AI: REASONING & PROBLEM SOLVING

Grado en Computación e Inteligencia Artificial / Bachelor in Computer Science and Artificial Intelligence BCSAI SEP-2025 AIRPS-CSAI.3.M.A

Area Computer Science

Number of sessions: 30

Academic year: 25-26

Degree course: THIRD

Number of credits: 6.0

Semester: 1º

Category: COMPULSORY

Language: English

Professor: **EUGENIO MARCHIORI -**

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EUGENIO MARCHIORI

Eugenio Marchiori, PhD, is currently a startup advisor and angel investor, focused on mostly on AI startups (e.g. www.portialabs.ai).

Before they were Principal Software Engineer (Director) at Google, acting as technical leader of a group of 60 engineers. With a passion for building respectful and helpful products, they run some of Android's efforts in the privacy and machine learning space. In his 12 years at Google, he has also worked on display ads, interviewed over a hundred people and mentored dozens of other Googlers.

Before his time at Google, Eugenio studied Computer Science at the Complutense University in Madrid where he graduated first in their class. He also got his PhD on "Contributions to the authoring of educational video games and simulations following a multidisciplinary approach", applying visual programming and other approaches to bring educators closer to educational games.

Eugenio is originally from Argentina, but has lived in Madrid and London for the past 20 years. In his very limited free time, Eugenio enjoys board-games, computer games and reading.

Office Hours

Office hours will be on request. Please contact at:

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SUBJECT DESCRIPTION

This is an introductory course to Artificial Intelligence expected to establishing the foundations of problem representation, search algorithms, and reasoning agents. The course will cover, at a high level:

- Introduction and intelligent agents
- Problem solving and search
- Complex environments
- Constraint Satisfaction Problems
- Adversarial Search and Games
- Knowledge and reasoning

During the course, students will be expected to apply the knowledge by writing Python code in individual and group settings, developing solutions to different problems in practice. The problems covered will include search problems (e.g. getting through a maze on different conditions) to adversarial games with full or partial information (e.g. checkers or poker).

After this course, students will have the theoretical knowledge to:

- Understand how a broad range of different AI problems are represented
- Reason about application of different search and reasoning strategies to real world problems
- Represent and apply intelligent agents in adversarial games and decision making

Moreover, the students will have practical experience in Python with:

- Writing and visualising search algorithms
- Solving real world constraint satisfaction problems
- Developing agents to participate in adversarial games

LEARNING OBJECTIVES

- Adquire a global perspective of Artificial Intelligence, its history and uses
- Understand agents, their representations and applications
- Apply search algorithms to problem solving, including identification and evaluation of such algorithms
- Learn about constraint satisfaction problems and apply solution strategies in practice
- Acquire basic concepts for game theory work in groups to develop agents to play games
- Understand decision making in uncertainty and the basic of probabilistic programming

TEACHING METHODOLOGY

IE University teaching method is defined by its collaborative, active, and applied nature. Students actively participate in the whole process to build their knowledge and sharpen their skills. Professor's main role is to lead and guide students to achieve the learning objectives of the course. This is done by engaging in a diverse range of teaching techniques and different types of learning activities such as the following:

Learning Activity	**Weighting**	**Estimated time a student should dedicate to prepare for and participate in**
Lectures	24.0 %	36.0 hours

Exercises in class, Asynchronous sessions, Field Work	6.0 %	9.0 hours
Group work	20.0 %	30.0 hours
Individual studying	50.0 %	75.0 hours
TOTAL	100.0 %	150.0 hours

AI POLICY

As a course on AI we acknowledge the immense value of GenAI to the industry and to society, as well as how it can improve course work. However, as Computer Scientists, it is important to understand how these systems work on your own and thus you are recommend not to use GenAI for coursework and especially for coding tasks. However, it will not be prohibited.

Generative artificial intelligence (GenAI) tools may be used in this course for any relevant task with appropriate acknowledgement. GenAI may not be used for the final exam. If a student is found to have used AI-generated content inappropriately, it will be considered academic misconduct, and the student might fail the respective assignment or the course.

If you are in doubt as to whether you are using GenAI tools appropriately in this course, I encourage you to discuss your situation with me.

Below, a suggested format to acknowledge the use of generative AI tools. Please note that acknowledging AI will not impact your grade.

I acknowledge the use of [AI systems link] to [specify how you used generative AI]. The prompts used include [list of prompts]. The output of these prompts was used to [explain how you used the outputs in your work]

If AI was permitted to use in your assignment, but you have chosen not to include any AI generated content, the following disclosure is recommended:

No content generated by AI technologies has been used in this assignment.

PROGRAM

SESSION 1 (LIVE IN-PERSON)

Lecture/Discussion, Introduction: Fundations

- Introduction
- Discussion of expectations and course contents
- Philosophical and technical foundations of AI

SESSION 2 (LIVE IN-PERSON)

Lecture/Discussion, Introduction: History and State of the Art

- Inception of AI
- Ups and downs of the industry
- Current state of the art applications of AI

SESSION 3 (LIVE IN-PERSON)

Lecture/Discussion, Agents, rationality and environments

- Understanding agents
- Rationality and agents

- Properties of environments
- Structure of agents

SESSION 4 (LIVE IN-PERSON)

Lecture/Discussion, Agentes, rationality and environments. Part 2

- Types of agents
- Inner working of agents
- Formulation of agent problemsStandard and real world problems

SESSION 5 (LIVE IN-PERSON)

Lecture/Discussion, Introduction to search algorithms

- Understanding search algorithms
- Basic search algorithms

SESSION 6 (LIVE IN-PERSON)

Lecture/Discussion, Uniformed search algorithms

- Dijkstra and Depth-first search
- Iterative deepening search

SESSION 7 (LIVE IN-PERSON)

Lecture/Discussion, Heuristic search algorithms

- Informed search strategies
- Heuristic functions

SESSION 8 (LIVE IN-PERSON)

Implementation and comparison of search strategies in Python (Assignment 1)

Demonstrate understanding and implementation of the different search strategies by proposing visualisations of the decision making process, costs and applications.

SESSION 9 (LIVE IN-PERSON)

Lecture/Discussion, Local search, optimization problems and search in continuous spaces

- Hill-climbing search
- Simulated annealing
- Evolutionary algorithms
- Local search in continuous spaces

SESSION 10 (LIVE IN-PERSON)

Lecture/Discussion, Search with non-deterministic actions

- Non-deterministic actions
- AND-OR search trees, try, try again

- Searching with no observation and partial observation

SESSION 11 (LIVE IN-PERSON)

Lecture/Discussion, Online Search Agents

- Online search problems and agents

SESSION 12 (LIVE IN-PERSON)

Lecture/Discussion, Game Theory and Heuristics

- Game Theory
- Optimal Decisions in Games
- Heuristic Alpha-Beta Tree Search

SESSION 13 (LIVE IN-PERSON)

Lecture/Discussion, Monte Carlo Tree Search and Stochastic Games

- Monte Carlos Tree Search
- Stochastic Games and evaluation functions

SESSION 14 (LIVE IN-PERSON)

Debrief on assignment 1.

- Discuss implementations and questions
- Recap search algorithms

SESSION 15 (LIVE IN-PERSON)

Lecture/Discussion, Partially observable games + Introduction of group assigment

- Partially observable games
- Limitations of Game Search Algorithms
- Development of an agent to participate in adversarial games, in Python.

SESSION 16 (LIVE IN-PERSON)

Lecture/Discussion, Defining CSPs

- Definitions and examples
- Inference in CSPs

SESSION 17 (LIVE IN-PERSON)

Lecture/Discussion, Backtracking and Local Search

- Variable and value ordering
- Intelligence backtracking
- Local search for CSPs
- Structure of problems

SESSION 18 (LIVE IN-PERSON)

Individual Assignment, CSPs in practice.
Application of CSP to a real world problem. Coding in Python.

SESSION 19 (LIVE IN-PERSON)

Lecture/Discussion, Knowledge, reasoning and planning

- Logical Agents

SESSION 20 (LIVE IN-PERSON)

Lecture/Discussion, Knowledge, reasoning and planning (part 2)

- First-Order Logic

SESSION 21 (LIVE IN-PERSON)

Lecture/Discussion, Knowledge, reasoning and planning (part 2)

- First Order logic (Part 2)

SESSION 22 (LIVE IN-PERSON)

Group Assignment, Application of AI to games (2/2)
Development of an agent to participate in adversarial games, in Python.

SESSION 23 (LIVE IN-PERSON)

Lecture/Discussion, Uncertain knowledge and reasoning

- Knowledge representation
- Automatic planning
- Probabilistic reasoning

SESSION 24 (LIVE IN-PERSON)

Debrief and study of individual Assignment, CSPs in practice.
Application of CSP to a real world problem. Coding in Python.

SESSION 25 (LIVE IN-PERSON)

Lecture/Discussion, Probabilistic programing

- Multiagent decision making
- Probabilistic Programming

SESSIONS 26 - 27 (LIVE IN-PERSON)

Final group speaker presentations, Application of AI to games
Students will need to demonstrate the agents working on simulated situations.

SESSION 28 (LIVE IN-PERSON)

Final group speaker presentations, Application of AI to games

Students will need to demonstrate the agents working on simulated situations.

SESSION 29 (LIVE IN-PERSON)

Interactive session, Group assignment conclusion

SESSION 30 (LIVE IN-PERSON)

Final exam.

EVALUATION CRITERIA

Students will be evaluated in a continuous manner. All individual and group assignments will have optional extra tasks, and in some cases the work will be presented to the rest of the class.

Each student has four chances to pass any given course distributed over two consecutive academic years: ordinary call exams and extraordinary call exams (re-sits) in June/July.

Students who do not comply with the 80% attendance rule during the semester will fail both calls for this Academic Year (ordinary and extraordinary) and have to re-take the course (i.e., re-enroll) in the next Academic Year.

criteria	**percentage**	**Learning Objectives**	**Comments**
Final Exam	30 %		Demonstration of understanding of whole syllabus and application of concepts on limited situations.
Individual assignments	20 %		
Group assignments	20 %		
Participation or presentations	20 %		
Quizzes	10 %		

RE-SIT / RE-TAKE POLICY

Students failing the course in the ordinary call (during the semester) will have to re-sit the exam in June / July (except those not complying with the attendance rule, who will not have that opportunity and must directly re-enroll in the course on the next Academic Year).

The extraordinary call exams in June / July (re-sits) require your physical presence at the campus you are enrolled in (Segovia or Madrid). There is no possibility to change the date, location or format of any exam, under any circumstances. Dates and location of the June / July re-sit exams will be posted in advance. Please take this into consideration when planning your summer.

The June / July re-sit exam will consist of a comprehensive exam. Your final grade for the course will depend on the performance in this exam only; continuous evaluation over the semester will not be taken into consideration. Students will have to achieve the minimum passing grade of 5 and can obtain a maximum grade of 8.0 (out of 10.0) – i.e., “notable” in the in the re-sit exam.

Retakers: Students who failed the subject on a previous Academic Year and are now re-enrolled as re-takers in a course will be needed to check the syllabus of the assigned professor, as well as contact the professor individually, regarding the specific evaluation criteria for them as retakers in the course during that semester (ordinary call of that Academic Year). The maximum grade that may be obtained in the retake exam (3rd call) is 10.0.

After ordinary and extraordinary call exams are graded by the professor, you will have a possibility to attend a review session for that exam and course grade. Please be available to attend the session in order to clarify any concerns you might have regarding your exam. Your professor will inform you about the time and place of the review session. Any grade appeals require that the student attended the review session prior to appealing.

Students failing more than 18 ECTS credits after the June-July re-sits will be asked to leave the Program. Please, make sure to prepare yourself well for the exams in order to pass your failed subjects.

In case you decide to skip the opportunity to re-sit for an exam during the June / July extraordinary call, you will need to enroll in that course again for the next Academic Year as a re-taker and pay the corresponding extra cost. As you know, students have a total of four allowed calls to pass a given subject or course, in order to remain in the program

BIBLIOGRAPHY

Recommended

- Stuart Russel, Peter Norvig. (2022). *Artificial Intelligence: A Modern Approach.* Pearson. ISBN 9781292401133 (Digital)

- Kelly Clancy. (2024). *Playing with Reality: How Games Shape Our World.* ISBN 978024154550 (Digital)

BEHAVIOR RULES

Please, check the University's Code of Conduct here. The Program Director may provide further indications.

ATTENDANCE POLICY

Please, check the University's Attendance Policy here. The Program Director may provide further indications.

ETHICAL POLICY

Please, check the University's Ethics Code here. The Program Director may provide further indications.