

Putting Software Testing Terminology to the Test

M.A.Sc. Seminar

Samuel Crawford, B.Eng.

McMaster University
Department of Computing and Software

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1 Introduction

- The Need for Standardized Terminology
- The Lack of Standardized Terminology

2 Project

- Research Questions
- Methodology

3 Results

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The Need for Standardized Terminology

- Engineering is applied science
- Scientific fields use precise terminology



SOFTWARE
ENGINEERING

The Need for Standardized Terminology

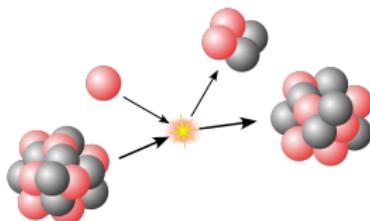
- Engineering is applied science
- Scientific fields use precise terminology



SOFTWARE
ENGINEERING



Penubag and Ramey (2010)



Kjerish (2016)



AzaToth (2008)

The Lack of Standardized Terminology

"The Problem"



(ISO/IEC and IEEE, 2022, Fig. 2)

The Lack of Standardized Terminology

"The Problem"



Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

The Lack of Standardized Terminology

"The Problem"

ISO/IEC/IEEE 29119-4 describes the **experience-based test design technique** of error guessing. Other **experience-based test practices** include (but are not limited to) exploratory testing (see [4.4.3.3](#)), tours, attacks, and checklist-based testing.

Adapted from (ISO/IEC and IEEE, 2022, p. 34)

The Lack of Standardized Terminology

“The Problem” (cont.)

What: by Object Under Test (OUT) – System Testing

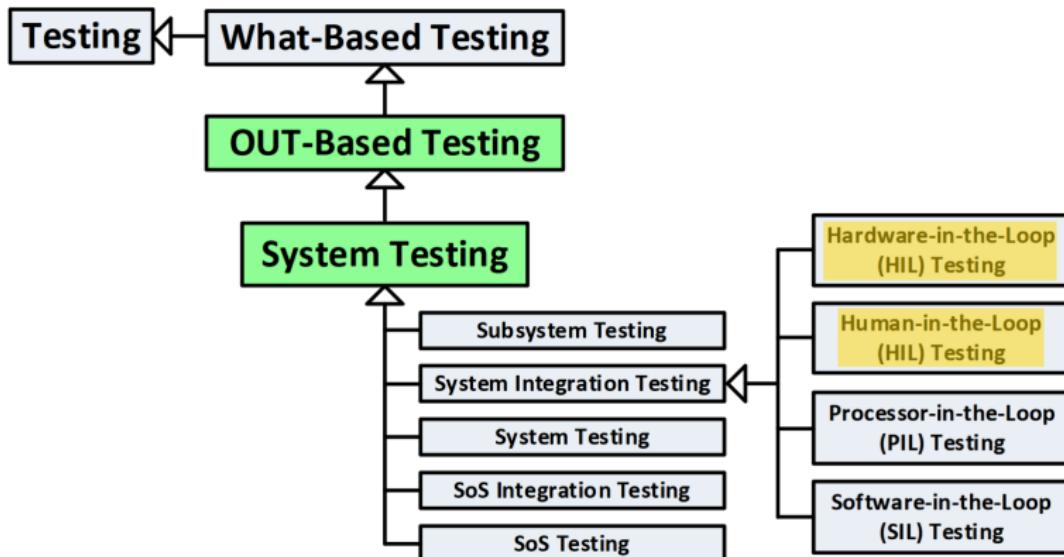


(Firesmith, 2015, p. 23)

The Lack of Standardized Terminology

“The Problem” (cont.)

What: by Object Under Test (OUT) – System Testing



Adapted from (Firesmith, 2015, p. 23)

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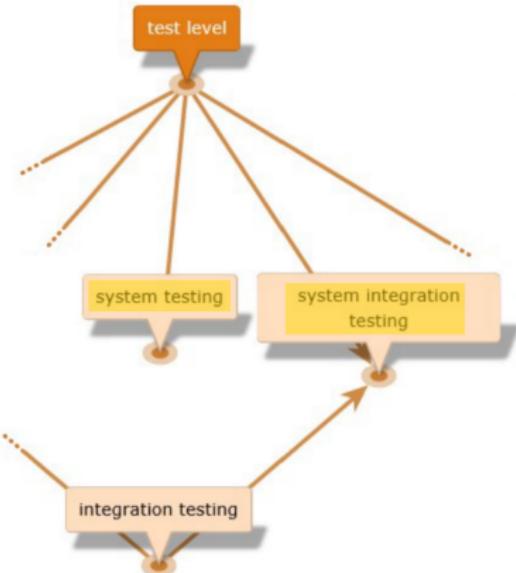
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Adapted from (Firesmith, 2015, p. 23)

The Lack of Standardized Terminology

“The Problem” (cont.)



Adapted from (Hamburg and Mogyorodi, 2024)

Adapted from (Firesmith, 2015, p. 23)

The Lack of Standardized Terminology

“The Problem” (cont.)



The Lack of Standardized Terminology

"The Problem" (cont.)

"Alpha testing is done by 'users within the organization developing the software'."

(ISO/IEC and IEEE, 2017, p. 17)



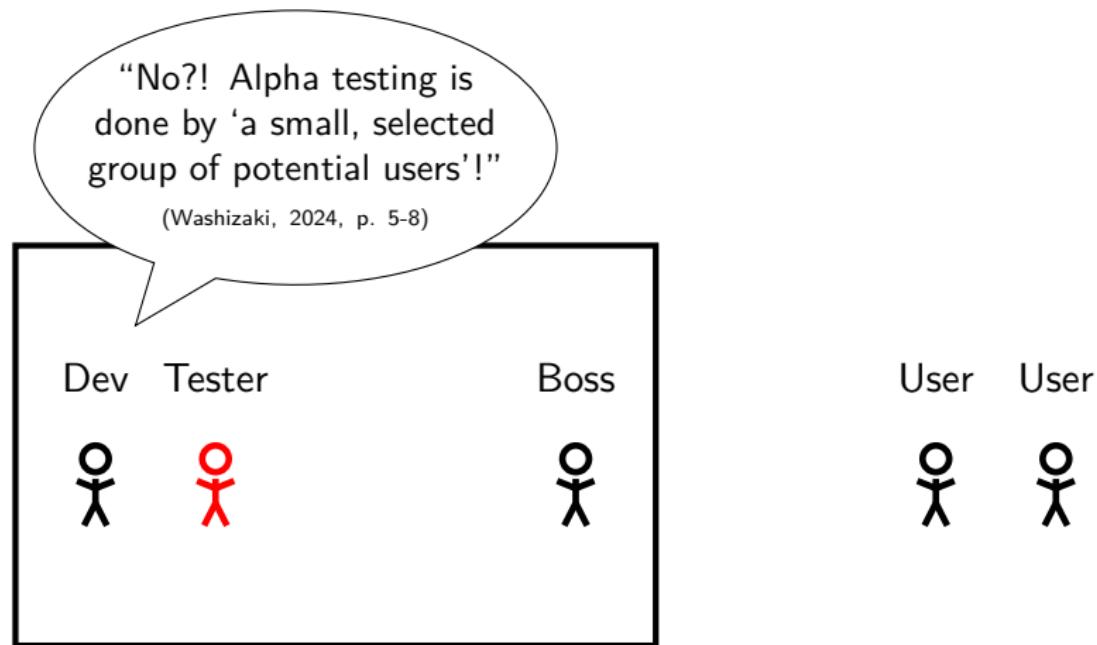
The Lack of Standardized Terminology

"The Problem" (cont.)



The Lack of Standardized Terminology

"The Problem" (cont.)



The Lack of Standardized Terminology

“The Problem” (cont.)



The Lack of Standardized Terminology

“The Problem” (cont.)



The Lack of Standardized Terminology

“The Problem” (cont.)

“How? Alpha testing is performed
‘in the developer’s test environment’,
but you didn’t bring anyone in.”

(Hamburg and Mogyorodi, 2024)



Barriers to Effective Communication

“The Problem” (cont.)

Interorganizational

Schools, companies, etc.



Barriers to Effective Communication

“The Problem” (cont.)

Interorganizational

Schools, companies, etc.



Intraorganizational

“Complete testing” could require the tester to:

- discover every bug,
- exhaust the time allocated,
- implement every planned test,
- . . . (Kaner et al., 2011, p. 7)

Taxonomies to the Rescue?

“The Problem” (cont.)

- Existing software testing taxonomies:
 - Tebes et al. (2020)
 - Souza et al. (2017)
 - Firesmith (2015)
 - Unterkalmsteiner et al. (2014)

Taxonomies to the Rescue?

"The Problem" (cont.)

- Existing software testing taxonomies:

- Tebes et al. (2020)
- Souza et al. (2017)
- Firesmith (2015)
- Unterkalmsteiner et al. (2014)

Focus on:

The Testing Process
Organizing Terminology
Relations between Approaches
Traceability between Stages

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Research Questions

Research Question 1

What testing approaches do the literature describe?

Research Question 2

Are these descriptions consistent?

Research Question 3

Can we systematically resolve any of these inconsistencies?

Methodology

Overview

Research Question 1

What testing approaches do the literature describe?

- ① Identify authoritative sources on software testing and “snowball” from them
- ② Identify all test approaches and testing-related terms described in these authoritative sources
- ③ Record all relevant data, including implicit data, for each term identified in step 2; test approach data are comprised of:

① Names	③ Definitions	⑤ Parents
② Categories	④ Synonyms	⑥ Flaws
- ④ Repeat steps 1 to 3 for any missing or unclear terms until the stopping criteria is reached

Methodology

Overview

Research Question 2

Are these descriptions consistent?

- ⑤ Analyze recorded test approach data for additional flaws
 - ① Generate relation graphs
 - ② Automatically detect certain classes of flaws
 - ③ Automatically analyze manually recorded flaws from step 3.6
- ⑥ Report results of flaw analysis

Research Question 3

Can we systematically resolve any of these inconsistencies?

- ⑦ Provide examples of how to resolve these flaws

Methodology

Procedure

- A row is created for each test approach

Name	Category	Definition	Parent(s)	Synonym(s)
A/B Testing	Practice (Fig. 2)	Testing “that allows testers to determine which of two systems or components performs better” (pp. 1, 36)	Statistical Testing (pp. 1, 36), ...	Split-Run Testing (pp. 1, 36)

Information from (ISO/IEC and IEEE, 2022)

Methodology

Procedure

- A row is created for each test approach

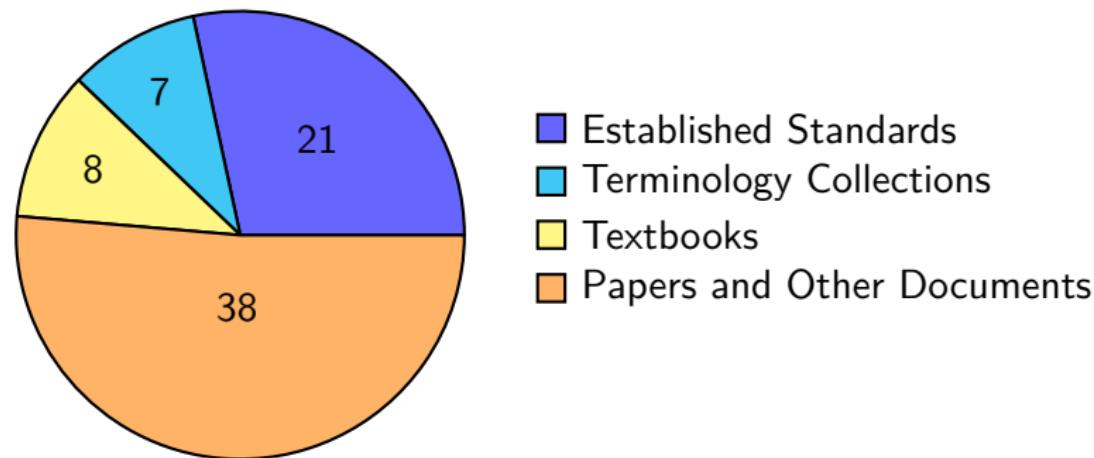
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A/B Testing	Practice (Fig. 2)	Testing “that allows testers to determine which of two systems or components performs better” (pp. 1, 36)	Statistical Testing (pp. 1, 36), ...	Split-Run Testing (pp. 1, 36)

Information from (ISO/IEC and IEEE, 2022)

- This information is gathered from sources by looking for
 - Glossaries, taxonomies, hierarchies, etc.
 - Testing-related terms
 - Terms described *by* other approaches
 - Terms that *imply* other approaches

Methodology

Sources

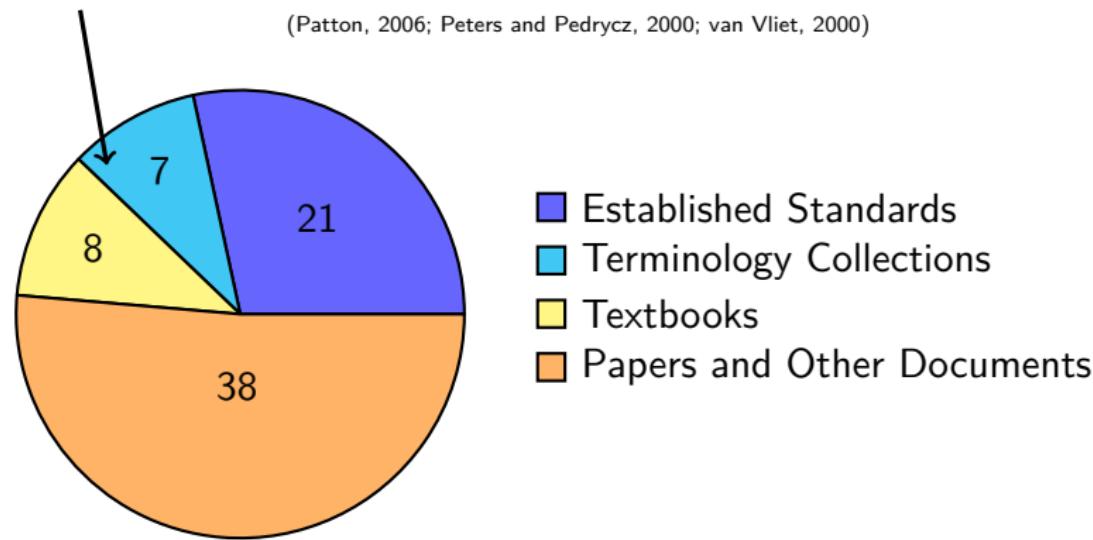


Methodology

Sources

Textbooks used at McMaster were our ad hoc starting points

(Patton, 2006; Peters and Pedrycz, 2000; van Vliet, 2000)



Methodology

Categories

Approach

Approach: a “high-level test implementation choice” (ISO/IEC and IEEE, 2022, p. 10) used to “pick the particular test case values” (2017, p. 465)

Methodology

Categories



Level: a stage of testing with “particular objectives and . . . risks”, each performed in sequence (ISO/IEC and IEEE, 2022, p. 12; 2021a, p. 6; 2021c, p. 6)

Methodology

Categories



Practice: a “conceptual framework that can be applied to . . . [a] test process to facilitate testing” (ISO/IEC and IEEE, 2022, p. 14; 2017, p. 471)

Methodology

Categories



Technique: a “procedure used to create or select a test model, identify test coverage items, and derive corresponding test cases” (2022, p. 11; 2021a, p. 5; similar in 2017, p. 467)

Methodology

Categories



Type: “Testing that is focused on specific quality characteristics”
(ISO/IEC and IEEE, 2022, p. 15; 2021c, p. 7; 2017, p. 473)

Methodology

Visualization Notation



Arrows point from a *child* node to a *parent* node.

Methodology

Visualization Notation



Lines without arrowheads connect *synonyms*.

Methodology

Visualization Notation



Dashed lines indicate a relationship is *implicit*.

Methodology

Visualization Notation



Dashed outlines indicate a term is *implicit*.

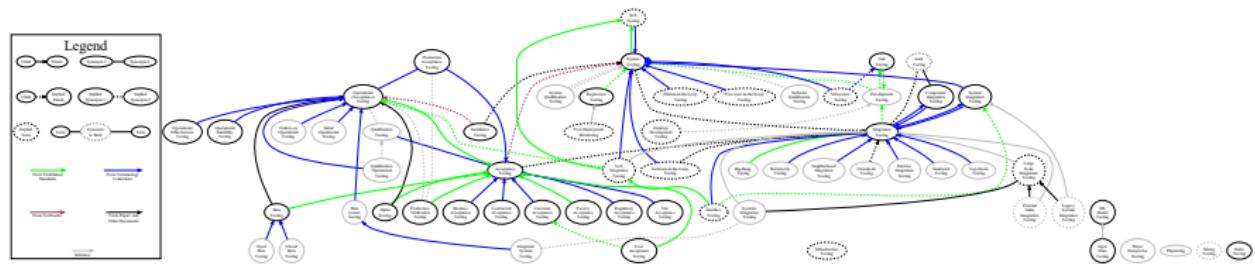
Dotted outlines indicate a term is a *synonym* to more than one term.

Graph of Test Approaches

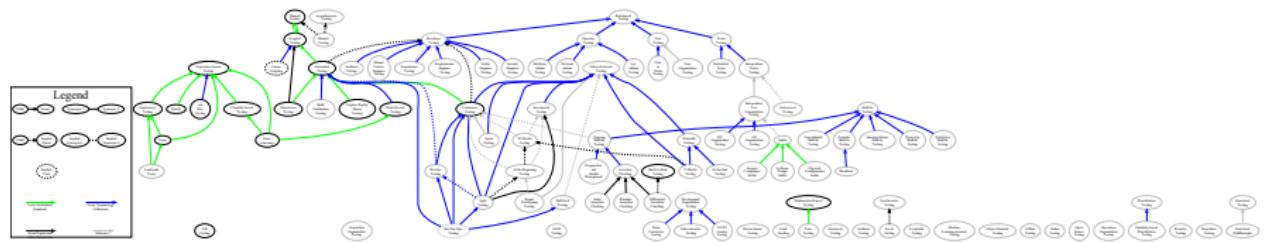
Graph of Test Approaches

! Dimension too large.

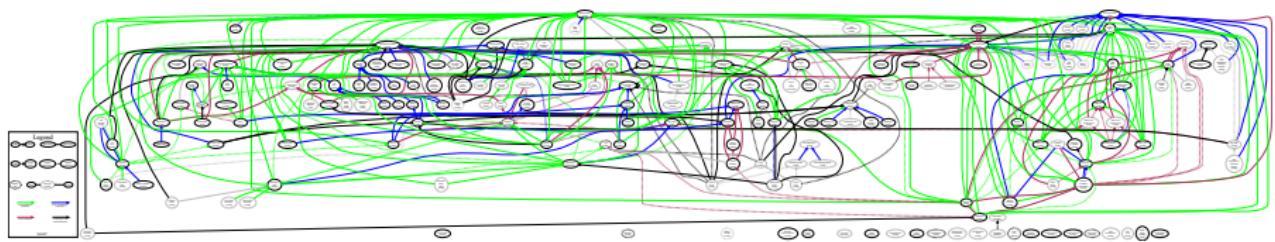
Graph of Test Levels



Graph of Test Practices



Graph of Test Techniques



Graph of Test Types



Methodology

Visualization Notation



(ISO/IEC and IEEE, 2022, Fig. 2)

Methodology

Visualization Notation



Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

Methodology

Visualization Notation

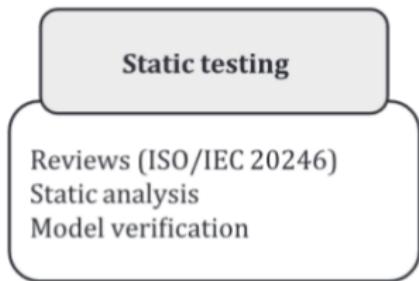


- Quite distinct but not necessarily orthogonal

Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

Methodology

Visualization Notation



- Quite distinct but not necessarily orthogonal
- When considering static testing in isolation, related *dynamic approaches* have grey backgrounds



Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

Graph of *Static* Test Approaches

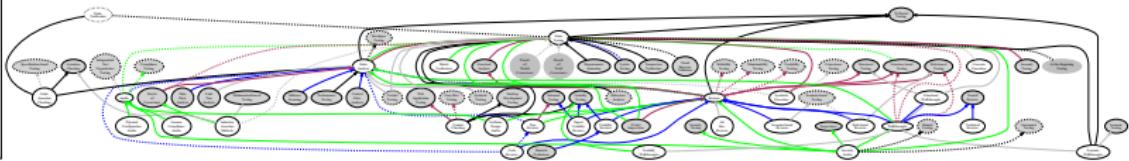
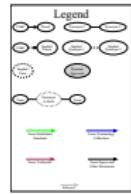


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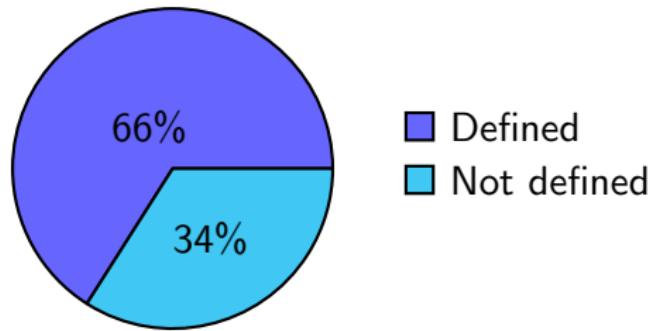
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Overview

- 561 test approaches →



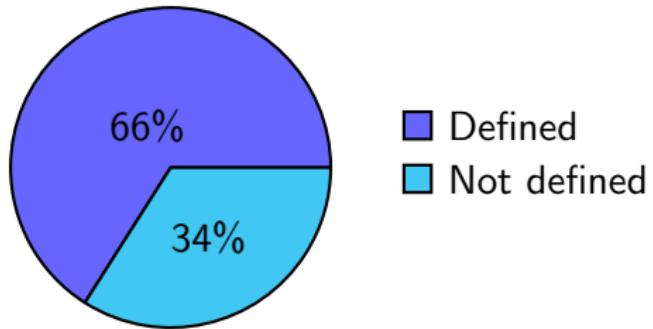
Overview

- 561 test approaches →
- 77 software qualities
(may imply test approaches)

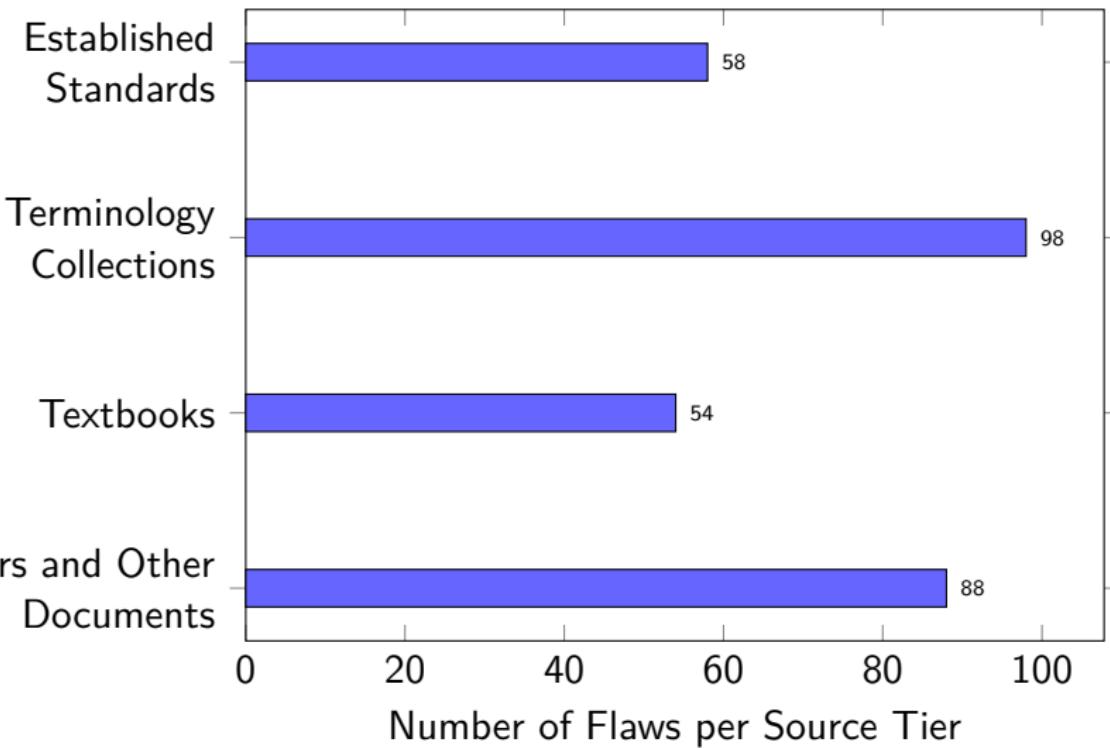


Overview

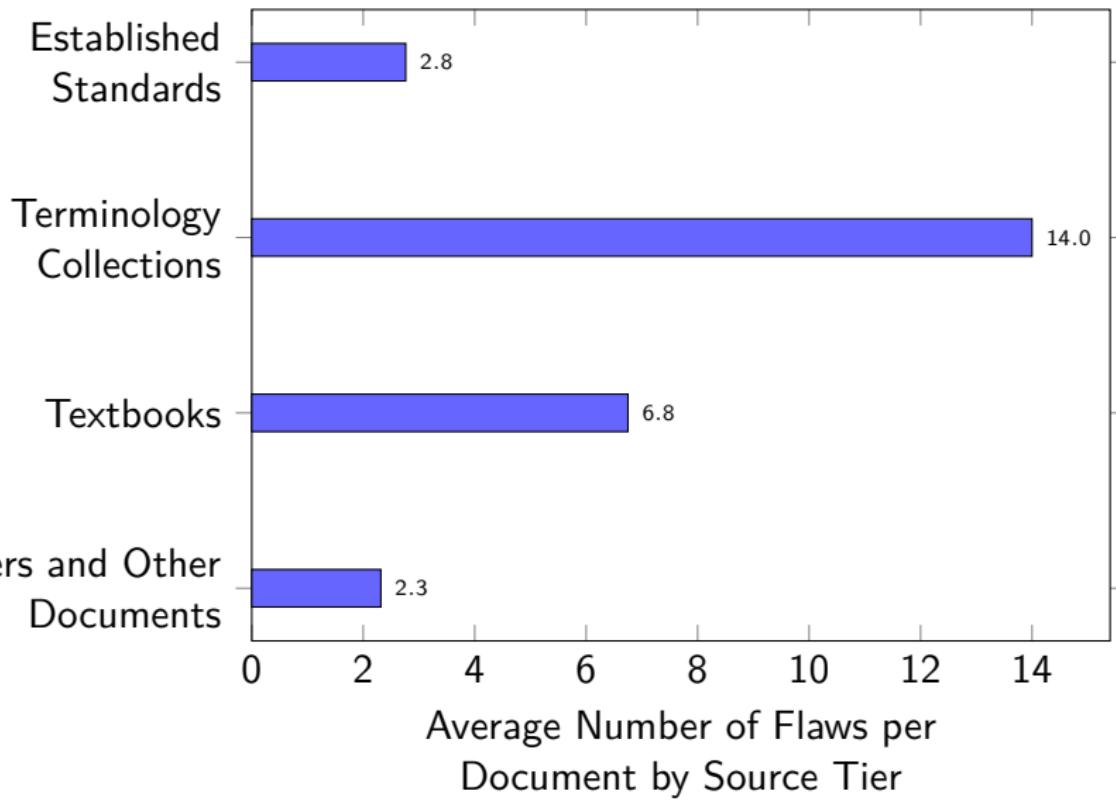
- 561 test approaches →
- 77 software qualities
(may imply test approaches)
- 298 flaws in the software testing literature



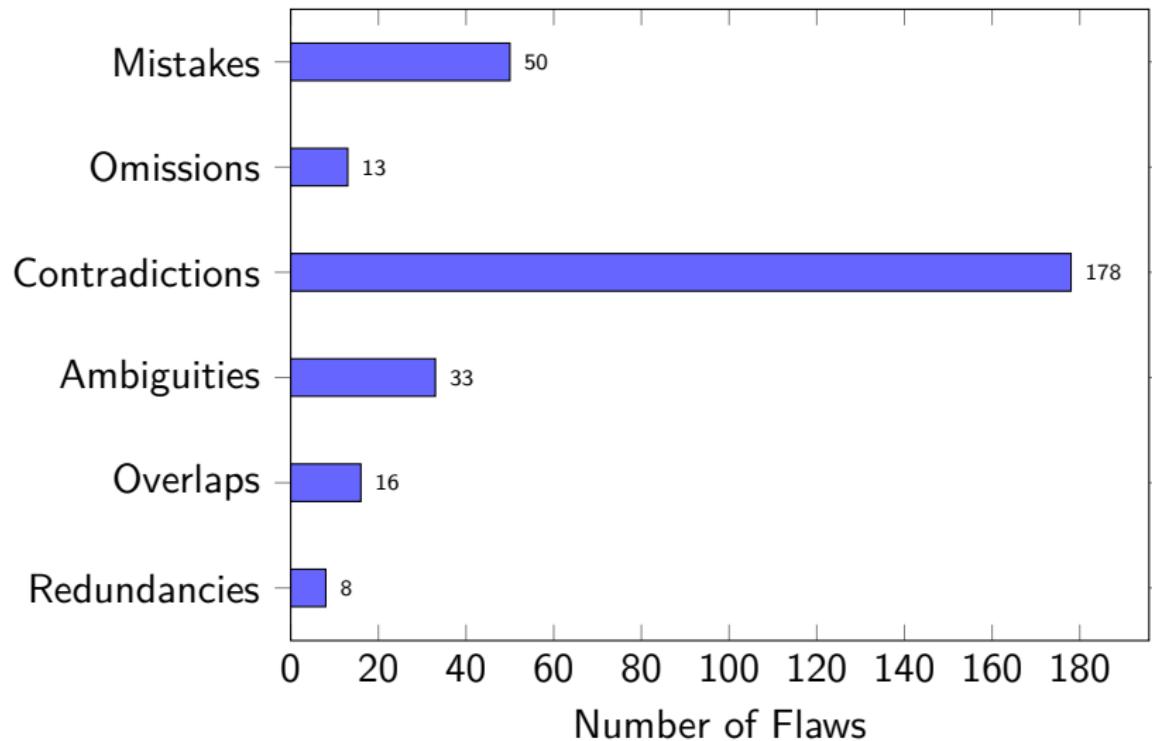
Flaw Summary by Source Tier



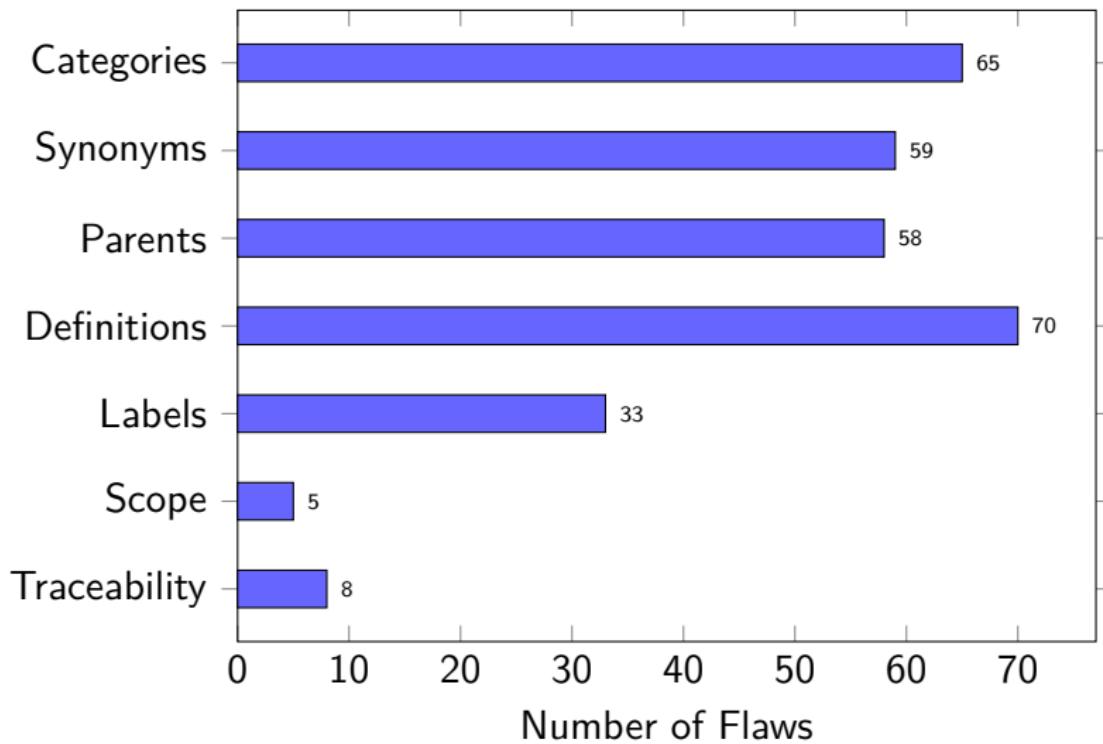
Normalized Flaw Summary



Flaw Summary by Manifestation



Flaw Summary by Domain



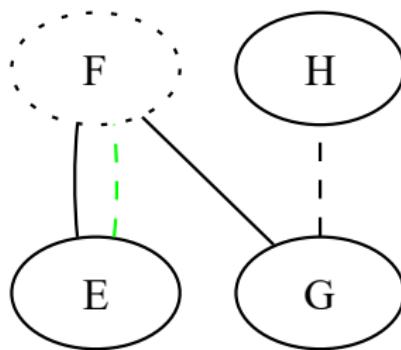
Automated Flaws

- Some terms are given as a synonym to two (or more) disjoint, unrelated terms, making the relation between the given synonyms ambiguous

Automated Flaws

- Some terms are given as a synonym to two (or more) disjoint, unrelated terms, making the relation between the given synonyms ambiguous
- These are included in generated visualizations automatically

Name	Synonym(s)
E	F (Author, 2022; implied by StdAuthor, 2021)
G	F (Author, 2017), H (implied by 2022)
H	X (StdAuthor, 2021)



Automated Flaws

Prominent examples of these “multi-synonyms”:

① Soak Testing:

- Endurance Testing
- Reliability Testing

Source(s)

(ISO/IEC and IEEE, 2021c, p. 39)

(Gerrard, 2000a, Tab. 2; 2000b, Tab. 1, p. 26)

Automated Flaws

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(ISO/IEC and IEEE, 2021c, p. 39)

(Gerrard, 2000a, Tab. 2; 2000b, Tab. 1, p. 26)

② Functional Testing:

- Behavioural Testing
- Correctness Testing
- Specification-based Testing

(Kam, 2008, p. 45)

(Washizaki, 2024, p. 5-7)

(ISO/IEC and IEEE, 2017, p. 196; ...)

Automated Flaws

Prominent examples of these “multi-synonyms”:

① Soak Testing:

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(Kam, 2008, p. 45)

(Washizaki, 2024, p. 5-7)

(ISO/IEC and IEEE, 2017, p. 196; ...)

③ Link Testing:

- Branch Testing
- Component Integration Testing
- Integration Testing

(implied by ISO/IEC and IEEE, 2021c, p. 24)

(Kam, 2008, p. 45)

(implied by Gerrard, 2000a, p. 13)

Acknowledgment

- Dr. Spencer Smith and Dr. Jacques Carette have been great supervisors and valuable sources of guidance and feedback
 - They have helped me refine the scope of this project
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- The past and current Drasil team have created a truly amazing framework!

Thank you!
Questions?

References I

- AzaToth. Myoglobin 3D structure, February 2008. URL
<https://commons.wikimedia.org/wiki/File:Myoglobin.png>.
- Donald G. Firesmith. A Taxonomy of Testing Types, 2015. URL
<https://apps.dtic.mil/sti/pdfs/AD1147163.pdf>.
- Paul Gerrard. Risk-based E-business Testing - Part 1: Risks and Test Strategy. Technical report, Systeme Evolutif, London, UK, 2000a. URL
https://www.agileconnection.com/sites/default/files/article/file/2013/XUS129342file1_0.pdf.
- Paul Gerrard. Risk-based E-business Testing - Part 2: Test Techniques and Tools. Technical report, Systeme Evolutif, London, UK, 2000b. URL
wenku.uml.com/document/test/EBTestingPart2.pdf.
- Matthias Hamburg and Gary Mogyorodi, editors. ISTQB Glossary, v4.3, 2024. URL https://glossary.istqb.org/en_US/search.

References II

- ISO/IEC and IEEE. ISO/IEC/IEEE International Standard - Systems and software engineering–Vocabulary. *ISO/IEC/IEEE 24765:2017(E)*, September 2017. doi: 10.1109/IEEESTD.2017.8016712.
- ISO/IEC and IEEE. ISO/IEC/IEEE International Standard - Software and systems engineering –Software testing –Part 2: Test processes. *ISO/IEC/IEEE 29119-2:2021(E)*, October 2021a. doi: 10.1109/IEEESTD.2021.9591508.
- ISO/IEC and IEEE. ISO/IEC/IEEE International Standard - Software and systems engineering –Software testing –Part 4: Test techniques. *ISO/IEC/IEEE 29119-4:2021(E)*, October 2021c. doi: 10.1109/IEEESTD.2021.9591574.
- 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)*, January 2022. doi: 10.1109/IEEESTD.2022.9698145.

References III

- Ben Kam. Web Applications Testing. Technical Report 2008-550, Queen's University, Kingston, ON, Canada, October 2008. URL <https://research.cs.queensu.ca/TechReports/Reports/2008-550.pdf>.
- Cem Kaner, James Bach, and Bret Pettichord. *Lessons Learned in Software Testing: A Context-Driven Approach*. John Wiley & Sons, December 2011. ISBN 978-0-471-08112-8. URL <https://www.wiley.com/en-ca/Lessons+Learned+in+Software+Testing%3A+A+Context-Driven+Approach-p-9780471081128>.
- Kjerish. Part of CNO cycle diagram, made just to be illustrative for nuclear reactions in general, December 2016. URL <https://commons.wikimedia.org/wiki/File:NuclearReaction.svg>.
- Ron Patton. *Software Testing*. Sams Publishing, Indianapolis, IN, USA, 2nd edition, 2006. ISBN 0-672-32798-8.

References IV

- Penubag and Arnaud Ramey. A few images illustrating forces, August 2010. URL https://commons.wikimedia.org/wiki/File:Force_examples.svg.
- J.F. Peters and W. Pedrycz. *Software Engineering: An Engineering Approach*. Worldwide series in computer science. John Wiley & Sons, Ltd., 2000. ISBN 978-0-471-18964-0.
- Erica Souza, Ricardo Falbo, and Nandamudi Vijaykumar. ROoST: Reference Ontology on Software Testing. *Applied Ontology*, 12:1–32, March 2017. doi: 10.3233/AO-170177.
- Guido Tebes, Luis Olsina, Denis Peppino, and Pablo Becker. TestTDO: A Top-Domain Software Testing Ontology. pages 364–377, Curitiba, Brazil, May 2020. ISBN 978-1-71381-853-3.

References V

- Michael Unterkalmsteiner, Robert Feldt, and Tony Gorschek. A Taxonomy for Requirements Engineering and Software Test Alignment. *ACM Transactions on Software Engineering and Methodology*, 23(2):1–38, March 2014. ISSN 1049-331X, 1557-7392. doi: 10.1145/2523088. URL <http://arxiv.org/abs/2307.12477>. arXiv:2307.12477 [cs].
- Hans van Vliet. *Software Engineering: Principles and Practice*. John Wiley & Sons, Ltd., Chichester, England, 2nd edition, 2000. ISBN 0-471-97508-7.
- Hironori Washizaki, editor. *Guide to the Software Engineering Body of Knowledge, Version 4.0*. January 2024.