

## **Ph.D. Position in model-based maintenance**

### **Title: Modeling for Prescriptive Maintenance of Complex Systems: a Bayesian Networks Approach**

A Ph.D. position is open at the "Computer Science and Digital Society" Research Unit (LIST3N). LIST3N is one of the 5 research units of the University of Technology in Troyes. The research project is with the "Dependability, Reliability and Maintenance" research group. This group mainly aims at developing stochastic approaches for the modeling of maintenance decision-making and operational safety problems.

The project will focus on assessing an optimal maintenance policy for a complex system consisting of several components with dependency among them. The primary interest of this project is to find a way to merge continuous degradation and Dynamic Bayesian Networks (DBN) to benefit from a more simple and realistic modeling of the degradation along with the interaction between the system components.

Maintenance decision-making is of prime importance for improving the global performance of industrial systems and structures during their useful life. Many maintenance and replacement models use different methods starting from static analysis like Fault Tree analysis, using random variables for failure time modeling, or employing stochastic processes for depicting the degradation behavior of the system. Today, due to improvements in industrial methods and also to fulfill the missions that are designed for, the systems are more and more complicated.

Therefore, more complex mathematical and statistical methods are needed to model the behavior of such systems. Recently, Probabilistic graphical models have been proposed to model the complexity of industrial systems and are widely used in dependability, risk analysis, and maintenance applications. Bayesian Networks (BN) and their temporal version, i.e.; Dynamic Bayesian Networks (DBN) which is suitable to capture the time dependency structure of system condition, are members of this family.

The primary interest of this project is to find a way to merge continuous degradation and DBN to benefit from simpler and more realistic modeling of the degradation along with the interaction between the system components.

The key questions, which arise in this project, are:

1. How to develop models for a complex system when the continuous degradation of some components can be measured directly and we already have for these components models of gradual degradation and optimized maintenance strategies?
2. How to develop global maintenance strategies for a system of the previous type and how to integrate the proposed strategies into the available model to analyze their performance?
3. How to model the quality of the available monitoring information and how to evaluate its impact on the performance of a smart maintenance strategy, which is by nature less robust to monitoring faults than a systematic strategy that does not exploit the monitoring information.
4. How to evaluate the reliability or operational availability of a complex system with dependencies between its components?
5. How to deal with the problem of modeling imperfect repair and its effects on a complex system subject to a prescriptive maintenance policy?

The objective of the research topic is to address all these questions by focusing primarily on the first three points which constitute a prerequisite for the rest.

Principal supervisors: Dr. Elham Mosayebi, Prof. Antoine Grall

The duration of this position is three years and the successful applicant will receive the salary (gross salary per month) as follows: 2044€ in 2023, 2100€ in 2024, 2200€ in 2025, 2300€ in 2026.

### **Key Duties and Responsibilities**

- To conduct a specified program of research under the guidance and direction of the supervisors.
- To engage in appropriate training and professional development opportunities as required by the university to develop research skills and competencies.
- To engage in the dissemination of the results of the research (oral and written) in which you are engaged, as directed by, with the support of, and under the guidance of the supervisors.
- To contribute and produce high-quality peer-reviewed publications.
- To present research outcomes at project meetings and relevant conferences.
- To engage in the wider research and scholarly activities of the research group.

### **Criteria**

- Applicants should have a professionally relevant background in probability, statistics, Markov models, etc (Master's diploma or equivalent is required).
- Strong implementation and programming knowledge ( R, Python, ...).
- Familiarity with Bayesian Networks and dynamic Bayesian networks will be appreciated.
- Ability to work independently on a tight schedule.
- Good ability to work effectively as part of a team to achieve results.
- Fluency in English and excellent communication skills.

### **To Apply:**

Interested candidates should apply by email to Dr. Elham Mosayebi ([elham.mosayebi@utt.fr](mailto:elham.mosayebi@utt.fr)), **quoting “Ph.D. Position 2023” in the subject line.**

Applications must include, in PDF format only:

1. Full CV including two referees;
2. A transcript of results for all university levels and courses;
3. A one-page abstract describing the MSc project (if applicable);
4. Short cover letter describing your motivation for applying for the position and how your experience and expertise match the research topic.

Applications will be accepted until the 30th of April 2023.