Syllabus

Course Description

Course Title	Large Language Models and Information Retrieval
Course Code	73072
Course Title Additional	
Scientific-Disciplinary Sector	INFO-01/A
Language	English
Degree Course	Master in Computing for Data Science
Other Degree Courses (Loaned)	
Lecturers	Dr. Andrea Rosani, Andrea.Rosani@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/43727
Teaching Assistant	
Semester	First semester
Course Year/s	2
CP	6
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	- 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 - Large Language Models for Information Retrieval - Evaluation of Information Retrieval Systems
Course Topics	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. - Large Language Models for Information Retrieval: 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.
Keywords	Indexing and Ranking Machine Learning for IR LLMs Evaluation Metrics
Recommended Prerequisites	Programming and algorithm data structures skills, Linear algebra, probability theory, basic machine learning concepts.
Propaedeutic Courses	
Teaching Format	Frontal lectures, exercices, lab.

Mandatory Attendance	The attendance is not compulsory, but students are highly encouraged to attend.
Specific Educational Objectives and Learning Outcomes	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. 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.
Specific Educational Objectives and Learning Outcomes (additional info.)	
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.
Evaluation Criteria	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
Supplementary Readings	
Further Information	Software used: Python as programming language
Sustainable Development Goals (SDGs)	Quality education