SOUTENANCE DE THÈSE

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Soutiendra sa thèse de **Doctorat** sur le sujet :

Optimisation de la disponibilité d'un système multi-états en présence d'incertitudes

Dans l'Unité de Recherche **:**

HEUDIASYC UMR CNRS 7253

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à l'UTC, centre Pierre Guillaumat, amphi L103

devant le jury composé de :

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M. Mohamed Sallak, maître de conférences, université de technologie de Compiègne, laboratoire Heudiasyc
M. Fahed Abdallah, professeur, université libanaise, génie informatique

Invitée **:**
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Abstract

Dependability has become a necessity in the industrial world during the twentieth century. An activity domain proposes means to increase the attributes of the system in a reasonable time and with a less cost. In systems engineering, dependability is define as the property that enables system users to place a justified confidence in the service it delivers to them and it is a measure of a system's availability, reliability, and its maintainability, and maintenance support performance, and, in some cases, other characteristics such as durability, safety and security. The key concept that our work is based on is the **availability.** The availability *A(t)* is the ability of a system to be operational at a specific moment.

The cost of some systems with high availability is very expensive. The designer must compromise between the availability and the economic costs. Users can reject systems that are unsafe, unreliable or insecure. Therefore, any user (or industry) will ask this question before getting any product: "What is the optimal product in the market?" To answer to this question, we must combine the following two points:

- The best availability of the system: The user wants a product that lasts as long as possible.
- The best cost of the system: The user wants a product without costing him a lot.

Several methods exist to calculate the availability of a system. However, these methods employ different probabilistic techniques to evaluate this criterion, but they remain effective only for very specific cases, for example the cases of binary systems. In real life, the systems corresponds to multi-states systems (MSS), in this case the application of most of these methods is restricted. In such scenarios, systems and their components can operate at different performance levels between working and failure states. However, the evaluation of the availability of the MSSs is more difficult than in the binary case, because we have to take into account the different combinations of the component failure modes. Throughout this thesis, we search for a method that helps us to compute and to optimize the availability of MSSs. In addition to the MSS aspect, there is the structural aspect of the system, which illustrates the type of connection connecting the components. In this case, the system become much complex. In general, most methods of availability assessment can be applied efficiently only to systems with a simple structure.

In this thesis, we are interested in the state of the system after a long period of time, which means that we need to calculate the steady availability of the system. Therefore, we choose to use the Markovian models to represent the complex MSS and to calculate its availability. On the other hand, in dependability studies, the knowledge that we have about the components availability is generally imprecise. This requires some methods that allow modeling and manipulation of such imprecision. However, in our work we want to calculate the imprecise availability using Markov models and introduce intervals to model the uncertainties. The basic idea in this work is that accurate initial distributions and transition matrices are replaced by imprecise distributions, taking inaccurate rates in terms of intervals. The intervals contain the unknown initial probability and the unknown transition matrix. For our best of knowledge, there is only one work in the literature that aims to solve this problem.

First, we present an original methodology using the Markovian models and interval analysis, for the availability assessment of an MSS. The originality of this work lies on the study of the properties related to the availability of MSSs by applying the method of constraints propagation by interval that was not used before in this domain. In these propagation methods, the interval domains associated with the real variables are contracted, without removing any value that can be coherent with the set of constraints obtained from the imprecise Markovian chain. Then, we propose a method that aims to optimize the imprecise availability of an MSS taking into account the system's cost factor.
A part of the work is devoted to present numerical study for different cases that illustrates the effectiveness of the proposed approach.