CS-E4740 - Federated Learning

L0 - Course Logistics

Assoc. Prof. Alexander Jung

Spring 2026

Calendar

Glossary

Book

GitHub

At a Glance

- 5 credits (approx. 130 hours of work)
- Fully online - no mandatory attendance.
- Part I (Feb.,Mar.): 8 lectures and assignments
- Part II (Apr.,May): student project (with peer review)

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Prerequisites

- **Linear Algebra.** Vectors $\mathbf{w} \in \mathbb{R}^d$, matrices $\mathbf{Q} \in \mathbb{R}^{d \times d}$, norms $\|\mathbf{w}\|_2$.
- **Multivariable Calculus.** Smooth functions $f(\mathbf{w})$ and their gradients $\nabla f(\mathbf{w})$.
- **Basic machine learning (ML).** Empirical risk minimization (ERM) $\min_{h \in \mathcal{H}} (1/m) \sum_{r=1}^{m} L\left(\left(\mathbf{x}^{(r)}, y^{(r)}\right), h\right)$.
- **Python.** Basic coding skills and familiarity with libraries `numpy` and `scikit-learn`

Learning Goals

After completing this course, you can

- represent federated learning (FL) applications using graphs
- formulate FL as optimization over graphs
- design FL algorithms via distributed optimization
- build trustworthy FL systems.

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Positioning of CS-E4740 in Curriculum

In what follows, we briefly explain how CS-E4740 relates to selected courses at Aalto University and University of Helsinki.

Related Courses - Bare Necessities

- **MS-A0001 - Matrix Algebra.** Introduction to linear algebra in $\mathbb{R}^d$. We will use $\mathbb{R}^d$ as the main mathematical structure for reasoning about FL.
- **CS-C3240 - ML.** Teaches basic techniques for training a single ML model on a given dataset. FL extends this centralized setting to networks of devices, each having access to its own dataset and model.
- **Data Analysis with Python.** Teaches how to implement basic ML methods in Python. Our course assignments require to implement (parts of) FL algorithms in Python.

Related Courses - Nice to Have

- **MS-C2105 - Introduction to Optimization.** Teaches basic concepts for the design and analysis of optimization methods. Our course formulates FL as an optimization problem. FL algorithms are obtained, in turn, by applying optimization methods to solve this problem.

- **ELEC-E5424 - Convex optimization.** Teaches advanced tools such as convergence analysis of gradient-based methods for the study and design of FL algorithms.

Related Courses - Follow Up

- **ELEC-E7120 - Wireless Systems.** Discusses the fundamentals of radio communications which can be used to implement FL algorithms.
- **ELEC-E8102 - Distributed and Intelligent Automation Systems.** Discusses automation systems consisting of interconnected sensors and actuators. We can use FL to train predictive models used by these devices.

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At a Glance

- Part I (Feb.,Mar.): 8 lectures and assignments
- Part II (Apr.,May): student project (with peer review)

Lecture Schedule

Lecture	Day	Topic
L1	Mon 23.02	From ML to FL
L2	Wed 25.02	FL Design Principle
L3	Mon 02.03	FL Algorithms
L4	Wed 04.03	Federated Clustering
L5	Mon 09.03	Federated RL
L6	Wed 11.03	Explainable FL
L7	Mon 16.03	Cyber-Security in FL
L8	Wed 18.03	Privacy in FL

Assignments (One per Lecture)

	Released	**Due**	**Topic**
A1	Mon 23.02	Mon 02.03	From ML to FL
A2	Wed 25.02	Wed 04.03	FL Design Principle
A3	Mon 02.03	Mon 09.03	FL Algorithms
A4	Wed 04.03	Wed 11.03	Federated Clustering
A5	Mon 09.03	Mon 16.03	Federated RL
A6	Wed 11.03	Wed 18.03	Explainable FL
A7	Mon 16.03	Mon 23.03	Cyber-Security in FL
A8	Wed 18.03	Wed 25.03	Privacy in FL

Project Schedule (April–May)

Milestone	**Date**
Project kickoff event	Wed 01.04.2026
First submission DL	Sun 26.04.2026
Peer Review – Start	Mon 27.04.2026
Peer Review – End	Sun 03.05.2026
Second submission DL	Sun 17.05.2026
Peer Review – Start	Mon 18.05.2026
Peer Review – End	Wed 27.05.2026

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Graded Activities

- **8 Assignments.** One for each lecture. Completion of assignments is tested via multiple choice quizzes.
- **Student Project.** Apply FL techniques to weather forecasting. Two submission rounds, each involving peer grading.

Points Breakdown

Component	**Points**
Assignments (one for each lecture)	40
Student Project (60 points)	
First Submission	5
Peer Review 1	8
Second submission (incl. MP4)	39
Peer Review 2	8
Total	**100**

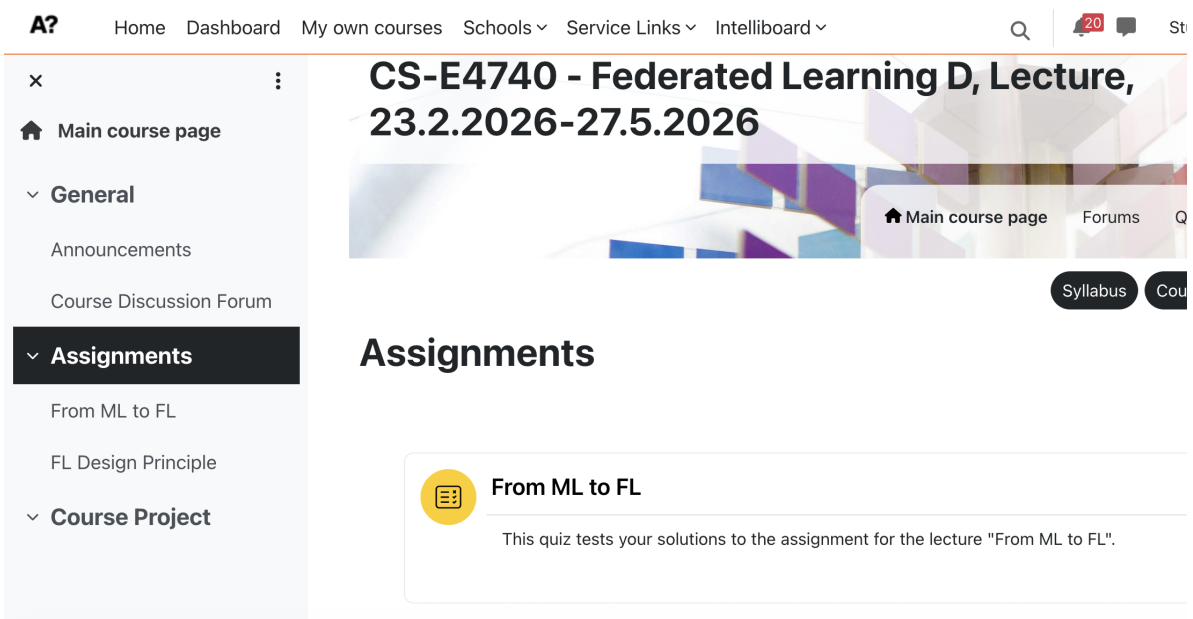
From Points to Grade

- **Grade 1** for 50-59 points.
- **Grade 2** for 60-69 points.
- **Grade 3** for 70-79 points.
- **Grade 4** for 80-89 points.
- **Top grade 5** for at least 90 points.

Assignment Workflow

- One assignment per lecture
- Small Python tasks and **conceptual questions**
- Released after the lecture
- Deadline: one week later
- **Completion via answering multiple-choice questions (Quizzes)**

Assignment Quizzes



Student Project Workflow

Step	**What you do**
First submission	Submit first version of project report.
Peer Review 1 (PR1)	Review assigned drafts and receive feedback
Second submission	Submit revised report **+response letter+ recorded slide talk**
Peer Review 2 (PR2)	Review submissions against reviews

Student Project - First Submission

Dataset (fixed):

- Weather data from Finnish Meteorological Institute (FMI)
- Preprocessing scripts and baselines provided

Your task:

- Design and evaluate **at least one FL method**
- Quantitative evaluation and discussion

Deliverables and assessment:

- IEEE-style report (template provided) + reproducible code
- Anonymous, rubric-based peer review (TA moderated)

Student Project – Second Submission

Goal: Improve your work based on peer feedback from the first submission.

Deliverables:

- **Revised IEEE-style report** (pdf)
- **Response-to-reviews letter** (pdf)
- **Project presentation** (mp4)

Response letter requirements:

- For **each comment** (point-by-point): **(i) what you changed, (ii) where in the report, (iii) why**
- If you disagree with a comment: explain briefly and professionally

Assessment:

- Second round of anonymous peer review (TA moderated)

Student Project – Recorded Slide Presentation

Deliverable (MP4):

- **Recorded slide talk (voice-over)** that summarizes your project

Strict limitations:

- **Max duration: 5:00 minutes** (hard cut; longer videos are penalized)
- **Max file size: 200 MB** (upload must succeed in MyCourses)

Expected content (suggested structure):

- Problem + dataset (30–45s)
- Method(s): at least one FL method (60–90s)
- Experimental setup + baselines (45–60s)
- Results + takeaways (90–120s)
- Limitations + future work (20–40s)

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Ground Rules

This course follows the **Aalto University Code of Conduct** (see here).

The goal of these ground rules is not control, but to ensure **a safe learning environment** for everyone.

There are two simple principles guiding all course activities.

Rule I — Be Honest

- This course involves a significant amount of **independent work**:
  - weekly assignments,
  - student project (report + recorded presentation),
  - peer review of other students' work,
- **Your submissions must reflect your own understanding.**
- Plagiarism undermines fair assessment.
- We randomly invite students to zoom meetings where they **need to explain their submitted work**.

Rule II — Be Respectful

This course aims to provide a **safe, inclusive, and respectful space**.

Respect applies to all course-related interactions, e.g., during lectures, peer reviews, discussion forum.

Disrespectful, discriminatory, or harassing behaviour has no place in this course and will be addressed according to university procedures.

A respectful environment is a **shared responsibility**.