GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Time series analysis, PG_00063033		
Field of study	Technologies for Industry 5.0		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2027/2028
Education level	first-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	4	Language of instruction	Polish
Semester of study	7	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Theoretical Physics and Quantum Informaton -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Patryk Jasik	
	Teachers		

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	0.0	0.0	30.0	15.0	0.0	45

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	45	5.0	25.0	75

Subject objectives

Gaining knowledge and skills related to time series analysis and modeling.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W06] demonstrates knowledge related to data analysis and engineering, machine learning, knows the principles of integrating data with management systems to analyze complex engineering and technological problems	The student performs analysis, exploration, and cleaning of time series data sets, is able to utilize statistical models and machine learning models, and can integrate various tools for analytics, data management, and storage.	[SW3] Assessment of knowledge contained in written work and projects
[K6_U06] performs analysis, exploration and cleaning of data sets, can use statistical models and machine learning models, integrate various analytical, management and data storage tools	The student demonstrates knowledge in time series analysis and modeling using machine learning methods to analyze complex engineering and technological problems.	[SU1] Assessment of task fulfilment
[K6_U01] applies knowledge of mathematics, physics, chemistry, IT tools and other engineering disciplines to solve theoretical, engineering and technological problems	The student applies knowledge of mathematics, physics, chemistry, computational tools, and other engineering disciplines to solve time-dependent theoretical, engineering, and technological problems.	[SU1] Assessment of task fulfilment

Subject contents

Introduction to Time Series (2 hours)

1. **Definition of Time Series**: Introduction to basic concepts and definitions.
   - Types of time series (continuous and discrete).
   - Applications of time series in various fields.
2. **Basics of Time Series Visualization**: Tools and techniques for visualization.
   - Drawing line and scatter plots.
   - Autocorrelation plots and correlograms.
   - Interactive visualizations.

Time Series Decomposition (4 hours)

1. **Decomposition into Components**: Theory and practice of time series decomposition.
   - Time series transformations.
   - Additive and multiplicative decomposition.
   - Analysis of trend, seasonality, and residual components.
   - Practical examples of decomposition in Python.

Anomaly Detection Methods (6 hours)

1. **Anomaly Detection Techniques**: Overview of methods for detecting anomalies in time series.
   - Statistical methods: deviation detection, Grubbs' and Dixon's tests.
   - Anomaly detection using ARIMA models and regression models.
   - Application of machine learning algorithms (Isolation Forest, One-Class SVM).

Predictive Modeling of Time Series (12 hours)

1. **Statistical Methods**: Traditional modeling methods.
   - ARIMA modeling: theory and application.
   - GARCH models for variance modeling.
2. **Machine Learning in Time Series Modeling**:
   - Use of linear regression and tree-based methods.
   - Ensemble techniques (bagging, boosting).
3. **Neural Networks**: Modern approaches to time series modeling.
   - Introduction to neural networks and RNN.
   - Long Short-Term Memory (LSTM) and Gated Recurrent Units (GRU).
   - Practical application of LSTM models in forecasting.
   - Latest models and packages.

Fourier and Wavelet Analysis (6 hours)

1. **Fourier Analysis**: Theory and application.
   - Fourier Transform: principles and interpretation.
   - Spectral analysis and its applications in time series.
   - Implementation of Fourier Transform in Python.
2. **Wavelet Analysis**: Theory and practice.
   - Wavelet Transform: principles and differences from Fourier.
   - Applications of wavelet analysis in time series.
   - Implementation of Wavelet Transform in Python.

Team Project (max 3 people) (15 hours)

- **Analysis of Real Data**: Case studies from various fields.
- **Creation and Presentation of Predictive Models**.
- **Solving Real-World Problems Using Learned Methods**.

Prerequisites and co-requisites

Knowledge of Python. Fundamentals of statistics and machine learning methods.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Team Project (max 3 students)	60.0%	100.0%

Recommended reading

Basic literature	Jason Brownlee, Introduction to Time Series Forecasting with Python, Machine Learning Mastery
Supplementary literature	Jason Brownlee, Deep Learning for Time Series Forecasting, Machine Learning Mastery
eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed

Guidelines for Creating the Project Report:

1. Report Title
2. Introduction - Motivation, Goals
3. Data Description - Data structure, variable description, origin
4. Description of Data Preparation Process - Step-by-step
5. Data Analysis - Assumptions, brief description of methods and analysis methodology
6. Data Modeling - Assumptions, brief description of methods and modeling methodology
7. Results, Conclusions, and Discussion

The report, along with all code, should be placed in a chosen repository (e.g., GitLab, GitHub).

Work placement	Not applicable

Document generated electronically. Does not require a seal or signature.