Deep Learning — Winter 2026

203.3834

Lecturer: Dr. Alaa Malouf
Lectures: Sunday, 13:00–16:00
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Prerequisites: Object Oriented Programming, Design and Analysis of Algorithms, Introduction to Machine Learning.

Overview. Deep Learning algorithms aim to learn **feature hierarchies**, in which higher-level representations are built upon lower-level ones. This hierarchical feature learning enables models to uncover structure in data and achieve state-of-the-art performance in a wide range of domains, including vision, language, and speech.

This course offers a comprehensive and practical introduction to modern deep learning architectures and their applications in artificial intelligence. Students will explore the mathematical principles and computational frameworks underlying neural networks, convolutional and recurrent architectures, optimization methods, transformers, and generative models.

The course emphasizes both theoretical understanding and hands-on implementation, with all assignments conducted in **PyTorch**.

Selected Topics:

The course covers both theoretical foundations and practical tools in deep learning. Throughout the semester, we will develop an understanding of how deep architectures are trained, optimized, and applied to real-world tasks. course framework, we will study the following topics:

- **Foundations:** Neural networks, backpropagation, optimization algorithms, initialization, and regularization.
- **Convolutional Networks (CNNs):** Architecture, visualization, and adversarial examples.
- **Recurrent Networks (RNNs):** Sequence modeling, LSTM, GRU, and image captioning.

- **Attention and Transformers:** Self-attention, encoder–decoder models, and large-scale architectures.

If time permits, the course will also touch upon selected advanced topics that extend the principles of deep learning to modern frontiers in vision and generative modeling. We will visit topics such as: **Vision Transformers (ViT)**, **Few-Shot Learning**, **Meta-Learning**, **Deep Generative Models**. The specific set of advanced topics will be selected based on available time and class progress.

Together, these subjects provide the theoretical and computational foundation for advanced research and applications in artificial intelligence, computer vision, and data-driven generative modeling.

Grading:

- Final written exam — **60%**
- Homeworks and Assignments — **40%**

Assignment Policy

Assignments will be released approximately every 2–3 weeks and are due two weeks after publication at 23:59. The detailed homework schedule is provided in the course syllabus. The following guidelines are binding; failure to comply with them may result in grade penalties or disqualification of the submission.

Submission Guidelines:

- All assignments must be completed and submitted **in pairs**. Collaboration on conceptual understanding between pairs is allowed, but sharing or duplicating solutions across pairs is strictly prohibited.
- Both partners are expected to have full understanding of the entire solution and may be asked to explain any part of their submission if requested by the course staff.
- Each assignment must be submitted through the designated **Moodle submission box** corresponding to that assignment.
- Submissions must be clear, well-organized, and complete. Unreadable, incomplete, or improperly formatted submissions may not be graded.

Deadlines and Late Submissions:

- Assignment due dates are binding as published on Moodle.
- Submissions up to **two days late** are accepted without penalty. Beyond this period, submissions will not be accepted except in exceptional, pre-approved circumstances.

- **No additional extensions** will be granted under normal conditions.

Academic Integrity:

- Students are encouraged to discuss ideas and approaches conceptually, but the written solution must reflect the pair's own independent work.
- Any form of plagiarism, code sharing, or unauthorized collaboration will be treated as a violation of the University's academic integrity policy and may lead to disciplinary action.

Communication:

- For questions or clarifications regarding assignments, students may contact the course staff through the Moodle discussion forum.
- Personal or technical issues related to submissions should also be reported promptly through Moodle or directly to the teaching assistant via e-mail.

Homework Tentative Schedule:

HW	Release Date	Submission Date
1	12.11.2025	03.12.2025
2	03.12.2025	24.12.2025
3	24.12.2025	07.01.2026
4	07.01.2026	25.01.2026

Note: The release and submission dates are tentative and subject to change. Updated dates will always appear on Moodle. All submissions are due at 23:59 on the stated date.

Exam Policy

Final Exam Grade Requirement: Students must obtain a grade of at least **55** in the final exam in order to pass the course.

The final course grade will be calculated only if this condition is met. If the exam grade is below 55, the final course grade will be determined solely based on the exam score, regardless of homework grades.

Exam Content: The exam will encompass all material covered in the lectures and tutorials and will rely solely on the content delivered therein.

Additional Notes: Further administrative details or clarifications regarding the exam format, permitted materials, and grading policies will be provided closer to the exam date through Moodle.

Tentative Combined Schedule

Week	Lecture		Tutorial		
	Date	**Topic**	**Date**	**Topic**	**Notes**
1	26.10	Introduction to Deep Learning	29.10	Intro to DL, PyTorch	—
2	02.11	Feedforward Networks	05.11	Logistic Regression	—
3	09.11	Backpropagation	12.11	Feedforward Networks	HW1 out
4	16.11	Optimization	19.11	Backprop. & Optimization (GPUs)	
5	23.11	Regularization	26.11	Batch Normalization	—
6	30.11	CNNs & Variations	03.12	CNNs	HW2 out; **HW1 due**
7	07.12	CNN Applications	10.12	CNN Variations	
8	14.12	RNNs, LSTMs & Attention	17.12	Semantic Segmentation	—
9	21.12	**— No Lecture —**	24.12	Sequence Models	HW3 out; **HW2 due**
10	28.12	Transformer Models	31.12	LSTMs, Transformers	
11	04.01	Vision Transformers	07.01	Vision Transformers	HW4 out; **HW3 due**
12	11.01	Few-Shot Learning	14.01	***TBD***	
13	18.01	Meta-Learning	21.01	***TBD***	—
14	25.01	***TBD***	—	**— No Tutorial —**	**HW4 due**

Notes: Lectures and Tutorials dates follow the university *academic timetable* (including special schedule days and official events). In particular: (i) **21.12** is a university no-classes day (psychometric test) — no lecture will be held on that day, but the tutorial on **07.01** runs as scheduled; (ii) Week **14** is lecture–only (no tutorial). **Homework is due two weeks after release at 23:59, unless otherwise announced.** Topics, dates, and deliverables may be adjusted to match class pace and guest availability.

Further Reading and References:

- **Deep Learning /** Ian Goodfellow, Yoshua Bengio, and Aaron Courville. MIT Press, 2016. (ISBN: 978-0-262-03561-3).
- **Pattern Recognition and Machine Learning /** Christopher M. Bishop. Springer, 2006. (ISBN: 978-0-387-31073-2).
- **Neural Networks and Deep Learning /** Michael Nielsen. Online book, 2015. `http://neuralnetworksanddeeplearning.com/`
- **Deep Learning with PyTorch /** Eli Stevens, Luca Antiga, and Thomas Viehmann. Manning Publications, 2020. (ISBN: 9781617295263).
- **Dive into Deep Learning (D2L) /** Aston Zhang et al. Open-source textbook, 2024. `https://d2l.ai`