

Selecting an appropriate Deep Learning algorithm for Predictive Maintenance

Abstract:

In industries, equipment maintenance is an important key, and affects the operation time of equipment and its efficiency. Thus, equipment faults need to be identified and solved, avoiding shutdown in the production processes. Deep learning (DL) techniques have been emerged as a promising tool in Predictive Maintenance (PdM) applications to prevent failures in equipment. In this context many deep learning algorithms are available. Hence, the research question of this paper is: What are the best deep learning algorithms to resolve predictive maintenance issues?

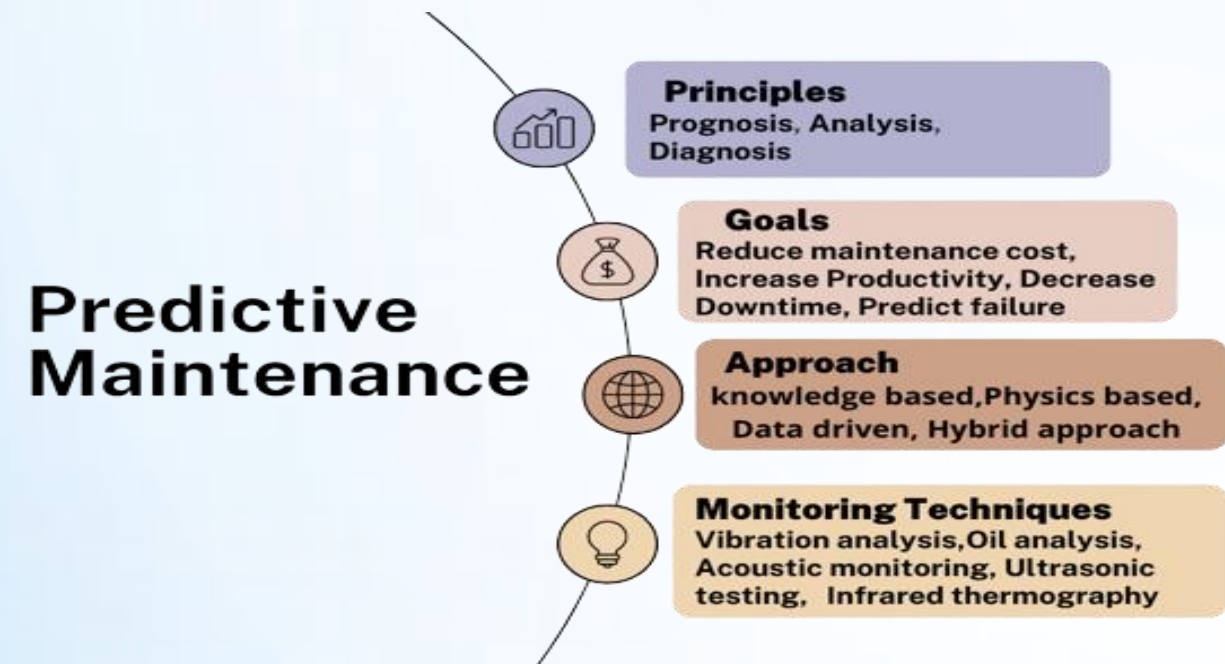
Objective:

Make a comparative study to choose the best deep learning algorithm for predictive maintenance.

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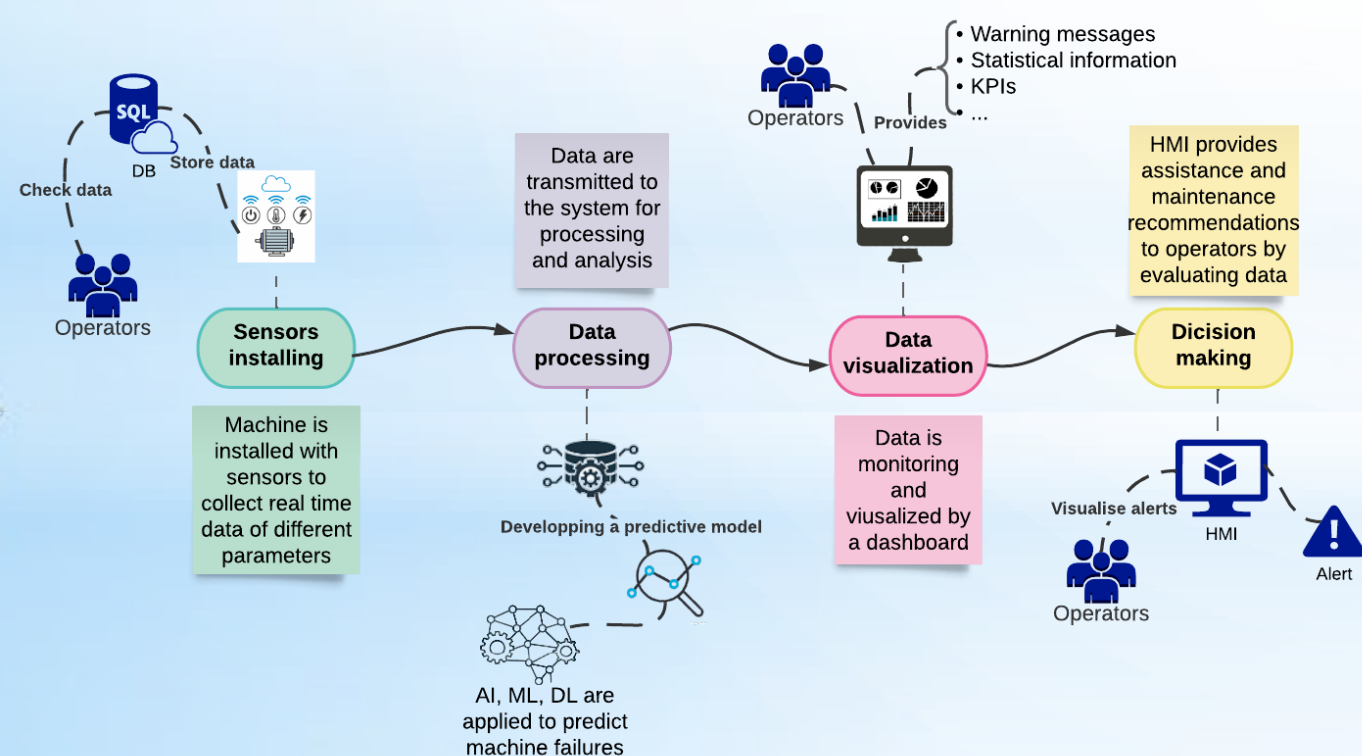
Predictive Maintenance

Predictive maintenance (PdM) is a recent preventive maintenance approach that consists of improving the performance and efficiency of the manufacturing process by increasing the life span of equipment and ensuring sustainable operational management [1]



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Deployment of PdM



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Deep Learning

Deep Learning (DL) is a subset of machine learning and artificial intelligence, that uses artificial neural networks to learn from data. These neural networks are designed to mimic the functioning of the human brain by processing data in successive layers[2].

The first and simplest architecture designed. It is formed by stacked neurons creating layers. In this network, information moves in one direction only, from the input nodes, through the hidden nodes and to the output nodes

One of the most established technique; it is based on the human visual cortex. A typical CNN structure consists of convolutional, pooling and fully-connected layers.

Type of ANN that is designed to handle sequential or time-series data, it has the concept of memory that helps to store the states or information of previous inputs by feedback loop, and use them to predict the output.

Divertive of RNN, it is designed to partly address a major limitation of the last (vanishing gradients); it can learn and memorize additions over a long period of time.

An unsupervised algorithm; is a generative model consisting of layers of stochastic and latent variables. DBNs are made up of RBMs that communicate with both the layers that precede and follow them.

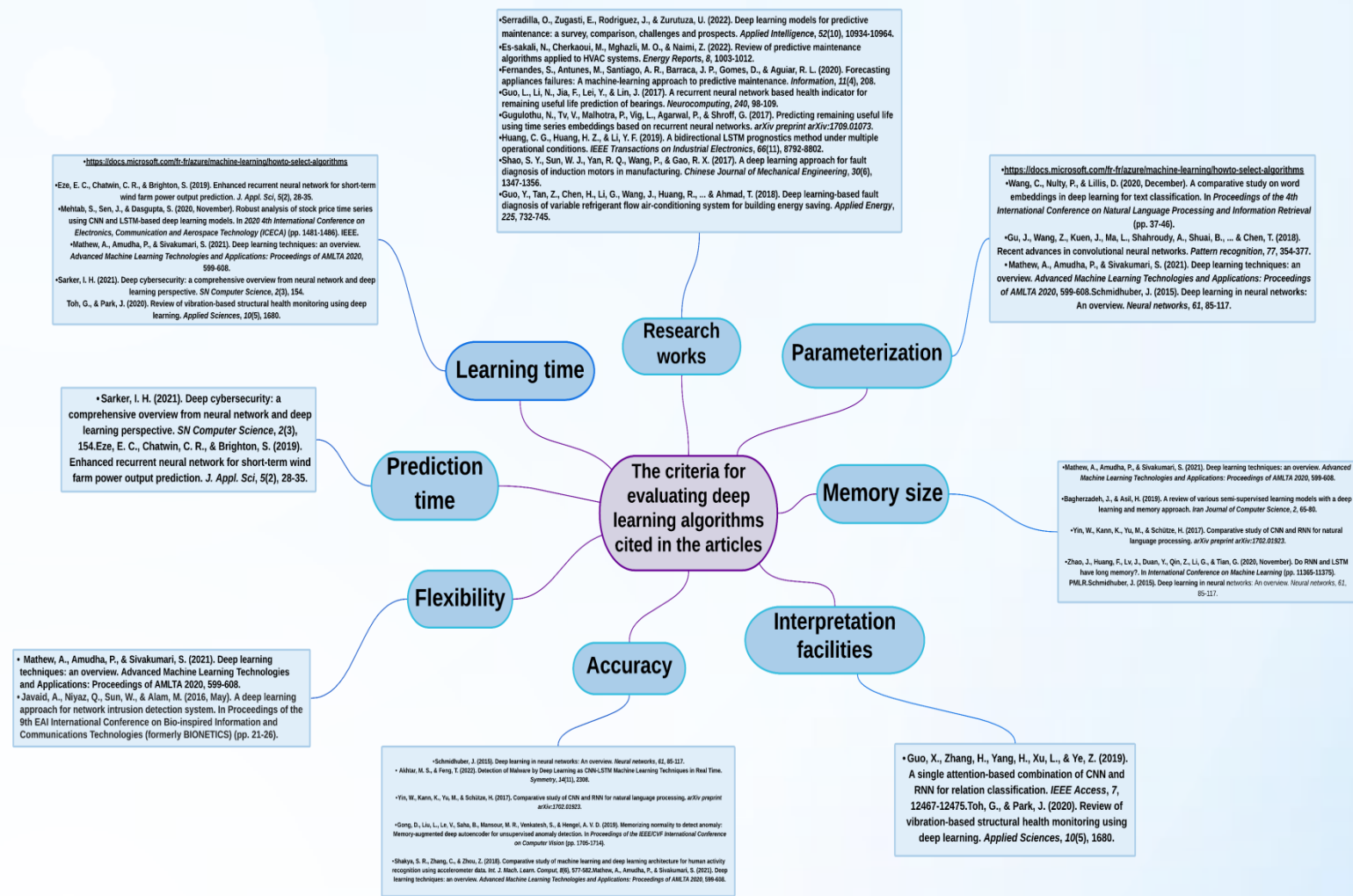
Generative stochastic ANN, that consists of a two-layer networking architecture containing a hidden layer and a visible layer. In RBMs, only the hidden and visible layers are connected.

Model that consists of two neural networks: a generator and a discriminator; which are trained simultaneously in a game-like manner.

Unsupervised learning neural networks which is based on the implementation of the backpropagation, it consists of two parts: an encoder and a decoder.

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Deep Learning for PdM



Criteria/Algorithm	CNN	RNN	LSTM	AE	GAN	FNN	RBM	DBN
Accuracy	****	****	****	**	***	**	**	****
Learning time	**	**	**	***	*	***	****	*
Memory size	***	****	****	**	**	**	**	**
Parameterization	***	**	**	*	***	***	*	***
Prediction time	**	****	****	***	***	***	*	**
Flexibility	****	****	****	**	**	**	****	**
Interpretation facilities	**	*	*	*	*	*	*	*
research works	***	***	****	***	**	*	**	**
Score	23	24	25	20	16	15	20	16

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Conclusion

The present research aims to select the most suitable algorithm for PdM, by a comparative study according to common criteria retained in the literature.

According to the scores, LSTM, CNN and RNN have shown best results.

Bibliographic References :

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