Master thesis proposal - 2018-2019

Stochastic modelling and statistical analysis of multivariate degradation with dynamic covariates and imperfect maintenance.

Student profile : Master 2 student in Applied Probability, Statistics, Data Science. Programming skills in R.

Keywords : Stochastic Processes, Mathematical Statistics, Reliability, Data Analysis, Industrial Data Science.

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Working place : Laboratoire Jean Kuntzmann (LJK), FIGAL team, Univ. Grenoble Alpes, Grenoble, France.

Length : 5 to 6 months, starting in February/March 2019

Remuneration : Standard internship grant : 550 euros/month.

Context : This internship proposal is part of a research project between Univ. Grenoble Alpes and EDF R&D, funded by the PGMO Research Initiative in Industrial Data Science. The project deals with the degradation of the steam generators of nuclear power plants. Three different degradation indicators are measured, which depend on heterogeneous design and operation conditions. The degradation phenomenon can be prevented by different types of chemical cleaning processes. EDF has constituted a database including all the information collected.

Objectives and Contents of the Internship : The aim of the project is to develop relevant mathematical models of the degradation process, to use them to analyze the database, in order to assess and predict the evolution of the degradation, and at the end to develop an efficient predictive maintenance strategy.

The observed degradation process is a multivariate stochastic process. Wiener, Gamma or Inverse Gaussian processes are possible models for this situation. The heterogeneity induced by the environmental conditions can be taken into account with dynamic covariates. Relevant models have to be found for modelling the effect of the cleaning process. One can think to generalize to degradation indicators the virtual age imperfect maintenance models commonly used for lifetimes. When a potential relevant model is built, statistical methods have to be developed in order to estimate its parameters. The methods will be implemented in R.

References

1. Kahle W., Mercier S., Paroissin C., *Degradation processes in reliability*, ISTE and Wiley, 2016.
2. Peng, W., Li Y.F., Yang Y.J., Zhu S.P., Huang H.Z., Bivariate analysis of incomplete degradation observations based on inverse gaussian processes and copulas, *IEEE Transactions on Reliability*, 65(2), 624-639, 2016.
3. Wang X., Balakrishnan N., Guo B., Residual life estimation based on nonlinear-multivariate Wiener processes, *Journal of Statistical Computation and Simulation*, 85(9), 1742-1764, 2015.
4. Zhao X., Doyen L., Gaudoin O., Xie M., Optimal inspection and replacement policy based on experimental degradation data with covariates, *IISE Transactions*, to appear, 2019.