

# RL 2021/22 Self-Check for Coding Proficiency

## 1 Purpose

The purpose of this document is to serve as a self-check to evaluate your coding proficiency and familiarise yourself with the expected coding skills required for the RL coursework. As part of the coursework, you will need to complete the following tasks:

- Install Python3 and standard ML libraries (e.g. Numpy and PyTorch)
- Create a virtual environment to organise dependencies (not required, but strongly suggested)
- Apply advanced knowledge of Python, including object-oriented programming (classes, constructors, functions), basic data structures (dictionaries, lists, Numpy arrays) and Python syntax

For latter exercises of the coursework implementing deep RL algorithms, you will be required to use PyTorch. We will provide a brief introduction to the basic PyTorch knowledge needed, so no prior knowledge is required.

## 2 Coursework Overview

For the coursework, you will need to provide implementations of RL algorithms within a predefined codebase that we provide. The codebase implements a general interface for RL algorithms and you will be tasked to implement specific functions in it. You will need to familiarise yourself with the provided codebase, in particular understand its required interface (make sure you understand the expected inputs and outputs of each function) and complete the implementation of specified functions. For some questions, besides implementing the required parts of an algorithm, we will also evaluate the performance of your algorithm in specified environments (such as in the Taxi example below). For these performance evaluations, we will use your implementation of the RL algorithm with hyperparameters specified (and ideally optimised) by you and grade your submission using (1) correctness of the implementation of the algorithm and (2) performance marks where stated.

## 3 Example Question: Tabular-RL SARSA

This question serves as an example for a coding task in the RL coursework. We suggest you go through this question carefully and evaluate whether you feel sufficiently confident in your coding skills to solve such a question. Please note that we will teach you all the required algorithmic details in the course. For this example you are not expected nor required to understand the RL algorithm below.

**SARSA** For this question, you will need to implement the RL algorithm SARSA. You can find details on the algorithm in Section 6.4 of the RL book (pages 129-131).

**Taxi-v3** We train the algorithm in the OpenAI Gym Taxi-v3 environment. In this environment, visualised in Figure 1, the goal is to navigate a taxi (yellow box - empty taxi; green box - taxi with passenger) to a passenger (blue location), pick it up and drop it off at the destination (purple location) in a grid-world. The task is successfully completed once the passenger is dropped off at its destination or failed after a maximum number of steps (which can be set as a hyperparameter). After each step, a numerical feedback in the form of a reward is provided. A reward of +20 is provided for successfully delivering the passenger to its destination, -10 for executing the actions pickup or dropoff illegally, i.e. trying to pickup a passenger at a location where no passenger is located or attempting to drop off without having a passenger in the taxi, and otherwise a reward

of -1 is provided at each step. Hence, the task consists of learning to navigate the grid-world and bringing the passenger as quickly to its target destination as possible.

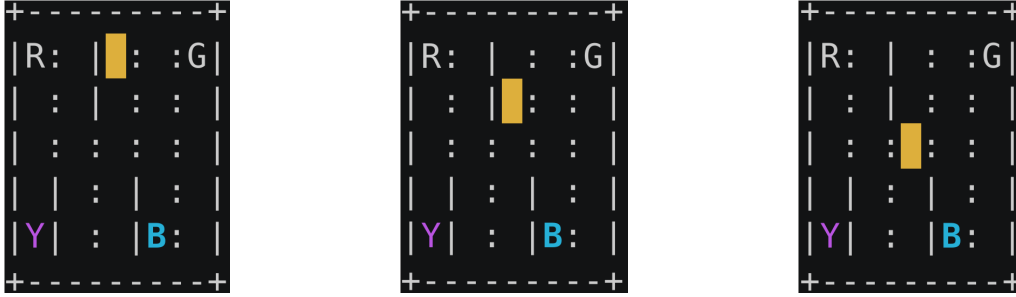


Figure 1: Rendering of two Taxi-v3 environment steps

**Implementation** Use the codebase provided and implement the following functions. All of the functions that you need to implement are located in the `sarsa.py` file.

1. In the abstract `Agent` class, implement the following function:
  - `act`, where you must implement the  $\epsilon$ -greedy exploration policy for action selection:

$$\pi(s) = \begin{cases} \arg \max_a Q(s, a) & \text{with probability } 1 - \epsilon \\ \text{random action} & \text{otherwise} \end{cases}$$

2. To implement SARSA, you must implement the following function in the `SARSAAgent` class:
  - `learn`, where you must implement SARSA updates:

$$Q(s_t, a_t) \leftarrow Q(s_t, a_t) + \alpha [r_{t+1} + \gamma Q(s_{t+1}, a_{t+1}) - Q(s_t, a_t)]$$

All other functions apart from the aforementioned ones **should not be changed**.

**Provided codebase** You can find example code for this example question in our [code repository](#). The example code includes the general framework as well as an implemented solution for the SARSA RL algorithm with the following files:

- `sarsa.py`: Includes abstract `Agent` class and `SARSA` class. This is where the SARSA algorithm would need to be implemented. You will receive such files with missing implementation of required functions in the coursework.
- `sarsa_solution.py`: This is a copy of the previous file including a possible solution to the required functions. You can find solutions under respective comments `### SOLUTION BELOW ###`.
- `train_sarsa.py`: Includes creation of the environment and agent before starting the training procedure with frequent evaluations of the RL algorithm. This is the main script you execute to train and evaluate your agent. You will only need to adjust the hyperparameters within this script, found in the `CONFIG` dictionary.
- `requirements.txt`: List of required Python requirements needed to execute the code. These can be installed using `pip install -r requirements.txt`.

## 4 Demonstrations

As part of the RL course, there will be several drop-in sessions where you will have the opportunity to ask questions about the coursework. Furthermore, there will be a tutorial lecture delivered by the TAs on how to implement and evaluate a RL system. A demonstration with more code will be provided as part of this lecture before the coursework is released. You can already find last year's tutorial lecture resources under <https://github.com/uoe-agents/Building-a-Complete-RL-System-Demonstration> which will be updated for this year's tutorial lecture.