Methods in my Research

Rasmus Ros

June 20, 2016

My research field, software engineering, is multi-disciplinary with traditions of both quantitative and qualitative research. Therefore there are usually many valid approaches to a research problem which I will give examples of here. Engineering research is often concerned with raw numbers but that is sometimes not enough to find satisfying explanations of results. Using a mix of methods improves the quality of research by illuminating the problem from multiple angles. My PhD studies have just started so I will focus on the methods that I plan to use in my research. The topic of my studies is closely tied to the experimental methodology, so lets start by jumping into that.

Software is increasingly developed by continuously delivering value, where release cycles are kept short in order to facilitate rapid feedback. Large amounts of system and user data is generated by software as part of regular operations. Taken together this facilitates an experiment-driven approach to software development where new versions or variants of the system can be evaluated by conducting controlled experiments. Even small variations of a product can be tested by experimentation instead of taking decisions based on opinion. This data-driven continuous experimentation is already popular in leading industry giants and has recently emerged as a new academic research field. There are many interesting research problems within continuous experimentation which are best studied in different ways.

One such problem is to study how continuous experimentation is used in companies that are currently practicing it. Conducting such a case study can be useful for gathering evidence on the benefits and challenges of continuous experimentation. A typical case study approach would be interviews with developers in a company. A qualitative synthesis is performed by finding patterns in the data which is then summarized. Finding a suitable company is a challenge, every company is not a leading industry giant.

Another approach is helping an innovative company getting started with continuous experimentation. This method is called action research and the purpose of using it is to solve a problem and produce guidelines for best practice. The difference between a case study and action research is that case studies is a passive observation and action research involves the researcher in the team, either as a participant or advisor. Concrete examples of ways of helping is showing how to conduct telemetry on software in embedded systems or how to interpret results by qualitative methods. Both case studies and action research are primarily qualitative methods, but the research

quality can be improved by doing a "triangulation" with quantitative methods such as data analysis on datasets from the software engineering process, the software itself, or users of the software.

Experimentation is another quantitative method that is used within software engineering. The subject group should ideally be as realistic as possible but is usually students in a laboratory setting because industrial developers are elusive creatures. Recruiting students is feasible, but the real issue is finding a suitable project with thousands of real world users that would allow students to experiment on the system. I do however plan to conduct experiments in my research, but the subject group is software instead of developers, as I will describe further on, but first I need to explain the context.

Automating parts of the continuous experimentation process is crucial. There are multiple software tools for conducting experiments on software; evaluating them by surveying their users can be interesting by itself. The tools help developers in the basics of controlled experimentation, splitting the user base into control and test and showing statistics and charts. Big companies such as google and facebook have internal tools that helps them with performing large number of parallel experiments, by preventing incompatible experiments. A simple example of that would be one developer testing the color of a button and another testing background colors at the same time, permutations where the button and background is the same color is not valid. To solve this all experiments must be subject to constraints and conditions which are checked before the experiment can be run. Research methods on such systems can be formal analysis on the system of constraints to prove properties of the system or case studies to see how it is used in practice.

Taking automation a step further is intriguing. Imagine a system where all permutations of the software is declared beforehand and the system will automatically find the version that performs best in terms of the dependent variable in the experiment. New variations can be added continuously and ill-performing variations removed when the system allows. Large amounts of data increases efficiency, but any data available will steer the system in the right direction. The main advantage is that the system can optimize for all permutations of the system against the dependent variable in the experiment directly, instead of the backwards solution of conducting an experiment and waiting for statistical significance and then performing the change. This is where we tie into experimentation, since this fully automated continuously experimenting system can be compared to a version where developers decide on which experiments to run. This comparison would itself be done as a controlled experiment, which concludes the planned methods of my research.

Choosing a suitable method depends on the context surrounding the subject of study and the chosen subject of study is often based on opportunity. Ethical considerations are important when experimenting with human subjects and should be addressed in research, the topic is however too complex to be covered here. I have described case studies, action research, data analysis and experimentation as reasonable research methods that I plan to use. By these examples I hope to have convinced you that both quantitative and qualitative methods are necessary when studying complex phenomena.