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Editorial

Systematic literature reviews in software engineering

Information and Software Technology has taken the lead in promoting and publishing systematic literature studies, including both systematic reviews and maps, in software engineering. Kitchenham et al. [1] introduced the concept of Evidence-based Software Engineering in 2004, and a key concern is the use of systematic literature studies. In the first issue of the journal in 2005, *Information and Software Technology* introduced a new article type, i.e. systematic reviews, and Prof. Kitchenham accepted to be an editor for systematic reviews for the journal. It is now eight years later and Prof. Kitchenham has decided to retire as an editor for systematic reviews. On behalf of the journal, we would like to take the opportunity to express our gratitude to Prof. Kitchenham for her contribution to the area of systematic reviews in terms of guidelines for systematic reviews [2], her research contributions to the field and her devotion to ensure publication of high quality systematic literature studies in *Information and Software Technology*.

The guidelines [2] have been indispensable in supporting researchers in conducting systematic literature studies. However, they have also generated a lot of discussions. The systematic part is often in the search after which a lot of judgment is needed. Thus, the procedure becomes quite subjective, and hence it is unrealistic to assume that different researchers would come up with the same set of papers at the end. For example, Kitchenham et al. [3] conducted a systematic literature review using manual search and found 20 relevant papers. In the discussion about limitations, the authors mentioned the fact that they used manual search and may have missed some relevant studies. For this reason, Kitchenham et al. [4] repeated the study using automated database search and found 33 additional studies. This example illustrates that we end up being forced into accepting samples of relevant paper; the challenge is to get the best possible sample from the population. Thus, the search strategy is key to ensure a good starting point for the identification of studies and ultimately for the actual outcome of the study.

The guidelines take database searches using search strings from the area of study as a starting point, but the guidelines also state clearly that other complementary searches are needed. The latter include for example: reference lists, grey literature, specific research outlets (journals or conferences) and researchers in the field. Unfortunately, all too often studies stop short of these additional sources. This is to some extent understandable given the amount of work it is to conduct a full-fledged search in a range of databases and then identify the relevant papers of sufficiently high quality. The searches in databases are challenging for several reasons, including selection of databases to use, different interfaces for the databases, different ways of constructing search strings, different search limitations in the databases and identification of synonyms of terms used. This reasoning leads to two conclusions: (1) the choice of the first step in the search strategy often becomes the only step, i.e. search databases (if using the guidelines [2]), and (2) given the challenges with the database searches, we may miss important literature.

The use of search strings and databases is inspired by the way systematic literature studies are conducted in medicine. However, other recommendations for searching relevant literature exist, such as reference-based search strategies [5]. In information systems, Webster and Watson recommend a snowballing approach [6] for doing the actual search. In summary, they recommend the following three-step process when searching for relevant literature:

1. The major contributions are likely to come from journal articles, and hence it is recommended to start with the leading journals in the field.
2. Go backward using the reference lists.
3. Go forward by looking at citations of the articles identified in steps 1 and 2 using the ISI Web of Science.

Based on the above, the two authors of this editorial started a discussion on how to improve our understanding of systematic literature studies. We agreed to propose a snowballing approach as a first step to systematic literature studies and on three challenges for research in relation to it.

Snowballing search strategy

1. Identify a starting set of papers, for example from some leading journals or from a quick search using some of the key terms in Google Scholar or Scopus.
2. Ask someone else to create an independent validation set of papers. This is a set of papers that you are expected to find. The persons identifying the validation set should keep the set confidential until the search is finalized.
3. Based on the starting set, snowball using the reference lists (backward snowballing) – look extra thoroughly on papers by authors already included, since they obviously conduct relevant research in relation to your objectives. The backward snowballing is also used for all papers found in forthcoming steps too.
4. Based on the set of papers found, snowball by looking at papers citing the papers found (forward snowballing). We would recommend using Google Scholar, since it captures more than individual databases.
5. Once no new papers are found iterating over steps 3 and 4, contact the authors of papers identified to ask them about: (1) papers in the area, (2) researchers conducting research in the area, and (3) additional papers from themselves. If additional papers are identified then go back to Step 3.

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After having a list of potentially interesting papers, it should be investigated whether the validation set of papers is a subset of the papers found. Based on the outcome, it must be decided how to continue. Independently, the snowballing search strategy is preferably complemented with searching some of the key databases in the field. However, the outcome of the comparison with the validation set affects the need to conduct complementary searches. If after conducting some complementary searches, none or very few additional papers are found then the search can be concluded, otherwise additional databases ought to be searched too.

This leads us to formulating three challenges where we would like to encourage research to further improve our understanding of systematic literature studies to help make them even more useful for both researchers and practitioners alike.

Challenges

1. Conduct studies using a snowballing search strategy as a starting point as outlined above.
2. Compare studies using snowballing and database searching respectively as the first step as for example done by Jalali and Wohlin [7].
3. Actually conduct studies according to the guidelines by Kitchenham and Charters [2], i.e. do not stop after the database search. The complementary searches are needed too. Keep track of which papers are found in which steps in the search strategy.

We look forward to seeing papers on the above and submissions are very welcome to *Information and Software Technology*. Even if Prof. Kitchenham retires as a special editor for systematic reviews, the journal intends to continue to promote and publish systematic literature studies, since we believe they are very important to continue to mature the field.

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On behalf of Information and Software Technology

Prof. Claes Wohlin
Editor-in-Chief,
Information and Software Technology,
Blekinge Institute of Technology, Sweden
E-mail address: claes.wohlin@bth.se

Prof. Rafael Prikladnicki
Guest contributor,
Information and Software Technology,
Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Brazil

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