Neural Network Laboratory Work – 6

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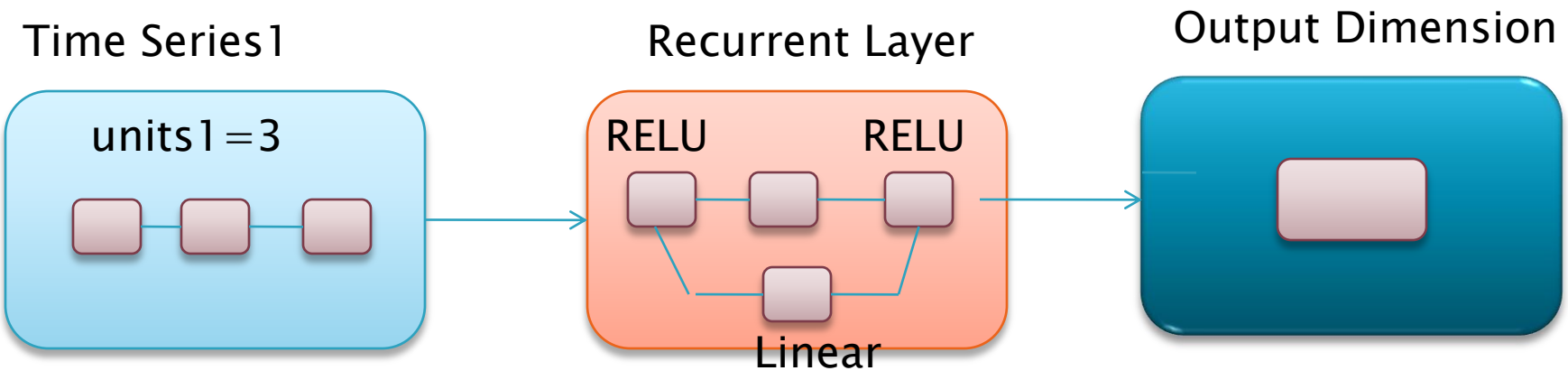
RNN USAGE

- **Recurrent neural networks** (RNN) are a class of **neural networks** that are helpful in modeling sequence data.
- Derived from feedforward **networks**, RNNs exhibit similar behavior to how human brains function.
- **Recurrent neural networks** produce predictive results in sequential data that other algorithms can't.

RNN Layers

- RNN: recurrent connections, information is kept in the hidden states.
- RNN: neurons in the hidden layer have recurrent layers ·
- RNN inputs are values of time series x1, x2, x3 at time moments t and at the previous time moments t-1, t-2,..., t-d .



RNN – Parameters

- model.add(SimpleRNN(units=100, input_shape=in_dim, activation="relu"))
- #units: Positive integer, dimensionality of the output space

- model.add(Dense(units=16, activation="relu"))
- #adding feed forward layer, 16 neurons in a hidden layer

- model.add(Dense(out_dim, activation='linear'))

RNN and Dense Layer – Parameters,Output and Shape

Layer (type)	Output Shape	Param #
simple_rnn_3 (SimpleRNN)	(None, 100)	10400
dense_5 (Dense)	(None, 16)	1616
dense_6 (Dense)	(None, 2)	34

Total params: 12,050
Trainable params: 12,050
Non-trainable params: 0

Loss per Epochs – 50 (Epochs)

```
Epoch 1/50
797/797 [==============================] - 1s 1ms/step - loss: 5.5789
Epoch 2/50
797/797 [==============================] - 0s 181us/step - loss: 0.7100
Epoch 3/50
797/797 [==============================] - 0s 180us/step - loss: 0.5907
Epoch 4/50
797/797 [==============================] - 0s 181us/step - loss: 0.5611
Epoch 5/50
797/797 [==============================] - 0s 195us/step - loss: 0.5650
Epoch 6/50
797/797 [==============================] - 0s 173us/step - loss: 0.6004
Epoch 7/50
797/797 [==============================] - 0s 185us/step - loss: 0.5968
Epoch 8/50
797/797 [==============================] - 0s 175us/step - loss: 0.5496
Epoch 9/50
797/797 [==============================] - 0s 185us/step - loss: 0.5509
Epoch 10/50
```

Loss per Epochs – 50 (Epochs)

```
Epoch 41/50
797/797 [==============================] - 0s 175us/step - loss: 0.5534
Epoch 42/50
797/797 [==============================] - 0s 173us/step - loss: 0.5269
Epoch 43/50
797/797 [==============================] - 0s 183us/step - loss: 0.5523
Epoch 44/50
797/797 [==============================] - 0s 165us/step - loss: 0.5396
Epoch 45/50
797/797 [==============================] - 0s 189us/step - loss: 0.5494
Epoch 46/50
797/797 [==============================] - 0s 173us/step - loss: 0.5368
Epoch 47/50
797/797 [==============================] - 0s 168us/step - loss: 0.5735
Epoch 48/50
797/797 [==============================] - 0s 173us/step - loss: 0.5368
Epoch 49/50
797/797 [==============================] - 0s 161us/step - loss: 0.5237
Epoch 50/50
797/797 [==============================] - 0s 164us/step - loss: 0.5550
```

MSE,RMSE and Correlation – Training and Testing Data

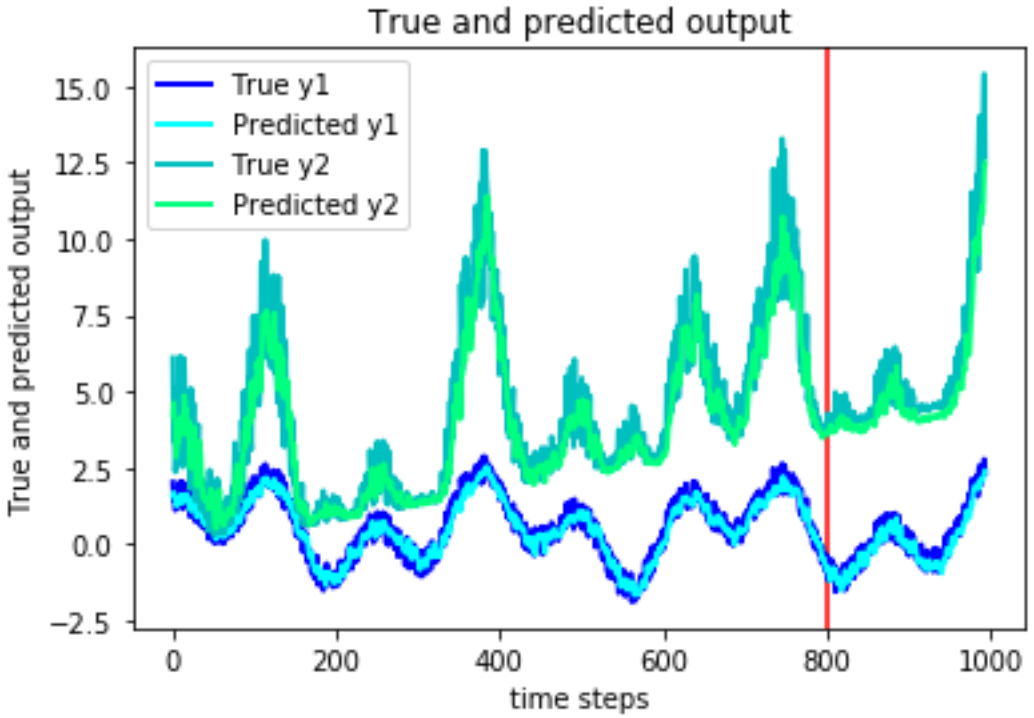
Train time series

	y1	y2
MSE	0.12	1.02
RMSE	0.34	1.01
Corr coef	0.95	0.94
Corr coef p	0.00	0.00

Test time series

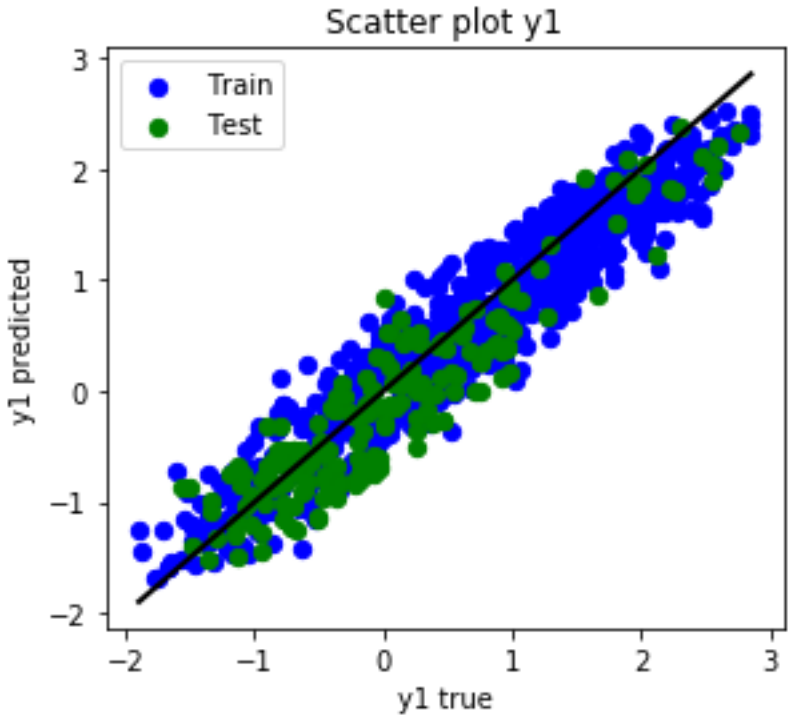
	y1	y2
MSE	0.14	0.84
RMSE	0.38	0.92
Corr coef	0.93	0.96
Corr coef p	0.00	0.00

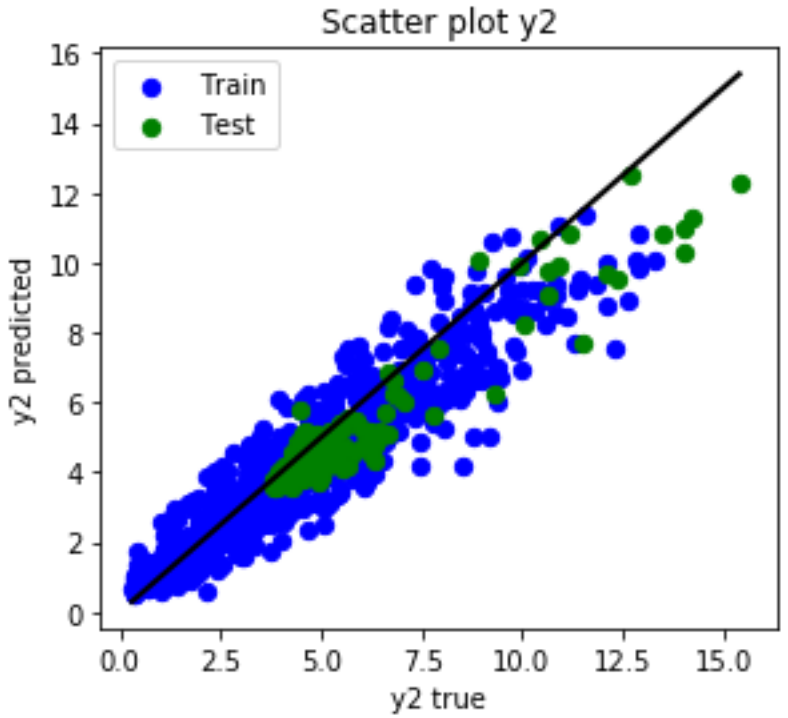
outputs and predictions as a function of time



Blue – Plot of Y1
Aqua – Predicted y1
Green – Predicted y2

Outputs and Prediction





Input and Output Dimesnion, Unit Steps

- N=2000 #number of time steps
- n=400 #number of time steps for training
- step = 5

EPOCHS Loss

```
395/395 [==============================] - 0s 202us/step - loss: 0.4789
Epoch 42/50
395/395 [==============================] - 0s 222us/step - loss: 0.4603
Epoch 43/50
395/395 [==============================] - 0s 205us/step - loss: 0.4038
Epoch 44/50
395/395 [==============================] - 0s 220us/step - loss: 0.4076
Epoch 45/50
395/395 [==============================] - 0s 210us/step - loss: 0.4579
Epoch 46/50
395/395 [==============================] - 0s 217us/step - loss: 0.3920
Epoch 47/50
395/395 [==============================] - 0s 187us/step - loss: 0.4113
Epoch 48/50
395/395 [==============================] - 0s 187us/step - loss: 0.3842
Epoch 49/50
395/395 [==============================] - 0s 197us/step - loss: 0.4123
Epoch 50/50
395/395 [==============================] - 0s 202us/step - loss: 0.3937
```

Train and Test Series – Coefficient

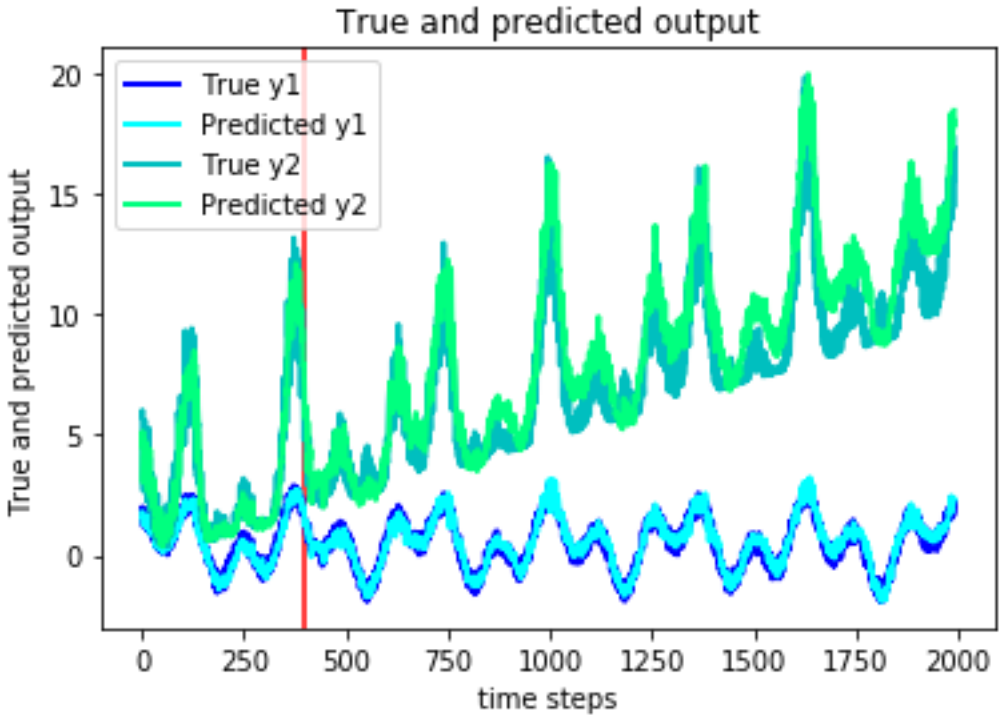
Train time series

	y1	y2
MSE	0.08	0.60
RMSE	0.28	0.77
Corr coef	0.97	0.97
Corr coef p	0.00	0.00

Test time series

	y1	y2
MSE	0.14	2.44
RMSE	0.38	1.56
Corr coef	0.93	0.95
Corr coef p	0.00	0.00

outputs and predictions as a function of time



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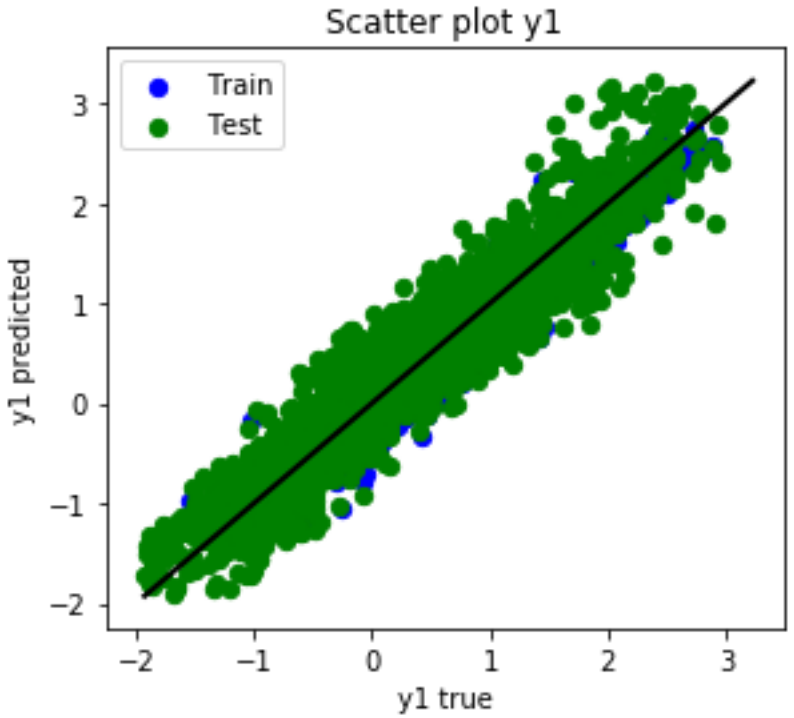
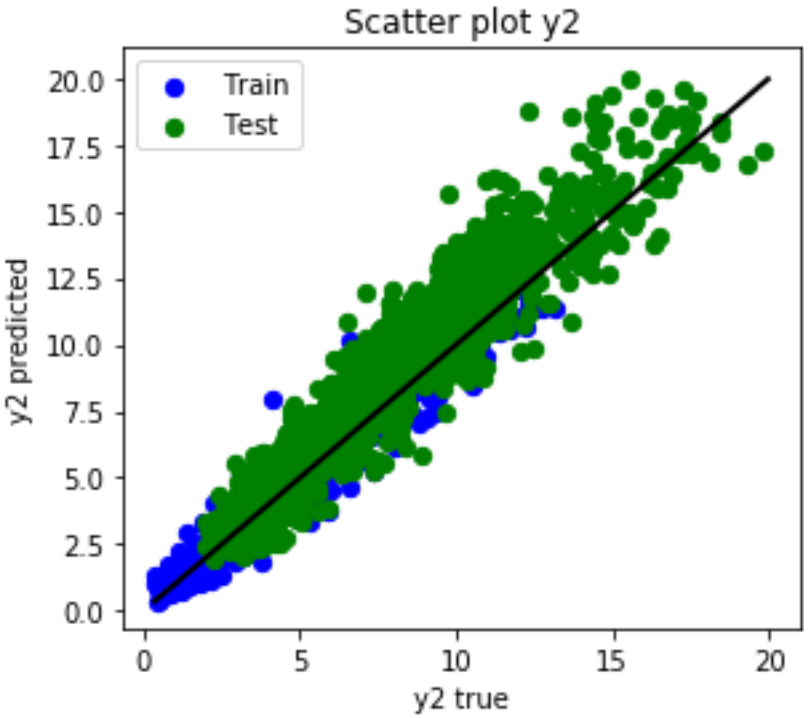
Outputs and Prediction





Thank You