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Editorial to the special issue “Reliability”

Title: Éditorial du numéro spécial “fiabilité”

Olivier Gaudoin[1]

This special issue of the Journal de la Société Française de Statistique is dedicated to Reliability. Reliability studies failures of complex systems. It is a widely interdisciplinary field, but a significant part of it concerns the mathematics of randomness. In probability, the aim is to build stochastic models of failures, degradation, repair and maintenance processes of various systems. In statistics, the aim is to propose inference methods to capitalize on operation feedback data, in order to assess and predict the reliability of these systems.

The proposed random models and statistical methods depend heavily on the nature of systems studied and data collected. Systems can be repairable or not, subject to corrective or preventive maintenance. Data observed can be degradations or failures, covariates, competing risks,... Data may be censored or missing. Time scale can be discrete or continuous. This special issue illustrates the variety of contexts, models and methods used in reliability.

By nature, reliability is suitable to interactions between universities and companies. The majority of works presented in this issue have been done within a collaboration of this type and describe the associated industrial applications. Finally, almost all of the papers are related to PhD theses.

This issue includes eight papers. The first four are concerned with a particular application context, develop an appropriate stochastic model and use statistical methods to address specific industry issues. The next four deal with statistical and probabilistic reliability issues in a broader framework.

The paper by Aurélie Billon, Laurent Bordes, Pierre Darfeuil, Sophie Humbert and Christian Paroissin is interested in modeling the degradation of a component of a gas turbine engine, with two competing types of failure mechanisms, independent or not. A multi-state Markov model is used. The assessment of intrinsic reliability helps to optimize the preventive maintenance policy.

The paper by Camille Baysse, Didier Bihannic, Anne Gégout-Petit, Michel Prenat and Jérôme Saracco concerns the reliability of an optronic equipment. The state of this system is characterized by an indicator called cool down time. Its evolution is modelized using hidden Markov models. Filtering techniques are used to rapidly detect the degradation of the system and plan maintenance before failure.

The paper by Karim Claudio, Vincent Couallier and Yves Le Gat concerns the modeling of failures in drinking water systems, using a linear extension of the counting Yule process. This

[1] Université Grenoble Alpes - Laboratoire Jean Kuntzmann - BP 53 - 38041 Grenoble Cedex 9
E-mail : olivier.gaudoin@imag.fr

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model takes into account a dynamic covariate, which can reflect the temporal variations due to climate. An application to real data demonstrates the interest of the dynamic covariate, both to explain past failures and predict future failures.

The paper by Guillaume Damblin, Merlin Keller, Alberto Pasanisi, Pierre Barbillon and Eric Parent is interested in estimating a seismic fragility curve, which links seismic loading to the probability of failure of a structure. A Bayesian approach is adopted, which uses several cost functions. The estimation is done on data simulating the behavior of a scaled building model.

The paper by Jean-Yves Dauxois, Sarah Jomhoori and Fatemeh Yousefzadeh considers the occurrence of corrective and preventive maintenances of a system as a competing risks situation. A test is developed to choose between two models for this situation, the "Exponential Delay Time" and "Random Sign Censoring" models. The test is based on a non-parametric estimation of the cumulative incidence functions.

The paper by Amel Mezaouer, Kamal Boukhetala and Jean-François Dupuy focuses on statistical inference in the class of linear transformation models, which includes the proportional hazards and proportional odds models. Data are supposed to be missing, in the sense that failure times are observable only for a random subset of the original sample.

The paper by Meryam Krit aims to determine if a system lifetime can be modelized by a Weibull distribution. It develops two new families of goodness-of-fit tests for the Weibull distribution, based on the Laplace transform. A comparison with usual tests demonstrates the benefits of these new families.

The paper by Stylianos Georgiadis and Nikolaos Limnios studies the computation of the interval reliability for a discrete-time semi-Markov process. This function is the solution of a Markov renewal equation. The results are illustrated on the example of a system with two operating states and one failure state.

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