

**AGH**AGH UNIVERSITY OF SCIENCE
AND TECHNOLOGY

Module name: Networks: Models and Computation

Academic year: 2019/2020 Code: ZSDA-3-0127-s ECTS credits: 3

Faculty of: Szkoła Doktorska AGH

Field of study: Szkoła Doktorska AGH Specialty: —

Study level: Third-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 0

Course homepage: —

Responsible teacher: Koźlak Jarosław (kozlak@agh.edu.pl)

Module summary

A student should know and understand the basic types of networks, their properties and fields of application as well as selected algorithms operating on them. He/she should be get to know in more detail some of the problems that can be solved with the help of network-based models.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	The student can to work in a group to prepare a scientific study and presentation fulfilling the tasks assigned to him/her and ensure a successful final result of the whole work.	SDA3A_K01	Scientific paper, Presentation
Skills: he can			
M_U001	The student is able to understand and analyze research papers about selected works on network models and algorithms operating on them.	SDA3A_U02	Scientific paper, Presentation, Activity during classes
Knowledge: he knows and understands			
M_W001	The student knows and understands the basic network models and selected algorithms operating on networks.	SDA3A_W01	Involvement in teamwork, Scientific paper, Presentation, Activity during classes
M_W002	The student knows the main research directions conducted in the field of network models and calculations using such models ..	SDA3A_W02	Scientific paper, Project

Number of hours for each form of classes

Suma	Form of classes										
	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
32	16	0	0	0	0	16	0	0	0	0	0

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	The student can to work in a group to prepare a scientific study and presentation fulfilling the tasks assigned to him/her and ensure a successful final result of the whole work.	-	-	-	-	-	+	-	-	-	-	-
Skills: he can												
M_U001	The student is able to understand and analyze research papers about selected works on network models and algorithms operating on them.	-	-	-	-	-	+	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	The student knows and understands the basic network models and selected algorithms operating on networks.	+	-	-	-	-	-	-	-	-	-	-
M_W002	The student knows the main research directions conducted in the field of network models and calculations using such models ..	+	-	-	-	-	-	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	32 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	16 h
Realization of independently performed tasks	16 h
Summary student workload	64 h
Module ECTS credits	3 ECTS

Additional information

Module content

Lectures

1. Kinds of networks. Technological networks. Social networks. Biological networks. Networks of information.
2. Fundamentals of network theory: Mathematics, measures and metrics, structure.
3. Network models. Random Graphs. Small-world model. Power Laws. Rich-Get-Richer. Long Tail. Models of network formation.
4. Surrounding Contexts of Networks: Homophily. Link formation. Link prediction. Network Robustness. Percolation theory.
5. Relationships. Balanced Networks. Positive and Negative Relationships. Signed networks.
6. Community detection, Hierarchical Clustering. Modularity. Overlapping Communities.
7. Identification of node roles in networks. Transitions between roles. Prediction of roles.
8. Graph matching. Exact matching. Inexact matching. Bounded simulation. MAG. TALE.
9. Identification of frequent patterns and anomalies in dynamic networks. Static graphs – methods based on: analysis of features of nodes, analysis of neighbourhoods of nodes, analysis of global features of graphs. Dynamics graphs – methods based on similarities of graphs, finding typical behaviour, observation of groups of nodes.
10. Spreading Phenomena. Propagation of information and disease in networks. Susceptible-Infected, Susceptible-Infected-Susceptible, and Susceptible-Infected-Recovered Epidemic Models. Epidemic prediction. Key nodes in networks.
11. Network Games. Congestion games and resource pricing. Cooperation in network games. Bayesian games.
12. Selected applications: Analysis of Social Media. Study of Elections, Public Opinion, and Representation. Analysis of Political Events.

Seminar classes

Students prepare in groups presentations and lectures about topics given by the teacher. These topics may concern, but are not limited to following problems:

- network representation and network state
- methods for identifying of groups / communities in networks
- network matching algorithms
- algorithms for identifying patterns and anomalies in evolving networks
- models of information propagation in networks

Teaching methods and techniques:

Lectures: Lecture using typical methods (projector, slides) and multimedia demonstrations of selected simulations.

Seminar classes: Preparation of presentations and papers in groups by students. Joint discussion of the problems presented and the results obtained.

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:

Calculation of final grade is based on the quality of the prepared presentation and scientific paper with the

overview of the given problem domain, participation in discussions and attendance at seminars and lectures.

The following elements will be taken into account when assessing the presentation and the paper:

- size of the thematic scope learned
- ordering the information presented and clarity of the presentation
- involvement in the student in learning sources related to the topic exceeding the sources directly indicated by the teacher
- editorial quality of the presentation and the paper
- quality of the presentation

Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:

Lectures:

- Attendance is mandatory: No

- Participation rules in classes: Students enrolled in the module can participate in the classes.

Seminar classes:

- Attendance is mandatory: Yes

- Participation rules in classes: Students enrolled in the module can participate in the classes.

Method of calculating the final grade

The final grade is calculated according to study regulations, taking into account the points acquired for the presentation and the paper, which are modified by indicators calculated on the basis of activity in discussions and the level of attendance at lectures.

Basic assessment (for each of the following components a student can get up to 20 points is calculated considering following aspects of the work:

- size of the thematic scope learned
- ordering the information presented and clarity of the presentation
- involvement of the student in learning sources related to the topic exceeding the sources directly indicated by the teacher
- editorial quality of the presentation and the paper
- quality of the presentation

For high attendance at lectures a student can get additional 10 points, and for a high activity during the seminar additional 20 points.

Points obtained are converted into percentages and the final grade is calculated according to thresholds of percentages specified in the study regulations for given grades.

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:

Backlogs resulting from absences from classes can be made up by preparing papers on additional topics given during the consultations.

Prerequisites and additional requirements

Prerequisites and additional requirements not specified

Recommended literature and teaching resources

1. David Easley, Jon Kleinberg, *Networks, Crowds, and Markets: Reasoning about a Highly Connected World* 1st Edition, Publisher: Cambridge University Press; 1 edition (July 19, 2010)
2. Albert-László Barabási, Márton Pósfai, *Network Science*, Cambridge University Press; 1 edition (August 5, 2016)
3. Mark Newman, *Networks: An Introduction*, Oxford University Press; 1 edition (May 20, 2010)

Scientific publications of module course instructors related to the topic of the module

1. Lukasz Oliwa, Jaroslaw Kozlak: Anomaly detection in dynamic social networks for identifying key events. *BESC* 2017: 1-6
2. Bogdan Gliwa, Jaroslaw Kozlak, Anna Zygmunt, Yves Demazeau: Combining Agent-Based and Social Network Analysis Approaches to Recognition of Role Influence in Social Media. *PAAMS* 2016: 109-120
3. Stanislaw Saganowski, Bogdan Gliwa, Piotr Bródka, Anna Zygmunt, Przemyslaw Kazienko, Jaroslaw Kozlak: Predicting Community Evolution in Social Networks. *Entropy* 17(5): 3053-3096 (2015)
4. Anna Zygmunt, Piotr Bródka, Przemyslaw Kazienko, Jaroslaw Kozlak: Key Person Analysis in Social Communities within the Blogosphere. *J. UCS* 18(4): 577-597 (2012)
5. Bogdan Gliwa, Jaroslaw Kozlak, Anna Zygmunt, Krzysztof Cetnarowicz: Models of Social Groups in Blogosphere Based on Information about Comment Addressees and Sentiments. *SocInfo* 2012: 475-488
6. Anna Zygmunt, Jaroslaw Kozlak, Bogdan Gliwa: Roles in Local Communities and Global Position in Social Media. *ASONAM* 2018: 1204-1211
7. Jaroslaw Kozlak, Anna Zygmunt, Bogdan Gliwa, Krzysztof Rudek: Dynamics of Social Roles in the Context of Group Evolution in the Blogosphere. *BESC* 2018: 179-184
8. Krzysztof Rudek, Jaroslaw Kozlak: Identification of Patterns in Blogosphere Considering Social Positions of Users and Reciprocity of Relations. *HAIS* 2018: 108-119

Additional information

None