**EEE511: Artificial Neural Computation**

**PREREQUISITES**:

Signals and systems, random signal analysis, linear systems, or instructor approval

# COURSE DESCRIPTION

This course covers the principles of artificial neural networks (ANN), collective computational phenomena emerging from simple interconnected elements. Biological neural motivation will be introduced. However, the course emphasis is on "artificial" with a focus on engineering aspects of the field. Our approach is based on engineering systems theory and statistical machine learning. We address how do we make a network of neuron-like elements learn from a set of data that is representative of the problem, to solve complex problems in life, such as pattern classification (speech recognition, and target recognition), function approximation and system identification, control of a robot or a plant, or anything else among a myriad of possible applications. Our purpose is to obtain a coherent overview of the field, an ability to find and digest deeper knowledge in any particular subfield, and most importantly, ability to apply an appropriate type of an ANN model to a given problem.

# COURSE TOPICS

* Introduction of ANN, inspirations from biological neural networks, neuron models, relations to other disciplines, applications, motivating demonstrations
* Perceptrons, historical significance in learning, convergence theorem, perceptron vs. statistical pattern recognition
* Single layer networks and unconstrained optimization methods, Single layer networks: LMS, LMS vs. Wiener filter
* Multilayer perceptrons and back-propagation
* Representational capabilities of MLPs, training issues
* Generalization, overfitting with multilayer networks
* Regularization, Cross-Validation
* Optimization methods for MLPs
* Regularization theory
* Radial basis function networks, Introduction, Exact interpolation
* Radial basis function networks, Regularization, Model selection
* Radial basis function networks, Learning basis functions
* Support vector machines, introduction
* Support vector machines: Separable and nonseparable cases
* Support vector machines: More on VC-dimension, the kernel trick
* Support vector machines: Regression, examples
* The self-organizing map, Introduction, The basic algorithm
* The self-organizing map, Some example applications, Analysis of the algorithm
* The self-organizing map, Variants of SOMs
* The self-organizing map: Tree-Structurd SOMs, Applications in optimization.
* Learning vector quantization, principal-component analysis
* Information theoretic learning
* Stochastic optimization methods
* Dynamic Programming and Reinforcement learning
* Temporal processing with feedforward networks
* Filtering of stochastic processes
* Neurodynamics and Recurrent networks