



Syllabus of the educational component

Program of educational discipline



Predictive analysis

Code and name of specialty

113 – Applied mathematics

Institute

Educational and Scientific Institute of Computer Science and Information Technology

Educational program

Intelligent data analysis

Department

Computer mathematics and data analysis

Level of education

Bachelor's level

Type of discipline

Special (professional), Selective

Semester

7

Language of teaching

Ukrainian

Teachers and developers



Lyubchik Leonid Mykhailovych

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Doctor of technical sciences, professor, professor of the Department of Computer Mathematics and Data Analysis of NTU "KhPI".

Work experience since 1981. The number of scientific and educational publications is more than 200. Leading lecturer in the disciplines: "Control theory", "Incorrect problems of data processing", "Predictive analysis". Scientific directions: control and decision-making under conditions of uncertainty, machine learning.

[Learn more about the teacher on the department's website](http://web.kpi.kharkov.ua/kmmm/uk/o_kafedre_ua/profesorstvo-vikladatskij-sklad/lyubchik-leonid-mihajlovich/)

http://web.kpi.kharkov.ua/kmmm/uk/o_kafedre_ua/profesorstvo-vikladatskij-sklad/lyubchik-leonid-mihajlovich/



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assistant, PhD

Number of scientific and educational publications 10

[Детальніше про викладача на сайті кафедри](https://web.kpi.kharkov.ua/kmmm/uk/yamkovyj-klym-sergijovych-2/)

<https://web.kpi.kharkov.ua/kmmm/uk/yamkovyj-klym-sergijovych-2/>

General information

Annotation

The discipline is aimed at studying the principles of forecasting, methods of building forecasting models and algorithms. Methods of estimating parameters of trend models, cyclical trend forecasting, singular and structural spectral analysis, methods of building regression and autoregressive forecasting models, methods of estimating their parameters, methods of identification and recurrent estimation of parameters of autoregressive models are studied. Forecasting is considered a task of learning from precedents, quality and accuracy estimates of forecasting, and the generalizing ability of the forecasting algorithm is given. The effect of overfitting the problem of choosing the complexity of the predictive model and the limitation of the complexity by regularization are studied.

Purpose and objectives of the disciplines

The purpose of studying the discipline is the formation of the ability to independently formulate and solve practical forecasting tasks based on mathematical methods and intelligent information technologies to support decision-making in conditions of uncertainty. |

Format of classes

Lectures, laboratory work, self-learning, consultations. The final control is an exam. |

Competences

GC 5. Ability to conduct research at the appropriate level.

GC 8. Knowledge and understanding of the subject area and understanding of professional activity.

GC 10. Skills in the use of information and communication technologies.

SC 18. Ability to choose and apply mathematical models and methods for statistical and intellectual analysis of data in conditions of uncertainty.

SC 19. The ability to apply mathematical methods and algorithms of machine learning, soft computing and computational intelligence for the analysis of uncertain data, forecasting, and decision-making.

Sc 22. Ability to use information technologies for statistical and intellectual data analysis, forecasting, decision-making, information search and knowledge extraction. |

Learning outcomes

LO 13. To use specialized software products and software systems of computer mathematics in practical work.

LO 21. Know and understand modern methods of solving mathematical problems, statistical and intellectual data analysis, forecasting, etc.

LO 23. To be able to apply existing and develop new algorithms and software tools for statistical and intellectual analysis of uncertain data.

LO 24. To be able to apply existing and develop new algorithms and software tools for processing measurement and observation data, texts, signals and images |

Scope of the discipline

The total volume of the discipline is 120 hours. (4 ECTS credits): lectures – 16 hours, laboratory work – 32 hours, independent work – 72 hours. |

Prerequisites for studying the discipline

"Probability theory", "Mathematical statistics", "Data and time series analysis". |

Features of the discipline, methods, and technologies of education

Lectures are conducted interactively using multimedia technologies. Laboratory works are carried out using free software - Scilab, and Xcos libraries. Educational materials are available to students in the Microsoft 365 environment through OneDrive and OneNote Class Notebook. |

Program of educational discipline

Topics of lectures

Topic 1. Introduction. Predictive analytics - principles, methods, means.

Polynomial and seasonal trend estimation and forecasting.

Topic 2. Evaluation and forecasting of the cyclical component.

Dynamic method of principal components, singular spectral analysis (SSA).

Topic 3. Regression forecasting models.

Forecasting based on multiple linear regression. Multicollinearity. Regularization and ridge regression.

Topic 4. Autoregressive forecasting models.

Autoregression model - moving average (ARMA). Autoregression model - integrated variable mean (ARIMA).

Topic 5. Identification and estimation of parameters of autoregression models.

Estimating the parameters of autoregressive models. Yule-Walker equation.

Topic 6. Forecasting based on machine learning.

The method of support vector machines (SVM). Linear SVM classification method. Linear SVMs are predictors of time series.

Topic 7. Non-linear forecasting models.

Nuclear methods of machine learning. Nuclear method of support vectors. Kernel nonlinear SVMs are predictors of time series.

Topic 8. Forecasting of multidimensional time series.

Representation of multidimensional time series in state space. Discrete Kalman filter. |

Topics of practical classes

|Practical classes within the discipline are not provided. |

Topics of laboratory work

|Topic 1. Study of algorithms of moving average and exponential smoothing.

Topic 2. Study of structural and singular spectral analysis algorithms.

Topic 3. Research of regularized algorithms for building regression predictive models. Topic 4. Research of autoregressive predictive models ARMA, ARIMA.

Topic 5. Research of recurrent algorithms for identification of autoregression models.

Topic 6. Research of forecasting algorithms based on support vector machines (SVM).

Topic 7. Development and research of nonlinear forecasting models.

Topic 8. Study of algorithms for forecasting multidimensional time series. |

Self-learning

| Topic 1. Study of exponential smoothing methods and algorithms. Linear trend. Linear trend and seasonality. Multiplicative trend and seasonality.

Topic 2. Study of methods of singular spectral analysis and methods of SSA forecast.

Topic 3. Study of regularization methods when building predictive regression models.

Topic 4. Study of methods of building autoregressive forecasting models ARMA, ARIMA.

Topic 5. Study of methods of estimating parameters of autoregression models.

Topic 6. Learning the method of support vector machines (SVM).

Topic 7. Study of forecasting methods based on kernel methods of machine learning and non-linear SVM predictors.

Topic 8. Study of methods of forecasting multidimensional time series in the space of states. |

Non-formal education

|Within the framework of non-formal education according to the relevant Regulation (<http://surl.li/pxssv>), the educational component or its separate topics can be taken into account in case of independent completion of professional courses/training, obtaining civic education, online education, professional internship, etc. In particular, individual topics of this component may be taken into account upon successful completion of the following courses:

Topics 1 - 3.

Coursera: Introduction to Predictive Modeling

<https://www.coursera.org/learn/introduction-to-predictive-modeling>

Coursera: Meaningful predictive modeling

<https://www.coursera.org/learn/meaningful-predictive-modeling?specialization=python-data-products-for-predictive-analytics>

Topics 4,5.

Coursera: Bayesian Statistics: Time Series Analysis

<https://www.coursera.org/learn/bayesian-statistics-time-series-analysis>

Coursera: Practical Time Series Analysis

<https://www.coursera.org/learn/practical-time-series-analysis>

Coursera: Demand Forecasting Using Time Series

<https://www.coursera.org/learn/demand-prediction-using-time-series>

Topics 6 - 8.

Coursera: Specialization Python Data Products for Predictive Analytics

https://www.coursera.org/specializations/python-data-products-for-predictive-analytics?topic=Data%20Science&sortBy=BEST_MATCH#courses

Coursera: Predictive Modelling with Azure Machine Learning Studio

<https://www.coursera.org/projects/predictive-modelling-azure-machine-learning-studio> |

Literature and educational materials

Basic literature

1. Гуськова В. Г., Бідюк П. І., Гасанов А. С. Ймовірісно-статистичні методи моделювання і прогнозування - Київ: Видавництво НПУ імені М. П. Драгоманова, 2022. 456 с.

https://enpuir.npu.edu.ua/bitstream/handle/123456789/41164/Huskova_Bidyuk_Gasanov.pdf?sequence=1&isAllowed=y

2. А. Т. Яровий, Є. М. Страхов. Аналіз часових рядів. Навчально-методичний посібник для студентів математичних та економічних спеціальностей. Освіта України. 2019.

https://onu.edu.ua/pub/bank/userfiles/files/fmfit/nachalni_materiali/navch_mat_111_mag/analiz_chasovykh_ryadiv.pdf

3. Predictive Analytics for Time Series with InstantML For Dummies. John Wiley & Sons, Inc. 2021.

<https://www.victa.nl/wp-content/uploads/Predictive-Analytics-For-Dummies-E-book-by-Tangent-Works.pdf>

4. Suhasini Subba Rao. A course in Time Series Analysis. 2022.

https://web.stat.tamu.edu/~suhasini/teaching673/time_series.pdf

5. Rob Hyndman, George Athanasopolous. Forecasting Principles and Practice, Monash University, Australia. 2019.

<https://otexts.com/fpp2/>

Additional literature

6. Marco Peixeirom. Time Series Forecasting in Python. 2022. Manning Publications Co.

https://www.methsoft.ac.cn/scipaper_files/document_files/Manning.Time.Series.Forecasting.in.Python.pdf

7. Jason Brounlee. Introduction to Time Series Forecasting with Python. 2019.

<https://machinelearningmastery.com/introduction-to-time-seriesforecasting-with-python/>

8. Edouard Duchesnay, Tommy Löfstedt, Feki Younes, Statistics and Machine Learning in Python, 2019.

https://www.academia.edu/-38813186/Statistics_and_Machine_Learning_in_Python_Release_0.2

9. Terence C. Mills. Applied Time Series Analysis. A Practical Guide to Modeling and Forecasting. 2019 Elsevier Inc.

http://repo.darmajaya.ac.id/5635/1/Applied%20Time%20Series%20Analysis_%20A%20Practical%20Guide%20to%20Modeling%20and%20Forecasting%20%28%20PDFDrive%20%29.pdf

Electronic resources

1. Rutger Lit. Time Series Lab Manual. 2022.

<https://timeserieslab.com>

https://timeserieslab.com/articles/tsl_documentation.pdf |

Assessment and grading

Criteria for evaluating student performance and distribution of points

The student's points in the discipline are calculated according to the following ratio:

- test papers: 20% of the semester grade;
- self-learning: 15% of the semester grade;
- laboratory: 25% of the semester grade;
- exam: 40% of the semester grade.

Rating scale

Total points	National assessment	ECTS
90–100	Perfectly	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactorily	D
60–63	Satisfactorily	E
35–59	Unsatisfactorily (further study required)	FX
1–34	Unsatisfactorily (further study required)	F

Norms of academic ethics and policy of the course

The student must adhere to the "Code of Ethics of Academic Relations and Integrity of NTU "KhPI": show discipline, education, benevolence, honesty, and responsibility. Conflict situations should be openly discussed in study groups with the teacher, and if it is impossible to resolve the conflict, it should be brought to the attention of the employees of the institute's directorate.

Regulatory and legal support for the implementation of the principles of academic integrity of NTU "KhPI" is posted on the website: <http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/>

Approval

Approved by

Date, signature
29.08.2024



Head of the Department
Olena AKHIEZER

Date, signature
29.08.2024



Guarantor of the Educational Program
Olena AKHIEZER