



## COURSE DATASHEET

<b>Semester:</b>	2025/26/1
<b>Course:</b>	Advanced methods in quantitative research II.
<b>Code:</b>	PEDIECON133
<b>Responsible department:</b>	
<b>Department code:</b>	DIGDI
<b>Responsible instructor:</b>	Dr. Zsolt Tibor Kosztyán

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### Course objectives:

Acquisition of advanced data-driven and model-driven quantitative and machine learning methodological knowledge and skills.

knowledge:

- Knows the concepts of data analysis related his/her doctoral research, ethics, data security, mathematics, statistics, programming principles and relationships necessary for innovative, researcher-level cultivation of the field of data science, especially data types, representations, transformation and optimization procedures, principles of multivariate statistics, machine learning. In order to master this, he processes source studies.
- Is aware of the operation of current technologies used for analysis and modeling and is able to apply them in real-world conditions, even in the case of large amounts of data. This is facilitated by the preparation of complex assignments
- He/She is familiar with the data analysis, mathematical, statistical, ethical concepts, algorithmic and programming principles and relationships necessary for the innovative, research-level cultivation of the field of artificial intelligence, especially in the areas of machine learning, reinforcement learning, network modeling and data processing, statistics, uncertainty management, cognition, human cooperation, which form the basis for lifelong learning and knowledge adaptation in changing industrial environments; In order to master this, he/she processes source studies. to prepare the assignment.
- He/She acquires high-level knowledge in the main application areas of artificial intelligence, such as recognition, recommendation, generation, assistance and similar systems. He/She is familiar with the problems associated with these areas and the main directions of solution options, the application limitations of related techniques; This is facilitated by interactive seminars and laboratory exercises.

ability:



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### Course objectives:

- Able to formalize complex classification, modeling, and forecasting problems that arise in different disciplines, to determine the necessary theoretical and practical methods, and to solve them.
- Knows the dependency relationships between data elements and the structuring and types of data. In the event of a change in technology, is able to make the data analysis strategy independent of technology.
- Able to interpret and decompose complex tasks that arise in different industrial environments and certain disciplines along known methods, to separate tasks according to scientific field, and to plan the solution.
- Able to effectively cooperate with a wide range of users of artificial intelligence, both in the field of preparation and application options and methods. Able to apply the acquired knowledge in specialized fields, e.g. in the healthcare, financial, industrial, educational, or service sectors.
- Able to easily interpret the results in a textual, visual, and verbal manner. Able to implement customizable systems, thus helping transparency and multiple usability.
- Individually able to extend their knowledge to unprecedented tasks based on their previous experiences using already known methods. Able to recognize research development and innovation directions, define related milestones and implement them, with an appropriate research background.

Skills are developed and measured by class and submitted assignments.

attitude:

- Keeps abreast of the latest results in artificial intelligence, data science and related fields, primarily related to



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### Course objectives:

mathematics, statistics, IT, and special areas, and strives to put them to the service of their own development.

autonomy and responsibility:

- Pays great attention to the precise completion of their tasks and the exact observance of deadlines, or ensuring their observance.
- Suitable for performing routine recognition, recommendation, generation and support system design tasks both individually and as a member or leader of a group.

### Course content:

Thematic:

Application of heuristic and meta-heuristic methods to solve optimization, classification and clustering tasks

Robust statistical methods

Gravity and potential models

Simultaneous application of model and data reduction methods (bi-, tri- and multiclustering procedures)

Machine learning methods I: application of gray and black box machine learning methods to unsupervised learning problems



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### Course content:

Machine learning methods II: application of gray and black box machine learning methods to supervised and semi-supervised learning problems

Prediction methods and model validation

Application of neural networks, deep learning methods

### Requirements, evaluation and grading:

Exam: written + oral

### Required and recommended readings:

1. Thulin, M. (2024). Modern Statistics with R. Second edition. Chapman & Hall/CRC Press. ISBN 9781032512440.
2. Andy P. Field (2025). Discovering Using Statistics R & R Studio. SAGE. ISBN: 978-1-4462-0045-2

Suggested textbooks:

Gilliland Michael. (2021): Business Forecasting: The Emerging Role of Artificial Intelligence and Machine



# UNIVERSITY OF PANNONIA

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### Required and recommended readings:

Learning, Wiley ISBN: 9781119782476

László Mátyás, Felix Chan (2021): Econometrics with Machine Learning, Springer, ISBN: 9783031151484

### Learning outcome:

Prerequisites:

Advanced methods in quantitative research I