture	Social Choice II

Attendance Requirements

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

General Schedule Information

WEEK 1: Noncooperative Games

Decision making under risk: utilities, preference relations, characterization of vNM utility functions

Normal form games: agents, actions, mixed strategies, dominant actions, Pareto-dominance, iterated removal of dominated actions.

Maxmin solution (security level)

WEEK 2: Noncooperative Games

Best responses, Nash equilibria, indifference principle, refinements of Nash equilibria, Zerosum games, value of games

Extensive form games, Sub-game perfect Nash equilibria, Alpha-beta pruning, Zermelo's Theorem

Outlook: AlphaZero, Pluribus

WEEK 3: Cooperative Games

Valuation Functions

Solution Concepts (Core, Shapley Value, Banzhaf Value etc.)

Game Representations

Computing Solutions

WEEK 4: Matching

Overview of different matching models

Stable Matching Algorithm and Properties

Manipulating Stable Matchings

Many-to-one Stable Matchings: algorithm and connection to one-one

WEEK 5: Matching

Exchange Problems

Top Trading Cycle

Multi-item exchange and other genaralisations

Rationing Problems

WEEK 6: Flexibility Week

WEEK 7: Fair Allocation

Fairness Concepts

Welfare Concepts

Algorithms for Fair Allocation

Computational Aspects

WEEK 8: Fair Allocation

Fair Allocation with Randomization

Fair Allocation with Money

Case of Chores / Bads

Advances Fairness Concepts

Complex Valuations and Entitlements

Allocation of Divisible Items

WEEK 9: Social Choice

Voting Rules

Axiomatic Properties

Tournament Solutions

Impossibility Results and Characterizations

Domain Restrictions

WEEK 10: Social Choice

Randomized Social Choice: Model, Gibbard's Random Dictatorship Characterization, Maximal lottery characterization, and no show Paradox

Multi-winner voting: Thiele Rules, sequential Thiele Rules, Method of Equal Shares, fairness notions, strategyproofness, committee monotonicity

Outlook: Participatory Budgeting.

Course Resources

Recommended Resources

The following are useful resources that cover important parts of the course:

Essentials of Game Theory A Concise, Multidisciplinary Introduction (https://www.gtessentials.org)

Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations (https://www.masfoundations.org)

Handbook of Computational Social Choice (https://www.cambridge.org/core/books/handbook-of-computational-social-choice/8AF63E87F76A5FC974D5E73536C52BD6)

Economics and Computation: An Introduction to Algorithmic Game Theory, Computational Social Choice, and Fair Division (https://link.springer.com/book/10.1007/978-3-031-60099-9)

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
	Patrick Lederer					No	No
	Shivika Narang					No	No
	Haris Aziz					Yes	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.