Statistical tools and data exploration for digitalization

Course description sheet

Basic information

Field of study Raw Materials Value Chain	**Didactic cycle** 2026/2027
Major All	**Course code** GRVNS.IIi1.14953.26
Organisational unit Faculty of Civil Engineering and Resource Management	**Lecture languages** English
Study level Second-cycle (engineer) programme	**Mandatoriness** Obligatory
Form of study Full-time studies	**Block** Foundation Modules
Profile General academic	**Course related to scientific research** No

Course coordinator	Daniel Saramak
Lecturer	Daniel Saramak, Edyta Brzychczy

Period	**Method of verification of the learning outcomes**	**Number of ECTS credits**
Semester 1	Completing the classes **Activities and hours** Lectures: 20 Laboratory classes: 20	2

Goals

C1	During the course, students will learn the principles of data and process mining for digitalization and process automation purposes. Digital twins of the process will also be presented.

Course's learning outcomes

Code	Outcomes in terms of	Learning outcomes prescribed to a field of study	Methods of verification
Knowledge – Student knows and understands:			
W1	Student knows the principles of data analytics in the enterprise.	RVN2A_W01, RVN2A_W06	Test, Report
W2	Student knows selected methods of Data Mining and Machine Learning.	RVN2A_W01, RVN2A_W02	Test, Report
W3	Student knows selected issues related to process mining methods.	RVN2A_W01, RVN2A_W02	Test, Report
Skills – Student can:			
U1	Student can perform data mining analysis	RVN2A_U01, RVN2A_U05	Test, Report
U2	Student can perform process mining analysis	RVN2A_U01, RVN2A_U05	Test, Report
Social competences – Student is ready to:			
K1	Student can perform data or process analysis in project groups.	RVN2A_K01, RVN2A_K02	Test, Report

Program content ensuring the achievement of the learning outcomes prescribed to the module

Curriculum content providing learning outcomes for the course module are as follow: general knowlege of data analysis; application of random variable distributions, parametric and non-parametric tests, regressive models.

Student workload

Activity form	Average amount of hours* needed to complete each activity form
Lectures	20
Laboratory classes	20
Preparation for classes	5
Preparation of project, presentation, essay, report	6
Examination or final test/colloquium	2
Contact hours	5
Realization of independently performed tasks	2

Student workload	**Hours** 60
Workload involving teacher	**Hours** 40

* hour means 45 minutes

Program content

No.	Program content	Course's learning outcomes	Activities
1.	1. Knowledge Discovery Process in the enterprise. 2. Exploratory tasks in Data Mining. 3. Introduction to Process Mining. 4. Process mining tasks. 5. Data analytics for digitalization, including RPA. 6. Statistical analysis of empirical data. 7. Theoretical distributions of discrete and continuous random variables. 8. Selected problems of estimation and statistical tests. 9. Correlation and regression – introduction to modeling.	W1, W2, W3, U1, U2, K1	Lectures
2.	1. Introduction to analytic software and data analysis. 2. Exploratory data analysis. 3. Process discovery from event logs. 4. Conformance checking and enhancement of the process. 5. Additional process perspectives analysis. 6. Descriptive characteristics of empirical data. 7. Application of random variable distributions. 8. Parametric and non-parametric tests. 9. Regressive models.	W1, W2, W3, U1, U2, K1	Laboratory classes

Extended information/Additional elements

Teaching methods and techniques :

E-learning, Flipped classroom

Activities	Methods of verification	Credit conditions
Lectures	Test	
Lab. classes	Test, Report	

Conditions and the manner of completing each form of classes, including the rules of making retakes, as well as the conditions for admission to the exam

To pass the course student is obligated to pass the test related to lectures content and prepare a report after laboratory classes. The test is passed by achieving 50% of all points. The report is evaluated according to the given instructions. 2 attempts for each element are given.

Method of determining the final grade

The final grade is based on the test and the laboratory classes (both positive grades) and is calculated according to the algorithm: FG= 0.5 * T+ 0.5 * L where: T – test grade, L – laboratory grade (evaluation of report).

Manner and mode of making up for the backlog caused by a student justified absence from classes

Laboratory classes need to be completed with another group. If it is not possible, an additional presentation on a given topic can be required.

Rules of participation in given classes, indicating whether student presence at the lecture is obligatory

Lectures are not obligatory; however, test evaluating knowledge is the first element of the final grade.
Laboratory classes are obligatory. After laboratory classes, a student prepares a report, which is the second element of the final grade.

Literature

Obligatory

1. Larose D, Larose Ch.: Discovering Knowledge in Data: An Introduction to Data Mining, 2nd Edition, Wiley, 2014
2. Van der Aalst, W.: Process mining. Data Science in Action. Springer, 2016
3. Dumas et al. Fundamentals of Business Process Management. 2nd edition, Springer, 2018

Optional

1. An overview of data mining and process mining applications in underground mining — Przegląd zastosowań technik drążenia danych i procesów w górnictwie podziemnym / Edyta BRZYCHCZY // Inżynieria Mineralna = Journal of the Polish Mineral Engineering Society ; ISSN 1640-4920. — 2019 R. 21 nr 1, s. 301–314. — Bibliogr. s. 310–313,
2. Conformance checking of a longwall shearer operation based on low-level events / Marcin SZPYRKA, Edyta BRZYCHCZY, Aneta NAPIERAJ, Jacek Korski, Grzegorz J. NALEPA // Energies [Dokument elektroniczny]. — Czasopismo elektroniczne ; ISSN 1996-1073. — 2020 vol. 13 iss. 24 art. no. 6630, s. 1–18
3. Modelling of processes with use of process mining techniques / Edyta BRZYCHCZY, Aneta NAPIERAJ, Marta SUKIENNIK // Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie ; ISSN 1641-3466. — 2018 vol. 116 no. 1995, s. 23–36. — Bibliogr. s. 33–36
4. Process modelling based on event logs / Edyta BRZYCHCZY // W: MAPE 2018 : XV international conference Multidisciplinary Aspects of Production Engineering : 05–08 September 2018, Zawiercie, Poland : conference proceedings, Vol. 1 iss. 1. — [Polska] : Wydawnictwo PANOVA, cop. 2018. — ISBN: 978-83-65265-25-8. — S. 385–392. — Bibliogr. s. 391–392
5. Process-oriented approach for analysis of sensor data from longwall monitoring system / Edyta BRZYCHCZY, Agnieszka TRZCIONKOWSKA // W: Intelligent Systems in Production Engineering and Maintenance : [ISPEM 2018 : Wrocław, 17-18.09.2018] / eds. Anna Burduk [et al.]. — Cham : Springer Nature Switzerland AG, cop. 2019. — (Advances in Intelligent Systems and Computing ; ISSN 2194-5357 ; vol. 835). — ISBN: 978-3-319-97489-7 ; e-ISBN: 978-3-319-97490-3. — S. 611–621
6. Wykorzystanie eksploracji procesów w przedsiębiorstwie — Use of process mining techniques in an enterprise / Edyta BRZYCHCZY // Inżynieria Mineralna = Journal of the Polish Mineral Engineering Society ; ISSN 1640-4920. — 2017 R. 18 nr 2, s. 237–244. — Bibliogr. s. 243, Streszcz.
7. Data analytic approaches for mining process improvement — machinery utilization use case / Edyta BRZYCHCZY, Paulina GACKOWIEC, Mirko Liebetrau // Resources [Dokument elektroniczny]. — Czasopismo elektroniczne ; ISSN 2079-9276. — 2020 vol. 9 iss. 2 art. no. 17, s. 1–17

Learning outcomes prescribed to a field of study

Code	Content
RVN2A_K01	The graduate is aware of the need to constantly update technical and scientific knowledge and is able to use this knowledge practically
RVN2A_K02	The graduate is aware of his theoretical knowledge and practical skills and critical evaluation of them. He is ready to independently search for solutions to theoretical and practical issues, consult experts. Appreciates the role of scientific research in the development and implementation of innovative techniques and technologies in industries related to mineral resources
RVN2A_U01	The graduate is able to use the acquired theoretical knowledge in practice
RVN2A_U05	The graduate has the ability to conduct oral speeches in a foreign language regarding the presentation of research results, technical analyzes, projects and reports, especially in the field of the mineral value chain
RVN2A_W01	The graduate has in-depth and up-to-date knowledge in the field of exact sciences, necessary to conduct research and practical work in the context of searching, obtaining, processing and disposing of mineral resources
RVN2A_W02	The graduate knows typical tools and IT techniques used in each stage of creating the value chain of mineral resources
RVN2A_W06	The graduate has well-established knowledge in the field of entrepreneurship and knows the market mechanisms, as well as the prevailing realities