

CEng 501 Deep Learning

Department of Computer Engineering @ METU – Fall 2022

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Lectures: Tuesday 09:40-12:30 @ BMB4.

Web: <https://dar.vin/501-F22¹> and <https://odtuclass.metu.edu.tr/>.

Description: This course aims to teach the fundamentals of deep learning. We will study the three major types of deep neural networks, namely, Multi-layer Perceptrons, Convolutional Neural Networks, and Recurrent Neural Networks, and take an in-depth look at their use in various machine learning problems such as supervised learning, unsupervised learning, generative modeling, and reinforcement learning. We will also explore the most recent developments in the field and state of the art applications of deep neural networks in computer vision and natural language processing. Weekly tentative schedule is as follows.

Date	Topic	Activities	
1	Oct 4	Course logistics. High-level introduction to deep learning.	Hw1 given Oct 5
2	Oct 11	Machine learning background and basics. <i>An overview of supervised learning</i>	Hw1 due Oct 16
3	Oct 18	Artificial neurons. Multi-layer Perceptrons <i>Biological neuron, artificial neuron, Perceptron, Multilayer Perceptrons, Activation Functions, Loss Functions, Backpropagation, Stochastic Gradient Descent</i>	
4	Oct 25	Convolutional neural networks (CNNs) <i>Connectivity types, Convolution, Convolutional neural networks, Pooling, AlexNet, Data augmentation, Dropout, Batch and group norm.</i>	
5	Nov 1	CNNs <i>More loss functions, Initialization, Implementing backpropagation in a modular way, Adaptive learning rate methods, Deconvolution</i>	
6	Nov 8	Applications of CNNs	Hw2 given Nov 8
7	Nov 15	Recurrent neural networks (RNNs) <i>Recurrent neural networks, Backpropagation through time, Long short-term memory networks, Gated recurrent units, Encoder-decoder architectures</i>	
8	Nov 22	Applications of RNNs	Hw2 due Nov 22
9	Nov 29	Self-attention, Transformers	
10	Dec 6	Applications of Transformers	Hw3 given Dec 6
11	Dec 13	Deep generative models <i>Boltzmann machines, Deep belief networks, Auto-encoders, Variational autoencoders, Generative Adversarial Networks, Diffusion</i>	
12	Dec 20	Deep reinforcement learning (RL) <i>Intro to RL, Deep Q-Learning, Deep policy gradient, Applications of RL</i>	Hw3 due Dec 20
13	Dec 27	Misc. topics <i>Double descent, Dynamic Filter Networks, Non-local neural networks, Graph Neural Networks, Neural architecture search</i>	
14	Jan 3	Misc. topics – latest trends, limitations, open issues	Exam

Textbook: There is no official textbook for the class. We will follow the state of the art mainly with papers and by using parts of the “Deep Learning” book by Goodfellow et al., which is available online.

Grading: Homework assignments 55% (15+20+20); Written exam 40%; Participation 5%

Prerequisites: Foundational knowledge in machine learning, calculus, linear algebra. Proficiency in Python.

¹Full url: <http://user.ceng.metu.edu.tr/~emre/Fall2022-DeepLearning.html>