Machine Learning

Homework 1

Perceptron learning algorithm

(Deadline. Feb 4, 23:59)

Problem 0 *(5 points)*

Registration on the Slack channel:

https://join.slack.com/t/ml2025spring-sectiona/shared_invite/zt-2xx6c58zr-57DE0EstDFik286RUPPpDQ

Problem 1 *(65 points, hand-written)*

You need to fit a binary classifier using the Perceptron Learning Algorithm on randomly generated data. Execute the following code in Python, substituting the value of the random state with the numeric sequence of your AUA ID:

```
import numpy as np

# Fixing the seed
random_state = 11111111  # Change to the numeric sequence of your AUA ID
np.random.seed(random_state)

# Generating the features
X = np.random.randint(1, 10, size=(4,3))

# Assigning the labels
y = np.asarray([1, 1, 0, 0]).reshape(-1, 1)

# Initializing the weights, bias term and the learning rate
rgen = np.random.RandomState(random_state)
w = np.round(rgen.normal(loc=0.0, scale=0.1, size=X.shape[1]), 2)
b = np.float_(0.)
```

```
learning_rate = 0.1

print(f"""
Features:
{X}

Labels:
{y}

Initial weights:
{w}

Initial bias:
{b}

Learning rate:
{learning_rate}
""")
```

Having the data generated, apply the algorithm **(manually, not in code)** including the details of all the steps (net input calculations, decision function outputs, parameter updated, etc.)

If convergence is not reached after 5 iterations, stop with the resulting weight values. Describe the final results.

Problem 2 *(30 points, coding)*

Take the Iris dataset and fit two Perceptron classifiers: one to classify the species between Setosa and Virginica (removing data points corresponding to Versicolor), and another to differentiate between Versicolor and Virginica (removing data points corresponding to Setosa). Describe the observed results.

Feel free to utilize the code provided in the slides. Submit the resulting Jupyter notebook.