

# Putting Software Testing Terminology to the Test

## M.A.Sc. Seminar

Samuel Crawford, B.Eng.

McMaster University  
Department of Computing and Software

Fall 2024

# Table of Contents

## 1 Introduction

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

## 2 Project

- Research Questions
- Methodology

## 3 Results

# Table of Contents

## 1 Introduction

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

## 2 Project

- Research Questions
- Methodology

## 3 Results

# The Need for Standardized Terminology

- Engineering is applied science
- Scientific fields use precise terminology



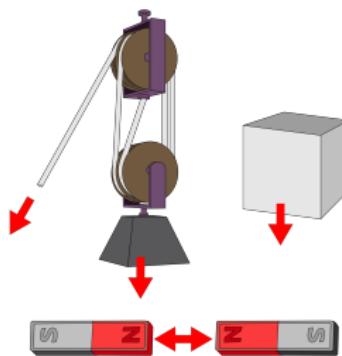
SOFTWARE  
ENGINEERING

# The Need for Standardized Terminology

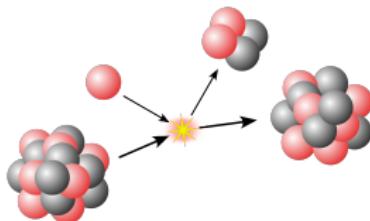
- Engineering is applied science
- Scientific fields use precise terminology



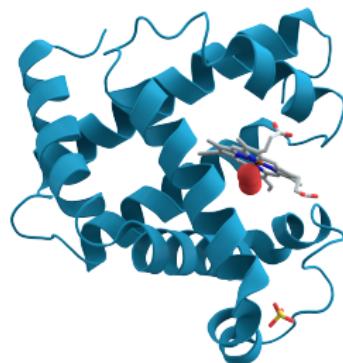
SOFTWARE  
ENGINEERING



Penubag and Ramey (2010)



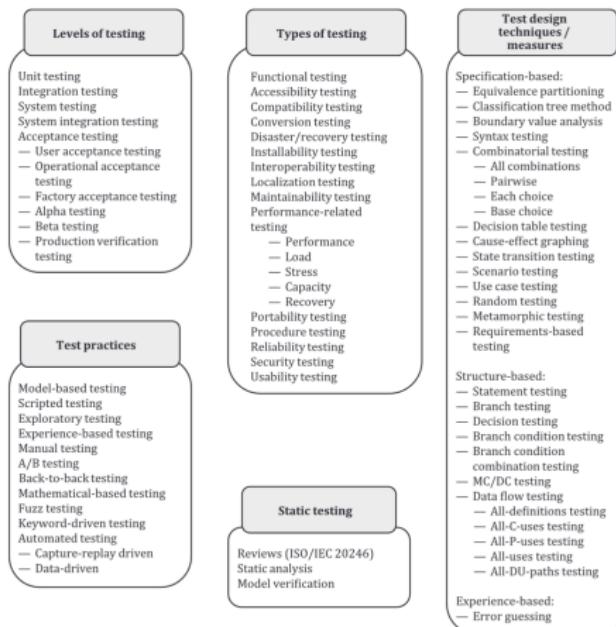
Kjerish (2016)



AzaToth (2008)

# The Lack of Standardized Terminology

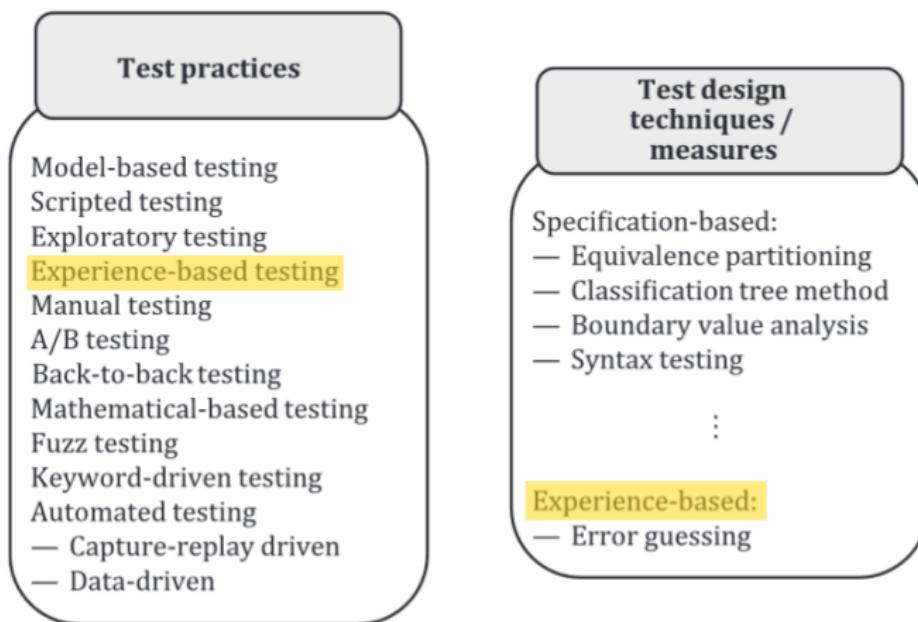
## "The Problem"



(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"

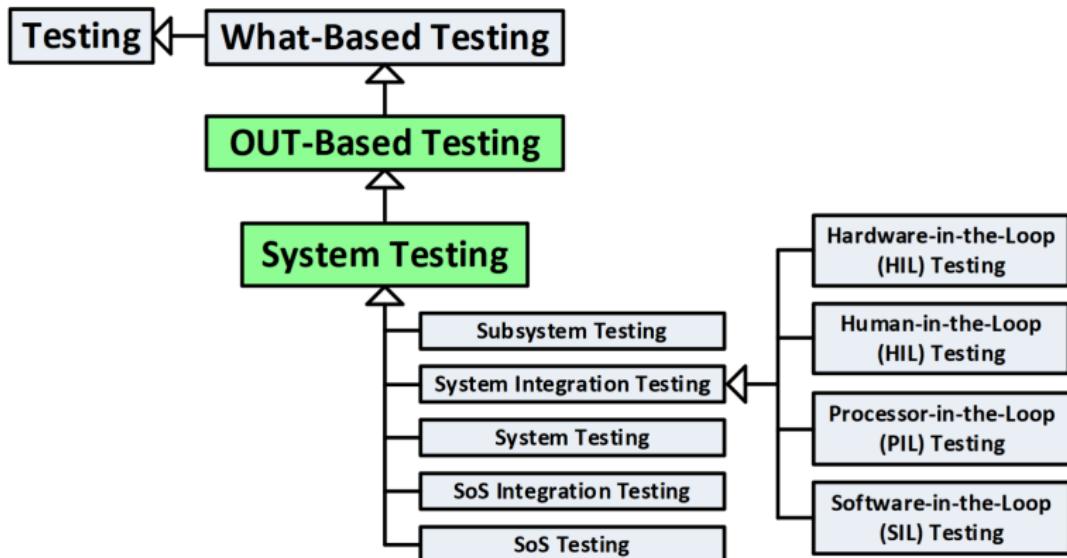
ISO/IEC/IEEE 29119-4 describes the **experience-based test design technique** of error guessing. Other **experience-based test practices** include (but are not limited to) exploratory testing (see [4.4.3.3](#)), tours, attacks, and checklist-based testing.

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

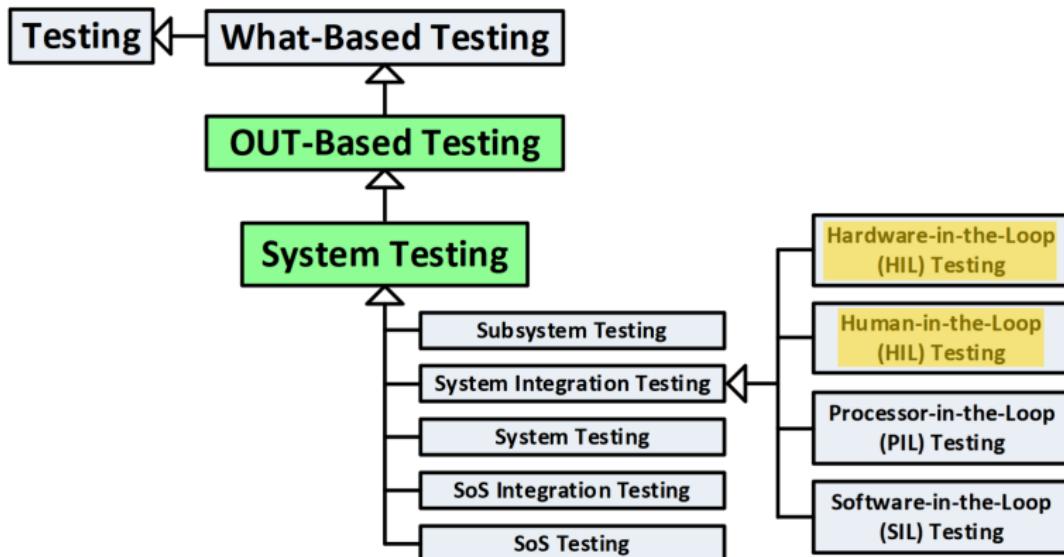


(Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

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

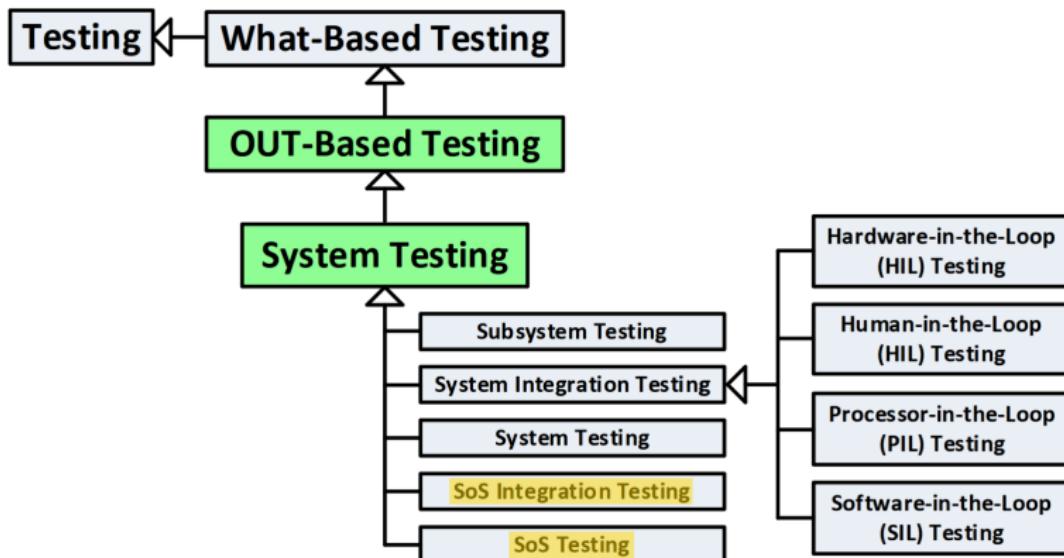


Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

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

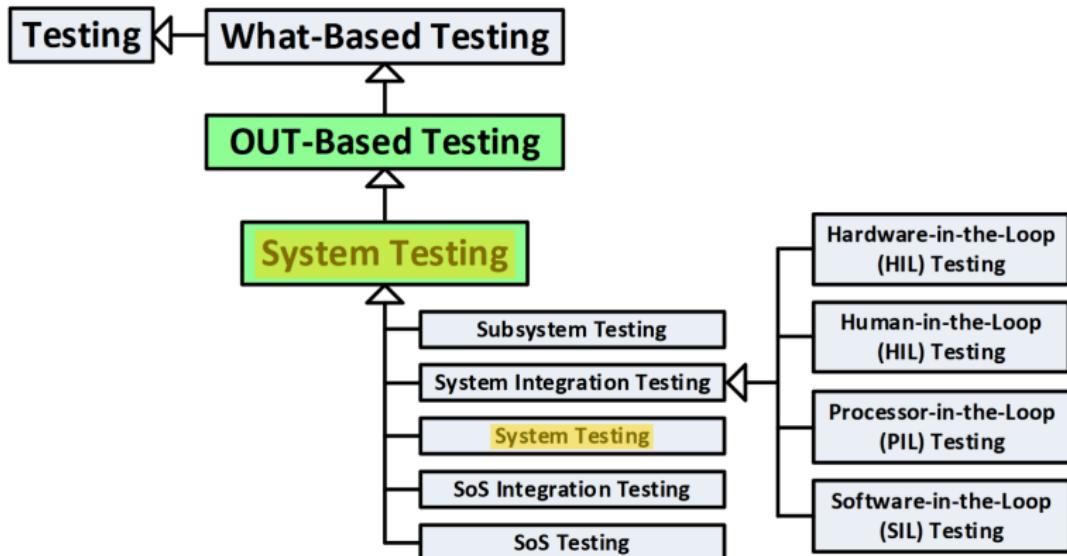


Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

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

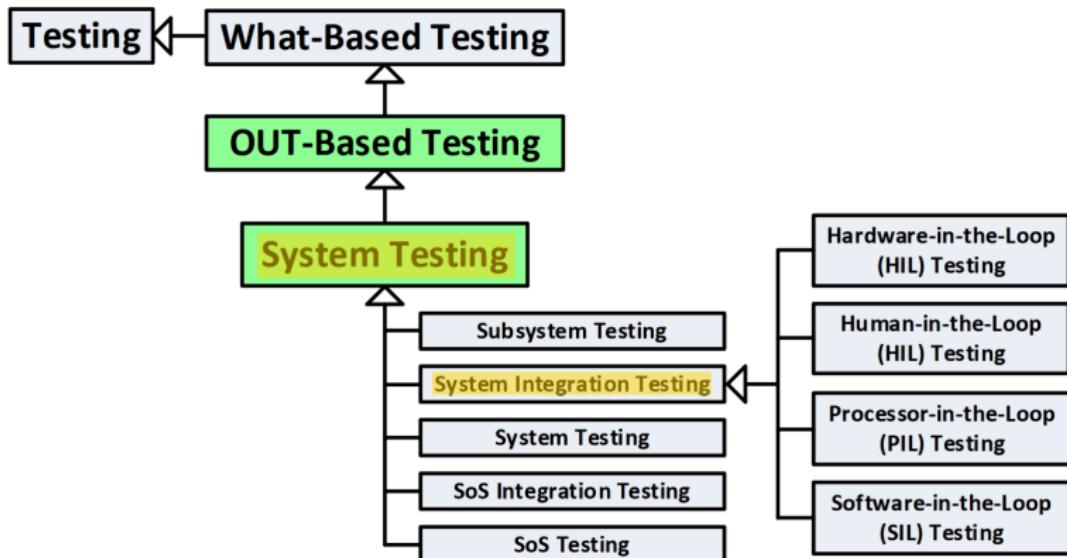


Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

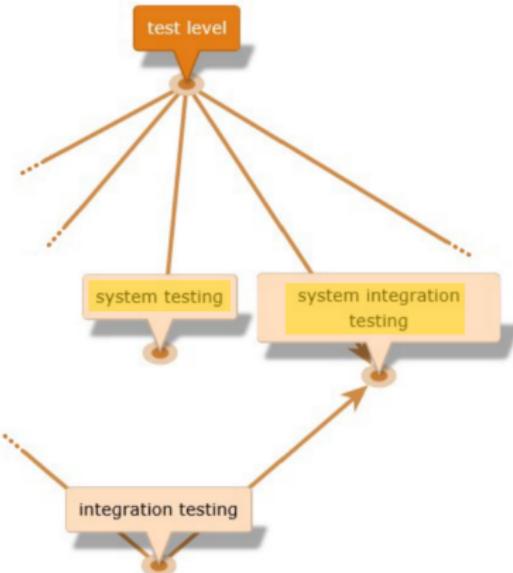
## What: by Object Under Test (OUT) – System Testing



Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

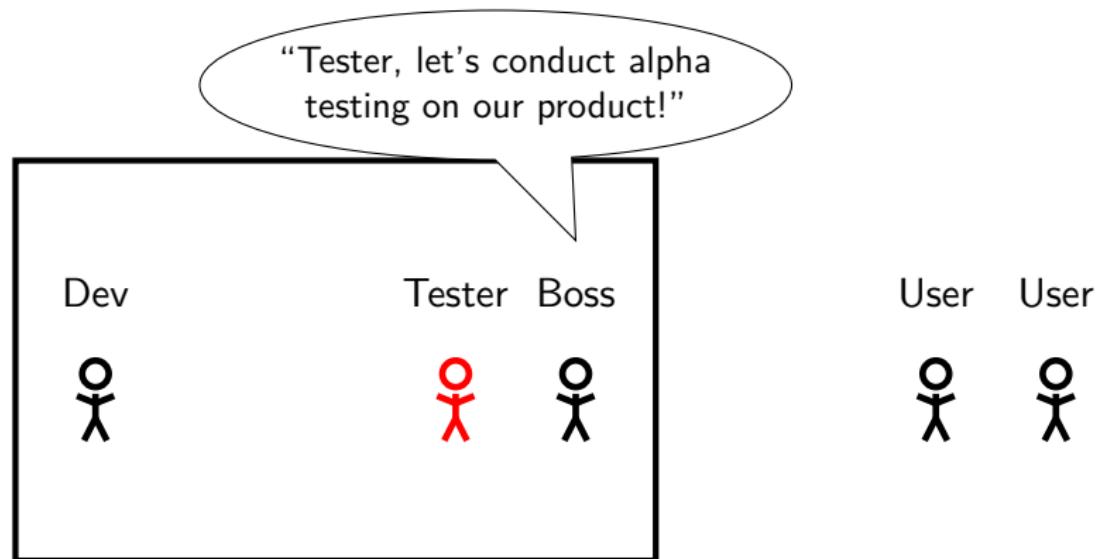


Adapted from (Hamburg and Mogyorodi, 2024)

Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

“The Problem” (cont.)

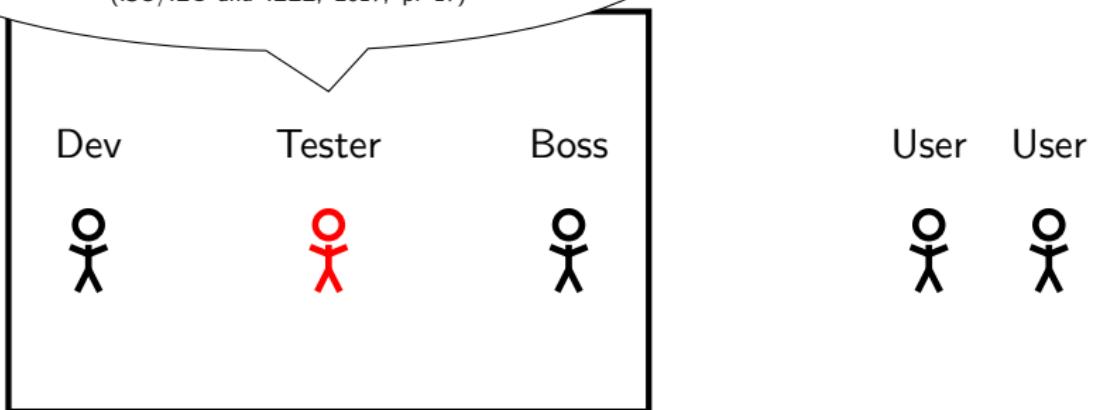


# The Lack of Standardized Terminology

## "The Problem" (cont.)

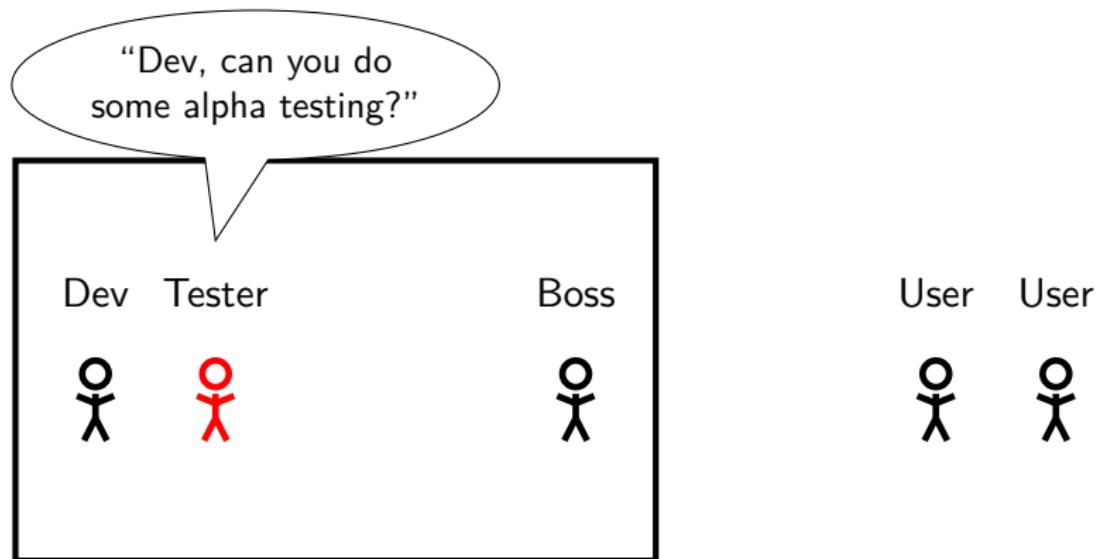
"Alpha testing is done by 'users within the organization developing the software'."

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



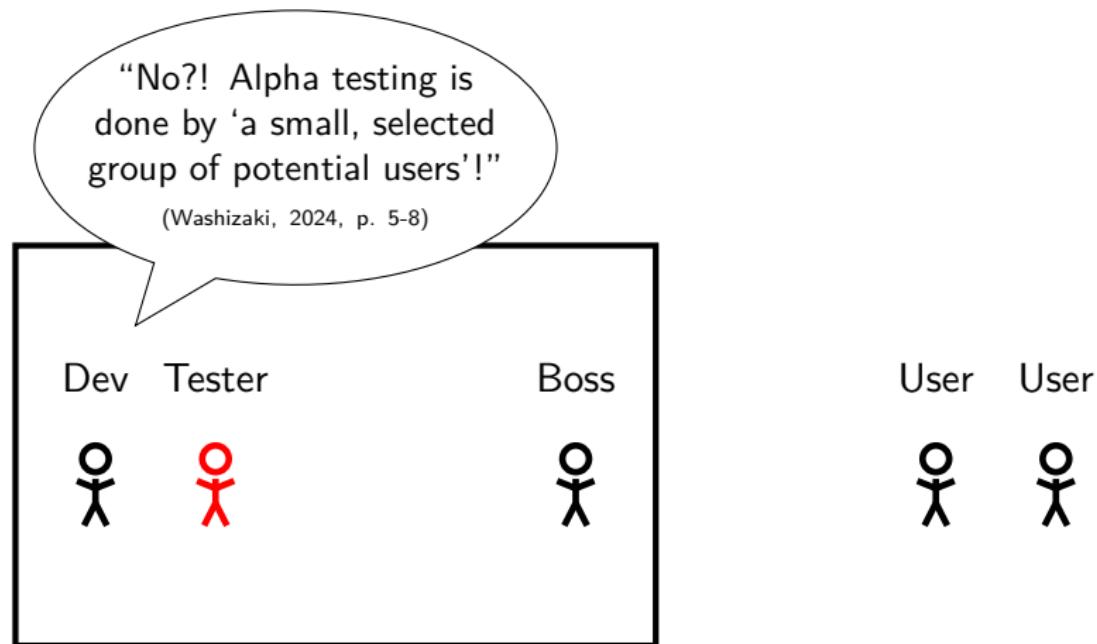
# The Lack of Standardized Terminology

## "The Problem" (cont.)



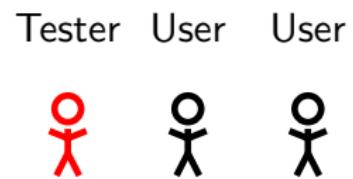
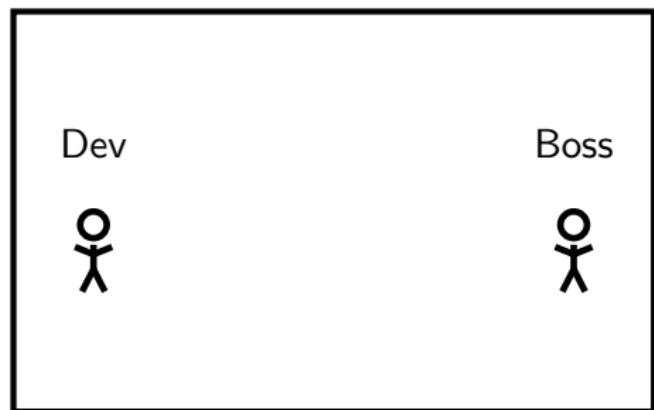
# The Lack of Standardized Terminology

## "The Problem" (cont.)



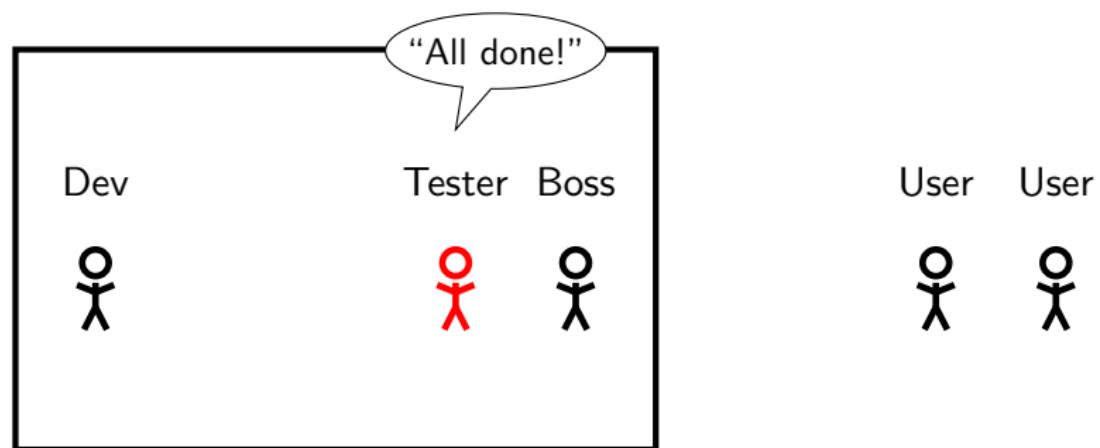
# The Lack of Standardized Terminology

“The Problem” (cont.)



# The Lack of Standardized Terminology

“The Problem” (cont.)

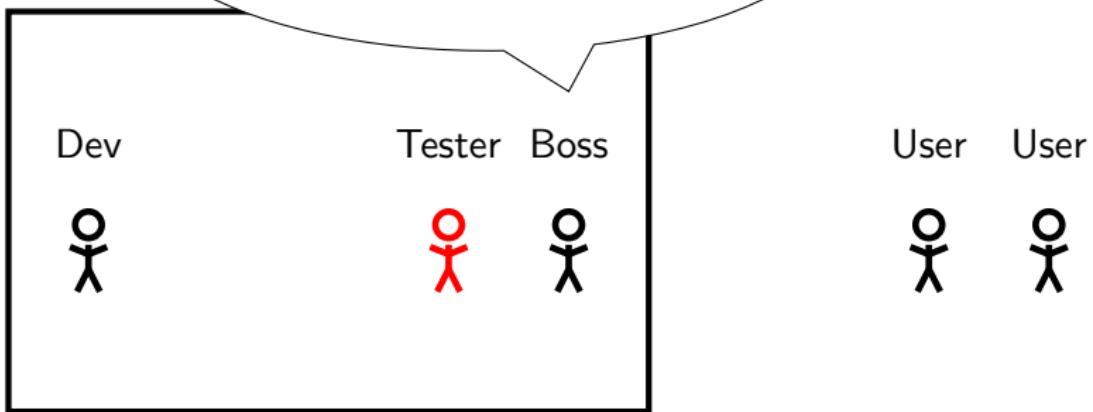


# The Lack of Standardized Terminology

“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)

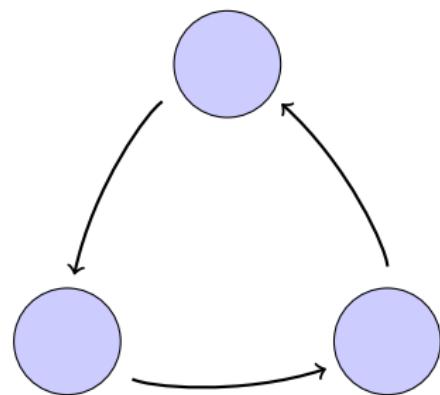


# Barriers to Effective Communication

“The Problem” (cont.)

## Interorganizational

Schools, companies, etc.

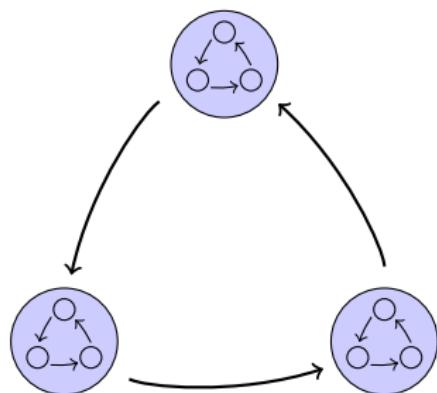


# Barriers to Effective Communication

“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)

Focus on:  
The Testing Process  
Organizing Terminology  
Relations between Approaches  
Traceability between Stages

# Table of Contents

## 1 Introduction

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

## 2 Project

- Research Questions
- Methodology

## 3 Results

# Research Questions

## Research Question 1

What test approaches do the literature describe?

## Research Question 2

How consistent are these descriptions?

## Research Question 3

Can we systematically resolve any of these inconsistencies?

# Methodology

## Procedure

### Research Question 1

What test approaches do the literature describe?

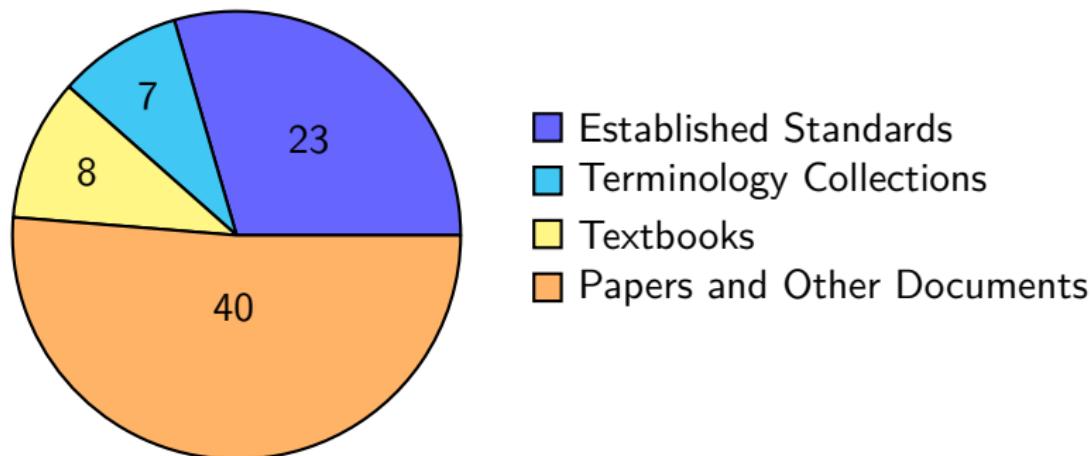
- ① Identify authoritative sources on software testing
- ② Identify all test approaches and testing-related terms
- ③ Record data for these terms; test approach data are comprised of:

① Names	③ Definitions	⑤ Parents
② Categories	④ Synonyms	⑥ Flaws
- ④ Repeat steps 1 to 3 for any missing or unclear terms

# Methodology

## Sources

In total, we investigate 78 sources

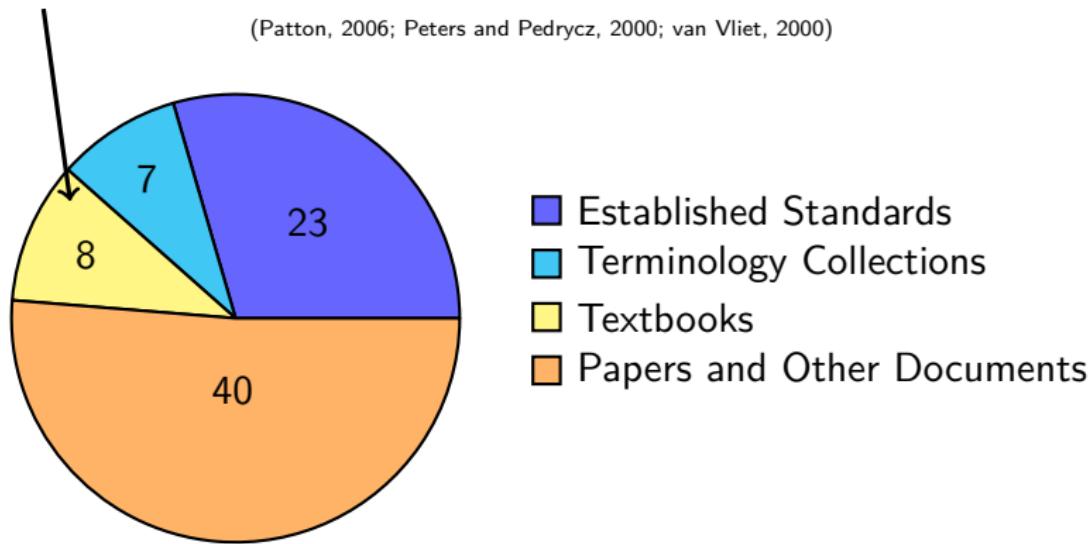


# Methodology

## Sources

Textbooks used at McMaster were our ad hoc starting points

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



# Methodology

## Terms

- 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

# Methodology

## Procedure

### Research Question 2

How consistent are these descriptions?

- 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

# Methodology

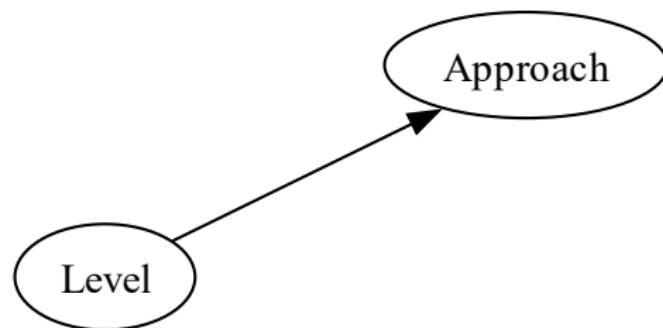
## Categories

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

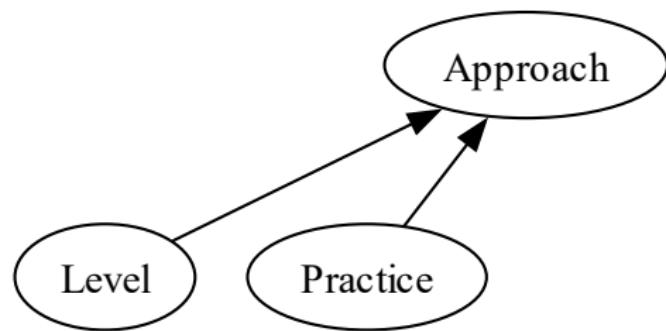
## Categories



**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

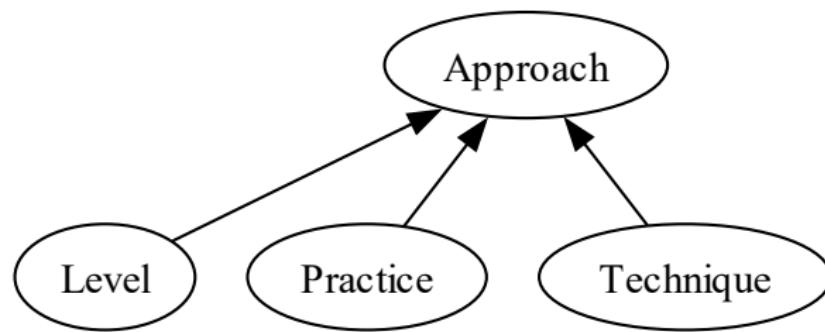
## Categories



**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

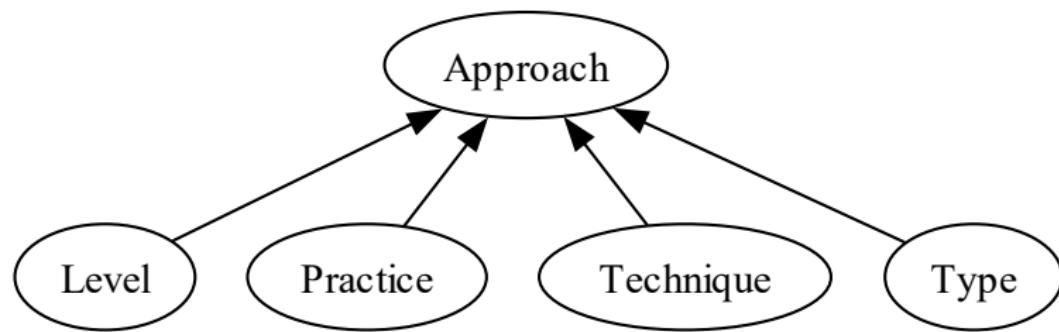
## Categories



**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

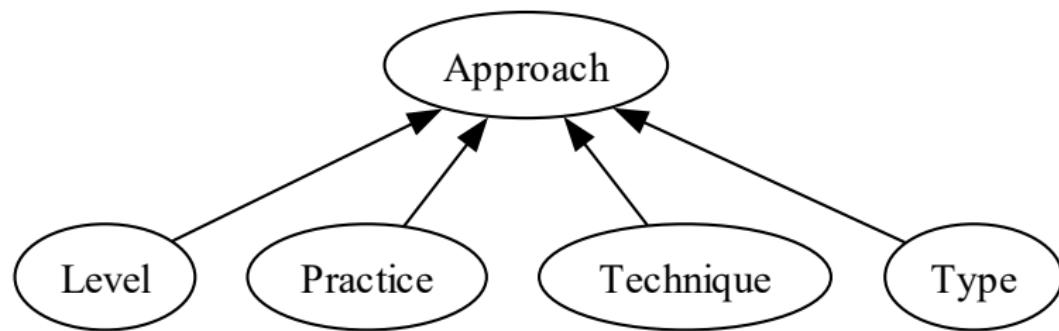
## Categories



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

# Methodology

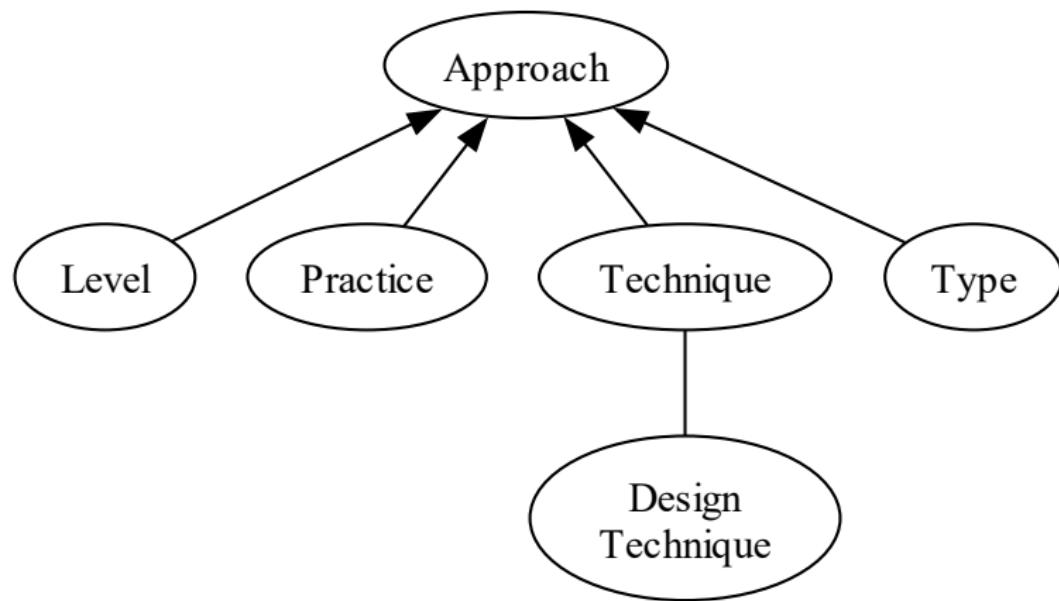
## Visualization Notation



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

# Methodology

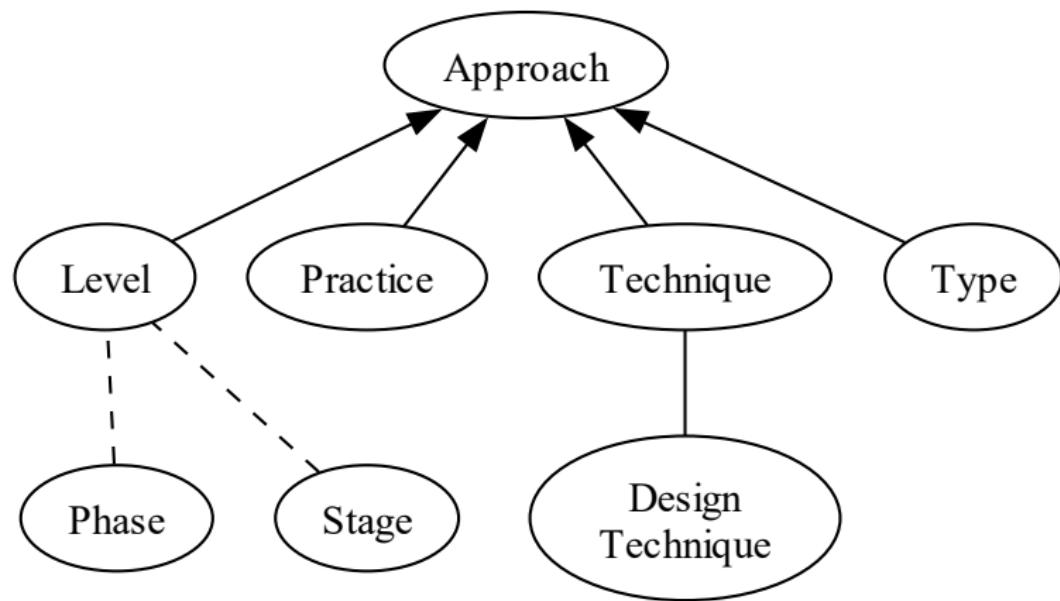
## Visualization Notation



Lines without arrowheads connect *synonyms*.

# Methodology

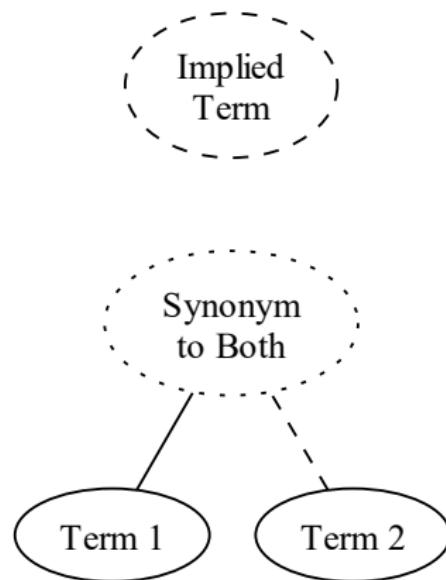
## Visualization Notation



Dashed lines indicate a relationship is *implicit*.

# Methodology

## Visualization Notation



Dashed outlines indicate a term is *implicit*.

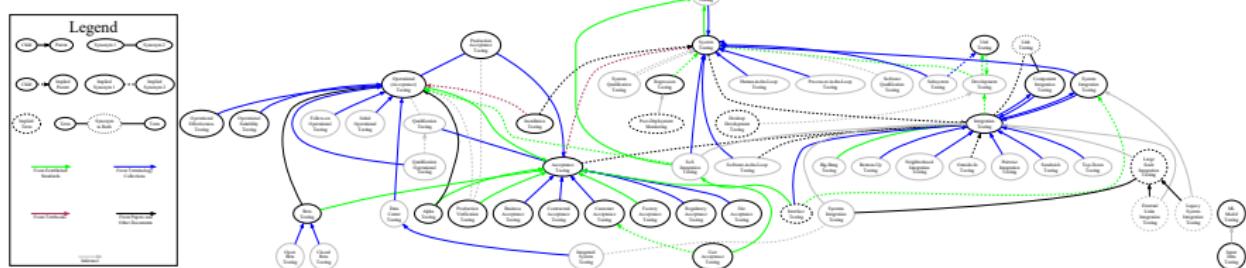
Dotted outlines indicate a term is a *synonym* to more than one term.

# Visualization of Test Approaches

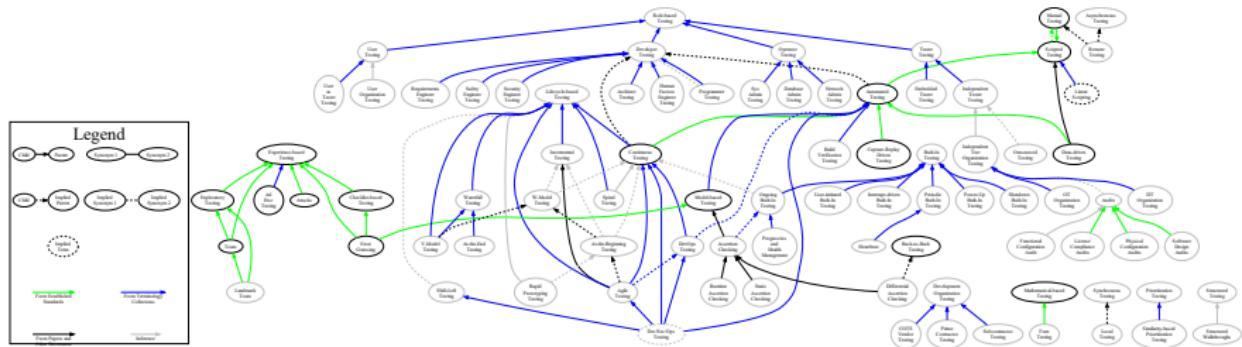
# Visualization of Test Approaches

! Dimension too large.

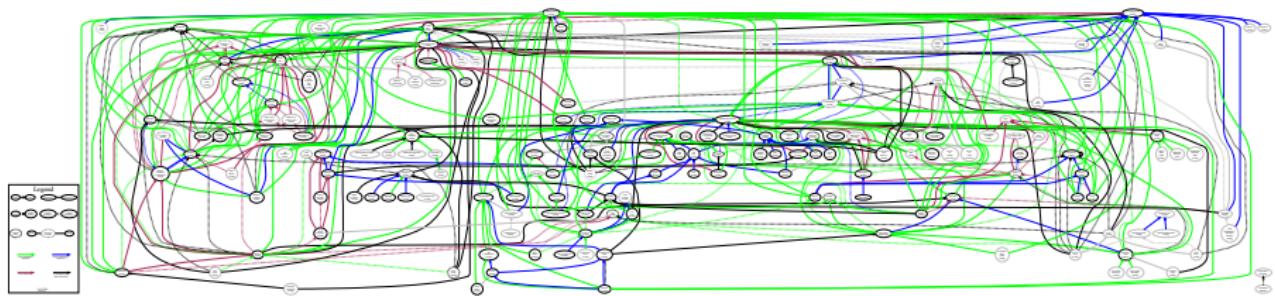
# Visualization of Test Levels



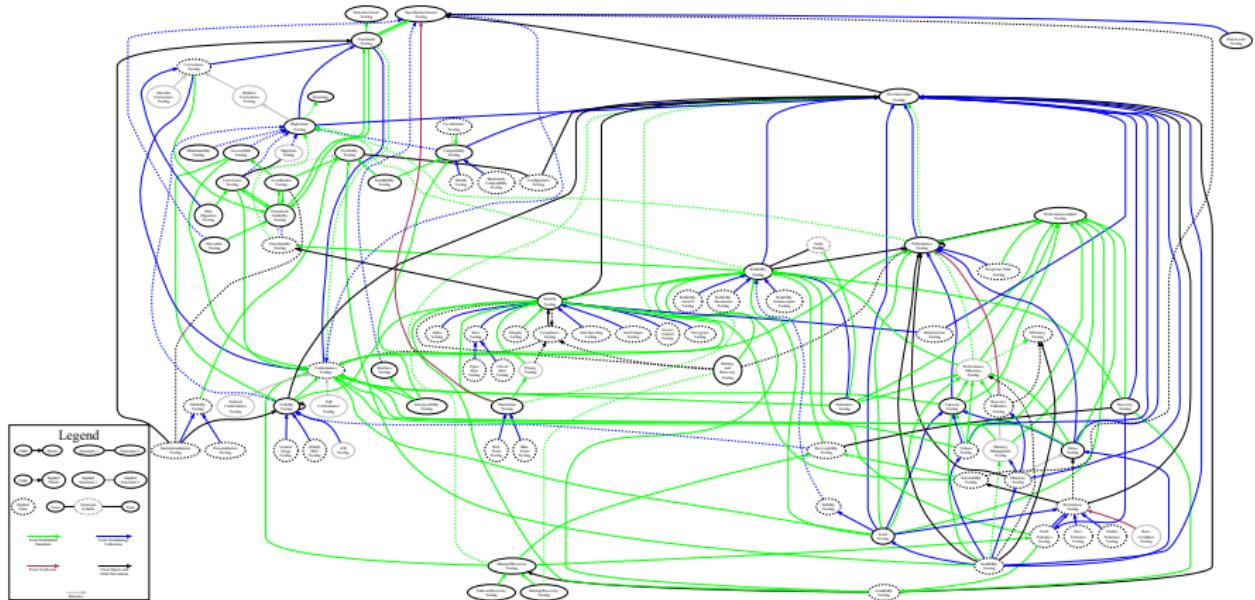
# Visualization of Test Practices



# Visualization of Test Techniques



# Visualization of Test Types



# Table of Contents

## 1 Introduction

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

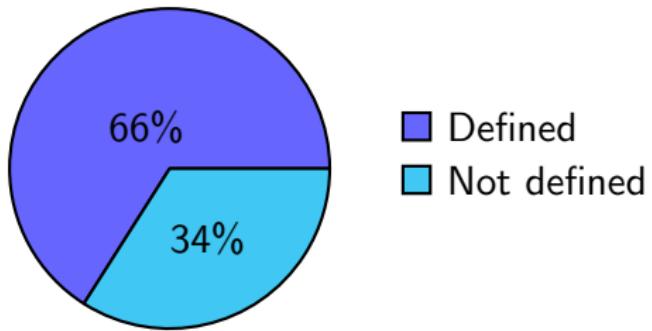
## 2 Project

- Research Questions
- Methodology

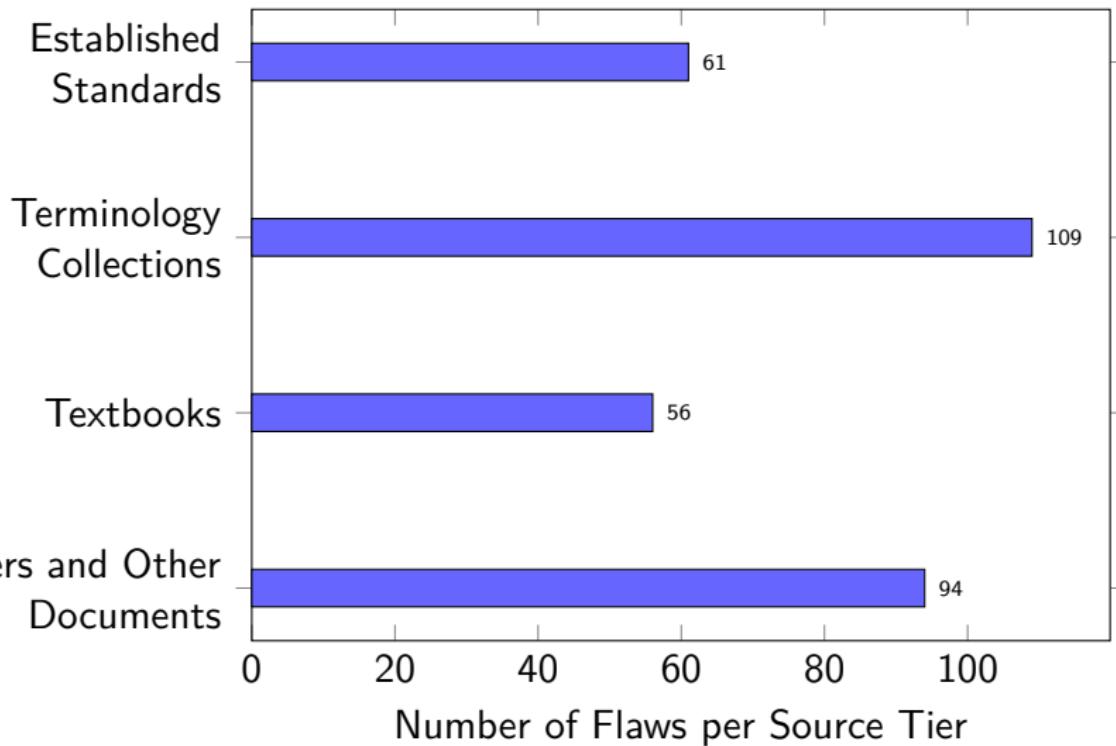
## 3 Results

# Overview

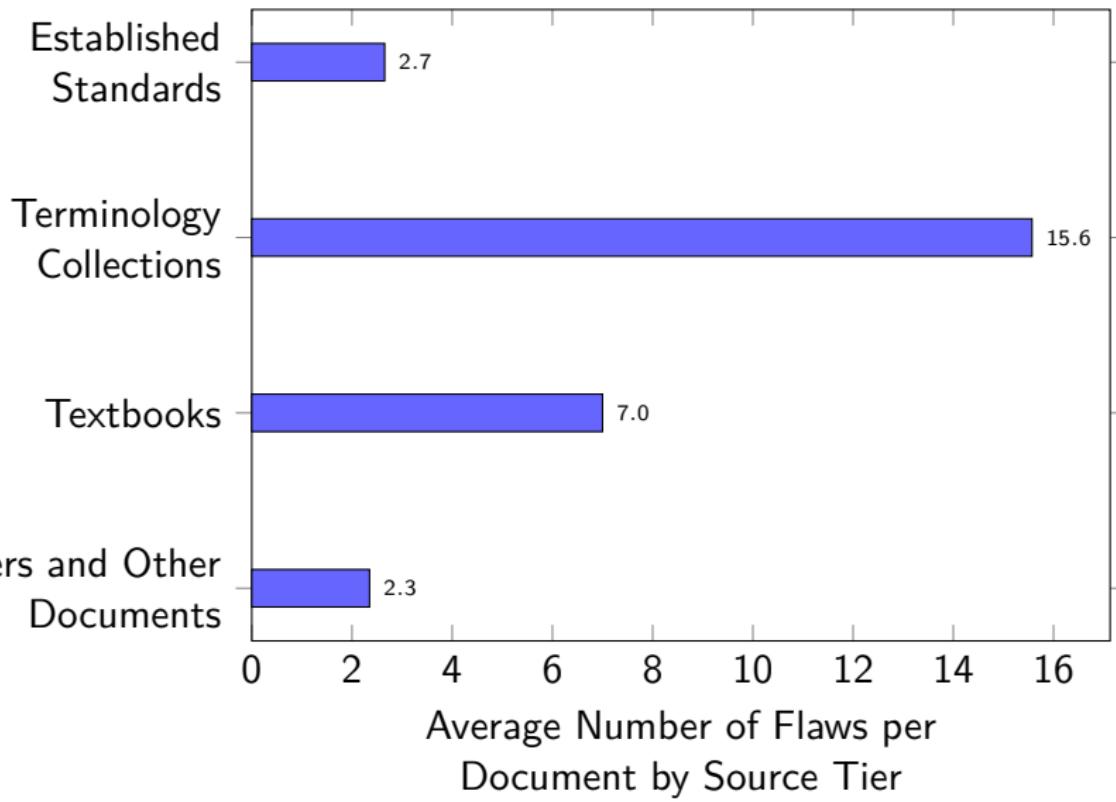
- 560 test approaches →
- 77 software qualities  
(may imply test approaches)
- 320 flaws in the software testing literature



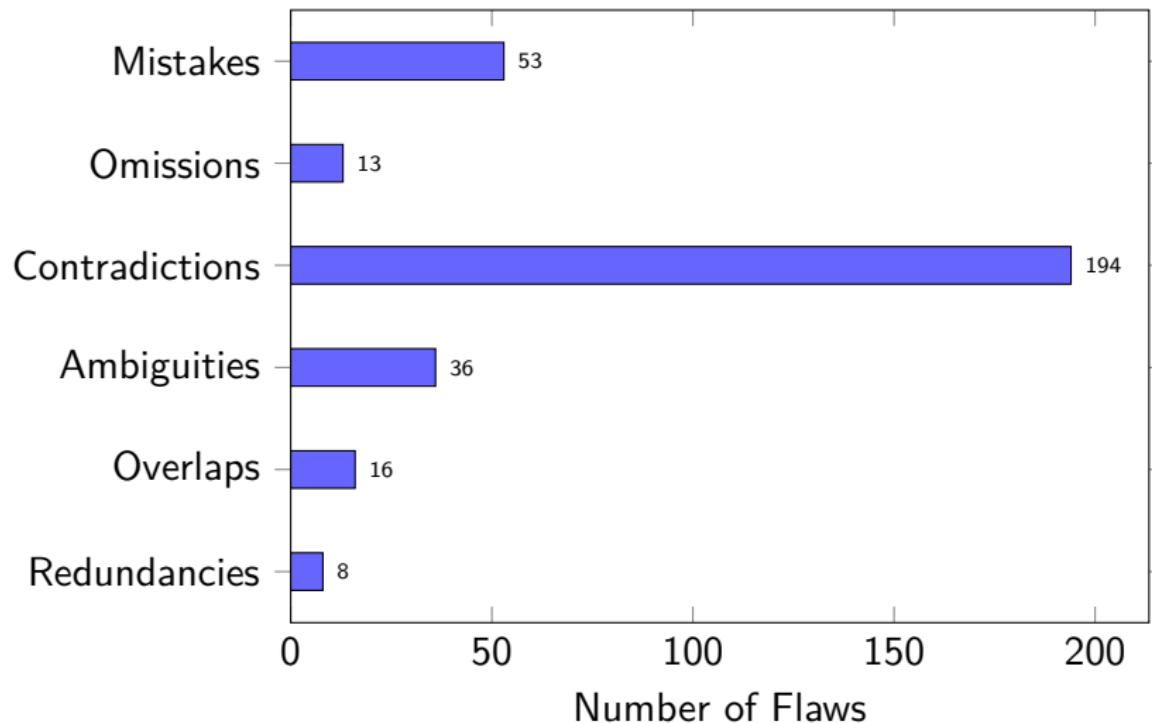
# Flaw Summary by Source Tier



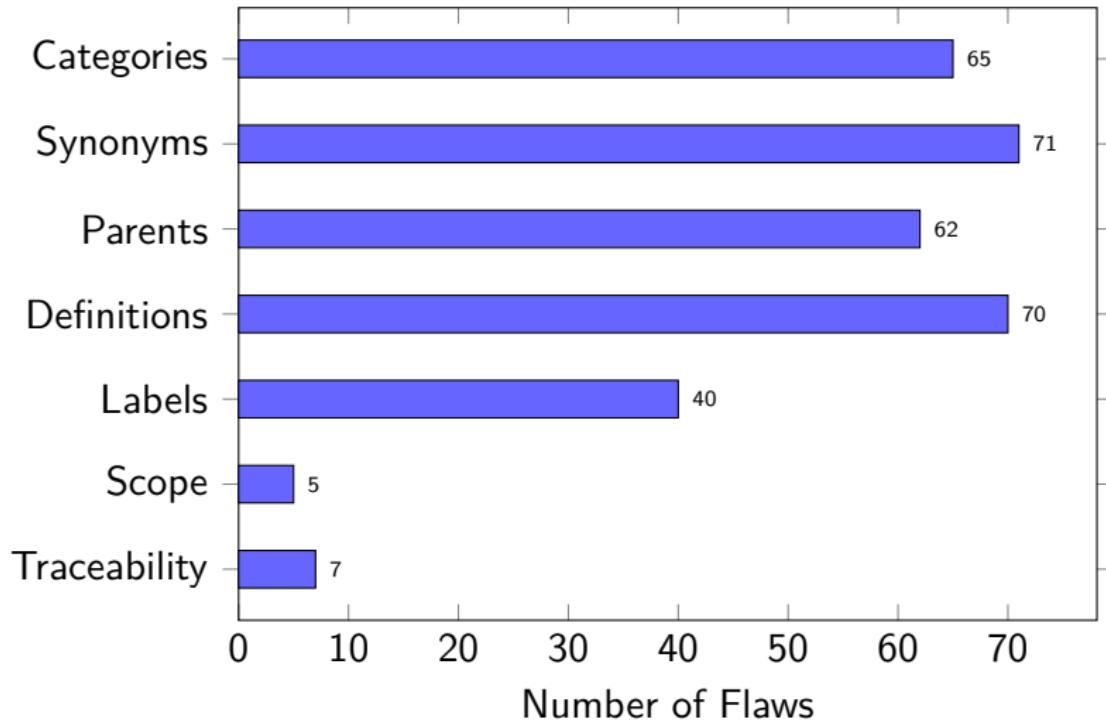
# Normalized Flaw Summary



# Flaw Summary by Manifestation



# Flaw Summary by Domain

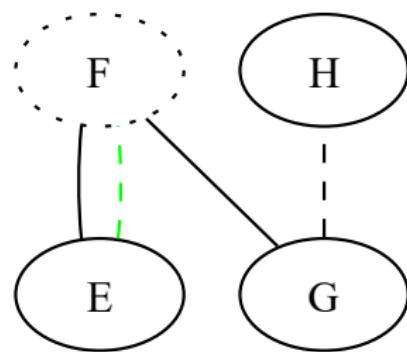


# Automated Flaws

## 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)



# Automated Flaws

## Intransitive Synonyms

Some prominent examples:

### ① Functional Testing:

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

### Source(s)

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

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

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

# Automated Flaws

## Intransitive Synonyms

Some prominent examples:

### ① Functional Testing:

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

### Source(s)

- (ISO/IEC and IEEE, 2017, p. 196; ... )  
(Washizaki, 2025a, p. 5-7)  
(Washizaki, 2025a, p. 5-7)

### ② Portability Testing:

- Flexibility Testing
- Configuration Testing

- (ISO/IEC, 2023)  
(Kam, 2008, p. 43)

### 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

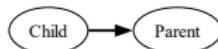
We also find some test approaches that are given as parents of themselves:

- 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

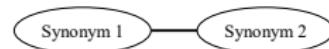
## Synonym and Parent-Child Overlaps

### Legend



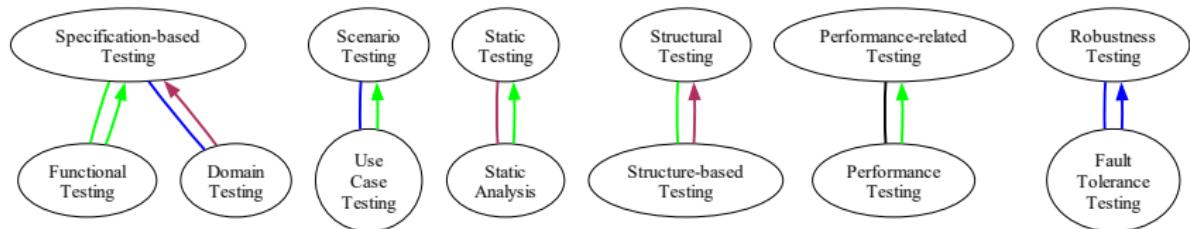
From Established Standards

From Terminology Collections



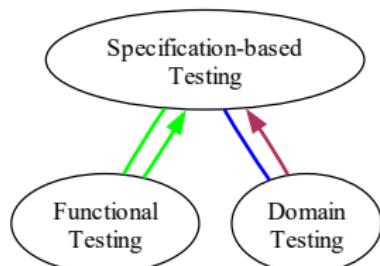
From Textbooks

From Papers and Other Documents



# Automated Flaws

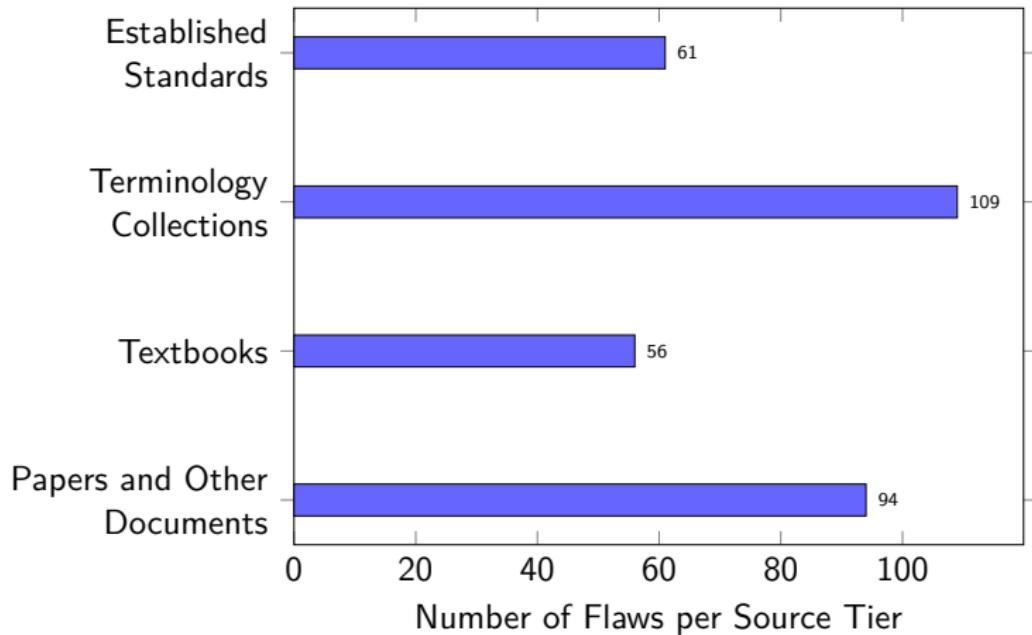
## Synonym and Parent-Child Overlaps



- 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

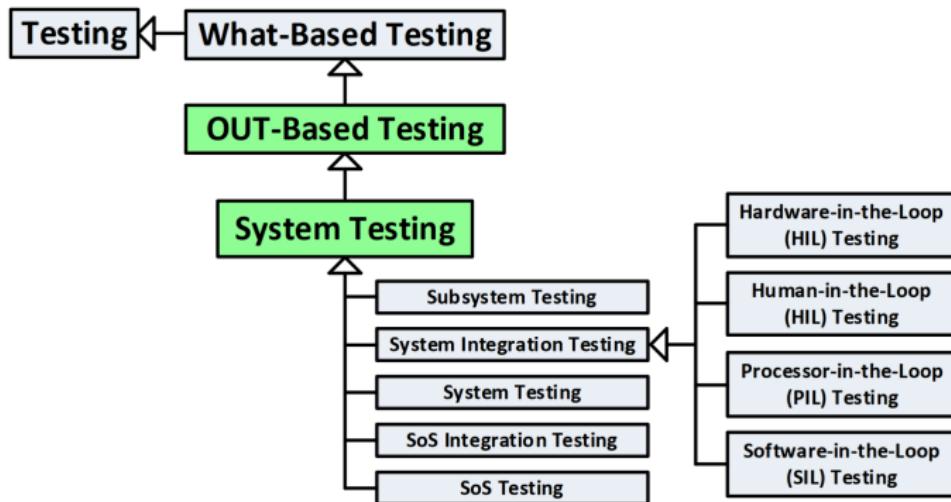
- The software testing literature is flawed, so don't assume everyone is on the same page



# 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)

# 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  $\text{\LaTeX}$  code, including regex
- ChatGPT and GitHub Copilot were both used for assistance with  $\text{\LaTeX}$  formatting

# 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](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](http://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](https://glossary.istqb.org/en_US/search).

## References II

- 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>.

## References IV

- 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.
- Penubag and Arnaud Ramey. A few images illustrating forces, August 2010. URL [https://commons.wikimedia.org/wiki/File:Force\\_examples.svg](https://commons.wikimedia.org/wiki/File:Force_examples.svg).

## References V

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 VI

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>.