

**Deep learning**  
**DM873**

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## Part I

# Formal course description

## Aim

Machine learning has become a part in our everyday life, from simple product recommendations to personal electronic assistant to self-driving cars. More recently, through the advent of potent hardware and cheap computational power, “Deep Learning” has become a popular and powerful tool for learning from complex, large-scale data. In this course, we will discuss the fundamentals of deep learning and its application to various different fields. We will learn about the power but also the limitations of these deep neural networks. At the end of the course, the students will have significant familiarity with the subject and will be able to apply the learned techniques to a broad range of different fields.

The course builds partly on the knowledge acquired in the course DM555 but can be taken by any Computer Science or Computational BioMedicine Master student.

In relation to the competence profile of the degree it is the explicit focus of the course to:

- giving the competence to plan and execute a deep learning task by means of deep neural networks.
- providing knowledge on the different types of deep learning approaches including their advantages and disadvantages.
- transfer learned methods to new fields of applications.
- challenges the student with real-life datasets and problem-solving skills

## Statement of aims

- The learning objectives of the course is that the student demonstrates the ability to:
- Describe the principles of deep neural networks in a scientific and precise language and notation
- Analyze the various types of neural networks, the different layers and their interplay
- Describe the feasibility of deep learning approaches to concrete problems
- Understand the theoretical mathematical foundations of the field
- Apply deep learning frameworks for solving concrete problems

## Pensum

- All lecture slides are relevant for the exams.
- All readings noted in the lecture list are relevant for the exam.
- Ian Goodfellow, Yoshua Bengio, Aaron Courville - The Deep Learning Book
- Gareth James, Daniela Witten, Trevor Hastie - Robert Tibshirani An Introduction to Statistical Learning (ISL)

Part II

exam topics

## Exam Form

5 minute presentation from the 6 topics

10 minutes questions

## Feed-Forward Networks

introduction

Function Principle

Output Units

Hidden Units

...

# Backpropagation

introduction

Function Principle

Computational Graphs

Backpropagation through time

...



## Regularization

introduction

Over/Underfitting & Model Capacity

Parameter Penalties

Bagging

Dropout

...

# Convolutional Neural Networks

introduction

Function Principle

Pooling

Initialization of the kernels

...

# Recurrent Neural Networks

introduction

Function Principle

Problems with long term memory

Long Short Term Memory

...

# Optimization for Neural Networks

introduction

Parameter Initialization

Adaptive Learning

Batch Normalization

Pre-training

...

## Autoencoders and GANs

introduction

Autoencoders

Variational Autoencoders

GANs

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