

Final Project: Introduction to Online Learning

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Projects should be done individually.

You have two options for the project:

- First, is to write a paper summary—see Section 1.
- Second, is to consider a problem from a domain that you are familiarized with, and suggest an approach to handle this problem using some of the tools/techniques that we have seen in class. This option is recommended to students who already have a research topic and are interested in exploring new approaches to handle it, based on what we have seen in class—see Section 2.

1 Paper Summary

The final report has to be written in Latex and should be no longer than 6 pages, excluding references. You can use format that we have been using for lecture notes or some other similar styles. The report summarizes and distills the main results of your assigned papers, and should include the following components:

- A short abstract, summarizing the entire survey.
- Introduction: Introduce the main topic of your assigned paper(s). Try to put it into the context of online learning and explain how it relates to topics covered in our lectures. Briefly mention the high-level results and explain the significance of the results (such as improvement over prior work).
- Problem setup: For this and the next two parts ("Main results" and "Proofs"), you can use the lecture notes as examples. For problem setup, you should describe the problems using necessary notation. Once again, you are not asked to cover everything in the paper, so only describe in detail what you plan to cover in this short survey.
- Main results: Describe the main algorithms/theorems. For algorithms, describe what they are doing at each step and what the key idea is behind it. For theorems, after the formal statement, try to explain in words what the statement really means and what the implications are.
- Critical review: write a critical review of the paper. How relevant is the problem to machine learning in general. Do the assumptions make sense? How reasonable/practical are the assumptions and Algorithms that the paper suggests?

- Proofs: Try to distill some proofs from the paper and reproduce them in the report. Due to space limit, most likely you can only fit 1-2 proofs into the report, so pick the ones that you think are most important/interesting. If the original proofs are long and complicated, try to break it down into several parts (in the form of lemmas for example), and only present the proofs for some of these parts.
- A short conclusion, highlighting the main message again.
- References.

Additional *optional* component:

- Open questions: Identify interesting and concrete open questions in the same direction that are not mentioned in the papers already. Mention briefly what you think the potential approaches are to tackle these open questions and/or why you think these are hard problems that require new techniques beyond what the papers present.

2 Applying Online Learning Technique to Solving Problems from Other Domains

Here the goal is to take a problem from a domain you are familiar with and try to treat it and solve it using ideas/techniques that we have seen in class.

The final report has to be written in Latex and should be no longer than 6 pages, excluding references. You can use format that we have been using for lecture notes or some other similar styles. The report summarizes and distills your approach to solving the problem using tools/ideas that we have learned in class, and should include the following components:

- A short abstract, summarizing the entire work.
- Introduction: Introduce your research question. Discuss the challenges, and current approaches. And describe in a high level how you suggest to tackle it using the techniques we have seen in class. Briefly discuss the benefits of your approach compared with existing ones.
- Problem setup: For this part you can use the lecture notes as examples. For problem setup, you should formally describe the problems using necessary notation. Try to use a minimum amount of notation to convey what you want to say.
- Main results: formally describe your approach to solving the problem. What are the tools/approach that you suggest to use. How are they different from current approaches. How practical is your approach (running-time).
- Empirical evaluation: Evaluate your approach empirically and compare it with existing approaches. Describe the empirical setting, and the way you evaluate.
- Guarantees: You are not required to prove anything. Nevertheless, you should state what guarantees you can hope for with your new approach (e.g., faster convergence, improved runtime, finding better solutions, etc.) Try to state these guarantees formally, and think on the assumption that should be made in order to enable these guarantees (again you do not have to prove anything). Explain the reason behind the assumptions that you would like to make.

- A short conclusion, highlighting the main message again.
- References.

Additional *optional* components:

- Proofs: formally state a guarantee regarding your new approach and provide a proof. Discuss, how realistic are the assumptions that you make.