University of Virginia
DS 7540. Machine Learning IV: Reinforcement Learning
Prof Tashman

Final Project Instructions
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Instructions
Students will apply their learning to the goal of completing a substantial course project. Each student can work individually or in teams of 2-3. This document outlines the necessary components of the final project.

Deliverables
The final group project has three deliverables of equal value (each worth 10% of overall grade):
- Paper
- Code
- Presentation

These are detailed below, along with general components of the project.

Components

1. Research aim

This is the motivation for the project. Examples:

 a. We will develop an RL system to control patient hemoglobin within a defined range
 b. We will develop an RL system that avoids dangerous outcomes defined as X

A project proposal needs to be submitted by the group. It must use reinforcement learning.
Since the project will be done over several months, it should be substantive and it should be relevant.

2. Data

Select a dataset that is easy to access (e.g., open source). You will carefully consider and describe the state space and action space in your project. Based on their characteristics, this will guide suitable algorithms.

3. Code Development

To implement the modeling and analysis, it will be necessary to develop code. The code should be in Python.

The code needs to be clearly written and documented in Python scripts (.py format) or Jupyter notebooks (ipynb format). ***Please clearly describe what the code does at the top of each file. Additionally, place the code's "task" in the filename.***

For full credit (10 PTS), the code needs to include these sections in a clean, commented, and comprehensive manner:

i. Data import and preprocessing (2 PTS)
Preprocessing include such tasks as imputing, binning, filtering, outlier treatment, feature engineering, text processing. If this is not necessary, provide justification.

ii. Data splitting / sampling (1 PT)
Sampling may not be needed, but splitting is a must. The test set should be left out for evaluation purposes. It should NOT be used in training.

iii. Exploratory data analysis, with at least 2 graphs. Be sure to include these in the paper and presentation (2 PTS)

iv. RL algorithms and relevant modeling (3 PTS)

v. Model evaluation (2 PTS)
This should include computation of relevant metrics. For example, if you goal is to keep a patient measurement in a range, what fraction of the time is it maintained by the system in that range? You should demonstrate that the system is working.

4. Project Presentation

One of the exciting things about being a data scientist is that they can drive major change at organizations. As a consequence, they can be called upon to communicate with executives. Strong communication skills (to a technical and non-technical audience) is critical.

In the final weeks of the course, each team will give a group presentation to the class.
Each member must present a portion of the project.

Components of the presentation should include:
i.   Executive summary: Discuss the research aims and what you have found
ii. Data summary: explain the state space, action space, etc.
iii. Model / algorithm discussion. As relevant, discuss reward functions, value functions, etc.
iv. Model performance
v. Conclusions and future research

A presentation earning full points will be strong in:
i.   Content
ii. Organization / aesthetics
iii. Delivery

5. Project Writeup

The project writeup should include the sections below. It could make sense to divide the section writing among teammates; in that case, give the paper a final review for consistency. **The paper should be no more than 7 pages single-spaced.** You can include tables and other artifacts in an appendix; it is not part of the page limit.

Sections:

i. Abstract
Although the abstract appears first, it should be written last. This includes a quick introduction, an overview of what was done, and a summary of findings.
ii. Data and Methods
iii. Results
iv. Conclusions
The conclusions section can include future work, if there was more time.
v. References. If you've used tools like ChatGPT, mention how they were used.

6. Project GitHub Repo (recommended but not graded)

Each team member should put their project on their GitHub page.
This should minimally consist of:

i. *README.md* page that summarizes the project: Purpose, major functionality, class methods
ii. Organized code
iii. A *requirements.txt* file listing the required packages

7. Teamwork

Each team member needs to make a substantial contribution and needs to be accountable.
If a teammate issue cannot be resolved within the group, please notify the instructor. Students not contributing meaningfully to the project will not receive an A in the course.

8. Data and Modeling Recommendations

- Early on, drop fields and records that are not needed
- Categorical variables with many levels can often be bucketed effectively. Conduct EDA to understand how best to bucket.
- When testing if the pipeline works properly, try on sample of data to save runtime

9. Final Notes and Advice

- If any issues come up during the course of the project, please reach out so we can address them
- You are encouraged to take on a challenging project, but if it cannot be completed in full and on time, select something simpler
- Practice the presentation beforehand
- Collaborate with others
- Meet face-to-face with your teammates
- Have fun!