

COURSE DESCRIPTION – ACADEMIC YEAR 2025/2026

Course title	Large Language Models and Information Retrieval
Course code	73072
Scientific sector	INFO-01/A
Degree	Master in Computing for Data Science (LM-18)
Semester	1
Year	2
Credits	6
Modular	No

Total lecturing hours	40
Total lab hours	20
Attendance	The attendance is not compulsory, but students are highly encouraged to attend
Prerequisites	Programming and algorithm data structures skills, Linear algebra, probability theory, basic machine learning concepts.
Course page	MS Teams

Specific educational objectives	The course belongs to the type "caratterizzanti – discipline informatiche". The objective of this course is to present the scientific underpinnings of the field of Information Retrieval (IR). The student will study fundamental, mathematically sophisticated IR concepts first and then more advanced techniques for information filtering and decision support, including transformer-based solutions and LLMs. This course provides students with a rich and comprehensive catalogue of information search and text processing techniques that can be exploited for the design and implementation of modern IR applications.
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Lecturer	Andrea Rosani
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Scientific sector of lecturer	INFO-01/A
Teaching language	English
Office hours	During the lecture time span, arrange beforehand by email.
Lecturing Assistant	--
Contact LA	--
Office hours LA	--
List of topics	• Web and mobile search • Boolean and vector-space retrieval models • Efficient document indexing, document mining and topic modelling • Traditional and machine learning-based ranking approaches • Foundation models

	• Evaluation of Information Retrieval Systems This course provides a comprehensive introduction to the principles and techniques of Information Retrieval (IR), focusing on both traditional methods and modern advancements. • Web and Mobile Search: Techniques for indexing, ranking, and retrieving information in large-scale web environments and mobile contexts, including challenges like personalization, context-awareness, and interface constraints. • Boolean and Vector-Space Models: Fundamental retrieval models including Boolean logic and vector space approaches, forming the basis for understanding document representation and relevance scoring. • Efficient Indexing, Document Mining, and Topic Modelling: Methods for building scalable indexing structures, mining valuable information from text corpora, and uncovering latent topics using models like LDA. • Ranking Algorithms: Traditional and Machine Learning-Based: Examination of classic ranking methods (e.g., BM25, PageRank) alongside machine learning-based techniques, including learning-to-rank and neural models for improved relevance and user satisfaction. • Foundation Models: Application of large pre-trained language models (e.g., BERT, GPT) in IR tasks such as semantic search, question answering, and conversational retrieval. • Evaluation of IR Systems: Approaches to measuring the effectiveness of retrieval systems using metrics like precision, recall, MAP, and nDCG, as well as methods for conducting user-centered evaluations.
Teaching format	Frontal lectures, exercises, lab.

Learning outcomes	Knowledge and understanding: • D1.4 - Basic knowledge of storing, querying and managing large amounts of data and the associated languages, tools and systems Applying knowledge and understanding: • D2.2 - Ability to address and solve a problem using scientific methods Making judgments • D3.2 - Ability to autonomously select the documentation (in the form of books, web, magazines, etc.) needed to keep up to date in a given sector Communication skills • D4.1 - Ability to use English at an advanced level with particular reference to disciplinary terminology.
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Assessment	Final Project with report + oral exam The project will cover the learning outcome D2.2 and D3.2. It will consist of the design of an IR system in a specific application domain selected by the students. The project domain, the attacked problem, the techniques, and the obtained results must be described in a report (max. 10 pages). The project report will cover the learning outcome D1.4 and can be done in groups of 2-3 people. The oral exam will cover the learning outcome D4.1. It is composed by the discussion of the project and some individual questions on the content of the project itself.
Assessment language	English
Assessment Typology	Monocratic
Evaluation criteria and criteria for awarding marks	Evaluation criteria - Project: 50% of the mark - Report: 30% of the mark - Final oral exam: 20% of the mark. Important note: both project and exam are required to be passed. Criteria for awarding marks Project: ability to implement data workflow to apply IR to real-world problems, correctness and clarity of the solution, experimental results, ability to solve IR problems with the appropriate technique. Report: ability to describe the proposed solution, with a critical approach describing the methodology and the results. Oral exam: ability to present and explain information retrieval concepts, methods and algorithms. ability to select appropriate solutions for IR problems.
Required readings	The suggested book for the introduction to information retrieval topics is: • C. D. Manning, P. Raghavan and H. Schutze. Introduction to Information Retrieval, Cambridge University Press, 2008. (Online: http://informationretrieval.org) Papers about the most recent advancements with regards to algorithms, information access modalities and interfaces will be provided during the course in electronic format. Copy of the slides will be available as well. Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it
Further readings	Gerhard. author Paaß, Foundation Models for Natural Language Processing Pre-trained Language Models Integrating Media , 1st ed.

	2023. Cham: Springer International Publishing, 2023. doi: 10.1007/978-3-031-23190-2.
Software used	Python as programming language