Graded Practical Session

Read carefully the three following exercises. Write down in a Word document or in a Jupyter notebook every choice, remark, information and result you think is important.

Exercise #1: Supervised Learning

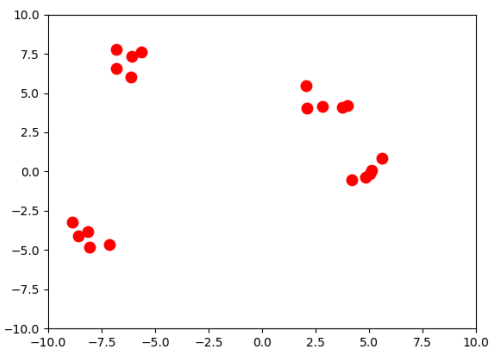
In a regression problem, we have to predict a continuous dependent variable, like a price, from independent variables.
We will use the dataset Auto MPG (https://archive.ics.uci.edu/ml/datasets/auto+mpg) and build some models to predict the energy efficiency (MPG) of vehicles of the end of 1970's and the beginning of 1980's.
The independent variables (attributes) in this dataset are : # of cylinders, displacement, horse power, weight, acceleration, model year, origin, car name.

1. Download the dataset at:
   http://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/auto-mpg.data
2. Read the data with pandas.
3. Clean the data by possibly removing rows with unknown values (*dropna* with pandas).
4. Visualize the data with the most adapted techniques to have a glance about the correlation of some pairs of attributes.
5. Divide the data into a training set and a test set (80% training, 20% test).
6. Normalize the data (preprocessing by normalization).
7. Train a linear regression model first, then train a Deep Neuron Network with two dense layers with relu activation functions.
   For the neuron network, use the optimizer Adam, and test the loss functions mean_absolute_error and mean_squared_error.
8. Compare the results of the different models (linear regression and MLP) on the test set.

For steps 2 to 8, write Python codes.

Exercise #2 : Unsupervised Learning

We assume the following cloud of 20 points randomly chosen in the interval [-10;10] :



Program a Python code that:

- generates the random points,
- by either using the template of the graded practice session about K-Means, program the K-Means algorithm with N centers, or use it from a Python library (***scikit-learn*** for example), in order to find the best possible clustering of the previous data consisting of 20 random points ; we assume that the coordinates of the cluster centers in K-Means are also chosen in the interval [-10;10].
- Finally, program the algorithm that consists in executing multiple K-Means with different numbers of centers and displaying the best result.

Exercise #3: Reinforcement Learning

In the problem of the arrows, n arrows are positioned vertically and oriented upwards or downwards. We want to swap the orientation of each arrow (see the figures below).

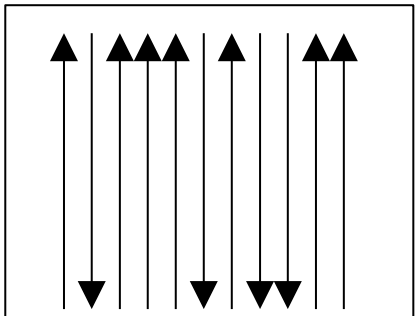


Figure 1a. Situation initiale

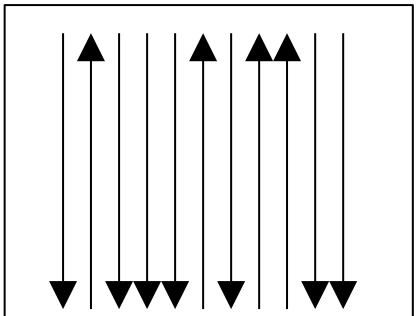


Figure 1b. Situation finale

We can modify a position with the two following cases:

- by swapping a sequence of three adjacent arrows having the same orientation (all upwards or all downwards)
- by swapping two adjacent arrows having opposite orientations (one is upwards and the other is downwards).

Questions:

1. Explain how you can define the MDP for this problem. Describe as clearly as possible how do you represent a state.
2. Program the environment using the template available on Moodle. You can modify it as you wish.
3. Give the optimal policy obtained by Q-Iteration for the initial state above.