Exercise: Reinforcement Learning
Data Science Specialization (Spring 2025)

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In this exercise, we want to apply Reinforcement Learning (RL). Here we will use Gymnasium, a library that implements many RL environments. It can can installed in Anaconda using the command

```
conda install -c conda-forge gymnasium
```

Documentation can be found at `https://gymnasium.farama.org`.

1 Tutorial on Gymnasium

On the Gymnasium website, there is an excellent tutorial on building and evaluating a simple Q-learning agent for playing the card game "Black Jack":

`https://gymnasium.farama.org/tutorials/training_agents/blackjack_tutorial/#sphx-glr-tutorials-training-agents-blackjack-tutorial-py`

2 Task

The grid world shown in the lecture was deterministic, i.e., there was no uncertainty about what the outcome of an action is. In general, RL can deal with scenarios where actions are *non-deterministic*, meaning that they sometimes have an effect that is different from what was intended.

The Gymnasium contains an environment called "Frozen Lake" under the category "Toy Text". Evaluate the methods presented in the lecture in this environment:

- Use a random (but fixed) 4x4 map.

- Apply Q-Learning using an ϵ-greedy action selection policy, where ϵ is fixed (does not "decay"). If you want, try Boltzmann action selection as well.

- For the ϵ, α, and γ parameters, you can use the recommend values, and/or try different combinations yourself.

- If you want, you can increase the size of state space (i.e., the size of the grid) and determine at what point the tabular approaches become infeasible.

In Moodle, you find a template notebook `FrozenLakeTemplate.ipynb` that already contains some code, in particular for plotting statistics (rewards, episode lengths, errors) and displaying Q values/policies graphically. The parts to be filled in by you (the agent itself as well as hyperparameters) are marked.

3 Bonus Task

Repeat the experiment with a different environment from the gymnasium of your choice.