Faculty common course 2021

English course title: Deep Learning

Swedish course title: Djupinlärning

Extent (credits): 5+3 (the extra 3 credits are obtained via a voluntary course project)

Language of instruction: English

*Recommended prerequisite*s: Basic undergraduate courses in linear algebra, statistics, probability, optimization and programming experience in Python, MATLAB or similar.

Learning outcomes of the course: After passing the course the student should be able to:
- describe and use backpropagation together with gradient descent and stochastic gradient descent to optimize a model;
- implement a fully interconnected multi-layer neural network;
- explain under and over fitting and what can be done to avoid them;
- describe and use different kinds of regularization techniques;
- describe and use deep convolutional networks for classification and regression;
- describe and use deep learning models for timeseries data:
- use modern environments for deep machine learning to solve practical problems;

*Specify which learning outcomes of the doctoral degree that are address/covered (see appendix 1 of the call or the template of ISP). Describe ho*w:
A1 – Data driven machine learning in general and deep learning in particular is becoming and important knowledge for virtually any scientific field where big about of data needs to be processed and analyzed.

B5 – Deep learning is a field which moves tremendously fast. We will in this course only be able to scratch on the surface, but we aim to give the students tools to identify the need for knowledge within this area.

For those who also opt for taking the additional project course we also address:

B2- The student formulate their own project and plan for the appropriate methods within a given time frame.

B4- The PhD student present and discuss the work from the project both in speech and writing.

Course contents: The lectures will be focused **on theoretical aspec**ts and the mandatory hand-in assignments on practic**al implementati**on of deep learning methods. The course will therefore deal less with particular applications within the field.
Feed forward neural networks, backpropagation, stochastic gradient descent, convolutional neural networks, residual neural network, semantic segmentation,

instance segmentation, over-/underfitting, bias-variance, regularization, practical methodology, batch normalization, transfer learning, different deep learning models for timeseries data

Instruction (course structure):
Lecture series: 8-10 lectures, (2 hours each). The lectures are given by the teachers.
Helpdesks: Sessions where students can get help with the hand-in assignments (see below).
Project (optional): Successful projects will be awarded an additional 3 hp. This is a great mechanism to spark bigger projects and spin-off collaborations. .

Assessment (form of examination): 3 to 4 bigger hand-in assignments. All assignments will be focused on implementation aspects for deep learning algorithms and models. In the first exercises, some of the standard deep learning methods will be implemented from scratch, and in the last exercises a state-of-the-art high-level software library for deep learning will be used. .

*Course examiner (name, e-ma*il): Niklas Wahlström, niklas.wahlstrom@it.uu.se

Department with main responsibility: Department of Information Technology

Contact person/s (course responsible teacher) (name, e-mail): Niklas Wahlström, niklas.wahlstrom@it.uu.se

Course dates/period: March- June 2021

Maximum number of participants: 50

Submit the application for admission to: Niklas Wahlström, niklas.wahlstrom@it.uu.se

Submit the application not later than: 1 March 2021, but the first come, first served principle applies in general. To complete the application a successful submission of a pre-course assignment will be required.