SATBAYEV UNIVERSITY

«Approved by»

Seilova N.A. _____
signature of the Director of the Institute

Юнусов Р. _____
signature of the head of the Department

«__» _____ 2019y.

SYLLABUS

CSE312 Advanced Neural Networks Models
Semester: autumn: 2019
2019/2020 Academic Year
3 credits (1/0/2)

Almaty, 2019

Developed by Professor of Department of Software Engineering:

Personal Information About the Instructor	Time and place of Classes		Contact Information	
	Lessons	Office hours	Tel:	e-mail:
Ravil I. Muhamedyev Room#XXX	According to the schedule	According to the schedule	8 707 684 43 70	ravil.muhamedyev@gmail.com

Course Duration: 3 credits, 15 weeks, 45 class hours

Course Pre-Requisites: Basic knowledge of Programming, Probability, Algorithms and Data Structure, Basic of Calculus & Linear algebra

Course Information

Course Description:

This course is about artificial neural networks (ANN) and their applications to solving real tasks.

First part of the course is focused on fundamentals of machine learning. We consider supervised, unsupervised learning and regression in detail. Some knowledge of linear algebra and differential calculus are needed to understanding this part of discipline.

The focus of the second part is to illustrate a number of machine learning algorithms (MLA) based on ANN. We provide detailed explanations of their inner workings. Some of the algorithms and methods included are MLP, LSTM, RNN, CNN etc.

The main objectives of the course:

- Consider the main types of machine learning and their tasks
- Learn the theoretical foundations of machine learning
- Examine data classification and clustering methods.
- Acquire practical skills in application of ANN.
- Get information on current trends in ANN

Learning outcomes

Understand

What are machine learning methods and algorithms and in which they should be used?

Know

Basic ANN capabilities in data processing tasks and software used for this

Be able to

Use ANN in practical data processing tasks.

Literature

1. Müller A. C. et al. Introduction to machine learning with Python: a guide for data scientists. – " O'Reilly Media, Inc.", 2016.375 c. isbn:1449369901 https://books.google.kz/books?id=1-4lDQAAQBAJ&printsec=frontcover&dq=isbn:1449369901&hl=ru&sa=X&ved=0ahUKEwjsna_FoPfeAhWpp4sKHeBmDMcQ6AEIJjAA#v=onepage&q&f=false
2. M. Tim Jones. Artificial Intelligence: A Systems Approach. INFINITY SCIENCE PRESS LLC Hingham, Massachusetts, New Delhi, 2008. ISBN: 978-0-9778582-3-1
3. Mohri M., Rostamizadeh A., Talwalkar A. Foundations of machine learning. – MIT press, 2012.-427 p.

4. AI Application Programming by M. Tim Jones .Charles River Media © 2003. ISBN:1584502789
5. Stuart Russell and Peter Norvig. Artificial Intelligence: A modern approach. Pearson Edition, Inc., Upper Saddle River, New Jersey 07458. 2010. ISBN-10: 0136042597, ISBN-13: 9780136042594
6. Рассел Стюарт, Норвиг Питер. Искусственный интеллект:Современный подход.- М.: Издательский дом «Вильямс», 2006.- 1408 с.
7. Pedregosa F. et al. Scikit-learn: Machine learning in Python //Journal of Machine Learning Research. – 2011. – Т. 12. – №. Oct. – С. 2825-2830.
8. Джонс М. Тим. Программирование искусственного интеллекта в приложениях.-М.: ДМК Пресс, 2004.-312 с.
9. LeCun Y., Bengio Y., Hinton G. Deep learning //Nature. - 2015. - V. 521. - №. 7553. - V. 436-444.
10. Muhamedyev R. Machine learning methods: An overview //CMNT. - 19(6). – 2015. - P. 14-29.
11. Internet resources focused on deep learning: tensorflow.org, caffe.berkeleyvision.org, deeplearning.net/software/theano (2017)

Week	Class work		
	Topic	Lectures	Seminars
Part 1. Fundamentals of learning			
1	Intro to machine learning and supervised learning	1	2
2	Spervised learning [1], basic of numpy, notes by linear algebra	1	2
3	Representation of data [2] [3]	1	2
4	Regressions, solving the tasks.	1	2
5	Mathematical basis of logistic regression, solving the tasks[4]	1	2
6	Artificial neural networks. Back propagation algorithm.		
7	Mathematical principles of artificial neural networks, Solving the tasks by multi layer perceptron (MLP)[5].		
8	MT (reports, test and etc.)	1	2
Part 2. Applied Machine learning			
9	Mathematical basis of MLP [6] [7] [8]	1	2
10	Accelerated learning of NN. Solving the tasks [9]. Individual reports[10].		
11	Deep learning networks. Keras, Capstone project[11]	1	2

[1] 3-+Supervised+Learning-Copy1
[2] 1-+Loading+a+dataset
[3] A simple classification task_Module 1+
[4] 3-Python_Basics_With_Numpy_v3_ANg_tasks.ipynb, 3-Python_Basics_With_Numpy_v3_ANg_decision.ipynb
[5] ML_lab07_MLP_classifier
[6] based on A.Ng lecture
[7] ML_lab07.1_AlgebraicApprouch
[8] **Optional task** Implementing a Neural Network from Scratch in Python – An Introduction http://www.wildml.com/2015/09/implementing-a-neural-network-from-scratch/ (from ANg)
[9] ML_lab07.2_AlgebraicApprouch_AccleratedLearning
[10] main topic is overview of paper related to ML (2016_A survey of transfer learning.pdf, 2017-Emotion in reinforcement learning agents and robots.pdf, 2018_ChapterSpringer_Aggarwal2018_Chapter_DeepReinforcementLearning.pdf, 2017-Hierarchical Dirichlet scaling process.pdf (mathematical basis), 2018_Chapter_Springer_Convolutional Neural Networks_HabibiAghdam-JahaniHeravi2017_Chapter_ConvolutionalNeuralNetworks, 2018_Chapter_Springer_CMS-RCNN-Contextual Multi-Scale Region-Based CNN for Unconstrained Face Detection_Zhu2017_Chapter_CMS-RCNNContextualMulti-ScaleR, 2018_Djakonov_book_boosting.pdf, 2018_Fardapaper-A-survey-on-deep-learning-for-big-data, 2018_Jurafsky_Martin_Sequence Processing with RNN_Speech_and_language_processing, Application of Big Data and Machine Learning in Smart Grid, and Associated Security Concerns: A Review
[11] ML_Capstone project

12	Presentation of reports. RNN, LSTM	1	2
13	Presentation of reports. Neural networks Regression[12]	1	2
14	Presentation of reports. Interpretation of "black boxes"[13] of machine learning SHAP. Unsupervised learning[14]	1	2
15	MT (projects defense, presentation of reports and etc.)	1	2
		15	30

LABORATORY WORKS

Week	Laboratory work	Cost (in points)	A task without mark * is mandatory (grade 3). To get a complete estimate, you need to solve the problem marked **. These complex tasks could be passed a week later.[15]
1	Python renew	0	
2	lab00_linear regression by numpy	5	MLF_LinearRegression_python_numpy_py_v.0.0.doc
3	lab01_Linear regression	5	MLF_LinearRegression_py_v.1.01.doc
4	lab02_polynomial regression	5	MLF_PolynomialRegression_py_v.1.1.doc
	Lab03.1_NumpyBasics		3-Python_Basics_With_Numpy_v3_ANg_tasks.ipynb
5	lab03_logistic regression	5	MLF_LogisticRegression_py_v.1.0.doc
7	lab07_MLP_classifier	5	MLF_MLPClassifier_py_v.1.0.doc
8			
9	AlgebraicApprouch	5	ML_lab07.1_AlgebraicApprouch
10	AlgebraicApprouch_AccleratedLearning	5	ML_lab07.2_AlgebraicApprouch_AcceleratedLearning
11	ML_Capstone project	20	ML_Capstone project
14	SHapley Additive exPlanations	5	MLFML_lab15_SHapley Additive exPlanations
		30	

TASKS

[12] Module+4
[13] ML_lab15_SHapley Additive exPlanations
[14] Applied Machine Learning: Unsupervised Learning
[15] Задача без* обязательная - оценка 3, для получения полной оценки нужно решить задачу с ** более сложные задачи допускается сдать на неделю позднее

for teachers supervised independent study of students (TSIS)

Week	SIS	Cost (in points)
3	Ex1-LinearRegression	4
5	Ex2-LogisticRegression	2
10	Ex3-Multi-class Classification and Neural Networks	4
11	Ex4- NeuralNetworks Learning	4
13	Ex5-Regularized Linear Regression and Bias v.s. Variance	3
14	Ex6*-SupportVectorMachine	4
15	Ex7*-DimensionalityReduction	4
	Ex8*-RecommenderSystems	3

TASKS

for student's independent study (SIS)

Week	TSIS	Cost (in points)
1	Octave/Mathlab command set	
2	Linux group operating system	
3	Machine learning algorithms	
4	Classification and clustering tasks	
5	Types of regressions	
6	Gradient descent algorithm	
7	Matrix equation of regression task	
8	Suppor vector machines	
9	Taxonomy of artificial Neural networks	
10	Back propagation error	
11	Decision trees	
12	How to measure the quality of classification	
13	Data preprocessing methods	
14	Dimentionality reduction	
15	Unsupervised learning	

COURSE ASSESSMENT PARAMETERS

Type of activity	Final scores
Attendance /participation	5%
Laboratory works	15%
SIS	12%
TSIS	8%
Midterm and endterm	20%
Final exam	40%
Total	**100%**

No	Assessment criteria	Weeks															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16-17

1.	Attendance / participation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1%
2.	Laboratory works	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	55%
3.	SIS			*					*							*	2%
4.	TSIS								*							*	2%
5.	Final examination															*	40%
	Total																**100%**

Lectures are conducted in the form of supervising of SIS on understanding of theory of given course, that is why students supplied with handouts uploaded into the intranet. Activity on lectures is required and is one of the constituent of final score. Mandatory requirement is preparation to each lesson.

Laboratories are organized in the form of research. The preparation to the laboratories is provided in the form of solving of typical problems according to the lectures topics, which within experiments with computational experiments that is one of the most important tools of understanding of modeling and simulation.

Grading policy:

Intermediate attestations (on 8th and 15th week) join topics of all lectures, laboratories, SIS-I, II, TSIS and materials for reading discussed to the time of attestation. Maximum number of points within attendance, activity, SIS, TSIS and laboratories for each attestation is 40 points.

Final exam joins and generalizes all course materials, is conducted in the complex form with quiz and problem. Final exam duration is 100 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;
- not to cheat. Plagiarized papers shall not be graded;
- to meet the deadlines;
- to come to classes prepared and actively participate in classroom work;
- to enter the room before the teacher starts the lesson;
- to attend all classes. No make-up tests are allowed unless there is a valid reason for missing them;

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;
- make any proposals on improvement of the academic process;
- track down their continuous rating throughout the semester.

Department of Computer Security and Information Systems

Lecturer *R.I.Muxamediev*

Minutes # 2 of Department of Software Engineering, «16» August 2019.