

Template for thesis project proposals

Project Title	Construct and optimise Recurrent Neural Networks for industrial applications on machine prognostics; Augmenting industrial data for supervised learning
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Keywords	Recurrent Neural Networks, time series forecasting, supervised learning, Prognostics and Health Management, fault detection

<p>Project description</p>	<p>Background:</p> <p>The current paradigm for maintaining industrial equipments is a combination of reactive and preventive actions. Take commercial transportation vehicles as example, they are typically maintained after an equipment failure occurs or according to preplanned visits to the workshops based on mileage or calendar time. This mixture of maintenance strategy is not ideal: i) it does not perform maintenance pro-actively well before the failure happens, i.e. severe component failures usually result in extra damage to the system and could be prevented; ii) planned maintenance with fixed time intervals does not guarantee all routinely changed parts have used all their potentials. Therefore, a shift of current maintenance strategy to one with more predictive maintenance is required: to inspect and repair components (well) before they causes a breakdown or severe damage to the system.</p> <p>Nowadays, with the development of electronic devices and the emergence of Internet of Things, huge amount of sensor data collected and transmitted remotely can be utilized for equipment monitoring, fault detection and prognostics. By processing sensor data during operations, condition of the equipment will be accessed and maintenance decision will be made. A common approach for machine prognostics is to estimate Remaining Useful Life (RUL) of the system. Many researchers applied Recurrent Neural Networks (RNNs) for estimating RUL based on sensor measurements, e.g. see reference [1,2,3,4]. Another common approach for prognostics is to generate index that reflects health status of equipment, e.g. reference [7,8], based on it's condition.</p> <p>A recurrent neural network (RNN) is a type of artificial neural network where connections between units form a directed cycle. It can use their internal memory to process arbitrary sequences of inputs and capture dynamic temporal behaviour, tutorials can be found in [5,6].</p> <p>In this project, the student will construct RNNs for predicting RUL of machines in different domains, including simulated data and real data from industrial application. The industrial data collected from large amount of vehicles performing transportation tasks in the field. Vehicles configuration, aggregated sensor values collected at different time are available. Service record that contains assessments and repair actions is provided. Based on sensor data and service records, a machine learning method for predicting RUL of equipment is expected to be proposed and evaluated.</p> <p>This project is programming oriented, the student will be working with some of the libraries that includes RNNs implementations, e.g. Theano and Keras.</p> <p>Objectives:</p> <ol style="list-style-type: none"> 1. Construct Recurrent Neural Networks, optimise it's architecture and training algorithms for predicting Remaining Useful Life of equipment. 2. Investigate and propose different scenarios augmenting industrial data for machine prognostics, e.g. generating targets/teaching signals for RNNs to learn? 3. Investigate what type of data representation technique can be employed for this application, e.g. histograms of aggregated values as input and use CNN-RNN model for the networks. <p>Research Questions:</p> <ol style="list-style-type: none"> 1. How to construct and train RNNs for predicting RUL? 2. How to augment industrial data for this study? <ul style="list-style-type: none"> - What type of representations can be used? - How to generate targets/teaching sequences based on service records? Does imposing arbitrary conditions based on application improves prediction performance? 3. How to augment the network architecture for different types of data representation (e.g. histograms with aggregated values as input)?
	<p>[1] Liu, Jie, et al. An adaptive recurrent neural network for remaining useful life prediction of lithium-ion batteries. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION MOEFFETT FIELD CA AMES RESEARCH CENTER, 2010</p>