Deep Reinforcement Learning Project Assignment

Data Mining Course – Master and PhD Level

Fall 2025

Overview

In this project, each student is required to choose at least one of the three defined tasks and solve it using Deep Reinforcement Learning (DRL) techniques. Students who successfully complete more than one task will be awarded bonus credit. The tasks are built around real-world datasets and demand problem formulation, environment design, and model experimentation.

Each task is associated with a specific dataset available publicly on Kaggle. Students must begin by exploring and understanding the dataset through Exploratory Data Analysis (EDA). Based on their insights, they should develop a simulation environment relevant to the chosen task. The environment should be described clearly and thoroughly in the final report.

After environment modeling, students are expected to implement and evaluate one or more DRL models appropriate for their problem setting.

Task 1: Flight Fare Pricing Agent (Score: 40)

Dataset: Flight Prices (Expedia, April–October 2022)

Figure 1: Flight pricing optimization scenario

Objective

Students will develop an agent that interacts with a dynamic environment to optimize airline ticket pricing. The agent should learn how to set ticket prices over time to achieve optimal performance, taking into account the temporal and contextual aspects of airline ticket sales.

Expected Outcome

The agent should be capable of learning an effective pricing policy that can adapt to various market or trip conditions and improve performance with respect to chosen metrics (e.g., revenue, fairness, efficiency). The outcome should show how the agent learns to price differently across routes, seasons, or booking windows.

Complementary Subtask: Competitive Airline Price Planning

Dataset: Flight Prices Dataset (Soylevbeytullah)

In addition to the primary pricing task, students will work on a complementary subtask that involves modeling competitive pricing strategies. In this task, students must select one airline from the dataset as their own company. Using the provided dataset, they should develop a DRL-based environment that models a market where multiple airline options exist. The agent should learn to set prices that are competitive with others while achieving desirable performance objectives (e.g., maximizing revenue or occupancy rate). This subtask focuses on dynamic price planning under competitive pressure.

Task 2: Real-Time Vehicle Scheduling (Score: 35)

Dataset: Real-Time Logistics Data for Optimization

Figure 2: Logistics and vehicle scheduling optimization

Objective

Students will develop a dispatching or scheduling agent that can optimize the movement of vehicles in a logistics network. The agent will operate within a simulated real-time logistics environment inspired by the dataset, where vehicle paths, schedules, and disruptions must be managed effectively.

Expected Outcome

The agent should demonstrate its ability to improve efficiency across logistics operations. Possible focuses include minimizing total delivery time, avoiding delays, improving route efficiency, and adapting to dynamic changes such as stop reasons or traffic fluctuations. Students should interpret and model relevant logistical components such as route assignments, stop sequences, and load management.

The final solution should showcase how the DRL agent manages real-time scheduling decisions that align with specific goals such as throughput maximization, route consistency, or reliability. The result should highlight learning improvements over time and describe the behavior of the agent in various logistical scenarios.

Task 3: Match Outcome Prediction Agent (Score: 35)

Dataset: Soccer Match Event Dataset

Figure 3: Soccer match prediction and analysis

Objective

Students will train an agent to predict the final outcome of a soccer match by processing sequences of in-game events. The environment should be constructed in such a way that the agent is exposed to the game events step-by-step, learning to anticipate the final result based on in-match developments.

Expected Outcome

The agent should be able to predict match results (win/draw/loss or score differential) with increasing accuracy as it observes more of the match sequence. The outcome should reflect the agent's learning progression and decision-making based on partial or full game histories.

Project Workflow

Each student should follow the structured workflow below:

1. **Dataset Exploration (EDA):** Analyze the chosen dataset to understand its structure, distributions, and relevant patterns. Summarize key insights.
2. **Environment Modeling:** Design and implement a simulation environment inspired by the dataset. Describe the environment in detail in your report.
3. **Model Testing:** Experiment with one or more DRL models suited to your environment. Analyze and report performance metrics and learning behaviors.

Submission Guidelines

- Submit a report (PDF) containing: EDA summary, environment description, model architecture(s), evaluation results, and insights.
- Submit your code with clear documentation and instructions.
- Cite the dataset and any external libraries or frameworks used.

Grading Criteria

- Correctness and clarity of environment modeling
- Creativity and rigor in applying DRL methods
- Quality and depth of analysis and interpretation
- Report writing and organization