Putting Software Testing Terminology to the Test

M.A.Sc. Seminar

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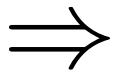
The Need for Standardized Terminology

- Engineering is applied science
- Scientific fields use precise terminology

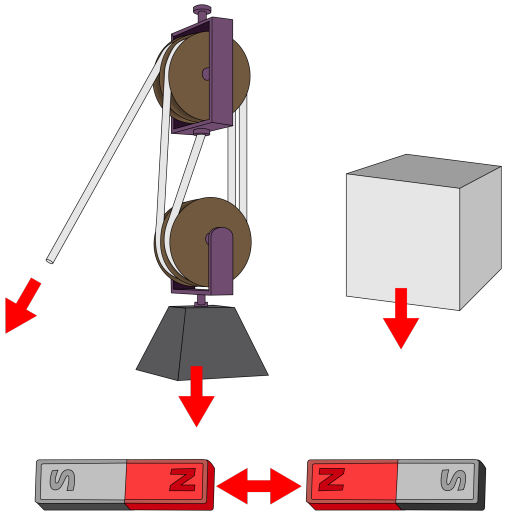


SOFTWARE ENGINEERING

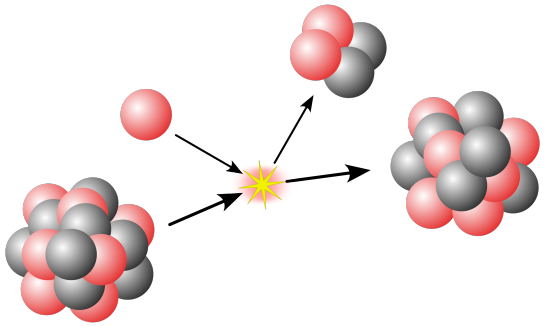
The Need for Standardized Terminology

- Engineering is applied science
- Scientific fields use precise terminology

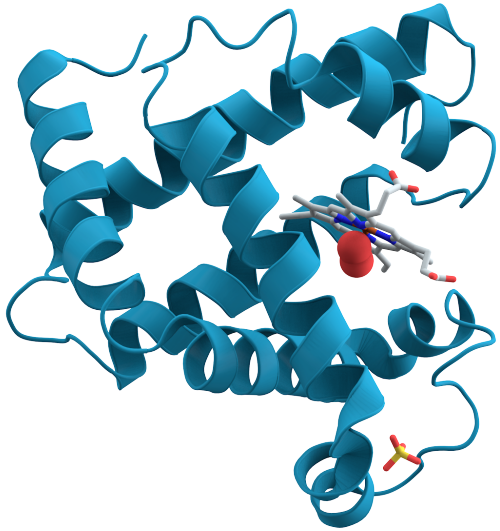
$\Rightarrow$ SOFTWARE ENGINEERING



Penubag and Ramey (2010)



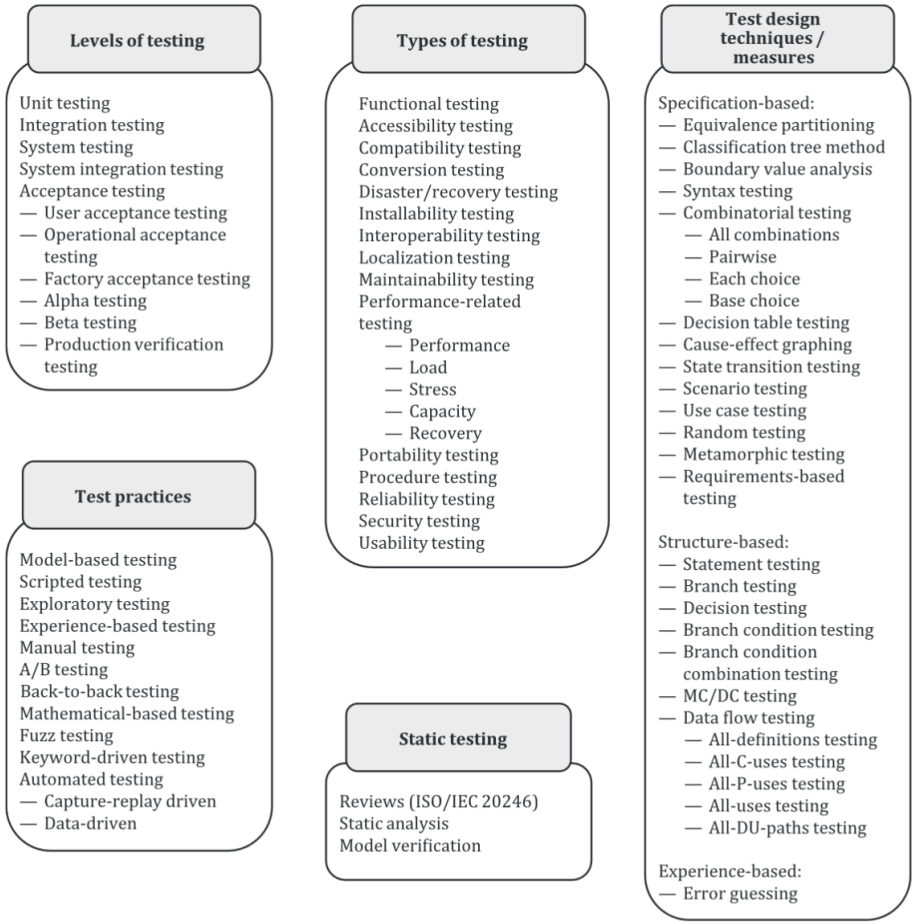
Kjerish (2016)



AzaToth (2008)

The Lack of Standardized Terminology

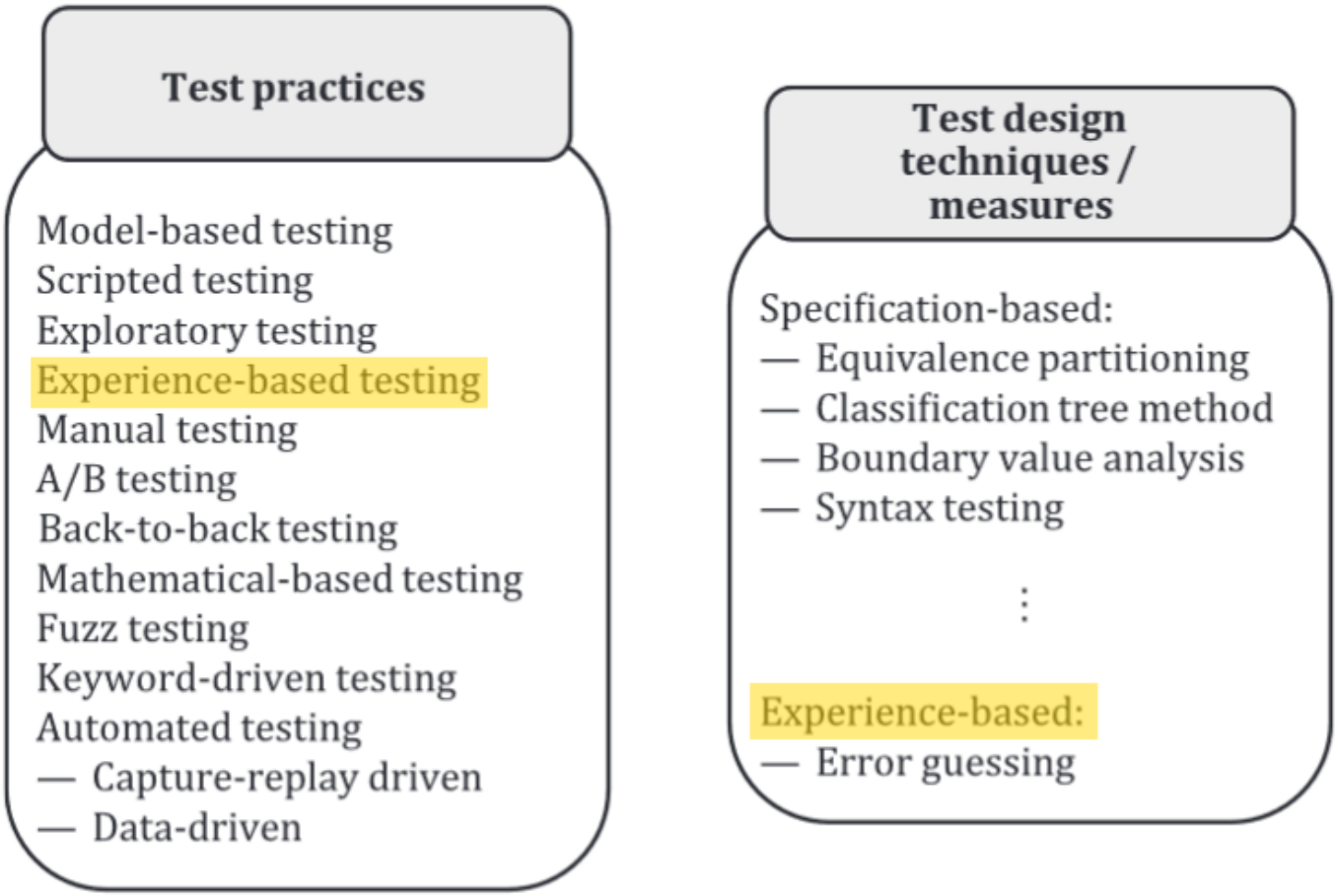
"The Problem"



(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

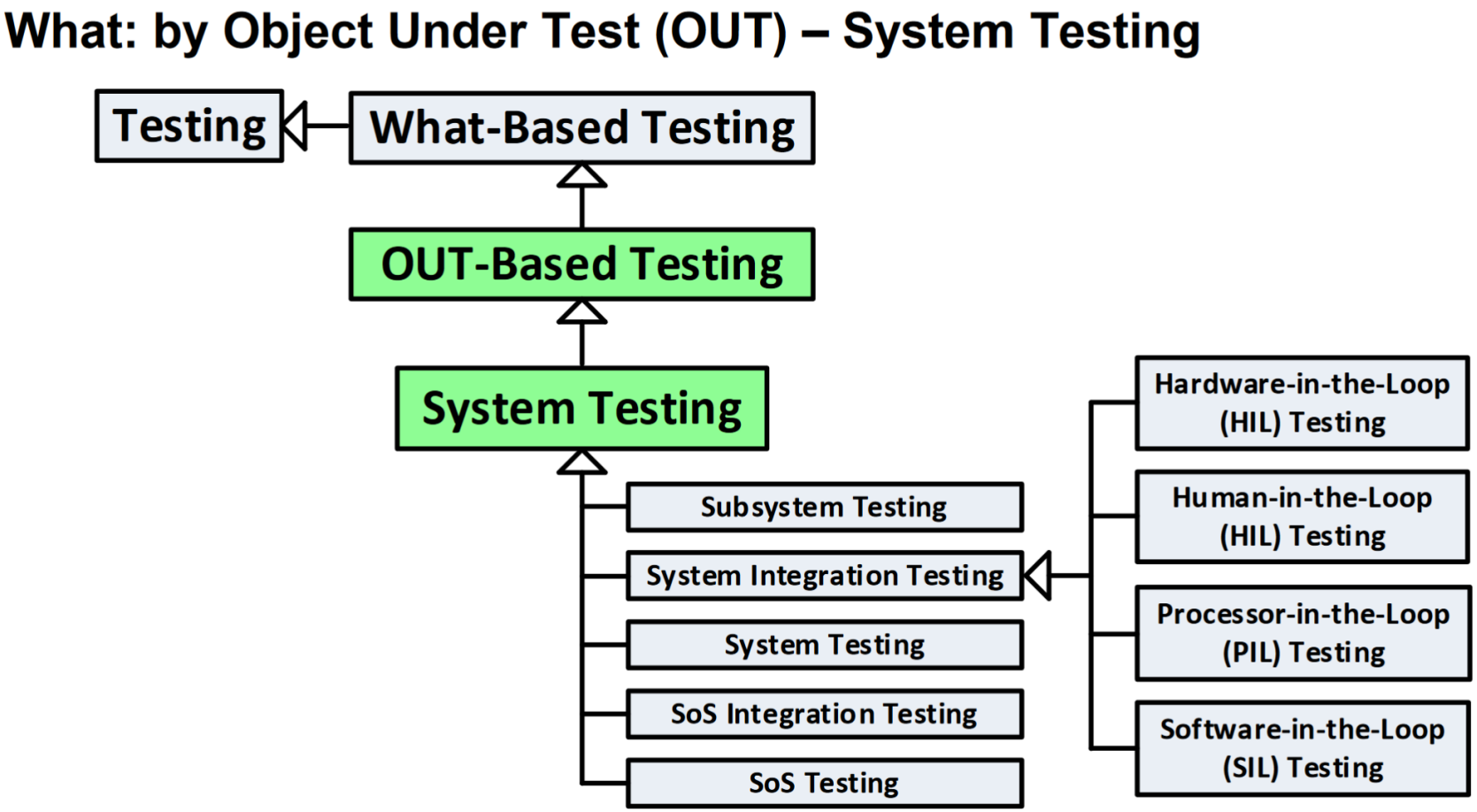
"The Problem"

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

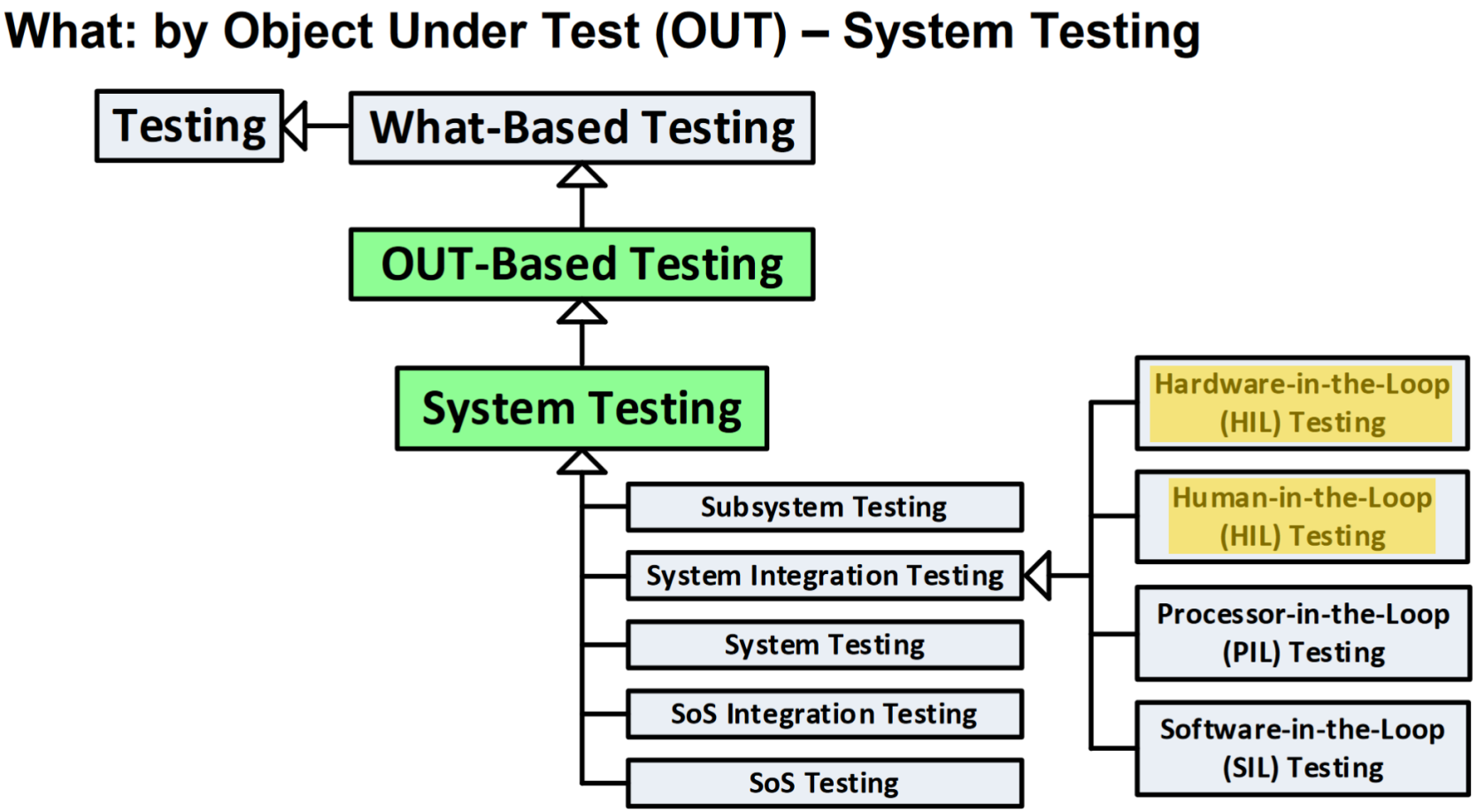
"The Problem" (cont.)



(Firesmith, 2015, p. 23)

The Lack of Standardized Terminology

"The Problem" (cont.)



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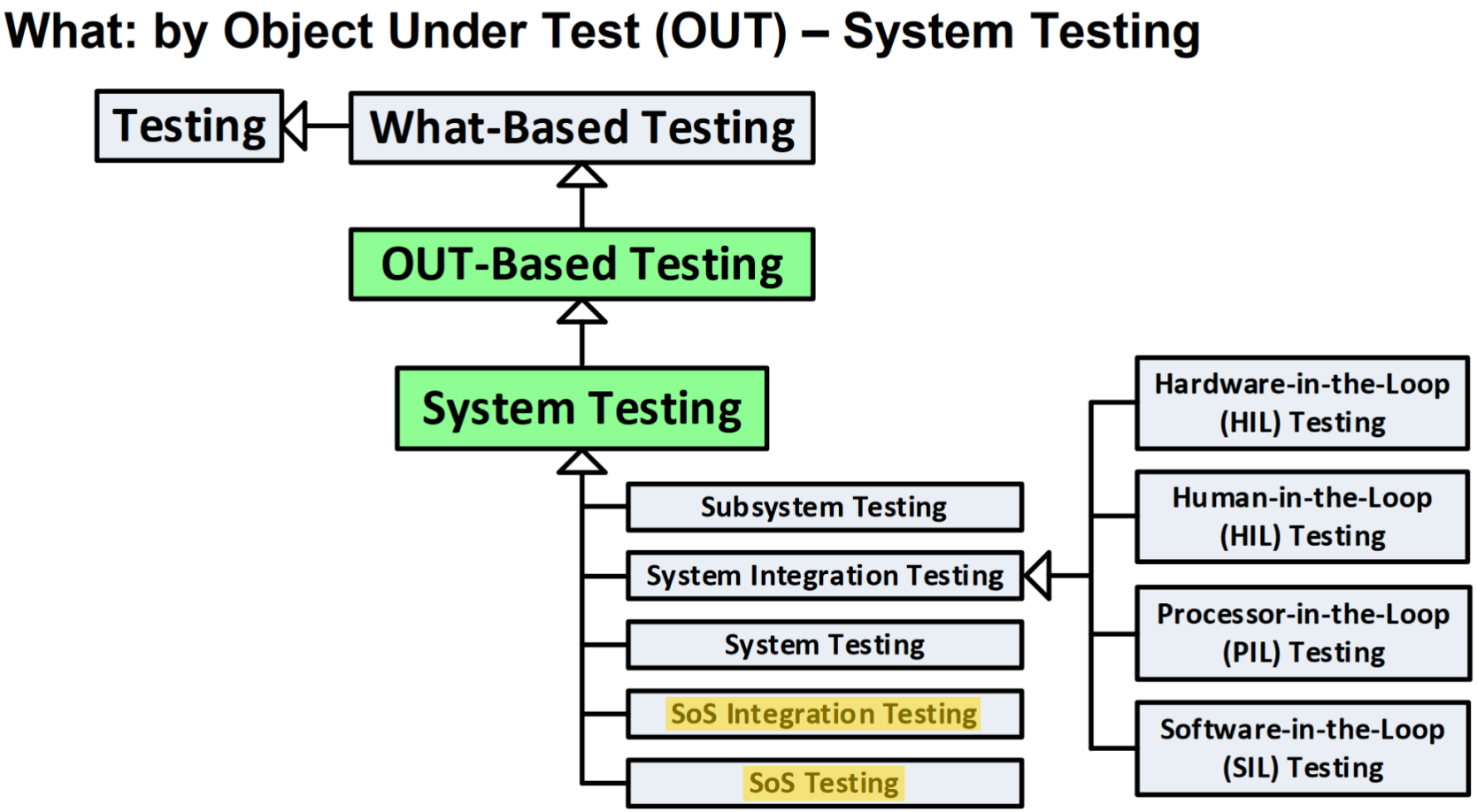

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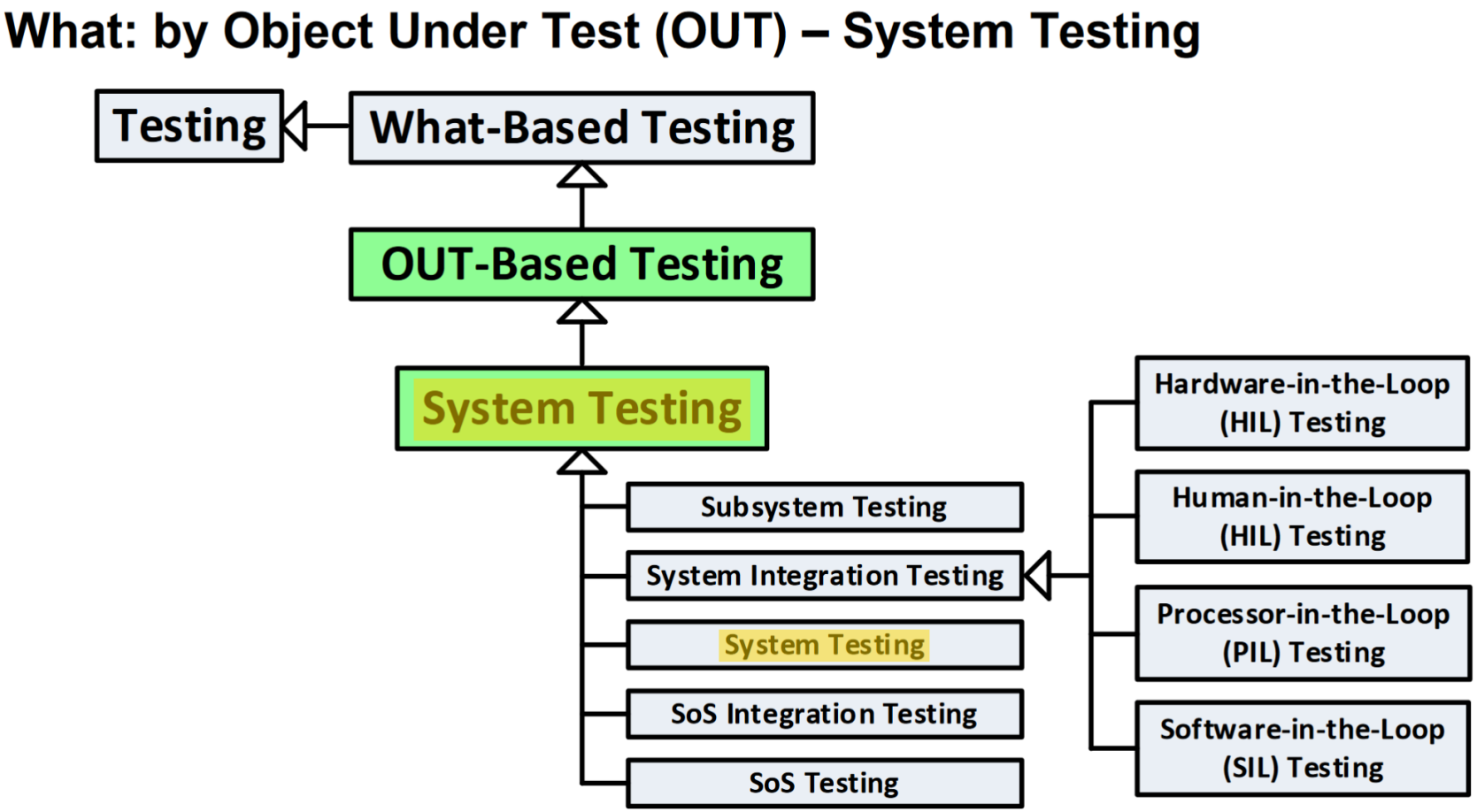

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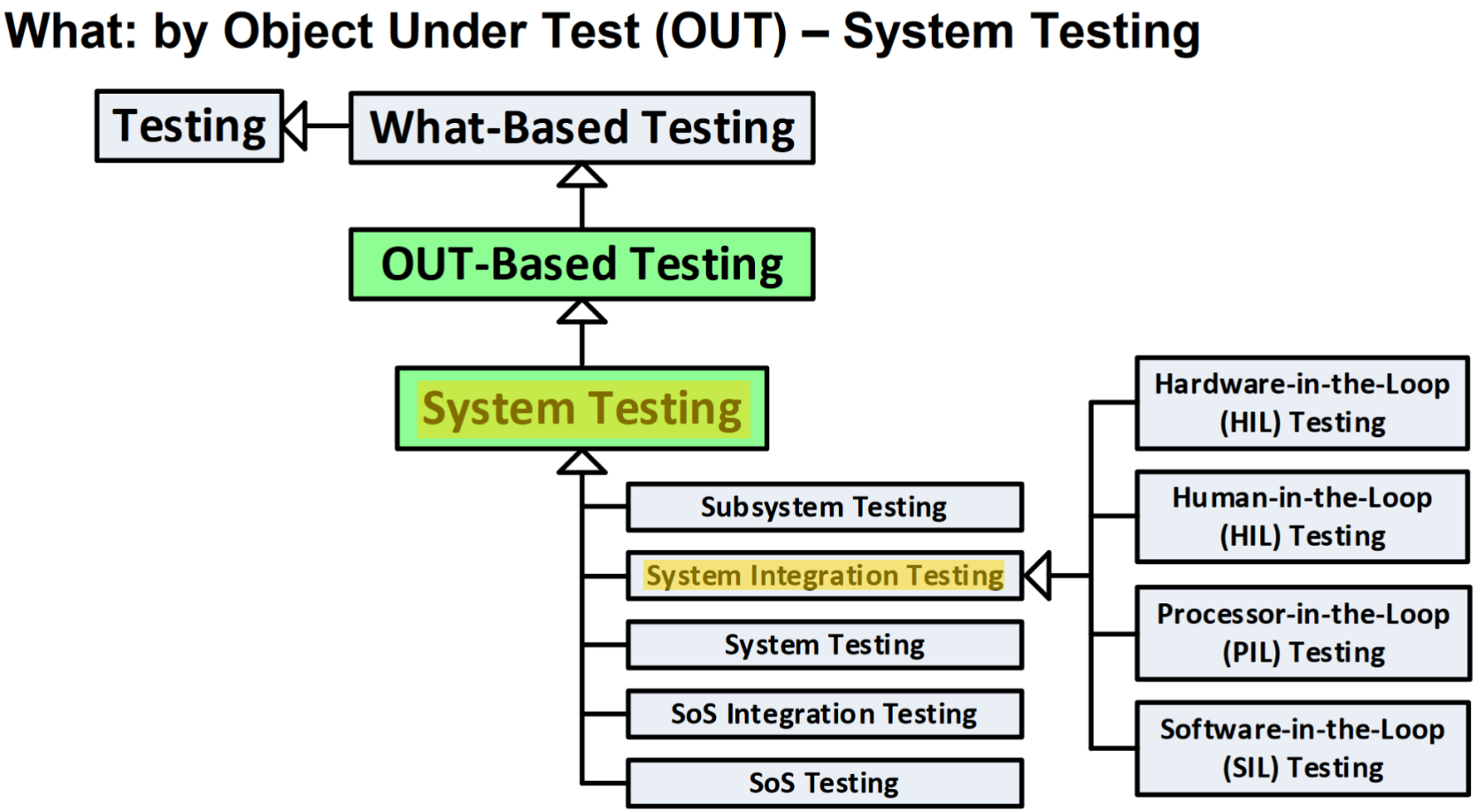

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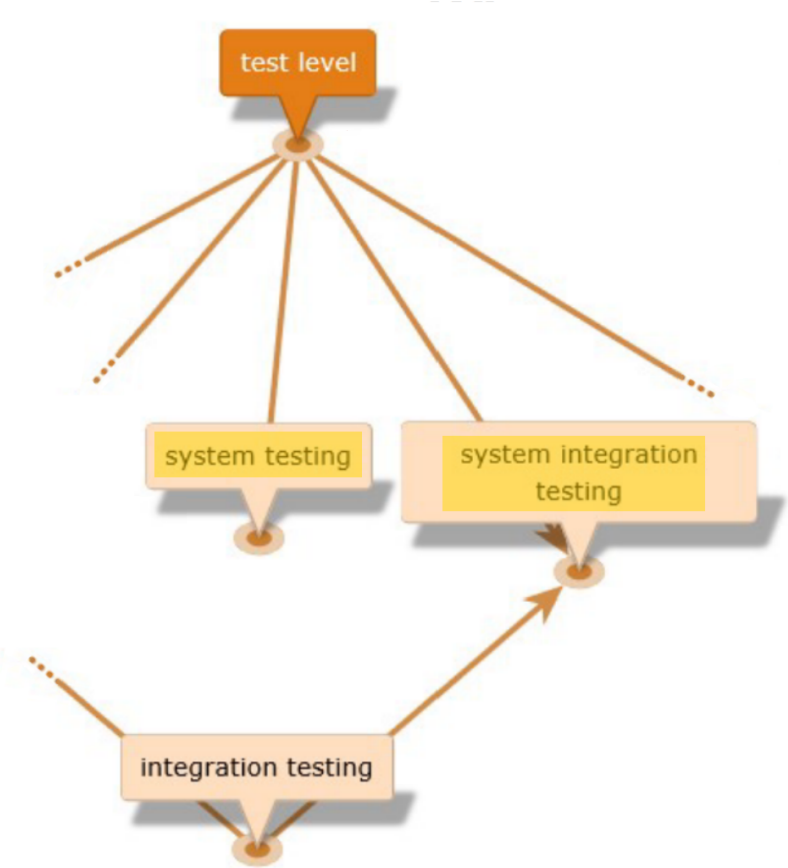
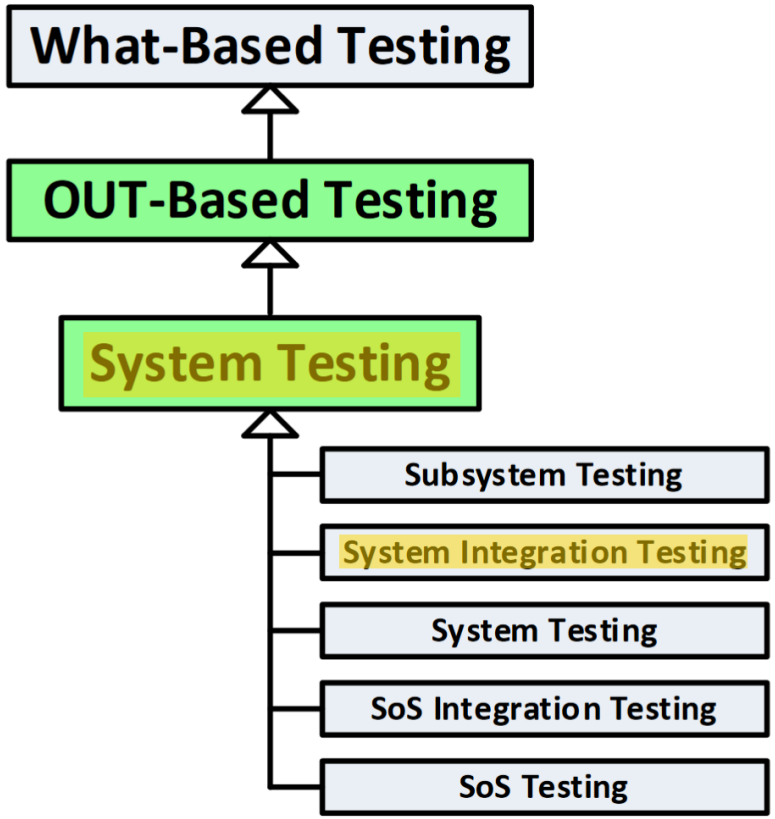


Adapted from (Hamburg and Mogyorodi, 2024)



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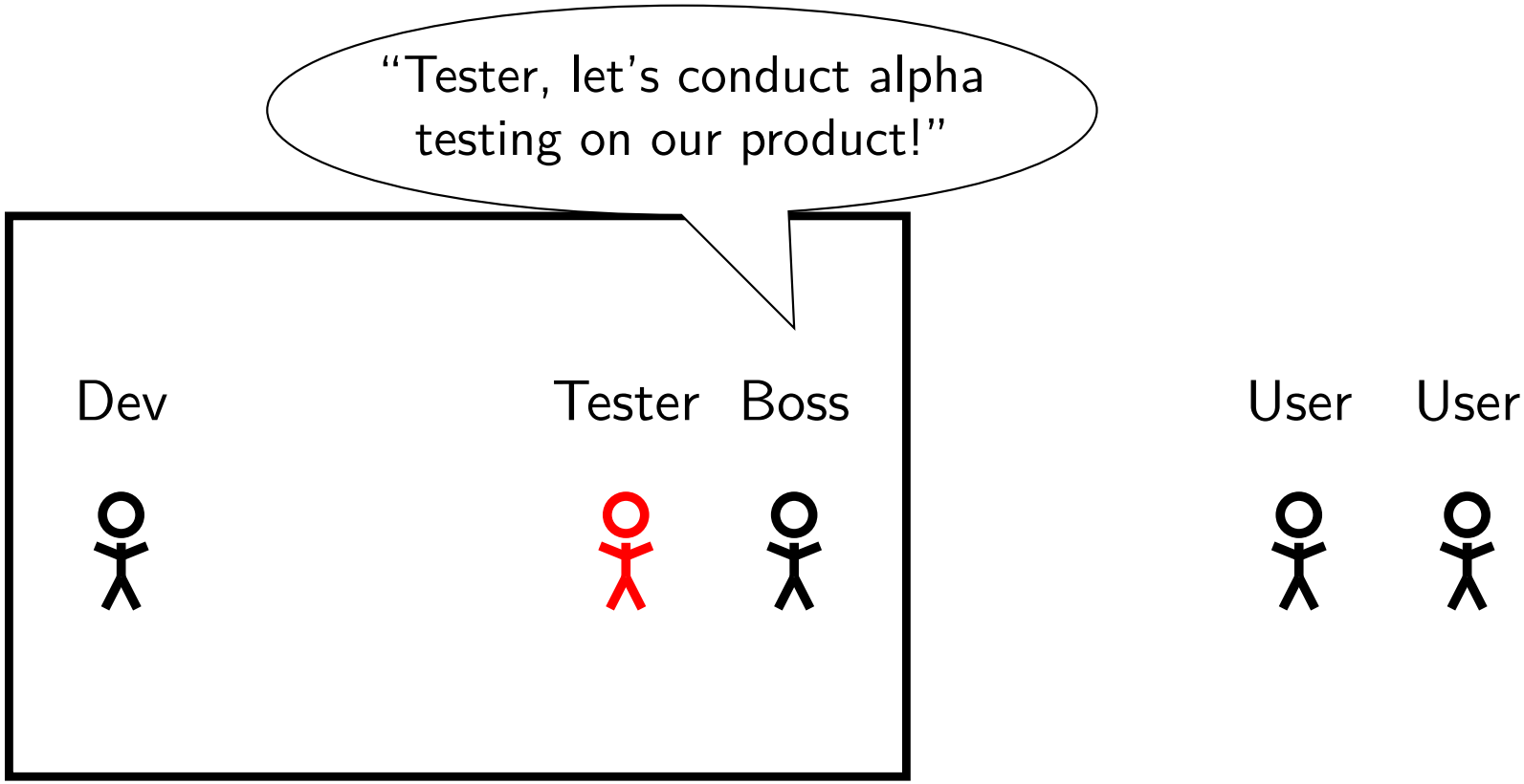

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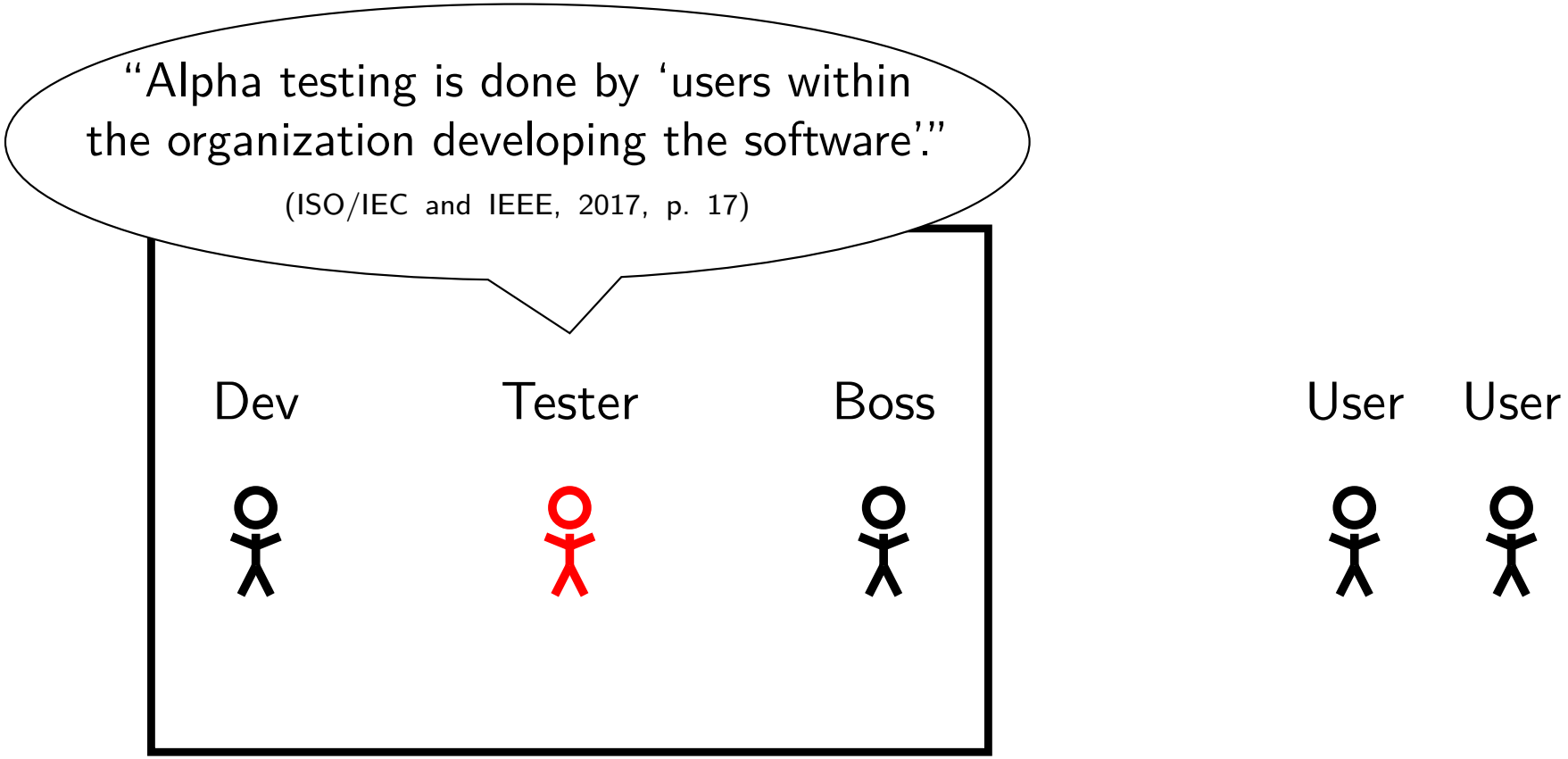

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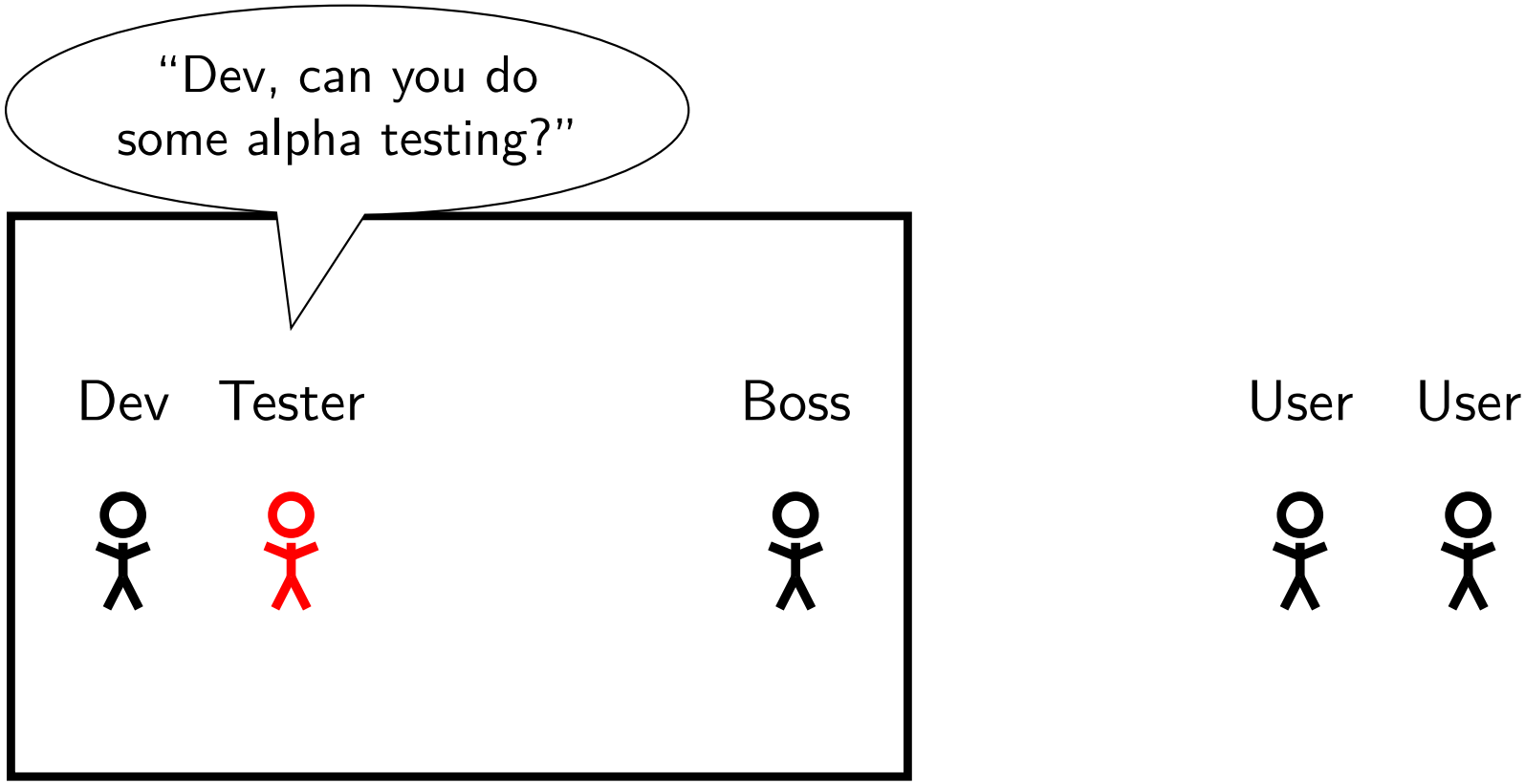

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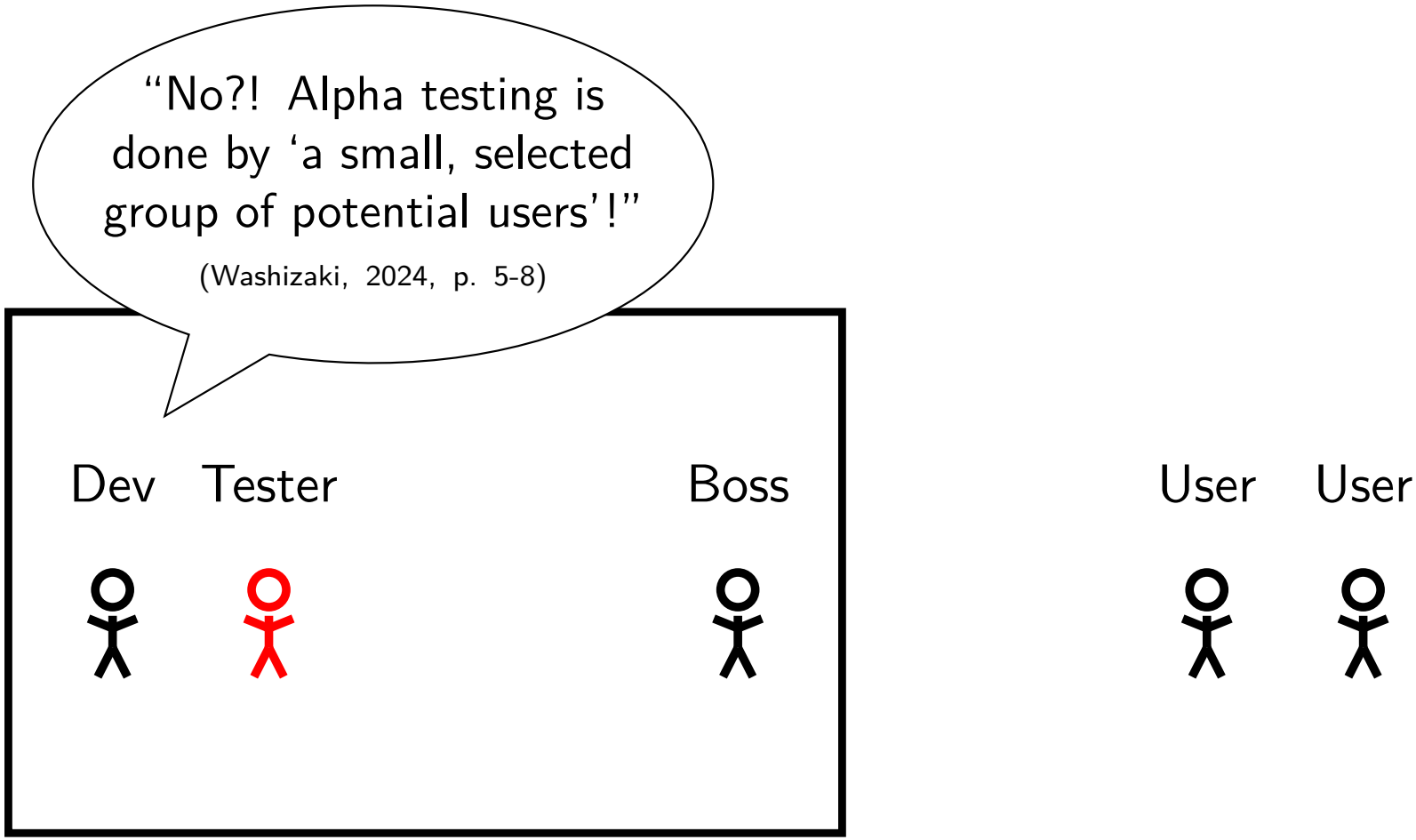

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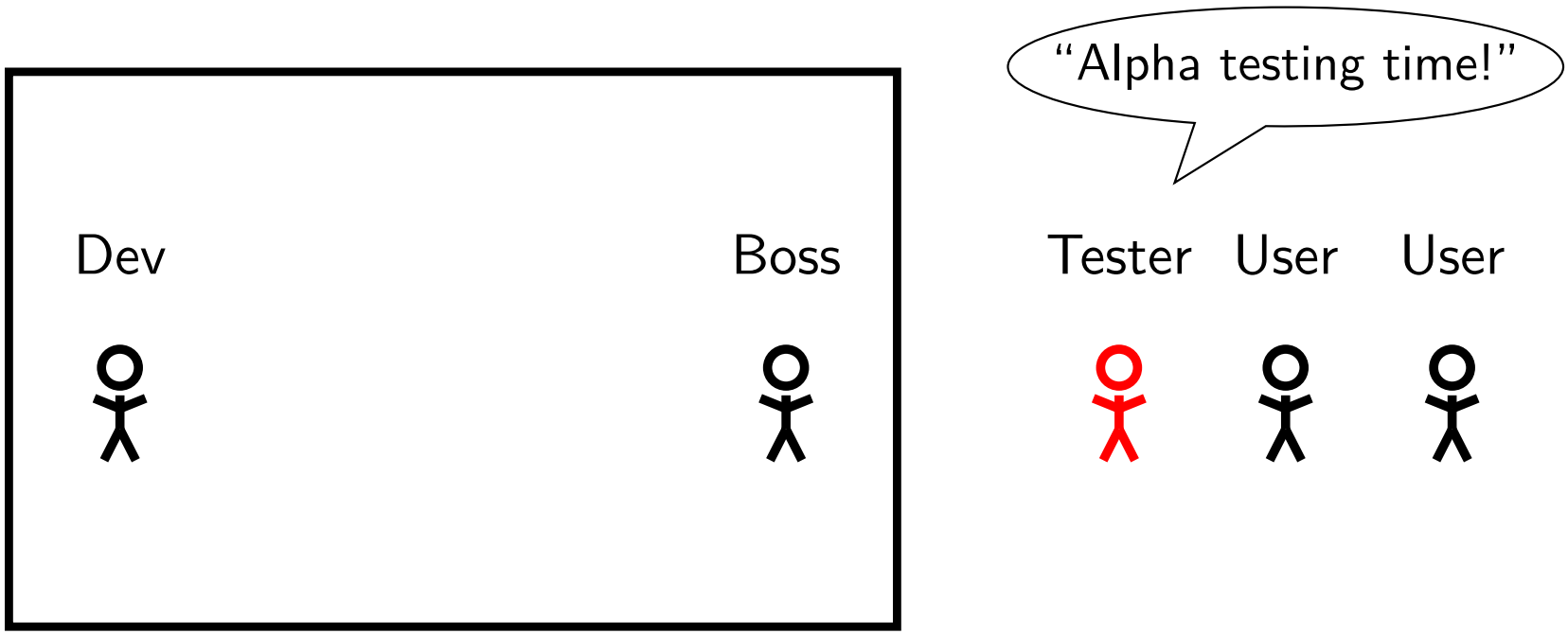

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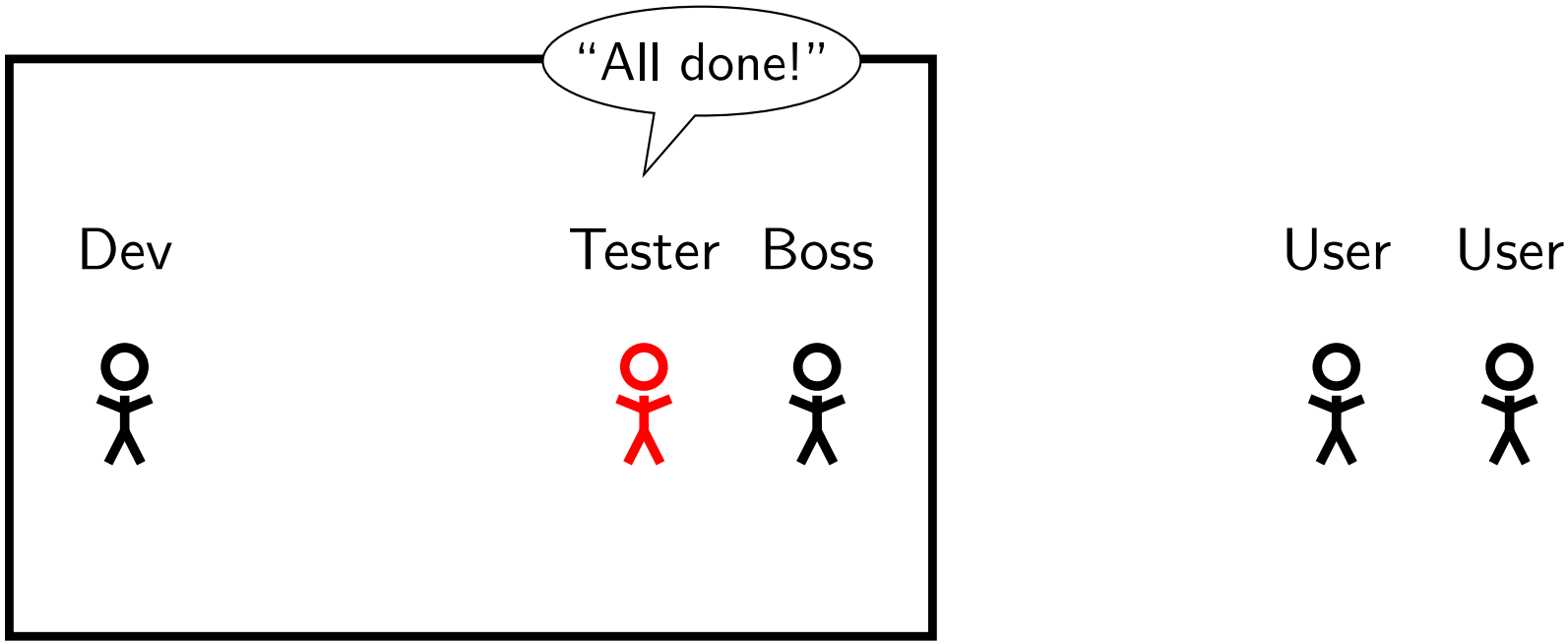

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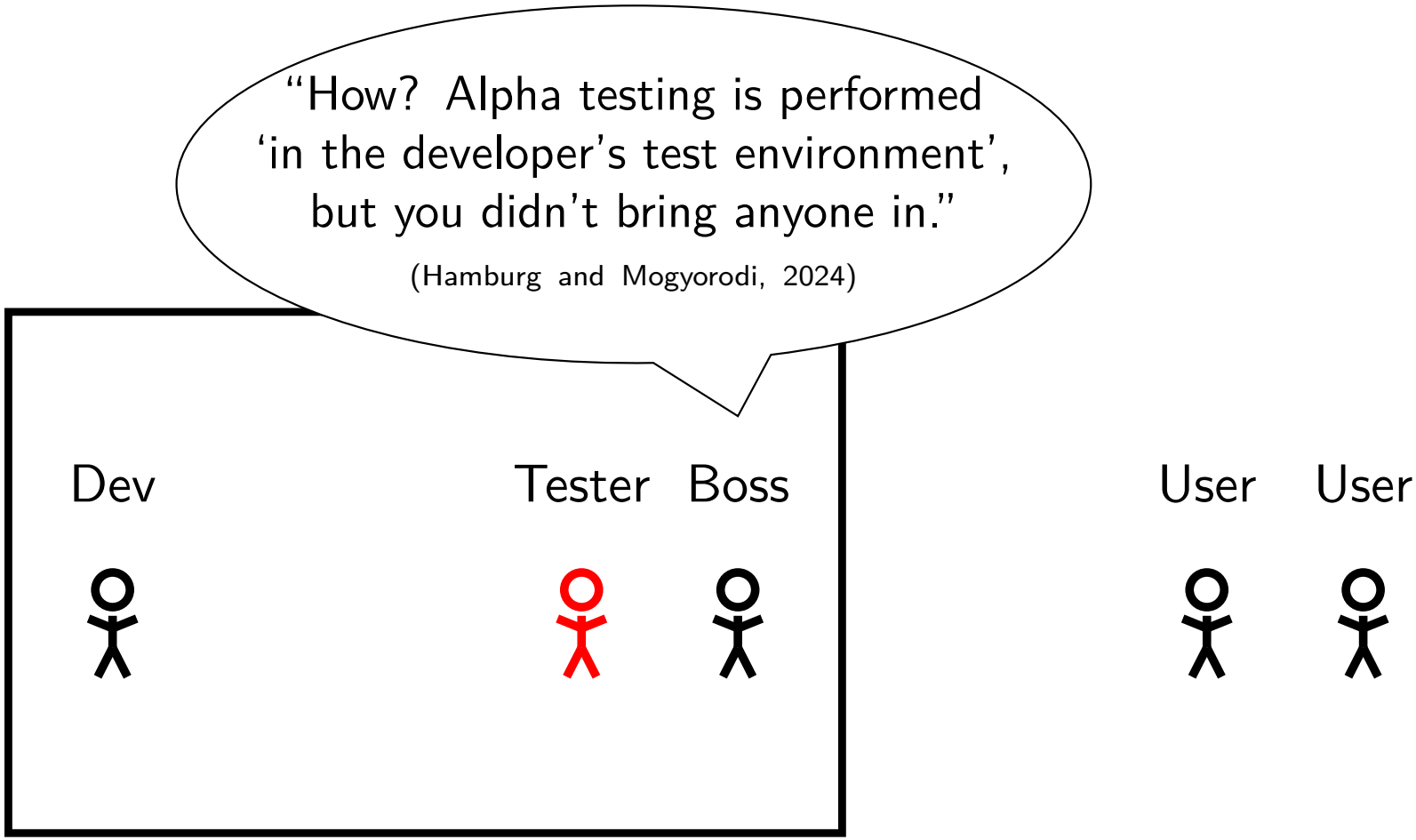
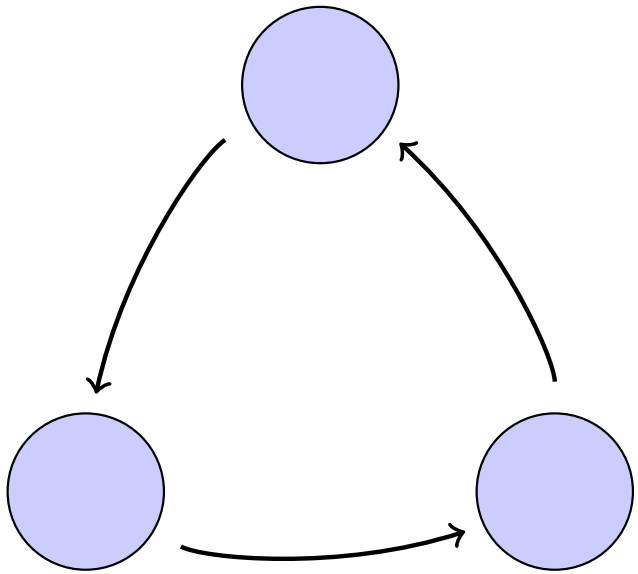


Interorganizational

Schools, companies, etc.



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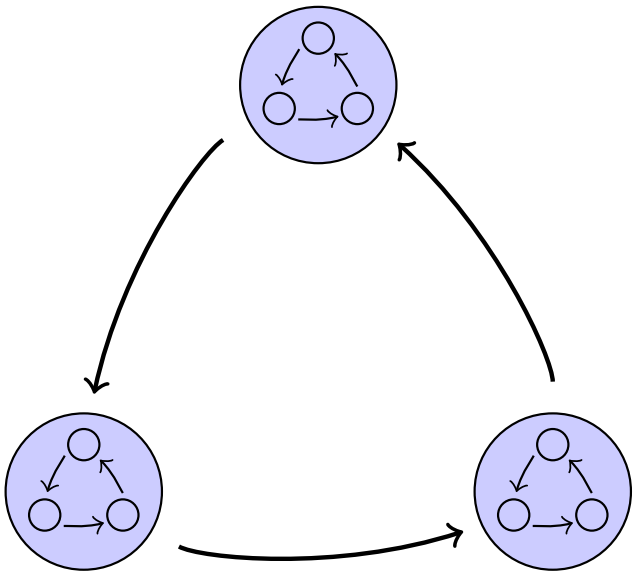

Intraorganizational

"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.)

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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?

Research Question 1

What testing approaches do the literature describe?

1. Identifying authoritative sources on software testing and "snowballing" from them
2. Identifying all test approaches and related testing terms that are used repeatedly and/or have complex definitions
3. Recording all relevant data, including implicit data, for each term identified in step 2; test approach data are comprised of:
   1. Names
   2. Categories
   3. Definitions
   4. Synonyms
   5. Parents
   6. Flaws
4. Repeating steps 1 to 3 for any missing or unclear terms until some stopping criteria

Methodology

Overview

Research Question 2

Are these descriptions consistent?

5. Analyzing recorded test approach data for additional flaws
    1. Generating relation graphs
    2. Automatically detecting certain classes of flaws
    3. Automatically analyzing manually recorded flaws from step 3.6
6. Reporting results of flaw analysis

Research Question 3

Can we systematically resolve any of these inconsistencies?

7. Providing examples of how to resolve these flaws

- 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)

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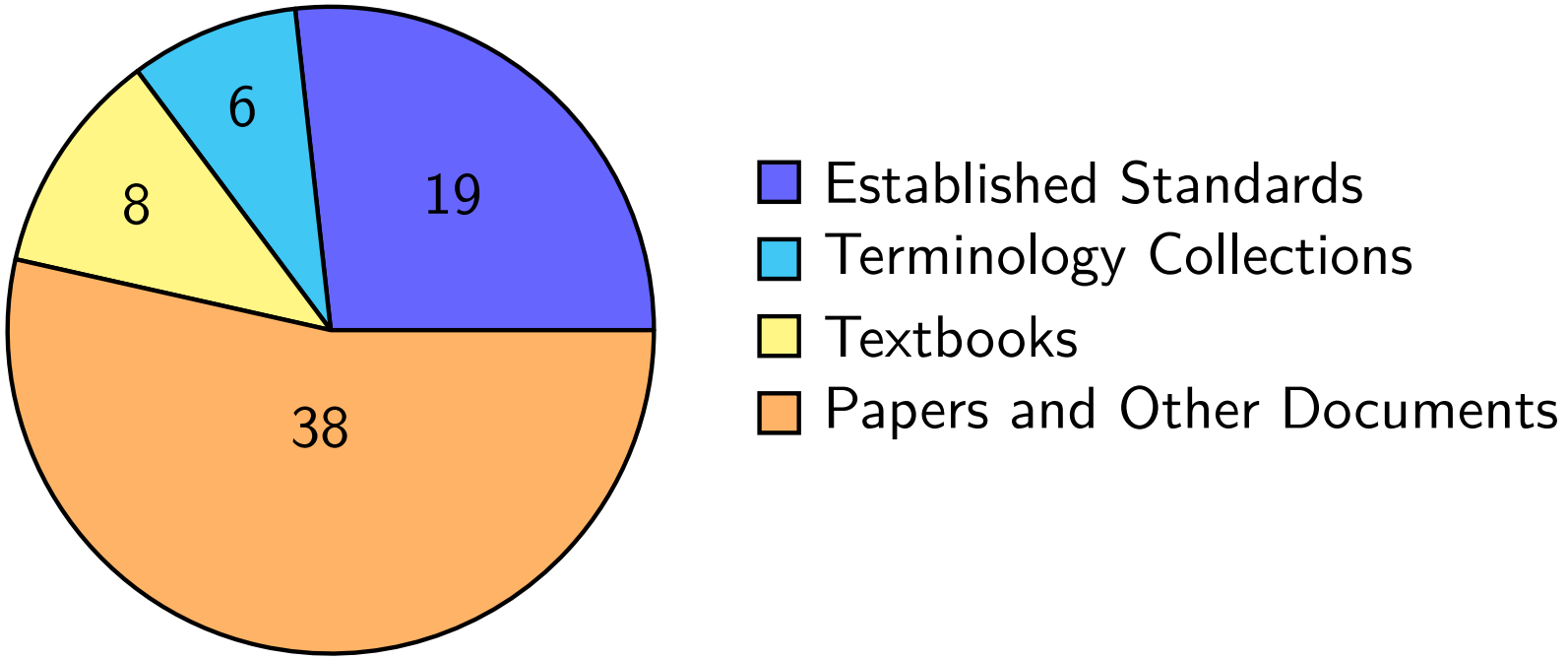
Information from (ISO/IEC and IEEE, 2022)

- 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

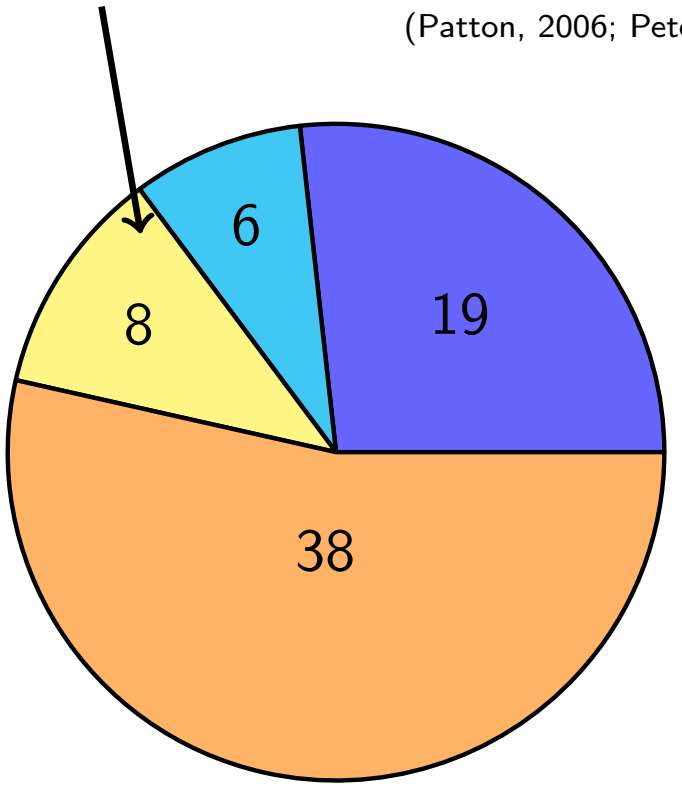


Methodology

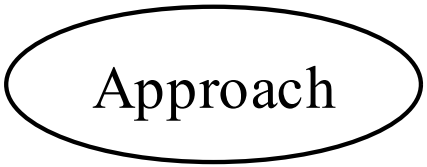
Sources

Textbooks used at McMaster were our ad hoc starting points

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



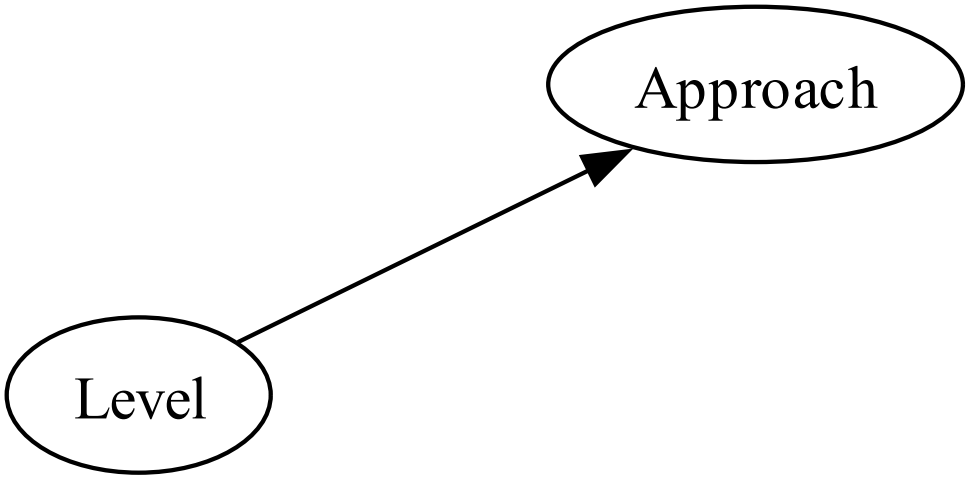
- Established Standards
- Terminology Collections
- Textbooks
- Papers and Other Documents



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

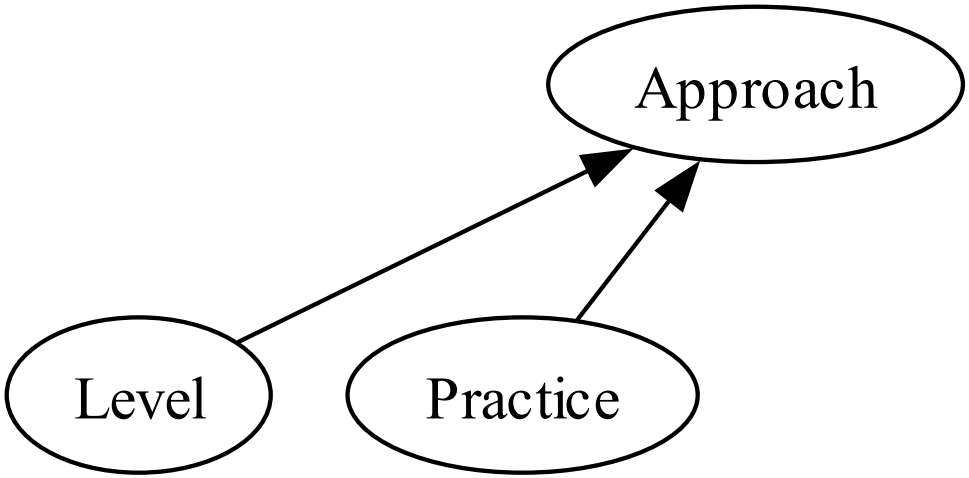
Categories



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

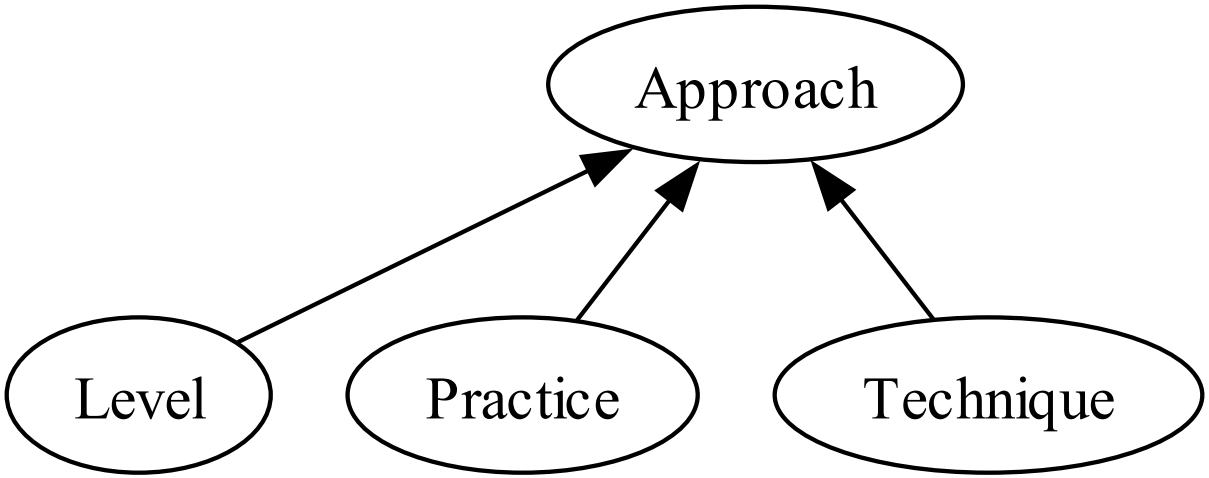
Categories



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

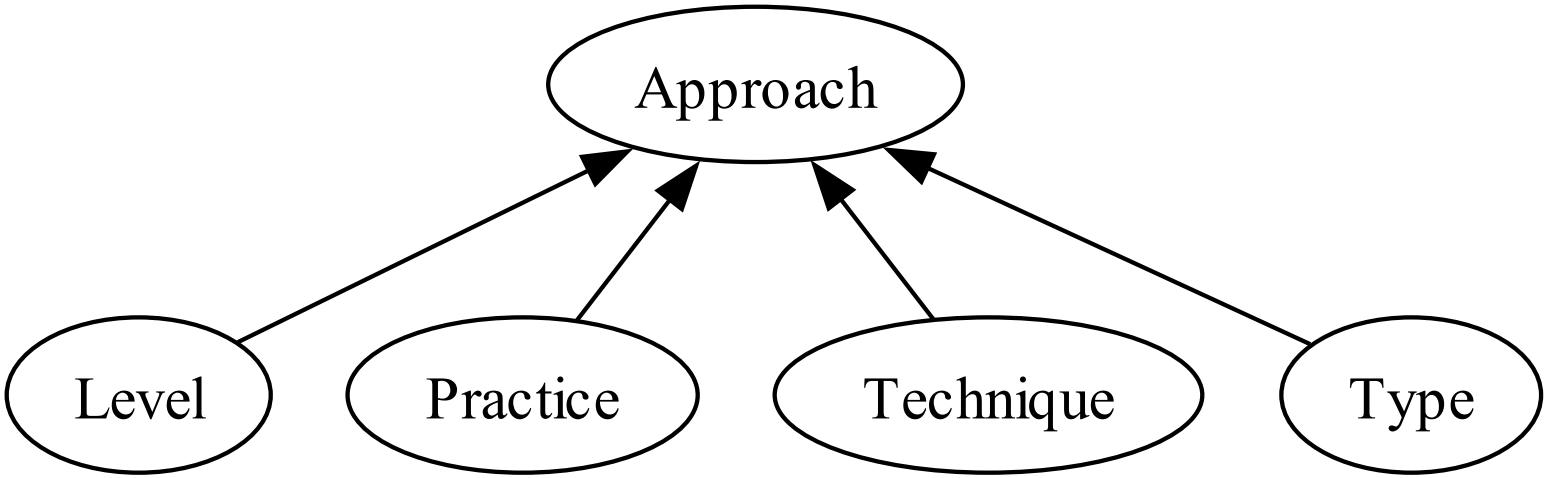
Categories



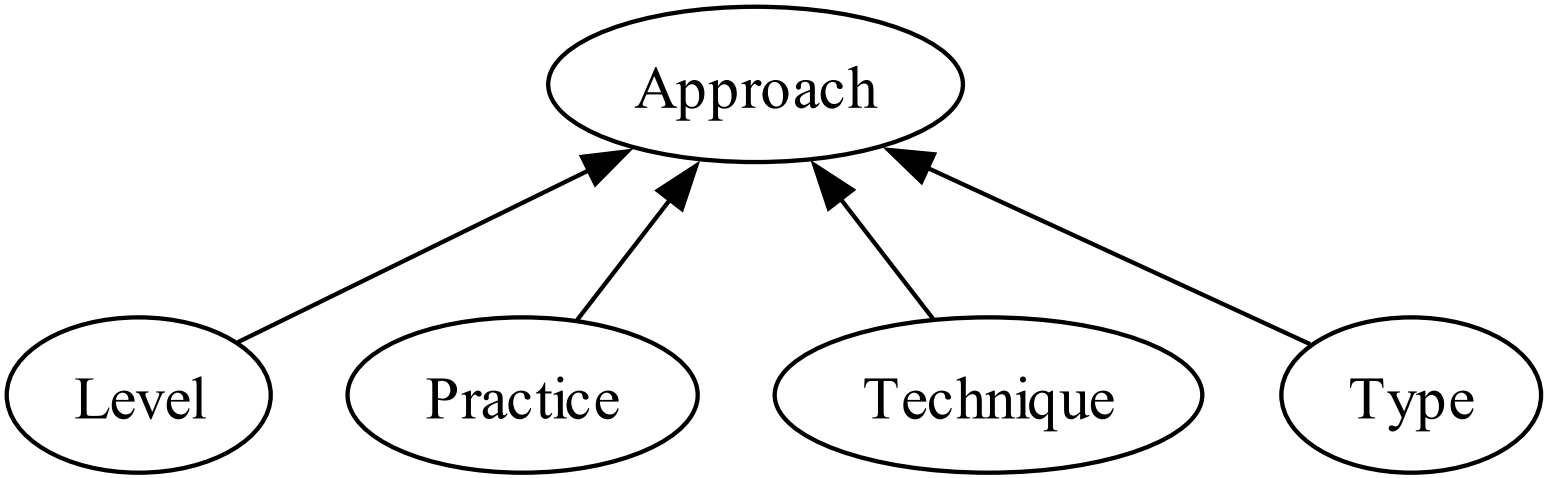
Technique: a "procedure used to create or select a test model, identify test coverage items, and derive corresponding test cases" (2022, p. 11; 2021a, p. 5; similar in 2017, p. 467)

Methodology

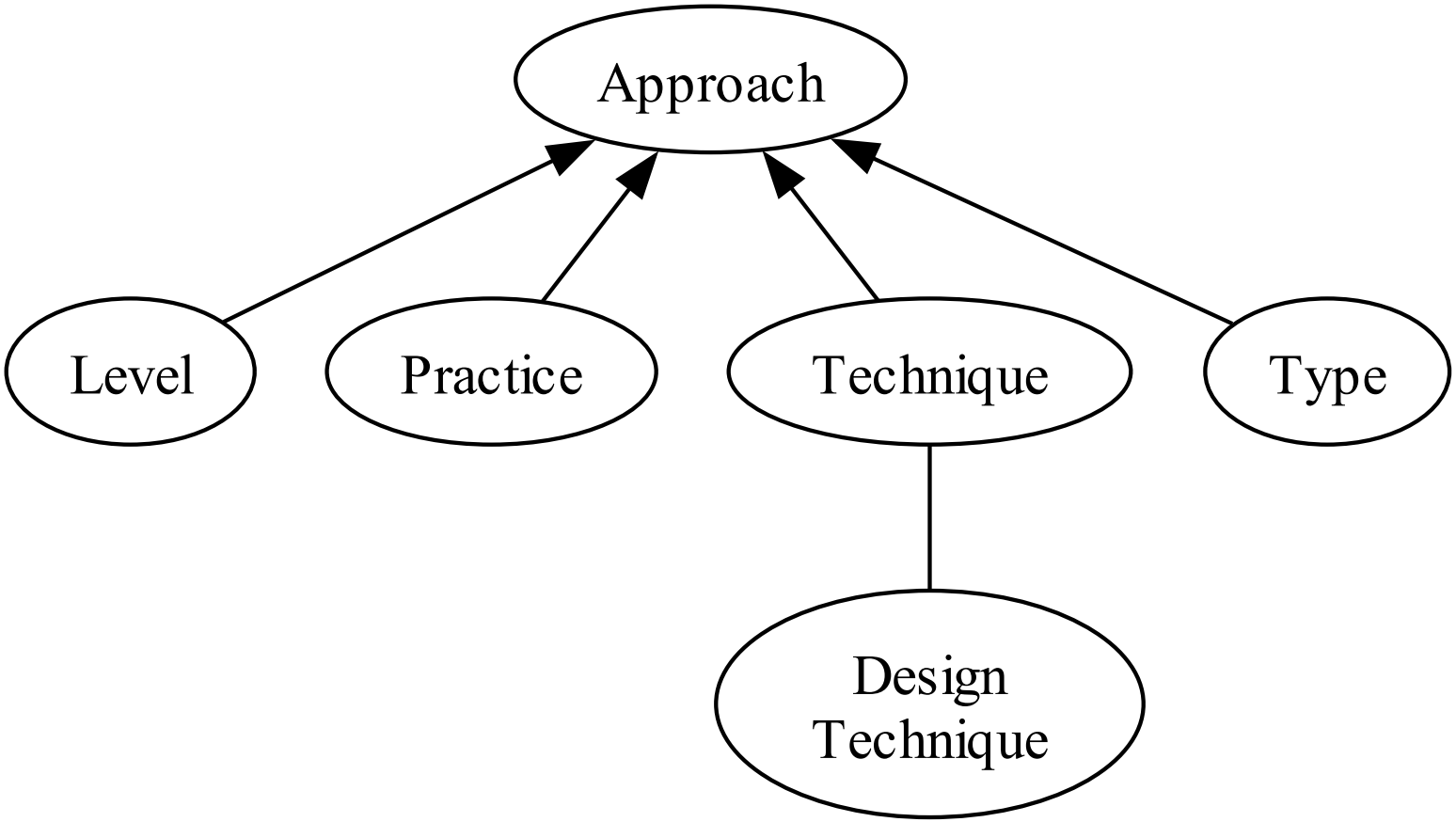
Categories



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



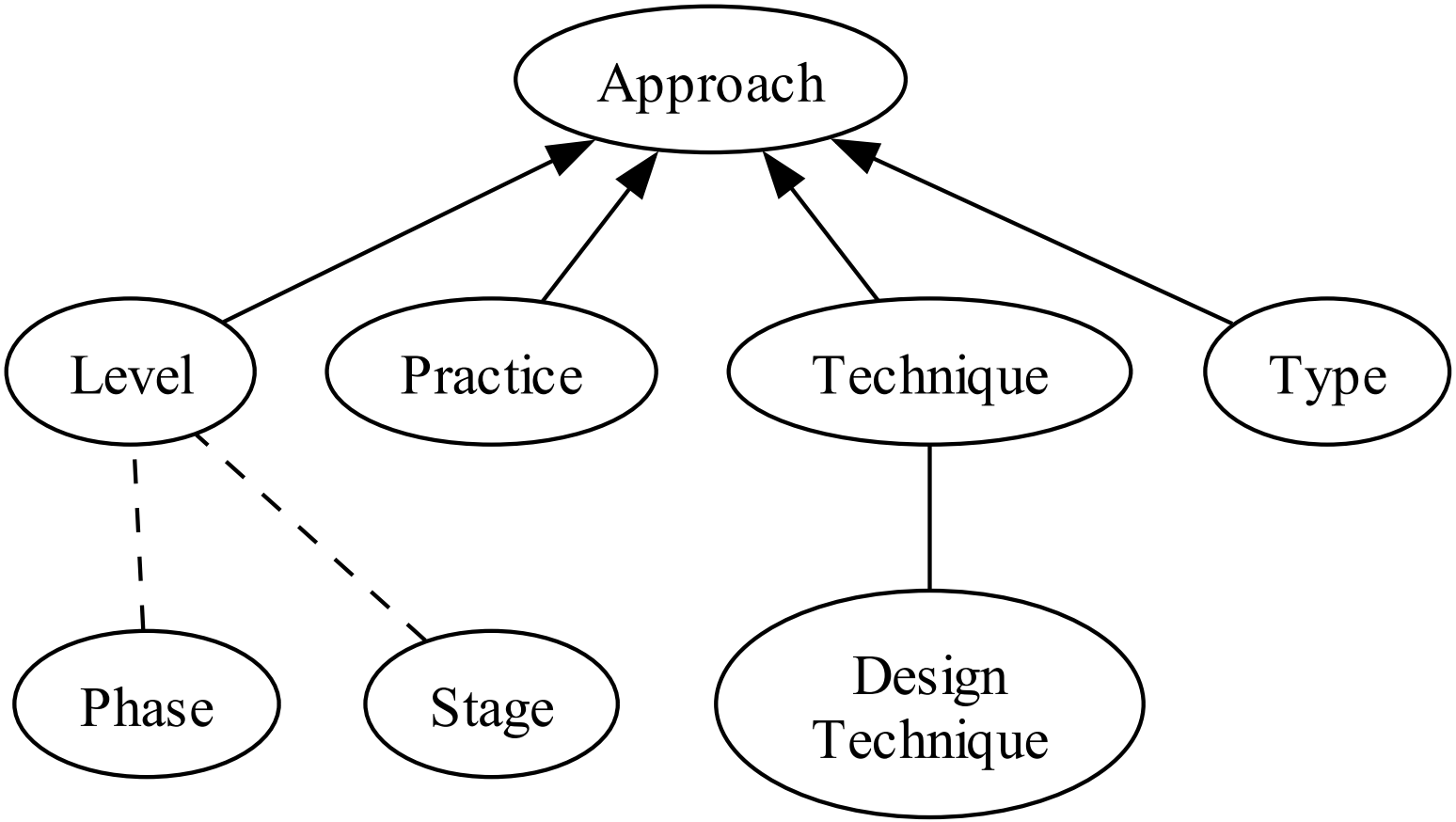
Arrows point from a *child* node to a *parent* node.



Lines without arrowheads connect *synonyms*.

Methodology

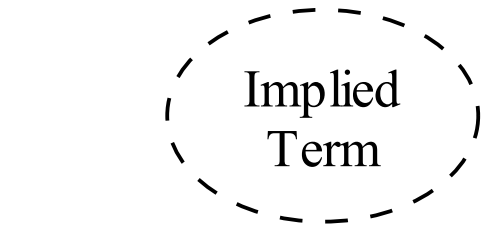
Visualization Notation



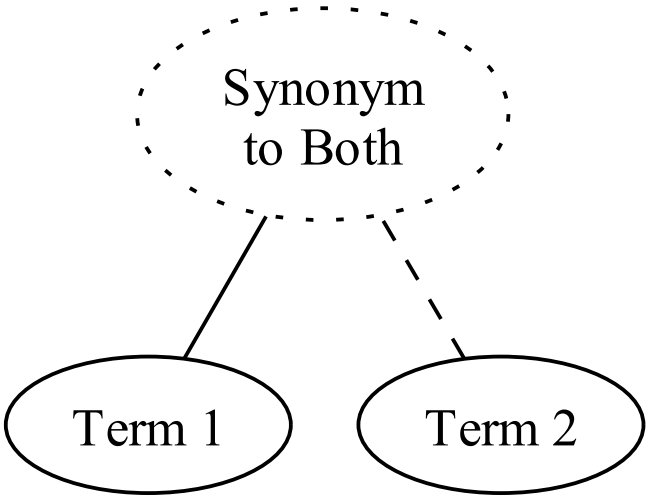
Dashed lines indicate a relationship is *implicit*.

Methodology

Visualization Notation



Dashed outlines indicate a term is *implicit*.



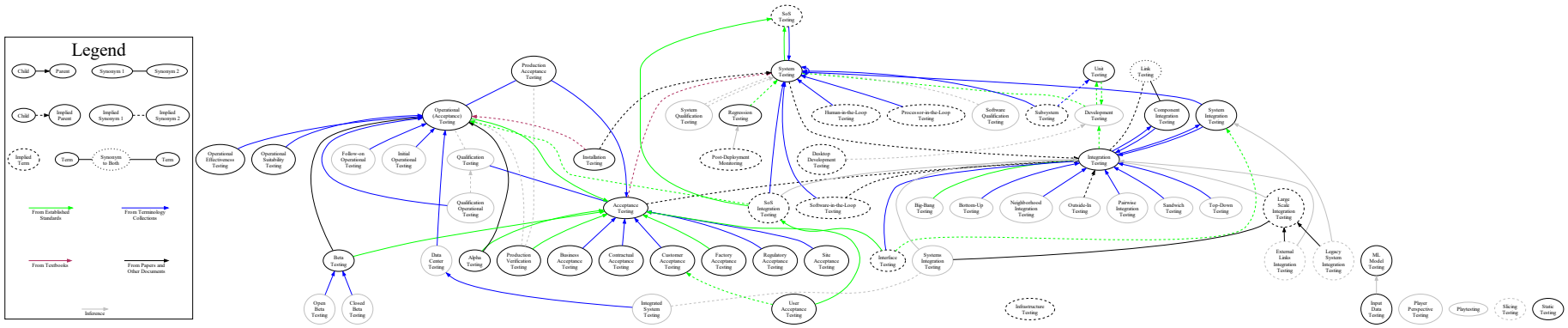
Dotted outlines indicate a term is a *synonym* to more than one term.

Graph of Test Approaches

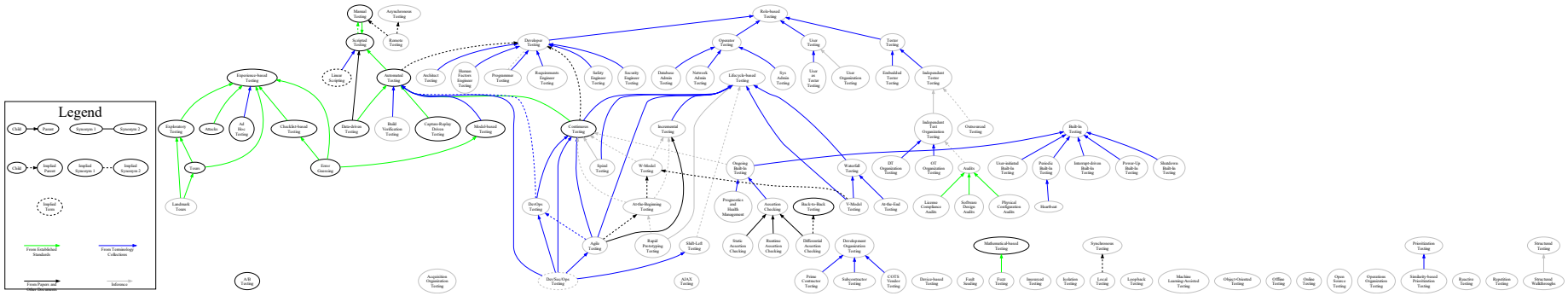
Graph of Test Approaches

```
! Dimension too large.
```

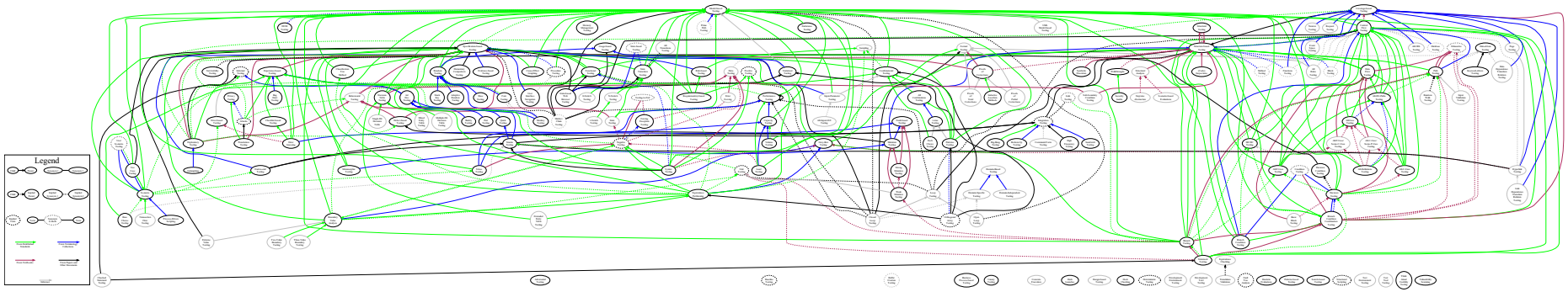
Graph of Test Levels



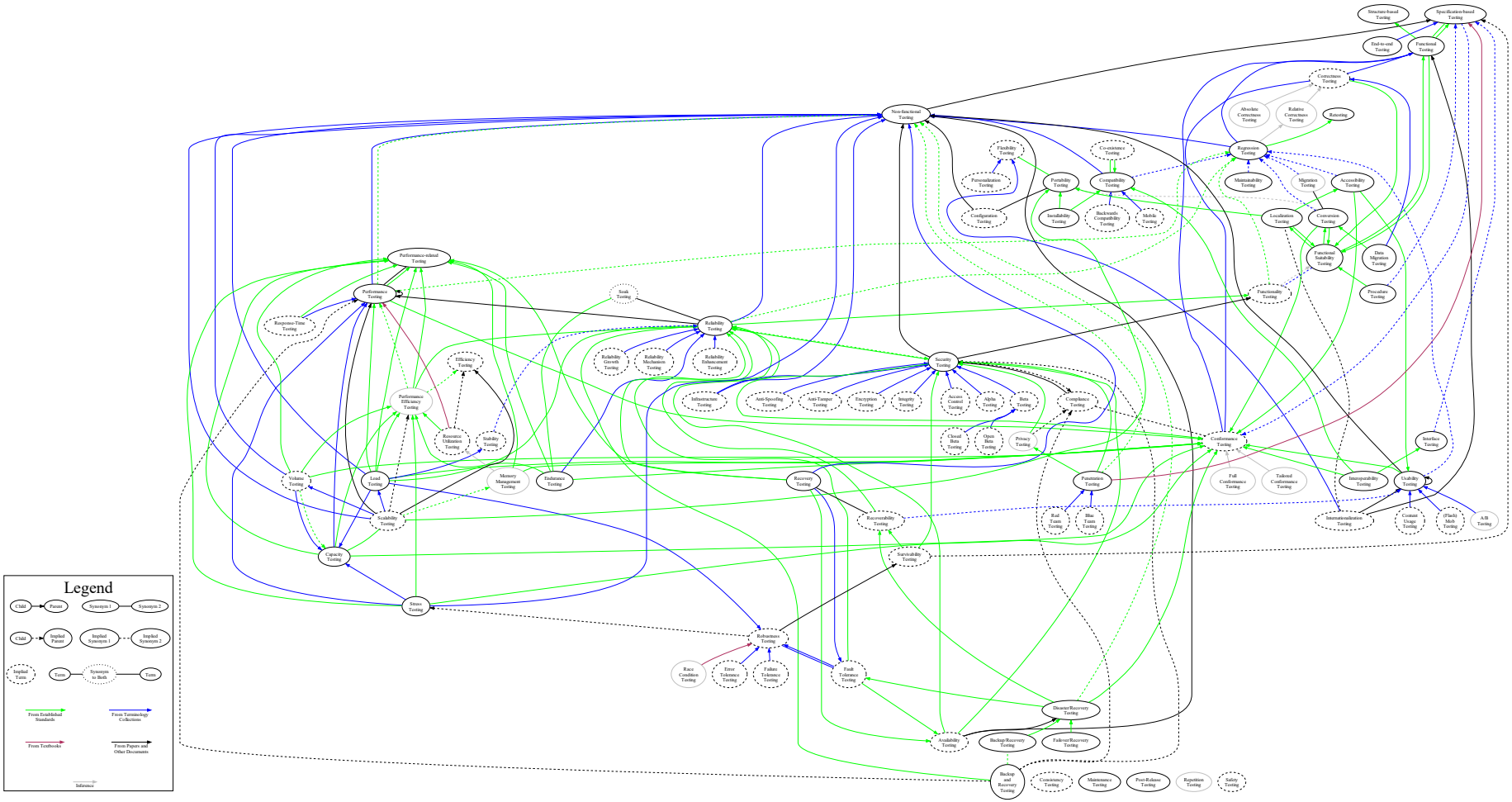
Graph of Test Practices



Graph of Test Techniques

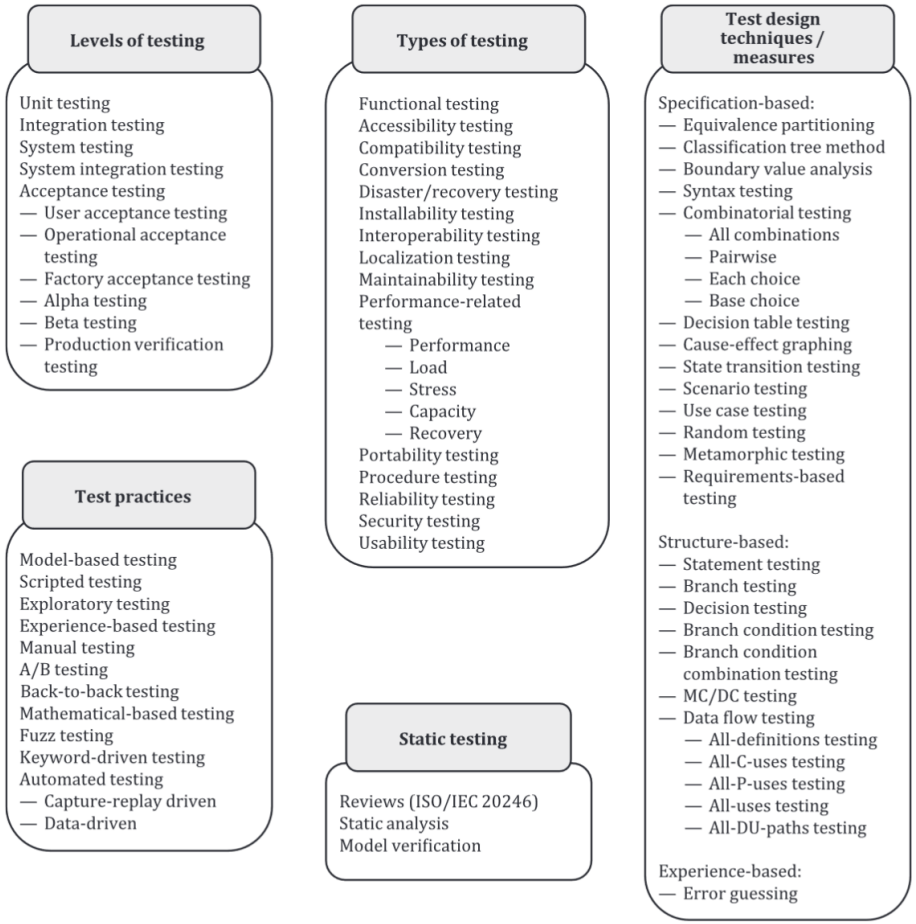


Graph of Test Types



Methodology

Visualization Notation



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

Methodology

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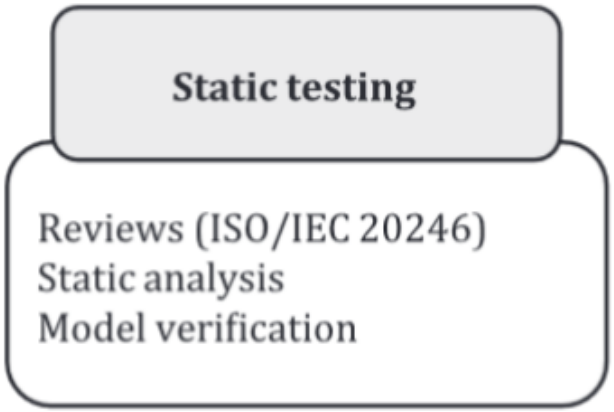

Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

Methodology

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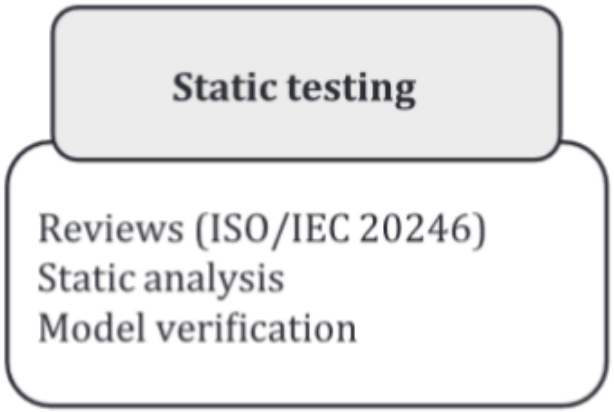

- Quite distinct but not necessarily orthogonal

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

Methodology

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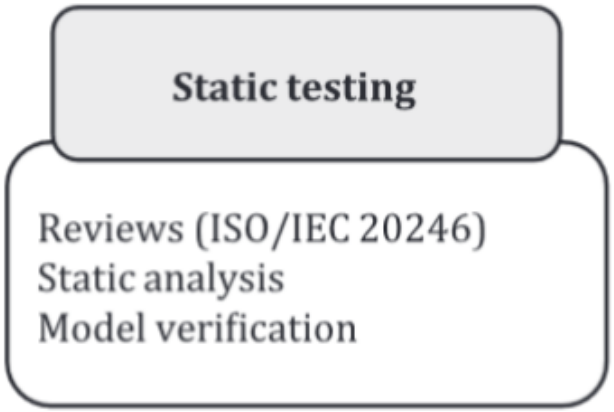
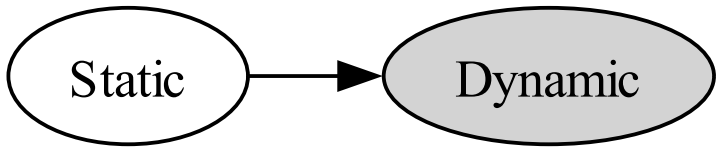
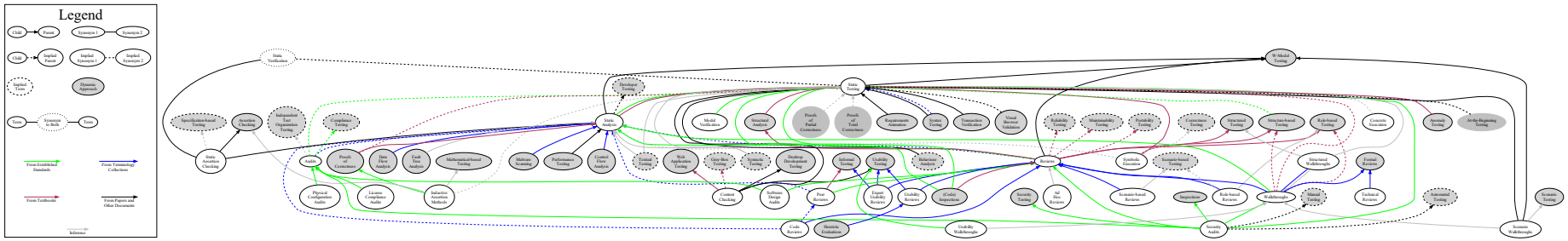


- Quite distinct but not necessarily orthogonal
- When considering static testing in isolation, related *dynamic approaches* have grey backgrounds



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

Graph of *Static* Test Approaches



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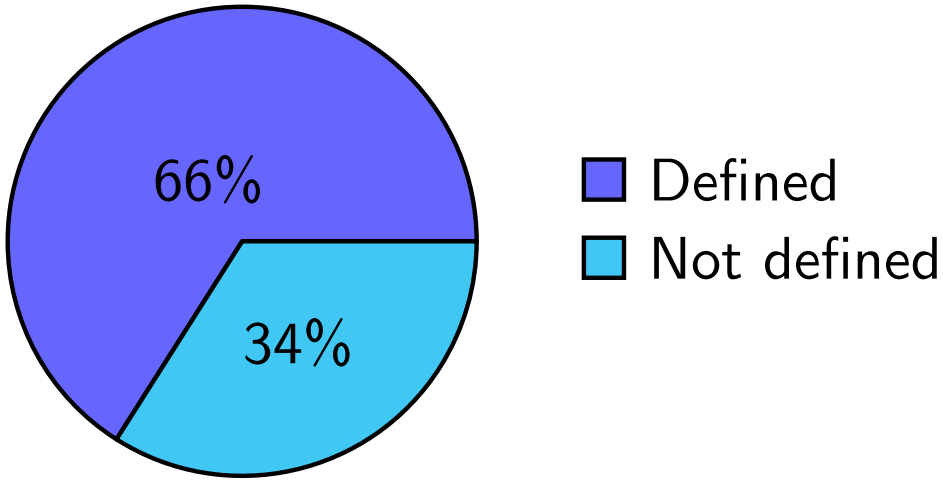
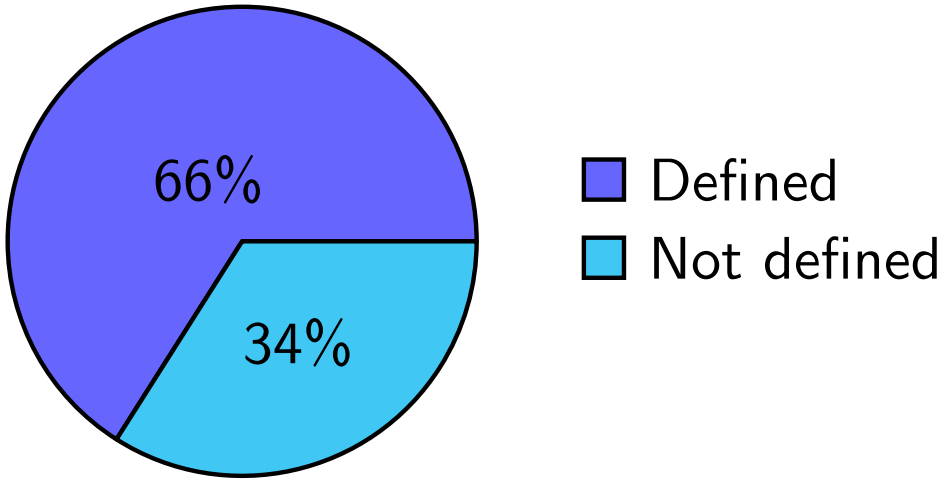
Overview

- 561 test approaches $\rightarrow$



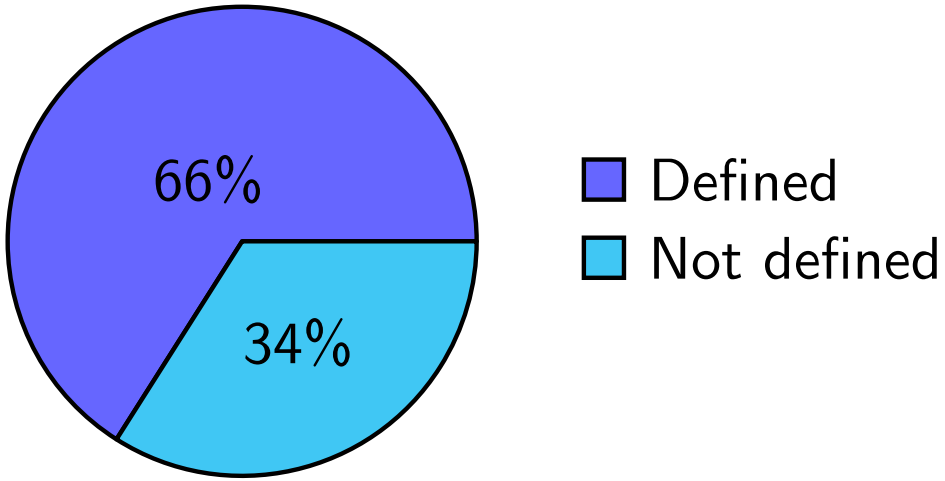
Overview

- 561 test approaches $\rightarrow$
- 77 software qualities
  (may imply test approaches)

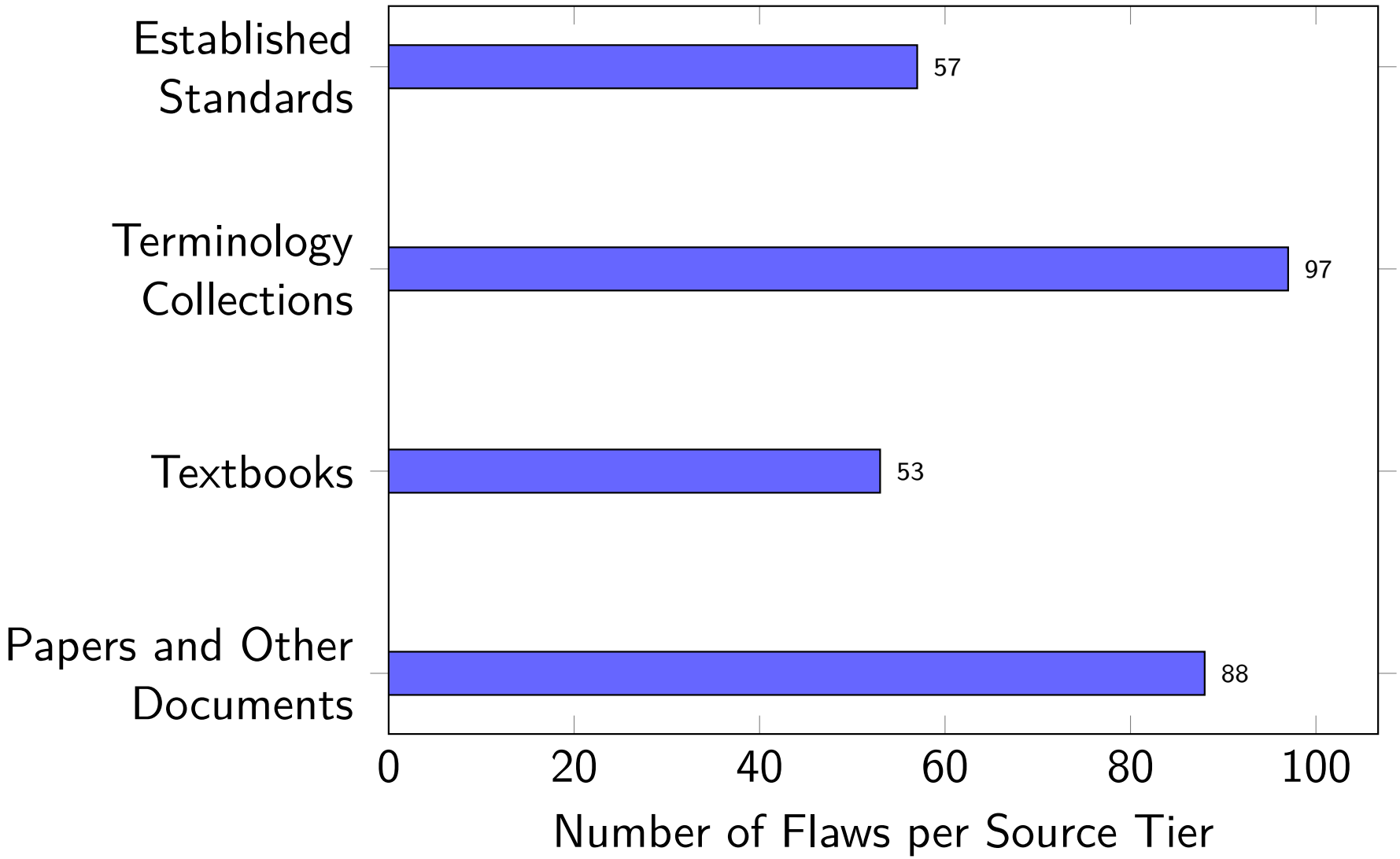


Overview

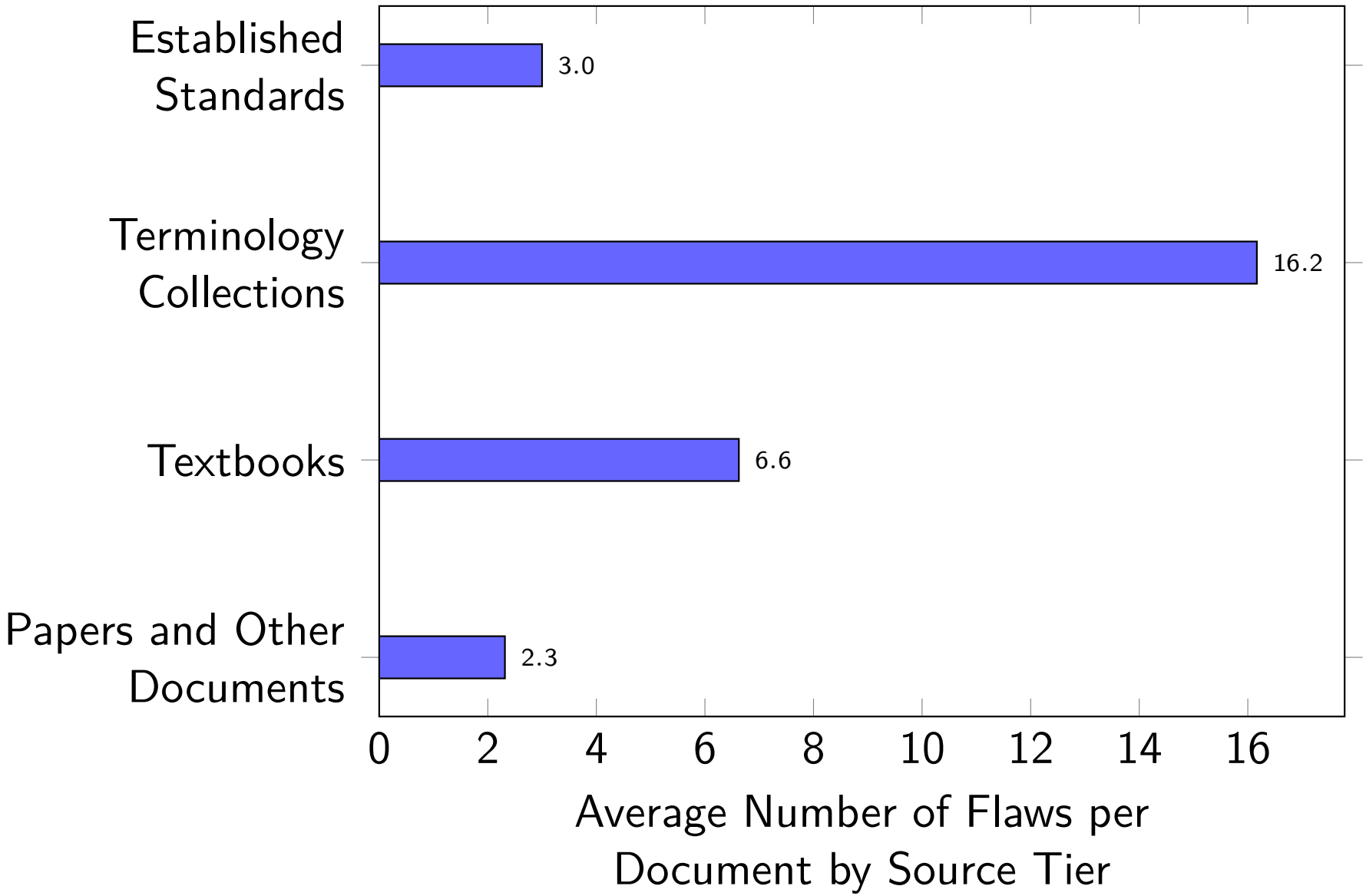
- 561 test approaches $\rightarrow$
- 77 software qualities (may imply test approaches)
- 295 flaws in the software testing literature



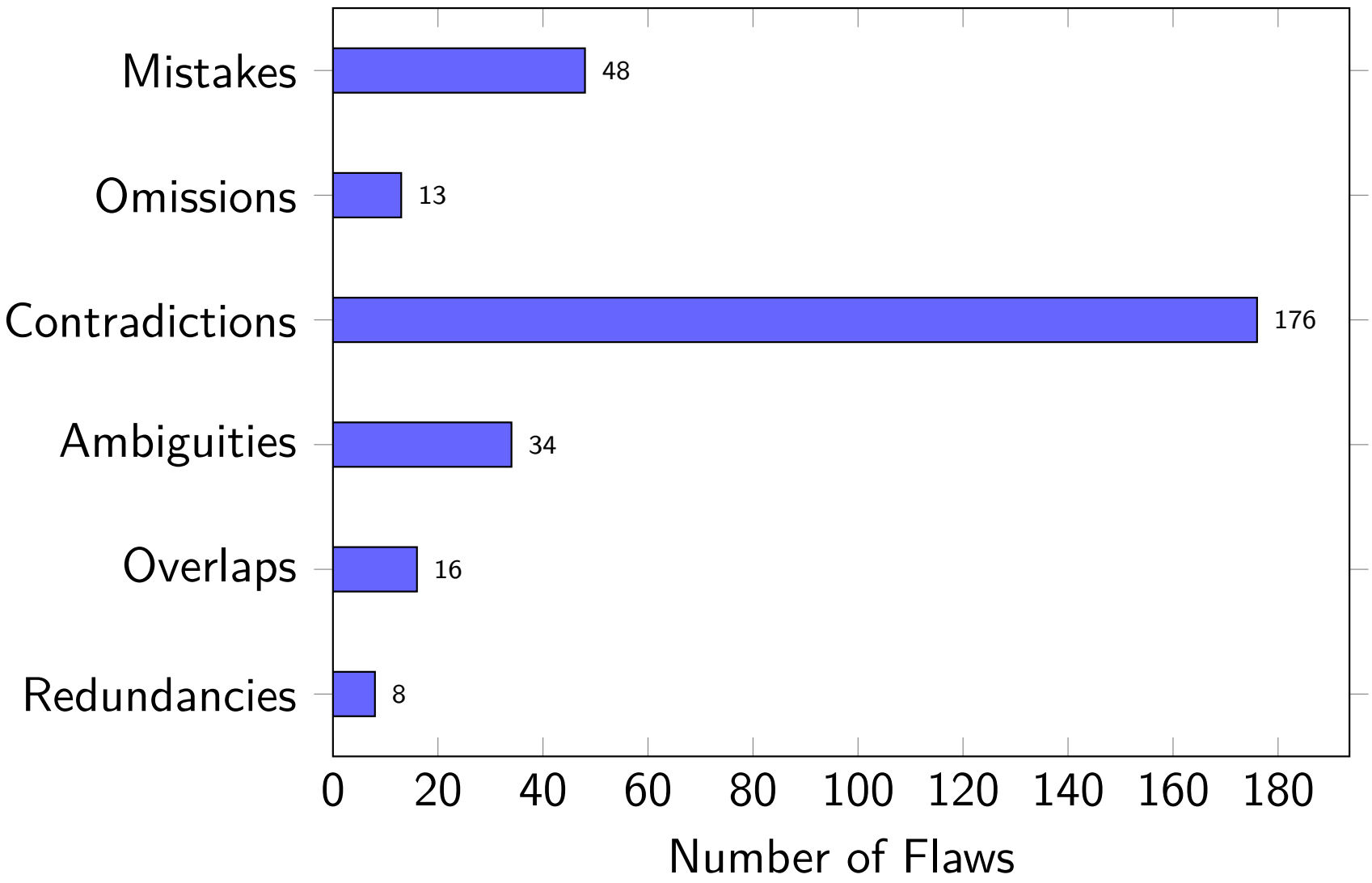
Flaw Summary by Source Tier



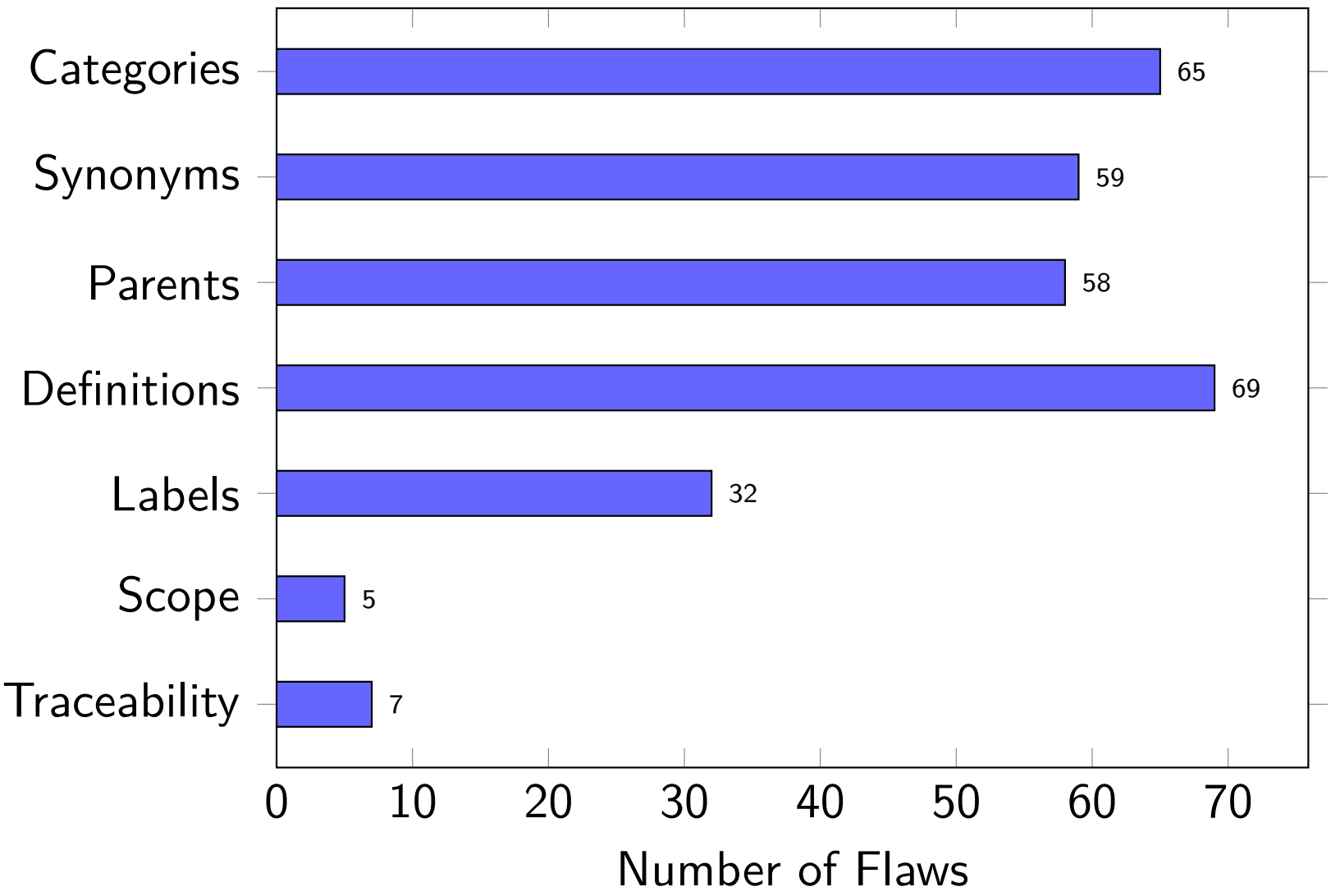
Normalized Flaw Summary



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

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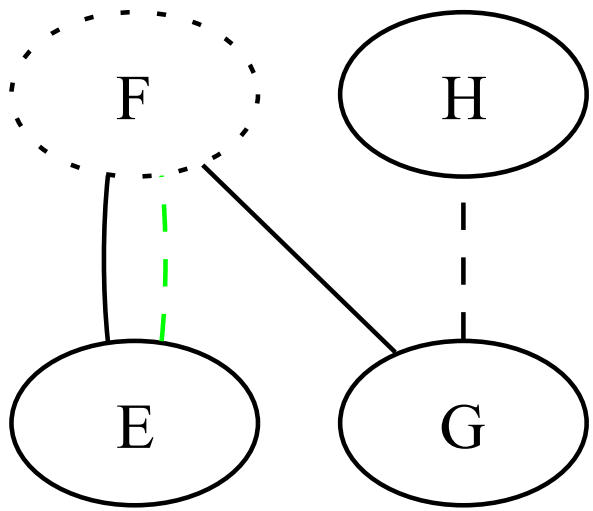
- These are included in generated visualizations automatically

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

Prominent examples of these "multi-synonyms":

	Source(s)
1. **Soak Testing:**	
• Endurance Testing	(ISO/IEC and IEEE, 2021c, p. 39)
• Reliability Testing	(Gerrard, 2000a, Tab. 2; 2000b, Tab. 1, p. 26)
2. **Functional Testing:**	
• Behavioural Testing	(Kam, 2008, p. 45)
• Correctness Testing	(Washizaki, 2024, p. 5-7)
• Specification-based Testing	(ISO/IEC and IEEE, 2017, p. 196; ...)

Automated Flaws

Prominent examples of these "multi-synonyms":

	Source(s)
1 Soak Testing:	
• Endurance Testing	(ISO/IEC and IEEE, 2021c, p. 39)
• Reliability Testing	(Gerrard, 2000a, Tab. 2; 2000b, Tab. 1, p. 26)
2 Functional Testing:	
• Behavioural Testing	(Kam, 2008, p. 45)
• Correctness Testing	(Washizaki, 2024, p. 5-7)
• Specification-based Testing	(ISO/IEC and IEEE, 2017, p. 196; ...)
3 Link Testing:	
• Branch Testing	(implied by ISO/IEC and IEEE, 2021c, p. 24)
• Component Integration Testing	(Kam, 2008, p. 45)
• Integration Testing	(implied by Gerrard, 2000a, p. 13)

Acknowledgment

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- The past and current Drasil team have created a truly amazing framework!

Thank you!

Questions?

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