IMPERIAL

Module Specification

Basic details

UID		Cohorts covered	Earliest cohort: Latest c:
Long title	Machine Reasoning		
New code	ELEC70068	New short title	

Brief description of module *(approx. 600 chars.)*

The overall aim of the course is to provide a foundational introduction to two essential elements of machine reasoning studied in Artifical Intelligence: planning and inference. Therefore the course focuses on algorithms for solving two types of question usually considered the domain of human intelligence and requiring some form of symbolic (rather than numerical or sub-symbolic) representation or reasoning: firstly, planning: suppose I am at (or in situation) X, and I want to get to Y: how do I do that And secondly, inference: suppose I know (or believe) that X is true, and I want to know if Y is true (or not), how do I do that?

In answering these questions, the more specific aims of the course are to: (1) learn declarative specification and programming in Prolog; (2) introduce efficient formulation of a problem space, a declarative notation for describing it, and algorithms for searching it; (3) introduce aspects of knowledge representation using propositional, predicate and modal logics, and algorithms for automated reasoning with those logics; and (4) introduce the concept of temporal reasoning using the Event Calculus.

1142 characters

Available as a standalone module/ short course? No

Statutory details

	ECTS	CATS	Non-credit	
Credit value	5	10	N	HECOS codes
FHEQ level	7			

Allocation of study hours

	Hours	
Lectures	20	
Group teaching	0	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	4	
Other scheduled	4	*Incl. project supervision, fieldwork, external visits.*
Independent study	97	*Incl. wider reading/ practice, follow-up work, completion of assessments*
Placement	0	*Incl. work-based learning and study that occurs overseas.*
Total hours	125	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? N

Module delivery

Delivery mode	Taught/ Campus	Other	
Delivery term	Term 1	Other	

Ownership

Primary department	Department of Electrical and Electronic Engineering
Additional teaching departments	0
Delivery campus	South Kensington

Collaborative delivery

Collaborative delivery?	N
External institution	N/A
External department	N/A
External campus	N/A

Associated staff

Role	CID	Given name	Surname
Module leader		Jeremy	Pitt

Learning and teaching

Module description

Learning outcomes	Upon successful completion of this module, in addition to getting a deeper understanding of the field of Artificial Intelligence, you will be able to: 1. use and evaluate different algorithms for searching a graph as a basis for planning and problem-solving 2. use and evaluate formal languages for knowledge representation and algorithms for automated reasoning in propositional, predicate and modal logics 3. understand and apply the cocenpt of declarative specification using Prolog (logic programming language) 4. implement algorithms for planning and inference in Prolog.

Module content	Search: search space, problem formulation, general graph search algorithm, graph theory; uninformed search strategies - depth first, breadth first, uniform cost, iterative deepening; informed search strategies - best first, A*, iterative deepening A*; analysis of algorithms - completeness, complexity, optimality; 2-player games: minimax, minimax to fixed ply, alpha-beta search; reinforcement learning and potential fields for path planning. Knowledge representation and reasoning: knowledge acquisition, knowledge engineering; propositional logic, predicate loigc, modal logic; semantic proof, syntactic proof, soundness and completeness of proof systems; resolution, unification; automated reasoning with calculus KE in propositional, predicate and modal logic; Event Calculus and reasoning about actions and events.
Learning and Teaching Approach	Through lectures you will be introduced to the general study of AI, based around logic problem solving by symbolic computation, search and coordination and reasoning. The basics of declarative programming in Prolog will be learned through four laboratories. There are also four tutorials to discuss the main concepts of AI analysed in this course: decalrative programming, planning, knowledge representation and reasonimg.
Assessment Strategy	The module is assessed by three components: (1) a 3-hour, closed book, written examination; (2) demonstration of a working Prolog program solving a planning and an inference problem; and (3) a written 2-3K word essay on the threats and opportunities of Artificial Intelligence (including Machine Reasoning and Machine Learning) for various applications (agriculture, infrastructure, transportation, etc.), from an ethical, legal, social, economic or environmental perspective, which might be suitable for submission to e.g. IEEE Technology & Society Magazine, There are an additional two laboratories in which students learn Prolog, implement a planning engine, and implement a reasoning engine. These will receive formative assessment only.
Feedback	You will be provided with continuous feedback on Tutorials, written feedback on exam example answer sheets and written feedback on formative coursework.
Reading list	Russel, S. & Norvig, P.: Artificial Intelligence: a modern approach, Prentice-Hall, 3rd ed, 2010

Quality assurance

Date of first approval	March 2022
Date of last revision	June 2023
Date of this approval	
Module leader	Prof Jeremy Pitt

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Notes/ comments	

Template version #####

Assessment details

Grading method	Numerical	Pass mark	50%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
Examination	3 hour closed book written examination	70%	50%	N
Practical	non-assessed laboratories and tutorials	0%	0%	N
Coursework	written essay	20%	50%	N
Coursework	Software demonstration	10%	50%	N
		100%		