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Modelling Software Reliability Using Hybrid Bayesian Networks

In this research, we analyse the problem of predicting software reliability from AI perspective. We observe that existing models are built based on expert knowledge including defining a set of metrics through surveys and causal relationships. We overcome their limitations by introducing new data collection, model construction and inference methodology. We propose a Hybrid Bayesian network that would estimate reliability of consecutive releases of software projects before a release decision, in terms of their residual (post-release) defects. We form this hybrid model by incorporating quantitative factors of development and testing processes into qualitative factors of requirements specification and documentation process without the need for any transformation. As quantitative factors, we select popularly used product, in-process and people metrics as well as introduce new ones depending on the availability of local data in the organizations. We also identify qualitative factors representing requirements specification process via surveys with development teams.

Dependencies between software metrics and defects are determined according to correlation and independence tests and graphical dependence analysis with chi-plots. We utilize a Monte Carlo technique to approximate joint probability distribution of the model over conditionals by inferring unknown distribution parameters. Empirical analyses on two industrial datasets show that (i) Hybrid Bayesian networks are capable of estimating reliability in terms of residual defects, (ii) proposed way of defining causal relationships, chi-plots, decreases error rates significantly, (iii) expert judgement-based models may not achieve as good prediction performances as statistical models, (iv) local data are so valuable and representative as expert knowledge in software organizations that they should be used primarily and strengthened with expert knowledge in predicting software reliability.

PUBLICATIONS

Journals

- 1) **A. T. Mısırlı**, B. Turhan, A. Bener, "An Industrial Case Study of Classifier Ensembles for Locating Software Defects". *Software Quality Journal*, vol.19, issue 3, September 2011.
- 2) **A. T. Mısırlı**, A. Bener, R. Kale, "AI-Based Software Defect Predictors: Applications and Benefits in a Case Study", *AI Magazine*, vol.32, issue 2, 2011.
- 3) **A. Tosun**, A. Bener, B. Turhan, T. Menzies, "Practical Considerations in Deploying Statistical Methods for Defect Prediction: A Case Study within the Turkish Telecommunication Industry". *Information and Software Technology Journal*, vol.52, issue 11, 2010.
- 4) **A. Tosun**, B. Turhan, A. Bener, "Feature Weighting Heuristics for Analogy Based Effort Estimation Models", *Expert Systems with Applications*, vol. 36, issue 7, September 2009.

Conferences

- 1) **A. T. Misirli**, B. Murphy, T. Zimmermann, A. Bener, "An Explanatory Analysis on Eclipse Beta-Release Bugs Through In-Process Metrics", in *Proceedings of 8th*

- International Workshop on Software Quality (WoSQ), collocated with 8th joint meeting of the European Software Engineering Conference and the ACM SIGSOFT Symposium on the Foundations of Software Engineering (ESEC/FSE), 2011.
- 2) **A. T. Misirli**, B. Caglayan, A. Miranskyy, A. Bener and N. Ruffolo, “Different Strokes for Different Folks: A Case Study on Software Metrics for Different Defect Categories”, in Proceedings of the 2nd International Workshop on Emerging Trends in Software Metrics (WETSOM), collocated with International Conference on Software Engineering (ICSE), 2011.
 - 3) B. Turhan, **A. Tosun**, A. Bener, “Empirical Evaluation of Mixed-Project Defect Prediction Models”, in Proceedings of the 37th International Euromicro Conference on Software Engineering and Advanced Applications (EUROMICRO), Best Paper Nomination, 2011.
 - 4) E. Kocaguneli, B. Caglayan, **A. Tosun**, A. Bener, “Experiences on Developer Participation and Effort Estimation” in Proceedings of the 37th International Euromicro Conference on Software Engineering and Advanced Applications (EUROMICRO), 2011.
 - 5) **A. Tosun**, A. Bener, R. Kale, “AI-Based Software Defect Predictors: Applications and Benefits in a Case Study”, in Proceedings of the 22nd International Conference on Innovative Applications on Artificial Intelligence, (IAAI), Deployed Application Award, 2010.
 - 6) B. Caglayan, **A. Tosun**, A. Miranskyy, A. Bener and N. Ruffolo, “Usage of Multiple Prediction Models Based On Defect Categories”, in Proceedings of the 6th International Conference on Predictor Models (PROMISE), 2010.
 - 7) E. Kocaguneli, **A. Tosun**, A. Bener, “AI-Based Models for Software Effort Estimation”, in Proceedings of the 36th International Euromicro Conference on Software Engineering and Advanced Applications (EUROMICRO), 2010.
 - 8) **A. Tosun**, A. Bener, “Reducing False Alarms in Software Defect Prediction by Decision Threshold Optimization”, in Proceedings of the 3rd International Symposium on Empirical Software Engineering and Measurement (ESEM), 2009.
 - 9) **A. Tosun**, A. Bener, B. Turhan, “Implementation of a Software Quality Improvement Project in an SME: A Before and After Comparison”, in Proceedings of the 35th International Euromicro Conference on Software Engineering and Advanced Applications (EUROMICRO) , 2009.
 - 10) A. Tosun, A. Bener, E. Kocaguneli, “BITS: Issue Tracking and Project Management Tool in Healthcare Software Development”, in Proceedings of the 21th International Conference on Software Engineering and Knowledge Engineering (SEKE) , 2009.
 - 11) E. Kocaguneli, **A. Tosun**, A. Bener, B. Caglayan, B. Turhan, “Prest: An Intelligent Software Metrics Extraction, Analysis and Defect Prediction Tool”, in Proceedings of the 21th International Conference on Software Engineering and Knowledge Engineering (SEKE), 2009.
 - 12) **A. Tosun**, B. Turhan, A. Bener, “Validation of Network Measures as Indicators of Defective Modules in Software Systems”, in Proceedings of the 1st International Conference on Predictor Models in Software Engineering (PROMISE), 2009.
 - 13) **A. Tosun**, B. Turhan, A. Bener, “Practical Considerations in Deploying AI for Defect Prediction: A Case Study within the Turkish Telecommunication Industry”, in Proceedings of the 1st International Conference on Predictor Models in Software Engineering (PROMISE), Best Paper Award, 2009.

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