B3M38DIT1
Fault detection of sensors with machine learning using LSTM neural networks

Vít Zeman

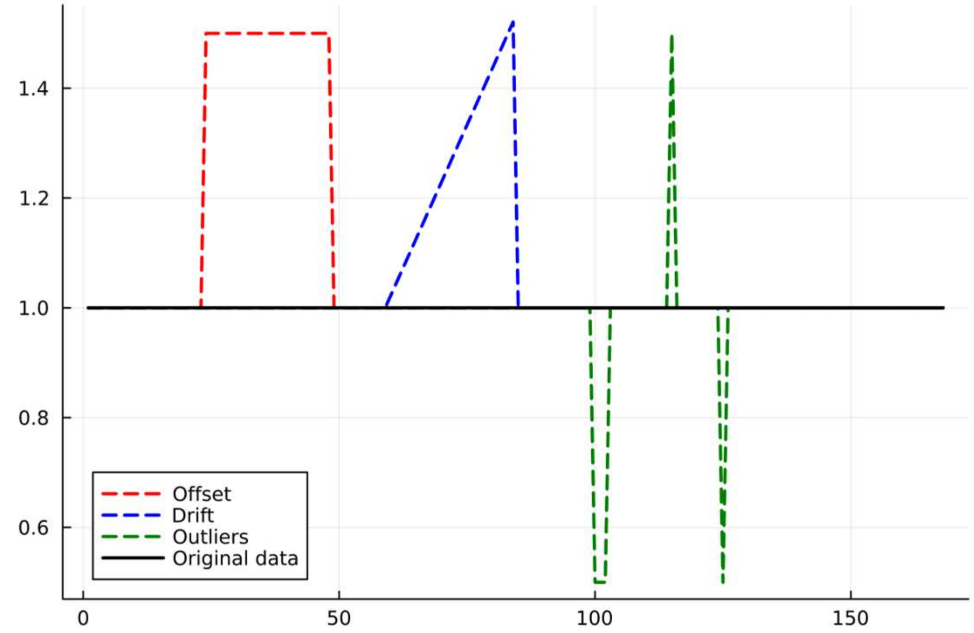
09.01.2023

Task

- Fault detection on temperature sensor
- Long-term time series data from multiple sensors
- Using Long short-term memory (LSTM) neural network

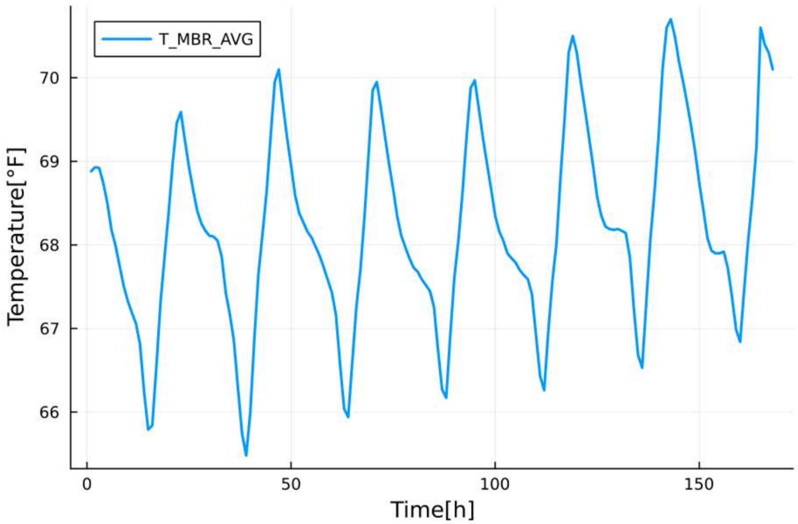
Faults

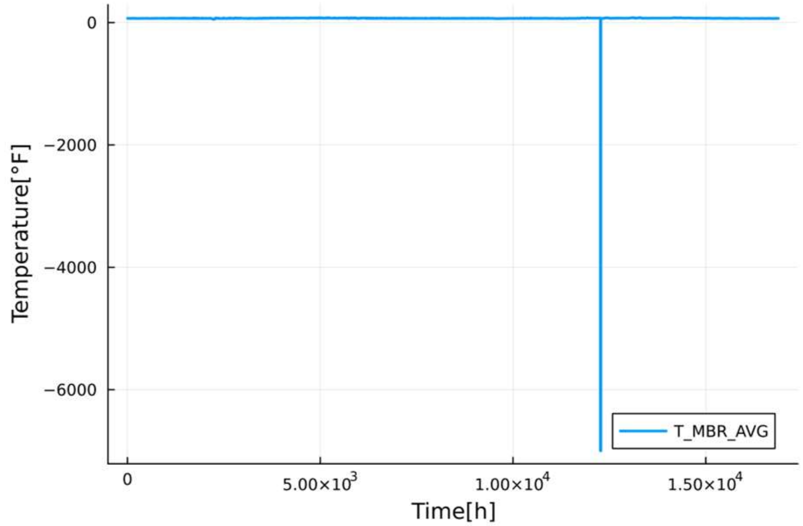
- Three types of faults:
- Drift:
  - Linear
  - [0.75; 1.25] kelvins every 5 days
- Offset:
  - Shift in temperature values
  - ± [0.5; 5] Kelvin
- Outliers:
  - Sudden big jump in value
  - ± [10; 30] Kelvin from average



Data

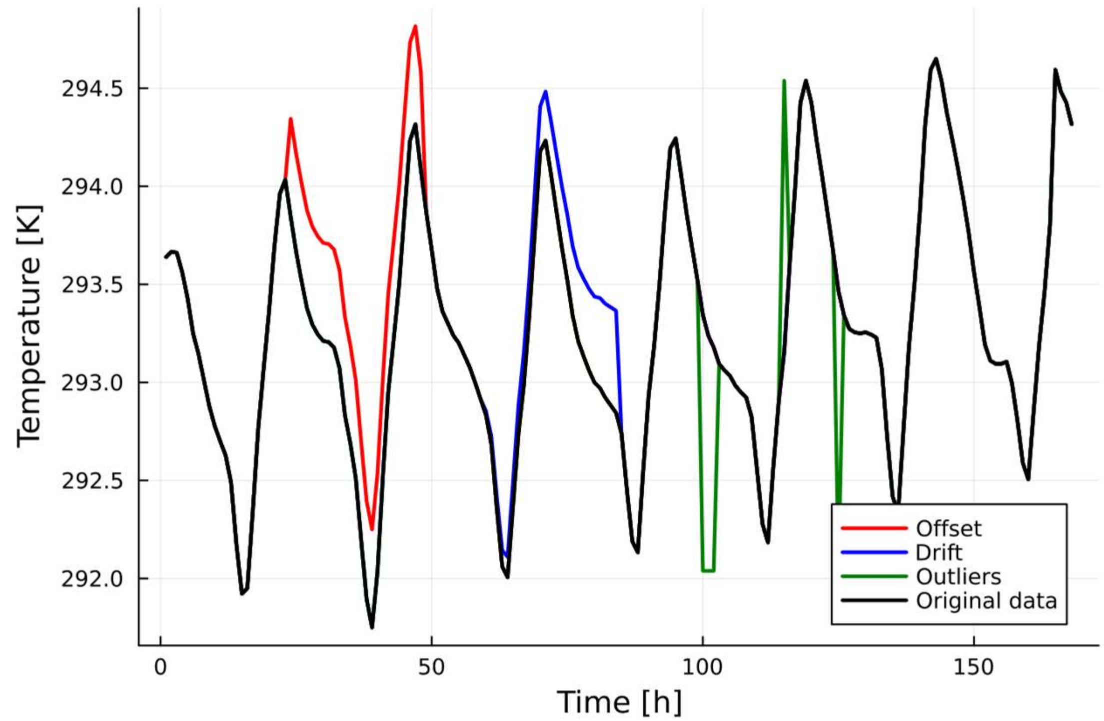
- Temperature, relative humidity, energy consumption and generation
- Approx. 704 days of continuous measurements
- Average over hour
- Inconsistencies (-6999 °F, missing data)





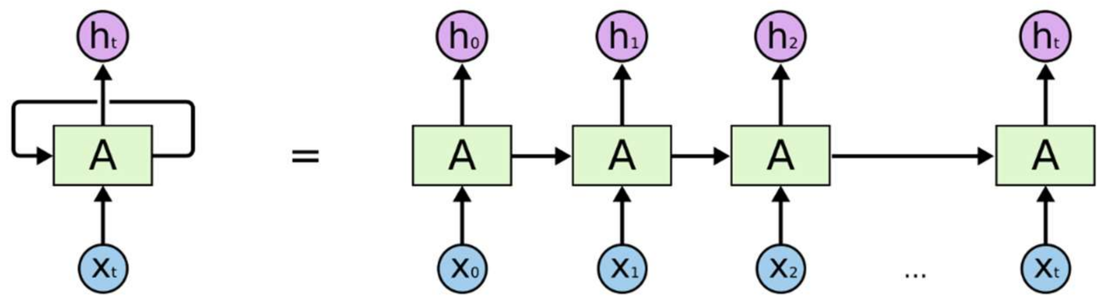
Dataset generation

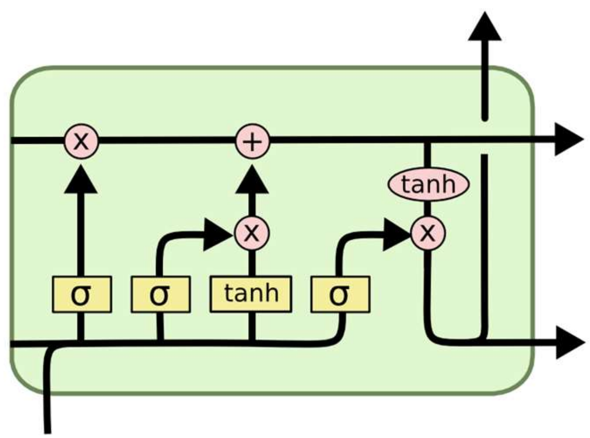
- Conversion to Kelvins
- Random location and duration
- 4 classes
  - Faultless
  - Drift
  - Offset
  - Outlier
- Distribution of [0.4, 0.2,0.2,0.2]



RNNs and LSTMs

- Memory: Previous input/output impacts current case
- RNNs
  - Only short memory
  - Vanishing or exploding gradient
- LSTMs
  - Added long term memory
  - Used for classification and prediction

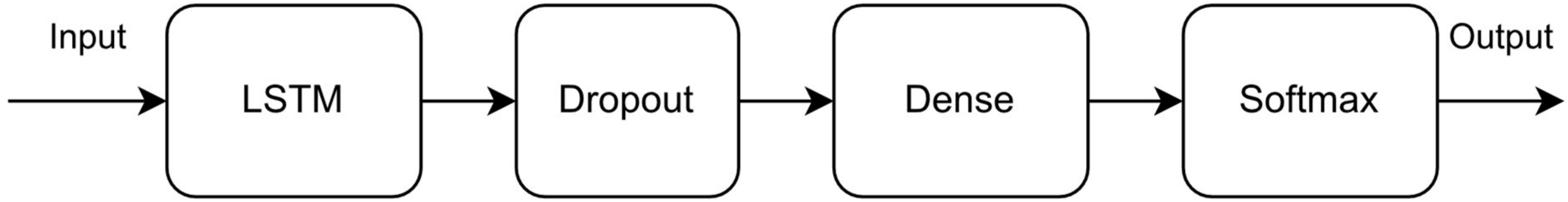




Images: https://colah.github.io/posts/2015-08-Understanding-LSTMs/

Proposed model

- Idea use LSTM to extract features
- Use Dense layers to classify outputs



- Metrics
  - Accuracy
  - Confusion matrix

Results

- Accuracy 64%

Ground truth \ Predicted	Faultless	Drift	Offset	Outlier
Faultless	1315	498	147	118
Drift	132	703	195	187
Offset	73	27	281	32
Outlier	53	95	95	657

References

[1] S. Hochreiter and J. Schmidhuber. Long short-term memory. Neural computation, 9:1735–80, 12 1997.

[2] R. C. Staudemeyer and E. R. Morris. Understanding lstm-a tutorial into long short-term memory recurrent neural networks. 2019.