A Proposed Basic Model for the Probabilistic Assessment of the Performance Quality of Computer-Based Systems

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Abstract - An assessor evaluating the extent to which a computer-based system meets performance requirements may have to consider and reconcile results from disparate sources of evidence, necessitating the application of engineering judgment. In addition, the assessor may not have all the evidence to make a definitive pronouncement of performance quality and therefore must factor in uncertainty into the assessment. We propose an adaptation of our basic “Good Enough” methodology, which offers a means by which the intuitive assessment of the acceptability and importance of disparate product and process evidence regarding the quality of characteristics of computer-based systems can be formalized and documented, to address this situation. An initial, basic version of the method’s mathematical model of the assessment process, customized for the evaluation of product evidence indicating the quality of a system’s performance, is presented in this short communication for review and comment by the performance community.

Keywords: Bayesian belief networks, probabilistic assessment, software performance

1. Introduction
A proposed basic model for the probabilistic assessment of the performance quality of a computer-based system is introduced in this short communication. This model is adapted from the base mathematical model of our generic “Good Enough” Methodology, a process by which engineering judgment as to the acceptability and importance of disparate process and product evidence regarding the quality of a given characteristic of a computer-based system is transformed into a system-level assessment as to the overall acceptability of the characteristic’s quality. Identifying relevant model components and structuring their relationships are the first steps in developing a “‘Good Enough’ Performance” (GEP) Methodology from the generic methodology.

Predecessor work introduced the “‘Good Enough’ to Release” (GETR) Methodology, which produces a system-level assessment as to the overall acceptability of a computer-based system for release to a user community [1]. The “Good Enough” Methodology is a generalization of GETR Methodology. All derived methodologies will have adaptations of the methodology’s three main components: a mathematical model of the assessment, model population methods, and result analyses.

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This communication begins with an overview of Bayesian belief networks, the formalism upon which the methodology’s model is based, as background. The proposed basic GEP model is then briefly described and possible extensions or refinements of categorical evidence nodes are explored. We then outline a proposed method for validating the GEP model.

2. An Overview of Bayesian Belief Networks
Bayesian belief networks (BBN), directed acyclic graphs with a set of nodes $N$, a set of edges $E$, and a probability distribution $P$ over $N$, are used to model our “Good Enough” evidence assessments because BBN have “long been recognized by many as the best means of modeling uncertainty.” [2, p. 2] Another reason for using BBN in modeling evidence assessments is that the BBN’s graphical component allows the representation of a complex set of events and relationships in an easily interpreted fashion.

We take advantage of the BBN’s ability to model uncertainty by allowing for its explicit quantification as one of a node’s state probabilities. An assessor develops the probabilities that evidence is Acceptable, Unacceptable, and/or Unknown as input; model output is the system-level probabilities that the overall quality of the indicated characteristic is Acceptable, Unacceptable, and Unknown. We believe there is value in stating outright the probability that the quality of evidence or system quality is unknown to allow for circumstances in which the development of evidence is incomplete. This robust design facilitates the use of the methodology at points early on in development and maintenance cycles when practitioners and researchers universally agree that system performance should be assessed.

3. The Proposed Basic “Good Enough” Performance Model
The proposed basic GEP model is presented in Figure 1. The Process Evidence branch of the GEP model is the same as the GETR model’s branch. The evidence represented in this branch come from “best practices” as reported in the literature and elicited from experts: maturity and definition of the development process (Process Quality); degree of belief in abilities of personnel involved in the development process (Developers’ Abilities); and quality of process artifacts (Artifact Quality) [1].

![Fig. 1: The Proposed Basic “Good Enough’ Performance” Model](image)

The evidence categories represented in the Product Evidence branch are selected based on results reported in [3 – 6]. These references are representative of the literature on software performance. The evidence category nodes can be expanded through the addition of child nodes to support input from sources of individual evidence; for example, the Non-Functional
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Requirements node could be expanded to have child nodes Performance, Dependability, and Robustness. Dependability could be further expanded by the addition of child nodes representing evidence on system reliability, availability, maintainability, and safety. Compatibility refers to the ability of the system’s proposed platform to support processing.

4. GEP Model Validation
We use several methods in [1] to provide an initial validation of the GETR model and methodology, including case studies and expert review. The case studies, in which we asked practitioners to replicate prior release decisions in GETR terms, were especially helpful in validating the GETR model; in all instances, GETR had successfully replicated the practitioners’ partially intuitive, partially reasoned decisions. We will use similar methods in validating the GEP model.

5. Conclusion
A proposed basic model for the probabilistic assessment of the quality of a computer-based system’s performance is presented in this short communication. The GEP model is part of a methodology to quantify and standardize the application of engineering judgment in the process of evaluating disparate pieces of process and product evidence. Model input is the qualitative and quantitative assessment of evidence quality; model output is the probabilities that the systems’ performance quality is Acceptable, Unacceptable, and Unknown. The other “Good Enough” methodology elements, importance analysis and model population methods, will be adapted and incorporated into the methodology as the GEP model matures.

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References