### **Project (CS 2078 only)**

Students will complete a project which studies in more depth one of the topics we cover in class. Students should work in groups of two or three. These projects should focus on one of the following:

* a novel approach which addresses one of the problems covered in class, properly evaluated
* a definition of a new problem, along with detailed argumentation of why this problem is important and challenging, an approach to solve this problem, and an evaluation of this approach
* an extensive analysis and experimental evaluation of one or more of the approaches covered in class
* A related research project suggested or approved by the instructor

In the **project proposal**, students should include the following: clear problem statement, extensive literature review, detailed outline of the approach, and planned experimental setup. A good source for learning about what work has been done in your domain of interest are search engines, Google Scholar, and arxiv.org. Students are encouraged to discuss a draft of the proposal with the instructor before the proposal is due. Proposals are expected to be well thought out. Note: a successful project does not have to show improved performance but can be an investigation that can clearly identify important properties about deep learning models or training.

The **project presentation**, scheduled for the last day of class, will describe the students' approach and their experimental findings in a clear and engaging fashion. This will be a chance to get feedback from the class before final submission of your report. Presentations will be about 10-15 minutes long. Please submit a copy of your slides to Canvas on the same day as your presentation.

The **project final report** should be formatted and should read like a conference paper (e.g. ICLR, AAAI, NeurIPS, CVPR, ACL, RLC), with clear problem definition and argumentation of why this problem is important, overview of related work, detailed explanation of the approach, and well-motivated experimental evaluation. Each student should document what part of the project they did, and how duties and tasks were divided.

Below are some tips for the project:

* The project should include some amount of novelty. For example, you cannot just re-implement an existing paper or project. You are allowed to use existing code for known methods, but your project is expected to be a significant amount of work and not just a straight-up run of some package.
* If your goal is to create a new method or model that performs better than existing approaches, then you must show it quantitively and rigorously.
  + You must show that your method is in some sense better (quantitatively) than at least some relatively recent existing methods. For example, you can show that your method achieves superior accuracy in some prediction task compared to prior methods, or that it achieves comparable accuracy but is faster. This outcome is not guaranteed to come out the way you intended during the limited timespan of a course project, so whether or not your method outperform the state of the art will only be a small component of your grade.
  + You must also show that your method behaves as intended. For example, if you were to create a method that is supposed to create sparse representations, then you must show that it does in fact have sparse representations. You must also show that this helps or not in obtaining higher performance.
  + Note: Throughout the history of ML, most new approaches achieve “higher performance” not due to design choices but due to sufficient hyperparameter tuning. Showing better performance is really challenging. I advise against this route and suggest an alternative line of work for the course project.
* Suggestion: make the goal of your project to understand something concrete about a model, data type, or learning process. In this line of work you do not need to try and show superior performance, you only need to try and answer a question that will teach someone something new about deep learning. For example, you could investigate what invariances a specific model architecture is able to exploit in different training scenarios.
* Suggestion #2: make the goal of your project to understand something deeper (pun intended) about deep learning covered in the coarse or learning something that was not covered by the coarse. This should be something nontrivial and involve something more than just taking and using a model or setting up a standard training paradigm.
* Suggestion #3: ask the instructor for some project ideas or verify your project proposal.
* You are encouraged to use any external expertise you might have (e.g. biology, physics, etc.) so that your project makes the best use of areas you know well, and is as interesting as possible.
* To get some ideas for projects, browse websites/proceedings for some of the latest conferences, e.g. ICLR, AAAI, NeurIPS, CVPR, ACL, etc.

**Rubric for project proposal:**

1. What is the question you want to answer? -- be specific
2. What do you propose to do?
3. What have others attempted in this space, i.e. what is the relevant literature?
4. Why is what you are proposing interesting?
5. Why is it challenging?
6. Why is it important?
7. What data do you plan to use?
8. What is your high-level idea of how your method will work?
9. In what ways is this method novel?
10. How will you evaluate the method, i.e. what metrics are you going to use, and what baselines are you going to compare to?
11. Give a (1) conservative and (2) an ambitious schedule of milestones for your project.

**Rubric for report:**

1. What is the question you want to answer?
2. What is the prior work in this space? Describe in detail in your own words.
3. How is your work novel, in the context of this prior work?
4. What is your proposed approach or specific questions/hypotheses you want to answer? Describe in detail.
5. Why should your approach work well for this task?
6. In what ways is your proposed approach ambitious? What value does answering your question provide?
7. How do you plan to evaluate your method, against what baselines? (It's possible these will have changed after the proposal stage.) What assumptions are you making? What experiments are you going to run to test your hypotheses?
8. What challenges have you encountered along the way?
9. What metrics are you going to use to evaluate your method? What datasets are you going to use? What are your experimental results?

**Rubric for presentation:**

1. How well did the authors (presenters) explain what problem they are trying to solve?
2. How well did they explain why this problem is important and/or challenging?
3. How clearly was prior work described? How well did the authors explain how their proposed work is different than prior work?
4. How clearly did the authors describe their proposed approach?
5. How novel and ambitious is the proposed approach?
6. How well did the authors describe their experimental validation? How informative were the figures used?
7. Were all/most relevant experimental settings (e.g. datasets, tasks) and baselines (competitor methods) included in the experimental validation?
8. To what extent is the performance of the proposed method satisfactory?
9. How informative were the conclusions the authors drew about their method’s performance relative to other methods? How sensible was the discussion of limitations? How interesting was the discussion of future work?