What paper types are accepted at the International Conference on Software Engineering?

Antonia Bertolino, Antonello Calabrò, Francesca Lonetti, Eda Marchetti, Breno Miranda
ISTI - CNR
Via G. Moruzzi 1, 56124, Pisa, Italy
name.surname@isti.cnr.it

***Abstract*—With the aim of identifying good structures and examples for papers in the software engineering field, we conducted a study of the type of papers accepted along four decades in the Research Track of the International Conference on Software Engineering (ICSE). We used for this purpose a categorization scheme for Software Engineering papers that was obtained by merging, extending and revising a few existing paper scheme proposals. This paper summarizes some outcomes relative to what topics and problems are addressed, what types of contribution are presented and how they are validated. Insights from the study could help ICSE authors, reviewers and conference organizers in focusing and improving future efforts.**

***Keywords*-Software Engineering conference; paper categorization; paper type; research contribution; research problem.**

I. Introduction

Among the skills a researcher's job requires is that of results dissemination to the community, typically by paper publication. However, writing good scientific papers is a difficult and effort-prone activity.

Within many research fields, expert guidance is provided on how to structure a paper content and how to articulate its parts. In 2003 Shaw [1] noted that researchers in software engineering (SE), however, had not yet developed well-understood guidelines for paper writing. Shaw's paper is widely referenced and other authors have analogously conducted literature analyses to identify SE research strategies and paper types [2]–[4].

In a recent work [5], we revised Shaw's categorization and proposed a new comprehensive "paper model" that can represent the article genres published in the SE field. We use here this model to categorize the papers accepted at the Internation Conference on Software Engineering (ICSE), with an emphasis on those appeared in the last five years.

As a matter of fact, top publication venues in the field have today become very exigent in terms of what is required in a good research paper. Hence paper writing guidelines are even more needed. This work however is not meant as a top-down recipe of how to write a successful ICSE paper (we would not dare writing such a paper!). It classifies and reports in *descriptive* way what papers have been successful so far.

II. Paper Categorization

To the best of our knowledge, there exist no other follow-up work after Shaw's study [1] that investigates paper types focusing particularly on ICSE corpus. Our categorization scheme is the result of merging, extending and revising the types of papers identified in relevant previous studies of SE literature, specifically [1]–[3] and in the call for papers of ICSE itself for some recent editions. In particular, we started from the three dimensions proposed in Shaw [1], and we added "topic" as a fourth one (as in [2]), deriving a four-dimensions categorization scheme as in the following:

- *problem*: what issue the paper would like to solve or the question the paper would like to answer. This includes the "Type of software engineering questions" of [1]. We identified five groups: *Development method*, *Analysis method*, *Specific instance*, *Generalization or characterization*, *Feasibility study or exploration*.
- *contribution*: what is the main result presented in the paper. This integrates the "Type of software engineering results" of [1], the "Type of article" of [3], the "Research approach" and "Research method" of [2], and finally the five paper *categories* of ICSE call for papers of 2014 and 2015 editions. The identified types of contribution are: *Theoretical*, *Technological*, *Empirical* and *Perspectival*.
- *validation*: what evidence the paper shows that the contribution is valid. As in [1], the identified types of validation are: *Analysis*, *Evaluation*, *Experience*, *Example*, *No_Validation*.
- *topic*: what is the main topic the paper addresses. This is in line with the "topic" of [2].

An extended description of this categorization scheme is presented in [5].

III. Methodology

Our study aims at answering the RQ: *What types of paper are accepted at ICSE?* We articulate the question in more detailed sub-questions, as follows:

RQ1: What topics are mostly investigated?
RQ2: What problems are mainly addressed?
RQ3: What is the main type of contribution?
RQ4: What is the main type of validation?

The corpus of the study consists of 1654 papers published in the ICSE proceedings from 1976 until 2016. Our study only refers to full papers (i.e., papers longer than 6 pages) in the technical research track. Consistently with similar studies such as [1], we classified the papers on the basis of their title, abstract and keywords. Similarly to [2] we adopted the following classification process: i) each paper was randomly

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assigned to two of the authors, who performed an independent coding for each of the four dimensions of the categorization scheme; ii) following the individual codings, one of the remaining authors compared the two categorizations, and in case of inconsistency he/she made the final assignment that was often (but not always) equal to one of the two assigned values.

This study was conducted in two phases:

a) First phase (Sample): we sampled a subset of 165 papers (10% of the whole set). The agreement between individual codings varied (on average it was 45%): disagreements usually occurred when the paper dealt with multiple problems or contributions. Based on the observations of the *Sample* phase, we refined and clarified the scheme description.

b) Second phase (5_Years): we examined all the 436 papers published from ICSE 2012 to ICSE 2016. The initial agreements between individual codings rose up to 75% that we judged as an acceptable result considering the subjective nature of the individual coding.

IV. Results

In the following we report the main observations collected from *Sample* and *5_Years* phases of our study. Further results are presented in [5], and raw data are available from [6].

A. RQ1: What topics are mostly investigated?

For lack of space, in Figure 1 we only show the results of the classification of topics for the ICSE technical research papers in the years 2014-2016.

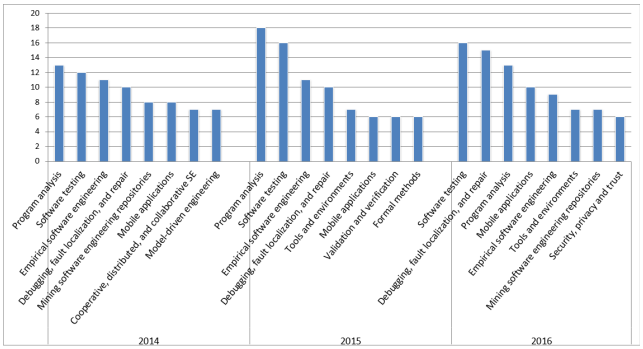

Fig. 1: Most covered topics per year (2014-2015-2016)

B. RQ2: What problems are mainly addressed?

The results of classification of problems addressed by the ICSE technical research papers are summarized in Table I (rows 2-6). In particular, the second and third columns (labeled *5_Years phase* and *Sample phase*) show the results about the second and first phase respectively. As evidenced by the second column, 31% of recent ICSE papers focuses on problems about methods or tools useful for analysis and evaluation of software artifact (*Analysis method*). Almost the same percentage of papers investigates on *Specific instance*, *Generalization or characterization* and *Development method* problems, while there are a few *Feasibility study or exploration* problems.

TABLE I: Results for Problem, Contribution and Validation

Problem	5_Years phase	Sample phase
Development method	19%	24%
Analysis method	31%	33%
Specific instance	24%	19%
Generalization or characterization	25%	20%
Feasibility study or exploration	2%	5%
Contribution	**5_Years phase**	**Sample phase**
Theoretical	35%	32%
Technological	40%	35%
Empirical	22%	27%
Perspectival	3%	5%
Validation	**5_Years phase**	**Sample phase**
Analysis	17%	7%
Evaluation	60%	34%
Example	8%	26%
Experience	4%	7%
No_Validation	12%	26%

C. RQ3: What is the main type of contribution?

Table I shows the results of the classification of contributions addressed by the ICSE technical research papers, for *Sample* and *5_Years* phases (rows 8-11). Both the columns evidence that the main contribution of ICSE papers is about *Technological* and *Theoretical*, while only few papers propose *Perspectival* approaches.

D. RQ4: What is the main type of validation?

Table I also presents the results of classification of type of validation for the *Sample* and *5_Years* phases (rows 13-17). Data collected during *5_Years* phase evidenced that the most frequent type of validation is *Evaluation* with a percentage of 60%, followed by *Analysis* with only 17%, whereas only the 12% of papers present *No_Validation*.

V. Discussion and Conclusion

This section puts on the table some interesting discussion points.

c) Paper Validation: Despite the increasing usage of *Evaluation* as main type of validation over the years, we have been somehow surprised to still find a certain percentage of papers having no validation.

d) Abstract: In [7], Budgen and coauthors show that the use of structured abstracts can provide improved readability and make it easier to understand the paper content. The proposed structure for abstracts in [7] includes: *Background*, *Aiming*, *Method*, *Results* and *Conclusions*. Our proposed categorization scheme can further contribute to improve structured abstracts by including an explicit reference to the type of validation which is missing in several ICSE papers.

e) This paper: This paper can be classified as: Problem - *Generalization or characterization*, Contribution - *Perspectival*, Validation - *No_Validation*, Topics - *Empirical Software Engineering*.

In conclusion, we hope that our introspection study can provide useful insights to ICSE authors and reviewers. In future, we will extend the present study by considering other software engineering venues, and make available the raw data [6] welcoming other colleagues to improve our results.

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