The Lane Department of Computer Science and Electrical Engineering

CpE 520: Introduction Neural Networks

Instructor: Dr. Nasser M. Nasrabadi
Classroom: ESB 201, Thursdays: 5:00-7.45pm
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Course Objective: Theories, principles, techniques, and procedures used in design implementation of supervised and unsupervised Neural Networks. Algorithms and computer programming for software realization with engineering applications.

Course Description:

Artificial neural networks (ANN) use learning algorithms that are inspired by our understanding of how the brain learns to perform different tasks. ANN has been applied to practical applications, such as speech recognition, object recognition, biometrics, image retrieval and many other real-world problems. This course introduces the fundamental concepts of neural networks and study several network models in detail. It addresses applications such as classification, regression, pattern recognition, face recognition, biometrics, data mining, time-series prediction, etc.. Following topics are covered: introduction to visual cortex and interaction of biological neurons. Supervised learning techniques using non-linear models such as multilayer perceptrons with the back-propagation learning algorithm, radial-basis function networks, support vector machine and kernel methods are covered. Unsupervised learning using Kohonen self-organizing feature maps is discussed. Several classical topics such as restricted Boltzman machines, deep belief nets, convolutional neural networks, recurrent networks including Hopfield networks, associative memory networks, deep autoencoders, Hebbian learning rule, Regularization Theory, principal component analysis and its kernel version are discussed. Finally applications of deep learning to biometrics, face recognition and object classification will be covered.

Class Format:

The course consists of lectures with discussions, reading assignments, and homework assignments using dedicated neural network software in Matlab. Each student will carry out an independent final project in an area subject to the instructor's approval. At the end of the course there will be a short written exam reviewing the basics of the course.

Grading:

- Homework Assignments, 50%
- Project, 30%
- Final Exam, 20%

Class Schedule:

Week 1: Introduction to Linear Algebra

Week 2: Introduction to linear regression and Linear classifiers

Week 3: Introduction to Fundamental concepts: neuron models and basic learning rules

Week 4: Introduction to visual cortex

Week 5: Multilayer neural networks and back-propagation learning algorithm

Week 6: Radial-basis function neural networks,

Week 7: Support vector machine and kernel methods

Week 8: Self-organizing Kohonen feature maps

Week 9: Restricted Boltzman machines, deep belief nets

Week 10: Convolutional neural networks its applications in vision (ImageNet database).

Week 11: Recurrent networks (Hopfield networks)

Week 12: Associative memory networks, deep autoencoders

Week 13: Regularization theory, Hebbian learning rule

Week 14: Principal component analysis and its kernel version

Week 15: Applications of Neural network to biometrics and vision problems

Week 16: Final Exam

Recommended Book:

Neural Networks and Learning Machines, by Simon Haykin, Third Edition , Prentice Hall, 2009
ISBN13: 978-0131471399
ISBN10: 0131471392