Welcome!

Figures from Krizhevsky et al., Shelhamer et al, Johnson et al, van den Oord et al, Silver et al.
What is Machine Learning?
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• “the acquisition of knowledge or skills through experience, study, or by being taught.”

• Can be (almost) mapped to reinforcement, unsupervised and supervised machine learning.
What is Machine Learning?

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What is Machine Learning?

• [Arthur Samuel, 1959]
  – Field of study that gives computers
  – the ability to learn without being explicitly programmed

• [Kevin Murphy] algorithms that
  – automatically detect patterns in data
  – use the uncovered patterns to predict future data or other outcomes of interest

• [Tom Mitchell] algorithms that
  – improve their performance (P)
  – at some task (T)
  – with experience (E)
ML in Nutshell

• Tens of thousands of machine learning algorithms
  – Hundreds new every year

• Decades of ML research oversimplified:
  – All of Machine Learning:
  – Learn a mapping from input to output $f: X \rightarrow Y$
    • e.g. $X$: emails, $Y$: \{spam, notspam\}
Types of Learning
Types of Learning

- **Supervised learning**
  - Training data includes desired outputs

- **Unsupervised learning**
  - Training data does not include desired outputs

- **Weakly or Semi-supervised learning**
  - Training data includes a few desired outputs

- **Reinforcement learning**
  - Rewards from sequence of actions
Synonyms

- Representation Learning
- Deep (Machine) Learning
- Deep Neural Networks
- Deep Unsupervised Learning
- Simply: Deep Learning
So what *is* Deep (Machine) Learning?
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- A few different ideas:
  - (Hierarchical) Compositionality
    - Cascade of non-linear transformations
    - Multiple layers of representations
  - End-to-End Learning
    - Learning (goal-driven) representations
    - Learning to feature extraction
  - Distributed Representations
    - No single neuron “encodes” everything
    - Groups of neurons work together

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Administrative details
Course prerequisites

- You should already know the fundamentals of deep learning
  - Fundamentals of deep machine learning and practical large-scale optimization for training
  - How to design and analyze deep feedforward neural networks
  - Convolutional neural networks and parameter sharing
  - Fundamentals of recurrent neural networks
Course goals

- Gain a better grasp of contemporary research in advanced deep learning topics such as:
  - Learn deep recurrent and memory networks,
  - Learn deep Turing machines,
  - Apply such deep learning mechanisms to various learning problems.
  - Know the open issues in deep learning, and have a grasp of the current research directions.
Reading

● No textbook, but the following books can be helpful:

● Required and optional readings will be published on the course page.
Course webpage

- Slides, readings, and schedule will be provided on the course homepage:

  http://user.ceng.metu.edu.tr/~gcinbis/courses/Spring18/CENG793

- We will use ODTU Class for handling submissions.
Evaluation

- Paper Presentation 15%
- Quizzes from assigned papers 25%
- Project (demonstration, presentation and report) 60%
Paper presentations

- Presentations will be evaluated in terms of clarity and correctness at
  - defining the problem addressed and the proposed method,
  - providing overview of background, when necessary
  - explaining the related work and motivations of the paper,
  - its advantages and disadvantages,
  - addressing the questions in class.

- **Important:** to properly present a paper, you may need to read closely related papers that provide necessary background. Start working on the presentation early.
Paper presentations

● I will progressively add paper titles to the schedule in the course page.

● Reserve the paper and the presentation date by email (first-come, first-served).

● Prepare well for the presentation: you will effectively be the instructor of the class during your presentation.
Paper quiz

- There will be a small quiz at the start of each lecture about the paper to be presented in class

- Each quiz will contain 1-2 questions per paper

- Attendance to the presentations are required: your quiz will be ignored if you leave the class after the quiz (exceptional cases aside)
Project

- Explore novel applications of contemporary deep learning techniques or develop novel deep learning techniques.
- Projects related to your research topics are encouraged.
- Significant novelty is expected
- **Report is expected to have the quality of a top-tier conference paper (CVPR/NIPS/ICLR/ICCV/ECCV/ICML).**
- The goal is to submit the report to a top-tier conference / journal
Project

- Three stages:
  1) Proposal: one-page description of the project topic and the planning for the project.
  2) Progress report & presentations
  3) Final report & presentations

- You are allowed and encouraged to use mainstream deep learning libraries like TensorFlow, PyTorch, Torch, Caffe, Keras, Theano, MatConvNet, etc.
Collaboration policy

- Plagiarism (including self-plagiarism) will not be tolerated.

- Ask ahead of time whenever you are in doubt.
Weekly syllabus (tentative)

- **Review of Fundamental Deep Learning Methods**
  - Problem Definition; Overview of Approaches; Autoencoders; Convolutional Neural Networks; Deep/Restricted Boltzmann Machines

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  - Unfolding; Backpropagation Through Time; Elman & Jordan Networks; Echo State Networks; Long Short Time Memory and its variants

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Weekly syllabus (Tentative) (Cont'd)

Deep Turing Machines
[Turing Machine; Neural Turing Machine; Neural Random Access Machine]

Deep Reinforcement Learning
[Reinforcement Learning; Deep Reinforcement Learning]

Deep Reinforcement Learning
[Reinforcement Learning; Deep Reinforcement Learning]

Why does it work?
[Different perspectives from biology and physics]

Discussion
[Deep Learning: Problems, Solutions, Open Issues and Directions]

Project demos