Module Specification

AI for Search and Optimisation

Version: 2022-23, v1.0, 28 Mar 2022

Contents

Part 1: Information

Module title: AI for Search and Optimisation

Module code: UFCEL1-15-M

Level: Level 7

For implementation from: 2022-23

UWE credit rating: 15

ECTS credit rating: 7.5

Faculty: Faculty of Environment & Technology

Department: FET Dept of Computer Sci & Creative Tech

Partner institutions: None

Delivery locations: Frenchay Campus

Field: Computer Science and Creative Technologies

Module type: Standard

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 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

Astar, 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.

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

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

MO2 Evaluate ethical and technical challenges presented by the application of modern Artificial Intelligence techniques.

MO3 Select, apply, and then evaluate and refine (as needed) appropriate AI-based search algorithms to solve one or more problems.

Hours to be allocated: 150

Contact hours:

Independent study/self-guided study = 126 hours

Face-to-face learning = 24 hours

Total = 150

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/D42A8B54-3F23-CB87-A329-699C348E03CA.html

Part 4: Assessment

Assessment strategy: The learning outcomes will be formally assessed through a mixture of short in-class tests (A, 25%), and one coursework element (B, 75%) composed of a set of deliverables.

The module is divided into three topics (search algorithms and landscapes, single-member search, population based metaheuristics).

Associated with each topic will be:

a coursework deliverable building on work done in the weekly practical sessions.

a short in-class test (typically of 40 minutes duration), to confirm knowledge and understanding of techniques applied in the coursework.

Both the coursework deliverables and the in-class tests will taken the form of on-line submissions to an automated marking system (e.g. DEWIS or Blackboard tests) to allow feedback to be easily and automatically provided.

Typically each coursework deliverable will involve submitting:

one or more pieces of source code solving a specified problem relevant to the topic (such as the examples above).

a series of multiple choice/multiple answer questions about the practical, legal and ethical issues surrounding the techniques implemented, and their possible use as part within a larger system.

To assist student literacy with accessing and responding to feedback, students will be allowed a small number of submission attempts for the earlier code deliverables, to give them the opportunity to improve their work in the response to the formative feedback provided. The number of allowed submission attempts per deliverable will reduce as the module progresses.

The resit attempt will be assessed in the same way as the first attempt, except that

component A will be a single 2-hour pc-lab based exam under controlled conditions.

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.

Assessment components:

In-class test - Component A (First Sit)
Description: In-class test: typically 3 of 40 minutes duration each .
Weighting: 25 %
Final assessment: No
Group work: No
Learning outcomes tested: MO1, MO2, MO3

Online Assignment - Component B (First Sit)
Description: Individual Coursework, typically composed of three deliverables, submitted to an online system (typically DEWIS) for automatic marking and provision of feedback.

Deliverables might typically include:
Submission 1 – source code and answers to a set of questions concerning problem characterisation search landscapes
Submission 2 –source code and answers to a set of questions concerning single member search algorithms.
Submission 3 –source code and answers to a set of questions concerning population-based search algorithms.
Weighting: 75 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO2, MO3

Examination - Component A (Resit)

Description: PC lab exam under controlled conditions
Weighting: 25 %
Final assessment: No
Group work: No
Learning outcomes tested: MO1, MO2, MO3

Online Assignment - Component B (Resit)
Description: Individual Coursework, typically composed of three deliverables, submitted to an online system (typically DEWIS) for automatic marking and provision of feedback.

Deliverables might typically include:
Submission 1 – source code and answers to a set of questions concerning problem characterisation search landscapes
Submission 2 –source code and answers to a set of questions concerning single member search algorithms.
Submission 3 –source code and answers to a set of questions concerning population-based search algorithms.
Weighting: 75 %
Final assessment: Yes
Group work: No
Learning outcomes tested: MO1, MO2, MO3

Part 5: Contributes towards

This module contributes towards the following programmes of study:

Artificial Intelligence [Frenchay] MSc 2022-23