COURSE DESCRIPTION CARD - SYLLABUS

Course name
Process Mining

Course

Field of study
Artificial Intelligence
Area of study (specialization)

Level of study
Second-cycle studies
Form of study
full-time

Year/Semester
1/1
Profile of study
general academic
Course offered in
English
Requirements
compulsory

Number of hours

Lecture
30
Laboratory classes
30
Other (e.g. online)
Tutorials
Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:

Prerequisites

A student starting this course should have basic knowledge of formal models for various technical problems, the life cycle of information systems, architecture of distributed systems, and economics. He should also have the ability to obtain information from the indicated sources and be ready to cooperate as part of the team.

Course objective

1. Provide students with basic knowledge on the use of modeling tools, execution, management, and

business process analysis.
2. Developing students' ability to solve problems related to designing and discovering business processes from event logs within the framework of technologies used in business.
3. Developing students' skills of work diagnostics and improvement of business processes with the use of tools used in business.
4. Shaping in students the ability to think analytically, make conclusions on the basis of observations and analytical models.

Course-related learning outcomes

Knowledge

1. The student has advanced and in-depth knowledge of systems supporting modeling, control, and implementation of business processes, theoretical foundations of their operation, as well as methods and tools used in the implementation of business processes. [K2st_W1]
2. The student has advanced detailed knowledge of modeling, discovering from event logs, analysis and diagnostics of business processes. [K2st_W3]
3. The student knows advanced methods, techniques and tools used in solving complex tasks of modeling and analyzing business processes and conducting research in the field of these tasks. [K2st_W6]

Skills

1. When formulating and solving engineering tasks, the student is able to integrate knowledge from various areas of computer science and artificial intelligence, and if necessary also economics, and to apply a system approach, taking into account also non-technical aspects. [K2st_U5]
2. The student is able to assess the usefulness and possibility of using new achievements (methods and tools) and new IT products used in business. [K2st_U6]

3. The student can correctly use the chosen method of estimating the labor consumption of new AI products used in business. [K2st_U7]
4. The student is able to apply conceptually new methods, solve complex computer science and tasks, including artificial intelligence tasks and tasks with a research component. [K2st_U10]

Social competences

1. The student understands that in computer science and artificial intelligence knowledge and skills very quickly become obsolete. [K2st_K1]
2. The student understands the importance of using the latest knowledge in the field of computer science and artificial intelligence 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 the scope of lectures:
- on the basis of answers to questions about the material discussed in the lectures,
b) in the scope of laboratories:
- based on the assessment of the current progress in the implementation of laboratory tasks,

Summative assessment:
a) in the scope of lectures, verification of the assumed learning outcomes is carried out by:
- assessment of knowledge and skills demonstrated in the written exam consisting of:
- a set of closed questions, from which each question can be answered with one correct answer out of four possible. For each correct answer 1 point is obtained, and for each wrong answer 1/3 point is deducted.
- A set of open-ended questions, for which you can get from 2 to 4 points.
To obtain a grade of 3.0, a minimum of 51% of points should be obtained, 3.5 - 61%, 4.0 - 71%, 4.5 - 81%, 5.0 - 91%.
b) in the scope of laboratories, verification of the assumed learning outcomes is carried out by:
- assessment of the implementation of project tasks including modeling, execution and analysis of business processes, partly performed during classes and partly as part of homework,
- timely execution of tasks;
Obtaining additional points for activity during classes, especially for:
- realization of additional tasks,
- discussion of additional aspects of the issue,
- the effectiveness of applying the acquired knowledge while solving a given problem,
- the ability to cooperate as part of a team practically carrying out a detailed task in the laboratory,
- remarks related to the improvement of teaching materials.

Programme content

The lecture program covers the following topics:
1. Introduction to business processes, process science, process mining, business process management, management methodology: lean management, six sigma.
2. Business process modeling methodologies: transition systems, Petri nets, workflow systems, BPMN, causal networks, process trees. Methods of verification and analysis of processes based on models.
3. Introduction to data mining: basics of statistical inference, machine learning, supervised and unsupervised learning, methods of assessing knowledge models, discovering local patterns: association rules, sequences and episodes.
4. Preparation of data for analysis: ETL process, typical data formats, preparation challenges, data quality assessment.
5. Basic algorithms for discovering models of distributed processes: the alpha algorithm and its variants
6. Advanced algorithms for discovering models of distributed processes: Heuristic Miner, evolutionary algorithms, algorithms based on state regions, algorithms based on regions and formal languages, Inductive Miner.
7. Models of mathematical programming: modeling with the use of expert knowledge, discovering models from data.
8. Verification of the compliance of the business process with the model and / or domain knowledge, methods of diagnosing the causes of deviations from the model.
9. Alternative business process perspectives: resource, cost and efficiency perspective.
The laboratory program covers the following topics:
1. Workflow systems on the example of jBPM system.

2. PM4Py development suite: analyze event logs, discover business process models, analyze business process models and improve processes.
3. Disco Tool: Analyze event logs, discover business process models, analyze business process models and improve processes.
4. Mathematical programming: modeling processes and systems using the mathematical programming paradigm.

Teaching methods

Lecture: multimedia presentation.
Laboratory: problem solving, practical exercises, team work, demonstration.

Bibliography

Basic

Wil van der Aalst, Process Mining: Data Science in Action, Second Edition, Springer, 2016, http://link.springer.com/978-3-662-49851-4 (free access from the university network).

Additional

1. H. Paul Williams, Model Building in Mathematical Programming, Fifth Edition, Wiley, 2013.
2. Gopal K. Kanji, 100 Statistical tests, Third Edition, SAGE Publications, 2006.
3. Peter Flach, Machine Learning: The Art. Of Science of Algorithms that Make Sense of Data, Cambridge University Press, 2012.
4. Tomasz P. Pawlak, Michael O'Neill, Grammatical evolution for constraint synthesis for mixed-integer linear programming, Swarm and Evolutionary Computation 64, art. no. 100896, pp. 1-16, Elsevier, 2021.
5. Tomasz P. Pawlak, Krzysztof Krawiec, Automatic synthesis of constraints from examples using mixed integer linear programming, European Journal of Operational Research 261:1141-1157, 2017.
6. Tomasz P. Pawlak, Krzysztof Krawiec, Synthesis of Constraints for Mathematical Programming with One-Class Genetic Programming, IEEE Transactions on Evolutionary Computation 23(1):117-129, IEEE Press, 2019.
7. Patryk Kudła, Tomasz P. Pawlak, One-class synthesis of constraints for Mixed-Integer Linear Programming with C4.5 decision trees, Applied Soft Computing 68:1-12, 2018.
8. Tomasz P. Pawlak, Synthesis of Mathematical Programming models with one-class evolutionary strategies, Swarm and Evolutionary Computation 44:335-348, Elsevier, 2019.
9. Daniel Sroka, Tomasz P. Pawlak, One-Class Constraint Acquisition with Local Search, GECCO '18, pp. 363-370, ACM, 2018.
10. Documentation of the jBPM system: https://docs.jbpm.org/latestFinal/jbpm-docs/html_single/
11. Documentation of the PM4Py package: https://pm4py.fit.fraunhofer.de/docs

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes, preparation for the exam, project preparation) [1]	40	1,5

[1] delete or add other activities as appropriate