

**“Hidden Markov Models used for Failure Prediction:
Contribution to Model Training and feature selection”**

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Topic: Engineering and Technology

Title: Hidden Markov Models used for Failure Prediction: Contribution to Model Training and feature selection

Project:

This subject follows works on maintenance and reliability based on Hidden Markov Models (HMM).

HMM can be used to model complex processes or systems. We used information criteria for model selection like Shannon Entropy, Akaike Criterion, Bayesian criterion, Hannan-Quinn criterion... in various case of study using HMM. These criteria were efficient to evaluate pertinence of model parameters, without a priori knowledge. An availability indicator based on HMM has been proposed. These results show the ability of HMM to train failure “signature”.

In actual works, we implement strategies based on multi models competition. In this case, different models are trained for each labeled situation (System OK, Some degradation, Failure situation...). In this PhD proposal, we want to focus on the case of multi models competition. A new strategy for training models could be developed. Information criteria will be used to enhance feature selected and to select efficient models.

Engineering and Technology topic

“Hidden Markov Models used for Failure Prediction: Contribution to Model Training and feature selection”

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Context

This subject follows works on maintenance and reliability ([1], [2] and [3]) based on Hidden Markov Models (HMM, Fig. 1). We show ability of HMM to detect failure before it occurs. We use also information criteria to validate HMM topology that better fit degradation of a process.

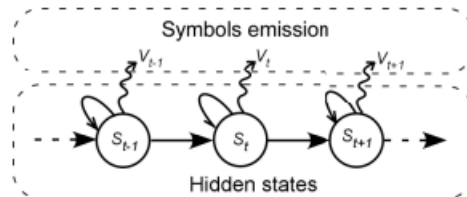


Fig. 1 Sample of HMM topology used to fit to process degradation.

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- First studies

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These criteria were efficient to evaluate pertinence of model parameters, without a priori knowledge. An availability indicator based on HMM has been proposed [4]. These results show the ability of HMM to train failure “signature” (Fig. 2 Sample test (food process)).

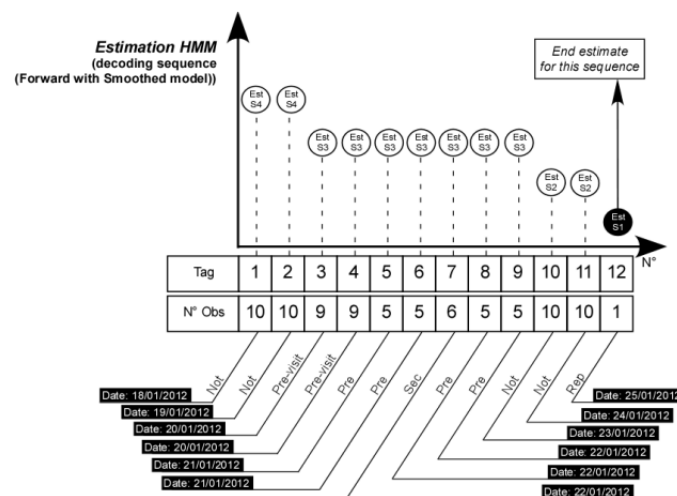


Fig. 2 Sample test (food process).

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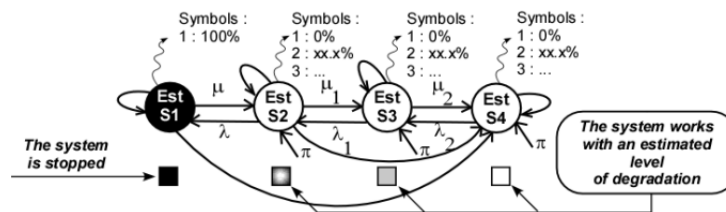


Fig. 3 Sample of topology.

- Contribution of this study

In this study, we want to focus on use of information criteria applied in case of multi models competition. A new strategy of training could be developed in case of multi models competition.

- Perspectives

New training algorithm for use in case of multi models competition.

An approach for assessment of level of degradation and RUL estimation based on: Hidden Markov Models,

Multi-stream Hidden Markov Models, Non-homogeneous Markov processes...

Bibliography:

[1] P. Vrignat, M. Avila, F. Duculty, F. Kratz, "Failure Event Prediction Using Hidden Markov Model Approaches", IEEE Transactions on Reliability, Vol. 64 (3), pp. 1038-1048, 2015.

[2] B. Roblès, M. Avila, F. Duculty, P. Vrignat, F. Kratz, "Hidden Markov model framework for industrial maintenance activities", Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability, Part O: Journal of Risk and Reliability, Vol. 228(3), pp. 230-242, 2014.

[3] P. Vrignat, M. Avila, F. Duculty, S. Aupetit, M. Slimane, F. Kratz, "Maintenance policy: degradation laws versus Hidden Markov Model availability indicator", Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability, Vol. 226(2), pp. 137-155, 2012. (Winner of the SAGE Best Paper Prize in 2012 by the editorial board of Journal of Risk and Reliability)

[4] P. Vrignat, M. Avila, F. Duculty, F. Kratz, "Use of HMM for Evaluation of maintenance activities", IJAIS, International Journal of Adaptive and Innovative Systems, Vol. 1, Nos. 3/4, pp. 216-232, 2010.