Advanced Artificial Intelligence

Final Project (60 pts in total)

Introduction

The lectures and readings in this class will cover a variety of topics in Advanced AI. The final project will give students the chance to build something they are passionate about and demonstrate their skills in implementing AI techniques. A requirement of this is novelty: students should attempt to contribute to the field by doing new research that has the potential to be published. Grading is largely weighted towards execution: a working prototype shows not only the students' ability to practice AI but also provides material for their portfolio.

The project will consist of five deliverables that contribute toward the final grade:

- A **pre-proposal** which should be a short paragraph identifying the members of your group and a description of your project. This pre-proposal will reassure me that you are thinking about your project and give me the opportunity to offer advice before the project proposal is submitted. (not graded, but required to receive full credit on the final project grade)
- A **proposal** where the students detail what they plan to create. This will be due ahead of the final project, and the instructor will provide feedback, tips, and changes to the project requirements. Also, a short presentation to the class. (**10 pts**)
- An **artifact**, i.e., code of the students' project. The artifact should demonstrate the students' contribution and proficiency on the subject matter and fulfill the requirements set forth in the proposal. (**25 pts**)
- A **report** that details the students' contribution. This should be similar to a short research paper and include all relevant results, experiments, etc. (**15 pts**)
- A **short presentation** illustrating the contribution of the work and showing the results. (**10 pts**)

The requirements and rubrics of these components are detailed below.

Important Dates

- Thursday, April 17, 2025: Project Pre-proposal by the time of the class.
- Sunday, May 4, 2025: Project proposal due.
- Thursday, May 8, 2025: Project proposal presentation in the class.
- Sunday, June 1, 2025: Project paper and artifact due.
- Thursday, June 5, 2025: Project presentation in the class.

Groups

For this project, you have the option of working in groups of 3 people (in case you cannot find your group, please communicate that with me). The following apply:

- You may choose group members from either the online or in-person section. It is up to you to coordinate how and when to collaborate. The instructor highly recommends using github for source control, and email/slack/instant messaging to coordinate and collaborate.
- All students in each group will receive the same grade. This is non-negotiable. Choose your members wisely.
- Use the Final Project Discord channel to post your ideas or find group members if you desire.

Guidelines

Students have the option for their project to either implement a new work from scratch or largely expand upon an existing work. There is a lot of flexibility here, but your proposal will be used to ensure that the work is

sufficiently scoped. Below are some general guidelines and things that you have to think about for the AI project:

- Define the Problem: Clearly articulate the problem you want to solve using AI. Understand whether AI is the most appropriate approach for the given problem.
- Formulate as an AI Problem: Represent your problem as an AI problem. Define the state space, action space, and reward function. Consider the time horizon of your problem.
- Choose an AI Algorithm: Select an AI algorithm that suits your problem.
- Documentation: keep comprehensive documentation of your AI project, including the problem definition, methodology, algorithm details, results, and any challenges faced.

Project Proposal

The project proposal is a document with a maximum of 2 pages of text. The goal of the proposal is to clearly define what you will do for your final project. The instructor will provide feedback on the project and adjust the scope if it is found to be too ambitious or lacking. Make sure to find a catchy title for your project J.

Your proposal should be a **pdf** document containing the following sections:

- Group Members (with student IDs and emails)
- Problem Statement and Motivation: What is the problem that you are solving? Why is it relevant and interesting? Why would the results you are proposing to achieve be significant? What environment simulation are you using? Are you building your own? Describe the dataset (if applicable).
- Approach: How do you plan to go about solving this problem? What AI algorithm will you design? What techniques are involved? This section will vary highly based on the type of project you are proposing, but it should convince me that you know what you're doing and that you have a plan for attacking the problem.
- Related Work and Novelty: What other work has been done on this topic, and how is it related to what you are trying to do? What other works are closest to yours? This section should demonstrate that (1) you have explored the space in some detail, and you know what's out there and (2) your work is a novel contribution.
- Evaluation Approach: How will you (and I) determine if your approach solves the problem? Negative results (demonstrating that an approach does not work) are acceptable here, provided that the approach was promising.
- Milestones: How will you get the work done? Present a timeline of what and when various work will be accomplished. If you are working in a group, discuss how the work will be divided. What is the simplest version of your project that you can absolutely promise will be done by the due date? How do you hope to extend it if you have time?
- Bibliography: containing the references cited in your proposal

You may be asked to revise your proposal if I believe it will lead to an unsatisfactory final project. In this case, your proposal grade will be based on both the original and revised proposals. Unlike the pre-proposal presentation, the proposal is a binding document which I will use to evaluate your final project. Minor deviations from it are okay, but any major changes need to be approved by me. If you are unsure if a change is ok, just ask.

Your proposal will be graded by how clear your requirements are and the proposal's adherence to the guidelines. A proposal with insufficient or overly ambitious scope will not receive fewer points but may need to adjust requirements.

Your project proposal also includes an informal presentation in the class to ensure that you understand your plans and that other students hear about your ideas for the project and give you feedback. The presentation

should not be more than 10 minutes with the following structure:

- **Title Slide:** Project Title, Team Members, Date
- **Introduction:** Briefly introduce the problem statement and its significance
- **Literature Review:** Highlight relevant literature and existing approaches.
- **Objective:** state the objectives and goals of your project.
- **Methodology:** Outline the AI algorithms and techniques you plan to use.
- **Dataset:** Describe the dataset (if applicable) or the environment in which your AI agent will operate.
- **Expected Challenges:** Anticipate potential challenges and how you plan to overcome them.

If you are using a simulator/env, it would also be nice to see a quick preview of the environment you use for your project.

If your group contains only online students, you can either tune in online via Zoom and present or email me a link to a video presentation by the time of the class so I can play it for everyone.

Artifact

The artifact is your implementation of your project. You may submit your code as either a zip file or a link to a GitHub repository or website. It should include very clear instructions on how to run the code (including dependencies, where to download the data, etc.). The artifact should include results (images, graphs, etc.) if your requirements indicate those deliverables.

The requirements in your proposal will be used to grade your artifact. Each requirement will graded as follows:

- 100%: Completed - the code and results fully meet the requirement
- 75%: Nearly Completed - The requirement was attempted but is lacking in some minor respects
- 50%: Incomplete - The requirement was partially completed
- 25%: Insufficient - The requirement was attempted but not significantly implemented
- 0%: Missing - The requirement was not fulfilled at all.

Final Paper (Report)

The report should be a short research paper (a maximum of 6 pages) detailing your contributions and results. I suggest using LaTeX; many conferences (AAAI, usenix, ACM, IEEE) provide appropriate templates. You should also provide a one-page or less document explaining how what you have done reflects or differs from your proposal.

It's suggested you follow the traditional format and have the following sections:

- **Abstract**: Summarize your problem and results.
- **Introduction**: Describing and motivating your problem. Spell out the research contributions here (remember, no suspense).
- **Related Work**: this should provide enough background on your topic for a fellow grad student to understand your paper. If your work is directly based on another piece of research, you should discuss that work here.
- **Approach**: Discuss your approach here in more detail than you did in the proposal. If I wanted to redo your project, I should be able to figure out how by reading this.
- **Results / Evaluation**: This is where you show me how you came to your conclusions. Detail your methodology, then give me the results. Explain the strengths and weaknesses of the approach.
- **Conclusions**: What have you (and the reader) learned because of your project? Which part is most significant? Where could you (or someone else) take this work from here?
- **Bibliography**: Containing the references cited in your paper.

All projects are different. You may need additional sections or to present your work a little differently. You will be presenting papers in class. The papers will give you an idea of the proper tone and organization of the paper.

The report will be graded based on:

- Quality - lacks typos, spelling errors, etc.
- Readability - it is easy to understand the contribution and results
- Completeness - it is clear from the report how well the project achieves the requirements. (I recommend making a header for each requirement).

Presentation

Each group will present their work on the final day of class. This is your opportunity to show off the work that you did. The presentation should be clear and engaging and demonstrate your contributions. Think of it as an advertisement for your paper (But don't leave us in suspense—in general, suspense is a bad thing in research papers. Tell us what you did up front. I promise I'll read the whole thing). If appropriate, demo your project. I will inform you of the length of the presentations when I know how many projects there are.

Your presentation can be an extension of the proposal slides you created before and should include the following information:

- **Title:** Project Title, Team Members, Date
- **Objectives:** Clearly state the goals and how they contribute to the field or real-world applications.
- **Background:** Provide a concise overview of relevant literature, emphasizing key theories and gaps addressed by your project.
- **Methodology:** Explain the chosen AI algorithms, the data used, and any modifications made. Highlight key aspects of your approach.
- **Results:** Present experiment results, metrics, and comparisons. Include visuals for clarity.
- **Implementation:** Describe technical aspects, showcasing code snippets and key features introduced.
- **Challenges and Limitations:** Discuss encountered challenges and limitations, demonstrating your problem-solving approach.
- **Future Work:** Propose potential areas for future improvement, showcasing a forward-thinking approach.
- **Conclusion:** Summarize main findings and contributions. Reflect on the learning experience.
- **Questions and Discussion:** Open the floor for questions, demonstrating a deep understanding of your project.

Your grade will be determined by:

- Completeness - did you include all the relevant information above?
- Creativity - how exciting was your presentation
- Timeliness - you will lose points if you go over time.

If your group contains only online members, you can either tune in online via Zoom and present or submit a video presentation link.