

Multi-Layer Perceptron

1. Why is the weighted summation $\text{net inputs} = \sum w \cdot x$ mostly used when calculating the net input from other neurons for a perceptron? What is the intuition behind this formula? You may dig out some hints from mathematics or life observation.
2. Perceptron, Logistic Regression, and Delta Rule
 - (1) Prove that a multi-input single-layer perceptron with a sigmoid activation function is mathematically equivalent to logistic regression.
 - (2) Define the cost (loss) function and derive the delta rule for a perceptron with multiple inputs, saying x_1, x_2, \dots, x_n , and sigmoid activation.
Note: You are required to write the answer to this question by HAND!
 - (3) Discuss whether the outputs of a multi-input perceptron with sigmoid activation and logistic regression are inherently probabilistic, and explain why or why not.
3. Solve a real-world forecasting problem (either classification or regression) in your working job using MLP.
 - (1) Briefly describe your forecasting problem.
 - (2) Illustrate partial data you collected for the problem. The dataset should have at least more than 300 data items.
 - (3) Solve the problem with the dataset you upload to the MLP playground at <https://stli.iim.ncku.edu.tw/nodejs/rocky-playground/dist/>. Since the tool can allow only two variables, you may perform feature selection or feature engineering such as PCA during data preprocessing.
 - (4) Perform a comprehensive experiment by considering different input feature sets and different configurations of the MLP. A configuration can be obtained by the various combinations of the following factors:
 - noise,
 - ratio of training to test data,
 - batch size,
 - learning rate,
 - activation function,
 - number of hidden layers, and
 - number of neurons per hidden layer.
 - (5) Discuss and analyze the experimental results to highlight whatever

insights or knowledge you identified. You should copy and paste necessary the screen snapshots to support your arguments.

Note: You need to perform data transformation from csv to json file format in order to run the MLP tool. We demonstrated this process in class already.

4. [Optional & Extra points]

Solve the recognition problem of the Tai-chi diagram using MLP.

- (1) List the program (including Colab URL) which generates the training data. In addition, describe your idea about the data generation.
- (2) List the MLP program (including Colab URL) which can successfully recognize the diagram.
- (3) Plot the training and forecasted data by the MLP.

