Multi-Input Multi-Output Electric Motor Modeling using Neural Networks

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Table Of Contents

What we discussed in the last meeting?

1. Problem definition
2. Neural networks introduction
3. Early results on public dataset
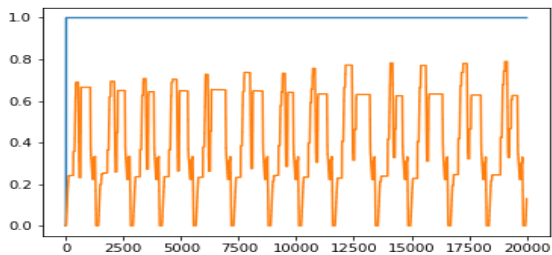4. Error in predicting impulse peeks
5. Prediction scaling problem

Dataset
Description

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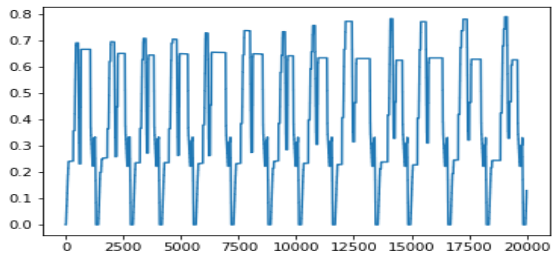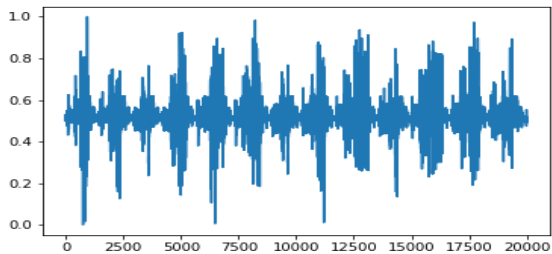3. Simulink dq-frame model is used

Dataset

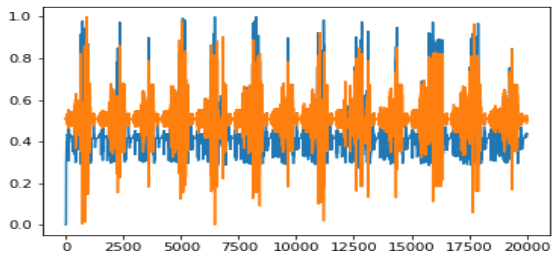Voltages

Dataset
Stator Pulse
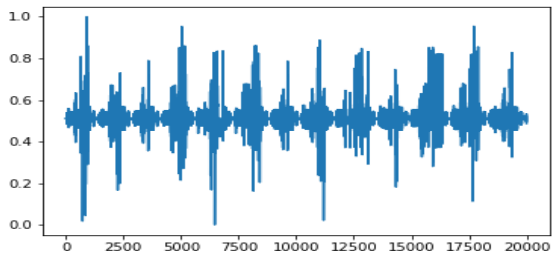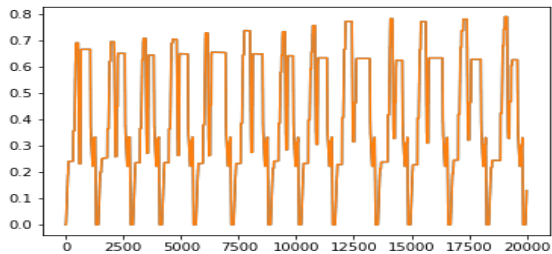
Dataset

Speed

Dataset

Currents

Dataset

Torque

Dataset

Voltage2 and Stator Pulse

Dataset
Train-Test Split

1. Single experiment
2. Biased if the split is 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
Input selection

1. Use simulking for downsampling
2. Stride $s = 1,5,10$; Works best at stride 1
3. Windows sizes that matter, $5 \leq w < 10$ and $10 \leq w \leq 100$
4. Ignore voltage 1
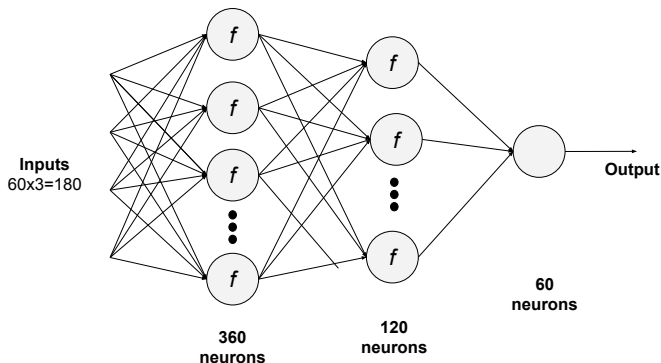5. Use either voltage 2 or stator pulse

Experiments
Output selection

1. Don't predict all time steps
2. Predict first, middle or last time step
3. Middle works better

Experiments
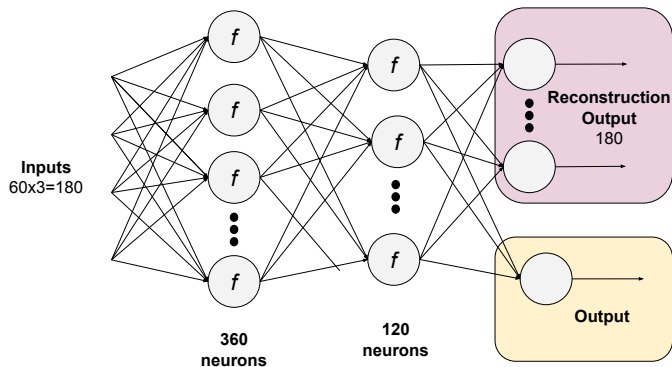
ANN for signal prediction

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

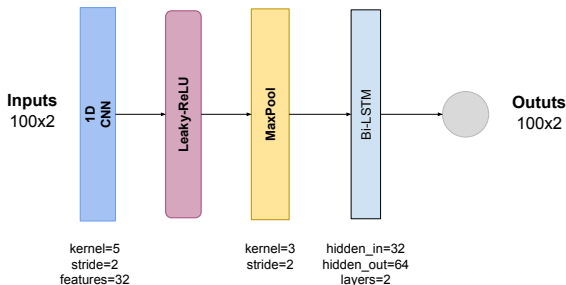# Experiments

ANN with auxiliary 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. Kernels capture $w \leq 10$
3. Channel featurization, correlate voltage2 and speed
4. Three outputs, three networks.
5. Input: $w \times 3$ 2-D vector, Output: 1
6. Activation, f: Leaky Relu (in conv)

Inputs 100x2 — 1D CNN — Leaky-ReLU — MaxPool — Bi-LSTM — **Ouputs** 100x2

kernel=5
stride=2
features=32

kernel=3
stride=2

hidden_in=32
hidden_out=64
layers=2

Results

Best Model

Model	w	Current1	Current2	Torque
ANN	100	0.223	0.197	0.101
ANN Aux	100	0.192	0.182	0.112
CNN	100	**0.107**	**0.104**	**0.091**

Table: MSE of different models.
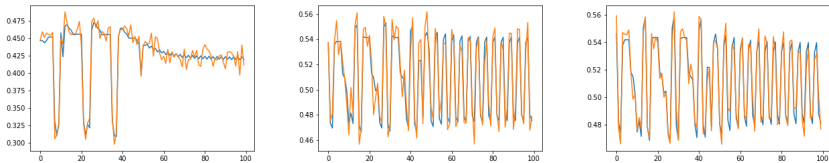
Results

Example Outputs

Figure: Left to right: current1, current2, and torque, orange color: predicted

Questions

1. Is data very simple?
2. When voltage 1 is not constant?
3. When Voltage 2 and stator pulse are not same?
4. Can signals be grouped into some classes?
5. Visual evaluations?
6. Other evaluation metrics?
7. Predict future(causal)?

Thank you!