Reflections on Research Methdology

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I am still a fairly new Ph.D. student, and after participating in the first part of this course I am now more aware of the diversity of research fields and their traditions and methodologies. I now also realise that my own methodology so far has not been well thought out, or even considered at all in fact. I never actively chose a methodology to follow, but rather passively followed my intuition and let a method arise organically.

During the course meeting we discussed different research traditions and their goals, object of study, methodologies and contributions. I think my research fit in well with our thoughts on engineering traditions. I do research on the Internet of Things (IoT), working on a middleware software developed in Java which is being used for health care application. My object of study is thus this middleware software, in which I implement new features and concepts with the goal to ultimately solve problems for end-users and help further development. Ideas for further development and research may come from observations made during real world usage of this system, e.g. a missing feature requested by end-users, a faulty behavior occurring in a situation that nobody anticipated or new ways of using and integrating the system. The idea is then developed further through discussions among colleagues, reading related literature and eventually draft designs and implementation of prototypes. As a prototype matures it can be better tested and evaluated and eventually incorporated with the middleware system, where it can be tested and evaluated on system level.

I think that this way of working, or variants of it, is typical for engineering fields, and permeates not only research but also industry and education. That is probably why, although my methodology arose intuitively without much thought put into it, it naturally adhered to the traditional methodology in engineering. And, upon reflecting on it now, I feel that it is, in fact, rather well motivated for my research. I work on ideas and problems that have been identified in the real world, and come up with and implement solutions, which are then tested and evaluated. One concern, though, which was also brought up during the course meeting, is that I evaluate my own work and is thus biased towards it. I think this merits putting much weight on related work, both when writing papers and doing research, in order to better put the work into context and judge it fairly in comparison to other similar works. Another important aspect of the evaluation, as pointed out by A. Georges et al. in one of the selected papers for this course, is to use a statistically rigorous method for performance evaluations[1]. After

reading their paper I realized my own method of evaluation was perhaps not the best, as I had used one of the common methods which they pointed out to not be statistically rigorous. I have learned from this and hope to do better in future papers.

Other methodologies that I think I might find useful in the future are field studies or field experiments, literature studies or surveys and mathematical proofs.

In a sense our research group already does field experiments, in the form of a development workspace for our system that is a copy of the live version. In this setting, we try out new features and versions before taking it into use for real. I can also imagine using field studies to observe and analyze how our system works in new application areas, other than health care. Many IoT systems focus on e.g. industry or home use, which could be a branch for us to explore.

I do not think that literature studies or surveys in and by themselves are research methodologies, in that they do not bring any new information or findings, but rather gather and summarize previous works. Nevertheless, they may provide insight in a research field and identify aspects or viewpoints that have yet to be explored, and thus guide further research. To a small extent, a literature study is of course what one generally does anyway when writing a paper, in order to properly being able to write about related work and put ones paper into context.

Although I have not used them yet, I think I may eventually have great use of mathematical proofs. I have already on multiple occasions implemented functionality that depends on e.g. state machines or algorithms, and I typically verify that they work as intended through testing, empirical analysis. However, for central and significant algorithms and data structures, on which others depend, being able to theoretically prove that their logic is sound and will always function may be of great importance. In particular, I think I might make use of this for my next paper.

Finally, another methodology that I really took a liking to was presented by S P Jones in his slide show *How to write a great research paper*, where he advocates starting to write your paper first, and then do your research[2]. Working this way would enable me to think through my ideas properly, and work out many of the problems I will face, before implementing them. Having to write parts of the paper first also means that I must consider my methodology and approach beforehand, rather than working out afterwards what I have actually done, and could prevent having to redo a lot of work.

References

[1] Andy Georges, Dries Buytaert, and Lieven Eeckhout. Statistically rigorous java performance evaluation. *SIGPLAN Not.*, 42(10):57–76, October 2007.

[2] Simon Peyton Jones. How to write a great research paper. Unpublished paper.