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EE 490/890: Introduction to neural networks and brain modeling

Instructor: Ramin Pashaie, PhD, Assistant Professor, Department of Electrical Engineering and Computer Science.

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Topics:

1 – Modeling a single neuron, Generation of action potentials, Integrate and fire model, Hodgkin-Huxley Model, Optogenetics.

2- Single-Compartment model, Multi-compartment model, Cable theory, Propagation of action potentials.

3 – Neural Coding, Rate coding, Temporal coding, Spike-train statistics.

4 - Feed Forward Neural Networks, Single and Multi-layer Perceptron, Back Propagation Learning Algorithm, Supervised learning rules, Hebbian Learning and Plasticity.

5 - Unsupervised Learning, Neurodynamics, Hopfield model.

6 - Principle Component Analysis, Independent Component Analysis, Supporting Vector Machine.

7 - Reinforcement Learning.

Recommended Text Books:

1 - **Theoretical Neuroscience: Computation and Mathematical Modeling of Neural Systems**, By: Peter Dayan, L. F. Abbott.

2 - **Neural Networks and Learning Machines**, By: Simon Haykin.

3 - **Fundamentals of Computational Neuroscience**, By: Thomas P. Trappenberg.

Prerequisites:

1 - Multi variable calculus and basics of probability theory.

2 - Some background in computer programming, e.g., Matlab programming.

Attendance requirement:

There is no attendance requirement for the lectures.

Grading:

1. Multiple mini-projects (70%),
2. Final Project (30%).