

Multivariate degradation with dynamic covariates and imperfect maintenance

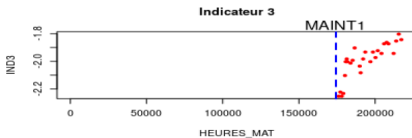
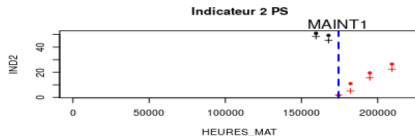
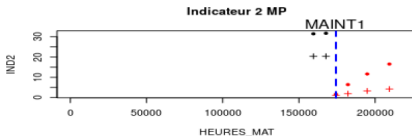
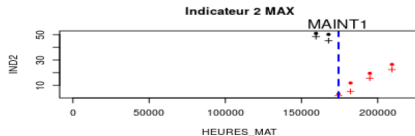
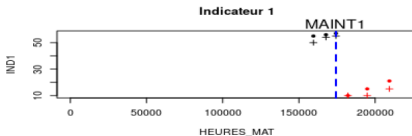
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- **Degradation** of the steam generators of nuclear power plants from EDF.
- The heat exchangers are affected by degradation (clogging), which may induce safety and performance issues.
- **Three dependent different degradation indicators** are measured in order to assess the clogging level.
- The degradation level depends on **heterogeneous** design and operation conditions (chemical conditioning).
- The degradation phenomenon can be prevented by different types of **maintenance** (chemical cleaning processes).
- **Aim of the study** : assess and predict the evolution of the degradation in order to develop an efficient **predictive maintenance strategy**.

Example of data



What we have done

- General framework for modelling multivariate degradation processes with dynamic covariates and imperfect maintenance.
- Degradation and dependency : multivariate Wiener processes.
- Piece-wise constant covariates
- Imperfect maintenance : Arithmetic Reduction of Degradation (ARD) and Arithmetic Reduction of Age (ARA) models.

Modelling multivariate degradation processes with time-variant covariates and imperfect maintenance effects

X. Wang, O. Gaudoin, L. Doyen, C. Bérenguer, M. Xie

To appear in *Applied Stochastic Models in Business and Industry*.

- Identify **useful simple models** from the general one.
- Study the **stochastic properties** of these models.
- Perform their **statistical analysis**, taking into account the time lag in the observations.
- **Predict** the evolution of the degradation, the remaining useful life and other quantities of interest.
- Build efficient **measurement plans** and an optimal **predictive maintenance strategy**.

Thank you for your attention