COS 514 (Fall 2025): Fundamentals of Deep Learning

Course Project Guidelines

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Overview

The course project constitutes 50% of your final grade in COS 514. It is an opportunity to explore a topic of your choice that relates to the mathematical or conceptual foundations of deep learning. Projects may be either *theoretical* or *experimental*, but they should demonstrate original thought, analysis, or implementation. A successful project may serve as a seed for future research, and in some cases may develop into a publication with additional work.

Objectives

The goal of the course project is to:

- Apply the theoretical and conceptual tools learned in class to a new research question or model.
- Gain hands-on experience in designing, testing, and analyzing deep learning systems or theoretical frameworks.
- Practice writing and presenting a technical research paper.

What Makes a Good Project

Your project should:

- Address a well-defined research question relevant to the course (e.g., generalization, optimization, implicit bias, diffusion models, credit attribution, or post-training).
- Include **a new contribution**: either a novel proof, a new experiment, a new dataset analysis, or a new interpretation of existing results.
- Be more than a literature review or survey of existing work. Projects that merely summarize your own prior research or existing papers without new content are not appropriate.
- Have a clear scope and a feasible plan for completion within the semester.
- Involve sound methodology and analysis, even if the results are preliminary.

Suggested Project Types

- **Theoretical:** Prove or empirically support new results related to optimization, generalization, implicit bias, or the expressivity of deep networks.
- **Experimental:** Implement and evaluate models or training paradigms discussed in class (e.g., contrastive learning, normalization, diffusion models).

- **Hybrid:** Combine theoretical insights with empirical validation, e.g., studying implicit bias of SGD in small networks.
- **Reproducibility:** Reproduce key results from a research paper and extend them with new experiments or analysis.

Project Deliverables and Deadlines

Team and Project Selection	November 1
Idea Presentations (3 min per team)	November 19
Final Presentations (in person)	December 10 (whole day, two sessions)
Final Paper Submission	December 15 (morning)

Teams of 2–3 students are recommended. Larger teams must propose projects of commensurate scope and difficulty.

Project Paper (40% of Final Course Grade)

Your written report should be 4–8 pages (NeurIPS or ICML format preferred) and include:

- **Motivation and Background:** Why is this problem interesting? How does it connect to course material?
- **Problem Definition:** State your research question or hypothesis precisely.
- **Methods:** Describe theoretical derivations, algorithms, or experimental setup.
- **Results and Analysis:** Present findings clearly with tables, figures, or proofs.
- **Discussion:** Reflect on what you learned and potential future directions.

Presentation (10% of Final Course Grade)

Each team will give a short presentation during the final project session. Presentations should:

- Clearly motivate the problem and explain your contribution.
- Summarize methods and key results at a high level.
- Stay within the allotted time (to be announced based on team count).

Advice and Expectations

- Aim for a **proof of concept (POC)**: even small-scale experiments or partial proofs are acceptable if they show thoughtful exploration.
- You may connect your project to your broader research interests, but it must include new work specific to this course.
- We encourage you to discuss ideas early with the instructor or TA during office hours.
- See past COS 514 projects here for inspiration.

Contact and Logistics

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We look forward to seeing your ideas!