SECTION A: DEFINITIVE

1.	**General course information**		
1.1	School: Science and Technology	1.6	Credits (ECTS): 8
1.2	Course Title: Deep Learning	1.7	Course Code: CSCI 475
1.3	Pre-requisites: CSCI 353 Programming Paradigms	1.8	Effective from: *Fall 2018*
1.4	Co-requisites: N/A		
1.5	Programs: *(in which the course is offered)* Computer Science ☐ Core ☒ Elective		

2. Course description (max.150 words)

This course is a one semester course intended for students majoring in Computer Science. It introduces the students to the fundamental concepts of deep learning. The main themes of the course are Benefits, properties and challenges of Deep Learning; Introduction to Machine Learning and Optimization; Challenges and Common Approaches; Logistics Regression; Gradient Descent; Perceptron Learning; Stochastic gradient descent; Multi-layer Perceptrons; Non-linearity in ANNs; Representational Capacity; Bias-variance dilemma; Overfitting, generalization; Regularization; Convolutional neural networks; Restricted Boltzmann Machines; Deep Recurrent Networks and Sequence Learning; Applications to pattern recognition from video data, speech recognition and natural language processing. The students will learn how to design a deep learning architecture. The course also explores several common deep learning techniques and exposes the students in learning how to use deep learning in a very efficient manner. Students will gain experience through assignments, with an emphasis on proper deep learning practices with appropriate applications.

3.	**Summative assessment methods** (tick if applicable)**:**				
3.1	Examination	☒	3.5	Presentation	☒
3.2	Term paper	☐	3.6	Peer-assessment	☐
3.3	Project	☒	3.7	Essay	☐
3.4	Laboratory Practicum	☒	3.8	Other *(specify)*	_____

4. Course aims

The aims of the course are:

1) to introduce students to the basic concepts and how to solve various problems using deep learning approaches;
2) to expose students to various deep learning concepts approaches such as Convolutional Neural Networks; Restricted Boltzmann Machines; Deep Recurrent Networks and Sequence Learning;
3) to familiarize students with a few deep learning frameworks that they may not have been exposed to.

5. Course learning outcomes (CLOs)

5.1 By the end of the course the student will be expected to be able:

1) to develop solutions using deep learning with Python programming language and environments to solve problems and perform specified tasks, using proper hyper parameters and optimization techniques;
2) to understand and apply concepts related to deep learning, such as logistics regression; gradient descent; regularization; Convolutional Neural Networks; Restricted Boltzmann Machines; Deep Recurrent Networks;
3) to understand the strengths and weaknesses of various deep learning approaches;
4) to critically determine how to select a deep learning approach for a domain and task;

5.2

CLO ref #	Program Learning Outcome(s) to which CLO is linked	Graduate Attribute(s) to which CLO is linked
1, 2	Assess technical problems and establish requirements for their solution; Design and implement deep learning solutions in the form of software;	Possess an in-depth and sophisticated understanding of their domain of study. Be intellectually agile, curious, creative and open-minded.
3, 4	Identify and describe the significant issues, challenges, and milestones within the field; Assess technical problems and establish requirements for their solution; Identify the theoretical capabilities and practical limitations related to deep learning;	Possess an in-depth and sophisticated understanding of their domain of study. Be intellectually agile, curious, creative and open-minded.

SECTION B: NON-DEFINITIVE
Course Syllabus
Details of teaching, learning and assessment

6.	**Detailed course information**		
6.1	Academic Year: 2018-19	6.3	Schedule (class days, time): Lecture: TBD Lab: TBD
6.2	Semester: Fall	6.4	Location (building, room): Lecture: TBD Lab: TBD

7. Course leader and teaching staff

Position	Name	Office #	Contact information	Office hours
Course Leader	Adnan YAZICI	#6213	adnan.yazici@nu.edu.kz	
Course Instructor(s)	Adnan YAZICI, Fatih DEMIRCI	#7425 #7424	adnan.yazici@nu.edu.kz fatih.demirci@nu.edu.kz	
Teaching Assistant(s)	TBD			

8. Course Outline

Session	Date (tentative)	Topics and Assignments	Course Aims (ref. # only, see item 4)	CLOs
Week 1		**Introduction to Machine Learning, Deep Learning, and Applications** [Introduction to Machine Learning and Deep Learning; Brief history; Benefits, properties and challenges of Deep Learning; Applications]	1, 2	**2, 3, 4**
Week 2		**Machine Learning and Optimization** [Linear Regression; Solving Optimization: Gradient Descent, Direct Solution; Generalization; K Nearest Neighbor;]	2, 3	1 - 5
Week 3		**Artificial Neural Networks** [Linear Classifiers and Their Limits; Perceptron Learning; Training a classifier; Cost Functions: 0-1 loss, linear regression, logistic nonlinearity, logistic regression;]	2, 3	1, 2, 5
Week 4		**Artificial Neural Networks** [Backpropagation; Singlelayer and Multilayer Perceptrons; Practical issues; Pre-training Steps; Weight Initialization; Overfitting & Extrapolation;]	2, 3	1 – 5

Week 5		**Introduction to Image Representation, Image Classification, K-NN and Linear Classifiers for Image Classification** [Definitions; image types; linear classification-I]	1,2	3,4
Week 6		**Convolutional Neural Networks-I** [Convolution layer; Stride; Padding; Spatial Dimensions]	2,3	3,4
Week 7		**Convolutional Neural Networks-II** [Different layers of processing; Pooling; Fully Connected layer] **Midterm**	2,3	3,4
Week 8		**Convolutional Neural Networks-Working Example, Deep Learning Hardware and Software** [Constructing CNN for recognizing symbols, CPUs, GPUs, TPUs, NPUs]	2,3	1,3,4,5
Week 9		**Working with CNNs in Practice** [Data Augmentation, Dropout, Transfer Learning, Power of Small Filters, Convolutions as Matrix Multiplication]	2, 3	3, 4
Week 10		**Recurrent Neural Networks and Applications** [RNN, LSTM]	2,3	3,4
Week 11		**Case Study-I** [Widely-used CNN Architectures; LeNet-5, AlexNet, ZFNet, VGGNet, GoogleNet, ResNet]	2,3	1, 3, 4, 5
Week 12		**Case Study-II** [Example CNN Applications; Age estimation and gender detection from facial images, image segmentation]	2,3	1, 3, 4, 5
Week 13		**Student Presentations - I**	2, 3	1, 2, 4
Week 14		**Student Presentations - II**	2,3	1,2,4

9.	**Learning and Teaching Methods**
1	Lecture-demonstration by teacher; Class projects; Homeworks
2	Formal face-to-face lectures and office hours.
3	Laboratory sessions to support lecture sections and provide with practical hands on experience with digital circuits and boards.

10.	**Summative Assessments**			
#	**Activity**	**Date** (tentative)	**Weighting (%)**	**CLOs**
	Weekly lab assignments		15%	3-6
	Homework		15%	3-6
	Midterm Exam		35%	1-7
	Attendance (Lecture and Labs)		5%	1-7
	Final Project		30%	6-7
	Extra Credit (projects well-written in IEEE conf. format and quality)		15%	3-6

11.	**Grading**	
Letter Grade	**Percent range**	**Grade description** (where applicable)
A	95-100	See Section 6 of "Academic Policies and Procedures for Undergraduate Programs" (available at https://registrar.nu.edu.kz/policies-and-procedures)
A-	90-94.9	
B+	85-89.9	
B	80-84.9	
B-	75-79.9	
C+	70-74.9	
C	65-69.9	
C-	60-64.9	
D+	55-59.9	
D	50-54.9	
F	0-49.9	

12.	**Learning resources** (use a full citation and where the texts/materials can be accessed)
E-resources, including, but not limited to: databases, animations, simulations, professional blogs, websites, other e-reference materials (e.g. video, audio, digests)	TBD -- Extensive on-line digital resources (readings, references, tutorials) will be utilized throughout the course.
E-textbooks	N/A
Laboratory physical resources	Labs will be conducted in appropriate computer labs (e.g., 7-422, 7-522) with required software installed
Special software programs	Keras, TenserFlow, Torch Other required software (Pyhton and Java) will be installed on the lab machines, and is available for free download to personal machines.

Journals (inc. e-journals)	N/A
Textbooks	We do not have a regular textbook for the course, though the following may be used as an occasional reference: • Y. Bengio, I. Goodfellow and A. Courville, "Deep Learning", MIT Press, 2016. • Geron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", O'Reilly, 2017. • Murphy, Kevin P. Machine learning: a probabilistic perspective. MIT press, 2012.

13. Course expectations

List the expectations of students for the course regarding the course attendance, class participation, group work, late/missed submission of assignments.

Attendance
Missing classes and habitual tardiness will have a negative effect on your grade, both directly (through your attendance grade) and indirectly (by not benefitting from the in-class experience).
You are also responsible for any announcements made during the class period, so be sure to ask your instructor, TAs, or classmates for any info that you may have missed if you did not attend.

Electronic Resources
Labs will be conducted in one of our hybrid computer labs, which are designed to accommodate the full range of course activities. The necessary programming tools are installed on the classroom lab computers, and are available online for free download to your own computer.
You are expected to check your Nazarbayev University e-mail on a daily basis for updates and announcements about the course.

Assignment Submission and Late Policy
Assignments must be submitted by the announced due date and time, as directed by the instructor. Some assignments may need to be submitted in the form of physical hard-copy in class, generally within the first five minutes of the start of the class period. Other assignments will need to be submitted digitally to Moodle. In case Moodle does not work, assignments need to be submitted by email to your instructor AND teaching assistant by the deadline date and time.

In general, there is no late policy; if you submit an assignment after it is due, you get zero points for your assignment. In cases of illness or family emergency, you must inform your instructor immediately if you believe you will not be able to submit your assignment on time. In such cases, an exception may be made at the discretion of your instructor.

Classroom Behavior
You are expected to act respectfully towards your fellow classmates, TAs, and instructors inside and outside of the classroom. We have a limited amount of time to cover a lot of material this semester, so you need to pay attention in class, and do your in-class work when it is assigned. Talking on your phone, texting, chatting online, browsing Facebook or other social media sites, and talking excessively

with your neighbors about non-class related stuff are just a few examples of behavior that is not acceptable, and will negatively impact your grade.

14. Academic Integrity Statement

Nazarbayev University and The School of Science and Technology have established high standards for academic integrity, using an approach in which students are trained to produce original work according to professional standards, and to properly cite and reference the work of others when it is appropriate to do so.

The specific guidelines are published in the NU Student Handbook. In particular,

- The assignments in this class are designed to introduce important concepts and techniques, and enable you to explore the material independently so as to gain insight and comprehension of the subject. Doing the work is much more important than getting the right answer.
- The course is designed such that the new material presented each day builds on the skills developed in the preceding days; thus, any action that interferes with this process (missing class, skipping the assignment, copying) will seriously impede your progress.
- You are welcome—and encouraged—to talk through concepts and ideas with your fellow students and to study with them, but do not give or receive direct help from your classmates on a graded assignment.
- Assignments should be completed individually. If you distribute your work to others, even if you are not intending them to copy it, this is still considered academic misconduct.
- Even the appearance of cheating or inappropriate copying should be avoided.
- Students should be aware that the assignment submission process incorporates an automated plagiarism detector.
- You may only get help on graded assignments from designated people—the instructors or TAs for the course. If you are struggling with an assignment, by all means, please seek help from them.

In the event that academic misconduct such as plagiarism or cheating is discovered, the student will receive no credit for the work, and the event reported to the Dean of your school. Egregious cases, or a second offense, can result in failure of the course and potential suspension or expulsion from the university.

When a student suspects that another student has violated the academic honesty policy, a re-port should be made to the appropriate faculty member.

15. E-Learning

If the content of the course and instruction will be delivered (or partially delivered) via digital and online media, consult with the Head of Instructional Technology to complete this section and/or provide a separate document complementary to this Template.

16. Approval and review

Date of Approval:	**Minutes #:**	**Committee:**
Date(s) of Approved Change:	**Minutes #:**	**Committee:**