Universidad de Alcalá

TEACHING GUIDE

Automated Planning

Degree in
Computer Science Engineering

Universidad de Alcalá

Academic Year 2025/2026

3rd Year - 2nd Semester

Approved by the EPS School Board on June 16th, 2025

TEACHING GUIDE

Course Name:	**Automated Planning**
Code:	**781003**
Degree in:	**Computer Science Engineering**
Department and area:	**Ciencias de la Computación** **Computer Architecture and Technology**
Type:	**Compulsory**
ECTS Credits:	**6.0**
Year and semester:	**3rd Year, 2nd Semester**
Teachers:	Adrián Domínguez Díaz
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	English

1. COURSE SUMMARY

This course offers a vision of the different models of knowledge representation and techniques that are used in the area of Artificial Intelligence called Automatic Planning.

Automatic Planning systems are used to determine the set of steps or actions that an agent must follow from an initial state to solve a specific problem, reaching a "goal" state. General algorithms and techniques are used for this, which are applicable in a wide variety of problems and do not require specific knowledge of the application domain.

This subject will mainly address classical planning and refinement planning. Classical planning is based on descriptive models in which certain ideal conditions are assumed (static environment, fully observable, etc.). In this context, heuristic planning techniques with domain independent heuristics will be studied; as well as hierarchical planning techniques, which allow incorporating expert knowledge on the problem domain.

Later, refinement planning will be studied, which addresses the integration of planning and action in real environments, where the ideal conditions of classical planning are not met. Refinement planning implies the use of an operating model of the agent, in charge of the execution of the plan, and of different techniques that allow converting the steps of the plan into concrete actions to be executed, as well as responding to unexpected situations, errors or inconsistencies between the plan and its execution.

The subject will also have a practical part that covers the following topics: the study of usual application domains of automatic planning, the modeling of planning problems using different representations, the implementation of simulations and visualizations of these problems and the development of intelligent agents capable of solving those problems trough automated planning algorithms.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following basic, generic and cross curricular skills:

en_CG8 - Knowledge of the basic subjects and technologies, which enable them to learn and develop new methods and technologies, as well as those that provide them with great versatility to adapt to new situations.

en_CG9 - Ability to solve problems with initiative, decision making, autonomy and creativity. Ability to know how to communicate and transmit the knowledge, skills and abilities of the profession of Computer Engineering Engineer.

en_CB1 - That students have demonstrated to possess and understand knowledge in an area of study that is based on general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

en_CB2 - That the students know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

en_CB3 - That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.

en_CB4 - That students can transmit information, ideas, problems and solutions to both a

specialized and non-specialized public.

en_CB5 - That the students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

en_TRU1 - Capacity of analysis and synthesis.

en_TRU2 - Oral and written competencies.

en_TRU3 - Ability to manage information.

en_TRU4 - Autonomous learning skills.

en_TRU5 - Team work.

Specific Skills

This course contributes to acquire the following specific skills:

en_CC4 - Ability to know the fundamentals, paradigms and techniques of intelligent systems and analyze, design and build systems, services and computer applications that use these techniques in any field of application.

en_CC5 - Ability to acquire, obtain, formalize and represent human knowledge in a computable way to solve problems through a computer system in any field of application, particularly those related to aspects of computing, perception and performance in intelligent environments or environments.

en_CC7 - Ability to know and develop computational learning techniques and design and implement applications and systems that use them, including those dedicated to automatic extraction of information and knowledge from large volumes of data.

Learning Outcomes

After succeeding in this subject the students will be able to:

RA1. Define the concept of AI Planning.

RA2. Explain how classic search techniques differ in planning systems.

RA3. Explain the differences between planning as search, operator-based planning and propositional planning, providing examples of domains where they are applicable.

RA4. Define and provide examples of each of the following techniques: Case- based, learning and probabilistic planning.

RA5. Compare and contrast static planning with those that need dynamic execution.

RA6. Explain the impact of dynamic planning in Robotics.

3. CONTENTS

Contents Blocks	Total number of hours
PART 1: Planning with deterministic models. Introduction to automatic planning; Representation of planning problems; Planning as search; Domain independent heuristics and heuristics planning; Search backwards; Search in the plans space; Hierarchical planning, Incorporation of planning in the actor.	28 hours
PART 2: Planning with refinement methods and other planning techniques. Actor operational model; Refinement methods; Performance through refinement; Planning through refinement; Integration of planning and action; Introduction time planning; Introduction to non-deterministic baking; Introduction to probabilistic planning; Introduction to planning and learning.	12 hours
PART 3: Development of intelligent agents through automatic planning. Application domains of automated planning: robotics, video games, etc.; Visualization and simulation of planning problems; Use of automated planning systems for the development of intelligent agents in static and dynamic environments.	20 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	58 hours (56 hours on-site +2 exams hours)
Number of hours of student work:	92
Total hours	150

4.2. Methodological strategies, teaching materials and resources

Lectures & Assessments	• **Theoretical lectures**: these lectures will be given in large groups, where the lecturer will develop the most relevant concepts to the course. • **Case studies resolution**: these will be given in small groups. In these sessions, the lecturer will pose diverse problems that can be solved using the techniques explored during the theoretical lectures. They will then be solved with the guidance of the lecturer. • **Reports and assignment presentations**: students will present reports and assignments, done individually or in small groups, in class. These presentations will use proper multimedia resources. • **Partial assessments**: throughout the course, the lecturer will pose several partial assessments to test the knowledge and practical application of students.
Autonomous work	• **Readings** • **Activities**: exercises, conceptual maps, exemplifications, information searches, etc • **Forum and activities participation**: usually through the e-learning platform used in the course.
Mentoring	• Mentoring will be done in groups as well as individually. The lecturer can assess the acquisition of skills and review the reports given by students.
Materials and resources	• The materials for the preparation of the face-to-face sessions, as well as the activities that the student must carry out individually, can be found on the Blackboard platform of the University of Alcalá. The functioning of this teaching tool will be detailed in the presentation class, as well as the dates of deliverables and partial exams, and the mechanism of communication with the students. • For each activity, the teacher will provide a series of bibliographical references that can be consulted in the library of the Superior Polytechnic School. For those activities that require it, the teacher will indicate the way to plan that activity, as well as the deliverables that should result from the realization of it.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Continuous Assessment:
Consists of completing, defending, and passing the laboratory assignments, as well as passing a midterm exam and a final exam.

Assessment through Final Exam:
Consists of completing, defending, and passing the laboratory assignments, as well as passing a final exam. The assignments must be submitted during the week prior to the final exam. The defense of the assignments will take place on a date to be agreed upon within the same week as the final exam.

Extraordinary Call

Consists of completing, defending, and passing the laboratory assignments, as well as passing a final exam. The assignments must be submitted during the week prior to the final exam. The defense of the assignments will take place on a date to be agreed upon within the same week as the final exam.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined:

CE1. The student is able to argue and contrast the general aspects of the planning systems.

CE2. The student is able to formally represent knowledge in planning systems.

CE3. The student is able to explain and apply different techniques and algorithms used in planning systems.

CE4. The student is able to develop software in which automatic planning problems are modeled, simulated and solved.

According to the RD 1125/2003 regulating the Diploma, the marks must adopt the scale of notes with a decimal number and a qualitative rating:

- 9,0 - 10 MATRÍCULA DE HONOR. Not exceeding 5%
- 9,0 - 10 SOBRESALIENTE
- 7,0 - 8,9 NOTABLE
- 5,0 - 6,9 APROBADO
- 0,0 - 4,9 SUSPENSO

Students who did not attend any of the assessment tests indicated below in the "Grading Criteria" table will be marked as NO PRESENTADO (NP).

GRADING TOOLS

This section specifies the assessment instruments that will be applied to each of the assessment criteria.

- Laboratory Practice (PL): This will allow the student to model, implement, and execute automatic planning systems.
- Intermediate Evaluation Tests (PEI): These consist of a demonstration of theoretical and practical knowledge about automatic planning systems.
- Final Evaluation Tests (PEF): These consist of a demonstration of theoretical and practical knowledge about automatic planning systems.

GRADING CRITERIA

In the ordinary continuous assessment call the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CG8, CG9, CC4, CC5	RA1, RA2, RA3	CE2, CE3, CE4	PL1	25%
CG8, CG9, CC4, CC5, CC7	RA1, RA2, RA3, RA4, RA6	CE2, CE3, CE4	PL2	15%
CG8, CG9, CC4, CC5	RA1, RA2, RA3	CE1, CE2, CE3	PEI	30%
CG8, CG9, CC4, CC5, CC7	RA1, RA2, RA3, RA4, RA5, RA6	CE1, CE2, CE3	PEF	30%

In the ordinary final evaluation call, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CG8, CG9, CC4, CC5	RA1, RA2, RA3	CE2, CE3, CE4	PL1	25%
CG8, CG9, CC4, CC5, CC7	RA1, RA2, RA3, RA4, RA5, RA6	CE2, CE3, CE4	PL2	15%
CG8, CG9, CC4, CC5, CC7	RA1, RA2, RA3, RA4, RA5, RA6	CE1, CE2, CE3	PEF	60%

Extraordinary call

In the case of the extraordinary call, the same percentages that have been established in the case of the ordinary final evaluation call will be maintained.

The teaching-learning methodology and the assessment process will be adapted as needed, in accordance with the guidelines of the Diversity Support Unit, to implement curricular adaptations for students with specific needs.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Malik Ghallab, Dana Nau and Paolo Traverso (2016). Automated Planning and Acting. Cambridge University Press, online ISBN: 9781139583923.
- Stuart Russell y Peter Norvig (2009). Artificial Intelligence: A Modern Approach. (Third Edition). Ed. Pearsons.
- McDermott, Drew; Ghallab, Malik; Howe, Adele; Knoblock, Craig; Ram, Ashwin; Veloso, Manuela; Weld, Daniel; Wilkins, David (1998). PDDL---The Planning Domain Definition Language. Technical Report CVC TR98003/DCS TR1165. New Haven, CT: Yale Center for Computational Vision and Control. CiteSeerX 10.1.1.51.9941

6.2. Additional Bibliography

- Malik Ghallab, Dana Nau & PaoloTraverso (2004). Automated Planning: Theory and Practice. The Morgan Kaufmann Series in Artificial Intelligence.
- James Allen y James Hendler (1990). Readings in Planning. Ed. Morgan Kaufmann Series in Representation and Reasoning.
- Fikes and Nilsson (1971). STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving, Artificial intelligence, 2 (3-4): 189-208.
- A. Blum and M. Furst (1997). Fast Planning Through Planning Graph Analysis. Artificial Intelligence, 90:281-300 (1997).
- Jörg Hoffmann (2001). FF: The Fast-Forward Planning System. AI Magazine, 22 (3):57-62.

Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.