

# 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

## 4 Next Steps

## 5 Conclusion

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## 3 Results

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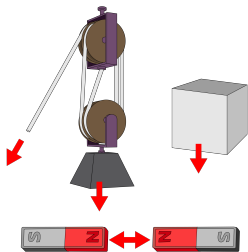
## 5 Conclusion

# The Need for Standardized Terminology

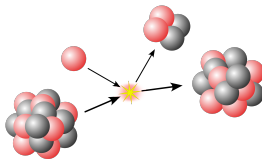
- Engineering is applied science
- Scientific fields use precise terminology



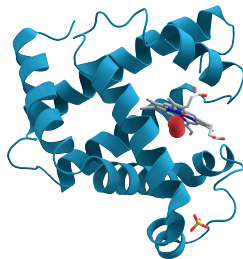
SOFTWARE  
ENGINEERING



Penubag and Ramey (2010)



Kjerish (2016)

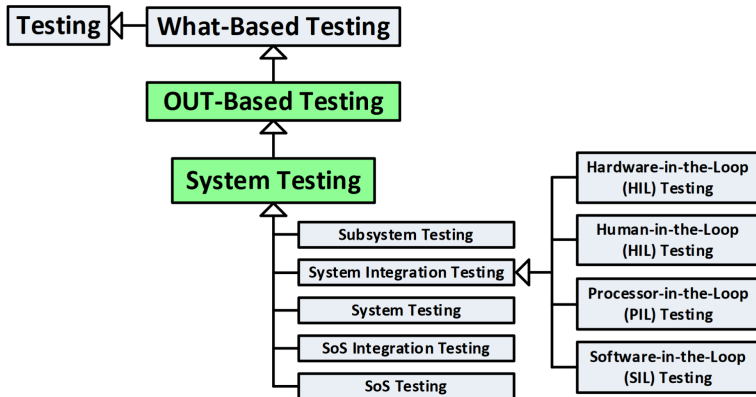


AzaToth (2008)

# The Lack of Standardized Terminology

## "The Problem"

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

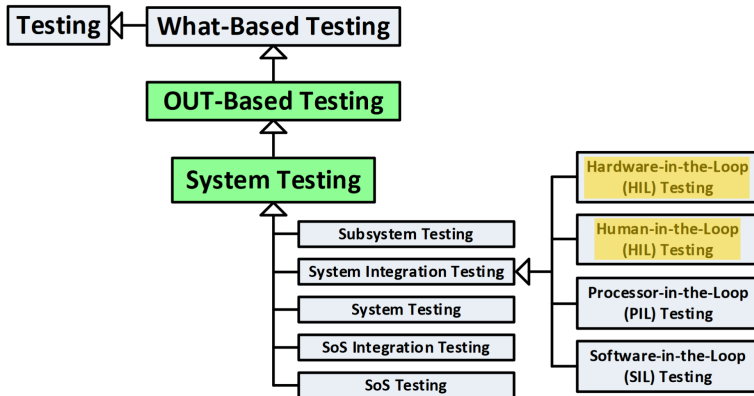


(Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

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

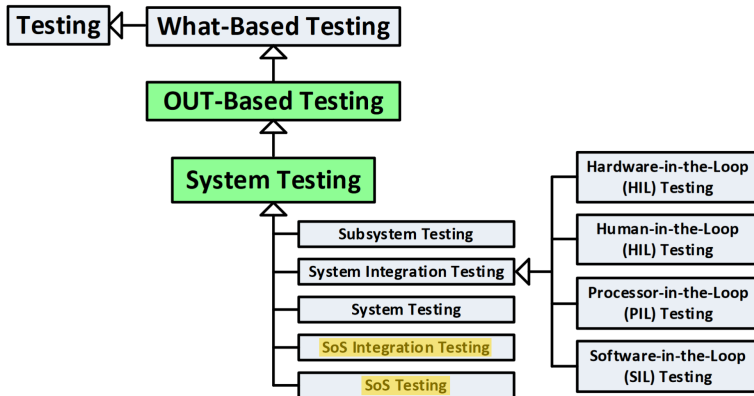


Adapted from (Firesmith, 2015, p. 23)

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## "The Problem"

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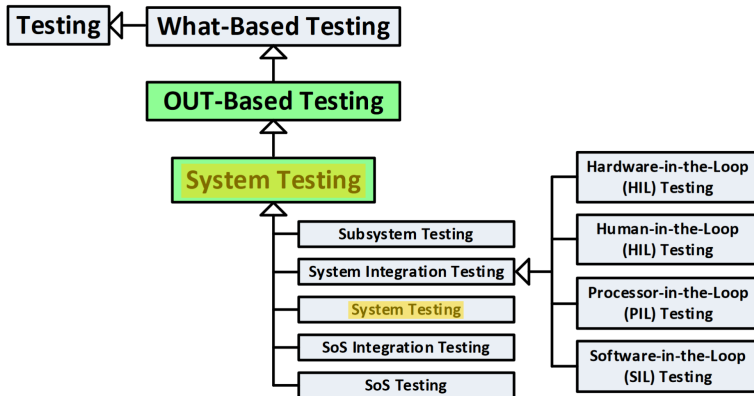


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# The Lack of Standardized Terminology

## "The Problem"

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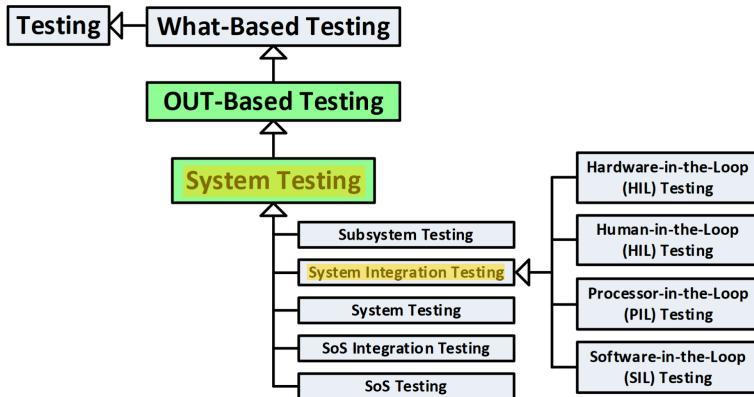
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# The Lack of Standardized Terminology

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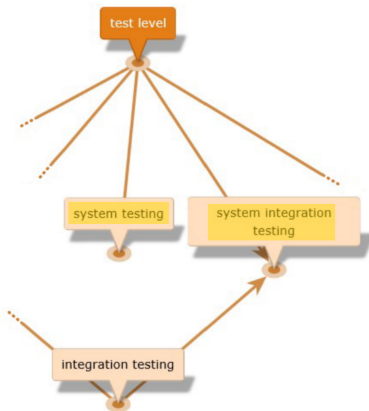
### What: by Object Under Test (OUT) – System Testing



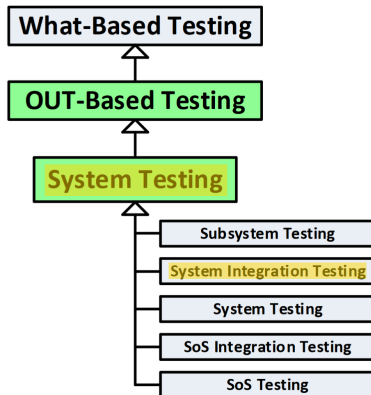
Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

## "The Problem"



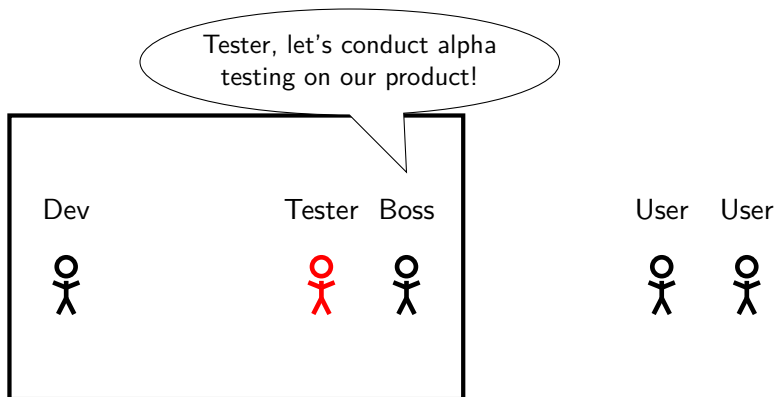
Adapted from (Hamburg and Mogyorodi, 2024)



Adapted from (Firesmith, 2015, p. 23)

# The Lack of Standardized Terminology

"The Problem" (cont.)

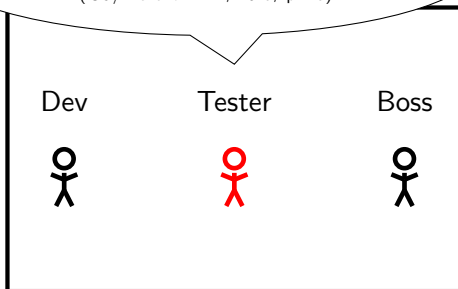


# The Lack of Standardized Terminology

## "The Problem" (cont.)

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

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

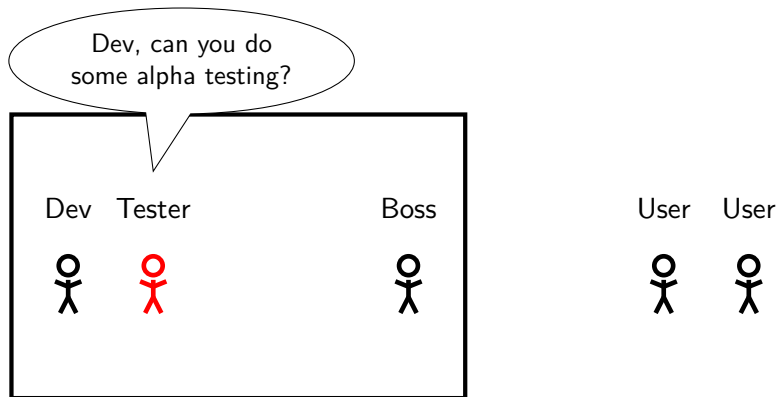


User User



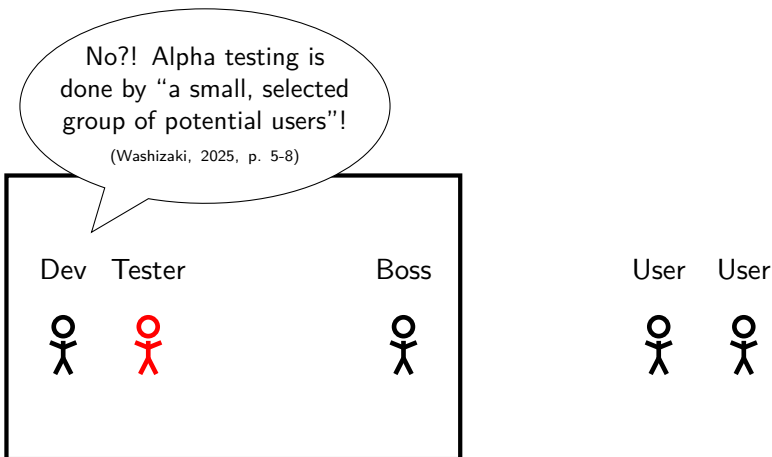
# The Lack of Standardized Terminology

"The Problem" (cont.)



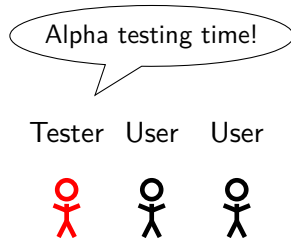
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## "The Problem" (cont.)



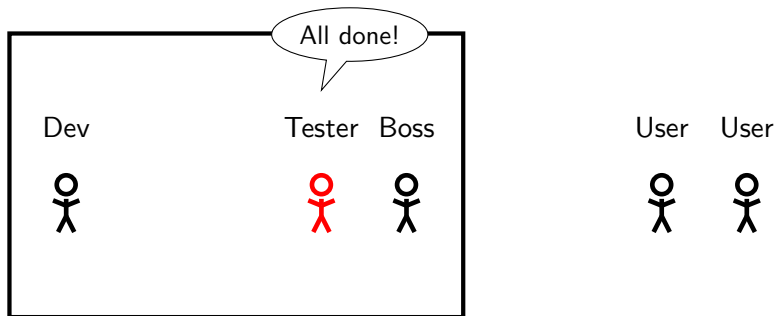
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"The Problem" (cont.)



# The Lack of Standardized Terminology

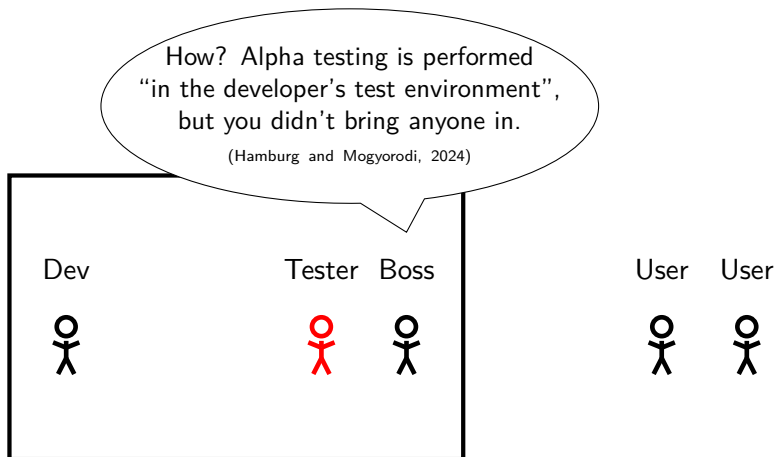
"The Problem" (cont.)





# The Lack of Standardized Terminology

## "The Problem" (cont.)

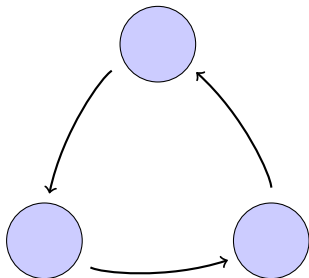


# Barriers to Effective Communication

"The Problem" (cont.)

## Interorganizational

Schools, companies, etc.

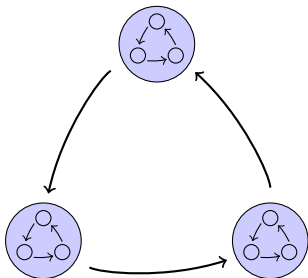


# Barriers to Effective Communication

“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

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# Research Questions

## Research Question 1

What test approaches do the literature describe?

## Research Question 2

How consistent are these descriptions?

## Research Question 3

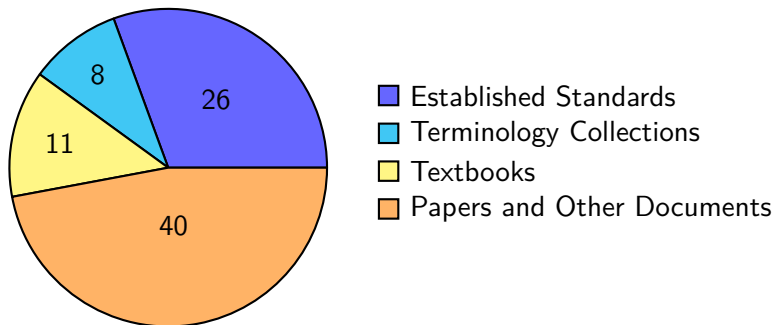
Can we systematically resolve any of these inconsistencies?

### 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

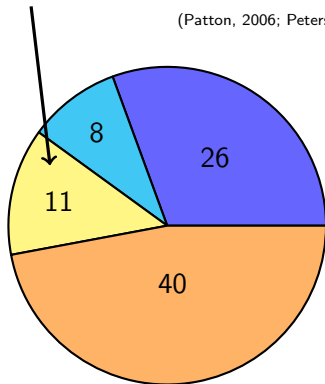
In total, we investigated 85 sources





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 built a glossary with a row for each test approach

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

Information from (ISO/IEC and IEEE, 2022)

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

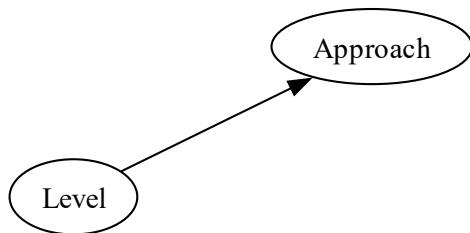
### Research Question 2

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

### Approach

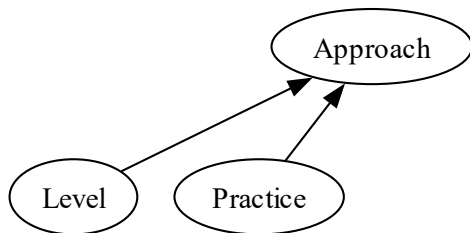
**Approach:** a “high-level test implementation choice” (ISO/IEC and IEEE, 2022, p. 10) used to “pick the particular test case values” (2017, p. 465)



**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

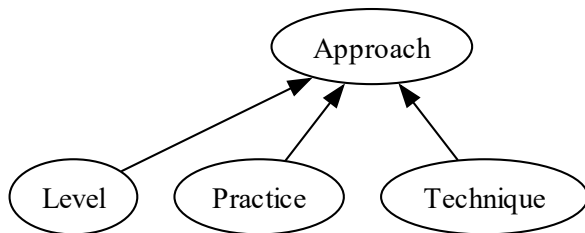
## Categories



**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

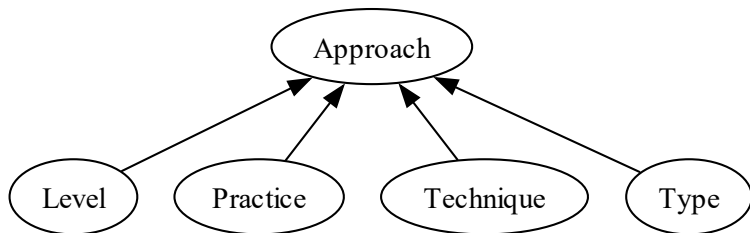
## Categories



**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)

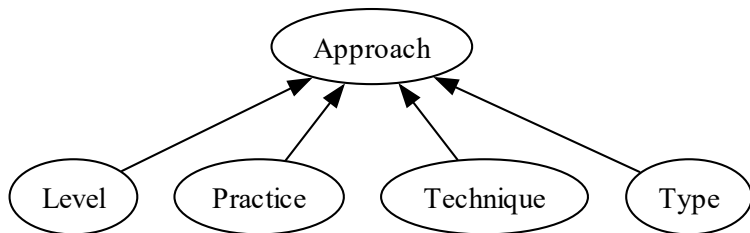
# Methodology

## Categories

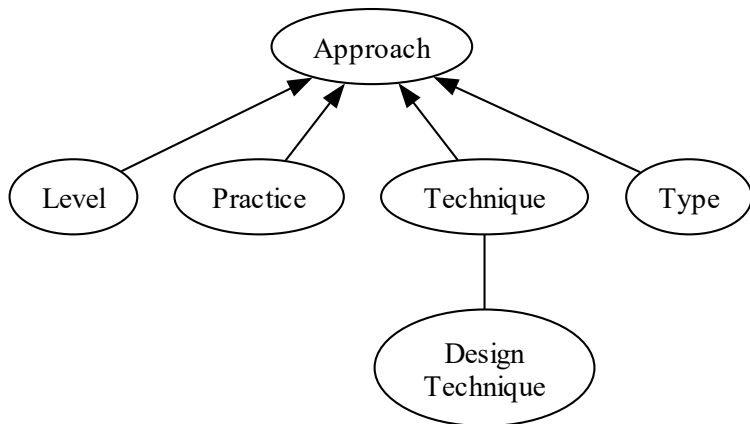


**Type:** “testing that is focused on specific quality characteristics”  
(ISO/IEC and IEEE, 2022, p. 15; 2021c, p. 7; 2017, p. 473)





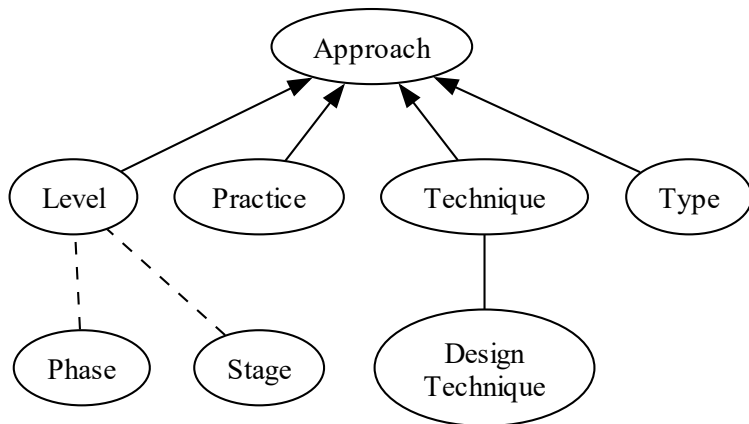
Arrows point from a *child* node to a *parent* node.



Lines without arrowheads connect *synonyms*.

# Methodology

## Visualization Notation



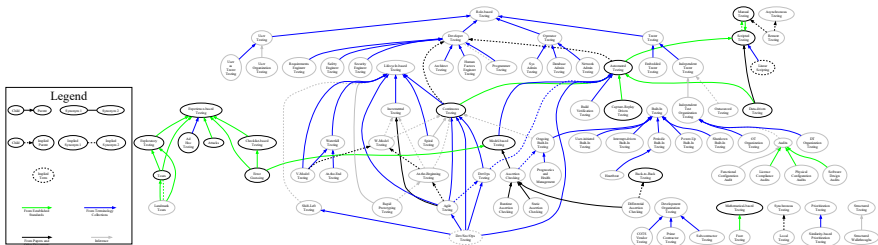
Dashed lines indicate a relationship is *implicit*.

# Visualization of Test Approaches

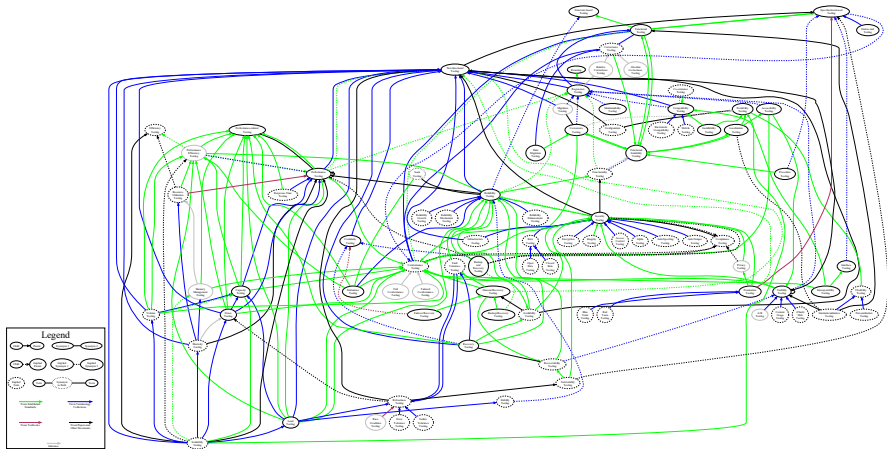
# Visualization of Test Approaches

! Dimension too large.

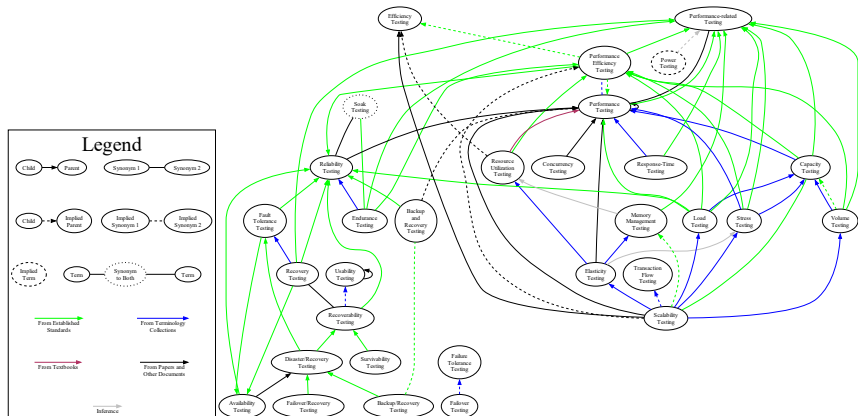
# Visualization of Test Practices



# Visualization of Test Types



# Visualization of Performance-related Testing





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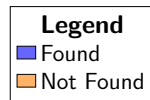
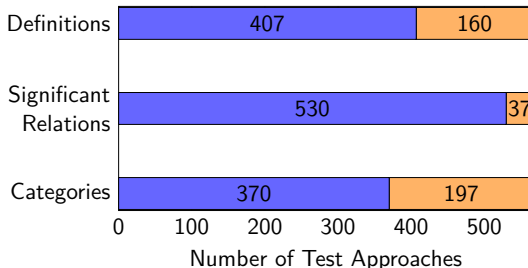
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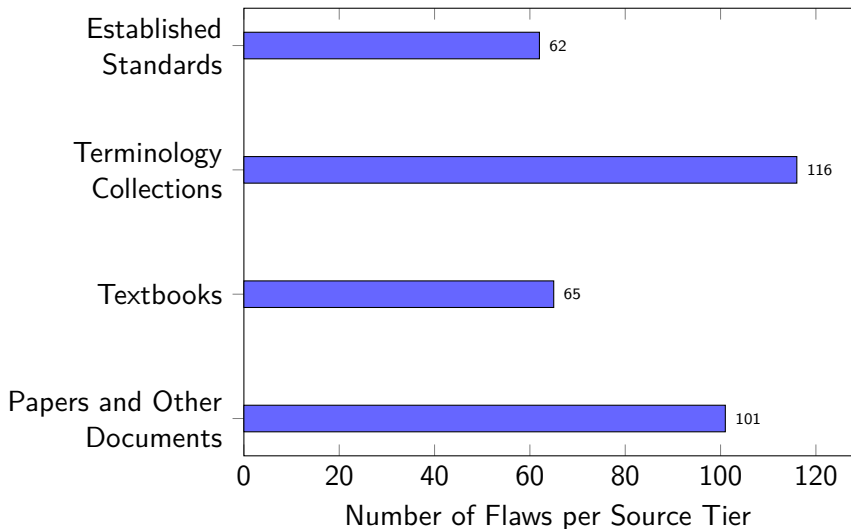
## 5 Conclusion

# Overview

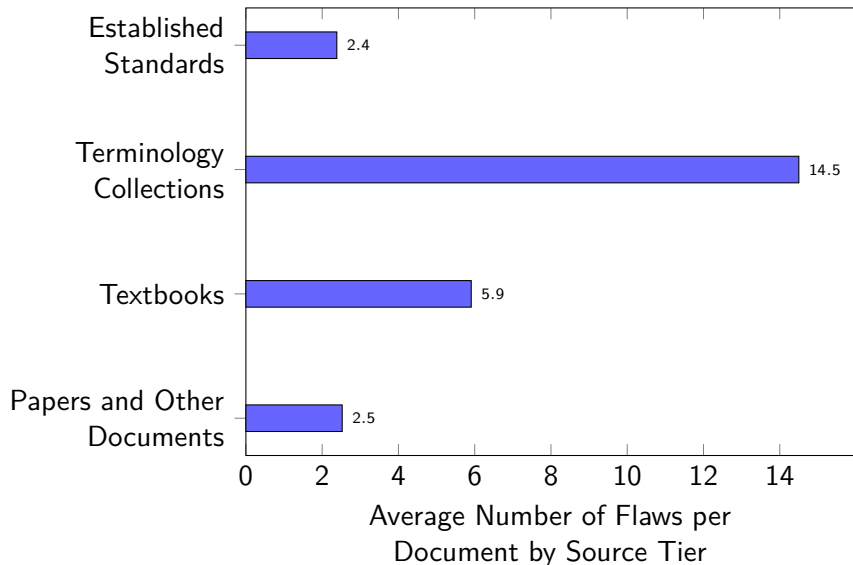
- 567 test approaches →
- 75 software qualities  
(may imply test approaches)
- 344 flaws in the  
software testing  
literature



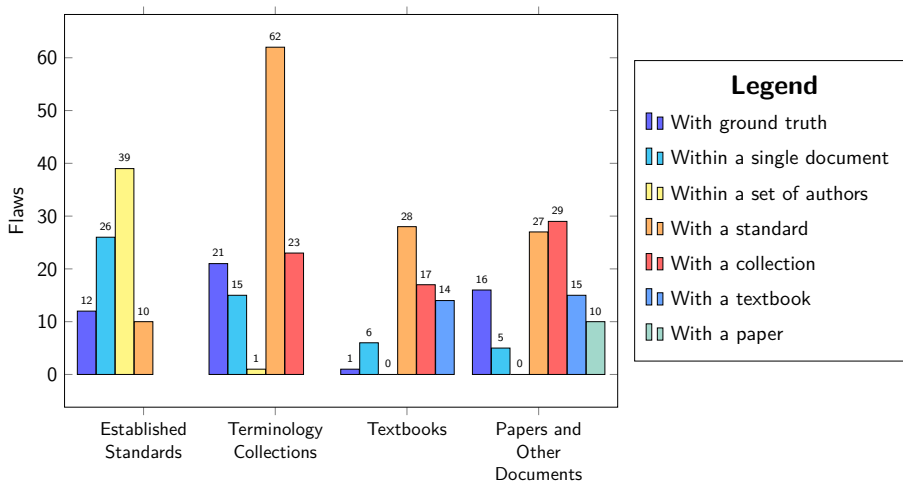
# Flaw Summary by Source Tier



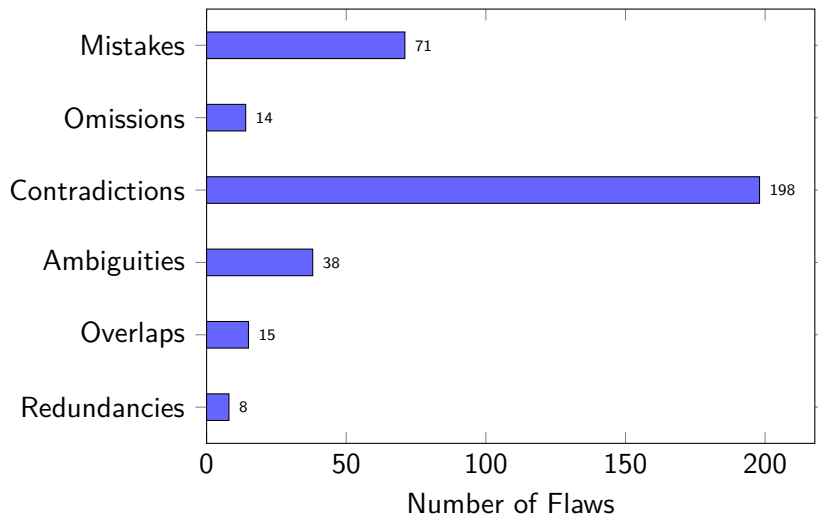
# Normalized Flaw Summary



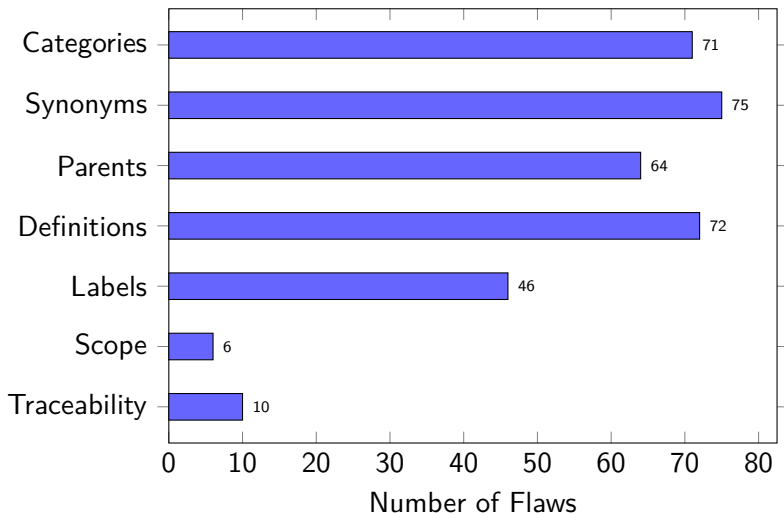
# More Detailed Flaw Summary by Source Tier



# Flaw Summary by Manifestation



# Flaw Summary by Domain



# General Flaw Observations

- ① Contradictions are the most common manifestation, likely due to our automation and inconsistencies between (sets of) authors
- ② Approach categories are the most subjective and one of the most common domains
- ③ Semantic flaws are more common than syntactic ones

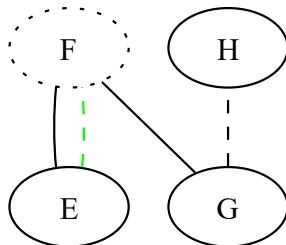


# Automated Flaws

## 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)                          |

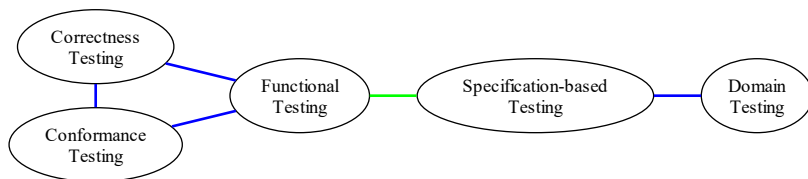


### Functional testing:

- Specification-based testing (ISO/IEC and IEEE, 2017, p. 196; van Vliet, 2000, p. 399; ...)
- Conformance testing *and* correctness testing (Washizaki, 2025, p. 5-7)

### Specification-based testing:

- Functional testing (ISO/IEC and IEEE, 2017, p. 196; van Vliet, 2000, p. 399; Kam, 2008, pp. 44–45, 48)
- Domain testing (Washizaki, 2025, p. 5-10)

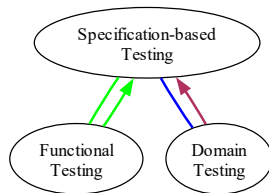


We also found some test approaches that are given as parents of themselves:

- 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



- 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, 2025, p. 5-10)
  - Child (Peters and Pedrycz, 2000, Tab. 12.1)

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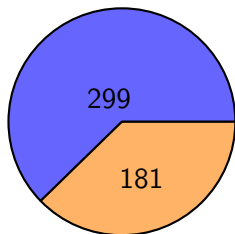
# Next Steps

## Threats to Validity

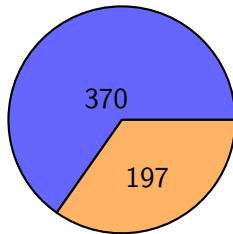
- 1 Performed by a single researcher over a period of time
- 2 Terms we defined: categories, flaws, . . .
- 3 Derived approaches: test types from qualities, test techniques from coverage metrics, . . .
- 4 Limits and enforcement of standards

# Next Steps

## Future Work



Before



After

### Legend

- Defined
- Undefined

- 1 Iterate over undefined test approaches
- 2 Investigate missing approaches
- 3 Fill in other approach data
- 4 Improve approach relation visualizations
- 5 Identify and detect more flaws

### Research Question 3

Can we systematically resolve any of these inconsistencies?

- It will be more effective to do this more systematically once the previous tasks are finished
- Our glossaries and tools for analyzing them provide a solid foundation for this task on which future researchers can build



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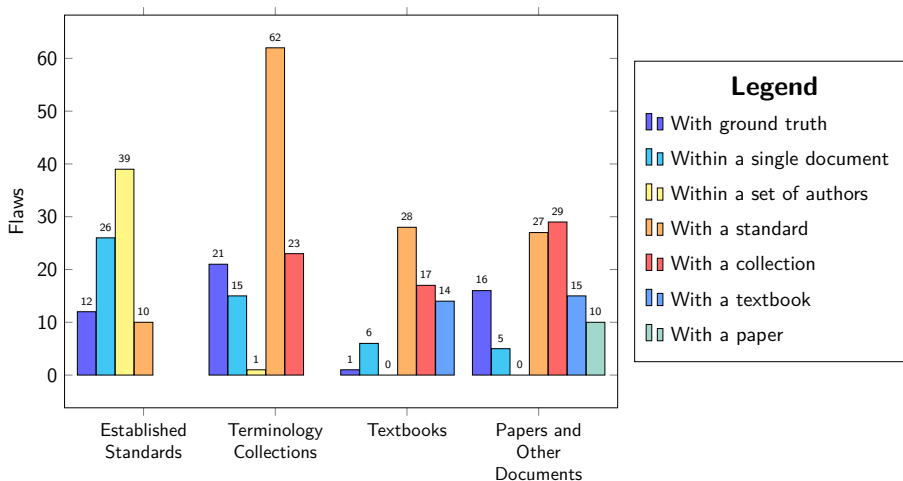
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# Conclusion

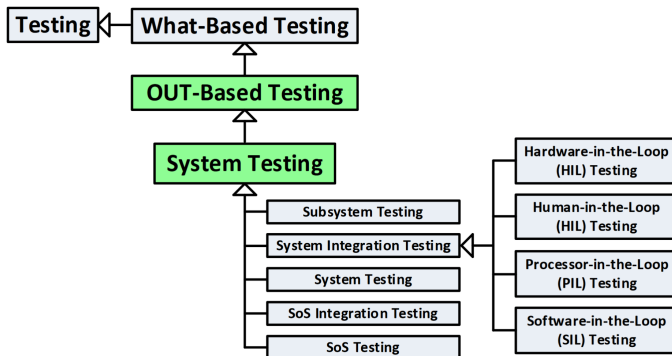
- The software testing literature is flawed, so don't assume everyone is on the same page



# 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
- My family has also supported me in more ways than I can count, and I cannot thank them enough
- 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

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