

Computer Science 4033/5033: Machine Learning

Semester project(s) assignment

August 27, 2018

The main idea of the project is to pick an area of ML that is of interest to you and explore it experimentally. The project is broken into two component projects: a short project and a long project. Every group will do a project in reinforcement learning and every group will do a project in supervised learning. The choice of which is long and which is short is up to you and your group! Both of these projects are hands-on! Although you will read papers, both projects **must** involve a lot of *doing*.

Both your long and your short components must satisfy the following requirements:

- Your project must include an experimental component where you pose a hypothesis, implement n experiments, and analyze the results. **You must implement your own code for your chosen machine learning method.**
 - What is involved in an experiment? It must have a hypothesis to test and it must include data and results and analysis. For example, “Decision trees will significantly outperform humans on the test set” is a valid hypothesis. “Decision trees will be awesome” is not a testable hypothesis.
 - For 5033 students: The second experiment is not simply changing one parameter and calling that a separate experiment. For example, changing the learning rate from 0.05 to 0.01 is not a second experiment. You must make a substantial change and a 2nd hypothesis to examine and test.
 - Short component: $n \geq 1$ per student in 4033 and $n \geq 2$ per student in 5033. This means that 4033 students are expected to experimentally verify their hypothesis in at least one way while students in 5033 must have at least 2 analyzed experiments.
 - Long component: $n \geq 2$ per student in 4033 and $n \geq 3$ per student in 5033.
- You must read and discuss at least n related papers (drawn from conferences, journals, book chapters, workshops, or technical reports).

- Short component: $n = 1$ for students in 4033 and $n = 2$ for students in 5033. All students must compare and contrast their approach to the papers they discuss. These numbers are additive for pairs.
- Long component: $n = 2$ for students in 4033 and $n = 4$ for students in 5033. All students must compare and contrast their approach to the papers they discuss. These numbers are additive for pairs.
- You must include learning curves or results of your learning approach. Graphs are best for explaining results. Use proper graphing software (e.g. pyplot in python, Matlab, numbers, excel, Mathematica, gnuplot, etc)
- You must compare your performance to n other approaches. Note that this requirement is not as onerous as implementing two systems. You can choose to compare to a hard-coded heuristic or to published results on the same data set. Or you can make use of a state-of-the-art approach where open-source code is available. $n \geq 1$ for students in 4033 and $n \geq 2$ for students in 5033. **You are welcome to use open-source machine learning packages for comparisons.**
- CS 5033 students are required to have some novelty to their projects while CS 4033 students are not required to (although it is always encouraged). This novelty must be explained in your writeup.
- If your environment or learning technique is stochastic, you must have multiple runs when analyzing your performance. This includes showing averages and standard deviations or confidence intervals. If runs are short, include at least 30 (and average). If runs are long, include at least 5 unless this is not possible. If it is not possible, talk to me!

Group projects: Group projects are required. Each person in the group needs to have a significant and well-defined contribution that will clearly be their piece. Groups can only have more than 2 students by approval. All oral and written presentations are joint presentations among group members.

Difference between undergraduate (4033) and graduate (5033) projects: Students in both 4033 and 5033 must do a project. The difference comes in the depth of the project expected. This is specified above with the differences in n for the requirements. It is also clarified in each rubric for each deliverable.

Grading: Please note that this semester-long project constitutes a significant portion (50%) of your grade and you should take it seriously. The overall project is worth 50% of

your grade and this will be split across the individual components and specifically between the short and the long components as well as all of the components listed below. Working on the project only right before each deadline will show in the quality of the project and will not result in a high grade. The weighting for each component will be done at the end of the semester and is based on the amount of work involved in each component. You will receive a grade for each component individually.

Project components and deadlines

Each of the deliverable components of the project are summarized below along with their relevant deadlines. All documents should be turned in to the relevant dropbox on Canvas unless otherwise specified. Grading rubrics are available on Canvas. **Except for the initial oral project proposal, all other checkpoints must be jointly satisfied by both members of the group for full credit. Note: you cannot repeat results from one checkpoint to another.**

Online RL project proposal: Sep 5 Create a single graphic (e.g. one slide) that summarizes your idea for a RL project proposal and post it to the piazza rl-project discussion forum. You do NOT have to have a group formed to make this post. Even if you do have a group, this post is a REQUIRED project component. This will be used to excite other students about your project and to form project groups. If you already have a group, this should be jointly presented. If you already know that you want to make your RL project short or long, be sure to mention that.

Written RL project proposal: Sep 10 In this one-page written proposal, your group should explain the problem domain that your group intends to explore, the methods that you plan to use, the hypotheses that you are exploring, and your expected results. You should outline the work for each group member. You need to state whether you intend to do a short or a long RL project.

Short RL project checkpoint and Long RL project checkpoint 1: September 24
Each short project has one checkpoint and each long project has two checkpoints. The items due are summarized below for short versus long. Each type of project has something due today.

Short RL project oral presentations: October 3 All short RL projects owe a final oral report today. Requirements specified in the rubric.

Online long SL project proposals: October 10 This is only for long SL projects (anyone who did a short RL project will need to do a long SL project). This time post your proposals online in the sl_project discussion board. Requirements are the same as with the RL proposals.

Short RL project written reports: October 10 All short RL projects owe a final written report today. Requirements specified in the rubric.

Written Long SL project proposals: October 15 See writeup above.

Long RL project checkpoint 2: October 15 Long RL projects have long project checkpoint 2 due.

Oral long RL projects: Oct 29/Oct31 Oral final report for the long RL projects.

Long SL checkpoint 1: Oct 31 Long SL projects owe long project checkpoint 1.

Written long RL projects: Nov 7 Final written report for the long RL projects.

Online Short SL project proposals: November 7 This is only for short SL projects (so anyone who did a long RL project will need to do a short SL project). Post to the sl_project forum as described above.

Written Short SL project proposals: November 12 See writeup above.

Short SL project checkpoint, Long SL checkpoint 2: November 19 short project checkpoint for short SL projects and long project checkpoint 2 for long SL projects.

Oral Short and long SL projects: Dec 3-5 Oral presentations for all projects. Long projects will go first so it is likely the short ones do not present until Dec 6.

Final project writeup: Dec 14 6:30pm ALL projects have a final writeup due at the end of our finals period. Note that this paper can be accepted any time up until the end of our class finals period but will not be accepted beyond this date/time.

The three checkpoints below are summarized without respect to it being RL or SL since the student group can choose.

Short project checkpoint This checkpoint focuses on your hypothesis and preliminary results. You should clearly restate your current hypothesis (this has likely evolved since your proposal document) and describe your preliminary results. There must be

learning results, even if they are very preliminary. Also include a realistic discussion of any difficulties that have cropped up and a summary of what is left to complete for the short project.

Long project checkpoint 1 This document focuses on a review of relevant literature. You must compare your proposed project to at least n (specified above) other papers (conference, journal, book, etc). Discuss how your project is different and what aspects of your project are the same as these projects. Are you repeating work that has already been done? Extending a method? As with all status reports, keep in mind that this will be useful for your final project report. Use your critical thinking skills in this report and avoid book report style. This checkpoint also requires a summary of current results.

Long project checkpoint 2 This document should summarize your experiments to date, show the learning curves or tables of results that you have so far, and discuss any difficulties that you are encountering. Last, outline the work left to finish. Results need to be presented graphically (e.g. learning curves or tables, not a long list of numbers or a screenshot).