**Lab 3 – Neural Network - MLP**

***Group members:***

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1.  Study Section 4.4.4. Download the dataset PNOz.dat and run the MLP. See whether you can get something similar to Fig. 4.16.

The general for time series prediction is as follows:

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Figure 4.16 in the book:

k = 3  # Number of past values used as input

tau = 2  # Step size for selecting past values

Result after trying the method:

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A screen shot of a graph

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2.  Use the knowledge you gained from #1 to solve the following problem:

Suppose that the local power company wants to predict electricity demand for the next 5 days. They have the data about daily demand for the last 5 years. Typically, the demand will be a number between 80 and 400.

1. Describe how you could use an MLP to make the prediction. What parameters would you have to choose, and what do you think would be sensible values for them?

 The prediction can be generated by split sand creating the training, validation, and testing dataset by approach as problem 1 above, then training MLP with typical values: k=4 and tau=2.

1. If the weather forecast for the next day, being the estimated temperatures for daytime and nighttime, was available, how would you add that into your system?

The weather information including the next day’s daytime and nighttime temperatures can be added as the new input to the neural networks. We need to prepare the data related to the prediction temperature for training, validation, and testing, then retrain the MLP model.

1. Do you think that this system would work well for predicting power consumption? Are there demands that it would not be able to predict?

This system will work well for predicting power consumption.

Some demands will not be able to predict. For example:

* Blackouts, natural disasters, or grid failures are not predictable from past demand.
* Public events: Large sports events, or festivals increasing demand.

3.  Modify the code to allow another hidden layer to be used. You will have to work out the gradient as well in order to compute the weight updates for the extra layer of weights. Test this new network on the Pima Indian dataset that was described in Section 3.4.4.

The Backpropagation algorithm works the same way, no matter how many hidden layers we add. The error from the output layer is passed back to the first hidden layer, and the same process is used to pass the error further back to the second hidden layer. The only difference is that we update the notation and use the correct inputs for each layer.

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4.  A recurrent network has some of its outputs connected to its own inputs, so that the outputs at time *t* are fed back into the network at time *t* + 1. This can be a different way to deal with time-series data. Modify the MLP code so that it acts as a recurrent network, and test it out on the Palmerston North ozone data on the book website.

The main changes:

#### Added Recurrent Connections: Introduced weights\_hidden\_hidden, which allows the hidden layer to retain information across time steps.

#### Added a Hidden State: The hidden state (self.hidden\_state) is stored and updated in each forward pass.

#### Modified Forward Pass to Include Recurrence: The new input to the hidden layer includes the previous hidden state.

#### Modified Backpropagation to Update Recurrent Weights: The backpropagation now updates the recurrent weight matrix weights\_hidden\_hidden in addition to the input and output weights.

#### Updated Training Process: The model now learns patterns over time using hidden state dependencies.

#### Applied to Time-Series Data: The model predicts outcomes based on previous values.

The result after modifying MLP into RNN from Problem 1 using the Palmerston North ozone data on the book website <https://homepages.ecs.vuw.ac.nz/~marslast/Code/Data/PNoz.dat>:

A screen shot of a computer

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