Syllabus

Course Description

Course Title	Advanced Data Management for Artificial Intelligence: Knowledge Graphs and Vector Databases
Course Code	71084
Course Title Additional	
Scientific-Disciplinary Sector	IINF-05/A
Language	English
Degree Course	PhD Programme in Computer Science
Other Degree Courses (Loaned)	
Lecturers	Prof. Davide Lanti, Davide.Lanti@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/34107
Teaching Assistant	
Semester	Second semester
Course Year/s	1
CP	2
Teaching Hours	20
Lab Hours	0
Individual Study Hours	50
Planned Office Hours	
Contents Summary	This course aims to equip Ph.D. students with: ¿ A solid understanding of modern data management paradigms, focusing on Knowledge Graphs and Vector Databases. ¿ The ability to model, query, and reason over semantic data using RDF, OWL, and SPARQL. ¿ Practical skills in designing and querying Virtual Knowledge Graphs with tools like Protégé and Ontop.

	¿ Knowledge of vector-based similarity search, indexing techniques, and the use of systems like Milvus. ¿ The competence to critically assess and apply these technologies in AI research and applications.
Course Topics	- Knowledge Graphs - RDF and OWL - Query Answering over KGs - Virtual Knowledge Graphs - Vector Databases - KNN - Approximated KNN - RAG
Keywords	Knowledge Graphs;Vector Databases
Recommended Prerequisites	
Propaedeutic Courses	
Teaching Format	Lectures. In person.
Mandatory Attendance	Attendance is not mandatory but strongly recommended. Non-attending students must contact the lecturer at the start of the course to agree on the modalities of the independent study.
Specific Educational Objectives and Learning Outcomes	D1 - Knowledge and Understanding - Understand the principles of semantic data representation using RDF, OWL, and SPARQL. - Demonstrate deep knowledge of virtual knowledge graphs, description logics, and vector database technologies. - Grasp the integration of symbolic and vector-based approaches in AI systems, including RAG. D2 - Applying Knowledge and Understanding - Design and query ontologies and knowledge graphs using tools such as Protégé and Ontop. - Build and optimize vector search systems, similarity measures, and indexing structures. - Implement retrieval-augmented pipelines combining vector search and large language models.

	D3 - Making Judgements - Critically assess semantic and vector-based methods for data management and AI integration. - Evaluate modeling and system design choices based on scalability, expressiveness, and performance. - Analyze and interpret experimental results to improve system design and methodology. D4 - Communication - Clearly present complex technical content in both academic and interdisciplinary settings. - Produce well-structured documentation, presentations, and research papers in the field. D5 - Learning Skills - Independently explore advanced literature and technologies in semantic and AI-driven data systems. - Design and conduct original research projects, demonstrating scholarly autonomy and innovation.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	The final exam will consist of either: - A critical presentation based on scientific literature, or - A small applied project related to the course topics (e.g., knowledge graphs, vector databases, retrieval-augmented generation).
Evaluation Criteria	Evaluation will be on a pass/fail basis, according to the following criteria: 1. Relevance and Understanding - The work demonstrates a solid grasp of the selected topic and its connection to the course content. 2. Analytical and Critical Thinking

	- The student shows the ability to analyze and explain key concepts, methods, or design choices. 3. Technical or Conceptual Accuracy - Presentations accurately synthesize the literature; projects are functional and coherent. 4. Communication and Clarity - The student clearly presents the material and responds appropriately to questions. To pass, students must meet acceptable standards in all areas. Outstanding work may be acknowledged informally during feedback.
Required Readings	All the required reading material will be provided during the course and will be available in electronic format. Copy of the slides will be available as well. While not strictly required, a useful reference for the first part of the course is *An Introduction to Description Logic* by Franz Baader, Ian Horrocks, Carsten Lutz, and Uli Sattler (Cambridge University Press). Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it and Ilaria Miceli, Ilaria.Miceli@unibz.it
Supplementary Readings	Scientific papers and additional books will be specified on each course topic during lectures.
Further Information	Protege, Ontop, Milvus
Sustainable Development Goals (SDGs)	Quality education