LUND UNIVERSITY
Faculty of Science

Syllabus for the course Introduction to Artificial Neural Networks and Deep Learning, NTF005F

Swedish title: Introduktion till artificiella neuronnätverk och deep learning

The course syllabus was confirmed by the Faculty board for graduate studies 14 May 2018. The course is in the third cycle and amounts to 7.5 credits.
The course syllabus is formally approved in Swedish. This is a translation.

Learning outcomes
On completion of the course, participants shall be able to:

Knowledge and understanding
- describe the construction of the multi-layer perceptron
- describe different error functions used for training and techniques to numerically minimize these error functions
- explain the concept of overtraining and describe those properties of a neural network that can cause overtraining
- describe the construction of different types of deep neural networks
- describe neural networks used for time series analysis as well as for selforganization

Skills and abilities
- produce update equations for a multi-layer perceptron with given specific error and activation functions
- prove basic properties of the multi-layer perceptron, such as non-linearity, probability interpretation of the output and the advantage of using an ensemble of neural networks
- implement a multi-layer perceptron to solve a typical classification or regression problem, including systematic choice of suitable model parameters to optimize the generalization performance
- show how to use a convolutional neural network to classify images, including suitable choices of layers and kernel sizes
- use a recurrent network, both deep and shallow, for time series problems

Judgement and approach
- analyse a typical problem within the subject area and deduce which method or methods that are most suitable to solve it
- identify possible loopholes in an analysis that can affect its reproducibility

Course content
The course covers the most common models in artificial neural networks with a focus on the multi-layer perceptron. The course also provides an introduction to deep learning. Selected topics:

- Feed-forward neural networks: the simple perceptron and the multi-layer perceptron, choice of suitable error functions and techniques to minimize them, how to detect and avoid overtraining, ensembles of neural networks and techniques to create them, Bayesian training of multi-layer perceptrons
- Recurrent neural networks: simple recurrent networks and their use in time series analysis, fully recurrent for both time series analysis and associative memories (Hopfield model), the simulated annealing optimization technique
- Self-organizing neural networks: networks that can extract principal components, networks for data clustering, learning vector quantization (LVQ), self-organizing feature maps (SOFM)
- Deep learning: Overview of deep learning, convolutional neural networks for classification of images, different techniques to avoid overtraining in deep networks, techniques to pre-train deep networks.

Teaching
The teaching consists of lectures, exercises and compulsory computer exercises.

Assessment
Assessment is based on written reports on the computer exercises and a written exam at the end of the course. In special cases, the exam can be oral.

Grading scale
Possible grades are Pass and Fail. To pass the course, the student must pass the exam and pass the reports on the computer exercises.

Language of instruction
The course is given in English.

Entry requirements
Basic programming knowledge. Mathematics: Calculus in one and several variables and linear algebra.

Additional information
This course corresponds to the course FYTN14, given in the second cycle (advanced level), and may not be credited together with FYTN14.