



Artificial Intelligence

1. Características generales

Docente Dr. Markus Eger (markus.eger@ecci.ucr.ac.cr)

Nombre Artificial Intelligence

Sigla PF-3335

Créditos 4

Horas 4

Requisitos ninguno

Correquisitos ninguno

Clasificación Curso propio

Ciclo Electiva

Horario Viernes 17:00–21:00 hrs, aula 6-6

Consulta Viernes 14:00-14:55 hrs (oficina 3-23)

2. Descripción

Symbolic/classical AI deals with developing algorithms to solve problems in unknown situations. This course presents an introduction into several such algorithms, with a focus on planning. Planning is a branch of Artificial Intelligence which deals with the problem of automatically finding action sequences to reach a given goal. In this course, we will discuss the challenges encountered when trying to solve this problem, and cover a variety of different planning algorithms and heuristics. We will also discuss applications of planning, like logistics, or video game playing. Additionally, we will discuss how AI agents can recognize plans executed by other agents in order to deduce their intentions. Since planning is a highly active field of research, the course will incorporate recent advances, including planning under uncertainty, temporal planning and multi-agent planning.





3. Objetivos

Objetivo general

In this class, the students will become familiar with AI algorithms and data structures related to classical planning. We will also cover recent advances in the area, such as planning under uncertainty and planning using agent beliefs.

Objetivos específicos

1. Learn about search procedures and logic that form the basis for many applications of classical AI.
2. Learn about the classical planning problem, its formulation and complexity, as well as classical algorithms to solve the problem.
3. Learn about planning heuristics, and how they can often be used to speed up classical planning practice.
4. Learn about recent advances in planning that go beyond the classical planning problem.
5. Learn about applications of classical planning.

4. Contenidos

You can find the course contents in Cuadro 1.

Cuadro 1: Ejes temáticos del curso y objetivos a los que contribuyen.

Objetivos	Eje temático	Desglose
1	Logic	Propositional and Predicate Logic, Worlds, Models
1	Pathfinding	Pathfinding on trees and graphs. Breadth-First Search, Depth-First Search, Heuristic Search. A*
2	Classical Planning	The Classical Planning Problem, the Planning Domain Definition Language (PDDL), planning as pathfinding
2, 3	Planners	Plan-Graphs, State-Space Planning, Plan-Space Planning, Planning Heuristics
4	Advanced Planning	Hierarchical Planning, Planning Under Uncertainty, Epistemic Logic and Planning
5	Planning Applications	Plan Recognition, Logistics, game AI





5. Metodología

This course consists of three major parts: The lectures given by the instructor, homework to be solved by the students each week, and a project in which the students will implement a planner. During the lectures, active participation is encouraged, and they will include activities to facilitate that. Most lectures will conclude with homework given to the students which has to be solved before the lecture of the following week. If homework was given, the following class period will consist of a lecture, and presentations of the homework problems from the past week.

Students are expected to solve as many of the homework problems that they feel comfortable presenting. Before students present their homework, they have to show the instructor which problems they have solved, and for each homework problem the instructor will then randomly choose a student that solved it to present their solution. 20 % of the student's grade is determined by how many homework problems they solved, while another 20 % is determined by how well they present their solution. The instructor reserves the right to deduct points for solved problems if the presentation indicates that the student does not understand the solution they are presenting.

The other 60 % of the grade are given for completing the project, which consists of four tasks, each worth 15 %. The four tasks are:

- Implement data structures to represent logical formulas, and the necessary code to perform queries on them.
- Implement the A* path finding algorithm.
- Implement a parser for PDDL files, and use the code developed in the first two tasks to complete the planner.
- Implement a better planning heuristic to improve the planner's performance.

Each of these tasks will be explained in detail in class, and on the course website. Additionally, at the end of the course, all student planners will enter a friendly competition between themselves. Competition placement is not graded, but we will discuss the results in the last class. If students wish to make experimental optimizations to their planner that they do not want graded, but considered for the competition, they can submit them separately.

All submitted work is required to be written in English, including code comments and variable names. Late submissions are generally not accepted and will lead to point deductions, except in accordance with article 24 of the Reglamento de Régimen Académico Estudiantil de la UCR. **Plagiarism will not be tolerated for any reason.** The instructor reserves the right to refer cases of plagiarism to the corresponding instances at UCR as specified in the Reglamento de Orden y Disciplina Estudiantil de la UCR.

6. Evaluación

The class evaluation consists of the following parts:





Project	60 %
• Logic Representation	15 %
• A* Algorithm	15 %
• PDDL Parser and Planner	15 %
• Planning Heuristic	15 %
Homework	40 %
• Submission	20 %
• Presentations	20 %

7. Cronograma

The class schedule can be found in Cuadro 2.

Cuadro 2: Cronograma del curso.

Sem.	Fecha	Tema
1	16 ago.	Discussion of the syllabus, Introduction to Logic
2	23 ago.	Logic and Pathfinding
3	30 ago.	No class. Instructor at conference
4	6 set.	The Planning Problem
5	13 set.	PDDL
6	20 set.	Planning as Pathfinding, Heuristics
7	27 set.	Graphplan
8	4 oct.	Plan-Space Planning
9	11 oct.	No class. Instructor at conference
10	18 oct.	Hierarchical Planning
11	25 oct.	Planning under Uncertainty
12	1 nov.	Multi-agent Planning
13	8 nov.	Epistemic Logic
14	15 nov.	Epistemic Planning





Cuadro 2: Cronograma del curso (continuación).

Sem.	Feach	Tema
15	22 nov.	Plan Recognition
16	29 nov.	Applications, Competition Results

Bibliografía

- Baltag, A. (2002). A logic for suspicious players: Epistemic actions and belief-updates in games. *Bulletin of Economic Research*, 54(1), 1–45.
- Blum, A. L., y Furst, M. L. (1997). Fast planning through planning graph analysis. *Artificial intelligence*, 90(1-2), 281–300.
- Bonet, B., y Geffner, H. (2001). Planning as heuristic search. *Artificial Intelligence*, 129(1-2), 5–33.
- Eger, M., y Martens, C. (2018). Keeping the story straight: A comparison of commitment strategies for a social deduction game. En *Fourteenth artificial intelligence and interactive digital entertainment conference*.
- Helmert, M. (2006). The fast downward planning system. *Journal of Artificial Intelligence Research*, 26, 191–246.
- Hoffmann, J. (2001). Ff: The fast-forward planning system. *AI magazine*, 22(3), 57–57.
- Ramírez, M., y Geffner, H. (2009). Plan recognition as planning. En *Twenty-first international joint conference on artificial intelligence*.
- Russell, S. J., y Norvig, P. (2016). *Artificial intelligence: a modern approach*. Malaysia; Pearson Education Limited,.
- Weld, D. S. (1994). An introduction to least commitment planning. *AI magazine*, 15(4), 27–27.
- Young, R. M., Pollack, M. E., y Moore, J. D. (1994). Decomposition and causality in partial-order planning. En *Aips* (pp. 188–194).

