Multivariate degradation with dynamic covariates and imperfect maintenance

Olivier Gaudoin

Laboratoire Jean Kuntzmann - Grenoble INP - Université Grenoble Alpes with EDF R&D, GIPSA-lab and City University of Hong Kong

PGMO Days 2020
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

Indicateur 1

Indicateur 2 MAX

Indicateur 2 MP

Indicateur 2 PS

Indicateur 3

Multivariate degradation
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

Future prospects

- 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