UNIVERSITY OF GOTHENBURG

DEPARTMENT OF MATHEMATICAL SCIENCES

MMA440 Mathematical Structures of Deep Neural Networks, 7.5 credits

Matematiska strukturer hos djupa neurala nätverk, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Mathematical Sciences on 2023-10-11 to be valid from 2024-01-15, spring semester of 2024.

Field of education: Science 100%
Department: Department of Mathematical Sciences

Position in the educational system

Main field of studies	*Specialization*
Mathematics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Entry requirements

General entry requirements and the equivalent of the courses MSG110 Probability Theory, MVG301 Programming with Python, and MMG500 Algebraic Structures. In addition to these requirements, it is also desirable with knowledge corresponding to the courses DIT013 Imperative Programming with Basic Object Orientation, MMA211 Higher Differential Calculus, and MMA201 Representation Theory.

Learning outcomes

On successful completion of the course the student will be able to:

- Explain the basic concepts of machine learning and deep learning.
- Use the most important deep learning architectures and training schemes.
- Train a neural network using common deep learning frameworks in Python.
- Use equivariant neural networks to satisfy symmetry constraints in learning problems.
- Explain the relationship between large-width neural networks and kernel machines.

- Interpret and discuss the research literature in selected subfields of deep learning.

Course content

Types of learning problems, bias-variance tradeoff, overfitting, regularization, feed-forward neural networks, backpropagation, gradient-based optimizer, Glorot- and He initialization, regularizing neural networks, convolutional neural networks, residual neural networks, transformer, graph neural networks, generative adversarial networks, counterfactual explanations, normalizing flows, equivariant neural networks, large-width neural networks, neural tangent kernels.

Form of teaching

Language of instruction: English

Assessment

The examination consists of written assignments during the course and a larger written project.

If a student who has twice received a failing grade for the same examination component wishes to change examiner ahead of the next examination session, such a request should be made to the department in writing and should be approved by the department unless there are special reasons to the contrary (Chapter 6 Section 22 of the Higher Education Ordinance). If a student has received a recommendation from the University of Gothenburg for study support for students with disabilities, the examiner may, where it is compatible with the learning outcomes of the course and provided that no unreasonable resources are required, decide to allow the student to sit an adjusted exam or alternative form of assessment. In the event that a course has ceased or undergone major changes, students are to be guaranteed at least three examination sessions (including the ordinary examination session) over a period of at least one year, but no more than two years after the course has ceased/been changed.

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).

Course evaluation

The course is evaluated with an anonymous questionnaire and/or a discussion with the student representatives. The results of and possible changes to the course will be shared with students who participated in the evaluation and students who are starting the course.