Course introduction

Neural Networks for Machine Learning Applications

Spring 2023

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Helsinki Metropolia University of Applied Sciences

Neural Networks for Machine Learning Applications

Code:	TX00EV91-3002
Timing:	09.01.2021 – 12.03.2021
Language of instruction:	English
Credits:	5 ECTS
Mode of delivery:	On-campus
	Online (Weeks 2-4, Sakari)
Unit in charge:	School of ICT

Teachers and contact sessions

Mondays 9:00 – 12:00
Weeks 2-4: Funet Meet (Zoom)
Weeks 5-10: KMD759

Sakari Lukkarinen
Senior Lecturer, Team Softa, Hyte and Smart

Mondays 13:00 – 16:00
Weeks 2-10: KMD759

Juha Kopu
Senior Lecturer, Team Softa, Hyte and Smart

https://oma.metropolia.fi/people-finder

Contents and prerequisites

Contents

- Basics of artificial neural networks, convolutional and recurrent neural networks, applications of neural networks

Prerequisites

- Basic algebra and statistics, intermediate programming skills, knowledge on handling measurement data.

Objectives

The student

1. Understands the structure of various types of neural networks and the basic mathematical machinery behind their operation,

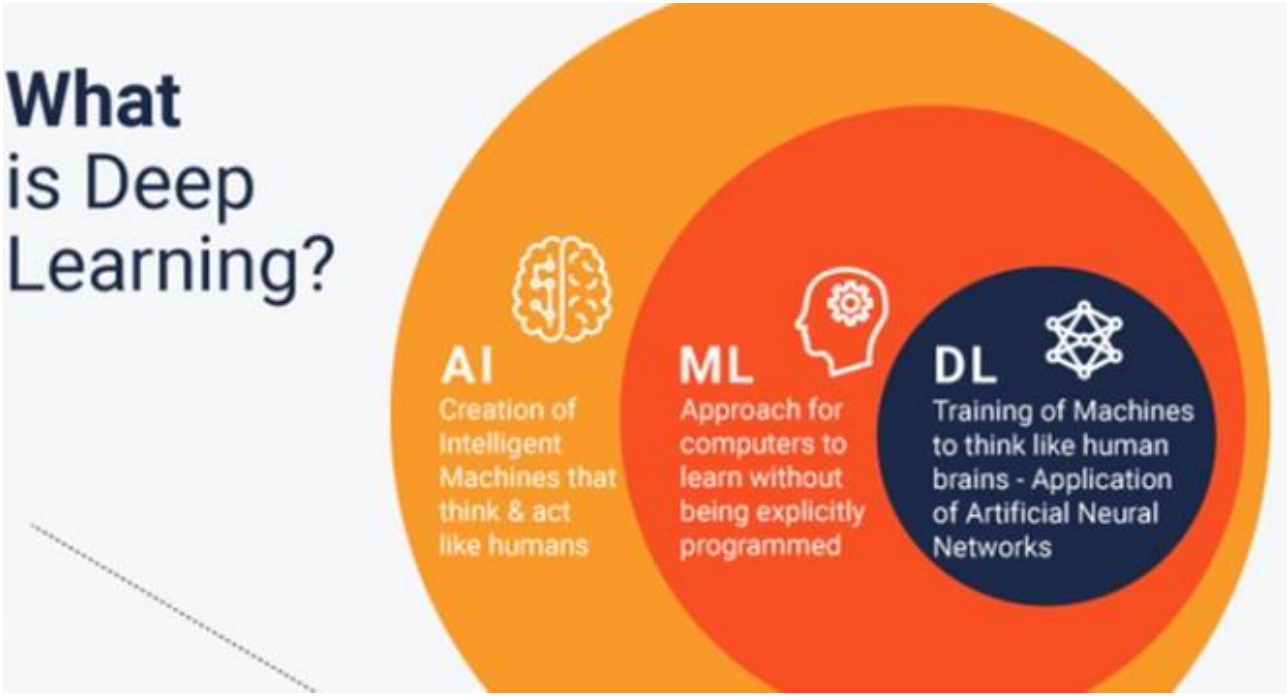
2. Acquires the knowledge needed to create neural networks and work with them; and skills related to programming, data manipulation, method selection, model building, and interpreting the outcome, and

3. Learns to apply these skills in different machine learning tasks involving e.g., image classification and natural language processing.

Neural Networks Applications

Deep learning and neural networks

The AI and ML systems rely increasingly on the concepts of *deep learning,* and are generally realized in the form of *artificial neural networks*.

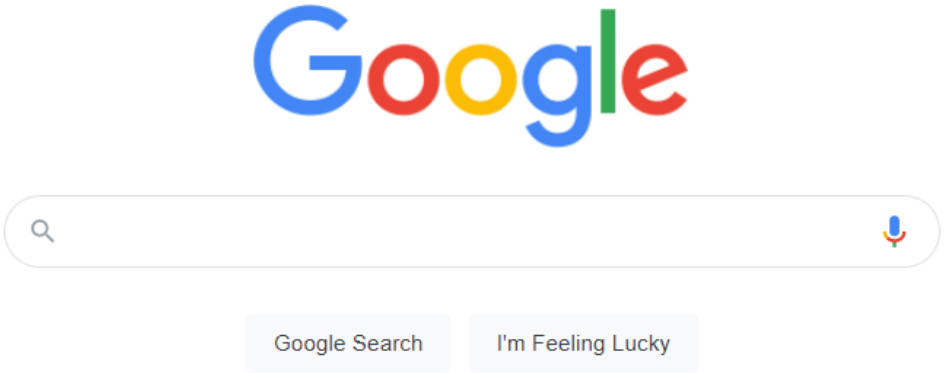


AI = Artifical Intelligence
ML = Machine Learning
DL = Deep Learning
ANN = Artificial Neural Networks

Deep Learning 101 — Role of Deep Learning in Artificial Intelligence

Human-computer interaction

Cognitive computing enables diverse forms of *human-computer interaction* using the methods of *machine learning* and *natural language processing*.



Social media and recommendation systems

https://www.netflix.com/fi-en/title/81254224

Generative systems - OpenAI

DALL·E 2 (openai.com)

DALL·E 2 can create original, realistic images and art from a text description. It can combine concepts, attributes, and styles.

User

help me write a short note to introduce myself to my neighbor

ChatGPT

Hi there,

My name is [Your Name] and I just moved in next door. I wanted to reach out and introduce myself. I'm looking forward to getting to know you and the neighborhood. If you ever need anything or just want to chat, please don't hesitate to stop by or give me a call.

Best,
[Your Name]

ChatGPT: Optimizing Language Models for Dialogue (openai.com)

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests.

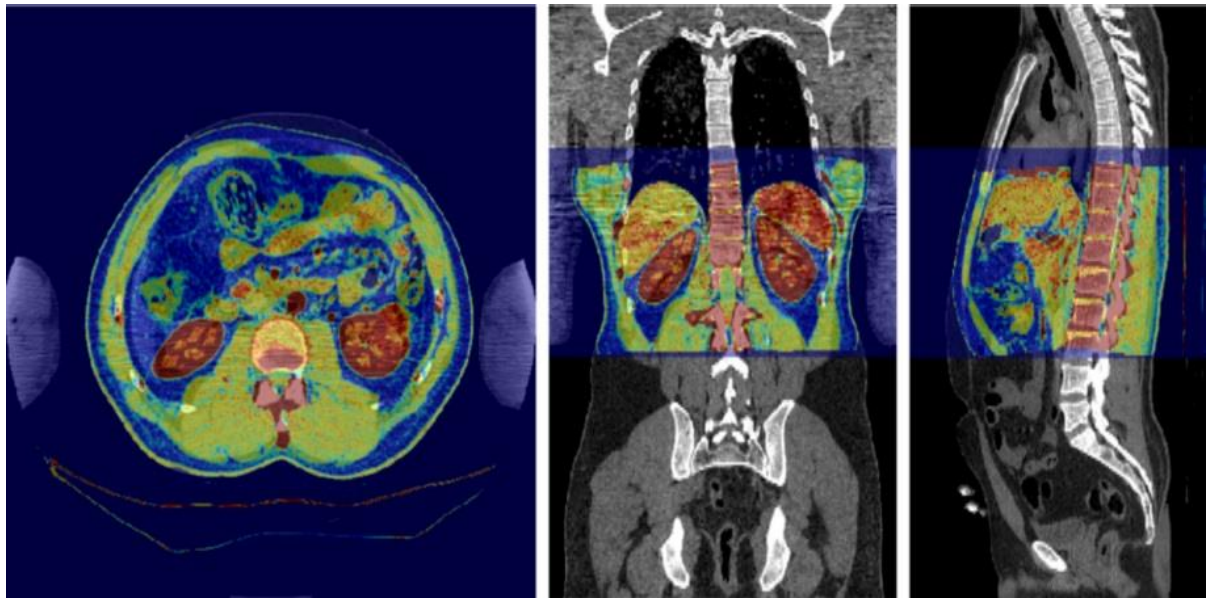
Jukebox (openai.com)

We're introducing Jukebox, a neural net that generates music, including rudimentary singing, as raw audio in a variety of genres and artist styles. We're releasing the model weights and code, along with a tool to explore the generated samples.

Healthcare

In healthcare, neural networks and machine learning algorithms are expected to have wide-ranging application e.g. on

- *imaging analytics*,
- *decision support*,
- *diagnostics* and
- *patient assistance*.



Machine learning for tomographic imaging – Physics World

Stanford Machine Learning Group

Our mission is to significantly improve people's lives through our work in Artificial Intelligence

Projects

We work on developing AI solutions for a variety of high-impact problems

ForestNet

Deforestation driver classification using satellite imagery.

PROJECT WEBPAGE

Solar Forecasting

Calibrated probabilistic solar irradiance forecasting.

PROJECT WEBPAGE

OGNet

Oil and gas infrastructure mapping in aerial imagery.

PROJECT WEBPAGE

CheXphoto

Chest X-Ray Transformation Dataset And Competition

PROJECT WEBPAGE

CheXpedition

Generalizability of top chest X-ray models on real world challenges.

PROJECT WEBPAGE

NGBoost

Probabilistic Prediction with Gradient Boosting

PROJECT WEBPAGE

CheXpert

A Large Chest X-Ray Dataset And Competition

PROJECT WEBPAGE

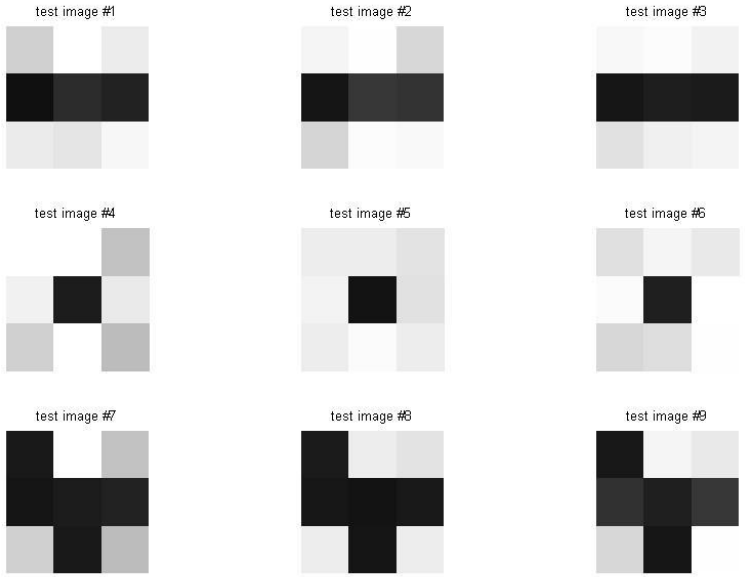
ECG Arrhythmia

Cardiologist-level arrythmia detection from ECG signals.

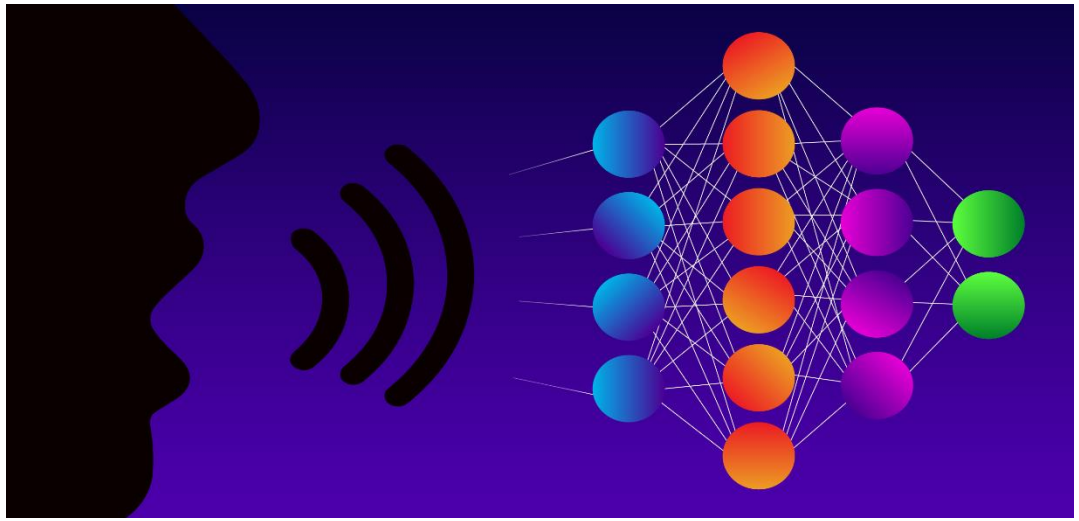
PROJECT WEBPAGE

https://stanfordmlgroup.github.io/

How are neural networks used?



Neural Network for pattern recognition- Tutorial



Deep Learning for NLP: An Overview of Recent Trends

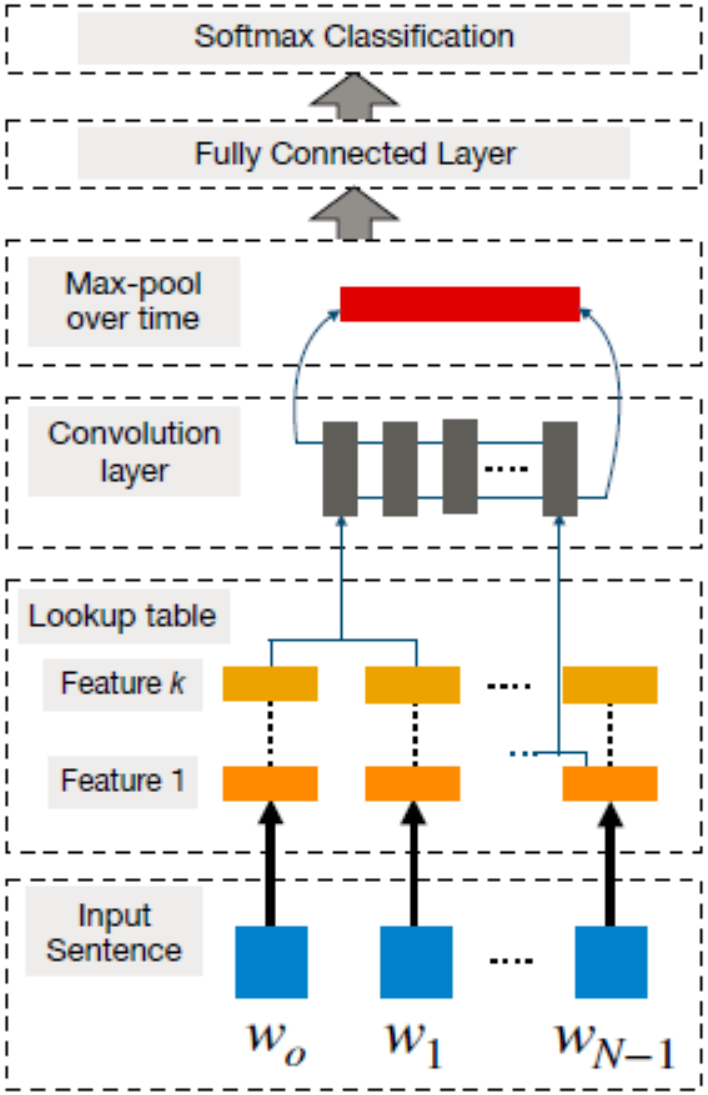
This course presents a detailed view on how neural networks are used in tasks like *pattern recognition* and *natural language processing*.

Topics of the course

The topics include

- an introduction to the essential concepts and algorithms needed for defining and training such networks
- an overview of architectural design choices relevant for specific tasks.

You are also provided a first-hand opportunity of building neural networks on their own.



Example of convolutional neural network (CNN) arhcitecture for natural language processing.

Schedule and workload

Week	Deadline	Workload	Topic
2		6 + 10	Introduction. Tools. Neural networks (NN). Case 0. Learning.
3	Case 0	6 + 9	Case 1. NN and numerical data.
4		6 + 9	NN and numerical data handling continues.
5	Case 1	6 + 10	Case 2. Convolutional neural networks (CNN) and image data.
6		6 + 9	CNN and image data handling continues.
7		6 + 10	Case 3. Recurrent neural networks (RNN) and natural language processing (NLP).
8	Case 2	0 + 10	(no contact teaching)
9		6 + 9	RNN, CNN and NLP continues.
10	Case 3	6 + 9	Review. Final test.
	TOTAL	**48 + 85**	**= 133 hours (5 ECTS)**

Lectures + Home work = Workload (hours)

Assessment and evaluation

Assessment

- Attendance and weekly reports (15 p)
- Case studies (55 p)
- Final examination (30 p)

Evaluation (max 100 p)

- 90 p >= Excellent (5/5)
- 80 p >= Very good (4/5)
- 70 p >= Good (3/5)
- 60 p >= Very satisfactory (2/5)
- 50 p >= Satisfactory (1/5)

Attendance and weekly reports

- Weekly assignments (weeks 2 – 10)
  - Write a short summary of your individual progress during this week, including e.g.
    - tools and concepts learned
    - personal experimentation and new ideas
    - questions and concerns about the week's topics and/or the course.
  - A simple text (without attachments) is sufficient; however, you can also consider submitting e.g. a notebook file, if you wish.
- Motivation
  - Helps the student to review and wrap up
  - Helps the teachers to get feedback

Case studies (55p)

Case studies will be published in OMA -> Assignments

Personal

- Case 0. Learning (5p) – basics of neural networks

Teamwork

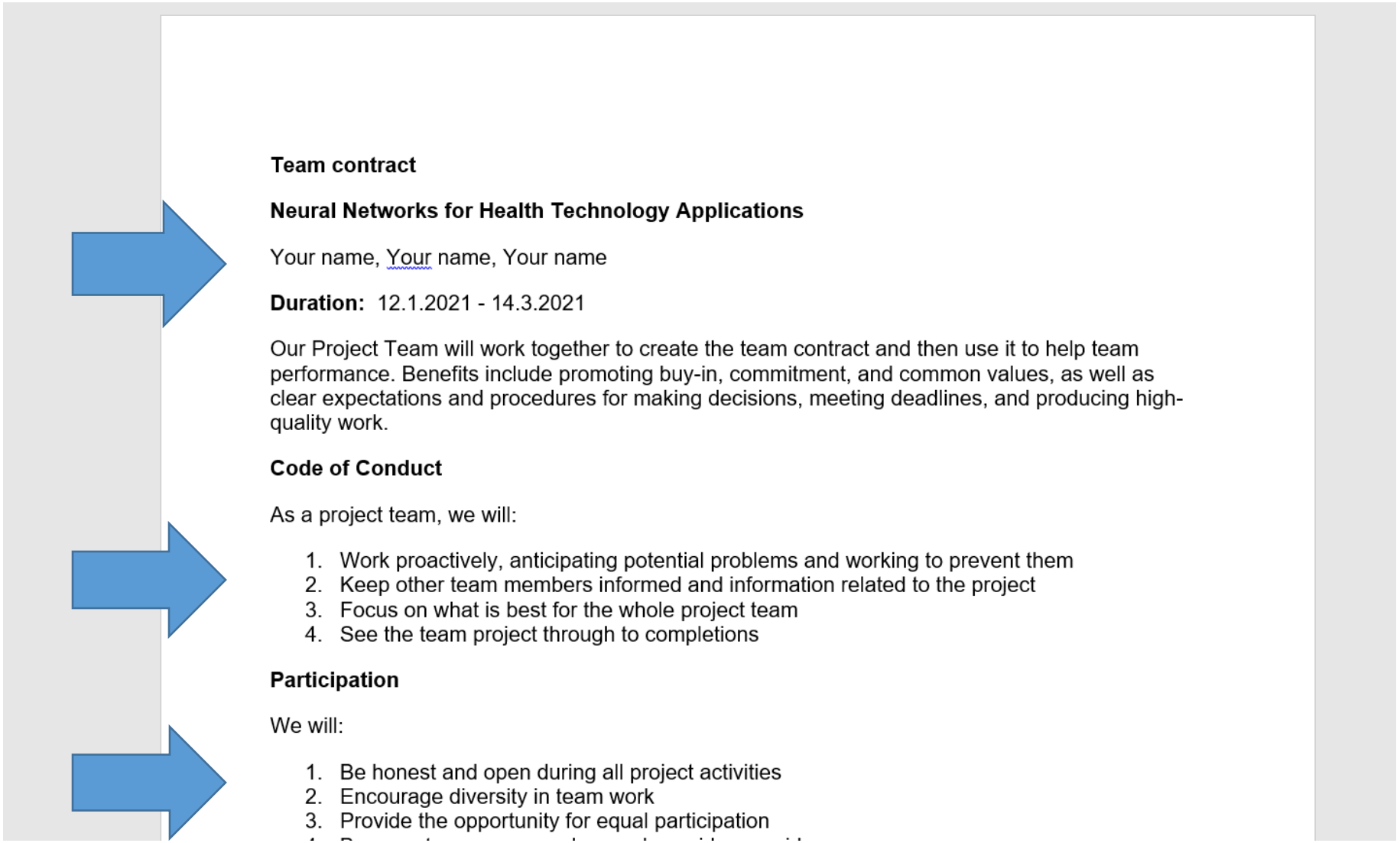
- Case 1. Numerical data (15p) – (dense) artificial neural networks (ANN)
- Case 2. Image data (20p) – convolutional neural networks (CNN)
- Case 3. Text data (15p) – word2vec, recursive (RNN) and convolutional neural networks (CNN)

Teamwork

Assignment: Team

- Make a small team max. 3 person.
- Discuss with your team members and make a contract how you are going to work together during this course.
- Use the attached template for the discussion and make necessary changes to your team contract.
- Return your team contract as attachment. Write also your team member names in the text field.

Team contract template



Team contract

Neural Networks for Health Technology Applications

Your name, Your name, Your name

Duration: 12.1.2021 - 14.3.2021

Our Project Team will work together to create the team contract and then use it to help team performance. Benefits include promoting buy-in, commitment, and common values, as well as clear expectations and procedures for making decisions, meeting deadlines, and producing high-quality work.

Code of Conduct

As a project team, we will:

1. Work proactively, anticipating potential problems and working to prevent them
2. Keep other team members informed and information related to the project
3. Focus on what is best for the whole project team
4. See the team project through to completions

Participation

We will:

1. Be honest and open during all project activities
2. Encourage diversity in team work
3. Provide the opportunity for equal participation

Final test

- Mon 6.3.2023 13:00 – 15:45
- Contents
  - Terminology and concepts
  - Essay type short answers
  - Explaining code snippets
- Individual
- Max 30p

Tools and materials

OMA -> Documents

- Lecture materials
- Assignments
  - Cases
- Notebook examples
- Reference and other materials

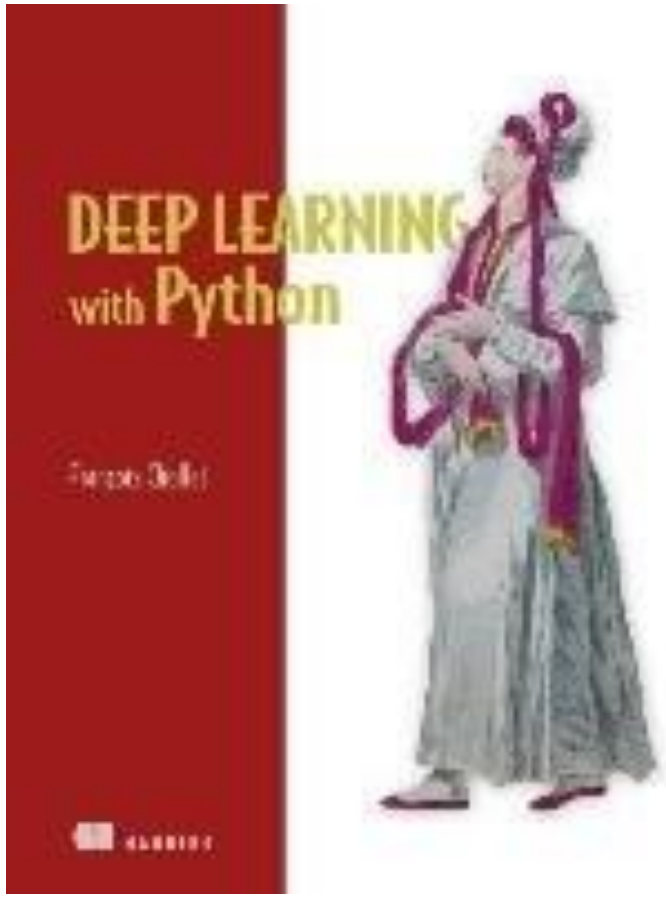
Software tools

- Python
- Notebook

Environments

- Kaggle
- Google Colab
- Anaconda Distribution

Book (recommended)



Deep learning with Python

- Chollet, Francois
- Manning Publications

Freely readable through Metropolia library services:

- OMA -> Tools -> Common Tools -> MetCat

https://metropolia.finna.fi/Record/nelli15.4100000001652948

Assignment - Team

- Study the first assignment: Team
- Discuss with your classmates and create teams for max. 3 persons
- If you need assistance in teaming, ask help