

Second Committee Meeting

Updated Progress Report

Samuel Crawford

McMaster University

Fall 2025

Table of Contents

1 Introduction

2 Project

- Research Questions
- Methodology

3 Results

4 Next Steps

Table of Contents

1 Introduction

2 Project

- Research Questions
- Methodology

3 Results

4 Next Steps

Introduction

Where Were We?

- We wanted to generate test cases in **Drasil**, our software artifact generation framework
 - Started writing test cases manually

Introduction

Where Were We?

- We wanted to generate test cases in **Drasil**, our software artifact generation framework
 - Started writing test cases manually
 - We stopped to understand software testing to follow existing standards
- What happened?
 - The domain of software testing is *much* larger than we expected
 - Software testing terminology and standards are *not* standardized

Introduction

Existing Taxonomies?

- Existing software testing taxonomies:

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

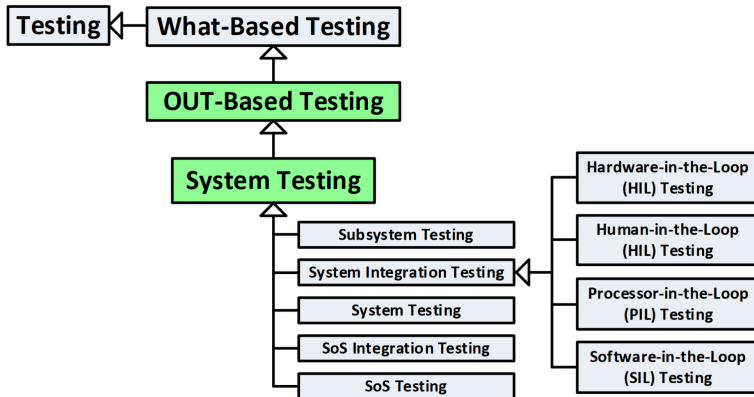
Focus on:

The Testing Process
Organizing Terminology
Relations between Approaches
Traceability between Stages

Introduction

Existing Taxonomies?

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

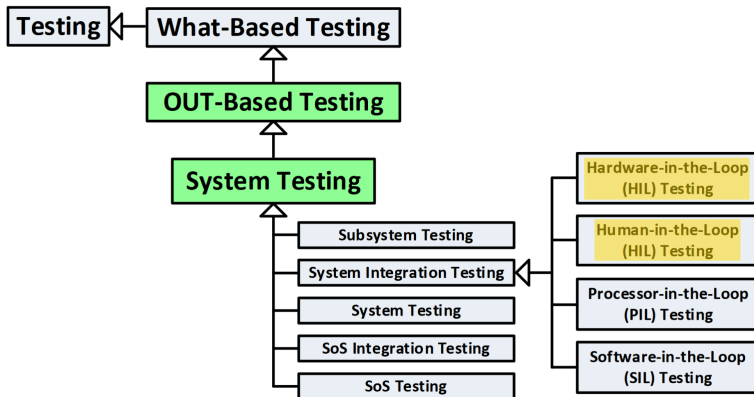


(Firesmith, 2015, p. 23)

Introduction

Existing Taxonomies?

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

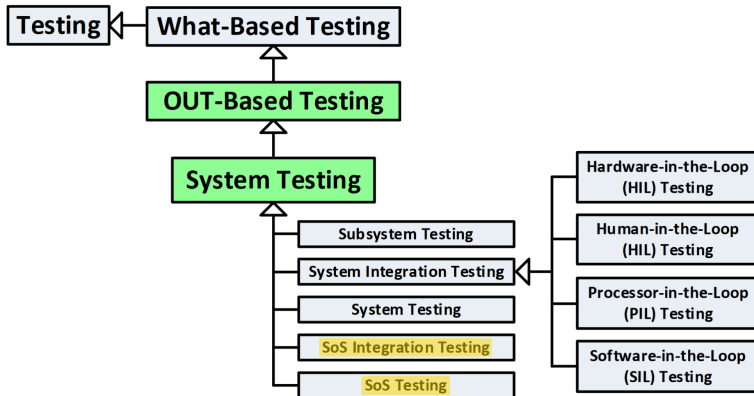


Adapted from (Firesmith, 2015, p. 23)

Introduction

Existing Taxonomies?

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

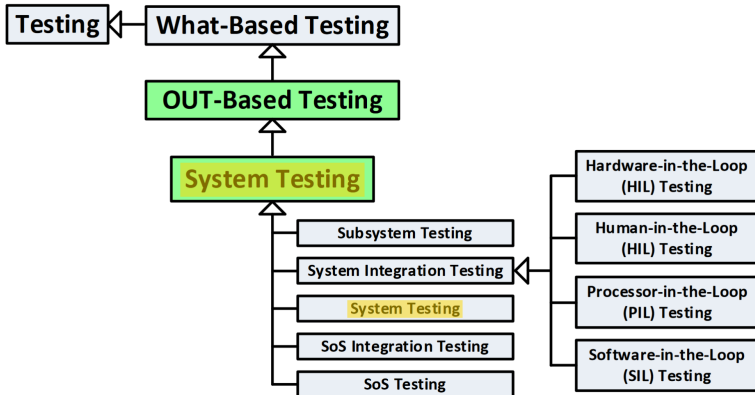


Adapted from (Firesmith, 2015, p. 23)

Introduction

Existing Taxonomies?

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

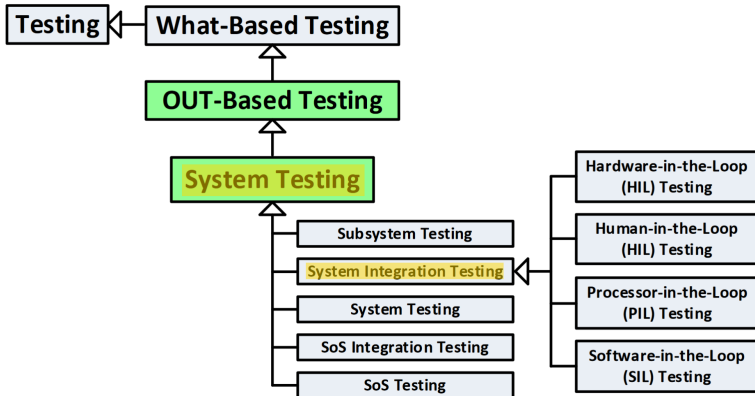


Adapted from (Firesmith, 2015, p. 23)

Introduction

Existing Taxonomies?

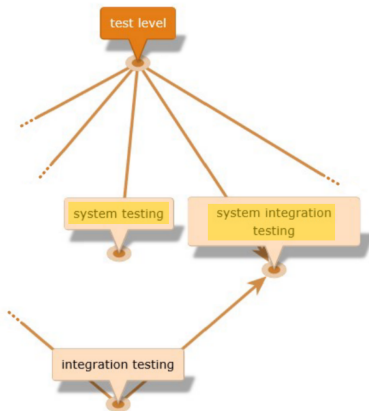
What: by Object Under Test (OUT) – System Testing



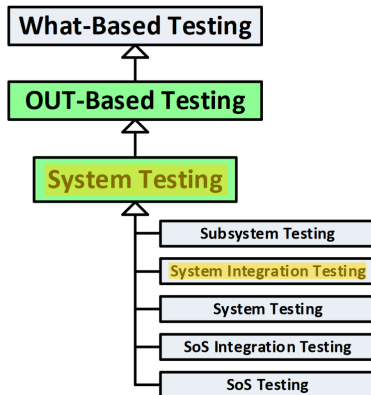
Adapted from (Firesmith, 2015, p. 23)

Introduction

Existing Taxonomies?



Adapted from (Hamburg and Mogyorodi, 2024)



Adapted from (Firesmith, 2015, p. 23)

Table of Contents

1 Introduction

2 Project

- Research Questions
- Methodology

3 Results

4 Next Steps

Research Questions

Research Question 1

What test approaches do the literature describe?

Research Question 2

Are these descriptions consistent?

Research Question 3

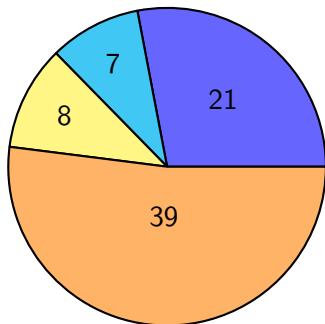
Can we systematically resolve any of these inconsistencies?

Research Question 1

What test approaches do the literature describe?

- ➊ Identify authoritative sources on software testing
- ➋ Identify all test approaches and testing-related terms
- ➌ Record data for these terms; test approach data are comprised of:
 - ➊ Names
 - ➋ Definitions
 - ➌ Parents
 - ➍ Categories
 - ➎ Synonyms
 - ➏ Flaws
- ➍ Repeat steps 1 to 3 for any missing or unclear terms

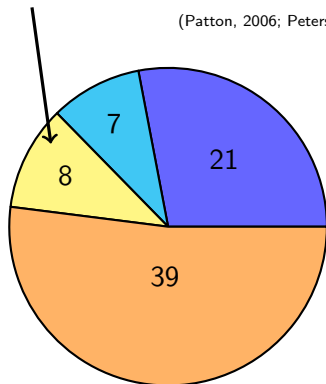
In total, we investigate 75 sources



- Established Standards
- Terminology Collections
- Textbooks
- Papers and Other Documents

Textbooks used at McMaster were our ad hoc starting points

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



- Established Standards
- Terminology Collections
- Textbooks
- Papers and Other Documents

- We build a glossary with a row 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)

- We gather this information from sources by looking for:
 - Glossaries, taxonomies, hierarchies, etc.
 - Testing-related terms
 - Terms described *by* other approaches
 - Terms that *imply* other approaches

Research Question 2

Are these descriptions consistent?

- ⑤ Automatically analyze recorded test approach data
 - ① Visualize approach relations
 - ② Detect certain classes of flaws
 - ③ 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?

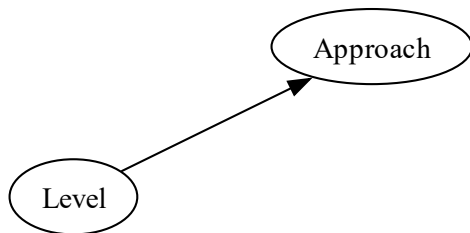
- ⑦ Provide examples of how to resolve these flaws

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

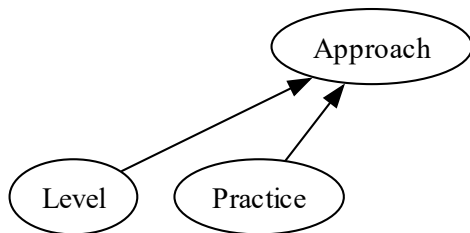
Categories



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

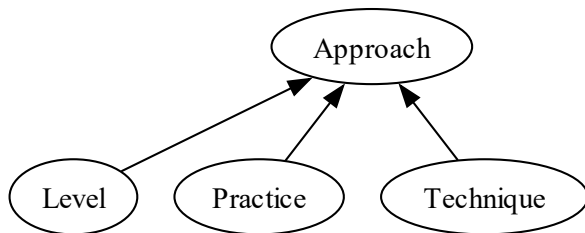
Categories



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

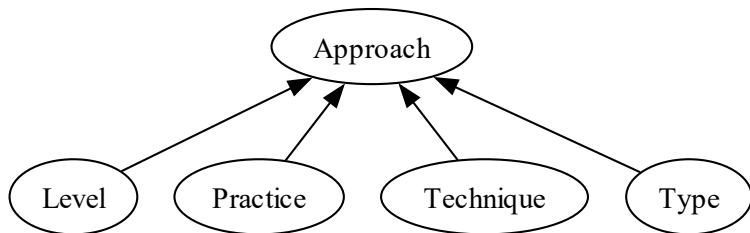
Categories



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

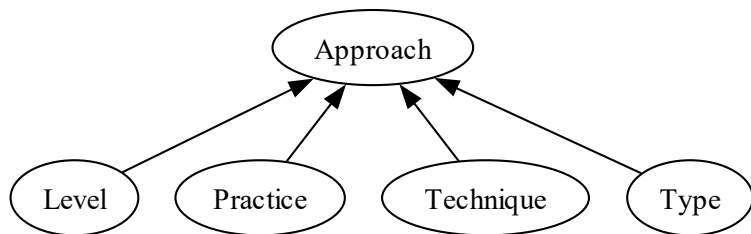
Categories



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

Methodology

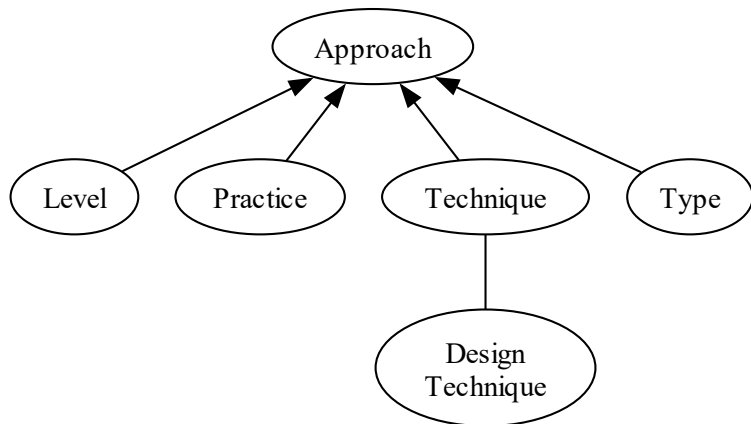
Visualization Notation



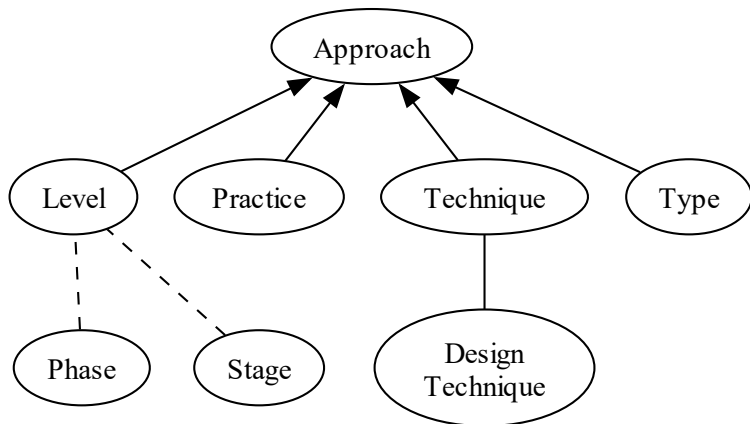
Arrows point from a *child* node to a *parent* node.

Methodology

Visualization Notation



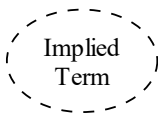
Lines without arrowheads connect *synonyms*.



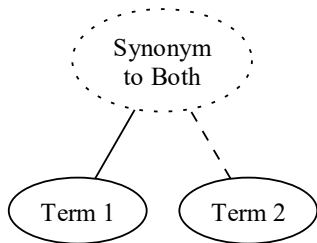
Dashed lines indicate a relationship is *implicit*.

Methodology

Visualization Notation



Dashed outlines indicate a term is *implicit*.



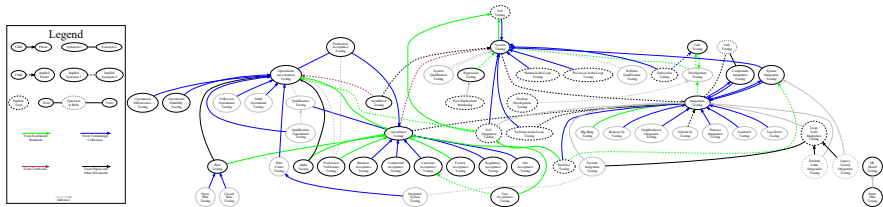
Dotted outlines indicate a term is a *synonym* to more than one term.

Visualization of Test Approaches

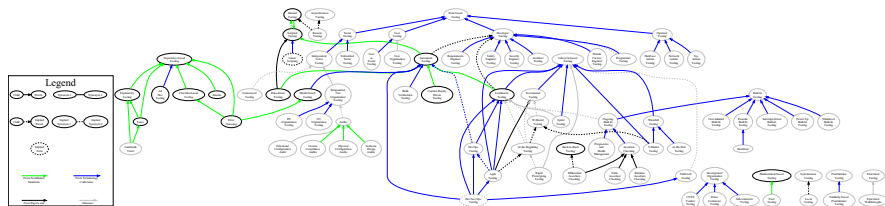
Visualization of Test Approaches

! Dimension too large.

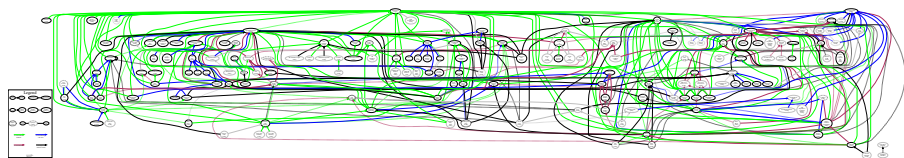
Visualization of Test Levels



Visualization of Test Practices



Visualization of Test Techniques



Visualization of Test Types

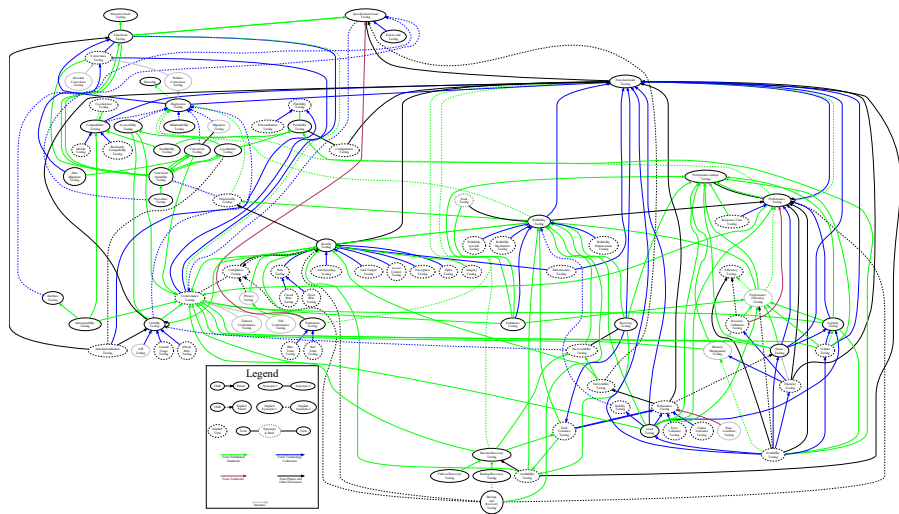


Table of Contents

1 Introduction

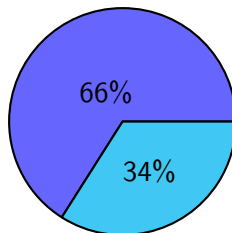
2 Project

- Research Questions
- Methodology

3 Results

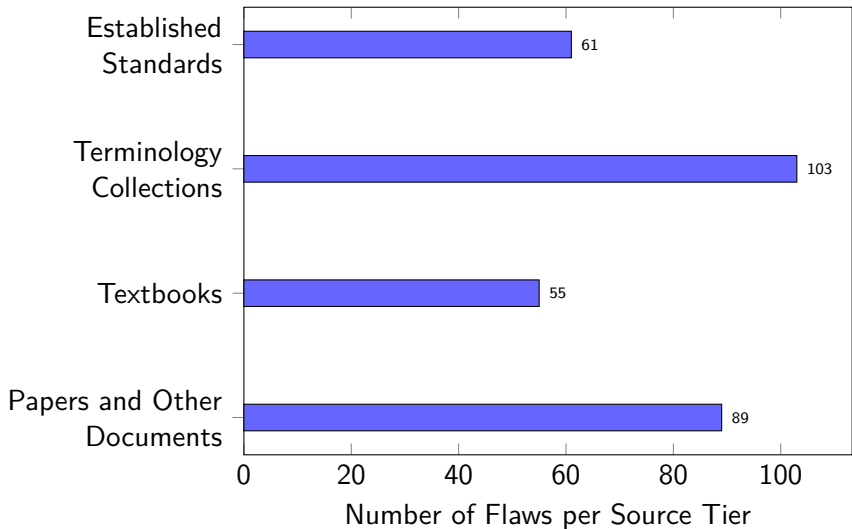
4 Next Steps

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

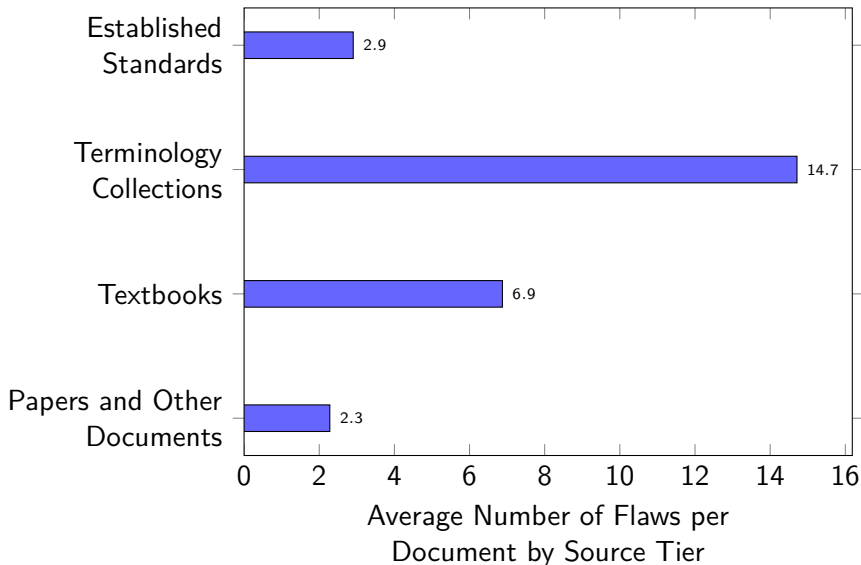


■ Defined
■ Not defined

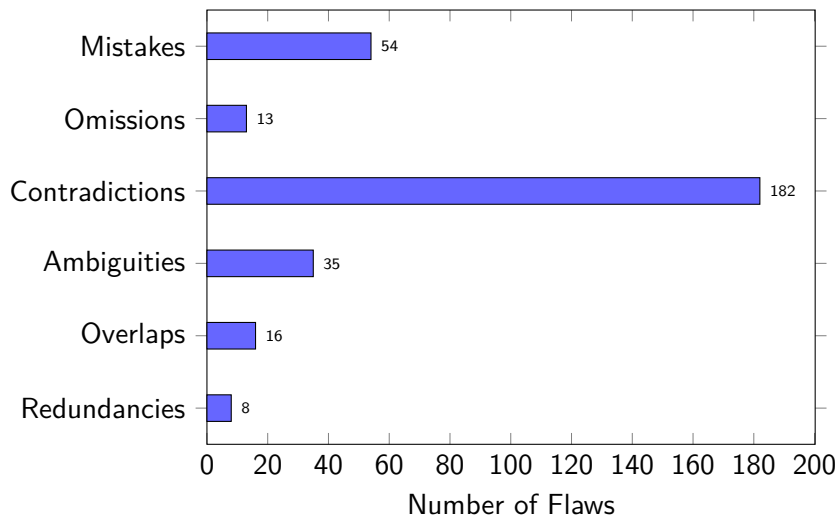
Flaw Summary by Source Tier



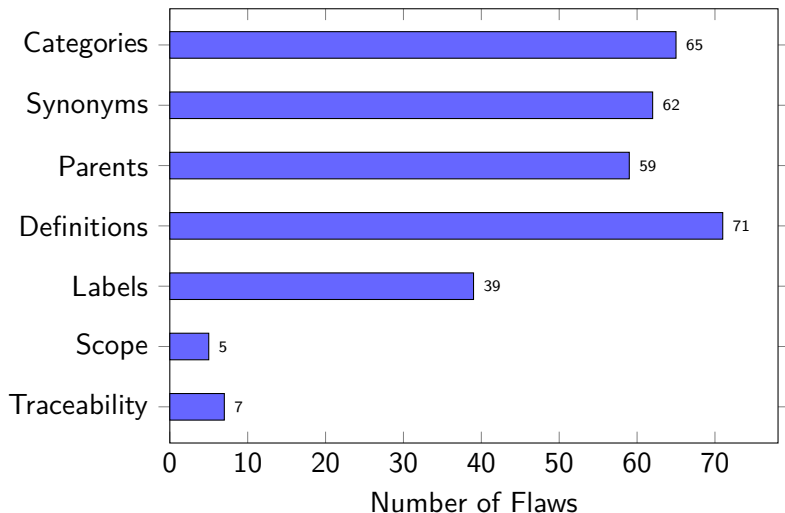
Normalized Flaw Summary



Flaw Summary by Manifestation



Flaw Summary by Domain

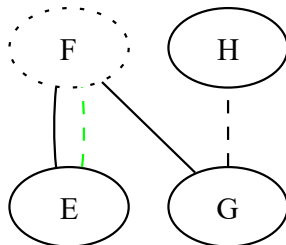


Automated Flaws

Intransitive Synonyms

Some terms are given as a synonym to two (or more) disjoint terms, making their relations ambiguous

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



Some prominent examples:

① **Functional Testing:**

- *Conformance Testing*
- *Correctness Testing*
- Specification-based Testing

Source(s)

(Washizaki, 2025a, p. 5-7)

(Washizaki, 2025a, p. 5-7)

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

Some prominent examples:

① Functional Testing:

- *Conformance Testing*
- *Correctness Testing*
- Specification-based Testing

Source(s)

(Washizaki, 2025a, p. 5-7)

(Washizaki, 2025a, p. 5-7)

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

② Portability Testing:

- Configuration Testing
- Flexibility Testing

(Kam, 2008, p. 43)

(ISO/IEC, 2023)

③ Soak Testing:

- Endurance Testing
- Reliability Testing

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

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

Automated Flaws

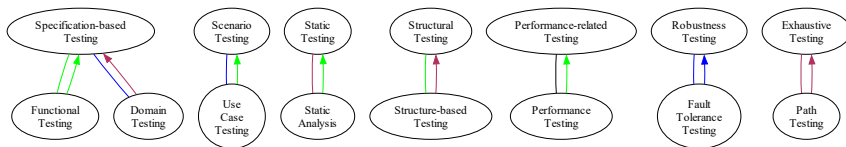
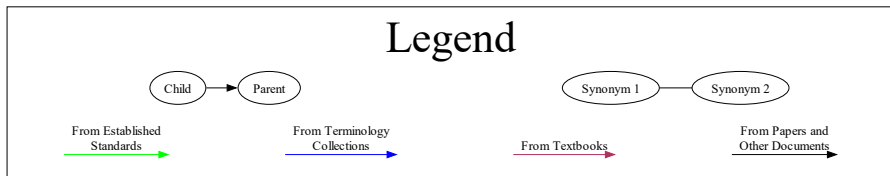
Irreflexive Parents

We also find some test approaches that are given as parents of themselves:

- ① Performance Testing (Gerrard, 2000a, Tab. 2; 2000b, Tab. 1)
- ② System Testing (Firesmith, 2015, p. 23)
- ③ Usability Testing (Gerrard, 2000a, Tab. 2; 2000b, Tab. 1)

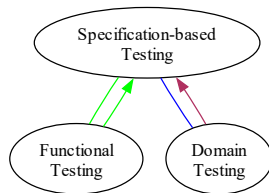
Automated Flaws

Synonym and Parent-Child Overlaps



Automated Flaws

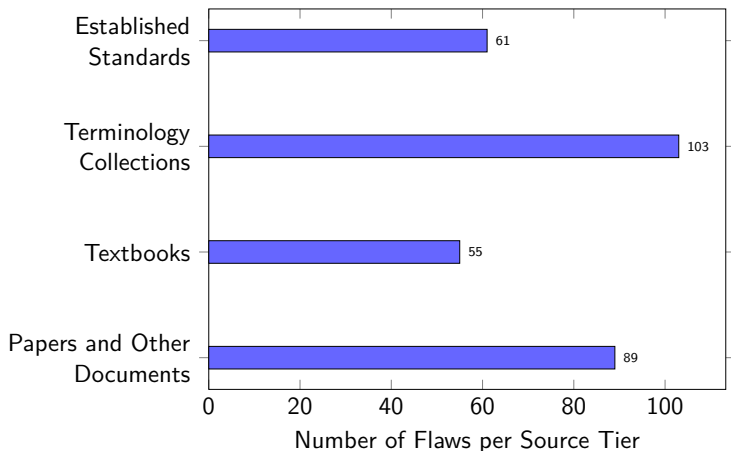
Synonym and Parent-Child Overlaps



- Functional testing is a:
 - Synonym (ISO/IEC and IEEE, 2017, p. 196;
van Vliet, 2000, p. 399; Kam, 2008, pp. 44–45, 48; ...)
 - Child (ISO/IEC and IEEE, 2021c, p. 38; Kam, 2008, p. 42)
- Domain testing is a:
 - Synonym (Washizaki, 2024, p. 5-10)
 - Child (Peters and Pedrycz, 2000, Tab. 12.1)

Conclusion

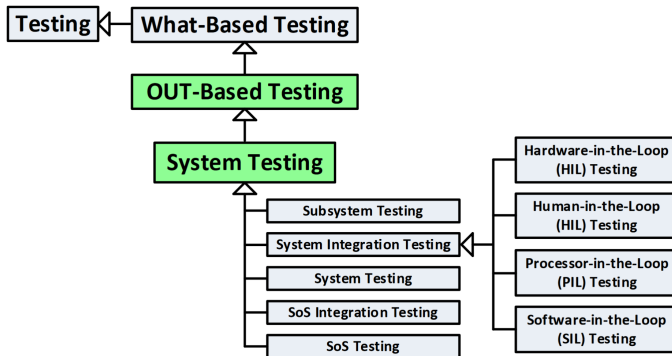
- The software testing literature is flawed, so don't assume everyone is on the same page



Conclusion

- The software testing literature is flawed, so don't assume everyone is on the same page
- Even if they are, there can still be issues!

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



(Firesmith, 2015, p. 23)

Table of Contents

1 Introduction

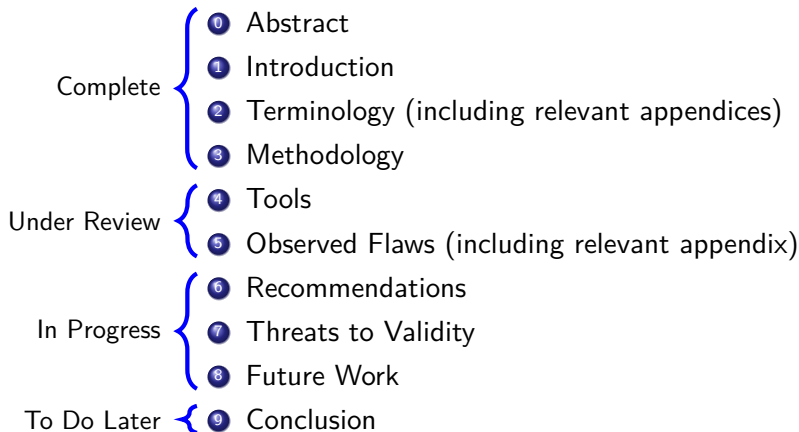
2 Project

- Research Questions
- Methodology

3 Results

4 Next Steps

Thesis Chapters



Acknowledgment

- Dr. Spencer Smith and Dr. Jacques Carette have been great supervisors and valuable sources of guidance and feedback
- The format of this presentation was *heavily* based on a previous presentation by Jason Balaci, who also provided a great thesis template
- ChatGPT was used to help generate supplementary Python code for constructing visualizations and generating \LaTeX code, including regex
- ChatGPT and GitHub Copilot were both used for assistance with \LaTeX formatting

References I

- 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.cn/document/test/EBTestingPart2.pdf.
- Matthias Hamburg and Gary Mogyorodi, editors. ISTQB Glossary, v4.3, 2024. URL https://glossary.istqb.org/en_US/search.

- ISO/IEC. ISO/IEC 25010:2023 - Systems and software engineering –Systems and software Quality Requirements and Evaluation (SQuaRE) –Product quality model. *ISO/IEC 25010:2023*, November 2023. URL <https://www.iso.org/obp/ui/#iso:std:iso-iec:25010:ed-2:v1:en>.
- 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.

References III

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.

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>.

Ron Patton. *Software Testing*. Sams Publishing, Indianapolis, IN, USA, 2nd edition, 2006. ISBN 0-672-32798-8.

References IV

- 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.
- 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].

References V

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.

Hironori Washizaki, editor. *Guide to the Software Engineering Body of Knowledge, Version 4.0a*. May 2025a. URL <https://ieeecs-media.computer.org/media/education/swebok/swebok-v4.pdf>.