COURSE DESCRIPTION CARD - SYLLABUS

Course name
Semantic web and social networks [S1SI1E>SSEM]

Course

Field of study
Artificial Intelligence

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
english

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

5,00

Coordinators

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Lecturers

Prerequisites

A student starting this subject should have basic knowledge of Internet technologies (including XML and JSON data representation formats), basics of logic and databases, basics of artificial intelligence, basics of graph theory, and Python programming. The student should have the ability to solve basic problems in the design of information systems and their implementation, as well as the ability to obtain information from indicated sources. The student should have the ability to use external programming APIs. S/he should be comfortable with the Python programming language. S/he should also understand the need to expand his or her competencies / have the willingness to cooperate as part of a team. Regarding social competence, the student must present such attitudes as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people, and teamwork skills.

Course objective

Provide students with basic knowledge of methods, technologies, and tools concerning Semantic Web, knowledge graphs, and social networks. Providing good practices of knowledge representation and integration on the Web and knowledge engineering (including, constructing knowledge graphs). Providing students with the mathematical basics of network data analysis and mining and basic network models. Providing students with knowledge of available IT tools (ready-made programs, libraries, APIs) for analysis and exploration of data represented in the form of networks, for learning representations (knowledge graph embeddings), and for using semantic networks, ontologies, knowledge graphs, and social networks in applications such as semantic search, recommendation systems, and for creating dashboards. Developing students' problem-solving skills in using and designing systems utilizing knowledge processing technologies, network data and social networks.

Course-related learning outcomes

Knowledge:
K1st_W3: has a well-grounded knowledge of fundamental computer science problems within the scope of artificial intelligence, including data mining, machine learning, optimization techniques, and multiple criteria decision analysis
K1st_W4: knows and understands the basic techniques, methods, algorithms, and tools used for solving computer problems as well as problems in artificial intelligence, including an automated recognition of patterns in network data of different types and their synthesis to knowledge, conclusions, and recommendations
K1st_W5: has a basic knowledge of key directions and the most important successes of artificial intelligence understood as an essential sub-domain of computer science, making use of the achievements of other scientific disciplines and providing solutions with a high practical impact; knows the history and recent trends in Artificial Intelligence, especially concerning Semantic Web, knowledge graphs and social networks

Skills:
K1st_U3: can formulate and solve complex data mining, optimization, and decision problems within the scope of computer science and, in particular, artificial intelligence, by applying appropriately selected methods such as clustering algorithms, classification techniques, optimization approaches, graph search methods, or decision analysis tools
K1st_U7: can carry out a critical analysis and an assessment of the functioning of both computer systems and AI methods concerning Semantic Web and social networks
K1st_U8: can design - following a pre-defined specification - and create an IT system by first selecting and then using the available methods, techniques, and computer tools (including programming languages) from the area of Semantic Web and social networks
K1st_U9: can adapt the existing algorithms as well as formulate and implement the novel algorithms in Python, including the algorithms typical for different streams of AI such as data mining, machine learning, artificial neural networks
K1st_U10: can retrieve, analyze and transform different types of data, protect it against undesired access, and carry out data synthesis to knowledge and conclusions useful for solving a variety of problems that occur in the work of a computer scientist - a specialist in the field of AI, including issues of industrial, business, and administrative nature
K1st_U11: can adapt and make use of the models of intelligent behavior (e.g., genetic algorithms, artificial neural networks, or decision support methods) as well as computer tools simulating such a behavior

Social competences:
K1st_K1: understands that knowledge and skills quickly become outdated in computer science and, in particular, AI, and perceives the need for constant additional training and raising one's qualifications
K1st_K2: is aware of the importance of scientific knowledge and research related to computer science and AI in solving practical problems which are essential for the functioning of individuals, firms, organizations, as well as the entire society
K1st_K5: can think and act in an enterprising way, finding the commercial application for the created AI-based systems, having in mind the economic benefits as well as legal and social issues

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Assessment based on points, which can be earned, as follows: 7 online quizes will be made available during the semester, with a deadline to solve them by the end of the lecture day. The last lecture will be set aside for a written credit (test) to earn additional / missing points.
Laboratory classes: The evaluation will be given based on the points that can be scored by realizing subsequent milestones of a project and presenting them in the classroom. The project can be done in a group of 1-3 people.

Programme content

The program covers the following topics:
Introduction to social networks, history and development of sociometry, examples of real social networks. Measures of centrality in networks: centrality by degrees of vertices, centrality by agency, centrality by proximity, network diameter, modularity in networks, algorithms for finding communities, correlations of vertex degrees, scale-free networks and phenomena, power laws and their mathematics, examples of phenomena described by power laws. Social network influence modeling and influence/trust propagation algorithms, edge prediction and recommendation, statistical social network models, learning dense vector representations for graph data, graph neural networks. Graph databases.
The concept of the Semantic Web, triple data model, RDF resource description language, knowledge representation using ontologies (OWL language), SPARQL query language, knowledge graphs on the Web, knowledge representation using vector models (embeddings), making use of existing resources (Wikidata / DBpedia, Freebase, YAGO) in own applications, semantic metadata on the Web (http://schema.org). Tools: rdflib library, Protégé, owlready2, AmpliGraph library and others.

Teaching methods

Lecture: slide show presentations, illustrated with examples and practical assignments that serve as a summary of the lectures and preparation for the assessment tests. Tutorials with interactive presentation of relevant tools, libraries in the form of, for instance, Jupyter notebooks.
Laboratory classes: solving illustrative examples on board and coding problem solutions in Python, conducting computational experiments, discussion on the chosen methods, teamwork, consultations, literature analysis, determination of functional and non-functional requirements, selection of data set(s), exploratory data analysis, selection of tools according to requirements, selection of suitable models / designs with a justification of their choice, pre-processing, experiments, presentation, technical report.

Bibliography

Basic:
1. Linked Data: Evolving the Web into a Global Data Space (1st edition). Tom Heath and Christian Bizer, Synthesis Lectures on the Semantic Web: Theory and Technology, 1:1, 1-136. Morgan & Claypool, 2011, http://linkeddatabook.com/book
2. Aidan Hogan, Eva Blomqvist, Michael Cochez, Claudia d'Amato, Gerard de Melo, Claudio Gutierrez, Sabrina Kirrane, José Emilio Labra Gayo, Roberto Navigli, Sebastian Neumaier, Axel-Cyrille Ngonga Ngomo, Axel Polleres, Sabbir M. Rashid, Anisa Rula, Lukas Schmelzeisen, Juan Sequeda, Steffen Staab, Antoine Zimmermann (2021) Knowledge Graphs, Synthesis Lectures on Data, Semantics, and Knowledge, No. 22, 1-237, DOI: 10.2200/S01125ED1V01Y202109DSK022, Morgan & Claypool
3. Albert-Laszlo Barabasi, Network Science, Cambridge University Press, 2016

Additional:
1. Demystifying OWL for the Enterprise, Michael Uschold, Morgan & Claypool Publishers, 2018
2. Semantic Web for the Working Ontologist, Third Edition, Dean Allemang, Jim Hendler, Fabien Gandon, ACM Books, 2020
3. An Introduction to Ontology Engineering. Keet, C.M. College Publications, volume 20, November 2018
4. Programming the Semantic Web: Build Flexible Applications with Graph Data 1st Edition, Toby Segaran, Colin Evans, Jamie Taylor, O'Reilly Media, 2009
5. Knowledge Engineering. Building Cognitive Assistants for Evidence-based Reasoning, Gheorghe Tecuci, Dorin Marcu, Mihai Boicu, David A. Schum, Cambridge University Press, 2016
6. Semantic data mining. An ontology-based approach. Agnieszka Ławrynowicz. Studies on the Semantic Web, Vol. 29. IOS Pres/AKA Verlag 2017
7. Programming Collective Intelligence. Building Smart Web 2.0 Applications, Toby Segaran, O'Reilly,

2007
8. Networks, Crowds and Markets: Reasoning About a Highly Connected World, David Easley, Jon Kleinberg, Cambrige University Press, 2010
9. Social Network Analysis: Methods and Applications. Stanley Wasserman, Katherine Faust, Cambridge University Press 1994
10. Models and Methods in Social Network Analysis, P.J. Carrington, J. Scott, S. Wasserman, Cambridge University Press 2005
11. Social Network Analysis: A Handbook, John P. Scott, SAGE Publications, 2000

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	65	2,50