Course title: INTRODUCTION TO KNOWLEDGE MODELLING

Lecturers	Full Prof. Sandra Lovrenčić, Ph.D. Vlatka Sekovanić, mag. educ. inf.
Language of instruction	Croatian and English
Study level	Bachelor
Study programme	Information and Business Systems
Semester	5th (winter)
ECTS	6
Goal	The main goal of the course is to introduce students to the basics of modeling and the presentation of domain knowledge and to automated reasoning as the core areas of artificial intelligence. Students will gain knowledge from automata theory and propositional and predicate logic, and they will apply this knowledge practically for modeling and problem solving in different domains of business. They will also learn the role of formalisms for knowledge modeling in the overall process of developing information and intelligent systems. After the completion of the course, the students should be able to: 1. Solve a given problem (word recognition, communication protocols etc.) in terms of finite and pushdown automata. 2. Test whether a given language is context-free and describe it by a nondeterministic pushdown automaton. 3. Construct a Turing machine for a given language recognition problem and for a given computation problem. Explain basic properties and differences in the modeling of problems in the field of information sciences by using propositional calculus and predicate calculus. 4. Model a given problem in the field of information sciences by using predicate calculus. 5. Express basic definitions and theorems, and explain concepts related to logical consequence. 6. Transform a given problem in the field of information sciences into the disjunctive, conjunctive and Skolem normal form. 7. Apply the Davis-Putnam-Logemann-Loveland algorithm in determining the satisfiability of a set of statements. 8. Apply a resolution rule and its modifications in determining logical consequence. 9. Analyze ways of finding solutions in logic programming languages and devise solutions to relatively simple given problems and implement them using a specified logic programming language.
General and specific learning outcomes	1. Understand and apply appropriate mathematical methods, models and techniques to solving problems in the information and business systems field. 2. Model business processes and data in organizations, and apply models in the development of organizational and information systems. 3. Understand and apply methods and techniques of information and software systems development in contemporary development environments.

	4. Keep track of professional literature in Croatian and a foreign language, prepare and independently deliver presentations in Croatian and a foreign language to professional and general public, and critically evaluate a presented professional topic.
Content	**1. Course introduction** - overview of the field of study, formal systems, importance of automata theory, importance of automatic reasoning, modelling and presentation of domain knowledge and reasoning as fundamental fields of artificial intelligence, motivational examples **2. Regular languages and finite automata** - basic concepts, regular languages, regular expressions, deterministic finite automata, nondeterministic finite automata, representation of automata, relationship of finite automata and regular expressions, examples of modelling selected problems **3. Context-free grammars** - non-regular languages and the pumping lemma, Chomsky hierarchy of grammars, definition of context-free grammars, deterministic and nondeterministic pushdown automata, relationship of context-free grammars and pushdown automata, Backus-Naur form, examples of modelling selected problems **4. Turing machine** - definition, deterministic Turing machine, nondeterministic Turing machine, language recognition and problem solving, variations of the Turing machine, examples of application **5. Knowledge modelling in propositional logic** - syntax and semantics, interpretation and truth of propositions, logical consequence, examples of knowledge modelling **6. Reasoning in propositional logic** - automatic reasoning, disjunctive and conjunctive normal form, resolution for propositional logic and its modifications, satisfiability problem and DPLL algorithm, examples of modelling and problem solving **7. Knowledge modelling in predicate logic** - syntax and semantics, sentence translation, examples of modelling knowledge of selected business domains **8. Reasoning in predicate logic** - prenex normal form, Skolem normal form, unification, Horn clause, resolution and its modifications, SLD resolution and clause search, logic programming, examples of modelling and solving business problems **9. Development of the field and application possibilities** - other types of logic (fuzzy, modal, temporal…) and their significance for artificial intelligence, automated theorem proving, model verification, formal verification of software and hardware
Exercises	At laboratory exercises students work on assignments related to the practical application of course materials on knowledge modelling and problem solving in information sciences, including automata theory and logic programming languages.
Realization and examination	Classes: Lectures, exercises Exam: Preliminary exam, oral exam, seminar paper, practical work
Related courses	**1.** Logic and Proof, University of Oxford, https://www.cs.ox.ac.uk/teaching/courses/2021-2022/logicandproof/ **2.** Logic for Computer Scientist, KTH Royal Institute of Technology, https://www.kth.se/student/kurser/kurs/DD1351?l=en

	3. Theory of Automata and Formal Languages, University of Minnesota Duluth, https://www.d.umn.edu/~amsutton/cs3531f21/ **4.** Formal Methods and Models, George Mason University, https://cs.gmu.edu/~gordon/teaching/cs330/syllabus.html
Literature	Basic: Goranko, V. (2017.) Logic as a Tool: A Guide to Formal Logical Reasoning, Wiley O'Reagan, G. (2017.) Concise Guide to Formal Methods: Theory, Fundamentals and Industry Applications, Springer Mozgovoy, M. (2010.) Algorithms, Languages, Automata, and Compilers: A Practical Approach, Jones and Bartlett Publishers Additional: Barwise, J.; Etchemendy, J. (2011.) Language: proof and logic, 2nd edition. CSLI publications Bratko, I. (2011.) Prolog programming for artificial intelligence, 4th edition. Pearson Education Canada Čubrilo, M. (1989). Matematička logika za ekspertne sisteme. Informator