

# Machine learning based models for lithium ion batteries

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## Motivation

- Our project aims to address whether ML can be used to model battery voltage
- We hope ML may offer an alternative to equivalent circuit and physics models

## Methodology

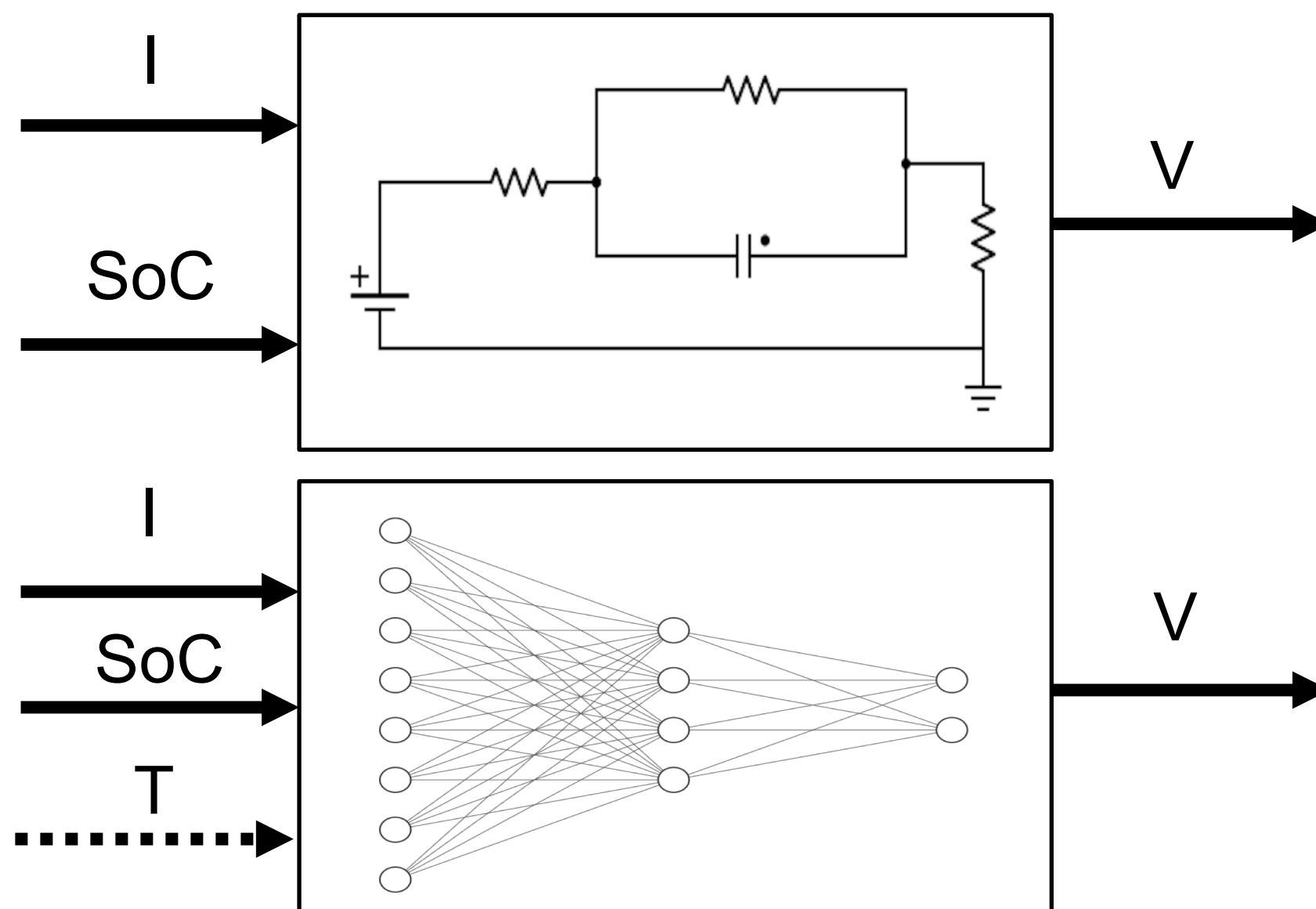


Fig 1. Model architecture

- *nn\_relu* and *nn\_tanh* 3 layer NNs with the architecture above and relu / tanh activations
- *Istm* a 2 layer NN with 20 recurrent neurons using tanh activations and sigmoid connections followed by 1 neuron FC linear layer

## Data

Data were acquired from six NCR18650B cells at these temperatures and cycles

- Temperature: 5°C, 25°C, 35°C
- Cycle: Const. Curr., HPPC, US06, UDDS

First validation held out random drive cycles

Second validation held out all US06 drive cycles

## Results

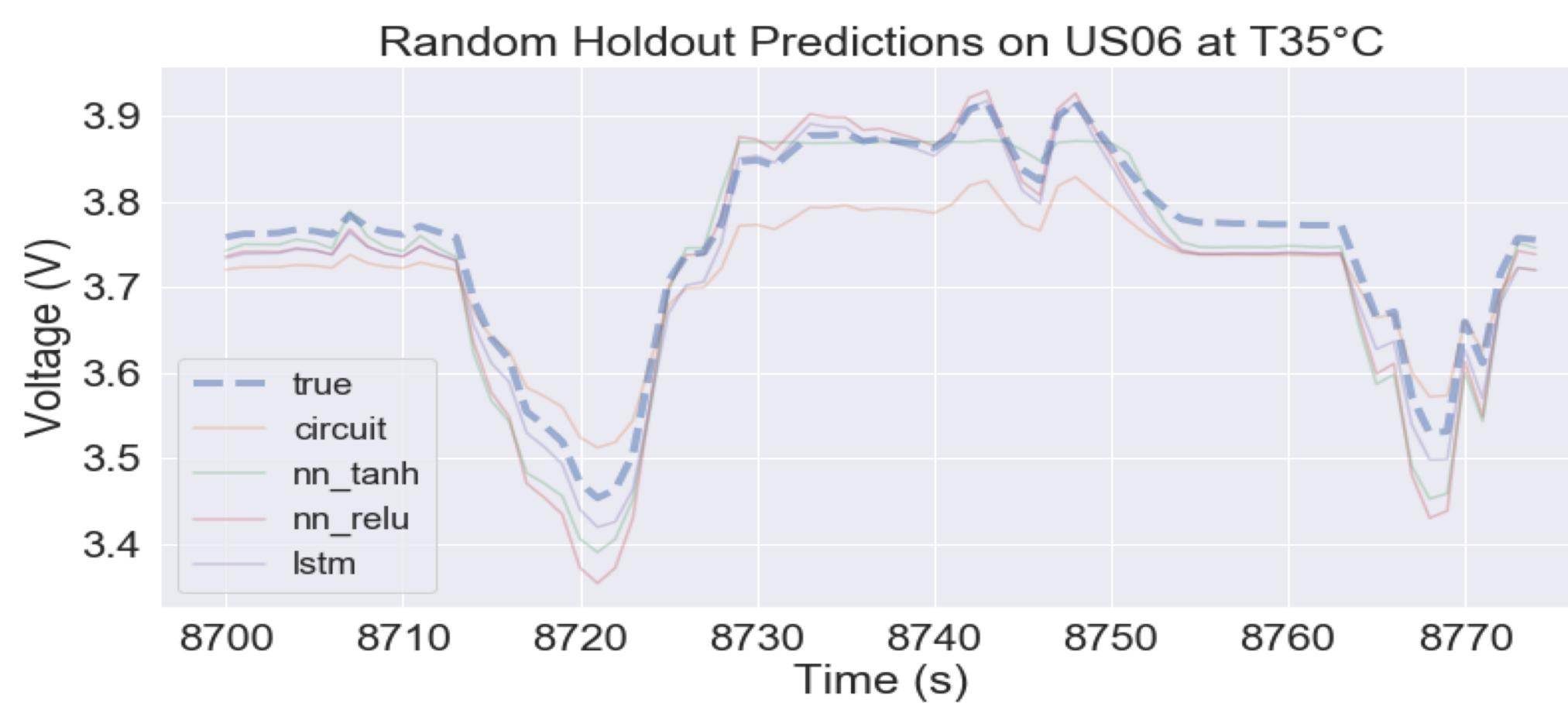


Fig 2. ML generalizes for battery voltage prediction

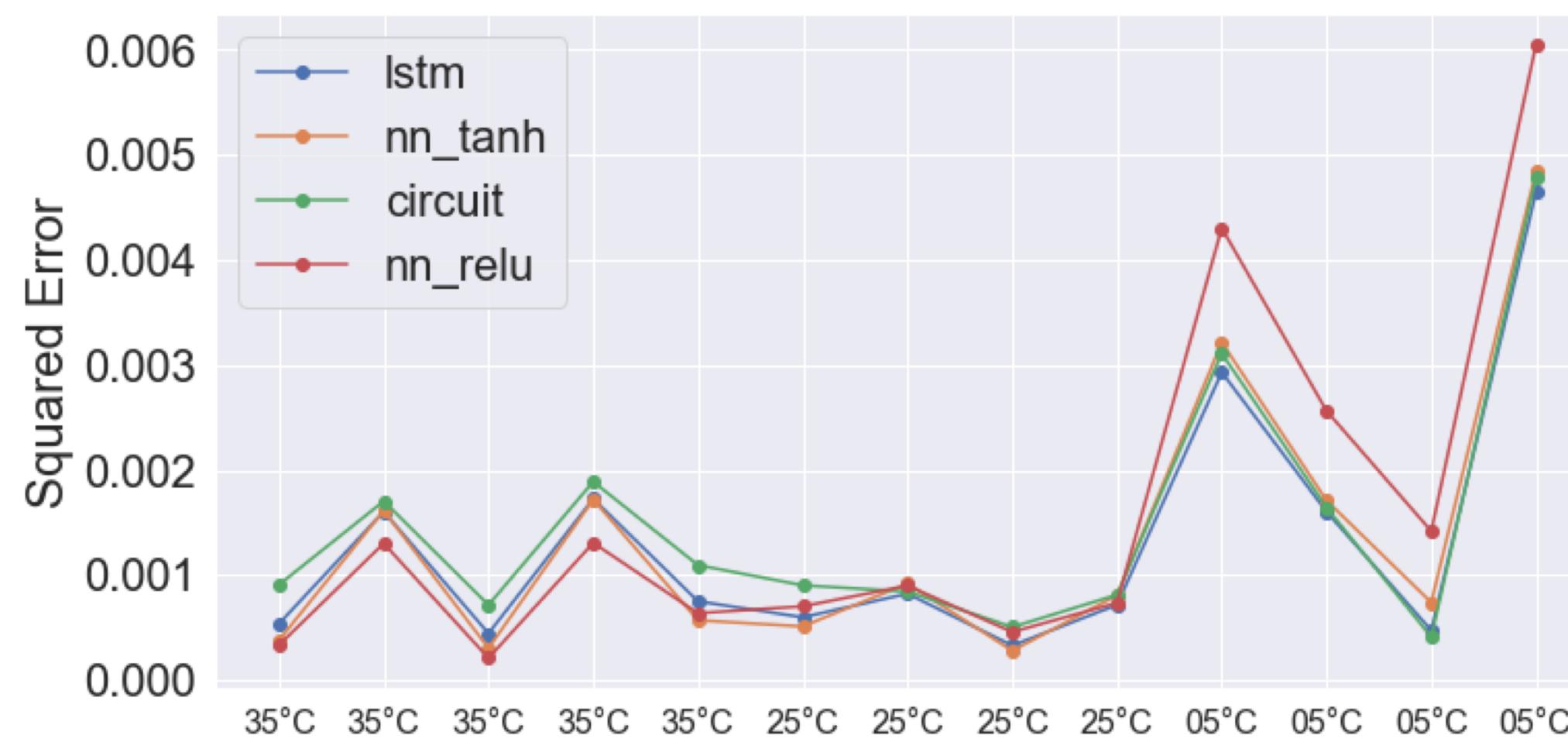


Fig 3. Predictions generalize to new drive cycles, additionally error and temperature appear related

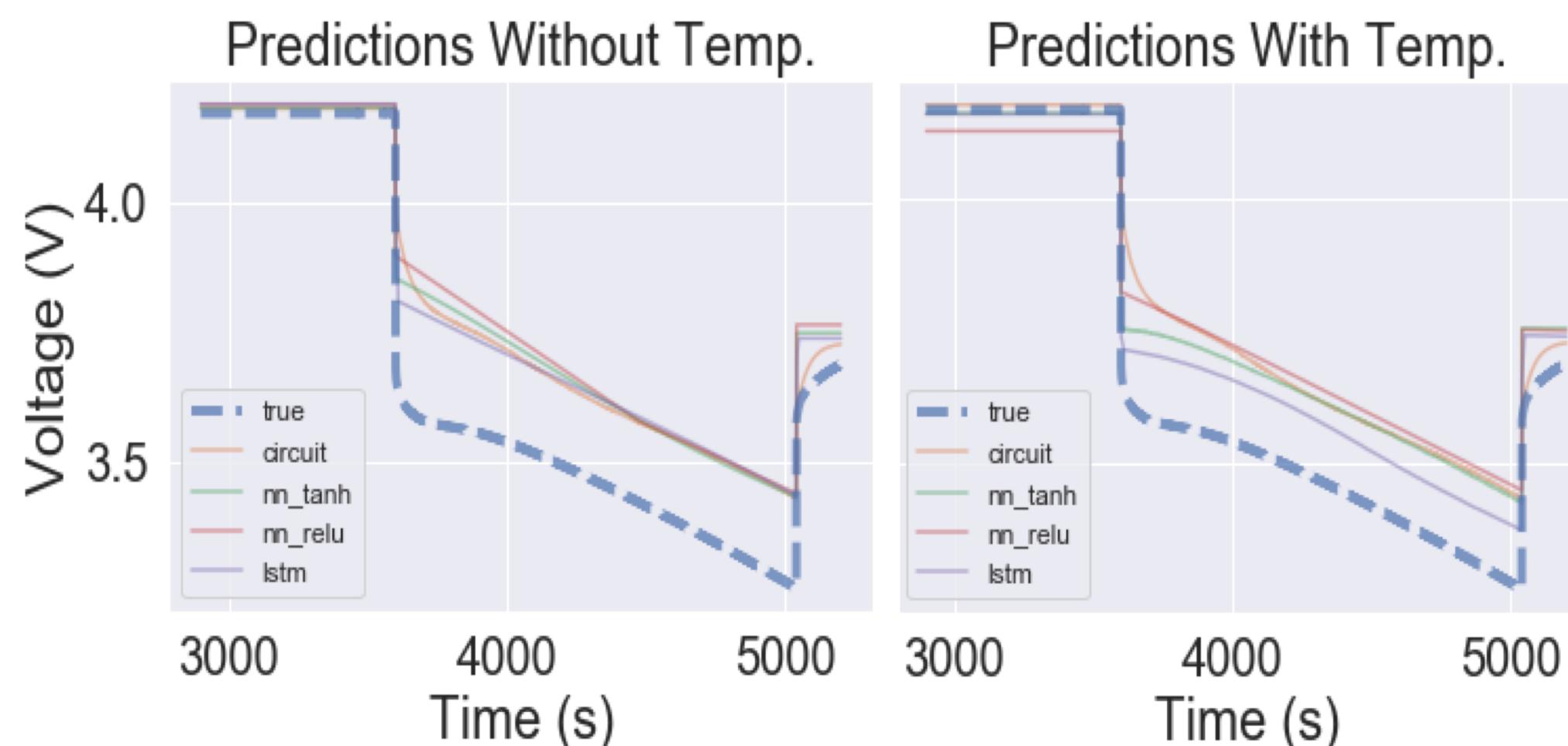


Fig 4. Including temperature allows more complex fits

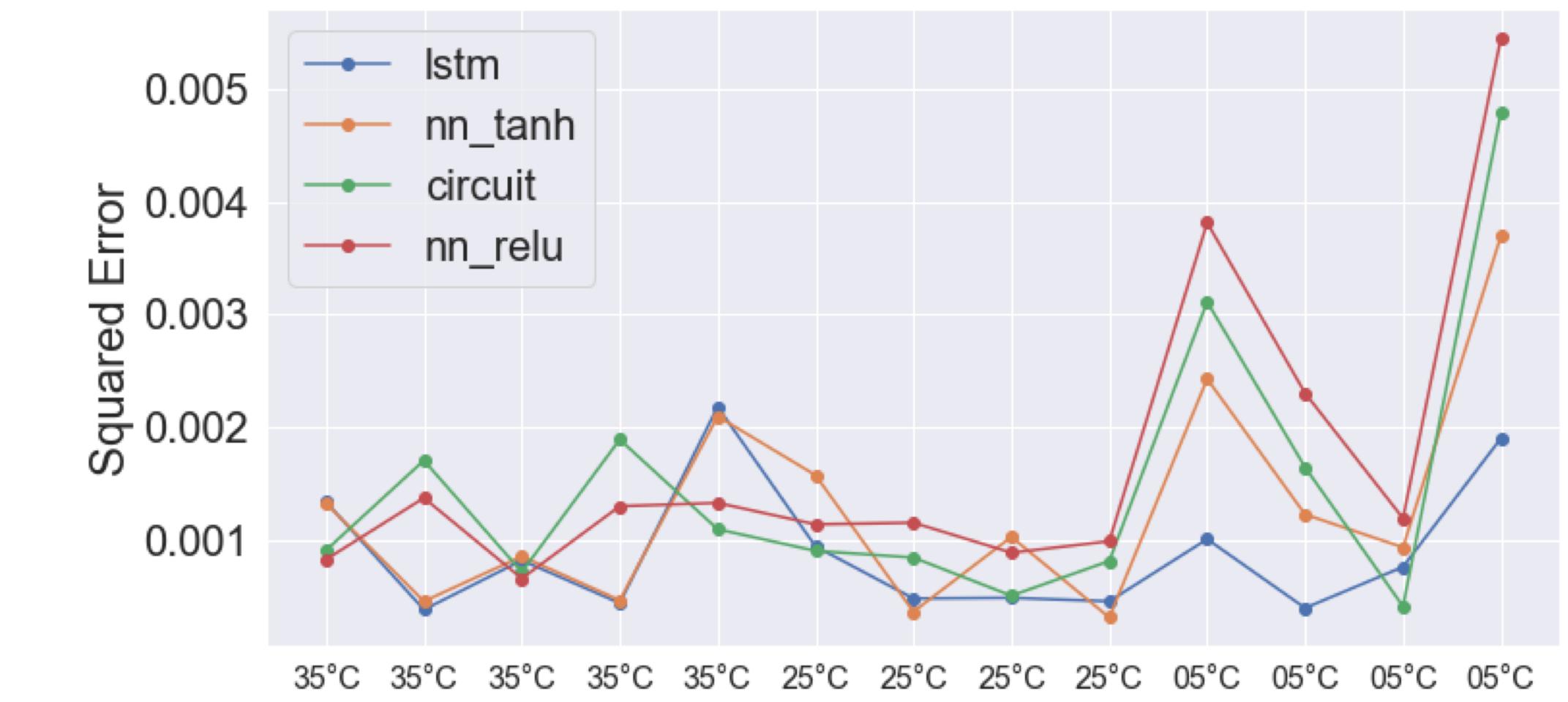


Fig 5. ML with temperature gives more robust prediction

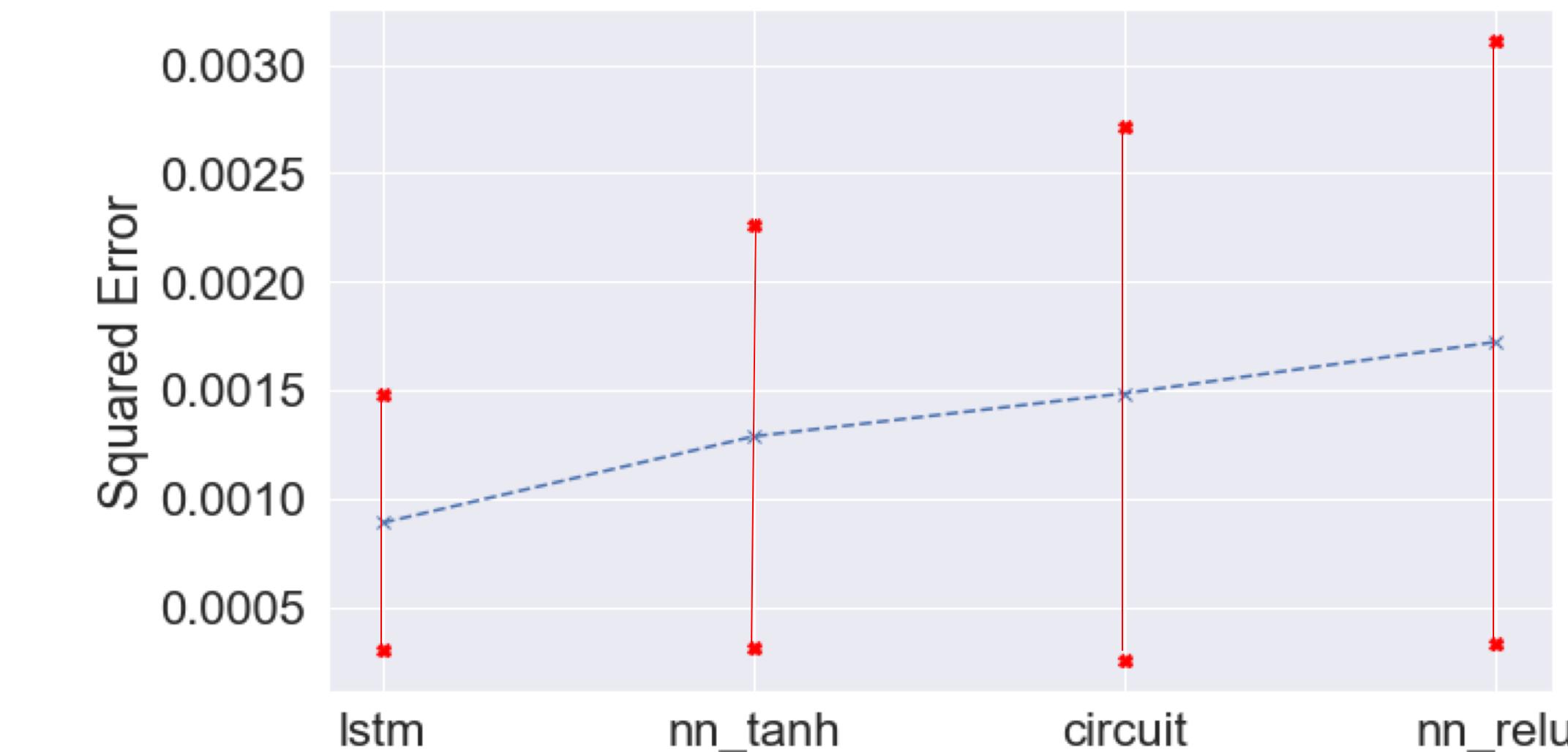


Fig 6. Model mean performance with std. deviations

## Conclusions

- ML models work, generalizing well to battery voltage prediction (measured by squared error)
- ML models show promise generalizing to previously unseen drive cycles, especially after incorporating temperature

## Acknowledgements

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