36125651 Neural Networks for Pattern Recognition – Statistical foundation, perspective and alternatives.

Graduate course

Instructor: Prof. Mayer Aladjem, http://www.ee.bgu.ac.il/~aladjem

THIS COURSE IS INTENDED TO BE LARGELY SELF-CONTAINED

PREREQUISITES: basic undergraduate mathematical courses.

This course is suitable for all fields of specialization of Electrical & Computer Engineering.

This course will cover the theory, computational aspects, and practice of a variety of neural techniques for data analysis. The presentation focuses on methods with the specific goal of predicting future outcomes, in particular regression and classification methods. From the perspective of pattern recognition, neural networks can be regarded as an extension of many conventional multivariate statistical methods for data analysis. In the recent years neural computing has emerged as a practical technology, with successful applications in many fields.

This course is based mainly on the book C.M.Bishop, "Neural Networks for pattern recognition", 1995. It will cover the materials in Chapters 1-9. In ddition I will teach topics related to the modern and recently developed methods for independent component analysis and blind source separation.

The lecture notes and handouts will be available in http://hl2.bgu.ac.il.

Final Grade:

70% homework - MATLAB programming assignments for neural network simulations. The course encourages students to use NETLAB toolbox described in the book I.T.Nabney "NETLAB Algorithms for Pattern Recognition", 2001. The latter book is intended to complement Bishop (1995). NETLAB toolbox is available for free www.ncrg.aston.ac.uk/netlab.

30% interview on the homework and the course topics - around 30 min. with each student.

Syllabus:
Fundamental concepts of statistical pattern recognition. Principle component analysis (PCA). Maximum Likelihood (ML) procedure. Stochastic approximation. Non-parametric and mixture models for density function. Expectation Maximization (EM) algorithm. Projection pursuit mixture density estimation. Single Layer (SL) network. Solution by Singular Value Decomposition (SVD). Radial Basis Function (RBF) networks. Regularization theory. Multi-Layer (ML) networks. Batch and sequential training. Random initialization. Error functions. Statistical interpretation of the outputs and the hidden units of the network. Visualization of high dimensional data. Learning and generalization. Bias- variance dilemma. Regularization: weight decay, early stopping of the training, training with noise. Architecture of the network: validation, complexity criteria, VC-dimension. Pre-processing and feature extraction.

Text books:

1. C.M.Bishop, "Neural networks for pattern recognition", Oxford University Press, 1995.
2. C.M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
3. I.T.Nabney "NETLAB Algorithms for Pattern Recognition", Springer, 2001.
4. T. Hastie, R. Tibshirani, J. Friedman, "The elements of statistical learning – Data Mining, Inference, and Prediction", Springer, 2001.
5. S. Haykin, "Neural Networks", Prentice-Hall, Inc, 1999.
6. Current papers.