# Syllabus

## *Descrizione corso*

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| **Titolo insegnamento** | Advanced Data Management for Artificial Intelligence: Knowledge Graphs and Vector Databases |
| **Codice insegnamento** | 71084 |
| **Titolo aggiuntivo** | |
| **Settore Scientifico-Disciplinare** | IINF-05/A |
| **Lingua** | Inglese |
| **Corso di Studio** | Corso di Dottorato di ricerca in Scienze e Tecnologie informatiche |
| **Altri Corsi di Studio (mutuati)** | |
| **Docenti** | prof. Davide Lanti,<br>Davide.Lanti@unibz.it<br>https://www.unibz.it/en/faculties/engineering/academic-staff/person/34107 |
| **Assistente** | |
| **Semestre** | Secondo semestre |
| **Anno/i di corso** | 1 |
| **CFU** | 2 |
| **Ore didattica frontale** | 20 |
| **Ore di laboratorio** | 0 |
| **Ore di studio individuale** | 50 |
| **Ore di ricevimento previste** | |
| **Sintesi contenuti** | This course aims to equip Ph.D. students with:<br>¿ A solid understanding of modern data management paradigms, focusing on Knowledge Graphs and Vector Databases.<br><br>¿ The ability to model, query, and reason over semantic data using RDF, OWL, and SPARQL.<br><br>¿ Practical skills in designing and querying Virtual Knowledge Graphs with tools like Protégé and Ontop. |

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| | ¿ Knowledge of vector-based similarity search, indexing techniques, and the use of systems like Milvus.<br><br>¿ The competence to critically assess and apply these technologies in AI research and applications. |
| **Argomenti dell'insegnamento** | - Knowledge Graphs<br>- RDF and OWL<br>- Query Answering over KGs<br>- Virtual Knowledge Graphs<br>- Vector Databases<br>- KNN<br>- Approximated KNN<br>- RAG |
| **Parole chiave** | Knowledge Graphs;Vector Databases |
| **Prerequisiti** | |
| **Insegnamenti propedeutici** | |
| **Modalità di insegnamento** | Lectures. In person. |
| **Obbligo di frequenza** | 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. |
| **Obiettivi formativi specifici e risultati di apprendimento attesi** | D1 - Knowledge and Understanding<br><br>- Understand the principles of semantic data representation using RDF, OWL, and SPARQL.<br>- Demonstrate deep knowledge of virtual knowledge graphs, description logics, and vector database technologies.<br>- Grasp the integration of symbolic and vector-based approaches in AI systems, including RAG.<br><br>D2 - Applying Knowledge and Understanding<br><br>- Design and query ontologies and knowledge graphs using tools such as Protégé and Ontop.<br>- Build and optimize vector search systems, similarity measures, and indexing structures.<br>- Implement retrieval-augmented pipelines combining vector search and large language models. |

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

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| | 2. Analytical and Critical Thinking<br>- The student shows the ability to analyze and explain key concepts, methods, or design choices.<br><br>3. Technical or Conceptual Accuracy<br>- Presentations accurately synthesize the literature; projects are functional and coherent.<br><br>4. Communication and Clarity<br>- The student clearly presents the material and responds appropriately to questions.<br>To pass, students must meet acceptable standards in all areas. Outstanding work may be acknowledged informally during feedback. |
| **Bibliografia obbligatoria** | 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.<br><br>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).<br><br>Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it and Ilaria Miceli, Ilaria.Miceli@unibz.it |
| **Bibliografia facoltativa** | Scientific papers and additional books will be specified on each course topic during lectures. |
| **Altre informazioni** | Protege, Ontop, Milvus |
| **Obiettivi di Sviluppo Sostenibile (SDGs)** | Istruzione di qualità |