

Assignment 13

Reinforcement Learning (RL)

EECE-6822 Machine Learning

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1. Objective

The objective of this activity is to run several code examples that study and illustrate reinforcement learning.

2. Prerequisite Readings

Sutton and Barto

- Ch.3-6

Geron

- Ch.18: Reinforcement Learning

Raschka

- Ch.19: Reinforcement Learning for Decision Making in Complex Environments

3. Code Examples

Example 1: Reinforcement Learning ←

This is the example code from **Ch.18** from Aurelian Geron's book.

[*B3-Geron] Aurelien Geron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly, 2022.

Open in your google colab and go through the code. You should read first the chapter itself from the book, before going through the code.

https://github.com/ageron/handson-ml3/blob/main/18_reinforcement_learning.ipynb

In this chapter, the author first explains what reinforcement learning is and what it's good at, then presents two of the most important techniques in deep reinforcement learning: policy gradients and deep Q-networks, including a discussion of Markov decision processes.

Example 2: Reinforcement Learning for Decision Making in Complex Environments

This code example is from **Ch.19** from Sebastian Rashka's book:

[*B3-Raschka] Sebastian Raschka, Yuxi Liu, and Vahid Mirjalili, *Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python*, Packt Publishing, 2022.

The source code (Jupyter Notebook) is located at the GitHub repository. You should read first the chapter itself from the book, before going through the code.

<https://github.com/rasbt/machine-learning-book/tree/main/ch19>

This chapter explores the following topics:

- Learning the basics of RL, getting familiar with agent/environment interactions, and understanding how the reward process works, in order to help make decisions in complex environments
- Introducing different categories of RL problems, model-based and model-free learning tasks,
- Monte Carlo, and temporal difference learning algorithms
- Implementing a Q-learning algorithm in a tabular format
- Understanding function approximation for solving RL problems, and combining RL with deep learning by implementing a deep Q-learning algorithm

Example 3: Other tutorials

--14 Different Types of Learning in Machine Learning

<https://machinelearningmastery.com/types-of-learning-in-machine-learning/>

4. Assignment

Using:

- Example 1 above; it shows how to use older versions of tensorflow and how to use gymnasium instead of openai gym,
- https://gymnasium.farama.org/introduction/migration_guide/, and
- Other sources you can find,

as inspiration for “how to” – you must modify the code from Example 2 in order to replace the use of OpenAI Gym (not supported since 2022) with Gymnasium. Also, fix additional issues you encounter in your attempt to run the code.

5. Deliverables

You must write (typed) a report and upload it as a PDF file on D2L. The report should be named “**hw13_report_LastName.pdf**”. You should also create a .zip archive with all your code and implementations of all parts of the assignment. Upload also this archive .zip file with the name “**hw13_implementation_code_LastName.zip**” to D2L. Hence, your D2L should contain two items: the report and the .zip file. **Do not include the report inside the .zip and upload only the .zip. They should be two separate items!**

The report should include the following sections and subsections. Make sure section titles are in bold font and pages are numbered.

- 1) **Title + course info + your name**
- 2) **Summary.** Describe in one paragraph what the objective of the assignment is.
- 3) **Description of Experiments and Discussion.** Describe the experiments you did. All tables and figures should be numbered and should have captions. All plots in all figures should have axes labels and titles. Present a meaningful discussion with the interpretation of the results you obtained. Explain if you expected the results or not; discuss the intuition behind it.
- 4) **Conclusion.** Present your conclusions; highlight what are your main takeaways that you learned from this assignment. Describe what issues you encountered and how you solved them.
- 5) **References.** Include all references that you used, as a numbered list. Cite them in the report itself; do not just list them! If your report has References that are not numbered and cited in the report, points will be deducted!