

PROJECT GUIDELINE: COSC 594/650 – FALL 2026

Optimization for Machine Learning

Instructor: Dongsheng Ding

Project Description

Each student develops, completes, presents, and submits their own study of an optimization problem for machine learning. Identify a concrete problem, formulate it mathematically, study relevant methods, and support a focused research claim with theory, experiments, or both. The final outcome is a conference-format research manuscript. Empirical projects also require a reproducible software artifact; theoretical projects do not require code or a software artifact. Choose a problem connected to the course and your research interests. You are encouraged to discuss potential problems with your advisor. If you do not have an advisor, contact the instructor or teaching assistant for help developing and refining an idea. Confirm your project scope with the instructor before submitting the proposal.

Section expectations. COSC 594 projects may develop a meaningful, rigorous extension of existing work. COSC 650 projects are expected to make a stronger original theoretical or empirical contribution. Both require rigorous formulation, sound reasoning, and credible evidence. The project should be capable of growing into a publishable paper at a top-tier conference or journal; an actual submission depends on sufficient novelty and evidence. **A paper summary or literature review is not a project.**

Project Milestones and Grading

The project is worth **45% of the total course grade**. The percentages below are course-grade contributions, not percentages within the project. The three main milestones are proposal, presentation, and final report, with a technical checkpoint between the proposal and presentation.

Stage	Weight	Submission	Due
Proposal	10%	Problem, research question, and plan	October 30
Checkpoint	5%	Initial results; artifact if applicable	November 13
Presentation	10%	Talk slides	November 23, 30
Final report	20%	Manuscript; artifact if applicable	December 9

Write your report in L^AT_EX using the [NeurIPS 2025 template](#); use the **preprint** option and include your name and affiliation. Submit each milestone on Canvas by **11:59 pm Eastern Time on its listed due date**. Presentation slides are due on your assigned presentation date. Check Canvas for your assigned presentation slot on **November 23** or **November 30**. The final report is due on **December 9**. **Late report submissions are not accepted.**

Proposal and Research Question – 10%

The proposal should make clear what you will investigate and how the result could be evaluated. A concise report of **two pages**, excluding references, is recommended. Include:

- **Problem and formulation:** Explain the machine learning task, motivation, decision variables, objective, constraints, and relevant assumptions.
- **Research question and contribution:** State a specific, falsifiable question. Identify the gap in existing work and the extension or original contribution you plan to make.
- **Related work and baseline:** Identify central references, explain their connection to your question, and select a result or method to reproduce or use as a baseline.
- **Validation and work plan:** Describe the planned analysis or experiments, evaluation metrics, available data and computing resources, likely risks, and a feasible sequence of tasks.

Possible directions include studying the effect of conditioning on first-order methods; evaluating dual, projected, or Lagrangian methods for constrained learning; analyzing stochastic or nonconvex optimization; or investigating optimization questions in neural networks, generative models, or reinforcement learning. These are starting points, not assigned topics. Narrow the scope to a question that can be answered carefully within the semester.

Technical Checkpoint – 5%

The checkpoint should show that the project has moved beyond a literature review and that the remaining plan is feasible. Summarize your initial technical progress in **one page**, add it into your proposal, and submit the updated document on Canvas. Include:

- **Current formulation and claim:** Restate the research question and explain any changes made after the proposal.
- **Baseline or reproduction:** Present a working baseline, a reproduced key result, or a verified derivation that establishes a reliable starting point.
- **Initial technical progress:** Give an explicit theorem statement and proof outline, an algorithm with a justified design, or preliminary experiments with clearly labeled settings and metrics. Separate proved, observed, and conjectured statements.
- **Validation and diagnosis:** Explain checks for mathematical correctness or implementation errors. Report useful negative results and remaining gaps rather than hiding them.
- **Next steps:** Identify the main risks, the minimum result needed to answer the question, and the work to finish before the presentation and report.

For a theoretical project, present the relevant derivations, theorem statements, or proof progress; code and a software artifact are not required. For an empirical project, submit runnable baseline code with the updated proposal and include enough configuration information to reproduce the initial results. Keep any software artifact connected to the claim being investigated.

Presentation Guideline – 10%

Present your research problem, approach, evidence, and conclusions during your assigned class session (will be announced on Canvas). Each student gives a **10-minute presentation followed by 2 minutes of Q&A**. Approximately **10 slides, excluding transition slides**, are recommended. A useful structure is:

1. **Motivation and question:** Introduce the machine learning task, its connection to optimization, and the precise optimization question your project addresses.
2. **Problem setup and prior work:** Define the notation and assumptions needed for the talk, and explain the optimization problem you study.
3. **Method and evidence:** Explain the main idea, one or two central technical results, and the analysis or experiments supporting them. Distinguish prior work from your contribution.
4. **Conclusion and limitations:** State what the evidence supports, what remains uncertain, and what will be revised in the final report.

Use readable slides, consistent notation, and figures that communicate the main comparisons. Explain intuitions before detailed mathematics. You do not need to cover every proof or experiment. Be ready to explain assumptions, design choices, and limitations, and acknowledge questions you cannot yet answer. Audience questions and feedback contribute to class participation, which is **5% of the course grade** under the syllabus.

Final Report Guideline – 20%

For this course, a final project report of **six pages**, excluding references and appendices, is recommended; prioritize a complete, focused argument over length. Use consistent notation, terminology, and formatting. The manuscript should include:

- **Abstract:** Summarize the problem, approach, main result, and its significance in one paragraph.
- **Introduction and related work:** Motivate the question, explain the research gap and relationship to the course, and state the contribution precisely. Explain how the project differs from the most relevant existing work.
- **Problem setup:** Define the mathematical formulation, notation, assumptions, and evaluation criteria. State which properties, such as convexity, smoothness, or constraint qualifications, are needed.
- **Method and main results:** Present the formulation, algorithm, theorem, or empirical finding that addresses the research question. Distinguish established results from your contribution and state limitations explicitly.
- **Derivations and analysis:** Include the reasoning needed to assess correctness. State theorems with their assumptions, explain key proof steps, and place longer supporting derivations in an appendix if needed. For an empirical study, justify the algorithmic choices and evaluation design.
- **Experiments and validation:** For empirical claims, describe the data or test problems, baselines, implementation, hyperparameters, compute budget, and metrics. Report variability when randomness affects the result. Include relevant ablations, diagnostic checks, and failures. Explain what the evidence does and does not establish.
- **Conclusion:** Answer the research question at the strength justified by the evidence and describe concrete remaining limitations or next steps.
- **Contribution and AI use statements:** Clearly distinguish your own contribution from prior work and disclose AI assistance as described in the AI policy below.
- **References and appendices:** Cite original sources and clearly attribute borrowed ideas, code, data, proofs, and figures. Include supplementary technical details, reproducibility information, and the required AI-use records.

Revise the manuscript using feedback from the technical checkpoint and presentation. Findings that do not support the original hypothesis can still be valuable when the methods are sound, the evidence is clear, and the conclusions are appropriately limited.

Reproducible Software Artifact

For empirical projects, submit a repository or code archive with the manuscript to reproduce the central results. Theoretical projects do not require code or a software artifact. Any submitted artifact should contain:

- A **README** stating the research question, repository structure, setup instructions, and commands for running the main experiments or demonstrations.
- **Environment and configuration files** with relevant package versions, random seeds, hyperparameters, and required hardware or approximate runtime.
- **Data instructions** explaining how to obtain and prepare the data or generate the test problems, including any access restrictions and applicable permissions.
- **Baseline and proposed-method implementations**, where applicable, with clear attribution for reused code and any modifications.
- **Evaluation and plotting scripts** linking reported tables, figures, or numerical examples to the commands that produce them. Preserve the configurations and result files used for the final report.

- An **AI Use Statement** consistent with the manuscript, and a clearly identified final code version or archive.

Check the instructions from a fresh environment when feasible. A small example or reduced-cost run should help a reader verify the setup before running larger experiments. If a central result cannot be reproduced within the available resources, explain the limitation and provide the available evidence. Share the artifact through the course submission channel; a public repository or conference submission is not required.

Use of Generative AI

AI tools may assist with brainstorming, coding, editing, and diagnostic feedback, subject to the syllabus. The research question, claimed contribution, technical decisions, validation methodology, and interpretation must be developed and defended by the student. You remain responsible for every submitted claim, derivation, citation, line of code, experimental result, and conclusion, and must be able to explain and reproduce the work without AI assistance.

Every AI-assisted submission must include an **AI Use Statement** that identifies:

1. The tool and model used.
2. The date or dates of use.
3. The purpose of the assistance.
4. The portions of the submission affected.
5. How the output was independently checked, corrected, or revised.

Include representative prompts and materially used outputs in an appendix, and retain complete interaction records until grading. The final manuscript and any submitted repository or code archive must contain an AI Use Statement. If no AI assistance was used, state: *"No AI tools were used in preparing this submission."* Ordinary, non-generative spell-checking need not be disclosed.

Verify AI-assisted mathematics, code, text, and figures independently. Locate, read, and check original sources before citing them. Do not fabricate citations, proofs, data, results, or novelty claims, or submit AI output that you do not understand and have not verified. Follow applicable attribution, licensing, data-use, and venue policies. Do not upload confidential research, others' unpublished work, restricted data, personal information, assessment materials, or protected course materials without authorization. No paid AI service is required. The instructor or teaching assistant may request an explanation, code demonstration, or reproduction to verify mastery.

Submission and Evaluation

Submit documents as PDFs and, for empirical projects, provide the required artifact using the instructions on Canvas. Label your manuscript and any submitted artifact with your name and course section. You are responsible for understanding and explaining all submitted work. At each stage, include the applicable AI Use Statement. Keep the final manuscript, any submitted code, and reported results consistent.

Work is evaluated on the clarity and significance of the question, correctness of the formulation and reasoning, depth of contribution appropriate to the course section, quality of validation and reproducibility, and clarity of communication. Use the milestone weights on page 1. Discuss scope or feasibility concerns with the instructor or teaching assistant early, and use Canvas or office hours for questions.

AI Use Statement for This Guideline

OpenAI Codex (GPT-6) assisted with drafting, editing, and L^AT_EX formatting of this guideline. The draft was based on the instructor-provided template and course syllabus. The instructor reviewed and revised the project requirements, due dates, grading weights, and report length and retains responsibility for the final guideline.