Module Specification

AI for Search and Optimisation

Version: 2024-25, v2.0, 20 May 2024

Contents

Part 1: Information

Module title: AI for Search and Optimisation

Module code: UFCEL1-15-M

Level: Level 7

For implementation from: 2024-25

UWE credit rating: 15

ECTS credit rating: 7.5

College: College of Arts, Technology and Environment

School: CATE School of Computing and Creative Technologies

Partner institutions: None

Field: Computer Science and Creative Technologies

Module type: Module

Pre-requisites: None

Excluded combinations: None

Co-requisites: None

Continuing professional development: No

Professional, statutory or regulatory body requirements: None

Part 2: Description

Overview: This module will give you an understanding of the concept of problem solving as a search through a space of possible solutions, and a range of contemporary Artificial Intelligence search methods.

Through hands-on experience you will acquire competency in formulating and characterising problems, selecting and implementing appropriate search algorithms, and evaluating the outcomes.

Features: Not applicable

Educational aims: This module aims to give the students underpinning knowledge and skills in: formulating tasks to be solved as search problems; characterising aspects of the context and nature of the problems that inform design decisions; selecting and implementing appropriate search algorithms; and evaluating, then refining, the systems they develop. It also aims to promote a consideration of the ethical and legal issues that arise from the use of AI-based systems for optimisation.

Outline syllabus: The first two weeks will be devoted to establishing core competency in data handling, coding, and the use of key python libraries such as numpy and sci-py. Thereafter the module is broadly divided into three topics. Interwoven within each is treatment of ethical and legal issues that can arise, and the need for system development to take account of the context in which they will be deployed.

1: Introduction to problem solving as search through a space of candidate solutions.

- problem formulation

- specifying constraints and quality metrics

- search landscapes

- characteristics of algorithms (completeness, optimality, efficiency)

2: Single member search algorithms:

- depth- and breadth-first for decision problems

- A*, best-first, hill-climbing (local search) for optimisation problems

- computational complexity and the limits of single member search

- meta-heuristic variants: Simulated Annealing, Tabu Search, Iterated Local search

3: Evolutionary Algorithms:

- Darwinian Evolution as a metaphor for population-based search

- Common framework (select-recombine-mutate-replace) for evolutionary algorirthms

- Evolutionary Algorithms for different. representations e.g. binary variables (Genetic Algorithms), continuous variables (Evolution Strategies) and trees (Genetic Programming)

Part 3: Teaching and learning methods

Teaching and learning methods: Lectures will introduce the core concepts and algorithmic essences of each topic listed in the syllabus. Each topic will be explained and illustrated with intuitive examples, expanded with developing the practical solutions to the real-world problems. Where appropriate, industry speakers will be invited to illuminate the concepts from their perspective.

Practical classes will provide supervised activities to cover different problem domains, with an emphasis on developing students' hands-on experience in solving real-world problems using a range of contemporary tools and algorithms. Example tasks will be chosen the emphasise the 'messy' nature of real-world problems - such as noisy, and/or time-varying evaluations of solution quality. They might include: solving constraint satisfaction problems, path-finding (for example, used by a non-player character in a game), and the evolution of tree-based models for classification or regression.

Scheduled teaching and learning study hours include lectures , practical classes/tutorials/project supervision/software demonstration. Independent learning study hours include engaged with essential and exploratory reading, practical study, assignment preparation and completion etc.

To build confidence, weekly lab-sessions, and end-of-topic 'reflection' sessions will provide the opportunity for informal feedback and discussions. In addition, weekly formative self-assessments tests on Blackboard will let you check your understanding of materials and receive detailed feedback in your own time.

Module Learning outcomes: On successful completion of this module students will achieve the following learning outcomes.

MO1 Apply AI concepts and processes to formulate appropriate representations and algorithms to solve a range of tasks taking into account the context in which they are being solved.

MO2 Select, apply, evaluate, and then refine (as needed) an appropriate AI-based search algorithms to solve one or more problems, taking account of ethical, legal and practical issues.

Hours to be allocated: 150

Contact hours:

Independent study/self-guided study = 126 hours

Face-to-face learning = 24 hours

Total = 0

Reading list: The reading list for this module can be accessed at readinglists.uwe.ac.uk via the following link https://rl.talis.com/3/uwe/lists/AECC8CDC-0B5E-4DDB-7723-7631D7A1A5AD.html

Part 4: Assessment

Assessment strategy: The assessment is designed to consolidate the student's familiarity with domain-specific vocabulary, well-known problems, well-understood approaches and algorithm evaluation techniques.

The assessment consists of submitting one or more pieces of source code that attempt to solve a given search/optimisation problem and an accompanying

academic report.

The resit attempt will be assessed in the same way as the first attempt except students will be expected to select a different option(s) from the one(s) selected in the first sit.

Assessment tasks:

Practical Skills Assessment (First Sit)
Description: Individual coursework which involves submitting one or more pieces of source code solving a specified problem using both a single-member search algorithm and an evolutionary algorithm to compare and evaluate performance
Weighting: 100 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO2

Practical Skills Assessment (Resit)
Description: Individual coursework which involves submitting one or more pieces of source code solving a specified problem using both a single-member search algorithm and an evolutionary algorithm to compare and evaluate performance
Weighting: 100 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO2

Part 5: Contributes towards

This module contributes towards the following programmes of study:

Artificial Intelligence [Frenchay] MSc 2024-25