A New Taxonomy of Software Testing Approaches

Seeking More Standardized Standards

Samuel Joseph Crawford, Jacques Carette, & Spencer Smith
{crawfs1, carette, smiths}@mcmaster.ca

Department of Computing and Software, McMaster University

April 22, 2023

Goal

The first step to any formal process is **understanding the underlying domain**. Therefore, a systematic and rigorous understanding of software testing approaches is needed to develop formal tools to test software. In our specific case, our motivation was seeing **which kinds of testing can be generated automatically by Drasil**, "a framework for generating all of the software artifacts for (well understood) research software" [1].

Problem

Most software testing ontologies seem to focus on the high-level testing process rather than the testing approaches themselves. For example:

- [2] mainly focuses on parts of the testing process (e.g., test goal, testable entity)
- [3] provides a foundation for classification but "does not aim at providing a systematic and exhaustive state-of-the-art survey of [either domain]" (p. A:2)

Methodology

Since a taxonomy doesn't already exist, we should create one!

- We started with an ad hoc approach, focusing on textbooks trusted at McMaster
- We then realized that this was too arbitrary, so we started from more established sources, such as IEEE and SWEBOK
- The goal of this approach is to iterate, eventually revisiting the original textbooks, until enough knowledge is built up to encounter diminishing returns (ideally no returns!)
- Since there are many standardized documents about software testing (or software in general), this should be trivial, no?

In Our Experience

NO.

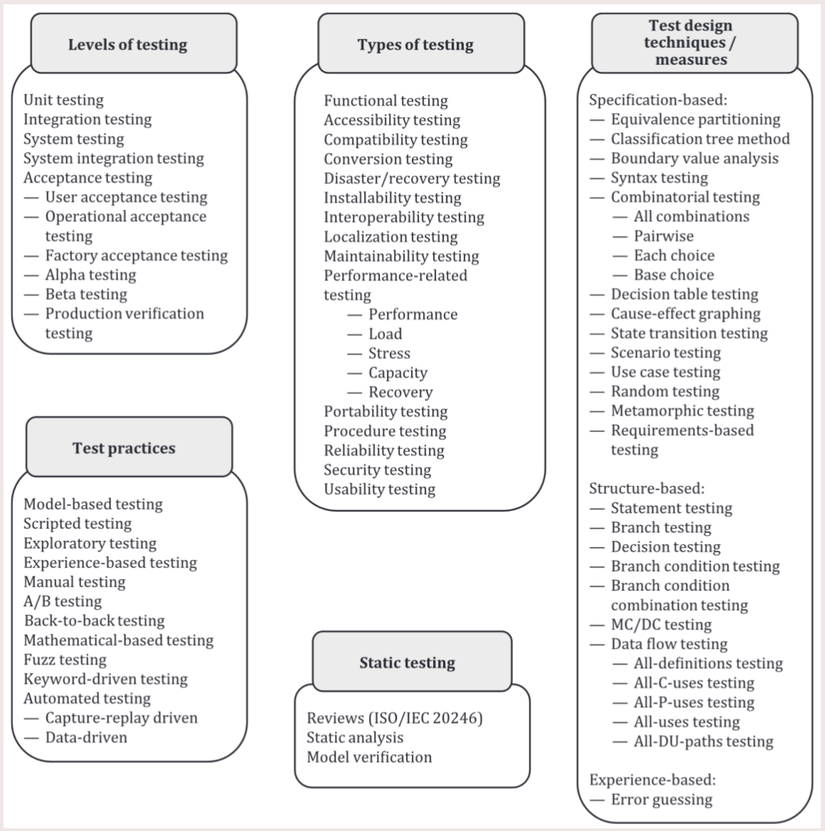

Figure 1: A classification of some "test approach choices" [4, p. 22].

Information often appears logical, but this often breaks down. For example, the classification of test approaches in Figure 1 reveals the following ambiguities:

- Experience-based testing is both a test design technique **and** a test practice
- What distinguishes the following pairs is unclear:
  - Disaster/recovery testing and recovery testing
  - Branch condition testing and branch condition combination testing

More Examples

A big contributor to the ambiguities in Figure 1 is the number of definitions that are not given. Despite its source [4] being a standard for general concepts related to software testing, it leaves much unstandardized. For example, as shown in Figure 1, most (55 out of 99) testing approaches mentioned do not have a definition! Eight of these were at the very least described in the previous version of this standard [5], and nine were present in the same way in another IEEE standard [6] that would have been available upon publication of this one. However, the presence of a definition does not guarantee that it is useful! See Figure 1 for some good (bad?) examples.

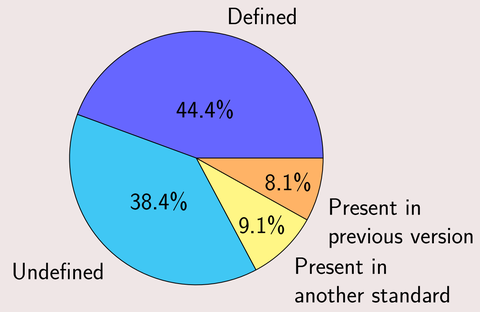

Figure 2: Breakdown of testing approach definitions from [4].

3.3809
software element
1. system element that is software
cf. system element, software/system element

3.1486
event sequence analysis
1. per

3.2697
operable
1. state of

Figure 3: Some less-than-helpful definitions from [6].

Conclusions & Future Work

- Current software testing taxonomies are incomplete, inconsistent, and/or incorrect
- For one to be useful, it needs to be built systematically from a large body of established sources
- We will continue investigating how the literature defines and categorizes software testing approaches to analyze any discrepancies and structure these ideas coherently

References

[1] J. Carette, S. Smith, J. Balaci, T.-Y. Wu, S. Crawford, D. Chen, D. Szymczak, B. MacLachlan, D. Scime, and M. Niazi, "Drasil," Feb. 2021.

[2] G. Tebes, L. Olsina, D. Peppino, and P. Becker, "TestTDO: A Top-Domain Software Testing Ontology," (Curitiba, Brazil), pp. 364–377, May 2020.

[3] M. Unterkalmsteiner, R. Feldt, and T. Gorschek, "A Taxonomy for Requirements Engineering and Software Test Alignment," *ACM Transactions on Software Engineering and Methodology*, vol. 23, pp. 1–38, Mar. 2014.
arXiv:2307.12477 [cs].

[4] ISO/IEC and IEEE, "ISO/IEC/IEEE International Standard - Systems and software engineering –Software testing –Part 1: General concepts," *ISO/IEC/IEEE 29119-1:2022(E)*, Jan. 2022.

[5] ISO/IEC and IEEE, "ISO/IEC/IEEE International Standard - Systems and software engineering –Software testing –Part 1: General concepts," *ISO/IEC/IEEE 29119-1:2013*, Sept. 2013.

[6] ISO/IEC and IEEE, "ISO/IEC/IEEE International Standard - Systems and software engineering–Vocabulary," *ISO/IEC/IEEE 24765:2017(E)*, Sept. 2017.

Acknowledgments

We thank the Government of Ontario for OGS funding.