Course guide
270433 - MGL - Large Language Models

Last modified: 04/02/2026

Unit in charge: Barcelona School of Informatics
Teaching unit: 270 - FIB - Barcelona School of Informatics.

Degree: BACHELOR'S DEGREE IN ARTIFICIAL INTELLIGENCE (Syllabus 2021). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer:

Others:

PRIOR SKILLS

General knowledge of machine learning and neural networks, as well as natural language processing.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE14. To master the foundations, paradigms and techniques of intelligent systems and to analyze, designing and build computer systems, services and applications that use these techniques in any field of application, including robotics.
CE15. To acquire, formalize and represent human knowledge in a computable form for solving 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.
CE16. To design and evaluate human-machine interfaces that guarantee the accessibility and usability of computer systems, services and applications.
CE18. To acquire and develop computational learning techniques and to design and implement applications and systems that use them, including those dedicated to the automatic extraction of information and knowledge from large volumes of data.
CE20. To select and put to use techniques of statistical modeling and data analysis, assessing the quality of the models, validating and interpreting.
CE27. To design and apply speech processing techniques, speech recognition and human language comprehension, with application in social artificial intelligence.

Generical:
CG2. To use the fundamental knowledge and solid work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG3. To define, evaluate and select hardware and software platforms for the development and execution of computer systems, services and applications in the field of artificial intelligence.
CG8. Perform an ethical exercise of the profession in all its facets, applying ethical criteria in the design of systems, algorithms, experiments, use of data, in accordance with the ethical systems recommended by national and international organizations, with special emphasis on security, robustness , privacy, transparency, traceability, prevention of bias (race, gender, religion, territory, etc.) and respect for human rights.
CG9. To face new challenges with a broad vision of the possibilities of a professional career in the field of Artificial Intelligence. Develop the activity applying quality criteria and continuous improvement, and act rigorously in professional development. Adapt to organizational or technological changes. Work in situations of lack of information and / or with time and / or resource restrictions.

Transversal:
CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.
CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.

TEACHING METHODOLOGY

The course introduces and explores in depth one of the most critical machine learning models for developing artificial intelligence applications today: Large Language Models (LLMs). Theoretical foundations are introduced through lectures where the instructor presents the core concepts. These lectures will also include dedicated time for discussion with students regarding previously assigned readings. These concepts are put into practice during laboratory sessions, where students learn to apply LLMs and develop solutions for specific problems. Students are required to complete and submit a final group project (2-3 people), as well as a smaller individual assignment of a more qualitative nature focused on the behavior of LLMs.

LEARNING OBJECTIVES OF THE SUBJECT

1.Understanding the building blocks of modern Large Language Models, including: ML models, learning algorithms, data processing, and evaluation.
2.Be aware of the main strengths and weaknesses of LLMs, thus being critical about what one can expect from them and how to get the best of them in any situation.
3.Be aware of the principal challenges, open problems, and research directions around LLMs
4.Acquire criteria to know what kind of models/strategies can be used to address Natural Language Processing problems, being able to adapt and use an LLM for solving them.
5.Develop critical thinking about LLMs, knowing the risks associated to them, and become conscious about the necessity of using them in a fair and safe way.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours small group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Introduction

Description:
In the introduction we will cover the following points: 1/ Why is this course important and necessary? 2/ Very brief history of Natural Language Processing. 3/ Brief history of Large Language Models. 4/ Where we are and where we are going.

Transformers within NLP

Description:
In this part, we will present the Transformers (self-attention) model within the context of Natural Language Processing and how this changed sequence to sequence applications:
1/ Word representation: distributional semantics and word embeddings;
2/ The Transformers architecture (self-attention);
3/ Use case: seq-to-seq approach to Machine Translation.

Auto-regressive Large Language Models

Description:
This is the core part of the course, and it covers the main training steps of LLMs. More concretely, we will address: 1/ Tokenization, 2/ Pre-training, 3/ Emergent skills of LLMs: zero-shot and few-shot learning, 4/ Post training for creating conversational agents (supervised fine tuning and reinforcement learning) , 5/ Prompt engineering

Limitations and Risks of LLMs

Description:
We will discuss briefly the following topics related to the risks associated with LLMs:
1/ Hallucinations, 2/ Bias and Fairness, 3/ LLM safety, 4/ LLM footprint, 5/ Model Collapse, 6/ LLMs and Artificial General Intelligence (AGI)

Advanced topics on LLMs

Description:
In this last part of the course we will discuss some advanced topics on LLMs, including Retrieval-Augmented Generation (RAG) and
Training LLMs for reasoning. Time permitting, we will devote the last session to discuss also other state-of-the-art topics based on the preferences from the students.

ACTIVITIES

Theory Classes

Description:
Hours dedicated to studying the material covered in lectures and completing the recommended readings.

Specific objectives:
1, 2, 3, 4, 5

Related competencies :
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CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.
CT4. Teamwork. Be able to work as a member of an interdisciplinary team, either as a member or conducting management tasks, with the aim of contributing to develop projects with pragmatism and a sense of responsibility, taking commitments taking into account available resources.

Full-or-part-time: 58h
Theory classes: 28h
Self study: 30h

Laboratory Sessions

Description:
Estimated hours dedicated to practicing the material from the laboratory sessions

Specific objectives:
1, 2, 4

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Full-or-part-time: 55h
Laboratory classes: 30h
Self study: 25h

Course group project

Description:
Estimated hours dedicated to carrying out the course group project (including planning, implementation, and documentation)

Specific objectives:
1, 2, 4

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Full-or-part-time: 26h
Theory classes: 1h
Self study: 25h

Individual course assignment

Description:
Horas estimadas dedicadas a realizar la práctica individual de la asignatura

Specific objectives:
2, 5

Related competencies :
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Full-or-part-time: 11h
Theory classes: 1h
Self study: 10h

GRADING SYSTEM

The course is graded as follows:

F = Final exam grade
PG = Group project grade
TI = Individual work grade

Final grade = 40% F + 40% PG + 20% TI

The assessment of teamwork skills is based on the work carried out during the group project.

The assessment of the skills on "Solvent use of information resources" is based on the practical work (both the group project and the individual work)

BIBLIOGRAPHY

Basic:
- Kamath, Uday; Keenan, Kevin; Somers, Garrett; Sorenson, Sarah. Large Language Models: A Deep Dive. Springer Cham, 2024. ISBN 978-3-031-65646-0.
- Daniel Jurafsky and James H. Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. 3rd. Online manuscript released January 6, 2026, 2026.