Multi-Input Multi-Output Electric Motor Signal Prediction using Neural Networks

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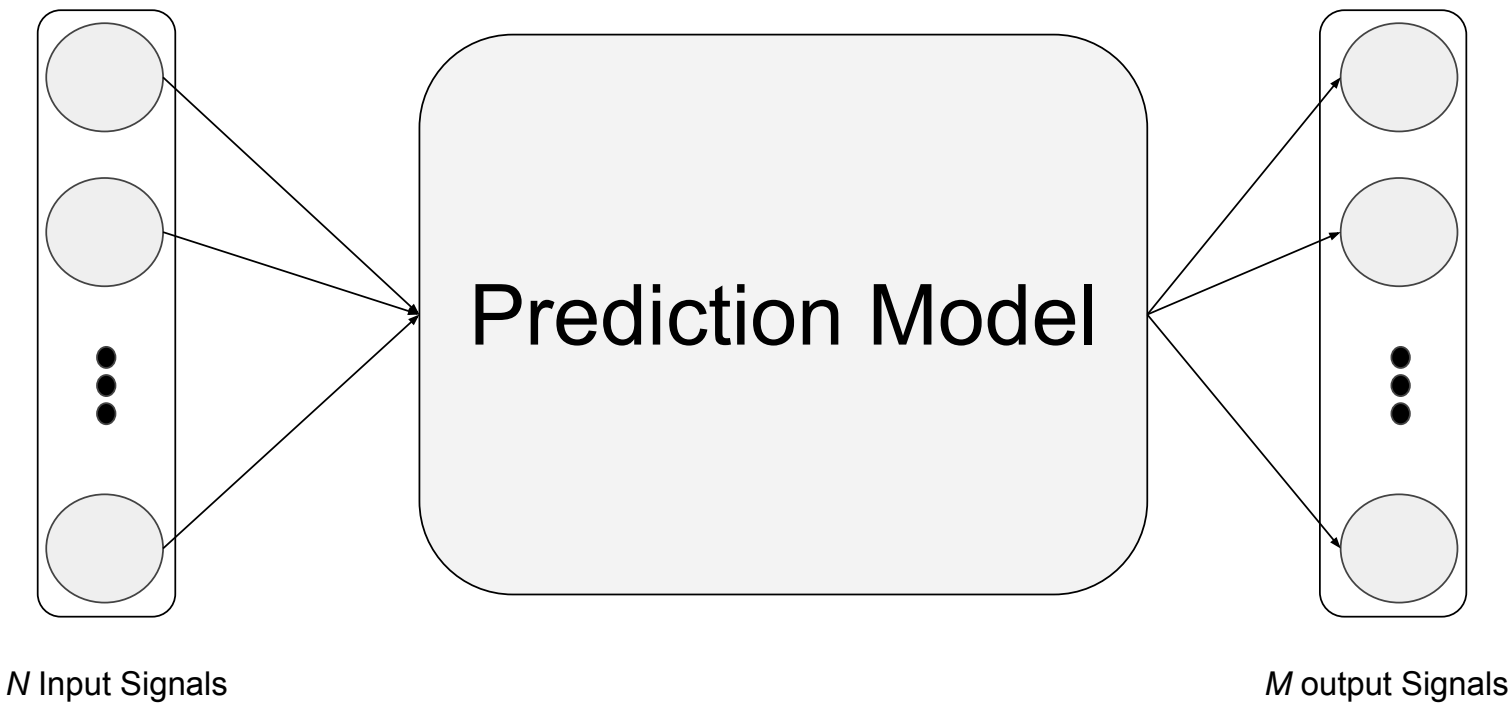
What we discussed in the last meeting?

1. Defined the problem
2. Brief introduction of feed-forward and recurrent networks
3. Results on a publicly available time series motor control dataset
4. Error in predicting impulse peeks and scaling problem



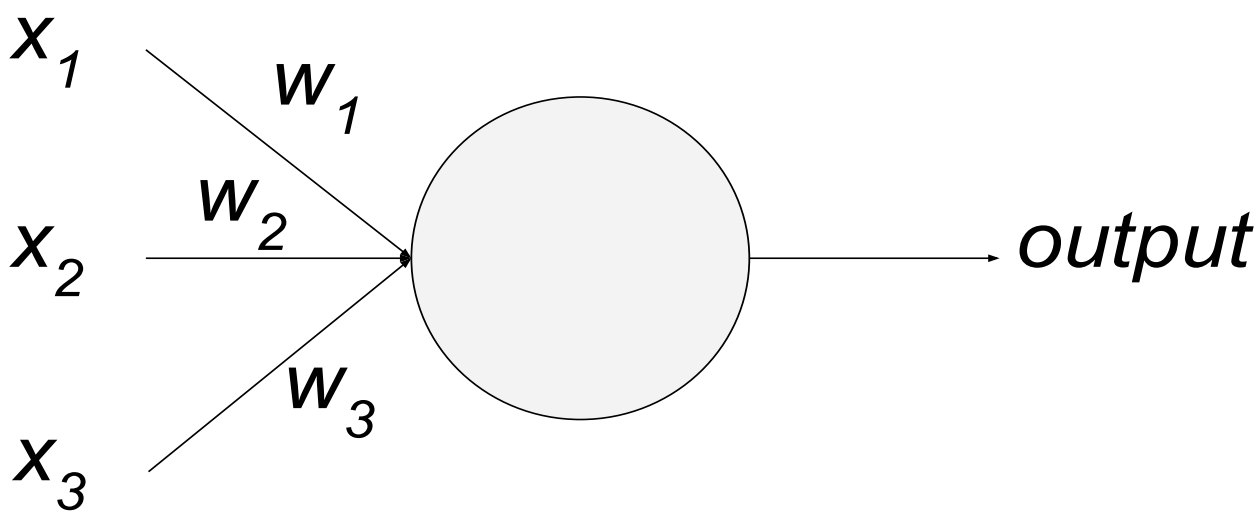
Dataset

Description

1. Single experiment
2. 1200 seconds long
3. Simulink dq-frame model is used

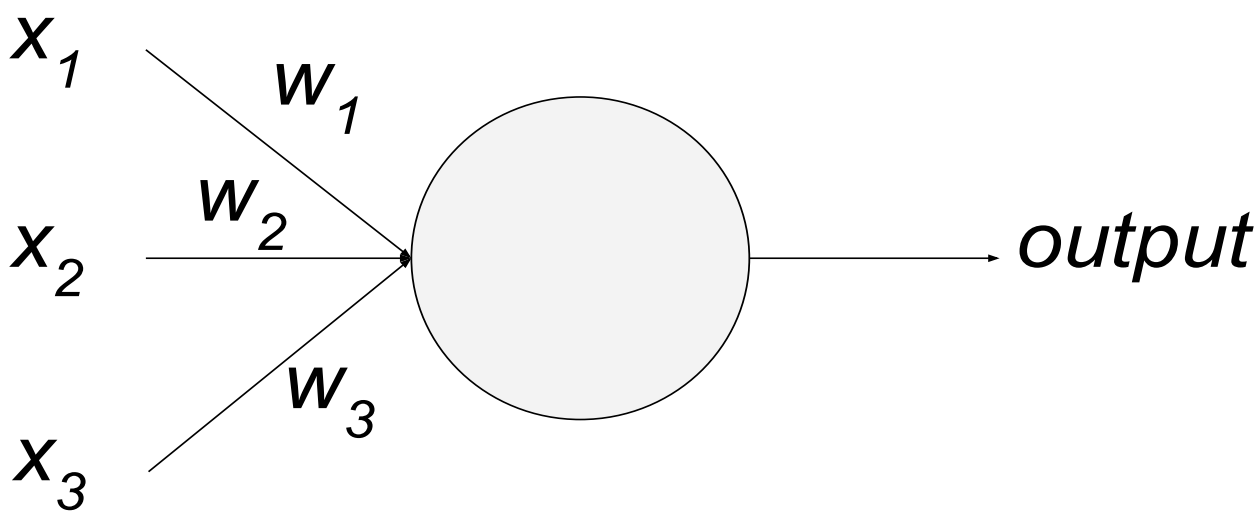
Dataset

Voltages



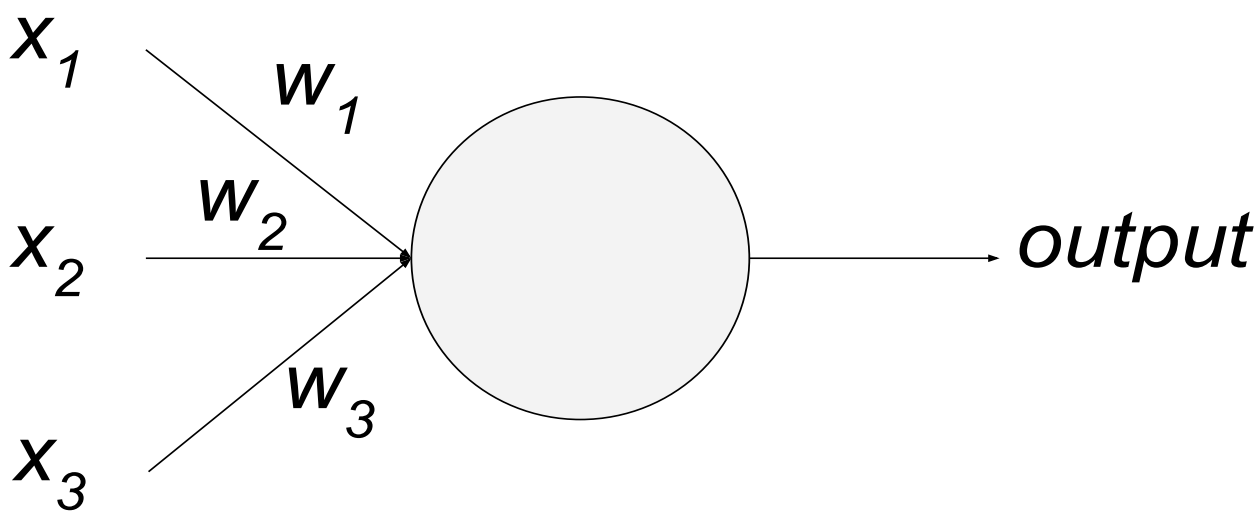
Dataset

Stator Pulse



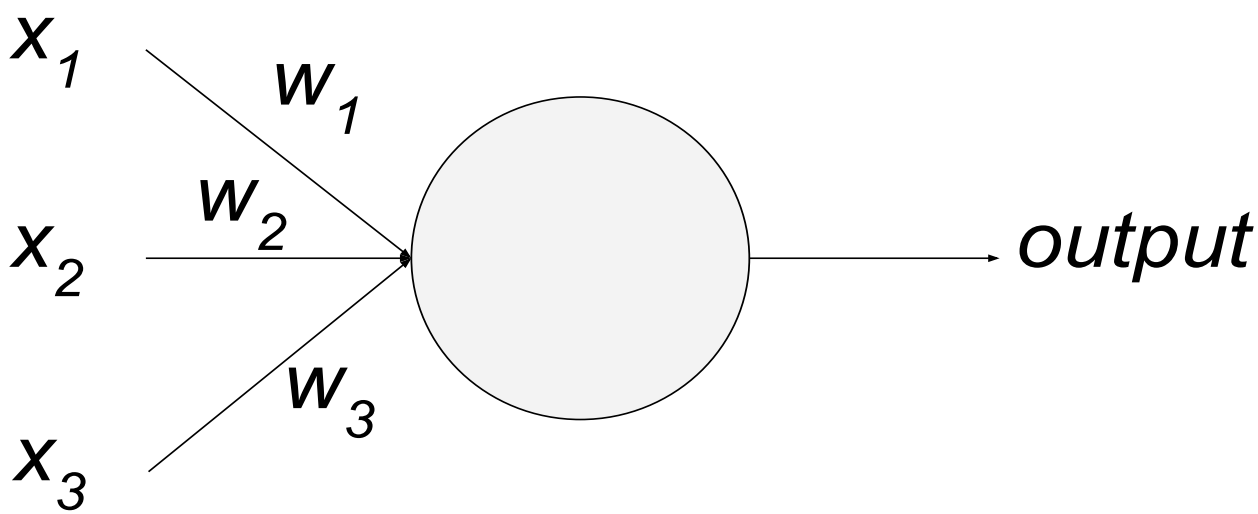
Dataset

Speed



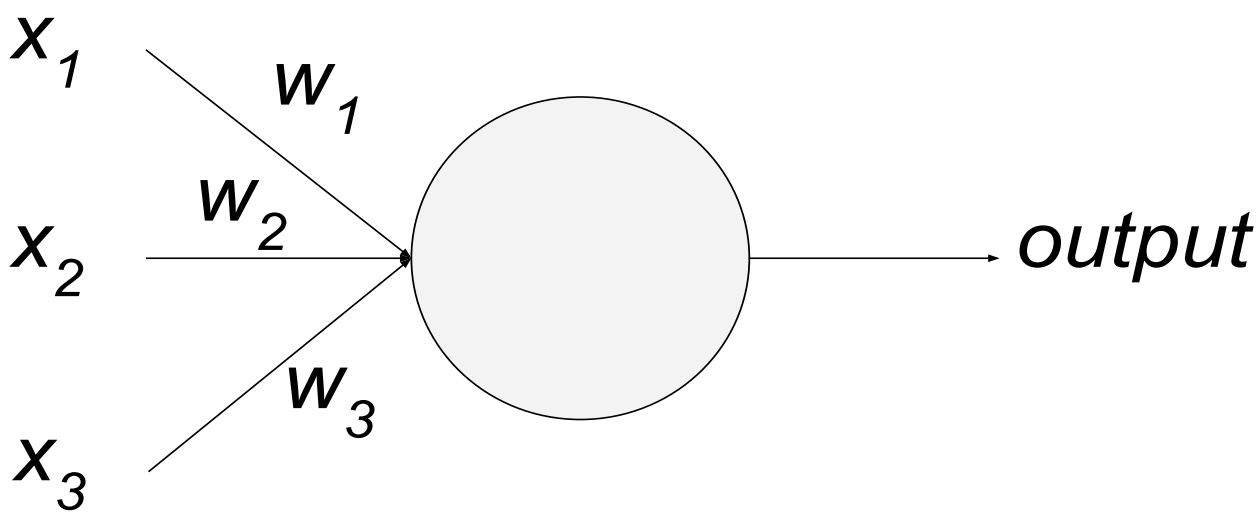
Dataset

Currents



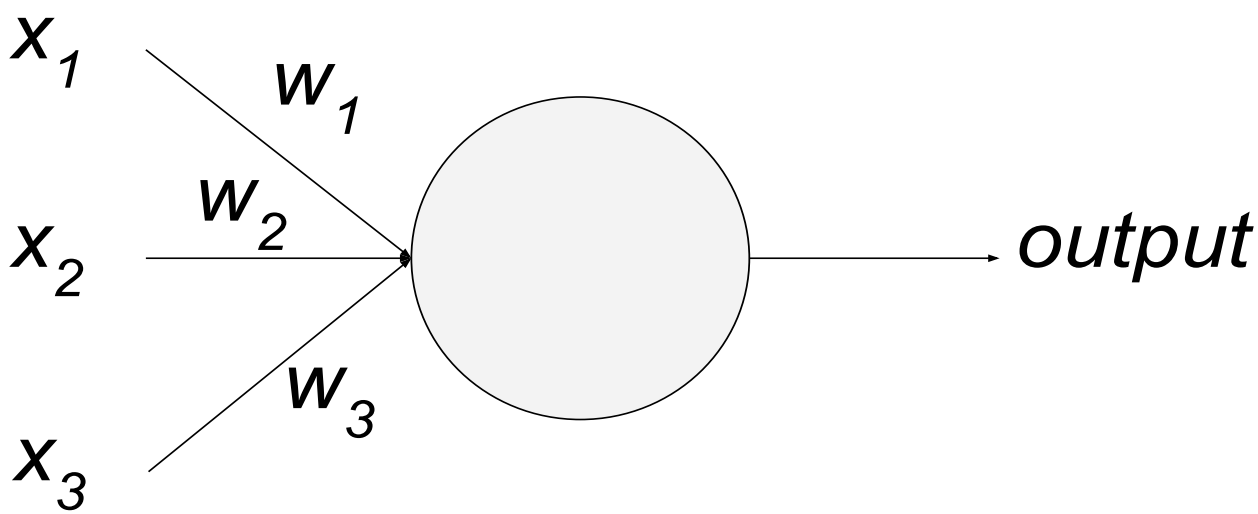
Dataset

Torque



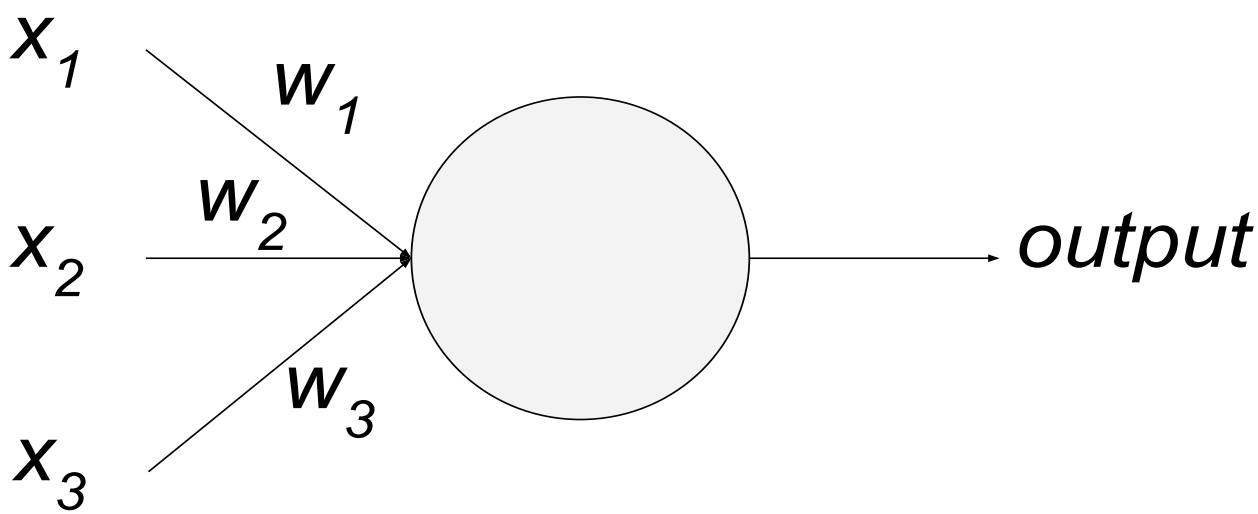
Dataset

Speed



Dataset

Voltage2 and Stator Pulse



Dataset

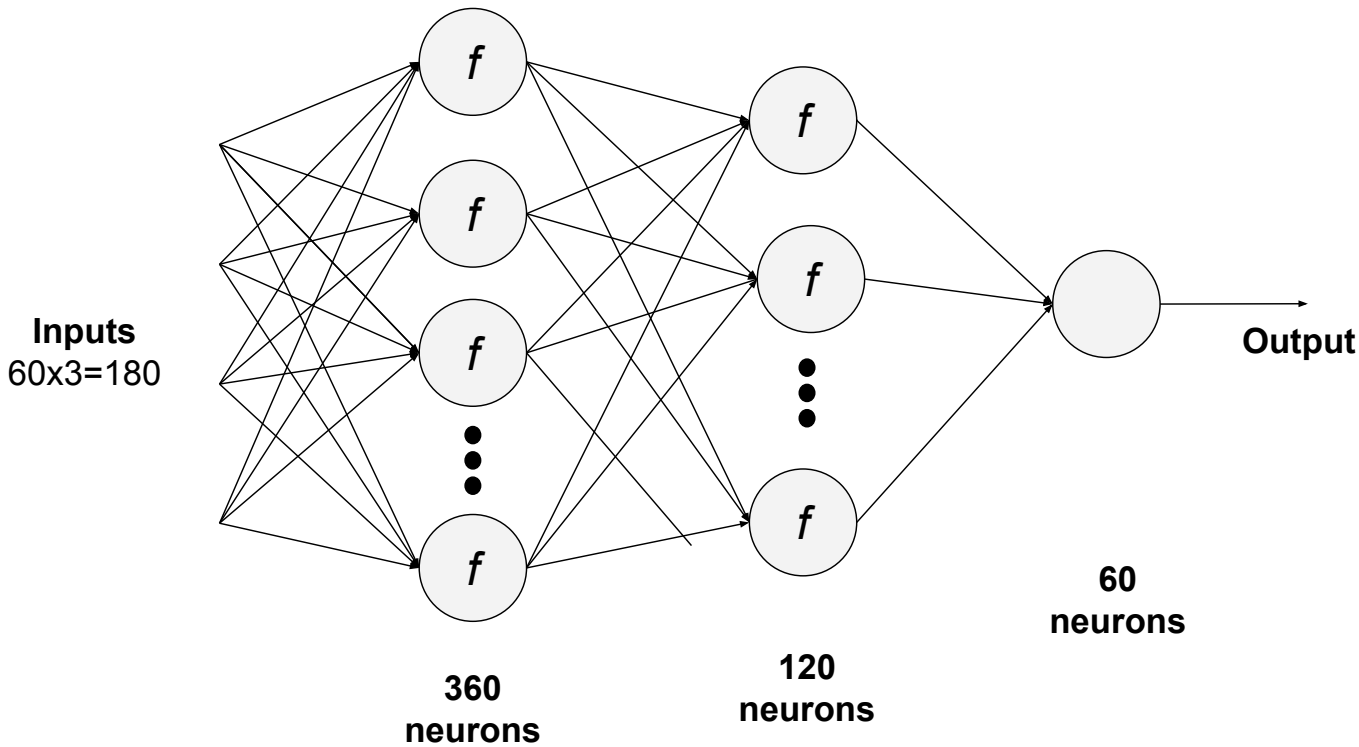
Train-Test Split

1. Single experiment
2. Biased if splitted like 0-800s and 800-1200s
3. Random sampling
   - 3.1 Take window w with stride s
   - 3.2 Randomply sample windows
   - 3.3 Train-test cover whole data
   - 3.4 No overlaping b/w train-test

Experiments

ANN for signal prediction

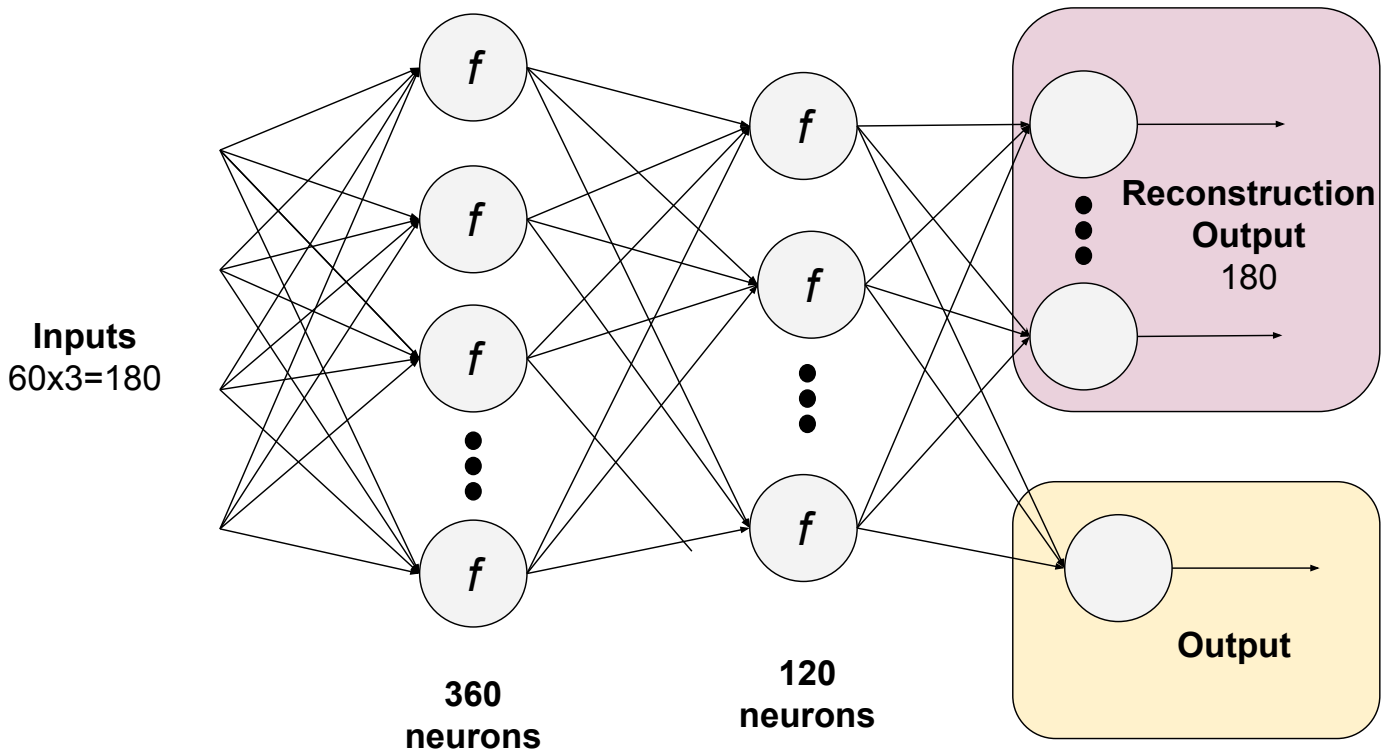
1. Three outputs, three networks.
2. Input: $w \times 3$ 1-D vector, Output: 1 middle value
3. Activation, f: Leaky Relu



Experiments

ANN with auxilary task

1. Also reconstruct input signal.
2. Three outputs, three networks.
3. Input: $w \times 3$ 2-D vector, Output1: 1, output2: $w \times 3$ 2-D vector
4. Activation, f: Leaky Relu



Experiments

Convolution network

1. CNN and ANN works better then RNN (Miller et al. 2018).
2. Three outputs, three networks.
3. Input: $w \times 3$ 2-D vector, Output1: 1
4. Activation, f: Leaky Relu

Results and Conclusions

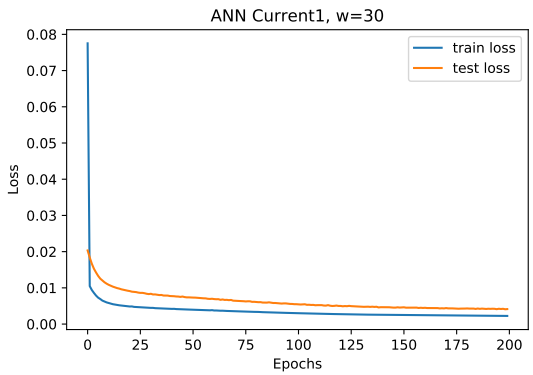
Best Model

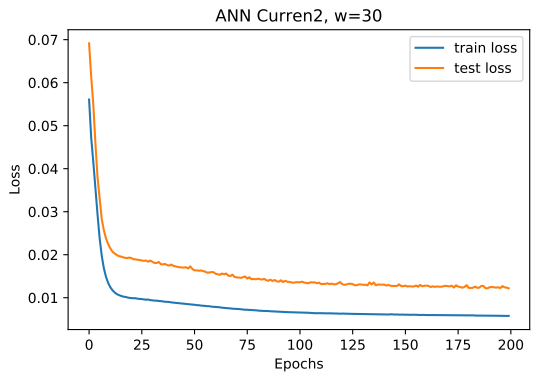
Model	w	Current1	Current2	Torque
ANN	100	0.072	0.197	0.672
	60	0.043	0.105	0.564
	30	**0.031**	**0.091**	**0.056**
LSTM	100	0.146	0.182	0.723
	60	0.136	0.107	0.688
	30	0.045	0.105	0.072
MO-LSTM	60	0.139	0.112	0.691
	30	0.051	0.109	0.081

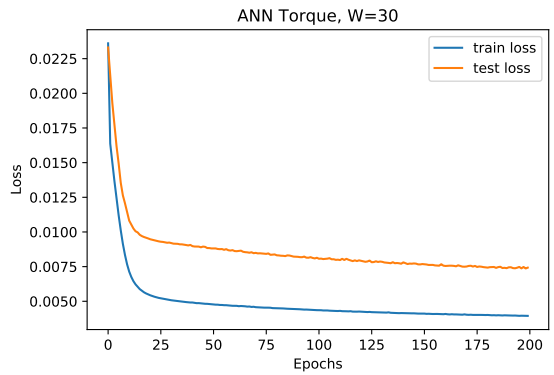
Table: MSE of different models with different sequence lengths.

Results and Conclusions

Model Convergence







Results and Conclusions

Example Outputs

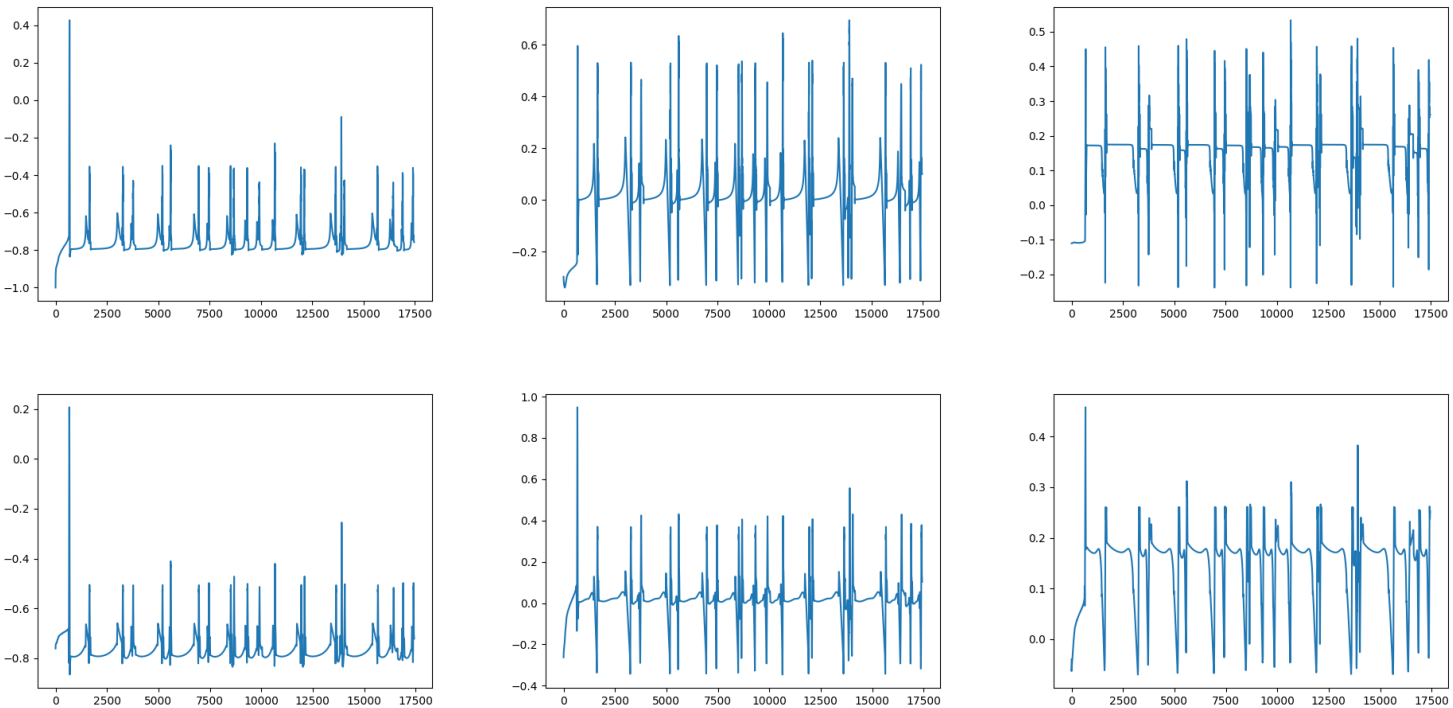


Figure: Top row: ground truth, bottom row: predicted signal, left to right: current1, current2, and torque

Results and Conclusions

Some Answers

1. How to handle continous signals? **Use tanh**
2. How to handle long sequences? **Find optimal subsequence**
3. Which prediction model to use? **ANN**
4. How to handle multiple outputs? **Independent Models**

Thank you!
Questions?