GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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|---|---|---|---|
| Subject name and code | Actuarial models, PG_00056621 | | |
| Field of study | Mathematics | | |
| Date of commencement of studies | October 2023 | Academic year of realisation of subject | 2024/2025 |
| Education level | second-cycle studies | Subject group | Optional subject group<br>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 | 2 | Language of instruction | Polish<br>Polish (English if necessary) |
| Semester of study | 3 | ECTS credits | 5.0 |
| Learning profile | general academic profile | Assessment form | exam |
| Conducting unit | Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | mgr Piotr Lebiedź | |
| | Teachers | mgr Piotr Lebiedź | |

| Lesson types and methods of instruction | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|---|
| | Number of study hours | 30.0 | 0.0 | 15.0 | 15.0 | 0.0 | 60 |
| | 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 | 60 | 0.0 | 0.0 | 60 |

**Subject objectives**

The objective of the course is to familiarize students with the concept of actuarial models, particularly those used for the valuation of property insurance. Throughout the course, students will also learn about market standards and best practices.

During the course, students should become acquainted with:

- the technical account of an insurance company;
- the role of pricing;
- data processing methods related to insurance valuation;
- GLM/GAM models;
- Machine Learning models with techniques for explaining them;
- commercialization of models and comparison of various scenarios;
- risk modeling, demand modeling, and price optimization.

As part of the course assessment, each student will prepare their own project using Python.

## Learning outcomes

| Course outcome | Subject outcome | Method of verification |
|---|---|---|
| [K7_U13] Understands the mathematical foundations of the analysis of algorithms and computational processes, can construct algorithms with good numerical properties, used to solve typical and unusual mathematical problems. | Knowledge of building GLM/GAM models, ML models, and price optimization problems. | [SU5] Assessment of ability to present the results of task<br>[SU4] Assessment of ability to use methods and tools<br>[SU3] Assessment of ability to use knowledge gained from the subject<br>[SU2] Assessment of ability to analyse information<br>[SU1] Assessment of task fulfilment |
| [K7_U11] Can construct mathematical models used in specific advanced applications of mathematics, can use stochastic processes as a tool for modeling phenomena and analyzing their evolution. | Preparation of high-quality predictive models using various variables, their transformations, and trend analysis. | [SU5] Assessment of ability to present the results of task<br>[SU4] Assessment of ability to use methods and tools<br>[SU3] Assessment of ability to use knowledge gained from the subject<br>[SU2] Assessment of ability to analyse information<br>[SU1] Assessment of task fulfilment |
| [K7_U08] Knows probability distributions and their properties; is able to use them in practical issues, is familiar with the basics of statistics (estimation issues and hypothesis testing) and the basics of statistical data processing. | Knowledge of Poisson, Gamma, Negative Binomial, Bernoulli, Tweedie, Normal, and Inverse Gaussian distributions, along with their characteristics and applications. Understanding of the t-test and interpretation of p-values. | [SU5] Assessment of ability to present the results of task<br>[SU4] Assessment of ability to use methods and tools<br>[SU3] Assessment of ability to use knowledge gained from the subject<br>[SU2] Assessment of ability to analyse information<br>[SU1] Assessment of task fulfilment |
| [K7_W09] Knows the rules of stochastic modeling in financial and actuarial mathematics or in natural sciences, in particular physics, chemistry or biology. | Knowledge of the specifics of stochastic modeling, discounting, and accounting for trend changes and inflation. | [SW2] Assessment of knowledge contained in presentation<br>[SW3] Assessment of knowledge contained in written work and projects |

## Subject contents

The course consists of:

**Lectures, covering topics such as:**

- The technical account of an insurance company
- The role of pricing and the actuary
- Data preparation
- The architecture of actuarial models
- Risk and demand models
- GLM/GAM
- Machine Learning and explainability
- Commercialization of models
- Price optimization
- Scenario analysis
- Implementation of ready-made pricing models

**Laboratories, where students will use Python to:**

- Process data
- Create visualizations
- Build and compare models
- Develop and analyze various business scenarios

**Project, where students will independently:**

- Prepare a tariff for a motor insurance product, taking into account both frequency and severity models.

<table>
<tr><td>Prerequisites and co-requisites</td><td>Basic knowledge of the following courses:<br><br>1. Probability Theory<br>2. Statistics<br>3. Statistics II<br>4. Databases<br>5. Forecasting Theory<br>6. Mathematical Analysis I<br>7. Mathematical Analysis II<br>8. Actuarial Mathematics<br><br>Basic knowledge of Python programming language.</td></tr>
<tr><td>Assessment methods and criteria</td><td><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Project</td><td>50.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>1. "Generalized Linear Models for Insurance Ratemaking", CAS Monograph Series.<br>2. "Pricing in General Insurance" - Pietro Parodi<br>3. "Comparative performance analysis between Gradient Boosting models and GLMs for non-life pricing", Viktor Martinez de Lizarduy Kostornichenko, University Carlos III of Madrid, Master in Actuarial Science and Quantitative Finance.<br>4. "Price Writer", Jeremy Keating.</td></tr><tr><td>Supplementary literature</td><td>Quantee Blog - https://www.quantee.ai/blog - access 9.08.2024.</td></tr><tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Create well-predicting frequency model;<br>2. Create well-predicting severity model;<br>3. Create well-predicting demand model;<br>4. Compare GLM to GBM built using the same variables;<br>5. Compare two GLMs with different features and/or transformations;<br>6. Reverse engineer premium using available variables.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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