ARI5004

Deep Learning

Mustafa Ümit Öner

Instructor	Course Information[1]	
Office: D531 - 4th Floor	Terms	: Springs
Faculty of Engineering and Natural Sciences	Time	: Tuesdays 19.00 – 22.00
Bahçeşehir University	Course Credit/ECTs	: 3/12
	Classroom	: D405
E-mail: mustafaumit.oner@eng.bau.edu.tr	Course Type	: Departmental Elective
Office Hours: Wednesdays @13:00 - 15:00		

Course Objective and Learning Objectives

Deep learning has become a primary tool for AI tasks in different domains such as computer vision, pattern recognition, natural language processing, machine translation, bioinformatics, and game playing. It has penetrated different industries, like healthcare, finance, self-driving cars, entertainment, social media, and games, with its enormous potential impact. As a result, it has become a highly demanded skill in both research and industry.

In this course, we will learn the basics of neural networks and their applications in various domains. The course will mainly focus on supervised learning-based methods. It will start with multi-layer perceptrons and gradually and eventually discuss more advanced topics such as attention and transformers. By the end of the course, students are expected to know the fundamentals of Deep Learning and be able to apply Deep Learning to different tasks. Besides, they will have a strong basis enabling them to understand the related work in the literature and extend it through further studies.

Course Structure

The course consists of two main components: learning foundations of deep learning and gaining hands-on experience in implementing the deep learning models. We will learn the foundations via in-class discussions. Each lecture will have some resources that will provide us with the details of the topic. These resources will be made available before the class, and you are strongly urged to go through them before the in-class discussion. We will gain hands-on experience by implementing the concepts and building deep learning models using PyTorch as an integral part of the classes.

Office Hours

You can make an appointment between 13:00 and 15:00 on Wednesdays to meet with your instructor online. Please contact your instructor via e-mail 2 days in advance to make an appointment.

Course Policy

[1] It is essential that the syllabus announced at the beginning of the term is not changed except when necessary. When a requirement occurs, the curriculum can be changed by the lecturer of the course by notifying this situation in writing or verbally beforehand. It is the student's responsibility to follow the current program.

Communication Channels and Methods:

All the communication (announcements, discussions, submissions, etc.) will go through Itslearning course site.

- You are strongly encouraged to post your questions and comments in the course's discussion forums. If you have any personal issues that you cannot post in the course discussion forum, you can contact your instructor via email.
- You must submit all your work via Itslearning course site. Hard copy submissions and submissions via email will not be accepted.

Attendance:

Attendance is not compulsory, yet highly recommended. There is a strong correlation between class attendance and success in the course since it provides a unique experience of interaction and discussion, which promotes learning. Class attendance and contributing to the discussions will be awarded up to a 5% bonus.

Disabled Student Support:

If you need support based on the impact of a disability, please get in touch with your instructor as soon as possible.

Course Resources

There are no specific books or resources that we will follow in this course. Yet, some recommended sources are listed below. Apart from that, we will have different resources specific to each topic. These resources will be made available through Itslearning course site at least one week before the class that the topic will be covered.

Recommended resources:

Type	Name	Description
Textbook	Deep Learning (Goodfellow et al., 2016)	The Deep Learning textbook is a resource intended to help students and practitioners enter the field of machine learning in general and deep learning in particular.
Textbook	Dive into Deep Learning (Zhang et al., 2021)	Interactive deep learning book with code, math, and discussions
Framework	PyTorch	An open-source machine learning framework that accelerates the path from research prototyping to production deployment.

Grading and Evaluation

Item	Description	Weight (%)
Weekly Quizzes	• There will be 14 weekly quizzes, weighted equally. • Your best 12 out of 14 quizzes will be retained. • Quizzes will generally (but not always) be released on Friday and due 72 hours later. • Solutions must be in PDF format and typeset in LaTeX. ○ Online editors such as Overleaf may be helpful in writing solutions: https://www.overleaf.com	24
Programming Assignments	• There will be 3 programming assignments, weighted equally. • Assignments will be auto graded using scripts. You must follow the submission guidelines; otherwise, you may get zero. • Selected solutions will be invited to present in the class.	27

Final Project	• Project proposal
	  ○ **Deadline: 28.03.2022 @23.59**
	  ○ It will **NOT be graded**, yet a prerequisite for doing a project.
	  ○ The proposal is subject to your instructor's approval. If your proposal is not good enough for the course project, you may need to change it.
	  ○ The project will be conducted as a group of two people. You are required to form your group by the proposal deadline.
	  ○ The proposal is strictly limited to **two pages including references.**
	  ▪ Should include: Introduction (problem statement and importance), Related works (what has been done), Materials and methods (what will be done), Summary and references
	• Midterm presentation (10%)
	  ○ **Deadline: 10.05.2022 @class**
	  ○ It is strictly limited to **5 minutes.**
	  ▪ Should include: Introduction, Related works, Materials and methods, Preliminary results, Discussion (next steps)
	• Final code and report submission (30%)
	  ○ **Deadline: 27.06.2022 @23.59**
	  ○ The report is strictly limited to **five pages including references.**
	  ▪ Should include: Introduction, Related works, Materials and methods, Results, Discussion, References
	  ○ Code must be deposited at GitHub and have a step-by-step explanation in README to reproduce the results.
	• Final presentation (9%)
	  ○ **Deadline: 05.07.2022 @class**
	  ○ It is strictly limited to **10 minutes.**
	  ▪ Should include: Introduction, Related works, Materials and methods, Results, Discussion, References
	
	All write-ups must be in PDF format following NeurIPS paper style:
	  ○ https://neurips.cc/Conferences/2021/PaperInformation/StyleFiles
	  ○ Online editors such as Overleaf may be helpful in writing reports: https://www.overleaf.com.
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Contribution Bonus	• Attending the lectures and contributing to the discussions will be awarded a 5% bonus.
	• The bonus will be prorated based on the number of weeks a student contributed to the lecture.
	• The followings during a lecture are accepted as a contribution:
	  ○ Asking at least one question
	  ○ Commenting on a subject at least once
		5 [bonus]

Late submissions:

You are given a total of 7 free late (calendar) days. You can use your late days **only in quizzes and programming assignments**. They do not apply to project items (i.e., project proposal, midterm presentation, and final code and report submission). Each late day is bound to only one assignment. For example, if you submit one quiz and one programming assignment 3 hours after the deadline, you will be charged for 2 late days.

Once you run out of late days, your late submissions will be penalized 20% per late day. However, submissions will not be accepted more than 3 days after the deadline.

Project items (i.e., project proposal, midterm presentation, and final code and report submission) have hard deadlines unless you have a valid excuse (like a medical report). Please comply with the deadlines of those items to avoid unpleasant situations.

Course Calendar

Week	Date	Topics
1	08.03.2022	Introduction to Deep Learning Learning and intelligence Machine learning (ML) and ML taxonomy (unsupervised to supervised) ML tasks (generative vs. discriminative) Linear separability (decision boundary) Linear transformation (matrix multiplication) Data space vs. feature space
2	15.03.2022	Artificial neural networks Activation functions Multi-layer perceptron Shallow vs. deep networks NNs are universal approximators
3	22.03.2022	Training neural networks Gradient descent Backpropagation
4	29.03.2022	Loss functions Optimization (Learning rate and optimizers - SGD, ADAM, etc.) Loss surfaces Weight initialization
5	05.04.2022	Full cycle of a deep learning project Diagnostics of neural networks (overfitting vs. underfitting / memorizing vs. generalizing / bias vs. variance) Hyperparameter tuning Regularization (weight decay, dropout)
6	12.04.2022	Convolutional neural networks Image filtering Parameter sharing Hierarchical representations Pooling Receptive field
7	19.04.2022	Normalizing inputs and activations Batch normalization Residual connections Training and visualizing CNNs
8	26.04.2022	Modern CNN architectures Applications of CNNs
-	03.05.2022	No class – holiday
9	10.05.2022	Recurrent Neural Networks (RNNs) Parameter sharing Unrolling and backpropagation
10	17.05.2022	Training RNNs Long Short Term Memory (LSTM) Gated Recurrent Units (GRUs)
11	24.05.2022	Applications of RNNs
12	31.05.2022	Attention and Transformers
13	07.06.2022	Advanced topics in deep learning I ○ Graph neural networks ○ Generative models (variational autoencoders and generative adversarial networks)
14	14.06.2022	Advanced topics in deep learning II ○ Self-supervised learning ○ Reinforcement learning

Academic Integrity, Cheating and Plagiarism

Academic integrity is a serious matter in this course. Any violation will be reported to the university's highest levels and maximum punishment will be argued for.

You are encouraged to form study groups to discuss quizzes and programming assignments. However, you must write down your own solutions without referring to the notes taken during discussions. It is a violation of academic integrity to copy, refer to or look at written solutions and code from another student or any other sources. It is also a violation of academic integrity to post your solutions and code online. Besides, you should write down the names of your collaborators in your submissions.

You are expected to comply with the University Policy on Academic Integrity and Plagiarism. Violations of the university policy can result in severe penalties, including failing this course and possible expulsion from Bahçeşehir University. If you have any questions about this policy and any work you are doing in the course, please feel free to contact your instructor for help.