

CS-456

Artificial neural networks

Gerstner Wulfram

Cursus	Sem.	Type
Biocomputing minor	E	Opt.
Computational Neurosciences minor	E	Opt.
Computational science and Engineering	MA2, MA4	Opt.
Computer science	MA2, MA4	Opt.
Cybersecurity	MA2, MA4	Opt.
Data Science	MA2, MA4	Opt.
Digital Humanities	MA2, MA4	Opt.
Electrical Engineering		Opt.
Financial engineering	MA2, MA4	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Robotics, Control and Intelligent Systems		Opt.
SC master EPFL	MA2, MA4	Opt.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Written
Workload	150h
Weeks	14
Hours	4 weekly
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

Since 2010 approaches in deep learning have revolutionized fields as diverse as computer vision, machine learning, or artificial intelligence. This course gives a systematic introduction into the main models of deep artificial neural networks: Supervised Learning and Reinforcement Learning.

Content

- *General Introduction: Deep Networks versus Simple perceptrons*
- *Reinforcement Learning 1: Bellman equation and SARSA*
- *Reinforcement Learning 2: variants of SARSA, Q-learning, n-step-TD learning*
- *Reinforcement Learning 3: Policy gradient*
- *Deep Networks 1: BackProp and Multilayer Perceptrons*
- *Deep Networks 2: Regularization and Tricks of the Trade in deep learning*
- *Deep Networks 3: Error landscape and optimization methods for deep networks*
- *Deep Networks 4: Statistical Classification by deep networks*
- *Deep Networks 5: Convolutional networks*
- *Deep reinforcement learning 1: Exploration*
- *Deep reinforcement learning 2: Actor-Critic networks*
- *Deep reinforcement learning 3: Atari games and robotics*
- *Deep reinforcement learning 4: Board games and planning*
- *Deep reinforcement learning 5: Sequences, recurrent networks, partial observability*

Keywords

Deep learning, artificial neural networks, reinforcement learning, TD learning, SARSA,

Learning Prerequisites**Required courses**

CS 433 Machine Learning (or equivalent)

Calculus, Linear Algebra (at the level equivalent to first 2 years of EPFL in STI or IC, such as Computer Science, Physics or Electrical Engineering)

Recommended courses

stochastic processes
optimization

Important concepts to start the course

- *Regularization in machine learning,*
- *Training base versus Test base, cross validation.*
- *Gradient descent. Stochastic gradient descent.*
- *Expectation, Poisson Process, Bernoulli Process.*

Learning Outcomes

- Apply learning in deep networks to real data
- Assess / Evaluate performance of learning algorithms
- Elaborate relations between different mathematical concepts of learning
- Judge limitations of algorithms
- Propose algorithms and models for learning in deep networks
- Apply Reinforcement Learning

Transversal skills

- Continue to work through difficulties or initial failure to find optimal solutions.
- Access and evaluate appropriate sources of information.
- Write a scientific or technical report.
- Manage priorities.

Teaching methods

ex cathedra lectures and miniproject. Every week the ex cathedra lectures are interrupted for at least one in-class exercise which is then discussed in classroom before the lecture continues. Additional exercises are given as homework or can be discussed in the second exercise hour.

Expected student activities

work on miniproject

solve all exercises

attend all lectures and take notes during lecture, participate in quizzes.

If you cannot attend a lecture, then you must read the recommended book chapters

Assessment methods

written exam (70 percent) and miniproject (30 percent)

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Others TAs are available during exercise sessions.
Every week one of the exercises is run as 'integrated exercise' during the lecture.
Choice between two different exercise sessions

Resources

Bibliography

- Textbook: Deep Learning by Goodfellow, Bengio, Courville (MIT Press)
- Textbook: Reinforcement Learning by Sutton and Barto (MIT Press)

Pdfs of the preprint version for both books are available online

Ressources en bibliothèque

- [Reinforcement Learning by Sutton and Barto](#)
- [Deep Learning by Goodfellow, Bengio, Courville](#)

Websites

- [http://for videos and lecture slides https://lcwww.epfl.ch/gerstner/VideoLecturesANN-Gerstner.html](#)
- [http://main web page is moodle](#)

Videos

- [http://yes, for most session.](#)