Oriel College
UNIVERSITY OF OXFORD

Summer Institute

Artificial Intelligence: Foundations and Algorithms

Syllabus

Summer Institute at Oriel College, Oxford

Summer Term 2024

A. Course Description

The course will provide an introduction to the field of Artificial Intelligence (AI), in particular, it will focus on the following five modules: (1) Problem Solving by Search, (2) Constraint Satisfaction Problems, (3) Algorithms for Playing Games, (4) Knowledge Representation and Reasoning, and (5) Machine Learning.

Within the first module we will present informed and uninformed techniques for solving such fundamental AI problems as navigating a road map. We will discuss depth-first, breadth-first, and iterative deepening search, as well as heuristic techniques such as the famous A* algorithm. The second module will introduce Constraint Satisfaction Problem (CSP) as a formal framework for representing and solving AI problems. We will show how to exploit CSP to solve such problems as colouring a map, so that no two adjacent territories have the same colour. In the third module we will present algorithms for playing games such as tic-tac-toe. We will focus on the well-known MINIMAX algorithm and discuss its properties. The fourth module is about logical formalisms used to represent and reasoning about agent's knowledge. We will show how basic logics, such as propositional and first-order logics, can be used for this task. Finally, in the fifth module we

will provide an introduction to the area of machine learning (ML) and describe linear regression as a basic ML model.

B. What will the student gain

The students will gain an undergraduate-level understanding of classical AI techniques and algorithms. They will be able to understand when such techniques are applicable and appreciate the challenges involved.

C. Reading Materials

- **Artificial Intelligence: A Modern Approach (4th Edition), by Stuart Russell and Peter Norvig.**

D. Syllabus

Day 1
(2 x 90min)
Introduction to Artificial Intelligence and uninformed search strategies (breath-first search, depth-first search, etc.).

Day 2
(2 x 90min)
Informed search strategies (including the A* algorithm).

Day 3
(2 x 90min)
Constraint satisfaction problems (backtracking search, tree-shaped CSPs, tree decomposition methods).

Day 4
(2 x 90min)
Games in AI (including the MINIMAX algorithm).

Day 5
(2 x 90min)
Assessment of the first part; students will give presentations in groups on previously chosen topics.

Day 6
(2 x 90min)
Introduction to the area of Knowledge Representation and Reasoning.

Day 7
(2 x 90min)
Application of basic logical formalisms for KRR (propositional logic, first order logic).

Day 8
(2 x 90min)
Introduction to Machine Learning and mathematical basis for ML.

Day 9
(2 x 90min)
Basic machine learning models (linear regression).

Day 10 Assessment (2 x 90min)
Assessment of the second part; students will give presentations in groups on previously chosen topics.

E. Lecturer

Dr Przemysław Wałęga is a Senior Researcher in Department of Computer Science at the University of Oxford. He works in the field of AI, focusing mainly on the area of Knowledge Representation and Reasoning. In particular, he provided a significant contribution in the area of temporal reasoning, by establishing theoretical results and developing practical reasoning algorithms for declarative temporal query languages. For more information see www.walega.pl.