Syllabus

Course Description

Course Title	Intelligent Agents
Course Code	76252
Course Title Additional	
Scientific-Disciplinary Sector	INFO-01/A
Language	English; German
Degree Course	Bachelor in Computer Science
Other Degree Courses (Loaned)	
Lecturers	Prof. Dr. Oliver Kutz, Oliver.Kutz@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/35483 Dr. Sarah Maria Winkler, SarahMaria.Winkler@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/44774
Teaching Assistant	
Semester	First semester
Course Year/s	3
CP	12
Teaching Hours	60
Lab Hours	60
Individual Study Hours	180
Planned Office Hours	36
Contents Summary	Module A: Knowledge Representation: • Multi-agent Systems and Games • Individuals and Relations: Predicate Calculus • The Datalog Logic Rule Language • Planning with Individuals and Relations • Applications in Natural Language • Knowledge Graphs and Ontologies

	Module B: Intelligent Agents Project: • AI paradigms: symbolic approaches vs. learning-based approaches • Overview of main AI techniques: exact and approximate methods, handling imperfect information, use and model of domain knowledge • Tools and programming techniques for the development of AI systems • Symbolic approaches: planning and search, constraint solving, propositional SAT solvers • Learning-based approaches: supervised vs. unsupervised and reinforcement learning, neural networks • Hands-on programming projects covering the above topics
Course Topics	Knowledge Representation is an advanced course on Artificial Intelligence technologies, and it introduces students to the foundational topics, methods, and theories in symbolic artificial intelligence, with a focus on how knowledge can be formally expressed and reasoned about. The course begins with a thorough exploration of classical first-order logic, covering its syntax, semantics, model theory, and proof theory, as a basis for knowledge formulation. It then moves on to Description Logics (DLs), which serve as a formal foundation for defining ontologies and knowledge bases. The module concludes with an analysis of key reasoning scenarios involving knowledge and ontologies, such as planning, non-monotonic reasoning, and common-sense inference, along with an introduction to selected non-classical reasoning approaches. Intelligent Agents Project focuses on the practical application of AI techniques to support human decision-making and to design autonomous systems. Students will actively engage in the development of software solutions that apply the AI methods introduced during the course to solve specific challenges. This hands-on experience is intended to deepen their understanding of various AI approaches and to highlight the complexities that arise in real-world applications. The goal of the module is to equip students with a versatile set of computational tools and methodologies, enabling them to address a range of practical problems and translate theoretical concepts into effective, working

	solutions.
Keywords	Knowledge representation, logic, symbolic AI techniques, machine learning, implementation of AI methods
Recommended Prerequisites	It is preferable to have already attended the basic courses on Artificial Intelligence and machine Learning. It is preferable that students have already done the Software Engineering course and have basic mathematical knowledge in Discrete mathematics and Linear Algebra.
Propaedeutic Courses	
Teaching Format	Frontal lectures, exercises in lab, support for projects.
Mandatory Attendance	Attendance is not compulsory but highly recommended as many labs require an adequate software and hardware infrastructure; non-attending students should contact the lecturer at the start of the course to get support and agree on the modalities of the independent study.
Specific Educational Objectives and Learning Outcomes	Knowledge and Understanding – D1.13 Know the principles of artificial intelligence and potentials and limits of intelligent systems in various application domains. Applying knowledge and understanding – D2.2 Be able to develop small and medium size programs using different programming languages and paradigms. – D2.15 Be able to adopt programming techniques of artificial intelligence to solve problems of computer science. Ability to make judgments – D3.1 Be able to collect and interpret useful data and to judge information systems and their applicability. – D3.2 Be able to work autonomously according to the own level of knowledge and understanding. – D3.3 Be able to take the responsibility for development of projects or IT consulting. Communication skills – D4.1 Be able to use one of the three languages English, Italian and German, and be able to use technical terms and communication appropriately. – D4.4 Be able to structure and write technical documentation. – D4.5 Be able to work in teams for the realization of IT systems.

	Learning skills – D5.1 Have developed learning capabilities to pursue further studies with a high degree of autonomy. – D5.3 Be able to follow the fast technological evolution and to learn cutting edge IT technologies and innovative aspects of last generation information systems.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Knowledge Representation: Final written exam (75%). Lab assignments (25%) Intelligent Agents Project: Lab assignments (60%) and oral presentation (40%)
Evaluation Criteria	The final exam is assessed based on the correctness and clarity of answers, the ability to summarize and evaluate content, establish relationships between topics, demonstrate critical thinking, construct sound arguments, and solve problems. To pass the exam, students must achieve a minimum score of 18 out of 30 in each module. Each module contributes 50 percent to the overall grade. For Knowledge Representation, the exam assesses the clarity of responses, the mastery of terminology and definitions introduced during the course, and the ability to solve fundamental exercises or effectively summarize and illustrate theoretical concepts. For Intelligent Agents Project, the evaluation is divided into two components: lab assignments (60 percent) and an oral presentation (40 percent). The lab assignments are group-based and assessed on the originality and technical quality of the deliverables, the quality of documentation and presentation, and the group's ability to collaborate effectively. Each assignment is evaluated individually, and the final lab score is the average of all submitted assignments. Missing an assignment deadline results in a score of zero for that task. To be admitted to the oral presentation, students must achieve at least 50 percent of the maximum possible score on the lab assignments.

	The oral presentation is an individual assessment that evaluates the student's ability to independently deepen their understanding of a selected course topic, summarize and connect relevant information, and clearly communicate their findings. The presentation topic must be agreed upon with the lecturer and must align with the course syllabus.
Required Readings	– David L. Poole and Alan K. Mackworth. Artificial Intelligence. Cambridge University Press, Cambridge, 3rd revised ed. edition edition, July 2023. ISBN 978-1-009-25819-7. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. Pearson, Hoboken, 4th edition edition, April 2020. ISBN 978-0-13-461099-3.
Supplementary Readings	Franz Baader, Ian Horrocks, Carsten Lutz, and Uli Sattler. An Introduction to Description Logic. Cambridge University Press, Cambridge, May 2017. ISBN 978-0-521-87361-1. George Luger. Artificial Intelligence: Structures and Strategies for Complex Problem Solving. Pearson, Boston, 6th edition edition, February 2008. ISBN 978-0-321-54589-3.
Further Information	Software Used: – Protégé (https://protege.stanford.edu) – ILTIS (https://iltis.rub.de) – DL Reasoners – Theorem provers – SAT- and SMT-Solvers, – planning tools, – Python libraries for reinforcement learning and neural networks
Sustainable Development Goals (SDGs)	Industry, innovation and infrastructure, Quality education

Course Module

Course Constituent Title	Knowledge Representation
Course Code	76252A
Scientific-Disciplinary Sector	INFO-01/A
Language	English
Lecturers	Prof. Dr. Oliver Kutz, Oliver.Kutz@unibz.it

	https://www.unibz.it/en/faculties/engineering/academic-staff/person/35483
Teaching Assistant	
Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	• Multi-agent Systems and Games • Individuals and Relations: Predicate Calculus • The Datalog Logic Rule Language • Planning with Individuals and Relations • Applications in Natural Language • Knowledge Graphs and Ontologies
Course Topics	Knowledge Representation is an advanced course on Artificial Intelligence technologies, and it introduces students to the foundational topics, methods, and theories in symbolic artificial intelligence, with a focus on how knowledge can be formally expressed and reasoned about. The course begins with a thorough exploration of classical first-order logic, covering its syntax, semantics, model theory, and proof theory, as a basis for knowledge formulation. It then moves on to Description Logics (DLs), which serve as a formal foundation for defining ontologies and knowledge bases. The module concludes with an analysis of key reasoning scenarios involving knowledge and ontologies, such as planning, non-monotonic reasoning, and common-sense inference, along with an introduction to selected non-classical reasoning approaches.
Teaching Format	Frontal lectures, exercises in lab, support for projects.
Required Readings	– David L. Poole and Alan K. Mackworth. Artificial Intelligence. Cambridge University Press, Cambridge, 3rd revised ed. edition edition, July 2023. ISBN 978-1-009-25819-7. - Stuart Russell und Peter Norvig. Artificial Intelligence: A Modern

	Approach. Pearson, Hoboken, 4. Auflage, April 2020. ISBN 978-0-13-461099-3.
Supplementary Readings	- Franz Baader, Ian Horrocks, Carsten Lutz, und Uli Sattler. An Introduction to Description Logic. Cambridge University Press, Cambridge, Mai 2017. ISBN 978-0-521-87361-1. - George Luger. Artificial Intelligence: Structures and Strategies for Complex Problem Solving. Pearson, Boston, 6. Auflage, Februar 2008. ISBN 978-0-321-54589-3.

Course Module

Course Constituent Title	Intelligent Agents Project
Course Code	76252B
Scientific-Disciplinary Sector	INFO-01/A
Language	German
Lecturers	Dr. Sarah Maria Winkler, SarahMaria.Winkler@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/44774
Teaching Assistant	
Semester	First semester
CP	6
Responsible Lecturer	
Teaching Hours	20
Lab Hours	40
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	– AI paradigms: symbolic approaches vs. learning-based approaches – Overview of main AI techniques: exact and approximate methods, handling imperfect information, use and model of domain knowledge – Tools and programming techniques for the development of AI systems – Symbolic approaches: planning and search, constraint solving,

	propositional SAT solvers – Learning-based approaches: supervised vs. unsupervised and reinforcement learning, neural networks – Hands-on programming projects covering the above topics
Course Topics	Intelligent Agents Project focuses on the practical application of AI techniques to support human decision-making and to design autonomous systems. Students will actively engage in the development of software solutions that apply the AI methods introduced during the course to solve specific challenges. This hands-on experience is intended to deepen their understanding of various AI approaches and to highlight the complexities that arise in real-world applications. The goal of the module is to equip students with a versatile set of computational tools and methodologies, enabling them to address a range of practical problems and translate theoretical concepts into effective, working solutions.
Teaching Format	Frontal lectures and programming exercises
Required Readings	David L. Poole and Alan K. Mackworth. Artificial Intelligence. Cambridge University Press, Cambridge, 3rd revised ed. edition edition, July 2023. ISBN 978-1-009-25819-7. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach. Pearson, Hoboken, 4th edition edition, April 2020. ISBN 978-0-13-461099-3.
Supplementary Readings	Franz Baader, Ian Horrocks, Carsten Lutz, and Uli Sattler. An Introduction to Description Logic. Cambridge University Press, Cambridge, May 2017. ISBN 978-0-521-87361-1. George Luger. Artificial Intelligence: Structures and Strategies for Complex Problem Solving. Pearson, Boston, 6th edition edition, February 2008. ISBN 978-0-321-54589-3.