

CS-456

Artificial neural networks

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Cursus	Sem.	Type
Biocomputing minor	E	Opt.
Bioengineering	MA4	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.
Sciences du vivant	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

- *Simple perceptrons for classification*
- *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*
- *Application 1: Convolutional networks*
- *Application 2: Sequence prediction and recurrent networks*
- *Deep reinforcement learning: Actor-Critic networks*
- *Deep reinforcement learning: applications*

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 2 miniprojects. Every week the ex cathedra lectures are interrupted for a short in-class exercise which is then discussed in classroom before the lecture continues. Additional exercises are given as homework. For the exercise sessions two time slots of 45 minutes will be offered, and students will sign up for one of the two.

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

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