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Integrated Dimensionality Reduction and Sequence Prediction using LSTM
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Problem
• Most industrial or complex processes present temporal dependencies which stretch over a long time.
• The underlying patterns in these processes can be extremely non-linear.
• Use of linear predictive model (ARMA/ARIMA[1]) is not suitable.
• Hidden Markov Model[2] has prediction limitation when dealing with temporal dependencies that stretch over long durations.

Objectives
• Use of external and a proposed integrated dimensionality reduction LSTM predictive systems for predicting message logs from industrial machines.
• Conversion of nominal codes (raw codes) to other vectorial paradigms to obtain better correlated patterns.

Methods
• External Methods: Recurrent Neural Networks (RNN) [3-7]
• Proposed Method: Integrated Dimensionality-reduction LSTM

Results
• ID-LSTM Prediction on OHE codes during training and testing phases (left plot) and index predictions (right plot) over a duration of 10K time-counts.

Conclusions
• We have transformed nominal codes to other vectorial representations with the objective of identifying correlated patterns using one hot encoding (OHE) and principal component analysis (PCA).
• Nominal integer codes are not sensible to use in the RNN.
• A separate dimensionality reduction by PCA is not needed: the ID-LSTM uses 10 hidden dimensions in the bottleneck layer.
• The ID-LSTM on OHE codes yield the best result on a small sample dataset.
• The use of ID-LSTM also obtains good results on reduced dimensional PCA vector codes (20-DIM-PCA).
• The ID-LSTM obtained < 5% error on the predicted OHE codes in a realistically large dataset.

Future Directions
• We suggest that it may be possible to combine the proposed model with an early anomaly detection algorithm.
• To allow continuous prediction of physical problems in the machines generating the message logs.
• Optimization of LSTM-based feature dimensionality reduction in a realistically large dataset.

References

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