Course Information

Course Code	5670543
Course Section	1
Course Title	NEUROCOMPUTERS AND DEEP LEARNING
Course Credit	3
Course ECTS	8.0
Course Catalog Description	Various aspects of neurocomputers emphasizing deep learning approaches. Brainlike computing, characteristics of neurocomputers. Deterministic, probabilistic and spiking neuron models. Feed forward and recurrent neural networks. Deep structures of feed forward and recurrent neural networks. Deep learning: supervised and unsupervised machine learning algorithms for various deep neural networks. Neuromorphic chips.
Prerequisites	No prerequisites
Schedule	Thursday , 13:40 - 16:30, EA207
Course Website	METUCLASS is used for loading course information lecture notes and for communication . Lecture notes and sample exam questions are partially available at http://www.eee.metu.edu.tr/~halici/
Learning Management System	METUCLASS: http://odtuclass.metu.edu.tr

Instructor Information

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Office Hours	Tuesdays 15:30-16:20

Course Objectives

This course aims to give an insight on various aspects of neurocomputers with an emphasize on deep learning approaches:

- Detailed knowledge on deterministic, probabilistic and spiking neurons, feed forward and recurrent neural networks, deep structures of feed forward and recurrent neural networks,
- Detailed knowledge various deep learning algorithms and applying this knowledge for solving practical problems,
- Familiarity on architecture of a recent neuromorphic chip for a better understanding of brain-like computing and differences of neurocomputers from conventional digital computers.

Course Learning Outcomes

Student, who passed the course satisfactorily will be able to:

- Describe brain-like computing and differences of neurocomputers from conventional digital computers,
- Understand various aspects of neurocomputers such as deterministic, probabilistic and spiking neurons, feed forward and recurrent neural networks, deep structures of feed forward and recurrent neural networks, deep learning algorithms for training them.
- Applying deep learning algorithms to solve realistic problems and measure their performances.

Instructional Methods

Lectures, Project based learning and student presentations of projects

Tentative Weekly Outline

Week	Topic	Relevant Reading	Assignments
1	Introduction to neurocomputers: Brainlike computing, characteristics of neurocomputers. Overview of artificial neuron models and neural network structures, machine-learning concepts.	Lecture notes on metuclass	
2	Recurrent neural network dynamics: Dynamics of deterministic recurrent neural networks, stability, energy (Lyapunov) function and attractors,	Lecture notes on metuclass	
3	Associative Memory: Hopfield Network as Autoasociative memory, Bidirectional Associative Memory (BAM)	Lecture notes on metuclass	
4	Basic feed forward neural networks and training: Deterministic neuron, Multilayer perceptron (MLP) and backpropagation learning. MLP for classification, regression and prediction.	Lecture notes on metuclass	
5	Deep learning for feed forward neural networks: Stacked auto encoders and training, sparse coding and drop out.	Lecture notes on metuclass	
6	Deep learning for feed forward neural networks (continues): Convolutional neural networks (ConvNET), structure and functions of layers in ConvNET, training.	Lecture notes on metuclass	Submission of project proposals by groups
7	MIDTERM-EXAM	Lecture notes on metuclass	
8	Deep learning for recurrent neural networks: Probabilistic neuron, Boltzmann machine (BM), deep learning for restricted Boltzmann machine (RBM).	Lecture notes on metuclass	
9	Appication Examples: Various application examples such as character segmentation, brain computer interface, face detection, object tracking	Lecture notes on metuclass	
10	Various networks Radial Basis Networks, Kohonen Networks, Spiking neural networks	Lecture notes on metuclass	

Week	Topic	Relevant Reading	Assignments
11	Training recurrent neural networks: Recurrent backpropagation and its variants, reservoir computing, long short term memory.	Lecture notes on metuclass	
12	Neuromorphic chips: Overview of neuromorphic chips and architecture of a recent neuromorphic chip such as SyNAPSE or TrueNorh.	Lecture notes on metuclass	Submission of project reports
13	Presentation of student projects		
14	Presentation of student projects (continues)		Submission of project presentation documents

Course Textbook(s)

Books:

1. Haykin S., Neural Networks and Learning Machines, Prentice Hall, Third Edition 2010

2. Bengio Y, Goodfellow IJ and Courville A. Deep Learning, Book in preparation for MIT Press, 2016
http://www.deeplearningbook.org

2. Paugam-Moisy H and Bohte S. Computing with Spiking Neuron Networks Computing with Spiking Neuron Networks, Handbook of Natural Computing, preprint, 2012 http://homepages.cwi.nl/~sbohte/publication/paugam_moisy_bohte_SNNChapter.pdf

Course Material(s) and Reading(s)

Material(s)

Lecture notes at metuclass

Web sites for publicly available dataset

Online courses on Neural Networks and Machine Learning

Matlab

Reading(s)

Web sites for deep learning methods and papers

Supplementary Readings / Resources / E-Resources

Readings

Online Courses:

Neural Networks for Machine Learning, by Geoffrey Hinton, coursera

https://class.coursera.org/neuralnets-2012-001

Resources

Online open sources:

http://deeplearning.net

https://www.tensorflow.org

http://caffe.berkeleyvision.org

http://deeplearning4j.org

Other

Datasets at websites such as:

http://deeplearning.net/datasets/

https://www.bbci.de/activities#competitio

Assessment of Student Learning

Assessment	Dates or deadlines
Midterm	22.11.2018
Final Exam	January 2019
Submission project proposal form	08.11.2018
Submisson of project reports	27.12.2018
Project presentations	27.12.2018 and 03.01.2019
Submission of project presentation documents	03.01.2019

Course Grading

Deliverable	Grade Points
Midterm exam	35
Final exam	40
Project	20
Attendance	5
Total	100

Course Policies

Class Attendance

Attendance to the lectures is very important to learn the topics

Attendace is to be taken into account as %5 of the grading.

Late Submission of Assignments

Late submission of assignments will 20% decrease in grading.

Make up for Exams and Assignments

Make-up is possible for Midterm and final if there is a report from Medical center of METU.

Final Exam Entrance Conditions

Being entered to Midterm (or having a report from Medical center of METU) and Project report being submitted

Class and Laboratory Rules (Eating-Drinking, Use of Mobile Phones and Electronic Devices, Civility, etc.)

Use of Mobile phones etc not allowed.

Information for Students with Disabilities

To obtain disability related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the ODTÜ Disability Support Office as soon as possible. If you need any accommodation for this course because of your disabling condition, please contact me. For detailed information, please visit the website of Disability Support Office: http://engelsiz.metu.edu.tr/

Academic Honesty

The METU Honour Code is as follows: *"Every member of METU community adopts the following honour code as one of the core principles of academic life and strives to develop an academic environment where continuous adherence to this code is promoted. The members of the METU community are reliable, responsible and honourable people who embrace only the success and recognition they deserve, and act with integrity in their use, evaluation and presentation of facts, data and documents."*

Project reports are checked in TURNITIN. Pligiarism is an ethical issue resulting in penalty.