COURSE DESCRIPTION CARD - SYLLABUS

Course name
Social Network Analysis and Mining [S2Inf1-TPD>AiESS]

Course

Field of study
Computing

Year/Semester
2/3

Area of study (specialization)
Data Processing Technologies

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
30

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

A student starting this course should possess basic knowledge of internet technologies and graph theory. The student should have the ability to solve fundamental problems in the design and implementation of IT systems, and the ability to acquire information from designated sources. The student should be proficient in using external programming APIs. They should be fluent in the Python programming language. They should also understand the need to expand their competencies / be willing to collaborate as part of a team. In terms of social skills, the student must demonstrate attitudes such as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for others, and the ability to work in a group.

Course objective

1. to provide students with basic knowledge of Web 2.0 (social networking and services) concepts and technologies. 2. to develop students" problem-solving skills on how to use and design systems using network data and social networks. 3. to provide students with knowledge of available IT tools (ready-made programs, libraries, APIs) for analysis and exploration of data represented in the form of networks 4. to provide students with the mathematical basics of network data analysis and mining and basic network models 5. to form in students the skills of teamwork. 6. to form in students the ability to obtain information from literature and other sources, integrate them, draw conclusions, and formulate and justify opinions on them through social media. 7. shaping in students the ability to creatively combine data from multiple heterogeneous sources and the ability to use social mechanisms in the created information systems.

Course-related learning outcomes

Knowledge:
student:
has extended and deepened knowledge of mathematics useful for solving complex computer tasks involving the use of network mechanisms (k2st_w1)
has structured and theoretically supported general knowledge related to programming aspects of network data processing (k2st_w2)
has advanced and detailed knowledge related to modeling of phenomena in social networks (k2st_w3)
has advanced and detailed knowledge of the processes occurring in the evolution cycle of network systems (k2st_w5)
knows advanced methods, techniques and tools used in solving complex engineering tasks and conducting research work in the field of social networks (k2st_w6)

Skills:
student:
is able to acquire information from literature, databases and other sources (in the native language and english), integrate them, interpret and critically evaluate, draw conclusions and formulate and fully justify opinions (k2st_u1)
is able to use analytical, simulation and experimental methods to formulate and solve engineering tasks and simple research problems (k2st_u4)
is able to assess the usefulness and possibility of using new it libraries for processing network data (k2st_u6)
is able to critically analyze existing technical solutions and propose their improvements (k2st_u8)
is able to assess the usefulness of methods and tools for solving an engineering task involving the construction or evaluation of an information system or its components, including recognizing the limitations of these methods and tools; (k2st_u9)
is able - using, among others, conceptually new methods - to solve complex it tasks using community mechanisms, including atypical tasks and tasks with a research component (e.g. diffusion processes in networks); (k2st_u10)
social competencies
student:
understands that in computer science, knowledge and skills become obsolete very quickly, (k2st_k1)
understands the importance of using social network analysis techniques in solving research and practical problems (k2st_k2)

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:
(a) in terms of lectures: on the basis of answers to questions on the material discussed in previous lectures,
b) in terms of project classes: on the basis of the evaluation of the current progress of the tasks,

Summative evaluation:
a) in the scope of lectures, verification of the assumed learning outcomes is realized by evaluation of

knowledge and skills on the basis of quizzes published after each lecture
b) in the scope of project classes, verification of the established learning outcomes is realized by evaluation of the student"s presented report on the realization of the project, with the presentation having the character of a public defense of the project in front of all the students of the course.

Obtaining additional points for activity during classes, among others for:
- discussion of additional aspects of the issue,
- efficiency of application of the acquired knowledge during the solution of the assigned problem,
- ability to cooperate as part of a team practically implementing a detailed project task

Programme content

The lecture program covers the following topics:

- introduction to social networks
- history and development of sociometry
- examples of real-world social networks
- centrality measures in networks: degree centrality, betweenness centrality, closeness centrality, network diameter
- modularity in networks, community detection algorithms, degree correlations
- scale-free networks and phenomena
- power laws and their mathematics, examples of phenomena described by power laws, mechanisms of power law distribution formation
- network formation models: Erdős–Rényi random network model, Watts–Strogatz small-world model, Barabási–Albert preferential attachment model
- micro and macro-evolution of networks
- information spreading models in networks, general SIR model and its modifications, network densification phenomenon, percolation phenomenon in networks
- influence modeling in social networks and influence/trust propagation algorithms, edge prediction and recommendation
- statistical models of social networks
- learning dense vector representations for graph data
- graph neural networks
- graph databases.

Project classes include a series of meetings aimed at illustrating the issues and technologies discussed during the lecture. Some meetings are dedicated to learning individual tools (Pajek, Gephi, visone, NetLogo) and libraries (NetworkX, igraph, PyGeometric), followed by a seminar meeting where students (individually or in groups) present selected topics for their final projects. The last part of the classes is strictly project-oriented, during which students work on their final projects. All final projects are presented at the end of the semester in a public presentation.

The project classes program covers the following topics:

- network research using Pajek: generating random networks, determining vertex evaluation measures, network visualization, analysis of the general network structure
- network visualization using Gephi and visone, determining simple measures for vertices and edges, visualization using determined measures
- network analysis and exploration using NetworkX and igraph libraries
- modeling diffusion phenomena in networks using the netlib library
- generating dense vector representations using graph2vec and DeepWalk algorithms
- data analysis using the Neo4J graph database.

Course topics

none

Teaching methods

Lecture: multimedia presentation, seminar with students’ presentations
Project: programming examples, small individual programming exercises

Bibliography

Basic

1. Agata Fronczak, Piotr Fronczak, Świat sieci złożonych. Od fizyki do Internetu. Wydawnictwo Naukowe PWN 2009
2. Mark Newman, Networks: An Introduction. Oxford University Press, 2010
3. Albert-Laszlo Barabasi, Network Science, Cambridge University Press, 2016

Additional

1. Programming Collective Intelligence. Building Smart Web 2.0 Applications, Toby Segaran, O"Reilly, 2007
2. Networks, Crowds and Markets: Reasoning About a Highly Connected World, David Easley, Jon Kleinberg, Cambrige University Press, 2010
3. Social Network Analysis: Methods and Applications. Stanley Wasserman, Katherine Faust, Cambridge University Press 1994
4. Models and Methods in Social Network Analysis, P.J. Carrington, J. Scott, S. Wasserman, Cambridge University Press 2005
5. Social Network Analysis: A Handbook, John P. Scott, SAGE Publications, 2000

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	2,00