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Title:
A tolerance interval based approach to address uncertainty for RAMS plus C optimization

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Abstract:
This paper proposes an approach based on tolerance intervals to address uncertainty for RAMS +C informed optimization of design and maintenance of safety-related systems using a combined Monte Carlo (MC) (simulation) and Genetic Algorithm (search) procedure. This approach is intended to keep control of the uncertainty effects on the decision criteria and reduce the computational effort in simulating RAMS+C using a MC procedure with simple random sampling. It exploits the advantages of order statistics to provide distribution free tolerance intervals for the RAMS+C estimation, which is based on the minimum number of runs necessary to guarantee a probability content or coverage with a confidence level. This approach has been implemented into a customization of the Multi-Objective Genetic Algorithm introduced by the authors in a previous work. For validation purposes, a simple application example regarding the testing and maintenance optimization of the High-Pressure Injection !
System of a nuclear power plant is also provided, which considers the effect of the epistemic uncertainty associated with the equipment reliability characteristics on the optimal testing and maintenance policy. This example proves that the new approach can provide a robust, fast and powerful tool for RAMS+C informed multi-objective optimization of testing and maintenance under uncertainty in objective and constraints. It is shown that the approach proposed performs very favourably in the face of noise in the output (i.e. uncertainty) and it is able to find the optimum over a complicated, high-dimensional non-linear space in a tiny fraction of the time required for enumeration of the decision space. In addition, a sensitivity study on the number of generations versus the number of trials (i.e. simulation runs) shows that overall computational resources must be assigned preferably to evolving a larger number of generations instead of being more precise in the quantification o!
f the RAMS +C attributes for a candidate solution, i.e. evolut!
ion is p
referred to accuracy.

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