



Vrije Universiteit Brussel

# Reliable Dynamic Graphical Models for Machine Degradation Modeling

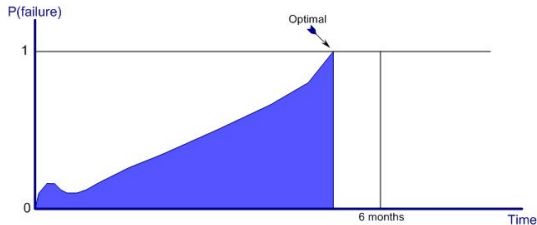
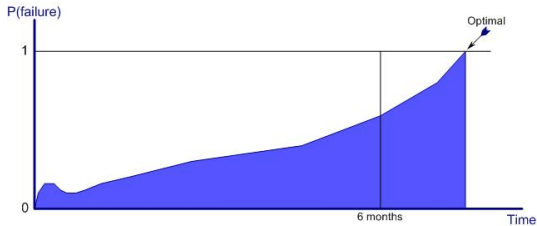
Francesco Cartella

6 September 2010

# Prognostics for Optimal Maintenance

- ▶ For (Flemish) industrial machine builders sector that need
  - ▶ Advanced condition monitoring techniques
  - ▶ Degradation modeling
  - ▶ Maintenance strategy

# Goal of Predictive Maintenance



# Modelling

- ▶ The goal is to assess with optimum accuracy the evolution of the components degradation
- ▶ We can apply powerful system modeling techniques to the maintenance problems
  - ▶ Dynamic Bayesian Networks
  - ▶ ...
- ▶ We need:
  - ▶ Capability of representing the dynamic aspects of the system
  - ▶ Capability of incorporating expert knowledge
  - ▶ Managing the complexity of the system

# Sources of uncertainty

- ▶ How can we face the uncertainty of the trained models parameters due to the limited sample size?
- ▶ Which are the effects of choosing a wrong model class?
- ▶ Wrong assumption of stationarity
- ▶ Wrong background knowledge

The model can have limited predictive capacities

→ Reliability analysis

# Reliability analysis

- ▶ Essential activity to ensure the quality of the model and to facilitate its acceptance by the industry
- ▶ The learning techniques should estimate the confidence level of any predictions the model makes

# Reliability analysis

- ▶ Each time a model is trained from a different sample the model will look a bit different
- ▶ We need a solution for carefully assess the sensitivity and robustness of the model parameters
- ▶ Several approaches and formulations seems to be suitable for use in the prognostic applications
  - ▶ Credal sets (seems a promising approach)
  - ▶ Confidence intervals
  - ▶ Bootstrapping

# Research directions

- ▶ Extend and test the techniques above mentioned for dynamic models (DBN)
- ▶ Extend matlab toolbox for reliability analysis
- ▶ Evaluate the approach with real data
- ▶ Compare with other techniques



# Questions/Suggestions?