KAZAKH-BRITISH TECHNICAL UNIVERSITY
SCHOOL OF APPLIED MATHEMATICS

Approved by
Dean of School of Applied Mathematics
A.A. Issakhov
«23» 08 2022

Syllabus
Mathematical foundations of the theory of machine learning and forecasting
Semester: Fall 2022
2022/2023 Academic Year
3 credits (2/0/1)

Instructor: Kuanysh Sh. Abeshev, professor

Personal Information about the Instructor	Time and place of classes		Contact information	
	Lessons	Office Hours	Tel.:	e-mail
Professor, Ph.D.	According to the schedule	TBA		
		TBA		

COURSE DURATION: 3 credits, 15 weeks, 45 class hours
COURSE PRE-REQUISITES: Linear Algebra, Probability and Mathematical Statistics, Programming languages (Python).

COURSE DESCRIPTION

Course objectives

Machine learning is a technology for designing and implementing algorithms that allow computers to automatically learn from data or past experience and improve their performance without explicit programming. It forms the basis of artificial intelligence. It includes algorithms to design coding with which computers can decipher information. This course covers the fundamental concepts of machine learning and popular machine learning algorithms, the basic concepts of supervised learning, unsupervised learning, and practical problem solving using simple Python programming.

Machine learning offers important new possibilities for solving today's complex problems, but it is not a panacea. To go beyond hype, engineers and scientists need to understand how and where machine learning tools are the best and where they are not.

Course outcomes

Upon successful completion of this course, students will:

1. Explain Machine Learning concepts, classifications of Machine Learning and write simple programs using python.
2. Describe Supervised Learning concepts.
3. Explain Support Vector Machine concepts.
4. Describe unsupervised learning concepts and dimensionality reduction techniques.
5. Discuss simple Machine Learning applications in a range of real-world applications using Python programming.

Knowledge: during the study of this course, students must obtain knowledge about how to explain with examples the basic terminology of machine learning, fit a model to data, optimizing cost function, handling, cleaning, preparing data, selecting and engineering data, learning algorithms Linear and Polynomial Regression, Logistic Regression, k-Nearest Neighbors, Support Vector Machines, Decision Trees, Random Forest, and Ensemble methods.

Skills: As a result of studying this course, students must be able to

- Programming with Python
- NumPy with Python

- Use pandas to handle Excel Files
- Using pandas Data Frames to solve complex tasks
- Web scraping with python
- Connect Python to SQL
- Use matplotlib and seaborn for data visualizations
- Use plotly for interactive visualizations
- Machine Learning with SciKit Learn, including
- Linear Regression and Polynomial Regression
- K Nearest Neighbors
- K Means Clustering
- Decision Trees
- Random Forests
- Support Vector Machines

Be qualified in
- Creation/manipulation application;
- gain skills of computational thinking and modeling acquired to date;
- Know:
- · The basics of NumPy and Pandas
- · How to use data visualization with Matplolib, Seaborn
- · How to use Python and Machine Learning to create predictive models

Literature

Required

1. Aurélien Géron. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition. 2019.
2. Chris Albon, Machine Learning with Python Cookbook, Practical Solutions from Preprocessing to Deep Learning, O'Rielly, 2018

Supplementary

1. Dipanjan Sarkar, Raghav, Bali, Tushar Sharma, Practical Machine Learning with Python, Apress, 2018.
2. Theodore Petrou, Pandas Cookbook, Recipes for Scientifi c Computing, Time Series Analysis and Data Visualization using Python, Packt, 2017.
3. Dmitry Zinoviev, Data Science Essentials in Python, 2018.

COURSE CALENDAR

Week	Class work				SIS (student's individual study)
	Topic	Lectures	Seminars	Chapters for reading	
1	Programming with Python. NumPy with Python. Use pandas to handle Excel Files	2	1	according to the lecture notes	SIS 1
2	Matplotlib and Seaborn for data visualizations	2	1	according to the lecture notes	SIS 2
3	The Machine Learning Landscape	2	1	according to the lecture notes	SIS 3
4	End-to-End Machine Learning Project. Working with Real Data.	2	1	according to the lecture notes	SIS 4
5	Classification Project.	2	1	according to the lecture notes	SIS 5

6	Training Models. Linear Regression.	2	1	according to the lecture notes	SIS 6
7	Gradient Descent.	2	1	according to the lecture notes	SIS 7
8	Polynomial Regression.	2	1	according to the lecture notes	SIS 8
9	Regularized Linear Models.	2	1	according to the lecture notes	SIS 9
10	Logistic Regression.	2	1	according to the lecture notes	SIS 10
11	Support Vector Machines. Linear SVM Classification.	2	1	according to the lecture notes	SIS 11
12	Nonlinear SVM Classification. SVM Regression.	2	1	according to the lecture notes	SIS 12
13	Decision Trees	2	1	according to the lecture notes	SIS 13
14	Ensemble Learning and Random Forests	2	1	according to the lecture notes	
15	Dimensionality Reduction. PCA.	2	1	according to the lecture notes	

COURSE ASSESSMENT PARAMETERS

Attendance and activity on lessons	10%
Home works and SIW	10%
Control works and midterm	40%
Final exam	40%
Total	**100%**

No	Assessment criteria	Weeks															Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.	Attendance and activity on lessons	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		7.0
2.	Home works and SIW																
3.	Control works and midterm				16			16				16			16		64
6.	Final examination															40	40
	Total								30						30	40	100

Lectures are conducted in the form of explaining the theory given in the course that is why students supplied with handouts uploaded into the intranet. Activity and attendance on lessons is mandatory. Mandatory requirement is preparation for each lesson.

Grading policy:

Intermediate attestations (on 8th and 15th week) join topics of all lectures, laboratories, homework, quiz and materials for reading discussed to the time of attestation. Maximum number of points within attendance, activity, homework, quiz and laboratories for each attestation is 30 points.
Final exam joins and generalizes all course materials, as a project defense. Final exam duration is 150 min, each presenter has 15 min. Maximum number of points is 40. At the end of the semester you receive overall total grade (summarized index of your work during semester) according to conventional KBTU grade scale.

ACADEMIC POLICY

Students are required:

- to be respectful to the teacher and other students;
- to switch off mobile phones during classes;
- DO NOT cheat. Plagiarized papers shall be graded with zero points!
- to come to classes prepared and actively participate in classroom work; to meet the deadlines;
- to enter the room before the teacher starts the lesson;
- to attend all classes. No make-up tests or quiz are allowed unless there is a valid reason for missing it;
- to follow KBTU academic policy regarding **W, AW, I, F** grades.
- When students are absent for 20% of the lessons or more (without Spravka), then their grade is F.
- When students have a score of 29 or less for attestation 1 added to attestation 2, then their grade is F.
- When students have a score of 19 or less (less than 50%) for their final exam, then their grade is F.
- When students do not come for their final exam, then their grade is F.

Students are encouraged to

- consult the teacher on any issues related to the course;
- make up within a week's time for the works undone for a valid reason without any grade deductions;

Professor at School of Applied Mathematics — Kuanysh Sh. Abeshev
Minutes # «__»_____, 2022