Integrated Dimensionality Reduction and Sequence Prediction using LSTM

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2 authors, including:

Lambert Schomaker
University of Groningen
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Integrated Dimensionality Reduction and Sequence Prediction using LSTM

Emmanuel Okafor and Lambert Schomaker
Institute of Artificial Intelligence and Cognitive Engineering, University of Groningen, The Netherlands

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) is not suitable.
- Hidden Markov Model (HMM) has prediction limitations 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.
- 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.
- The left and right plots show the confusion matrix, that is, the plot of the output predictions against their target values for both training and testing phases respectively for subset 9.

Notes

- A separate dimensionality reduction by PCA is not needed: the ID-LSTM uses 10 hidden dimensions in the bottleneck layer.
- One-hot-encoding is a must: do not try to predict arbitrary raw integer codes.

Data Representations

- One-Hot-Encoding Codes
- 3-DIM Principal Component Analysis (PCA) Codes

References


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