Empirical Research Methods for Software Engineering

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ABSTRACT

This full day tutorial introduces the use of empirical methods appropriate to research in automated software engineering. Using a blend of lecture and discussion, it aims to provide ASE researchers and practitioners with a foundation for conducting and critiquing empirical studies. The tutorial covers of the principal methods applicable to ASE: controlled experiments, quasi-experiments, case studies, survey research, ethnographies, and action research and relates these methods to relevant metatheories in the philosophy and sociology of science. The tutorial presents techniques applicable to each of the steps of a research project, including formulating research questions, theory building, data analysis (using both qualitative and quantitative methods), building evidence, assessing validity, and publishing. The tutorial is relevant for researchers, who will be able to conduct and write more credible empirical studies; for reviewers who will be able to provide qualified judgments of papers; and for practitioners, who will be able to more effectively interpret published results within the context of their own organizations.

Categories and Subject Descriptors

D.2.0 [**Software Engineering**]: General—*research methodology*

General Terms

Experimentation, Human Factors, Theory

1. OVERVIEW

Despite the widespread interest in empirical research in software engineering over the past decade or so, software engineering still lacks a coherent methodological foundation. There is little guidance available on which research methods are suitable, and how to choose between them. Many researchers select inappropriate methods due to a lack of understanding of the goals underlying the method employed, or due to a lack of knowledge about alternative methods. The problem is especially acute for research questions in ASE involving the interaction of automated tools with the social and cognitive activities of large software development teams.

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The aim of this tutorial is to cover the key questions to consider in selecting empirical methods, from the philosophical issues about the nature of scientific knowledge, to the practical considerations for applying empirical methods. Our goal is to show how methods can be selected and combined to produce a valid research strategy in response to a well-defined research question. The intended audience for this tutorial includes both the producers and consumers of empirical studies. An overview of the key ideas presented in this tutorial is available in [1].

2. ABOUT THE PRESENTER

Steve Easterbrook is a Professor of Computer Science at University of Toronto. He received his PhD in 1991 from Imperial College, London. He joined the faculty in the School of Cognitive Science at the University of Sussex, where he pioneered new degree programs in human-centered software design. From 1995 to 1999, he led the research team at NASA's Independent Verification and Validation (IV&V) Facility in West Virginia, where he investigated techniques for software verification for the Space Shuttle Flight Software, the International Space Station, the Earth Observation System, as well as several planetary probes. In 1999 he joined the faculty at U of T, where he continues his research and teaching in software verification, requirements and systems analysis and software engineering. He has published over 60 peer- reviewed papers in software engineering. He served as general chair for the Requirements Engineering Conference, RE'01, and program chair for ASE 2006 and has served on the program committee for many conferences and workshops in Requirements Engineering and Software Engineering. For the past two years, he has taught a graduate level course on Empirical Research Methods in Software Engineering [2] at the University of Toronto.

3. REFERENCES

[1] Easterbrook, S. M., Singer, J., Storey, M-A., and Damian, D., Selecting Empirical Methods for Software Engineering Research. In F. Shull, J. Singer and D. Sjøberg(eds) *Guide to Advanced Empirical Software Engineering*, Springer, 2007.

[2] http://www.cs.toronto.edu/~sme/CSC2130/