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## Paul Hofmann - Hidden Markov Models for Predicting Failure Events

We are using mixed membership Markov models (MMMM) to predict discrete failure events and POMDP (partially observable Markov decision process) to optimize the best action to take on an asset and how to assign the right task to the right resource. We use probabilistic graphs to model the prediction of failure events in the future, not classifying assets as likely to fail vs unlikely to fail and handling missing data in a very elegant way. We model the degradation path of individual assets, to predict overall failure rates. Instead of a separate distribution for each hidden state, we use hierarchical mixtures of distributions in the exponential family. In our approach the observation distribution of the states is a finite mixture distribution of a small set of (simpler) distributions shared across all states. Using tied-mixture observation distributions offers several advantages. The mixtures act as a regularization for typically very sparse problems, and they reduce the computational effort for the learning algorithm since there are fewer distributions to be found. Using shared mixtures enables sharing of statistical strength between the Markov states and thus transfer learning. We determine for individual assets the trade-off between the risk of failure and extended operating hours by combining a MMMM with a partially observable Markov decision process (POMDP) to dynamically optimize the policy for when and how to maintain the asset.

**Keywords:** AI, POMDP, Markov Model, Mixed membership models, Predictive maintenance

### Biography:

**Prof. Paul Hofmann** has a PhD in nonlinear quantum dynamics. He was Researcher and Assistant Professor at top German and US Universities, Northwestern University in Evanston/Chicago, Illinois, USA, Technical University at Darmstadt and Technical University in Munich (TUM), Germany. He was a visiting scientist at MIT in 2009.

Paul is a seasoned executive leader with 25+ years of international experience in chemical (BASF) and IT industry. He was VP R&D at SAP Labs Palo Alto, USA, CTO AI & Data Science NA at Accenture Resources, and two-time CTO of two successfully startups acquired by Intel and Nokia respectively.