Warsaw University of Technology | Doctoral School No. 3

Course offered in the Doctoral School No. 3 – Spring semester of the 2021/2022 academic year

TITLE
Intelligent Information Systems
CONDUCTING UNIT
Doctoral School No. 3
SCIENTIFIC DISCIPLINE
Information and communication technology
IMPLEMENTING UNIT
103000 - Faculty of Electronics and Information Technology
SUMMARY DESCRIPTION
The course aims to familiarise students with advanced information methods and techniques, especially methods of knowledge representation and artificial intelligence, which are or may be used in the design and/or implementation of intelligent information systems. The lecture prepares students to design components of such systems and to undertake research in this field. The lecture is organised as a path leading from the morphology of the classical information system, i.e. determining its components with the greatest possible accuracy, and then looking for the answer to the question: which of these components can be equipped with "intelligence" using knowledge representation methods and artificial intelligence, leading to - as a result - the development of a map of the architecture of a generic intelligent information system in which those places are indicated where the "intelligent" components can be added. The motto of the lecture is R. Hamming's saying: "The purpose of computing is insight, not numbers." The lecture is accompanied by students' projects that are practical applications of the lecture's topics.
FULL DESCRIPTION
1. Introduction. Intelligence (2 hours) A descriptive definition of the concept of intelligence and artificial intelligence (AI) is provided. In relation to human intelligence, the multidimensional approach proposed by prof. H. Gardner is discussed. AI was defined using its definition given by Prof J. McCarthy. 2. Basic concepts: data, information, knowledge, system, information system(4 hours)

A linguistic approach is used to define data, information and knowledge. The notion of intelligent information system is defined, Examples of intelligent information systems are discussed.

3. Knowledge representation (3 hours)

A formal definition of knowledge representation as a pair: (i) language, and (ii) a set of knowledge manipulation operators, with an emphasis on inference mechanism(s) is given. The inference mechanism is a crucial element of this definition as it determines the level of "intelligence" of the system. The choice of knowledge representation determines the effectiveness of an intelligent information system.

4. Naive Bayes Classifier (2 hours)

Naive Bayes classifier is presented as an example of a main element of an intelligent information system that is also a decision-making system.

5. Classical logic as a method of knowledge representation. Information system in logic (6 hours)

In the lecture, classical logic plays a special role as a method of knowledge representation, constituting a specific point of reference for other methods (benchmark). Formally, information systems in logic are theories. An example of an information system in logic is given, showing that answering questions is about proving theorems.

6. Information systems in non-classical logic (2 hours)

Reiter's default logic allows one to describe typical/casual situations, though burdened with uncertainty. An example of an information system based on this logic is provided.

7. Semantic Networks (2 hours)

A definition of semantic atoms (semantic atoms, semantic primitives, semantic universals) is given. A genesis and applications of semantic atoms e.g. the creation of meta-language(s) in which it is possible to write sentences of a given natural language in a syntactic abbreviated form and thus create information systems is presented.

8. Semantic atoms (2 hours)

A definition of semantic atoms (semantic atoms, semantic primitives, semantic universals) is given. A genesis and destiny of semantic atoms i.e. the creation of meta-language(s) in which it is possible to write sentences of a given natural language in a syntactic abbreviated form and thus create information systems is presented.

9. Frames and scripts (2 hours)

Prof Minsky's frames mainly describe the structural aspect of the world modelled in the information system, showing the objects and relations occurring in it. The scripts proposed by Prof R. Abelson and Prof R. Schank as an extension of the framework concept to represent the behavioural aspect of the world are discussed.

10. Ontologies (3 hours)

A definition of ontology is given. Ontologies are presented as a tool for modelling both structural and behavioural aspects of the real world and creating information systems, including intelligent systems.

11. Neural networks (2 hours)

This lecture is not conceived as a ground lecture on neural networks, its purpose is to provide general information about network functions and to indicate those functions that may be useful in designing and building intelligent information systems. An example of an information system using a deep neural network is provided.

LITERATURE

1. Barr A., Feigenbaum E. A., The Handbook of Artificial Intelligence, vol. I, II, III, William Kaufmann Inc, 1981.
2. Brachman R., Levesque H. (editors): Readings in Knowledge Representation, Morgan Kaufmann, 1985.

3. Brachman R., Levesque H.: Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
4. Cichosz P.: Systemy uczące się. Warszawa, WNT, 2001.
5. Cichosz P.: Data Mining Algorithms. Explained Using R. Wiley, 2015.
6. Gelfond M., Kahl Y., Knowledge Representation, Reasoning, and the Design of Intelligent Agents: The Answer-Set Programming Approach, Cambridge University Press, 2014.
7. van Harmelen F., Lifschitz V., Porter B. (edytorzy), Handbook of Knowledge Representation, Elsevier, 2008.
8. Jakus G., Milutinovic V., Omerovic S., Concepts, Ontologies, and Knowledge Representation, Springer, 2013.
9. Lemos N.: An Introduction to the Theory of Knowledge, Cambridge University Press, 2007.
10. Muraszkiewicz M., Rybiński H.: Bazy danych, Wydawnictwo Akademickie, 1993.
11. Parsaye K., Chignell M., Khoshafian S., Wong H, Inteligent Databases. Object Oriented, Deductive Hypermedia Technologies, Wiley, 1989.
12. Russel S., Norvig P.: Artificial Intelligence. A Modern Approach. Pearson Education Inc., 4th edition, 2020.
13. Sowa J.F.: Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks Cole Publishing Co., Pacific Grove, 2000.
14. Tarski A., Wprowadzenie do logiki, Philomath, 1996.
15. Ullman J. D: Podstawowy wykład z systemów baz danych, WNT, 2001.

Also: Weka or (other) Library(s), github, R package(s), Python package(s).

LEARNING OUTCOMES

KNOWLEDGE:

w01 knows the definitions of key concepts in the field of intelligent information systems (data, information, knowledge, knowledge representation method, inference, answering questions, knowledge discovery, intelligent information system)

w02 knows the main methods of knowledge representation used for modeling the real world and designing and implementing intelligent information systems

w03 knows the principles and rules of designing intelligent information systems

w04 knows the methods of assessing intelligent information systems

SKILLS:

u01 can analyze information needs and adjust the knowledge representation method to it

u02 knows how to implement knowledge representation methods or modify their existing implementations

u03 can assess the quality of an intelligent information system based on the effectiveness of answering queries

SOCIAL COMPETENCE:

k01 uses appropriate methods of oral and written communication in the field of formulating intelligent information systems tasks

k02 effectively cooperates in a team on research work and/or intelligent information systems implementation

ASSESSMENT METHODS AND CITERIA; COURSE COMPLETION FORM

Checking the assumed learning outcomes is carried out by:

- summarizing the knowledge and skills demonstrated in the written test and oral conversation,

- assessment of knowledge and skills related to the implementation of project tasks assessment of the implementation and experimental work performed and the quality of documentation, - formative assessment related to participation in consultations and an interactive form of lecture. Grading on the basis of the project evaluation, written test and conversation at the end of the course.

LANGUAGE OF THE COURSE	ECTS CREDITS
English	4

TYPE OF CLASSES	NUMBER OF HOURS	COURSE INSTRUCTOR
Lecture	30	Mieczysław Muraszkiewicz, prof. dr hab.
Project	30	Mieczysław Muraszkiewicz, prof. dr hab.
Consultations	10	Mieczysław Muraszkiewicz, prof. dr hab.