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Chair of Data Science and Data Engineering
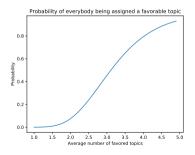Prof. Dr. Emmanuel Müller

Seminar Neural Networks and Deep Learning

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Today

- Kick-Off Meeting
- Some Formalities
- Short Overview of the Topics

- Choose a couple topics
    - Since we are only a few, you can make these requests quite complicated (I prefer topic 1, but I would also take 3 or 7, except when I can do it in german, then I would prefer topic 12)
- Send your choice to Simon.Kluettermann@cs.tu-dortmund.de (till tomorrow 20.10.2021 23:59)
- You will be assigned one in the next days
- Earlier submission will not be preferred, so take your time

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Objective of this Seminar

- Introduction to a wide range of machine learning
  - Researching current scientific ideas
  - Understanding state-of-the-art techniques
  - Writing a clear and concisive scientific report
  - Presenting and discussing your findings

$\rightarrow$Not a bad start for a final thesis.... $\rightarrow$maybe just talk to your supervisor about this

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Timeline

1. 3min Presentations in Class (November 2, 15:30-17:00)
2. Presentation in Class (Weekly, Tuesdays 15:30-17:00, starting November 9)
3. Discussion of your Topics (afterwards)
4. Writing of your Report (till two weeks after your Presentation)

- All parts required!

- Everything will be done in english. If this is a problem for you, please write Simon.Kluettermann@cs.tu.dortmund.de

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Tasks of this Seminar

1. Choose a couple of topics from our list, you will be assigned to one of them
2. Read and understand the chapters given to you
3. Find, read and understand related literature. Try to get a wide picture of your Topic.
   - You will often find alternative sources
   - Some Topics include a programming sections, but for all topics some programming can be useful.

- Final Results:
  - Presentation (30min +10min questions)
  - Written Report (at least 6 Pages double column, ACM template equivalent. Imagine yourself explaining your Topic to another student)
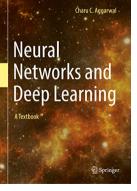
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Topics

- Based on the Book "Neural Networks and Deep Learning"
- by C. Aggarwal, ISBN 978-3-319-94463-0
- Freely available trough University Network (Springer Link)
- Some Topics contain programming assignments. We suggest using google colab for these.

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Week 1: November 9

Topic1: Basics of NN, Feed Forward Networks, loss functions and activations
Chapters 1.2,1.4,1.5 and train a simple Dense Neural Network on MNIST

Topic2: Alternative Models, Least Square Regression and SVMs
Chapters 2.1-2.4

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Week 2: November 16

Topic1: What is Backpropagation?
Chapters 3.1,3.2 and 3.7

Topic2: How to use Backpropagation
Chapters 3.3-3.6

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Week 3: November 23

Topic1: Methods against overfitting: Regularisation, Early Stopping and Ensemble Methods
Chapters 4.4-4.6

Topic2: Advanced training methods: Continuation/Curriculum Learning, Parameter Sharing and Pretraining
Chapters 4.7-4.9

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Week 4: November 30

Topic1: What are recurrent NN and Echo State Networks/Reservoir Computing
Chapters 7.1-7.4 also train a simple RNN

Topic2: Compare LSTMs and GRUs
Chapters 7.5 and 7.6, also briefly summarize 3 applications for RNNs (see for example Chapter 7.7)

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Week 5: December 7

Topic1: Convolutions in Practice
Chapter 8.2, the Introdutions to convolutions from AIMA4, pages 811-813 and train a simple
convolutional neural network on MNIST

Topic2: Convolutions in Theory
Chapters 8.1, 8.3 and briefly summarize 3 applications (see for example chapter 8.6)

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Week 6: December 14

Topic1: Hopfield Networks and Boltzmann Machines
Chapters 6.1-6.4 and briefly summarize 1-2 applications (see for example chapter 6.5) or implement a simple model

Topic2: Graph Machine Learning
Chapter 2.7 + 1 other source, my suggestions: distill.pub on GNN

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Week 7: December 21

Topic1: Explaining Autoencoders
Chapter 2.5 and train a simple Autoencoder on MNIST

Topic2: Advanced Autoencoder concepts
Chapters 4.10 and 8.5

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Week 8: January 11

Topic1: Introduction to Reinforcement Learning
Chapters 9.1-9.4 also implement an RL algorithm for a simple game

Topic2: Advanced RL algorithms
Chapters 9.5, 9.6 and briefly summarize 3 applications for RL (for example Chapter 9.7)

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Week 9: January 18

Topic1: GANs
Chapter 10.4 and train a simple GAN on MNIST

Topic2: A brief summary of unsupervised Machine Learning
A Paper, for example "A Survey on Unsupervised Machine Learning Algorithms for Automation,
Classification and Maintenance" by Khanum et al 2015

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Week 10: January 25

Topic1: Attention Mechanisms
Chapters 10.2 and look for alternative sources!

Topic2: Competitive Learning
Chapters 10.5 and look for alternative sources!

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- Week 1: Intro to Ml *2
- Week 2: Backpropagation *2
- Week 3: Training techniques *2
- Week 4: Recurrent NN *2
- Week 5: Convolutions *2

- Week 6: Boltzmann Machines, Graph ML
- Week 7: Autoencoders *2
- Week 8: Reinforcement Learning *2
- Week 9: GANs, unsupervised ML
- Week 10: Attention Mechanisms and Competive Learning