Course Outline

Contents

Course Details

Course Code	COMP4418
Course Title	Knowledge Representation and Reasoning
Convenor	<u>Abdallah</u> Saffidine
Admin	<u>Alexander</u> Lam
Classes	**Classes are scheduled as follows:** **4-6pm Tuesday Online** **4-6pm Thursday Online** **We will be adopting a mix of pre-recording videos and live interactive sessions.** **At the moment we are planning to provide pre-recorded lectures for each week and use the 4-5pm lecture slot for each lecture as a live interactive problem solving session. Students will be left the 5-6pm lecture slot to work on problem sets and and assignments.** **Keep an eye on the course noticeboard for details.**
Consultations	Please request a time by email.
Units of Credit	6

Course Website	http://cse.unsw.edu.au/~cs4418/ (http://cse.unsw.edu.au/~cs4418/21T3/)
Handbook Entry	http://www.handbook.unsw.edu.au/undergraduate/courses/current/COMP4418.html (http://www.handbook.unsw.edu.au/undergraduate/courses/current/COMP4418.html)
Student Reps	stureps@cse.unsw.edu.au Email the stureps if you have any issues with the course. They will pass these anonymously to the relevant people to get the issues resolved.

Course Summary

Knowledge Representation and Reasoning (KRR) is at the core of Artificial Intelligence. It is concerned with the representation of knowledge in symbolic form and the use of this knowledge for reasoning. This course presents current trends and research issues in Knowledge Representation and Reasoning (KRR). It enables students interested in Artificial Intelligence to deepen their knowledge in this important area and gives them a solid background for doing their own work/research in this area. The topics covered include: Commonsense reasoning, Propositional and First-order Logic, Answer set programming, Planning, Reasoning about action, Constraint programming.

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.

Assumed Knowledge

Students are expected to have some background in symbolic logic and general AI, which might come from COMP3411 or COMP9414: Artificial Intelligence or COMP9814: Extended Artificial Intelligence. The handbook entry (undergraduate) (https://www.handbook.unsw.edu.au/undergraduate/courses/2020/COMP4418/?year=2020) and handbook entry (postgraduate) (https://www.handbook.unsw.edu.au/postgraduate/courses/2020/COMP4418/?year=2020) require these as pre-requisites for this course. Students with a background in symbolic logic and/or artificial intelligence obtained by other means should contact Student Support Services to request a waiver for the pre-requisite.

Student Learning Outcomes

COMP4418 is focussed on current trends and issues in Knowledge Representation and Reasoning. The intent of this course is to connect students to the topics through lecturers who know their subjects intimately, through continuing active use and research. To this end, there are three lecturers, each with great expertise in the topics they present. The course is structured to keep related topics close together, and to develop some themes. Assessment is based around assignments, which supports "learning by doing" and a final written exam that will examine the material taught across the course.

As a result of this course, students will:

- develop an understanding of theoretical and practical issues in symbolic knowledge representation and reasoning, in general;
- develop an understanding of the capabilities of specific knowledge representation formalisms for specific tasks;
- learn techniques specific to specific knowledge representation problems and formalisms; and,
- have practical experience in using special-purpose languages for (some of) commonsense reasoning, ontologies, planning, reasoning about actions, and constraint programming.

Course Learning Outcomes

Code	Description
CLO1	Understand theoretical and practical issues in symbolic knowledge representation and reasoning, in general.
CLO2	Understand the capabilities of specific knowledge representation formalisms for specific tasks.
CLO3	Make effective use of techniques specific to specific knowledge representation problems and formalisms.
CLO4	Make effective use of special-purpose languages for (some of) commonsense reasoning, ontologies, planning, reasoning about actions, constraint programming.

Graduate Capability

Graduate Capability	Acquired
Scholars capable of independent and collaborative enquiry, rigorous in their analysis, critique and reflection, and able to innovate by applying their knowledge and skills to the solution of novel as well as routine problems	Through assignments and interactions in class (interactive on-line lectures).
Entrepreneurial leaders capable of initiating and embracing innovation and change, as well as engaging and enabling others to contribute to change	Through interactions in class (interactive on-line lectures) and the class Forum.
Professionals capable of ethical, self- directed practice and independent lifelong learning	Through interactions in class (interactive on-line lectures) and the class Forum. Also by following up on recommended reading and resources provided (see below). Also through self study.
Global citizens who are culturally adept and capable of respecting diversity and acting in a socially just and responsible way	Through interactions in class (interactive on-line lectures) and the class Forum.

Teaching Strategies

- Lectures: introduce concepts, provide examples to enhance learning.
- Interactive Lectures: interactively solve problems with student participation in order to further enhance learning.
- Assignments: allow students to solve significant problems and formatively build their understanding of important concepts explained in lectures and developed in interactive lectures.
- Final Exam: summatively assess student learning of important concepts formatively developed in the course.

Teaching Rationale

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.

The course will be taught through pre-recorded lectures, interactive problem solving lectures (during lecture time), problem sets for self study, formative assessment tasks through three (3) assignments and a summative assessment task through a final exam.

Student Conduct

The **Student Code of Conduct** (Information (https://student.unsw.edu.au/conduct) , Policy (https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf)) sets out what the University expects from students as members of the UNSW community. As well as the learning, teaching and research environment, the University aims to provide an environment that enables students to achieve their full potential and to provide an experience consistent with the University's values and guiding principles. A condition of enrolment is that students *inform themselves* of the University's rules and policies affecting them, and conduct themselves accordingly.

In particular, students have the responsibility to observe standards of equity and respect in dealing with every member of the University community. This applies to all activities on UNSW premises and all external activities related to study and research. This includes behaviour in person as well as behaviour on social media, for example Facebook groups set up for the purpose of discussing UNSW courses or course work. Behaviour that is considered in breach of the Student Code Policy as discriminatory, sexually inappropriate, bullying, harassing, invading another's privacy or causing any person to fear for their personal safety is serious misconduct and can lead to severe penalties, including suspension or exclusion from UNSW.

If you have any concerns, you may raise them with your lecturer, or approach the School Ethics Officer (mailto:ethics-officer@cse.unsw.edu.au) , Grievance Officer (mailto:grievance-officer@cse.unsw.edu.au) , or one of the student representatives.

Plagiarism is defined as (https://student.unsw.edu.au/plagiarism) using the words or ideas of others and presenting them as your own. UNSW and CSE treat plagiarism as academic misconduct, which means that it carries penalties as severe as being excluded from further study at UNSW. There are several on-line sources to help you understand what plagiarism is and how it is dealt with at UNSW:

- Plagiarism and Academic Integrity (https://student.unsw.edu.au/plagiarism)
- UNSW Plagiarism Procedure (https://www.gs.unsw.edu.au/policy/documents/plagiarismprocedure.pdf)

Make sure that you read and understand these. Ignorance is not accepted as an excuse for plagiarism. In particular, you are also responsible that your assignment files are not accessible by anyone but you by setting the correct permissions in your CSE directory and code repository, if using. Note also that plagiarism includes paying or asking another person to do a piece of work for you and then submitting it as your own work.

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and 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.

If you haven't done so yet, please take the time to read the full text of

- UNSW's policy regarding academic honesty and plagiarism (https://student.unsw.edu.au/plagiarism)

The pages below describe the policies and procedures in more detail:

- Student Code Policy (https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf)
- Student Misconduct Procedure (https://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf)
- Plagiarism Policy Statement (https://www.gs.unsw.edu.au/policy/documents/plagiarismpolicy.pdf)
- Plagiarism Procedure (https://www.gs.unsw.edu.au/policy/documents/plagiarismprocedure.pdf)

You should also read the following page which describes your rights and responsibilities in the CSE context:

- Essential Advice for CSE Students (https://www.engineering.unsw.edu.au/computer-science-engineering/about-us/organisational-structure/student-services/policies/essential-advice-for-cse-students)

Assessment

Item	Topics	Due	Marks	Contributes to
Assignment 1	Introduction to KRR, formal logic and reasoning, commonsense reasoning	Week 5	15%	
Assignment 2	Decision making	Week 8	15%	
Assignment 3	Non-monotonic reasoning, reasoning about actions	Week 11	15%	
Final Exam	All topics	Exam Period	55%	

Course Schedule

Week	Lectures	Assignments	Lecturer	Notes
1	Introduction to KRR, Modelling, Propositional Logic	-	Maurice Pagnucco	14 September 16 September
2	Formal Logic and Reasoning, First-order Logic	-	Maurice Pagnucco	21 September 23 September
3	Implementing Formal Reasoning, Commonsense Reasoning	-	Maurice Pagnucco	28 September 30 September
4	Multi-agent Resource Allocation	-	Haris Aziz	5 October 7 October
5	Social Choice	Assignment 1 Due	Haris Aziz	12 October 14 October
6	Break	-	-	18 October
7	Cooperative Game Theory	-	Haris Aziz	26 October 28 October

8	Introduction to Answer Set Programming	Assignment 2 Due	Abdallah Saffidine	2 November 4 November
9	Solving problems with Answer Set Programming	-	Abdallah Saffidine	9 November 11 November
10	Reasoning about Actions	-	Abdallah Saffidine	16 November 18 November
11	-	Assignment 3 Due	-	22 November

Resources for Students

This course does not have a prescribed textbook. Notes and/or slides on each topic will be made available on the class web page. References to the literature may be provided in lectures as relevant to the topic at hand. The following resources may be useful in gaining a more general understanding of knowledge representation and reasoning for and beyond this course.

1. General Knowledge Representation and Reasoning
    - Ronald J. Brachman and Hector J. Levesque. Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
2. Planning
    - Malik Ghallab, Dana Nau, Paolo Traverso, Automated Planning — theory and practice, Morgan Kaufmann, 2004. Chapters 1 to 6, especially.
3. Answer Set Programming
    - Bruce Porter, Vladimir Lifschitz, Frank Van Harmelen, Handbook of Knowledge Representation, Elsevier, 2007.
    - Potassco User Guide (http://sourceforge.net/projects/potassco/files/potassco_guide/2010-10-04/guide.pdf/download)
4. Agent Programming
    - Raymond Reiter, Knowledge in Action, MIT Press, 2001.
    - Michael Thielscher, Action Programming Languages, Morgan & Claypool, 2008.
5. Constraints
    - Constraint Logic Programming using ECLiPSe. Krzysztof Apt and Mark Wallace. Cambridge University Press, 2007.
    - Programming with Constraints: An Introduction. Kim Marriott and Peter J. Stuckey. MIT Press, 1998.
    - Francesca Rossi, Peter van Beek, and Toby Walsh (Eds), Handbook of Constraint Programming. Elsevier, 2006. ISBN 0-444-52726-5, 978 pages.
    - Rina Dechter. Constraint Processing. Morgan Kaufmann, 2003.
6. Nonmonotonic Reasoning
    - Michael R. Genesereth and Nils J. Nilsson. Logical Foundations of Artificial Intelligence, Morgan Kaufmann, 1987.T

7. Reasoning about Knowledge
    - Hector J. Levesque, Gerhard Lakemeyer. The Logic of Knowledge Bases, 2002.
8. Belief Change
    - Sven Ove Hansson, Textbook of Belief Dynamics: Theory Change and Database Updating, Kluwer Academic, 1999.
    - Salem Benferhat, Souhila Kaci, Daniel Le Berre, Mary-Anne Williams. Weakening conflicting information for iterated revision and knowledge integration. Artificial Intelligence 153(1-2): 339-371, 2004.
    - Adnan Darwiche, Judea Pearl. On the Logic of Iterated Belief Revision. Artificial Intelligence 89(1-2): 1-29, 1997.
    - Hirofumi Katsuno, Alberto O. Mendelzon. Propositional Knowledge Base Revision and Minimal Change. Artificial Intelligence 52(3): 263-294, 1992.
9. Description Logics
    - Franz Baader, Diego Calvanese, Deborah McGuinness, Daniele Nardi, Peter Patel-Schneider, The Description Logic Handbook: Theory, Implementation and Applications, Cambridge University Press, 2003.
10. Game Theory/Social Choice
    - Y. Shoham and K. Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations. Cambridge, U.K.: Cambridge Univ. Press, 2008.
    - J. Rothe. Economics and Computation. Springer, 2016.
    - G. Chalkiadakis and E. Elkind and M. Wooldridge, Computational Aspects of Cooperative Game Theory, Morgan & Claypool, 2010.

Course Evaluation and Development

This course is evaluated each session using the myExperience system.

Student feedback will be obtained by electronic survey at the end of the course through myExperience (https://myexperience.unsw.edu.au/) . Students are also encouraged to provide informal feedback during the session, and to let the Lecturer-in-Charge know of any problems as soon as they arise.

Student feedback from the last offering indicated that students were satisfied with the course, but suggested to include more guidance to the programming languages in the lectures. We will endeavour to achieve that in this offering.

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