

The Importance of Systematic Review as a Scientific Research Method for Computer Science: A Quantitative Systematic Review

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Abstract. The importance of Systematic Review to Computer Science research as a scientific method has to be assessed, because interdisciplinary and Internet scientific research are demanding it. Hence, this work is a quantitative systematic review of Systematic Reviews in the domain of Computer Science. Scientific Journal papers have been extracted from a number of representative databases between the years 2006 and 2012. From an initial amount of 3,097 papers, only 138 were selected resulting in a survival rate of 4.46%.

Keywords: Computer Science Research, Computer Science Teaching, Research Education, Scientific Methodology, Systematic Review.

1. Introduction

Science is becoming more interdisciplinary [1] and Computer Science is no exception. Moreover, when it comes to researches that are related to the Internet, technological issues have lost their supremacy to the Human factor. Hence, the importance of Systematic Review to Computer Science research as a scientific method has to be assessed.

Systematic Review is a method to identify the studies related to a common subject that aims to obtain unbiased knowledge in a comprehensive, systematic and replicable review of the scientific literature. The use of this method in health care studies had become popular in the middle of the 90's, but its application was already significant and consolidated in the 80's [2]. Hence, the method of Systematic Review came to be easily coupled to medicine in order to validate results and to assess the strength and quality of scientific evidence, especially with regard to clinical recommendations. However, the benefits of a Systematic Review do not apply only to health related sciences. Research in Social Sciences has been using it too [3], [4]. In fact, its use is well known in research related to humans where the outcome statements are too expensive or sometimes even impossible.

The human factor in research alone justifies the need of Systematic Reviews. Two major issues that support this statement are the bias due to conflict of interest, and the assessment of strength and quality of scientific evidence [2]. Notwithstanding that, the interdisciplinary approach in research is also a good enough motive for requiring Systematic Reviews. It is reasonable to consider that an interdisciplinary approach implies in the investigation of two or more fields, instead of only one, and that may imply in twice as much information to investigate than a traditional single field research.

Additionally, this increase in amount of data and scientific papers demands a systematic approach to elaborate the scientific literature review, in other words, a Systematic Review. Again, this would prevent unwanted bias in the scientific literature review and it could provide as in the case of Evidence-Based Medicine [2] the assessment of strength and quality of scientific evidence.

Hence, this work is a quantitative systematic review of Systematic Reviews in the domain of Computer Science. That is, it inquires the relevance of Systematic Reviews to Computer Science research as a scientific method. For the organization of this paper, we chose IMRAD structure [4]: introduction, methodology, results and discussion. This structure is part of the uniform requirements for manuscripts submitted to biomedicine journals from the International Committee of Medical Journal Editors. The adoption of this

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framework should facilitate the information storage and retrieval in international databases by search engines for research purposes like systematic reviews and meta-analysis.

2. Methods

A Systematic Review is a method to cluster a set of primary studies which are similar in theme and area of analysis, and subsequently goes through a selection process in order to point out the studies which fit the specified selection criteria. This work reproduces the method of systematic review to identify studies which also use the systematic review in the field of Computer Science. Otherwise stated, this is a quantitative synthesis of other reviews of the literature regarding the Information Technology area. Besides, the steps of a systematic review may be divided in:

- To determine the rules for the review implementation;
- To establish the criteria for inclusion and exclusion;
- To investigate relevant studies;
- To assess the quality, the information extraction, and the synthesis.

The Systematic Review performed in this paper was based on the study of two other Systematic Reviews in Computer Science, Breivold *et al.* in [6], and Ampatzoglou and Stamelos in [7], which are based on [8].

2.1. Review Rules

Unlike traditional reviews, where there exists absence of rules for information research and analysis, Systematic Reviews are closely based on criteria for selection of primary studies and systematic methods. The goal is to achieve a reliable result through a maximum range of studies which could contribute to the analysis and synthesis of information. It begins over the establishment of standards for the execution of the process. In this work, a search term is determined for the collection of papers, it is selected the criteria for paper inclusion and exclusion of the review, and it is also established how to extract and synthesize the information.

2.2. Inclusion and Exclusion Criteria

The criteria for inclusion and exclusion are the keys to the identification of primary studies that meet or not the requirements for analysis. The criteria are the paper must have been written in English and it must be a Systematic Review of studies related directly to the field of Computer Science. In addition to that, these studies must have been published in scientific journals between the years 2006 and 2012.

2.3. Investigation of Relevant Studies

In order to identify studies of interest, the search has been done in scientific databases: ACM, IEEE, Compendex, Elsevier, ISI Web of Science and Springer. The search term was "Systematic Review" and "Computer Science".

The process of identification and investigation of relevant researches has been divided in two phases. The first one began by examining databases through the search terms cited above. Afterwards, these studies have undergone a selective phase by reading, where the studies which did not match the inclusion criteria or fit in any of the exclusion criteria were removed.

2.4. Information Evaluation

The evaluation of information was succinctly made by verifying the authenticity and importance of the content from the relevant selected studies. By means of scanning the readings the papers were classified and an overview of the areas studied was obtained.

3. Results

This Systematic Review presents the statistics of publications of systematic reviews in Computer Science between 2006 and 2012. Moreover, it presents the areas of Computer Science that have been publishing consistently Systematic Reviews, thus giving an idea of the importance and impact of this methodology.

All the way through the synthesis phase of data 3,097 articles were examined, out of which 138 were selected. The selection analysis of the studies was made in an orderly manner, quantified and documented, as shown in Table 1.

Table 1. Outcomes from research grounded on scientific databases.

Database	Total results	Papers published in Journals	Papers in English	Included papers
ACM	536	536	536	50
Compendex	131	41	40	20
Elsevier	584	584	584	38
IEEE	740	166	166	10
ISI Web of Science	12	4	4	2
SpringerLink	1094	333	325	18
TOTAL	3097	544	369	138

In Figure 1 below, it has a comparison of the total publications obtained before the results go through the process of refinement.

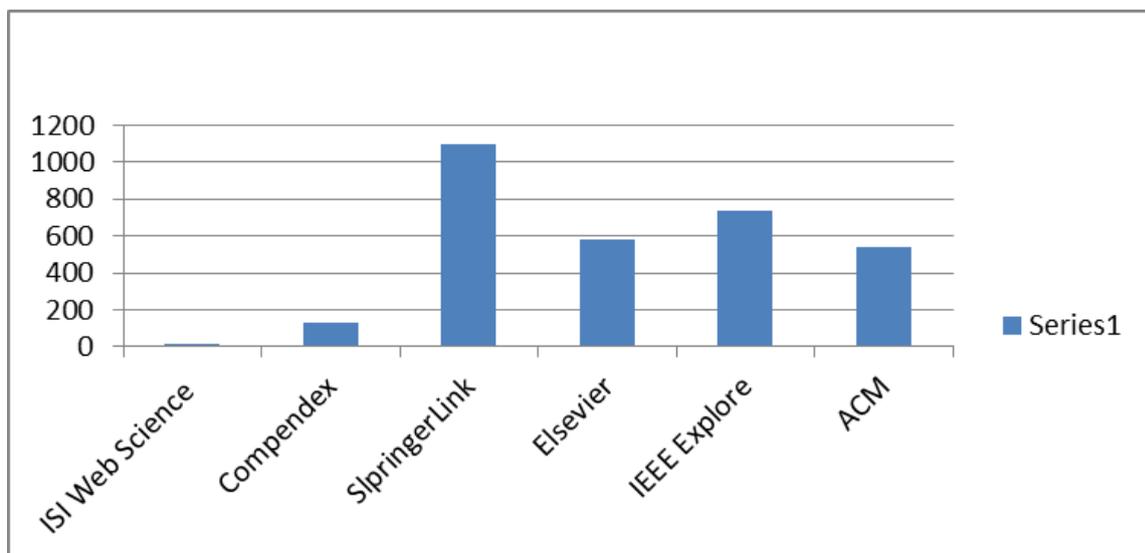


Fig. 1: Initial search.

An illustration of the publications evolution of systematic reviews from 2006 to 2012 is presented in Figure 2.

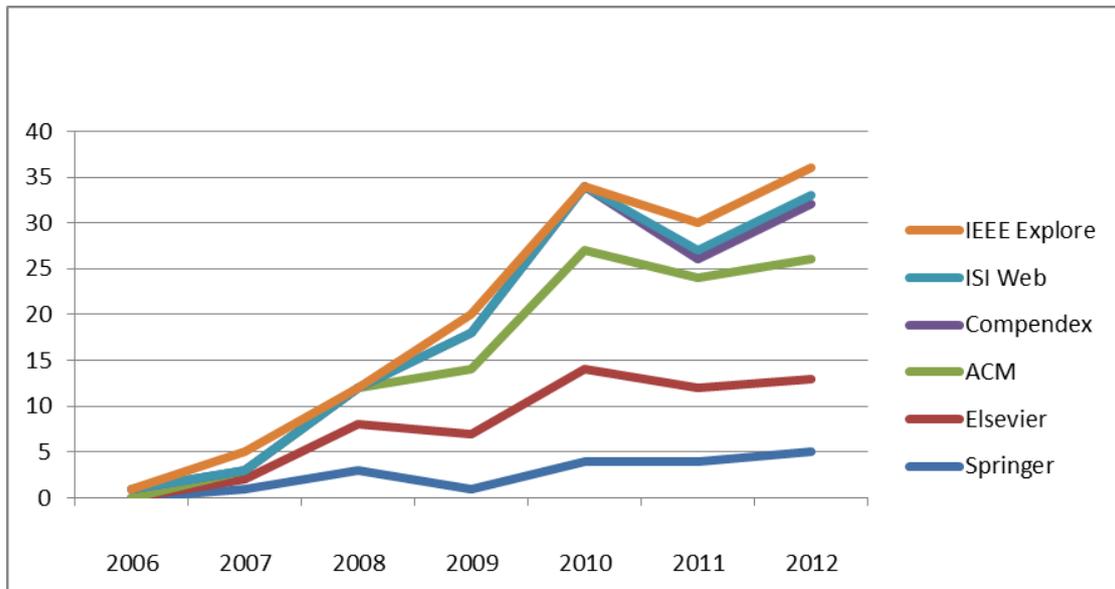


Fig. 2: Publications of systematic reviews in Computer Science from 2006 to 2012.

In Figure 3, it is shown a direct comparison of the number of selected publications from scientific databases fractioned for years.

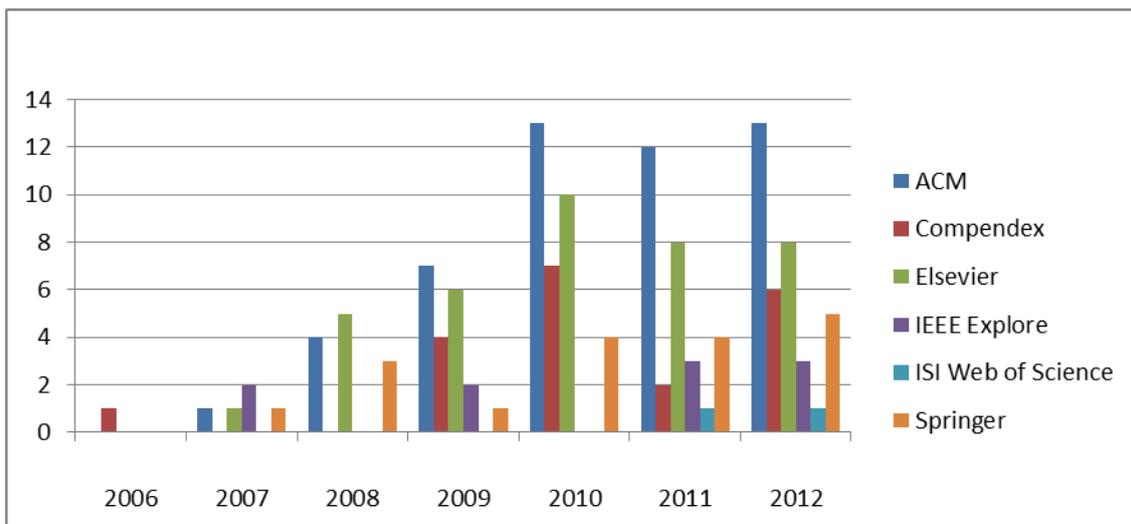


Fig. 3: Comparison among databases.

4. Discussion

The result has shown the growing number of published Systematic Reviews in Computer Science in recent years, Fig. 3. The period from 2006 to 2012 is enough to provide a clear perception and the sensitive growth of publications in recent years.

For the analyzed period of time of this research, half of the survived studies were published in the last third of the amount of time. In other words, the amount of Systematic Reviews published in the last two years is approximately the same as the amount published in the previously four years. Therefore, the publication of Systematic Reviews has doubled in the past two years compared to four previous years. Hence, the importance of teaching Systematic Review for the education of Computer Scientists is established.

Another issue to highlight is that the research started with 3,097 papers and selected 138, a survival rate of 4.46%. That means that the Systematic Review process is laborious and it requires much attention. It has

to be considered that this work is Systematic Review of Systematic Reviews. Consequently, it may be regarded as a baseline for Systematic Reviews in Computer Science.

Finally, it is important to report that in the Department of Computer Science of the “Federal University of Tocantins” (UFT – Universidade Federal do Tocantins), Systematic Review has been taught in the discipline of Scientific Methodology for the last two years resulting in the publication of papers in national conferences [9] and this paper itself, i.e., teaching Systematic Reviews for undergraduate students of Computer Science has been effective, which suggests further studies of efficiency in the learning process.

5. References

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