Course guide
2707240 - MEL - Memory and Experience Based Learning

Last modified: 30/01/2026

Unit in charge: Barcelona School of Informatics
Teaching unit: 723 - CS - Department of Computer Science.

Degree: MASTER'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2017). (Optional subject).

Academic year: 2025 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer:

Others: Segon quadrimestre:
JAVIER VAZQUEZ SALCEDA - 10

PRIOR SKILLS

The requirements are the ones provided by the mandatory courses of the Master, especially those provided by Introduction to Machine Learning (IML).

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.

Generical:
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Basic:
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.

TEACHING METHODOLOGY

The teaching methodology will include both theoretical lecture sessions, sessions with practical examples of the concepts and algorithms explained in the course, and also some sessions devoted to support the practical work of the students.

The teamgroup work will consist on the design, implementation, application and validation of a Case-Based Reasoning project to solve a realistic problem. The project will be developed in parallel to the topics presented in the course following the structure:
- new topics/techniques are introduced in the classroom
- if these topics/techniques are suitable to be used in the Practical Work, then students are asked to attemp their application as autonomous work.
- the work done is discussed and validated by the lecturer next weeks in the classroom.

LEARNING OBJECTIVES OF THE SUBJECT

1.Being able to decide when a problem is suitable to be solved through an experiential learning scheme (a CBR paradigm)
2.To be able to design a CBR case structure (problem description, solution) for a given realistic problem
3.To be able to design and implement a Case Library (selecting the proper indexing mechanisms, library structure and similarity functions) for a given realistic problem
4.To be able to design and implement an appropriate adaptation function (adapting solutions from previous cases to a new one) for a given realistic problem
5.To be able to design and implement a CBR Maintenance mechanism (defining a case relevance metric, selecting a maintenance strategy, implementing a library maintenance module) for a given realistic problem.
6.To be able to validate a CBR prototype (create a set of case examples, validate all CBR components) and analise the results.
7.Get some basic knowledge on Cognitive AI theories and methods for Memory-based learning (Exemplar Learning, Instance-based Learning, Experiential Learning, Case-Based Learning) and their foundations on Cognitive Sciences.

STUDY LOAD

Type	Hours	Percentage
Self study	105,0	77.78
Hours large group	30,0	22.22

Total learning time: 135 h

CONTENTS

Human memory theories and their relevance to AI

Description:
Basic overview of the role of memory in learning principles and classification of Machine Learning techniques

Memory and learning in cognitive AI

Description:
Early AI and symbolic systems are examined, focusing on the physical symbol system hypothesis and early views on learning and memory as symbol manipulation and retrieval.

Conceptual analysis of classic AI programs to identify implicit cognitive assumptions about memory

Exemplar and instance theories of learning

Description:
Models based on examples and instance theories from cognitive psychology are presented as alternatives to rule-based abstraction, emphasizing similarity-based generalization and episodic traces.
How example theories challenge classical symbolic perspectives on learning is analyzed.

Cognitive foundations of instance-based learning

Description:
Cognitive Foundations of Instance-Based Learning

Instance-Based Learning (IBL) is presented as a computational analogue of example-based cognition, framing learning as memory accumulation rather than model induction.

Reasoning with explicit instances and similarity judgments in small decision problems.

Algorithmic structure of instance-based learning

Description:
Algorithmic structure of learning based on instances

Formal IBL algorithms, more accurate research methods, similarity metrics, incremental learning and employment policies.

Overview of techniques and limitations in Exemplar Learning and IBL

Description:
Scalability, noise sensitivity, feature relevance, and the need for knowledge-based memory control.

Experiential Learning

Description:
Experience and episodes. Experiential learning.

CBR System Components

Description:
Description and analysis of the basic components, architecture and processes of CBR systems

CBR Academic Demonstrators/Examples

Description:
Review of the most significant CBR systems and comparison of features

CBR Application on a real domain

Description:
A real application will be described and analysed.

Problems in the development of CBR systems

Description:
a. Competence
b. Space Performance
c. Time Performance

Reflective Reasoning in CBR

Description:
Case base maintenance techniques as a form of reasoning and learning

Hybrid Systems

Description:
Description and analysis of CBR neurosymbolic systems

CBR Systems' Evaluation

Description:
The various techniques for evaluating the performance and quality of CBR systems will be studied and applied.

Advanced Research Issues in CBR

Description:
a. Temporal CBR
b. Spatial CBR
c. Hybrid CBR Systems
d. Recommender Systems: CBR as a recommendation tool
e. Agents and CBR
f. Distributed CBR

ACTIVITIES

Memory and Learning in humans and Cognitive AI

Specific objectives:
1, 7

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 4h
Theory classes: 2h
Self study: 2h

Exemplar and instance theories of learning. Cognitive foundations.

Specific objectives:
7

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 8h
Theory classes: 2h
Laboratory classes: 1h
Self study: 5h

Exemplar Learning and Instance Based Learning: Cognitive foundations, algorythms and techniques.

Specific objectives:
7

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 11h
Theory classes: 4h
Laboratory classes: 1h
Self study: 6h

Experience and episodes. Experiential Learning.

Specific objectives:
7

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 6h
Theory classes: 2h
Laboratory classes: 1h
Self study: 3h

Fundamentals of Case-based Reasoning & Academic Demonstrators

Specific objectives:
1, 2

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 9h
Theory classes: 2h
Laboratory classes: 1h
Self study: 6h

CBR System Components. CBR reasoning cycle.

Specific objectives:
2, 3, 4

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 13h
Theory classes: 2h
Laboratory classes: 2h
Self study: 9h

CBR Application on a real domain

Specific objectives:
2, 3, 4, 5

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 3h
Theory classes: 1h
Laboratory classes: 1h
Self study: 1h

CBR Development Problems

Specific objectives:
2, 3, 5

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 10h 30m
Theory classes: 1h 30m
Laboratory classes: 1h
Self study: 8h

Reflective Reasoning in CBR. CBR System Maintenance

Specific objectives:
5

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 11h 30m
Theory classes: 1h
Laboratory classes: 3h
Self study: 7h 30m

CBR Applications and Development Tools & CBR Systems' Evaluation

Specific objectives:
6

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.

Full-or-part-time: 9h
Theory classes: 1h
Laboratory classes: 1h
Self study: 7h

Advanced CBR systems Research Issues

Specific objectives:
2, 3, 4, 5

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.

Full-or-part-time: 5h
Theory classes: 1h
Self study: 4h

Practical work (PW) public presentation & discussion

Specific objectives:
2, 3, 4, 5, 6

Related competencies :
CG1. Capability to plan, design and implement products, processes, services and facilities in all areas of Artificial Intelligence.
CEA12. Capability to understand the advanced techniques of Knowledge Engineering, Machine Learning and Decision Support Systems, and to know how to design, implement and apply these techniques in the development of intelligent applications, services or systems.
CEA3. Capability to understand the basic operation principles of Machine Learning main techniques, and to know how to use on the environment of an intelligent system or service.
CEP5. Capability to design new tools and new techniques of Artificial Intelligence in professional practice.
CEP2. Capability to solve the decision making problems from different organizations, integrating intelligent tools.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT7. ANALISIS Y SINTESIS: Capability to analyze and solve complex technical problems.
CB8. Capability to communicate their conclusions, and the knowledge and rationale underpinning these, to both skilled and unskilled public in a clear and unambiguous way.

Full-or-part-time: 22h 30m
Guided activities: 1h 30m
Self study: 21h

GRADING SYSTEM

Evaluation of the knowledge and skills obtained by the students will be assessed through one practical project work (PW) which will be done on a team group basis.

The teamgroup work will consist on the design, implementation, application and validation of a Case-Based Reasoning project to solve a realistic problem. The project will be developed in parallel to the topics presented in the course following the structure:
- new topics/techniques are introduced in the classroom
- if these topics/techniques are suitable to be used in the Practical Work, then students are asked to attemp their application as autonomous work.
- the work done is discussed and validated by the lecturer next weeks in the classroom.

The final grade will be computed as follows:

FinalGrade= PWGr * WFstud, where 0 <= WFstud <= 1.2

WFstud is a Working Factor evaluating the work of a particular student within his/her teamwork in PW. It will be obtained by observing and assessing the load of work and degree of participation of each student throughout the development of the PW. In normal conditions, the WFstud = 1.

The PWGr will be computed as follows:

PWGr = 0.5 * TeachA + 0.5 * SelfA

where TeachA is the teacher assessment of the teamwork evaluated according to:

- The methodology of the work (0.5)
- The quality of the report written (0.2)
- The quality of the oral exposition (both presentation and content assessed, as well as the ability to answer questions) (0.2)
- Planning, coordination and management of the team (0.1)

and SelfA is the individual assessment of each student by all the members of his/her team.

BIBLIOGRAPHY

Complementary:
- Sànchez-Marrè, M. Intelligent Decision Support Systems [electronic resource]. 1st ed. 2022. Springer International Publishing : Imprint: Springer, 2022. ISBN 978-3-030-87789-7.