

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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Table of Contents

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



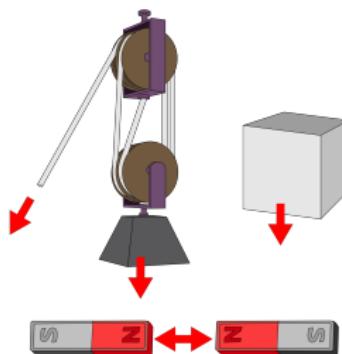
SOFTWARE
ENGINEERING

The Need for Standardized Terminology

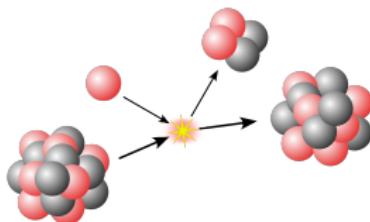
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- Scientific fields use precise terminology



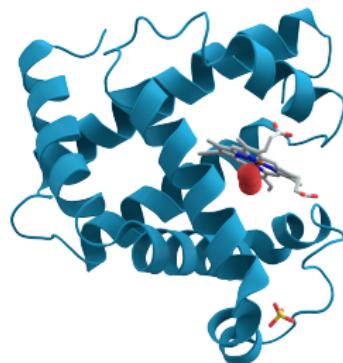
SOFTWARE
ENGINEERING



Penubag and Ramey (2010)



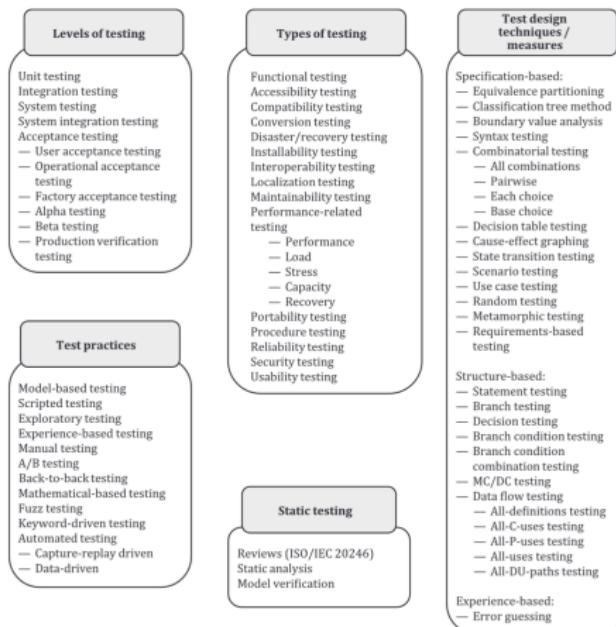
Kjerish (2016)



AzaToth (2008)

The Lack of Standardized Terminology

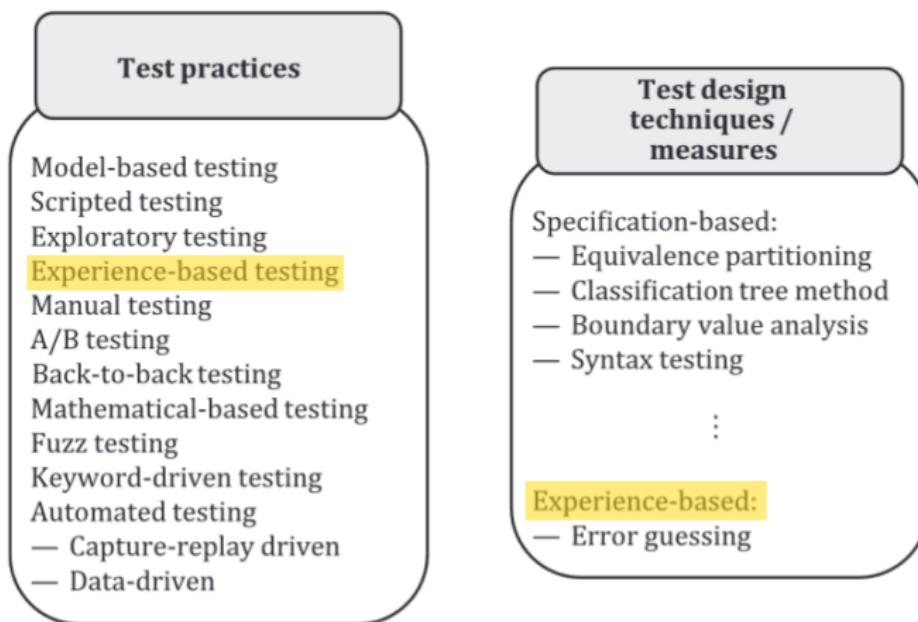
"The Problem"



(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"

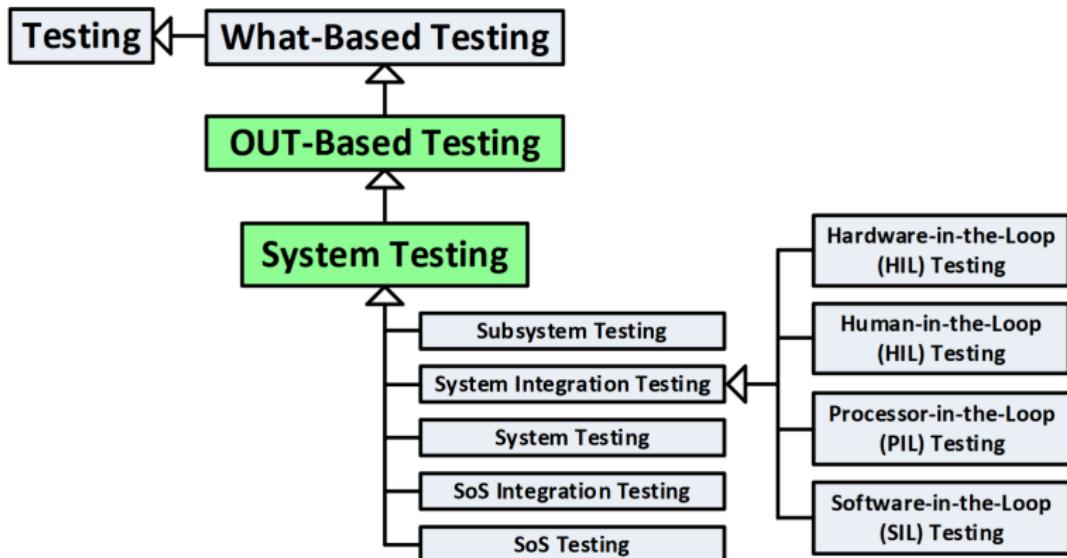
ISO/IEC/IEEE 29119-4 describes the **experience-based test design technique** of error guessing. Other **experience-based test practices** include (but are not limited to) exploratory testing (see [4.4.3.3](#)), tours, attacks, and checklist-based testing.

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

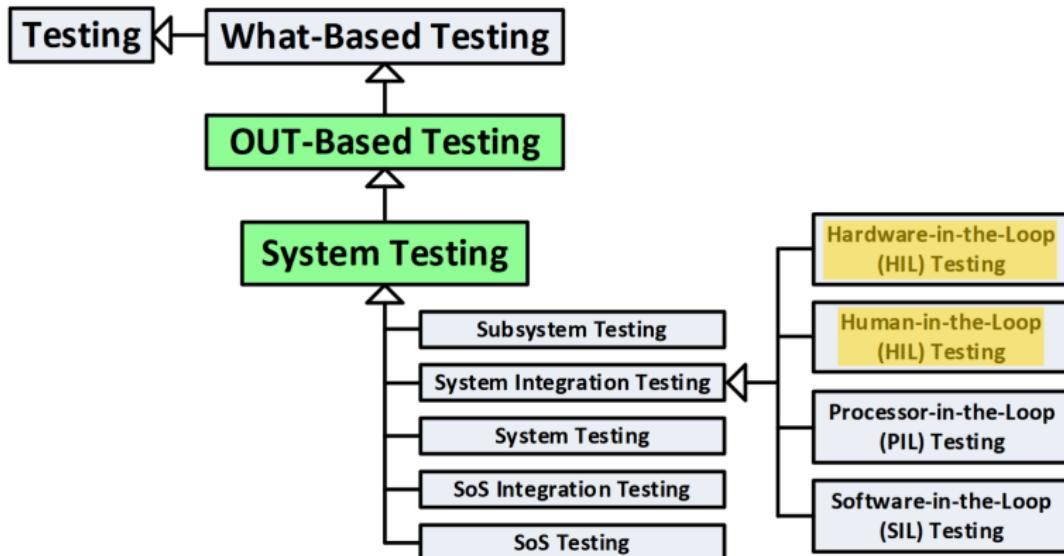


(Firesmith, 2015, p. 23)

The Lack of Standardized Terminology

“The Problem” (cont.)

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

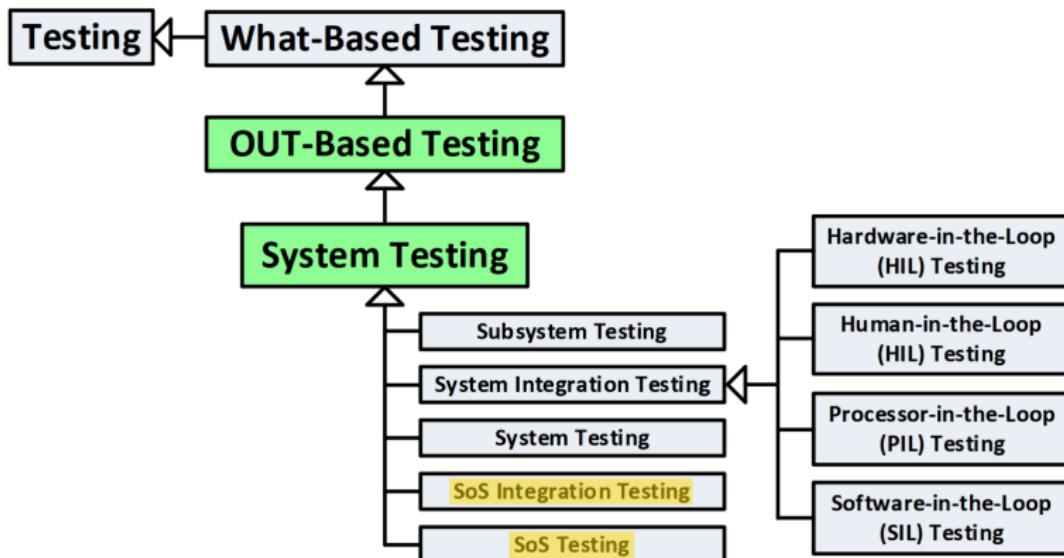


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The Lack of Standardized Terminology

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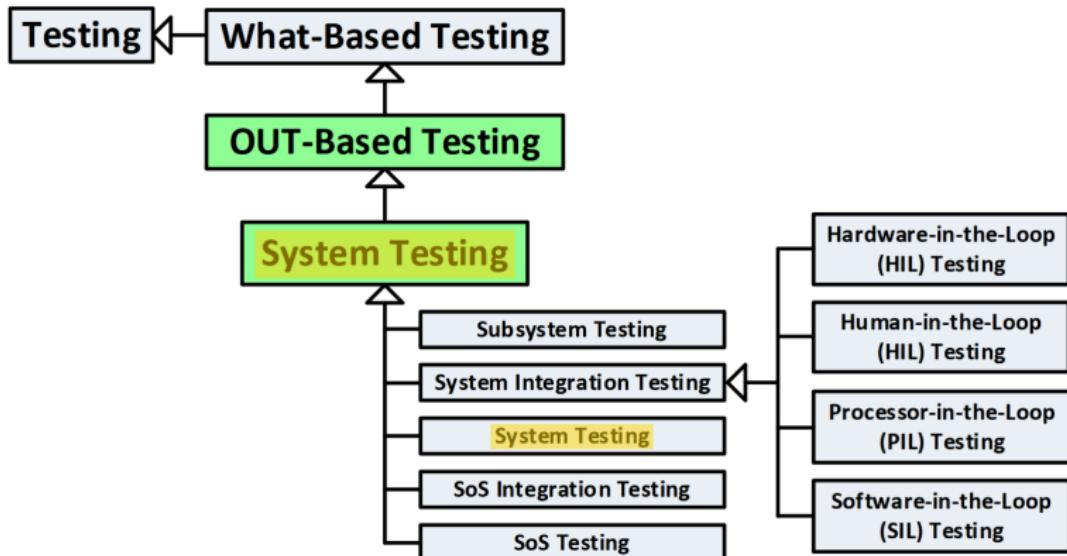


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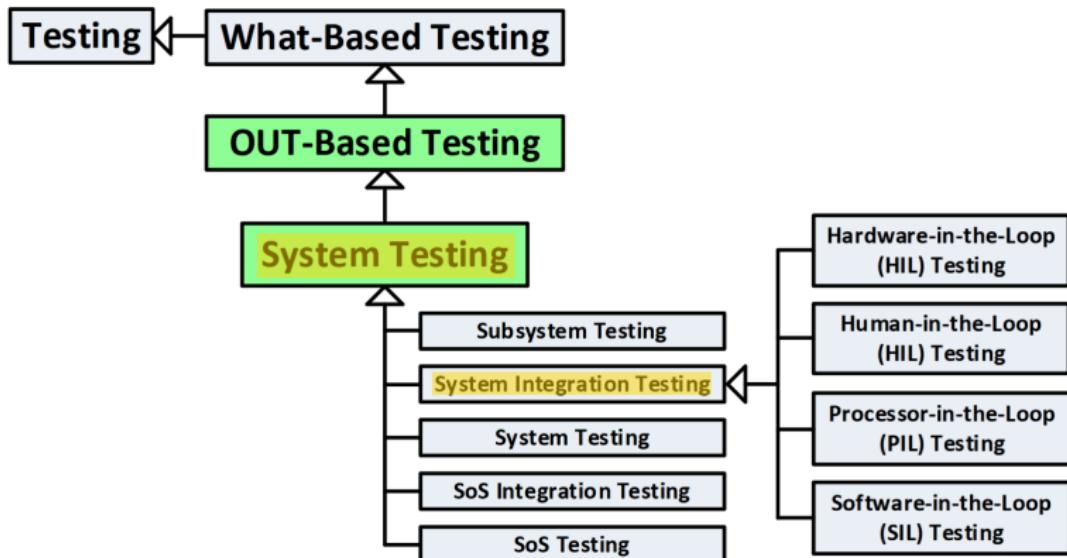


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The Lack of Standardized Terminology

“The Problem” (cont.)

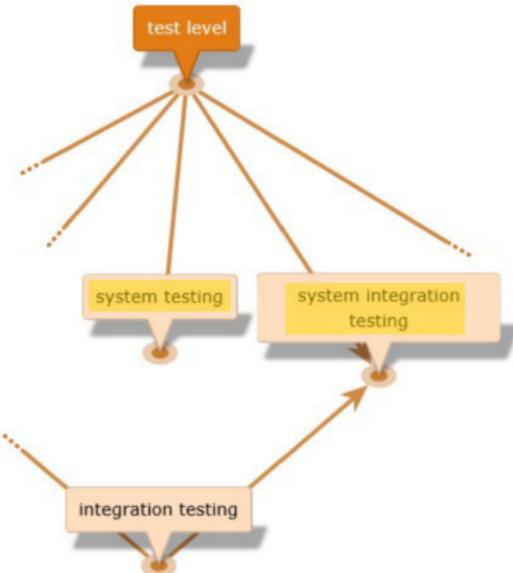
What: by Object Under Test (OUT) – System Testing



Adapted from (Firesmith, 2015, p. 23)

The Lack of Standardized Terminology

“The Problem” (cont.)



Adapted from (Hamburg and Mogyorodi, 2024)

What-Based Testing

OUT-Based Testing

System Testing

Subsystem Testing

System Integration Testing

System Testing

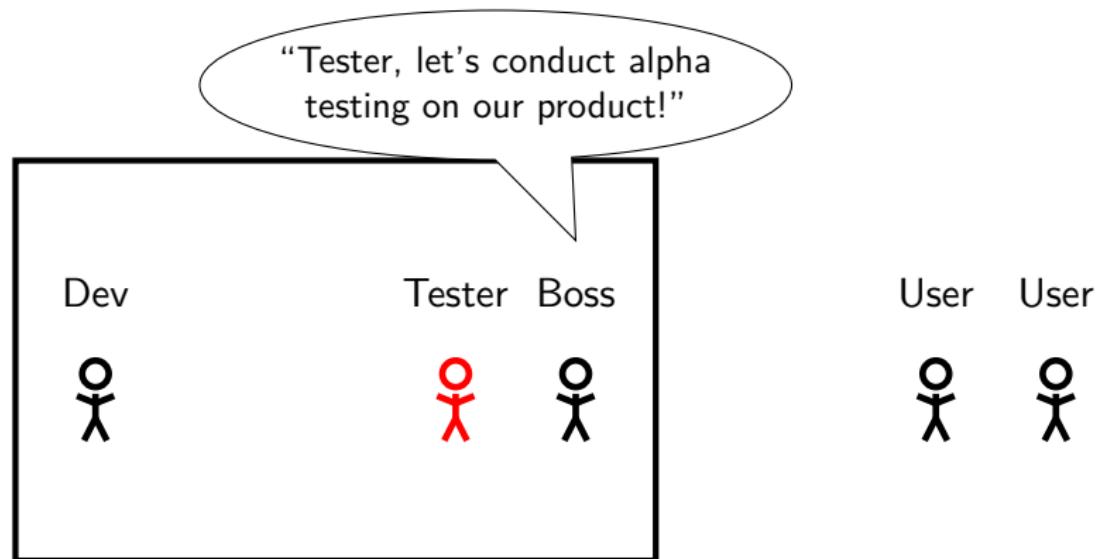
SoS Integration Testing

SoS Testing

Adapted from (Firesmith, 2015, p. 23)

The Lack of Standardized Terminology

“The Problem” (cont.)

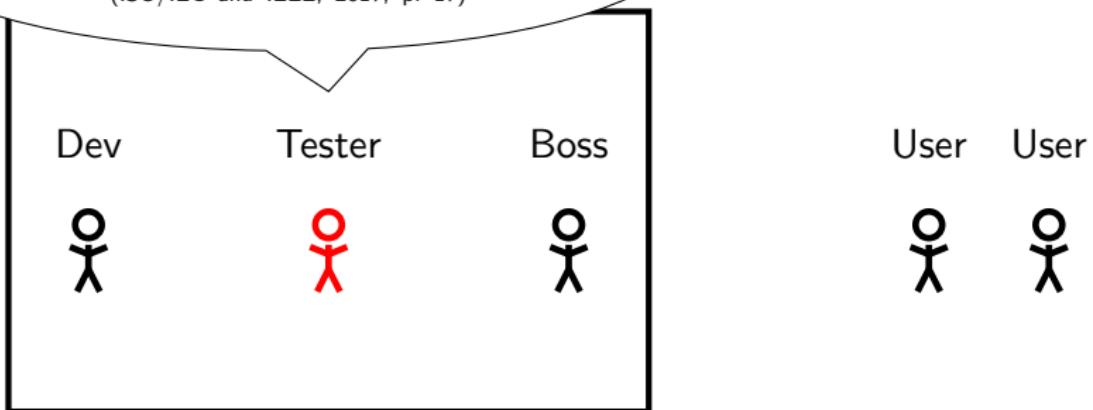


The Lack of Standardized Terminology

"The Problem" (cont.)

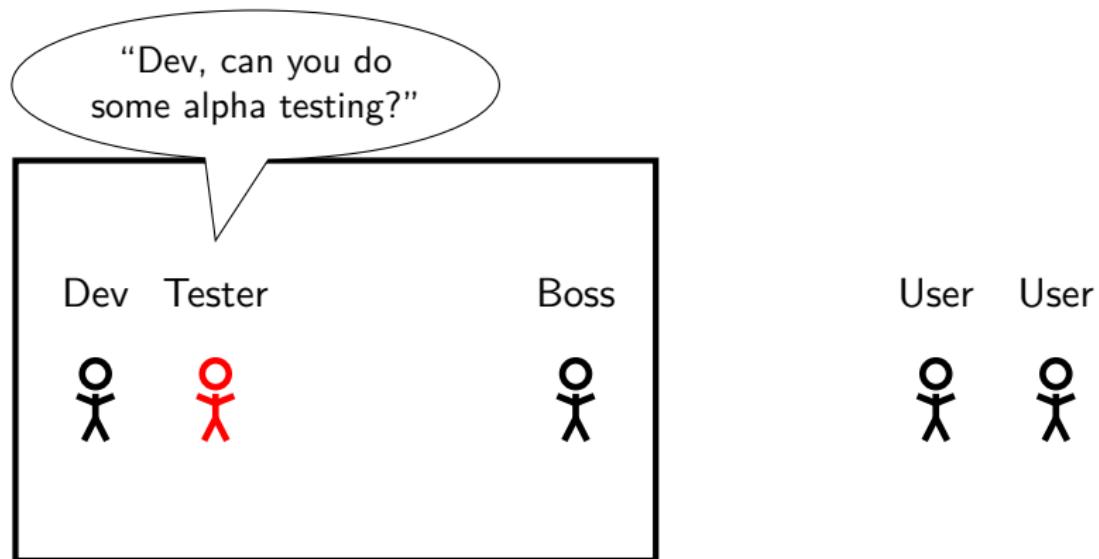
"Alpha testing is done by 'users within the organization developing the software'."

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



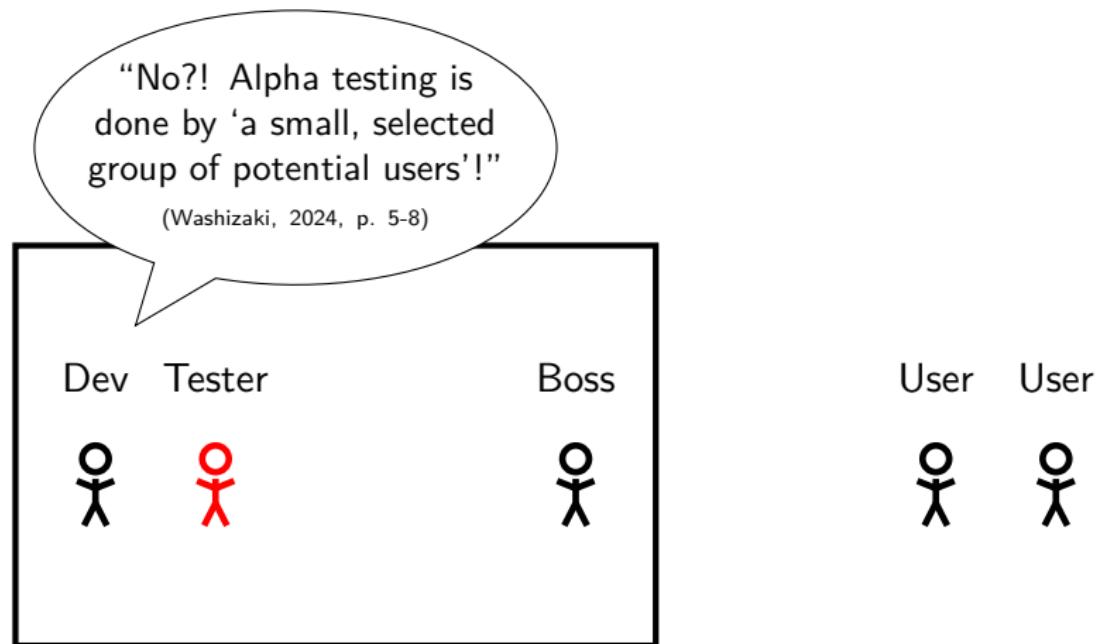
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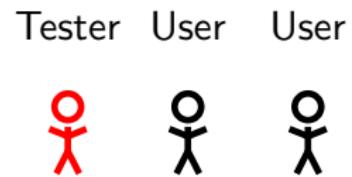
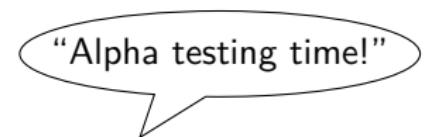
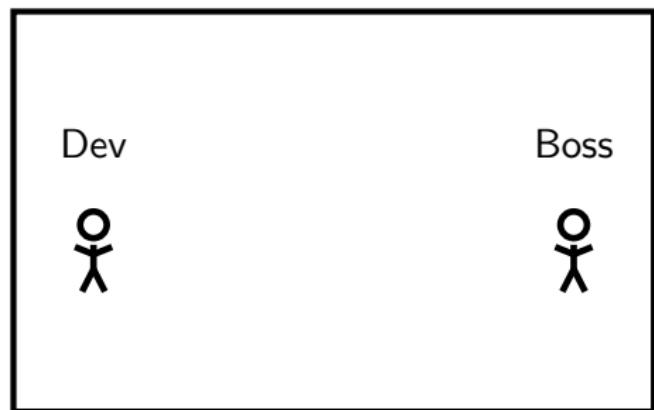
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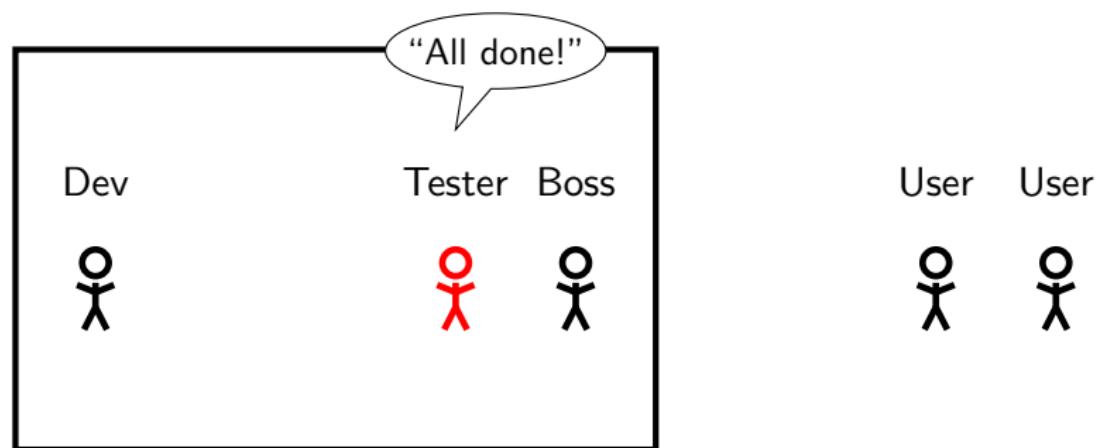
The Lack of Standardized Terminology

“The Problem” (cont.)



The Lack of Standardized Terminology

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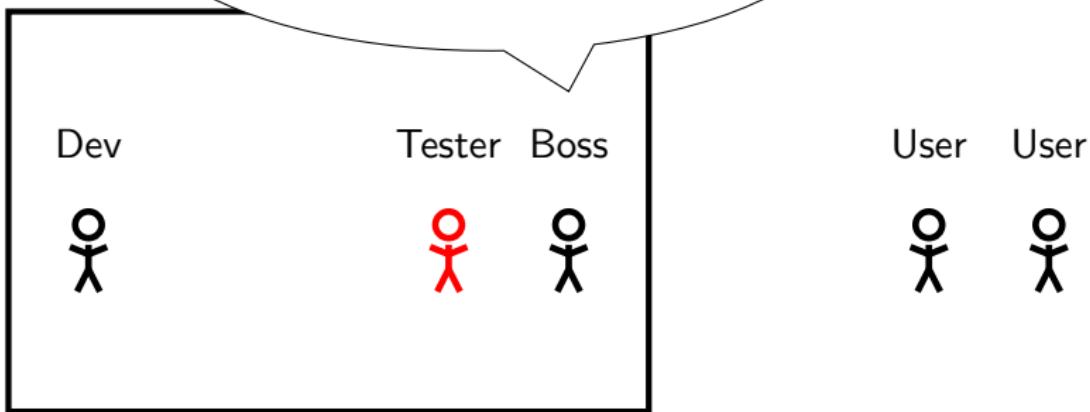


The Lack of Standardized Terminology

“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)

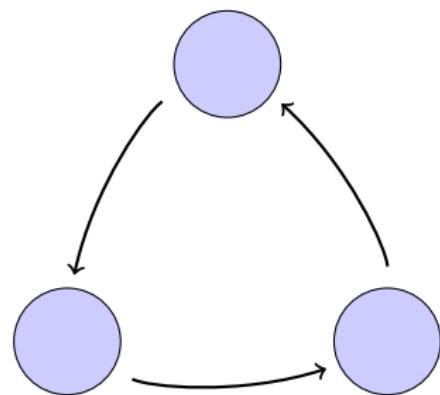


Barriers to Effective Communication

“The Problem” (cont.)

Interorganizational

Schools, companies, etc.

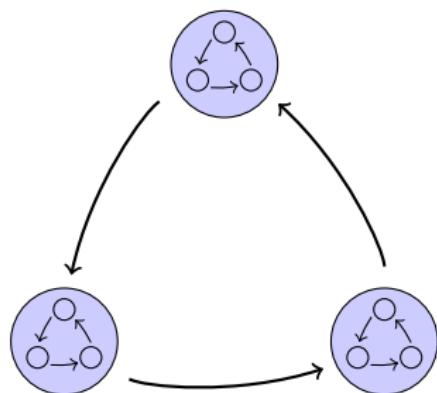


Barriers to Effective Communication

“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:

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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?

Methodology

Overview

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	③ Definitions	⑤ Parents
② Categories	④ Synonyms	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

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

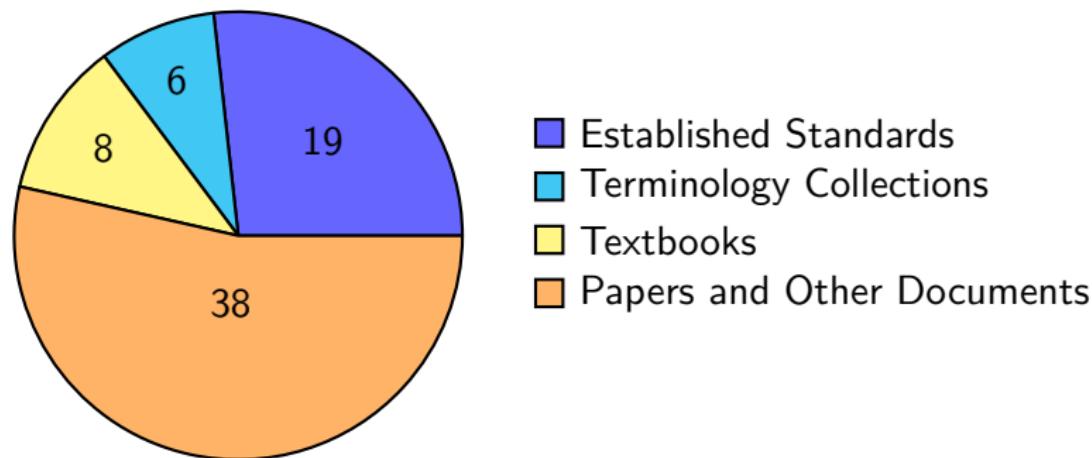
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Information from (ISO/IEC and IEEE, 2022)

- 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

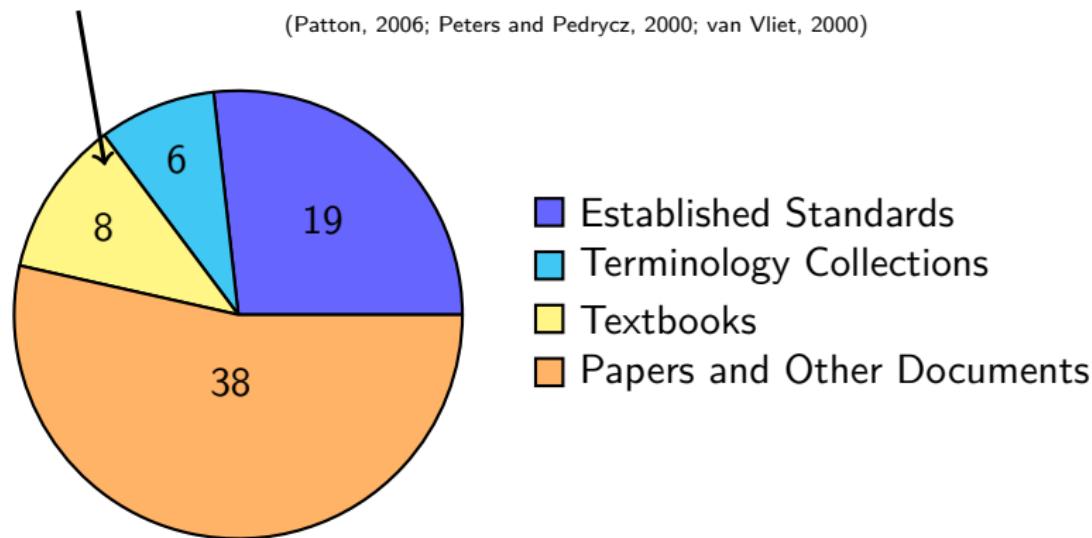


Methodology

Sources

Textbooks used at McMaster were our ad hoc starting points

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



Methodology

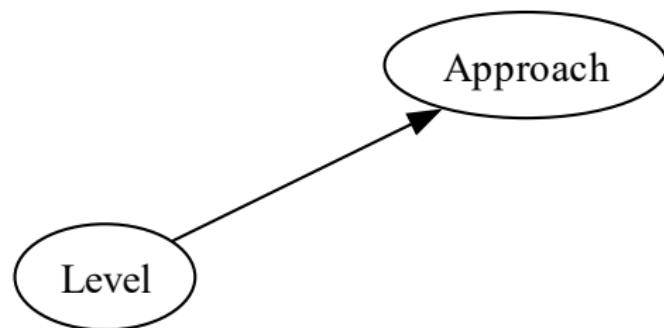
Categories

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

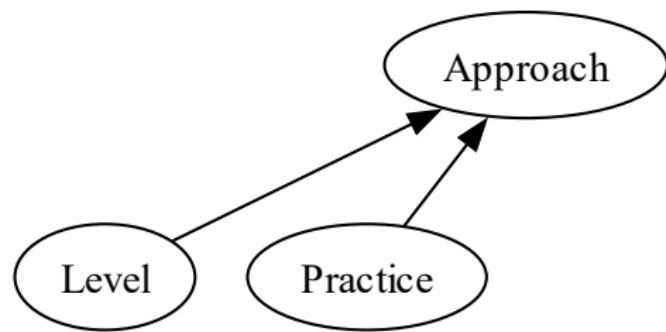
Categories



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

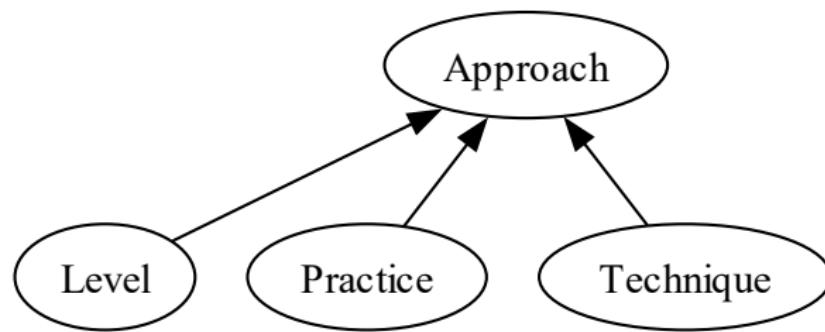
Categories



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

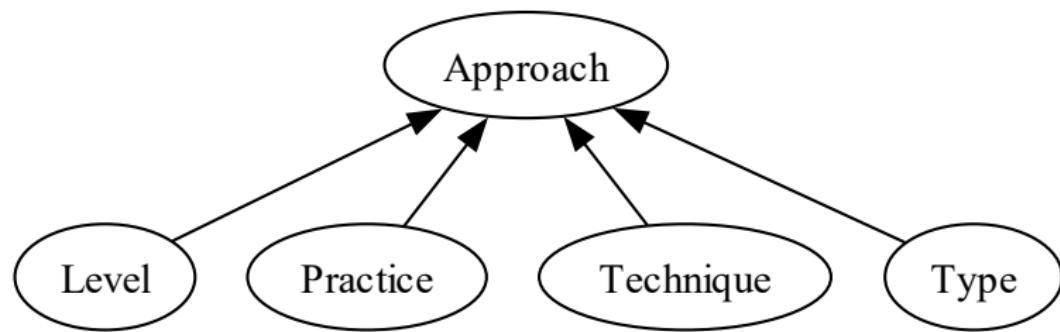
Categories



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

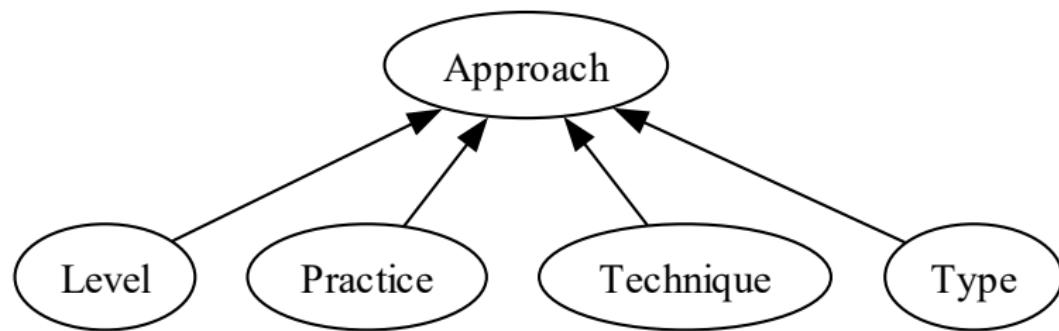
Categories



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

Methodology

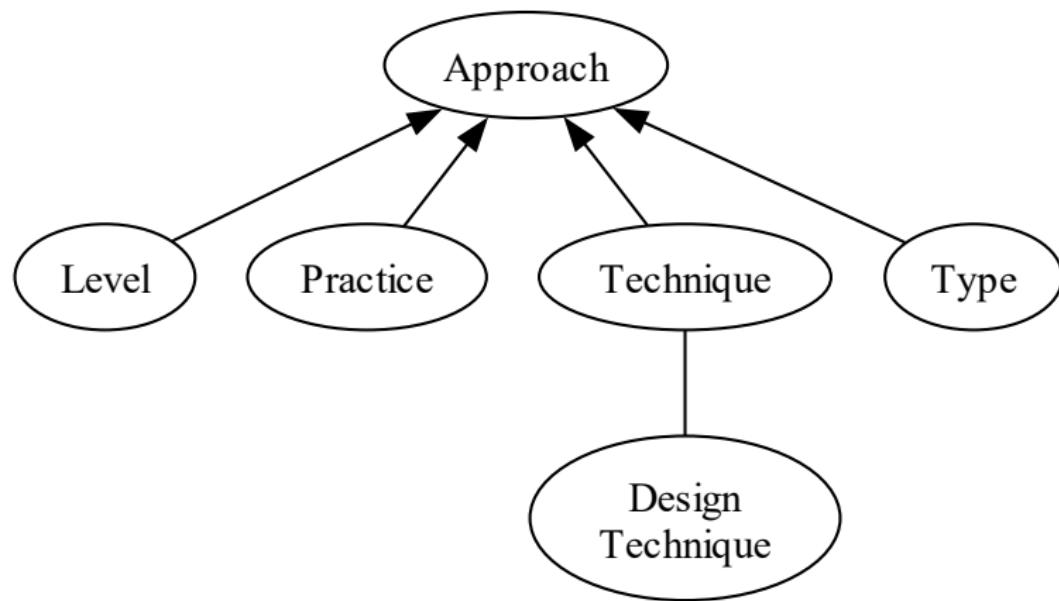
Visualization Notation



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

Methodology

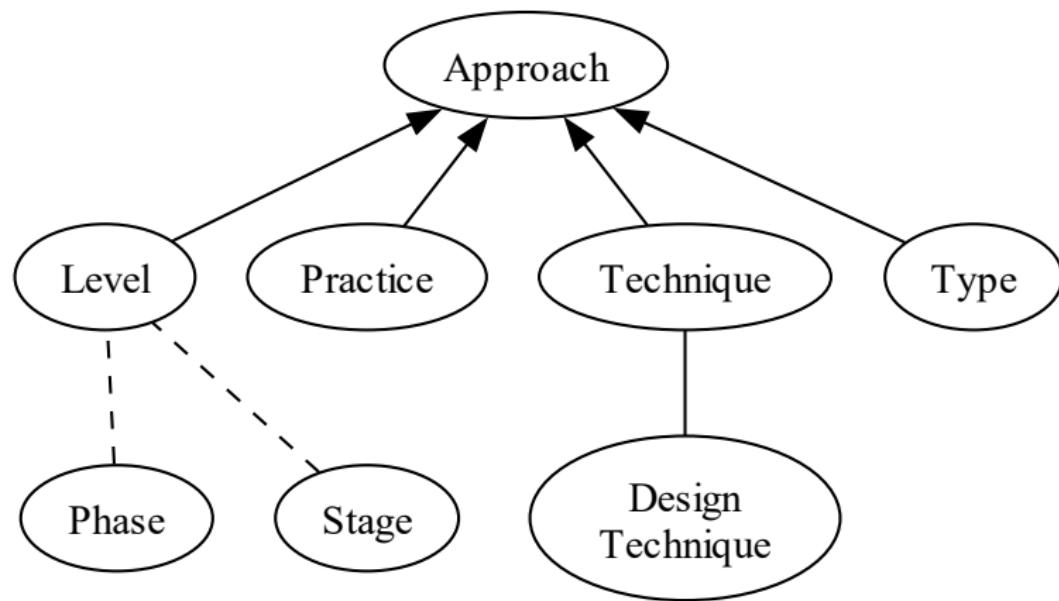
Visualization Notation



Lines without arrowheads connect *synonyms*.

Methodology

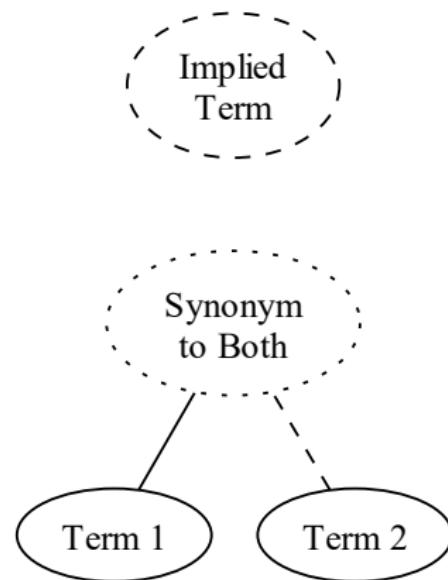
Visualization Notation



Dashed lines indicate a relationship is *implicit*.

Methodology

Visualization Notation



Dashed outlines indicate a term is *implicit*.

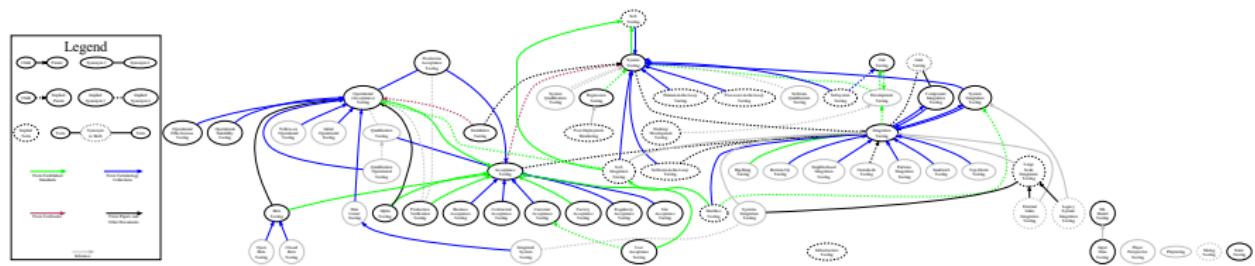
Dotted outlines indicate a term is a *synonym* to more than one term.

Graph of Test Approaches

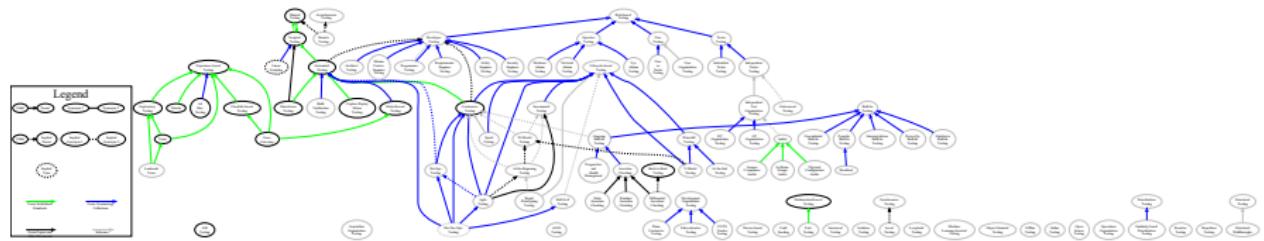
Graph of Test Approaches

! Dimension too large.

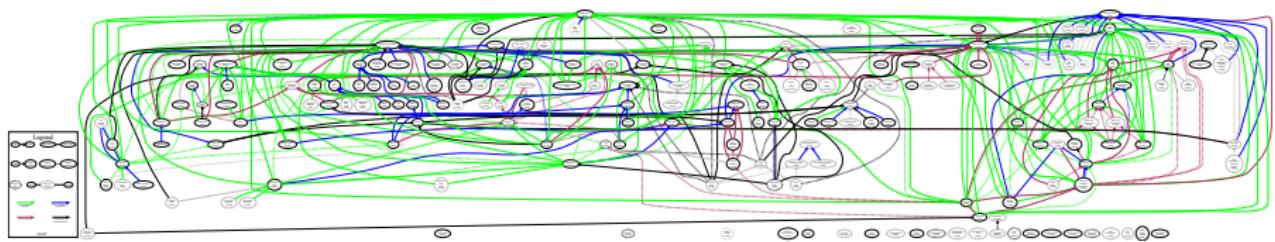
Graph of Test Levels



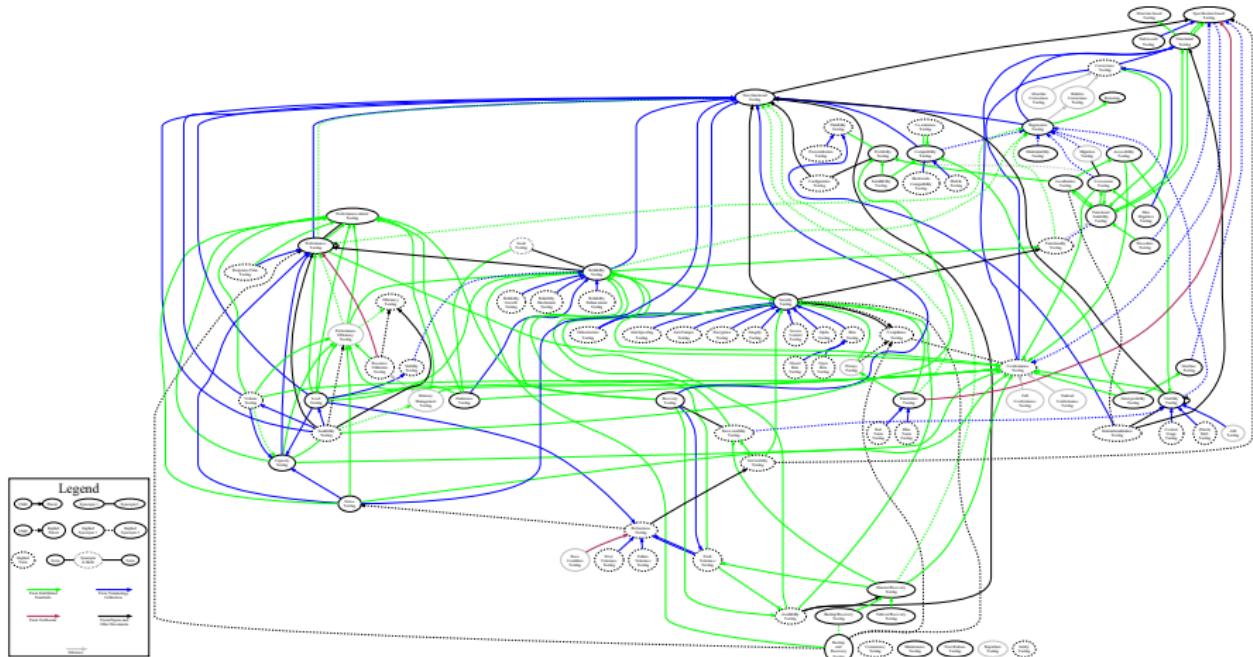
Graph of Test Practices



Graph of Test Techniques

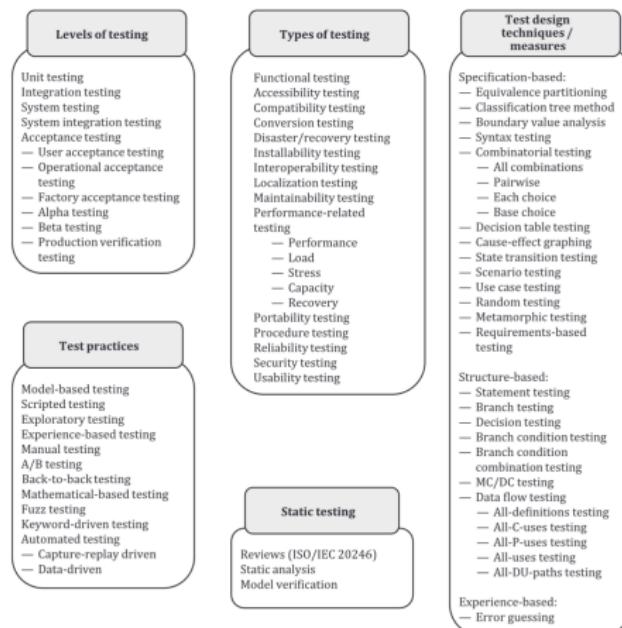


Graph of Test Types



Methodology

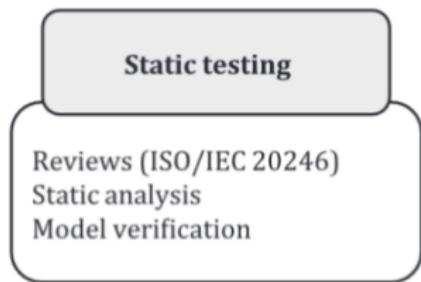
Visualization Notation



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

Methodology

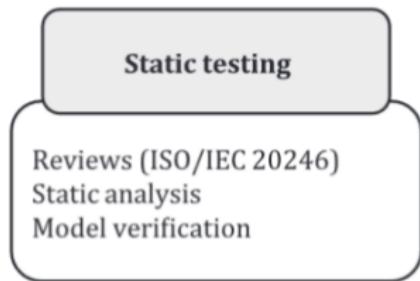
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Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

Methodology

Visualization Notation

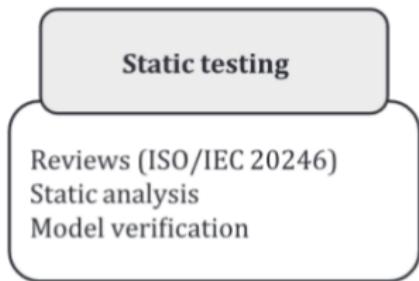


- Quite distinct but not necessarily orthogonal

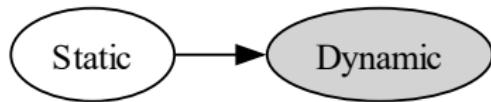
Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

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

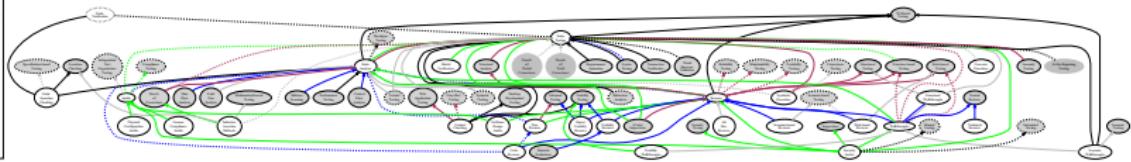
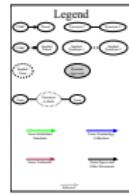


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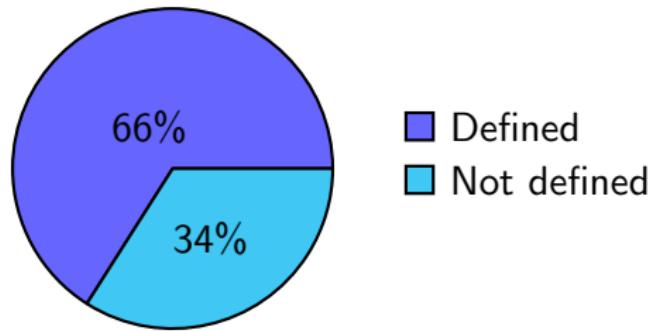
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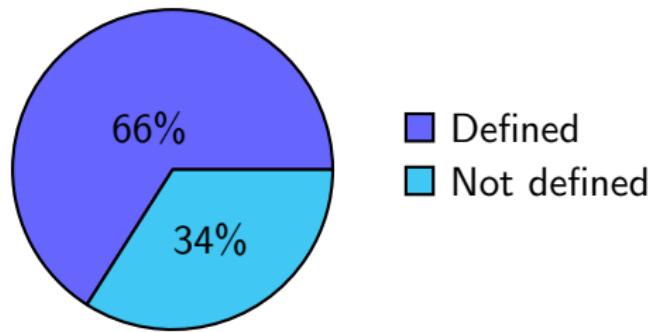
Overview

- 559 test approaches →



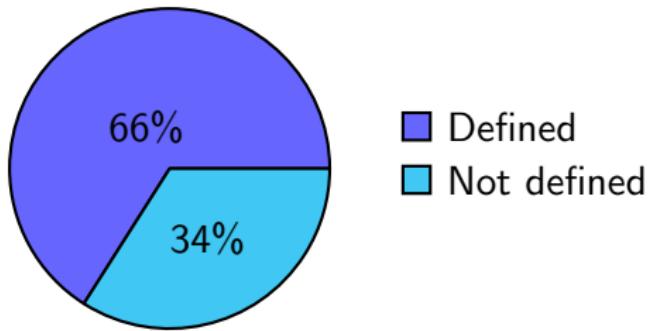
Overview

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

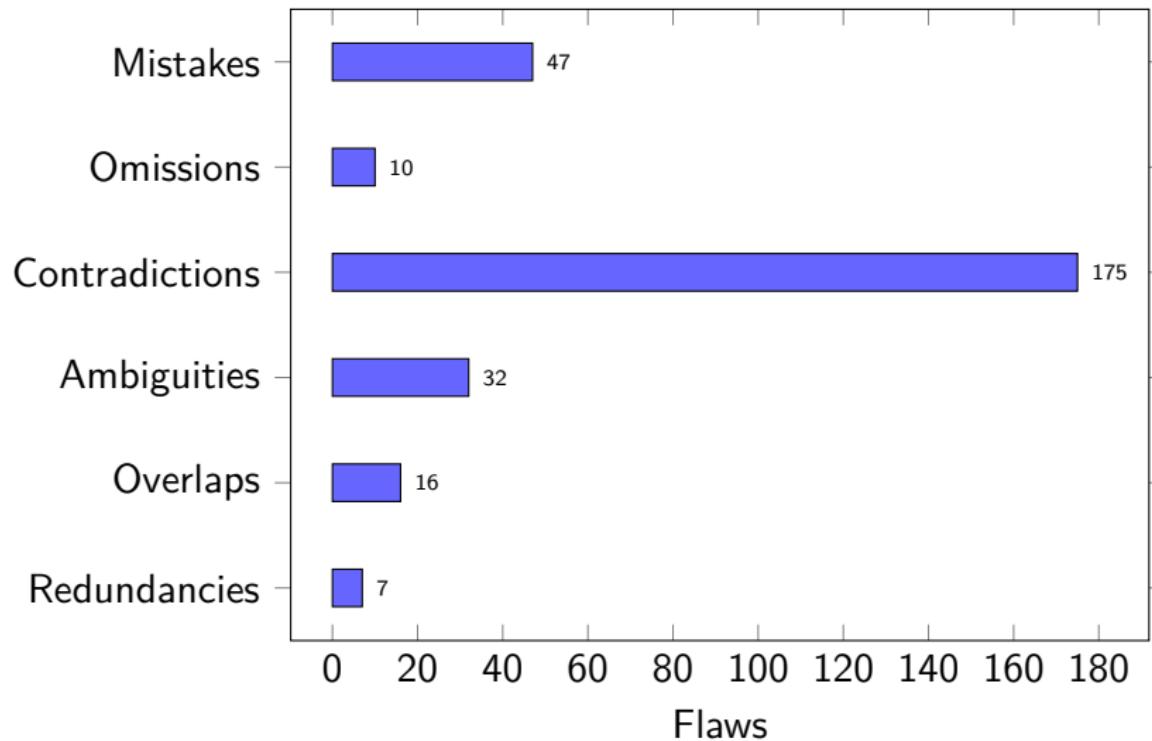


Overview

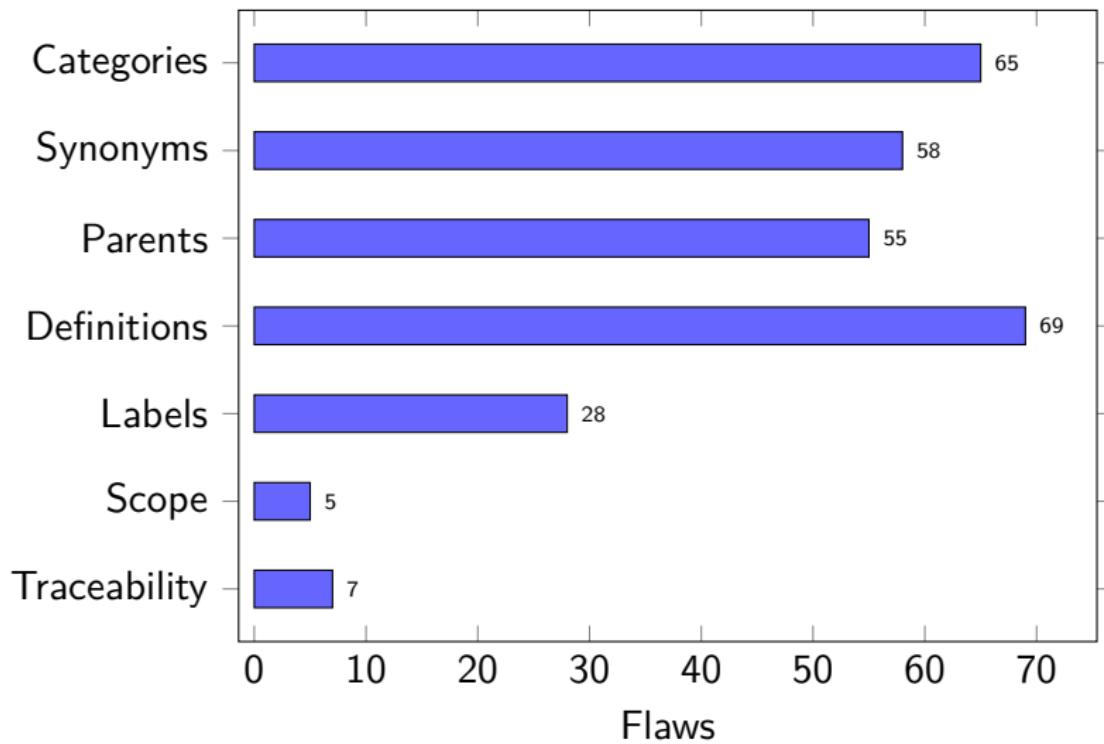
- 559 test approaches →
- 77 software qualities
(may imply test approaches)
- 287 flaws in the software testing literature



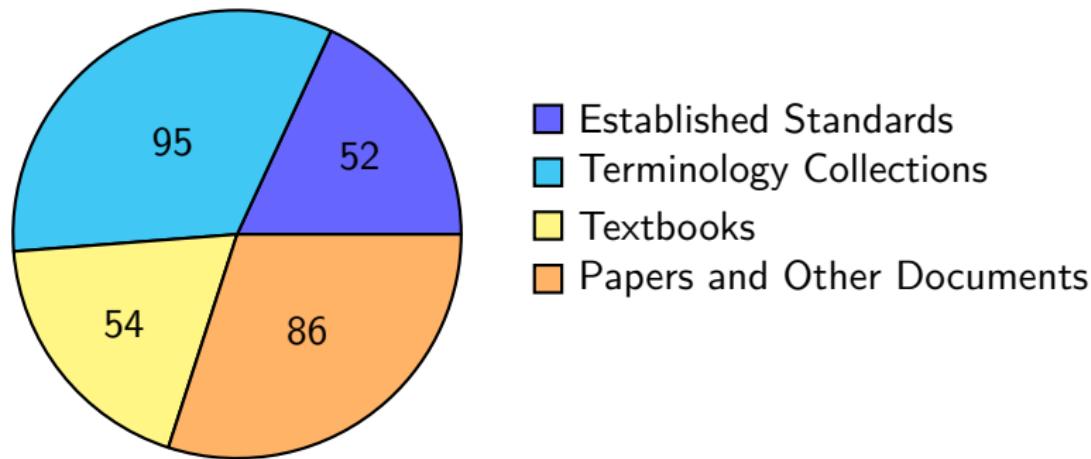
Flaw Summary by Manifestation



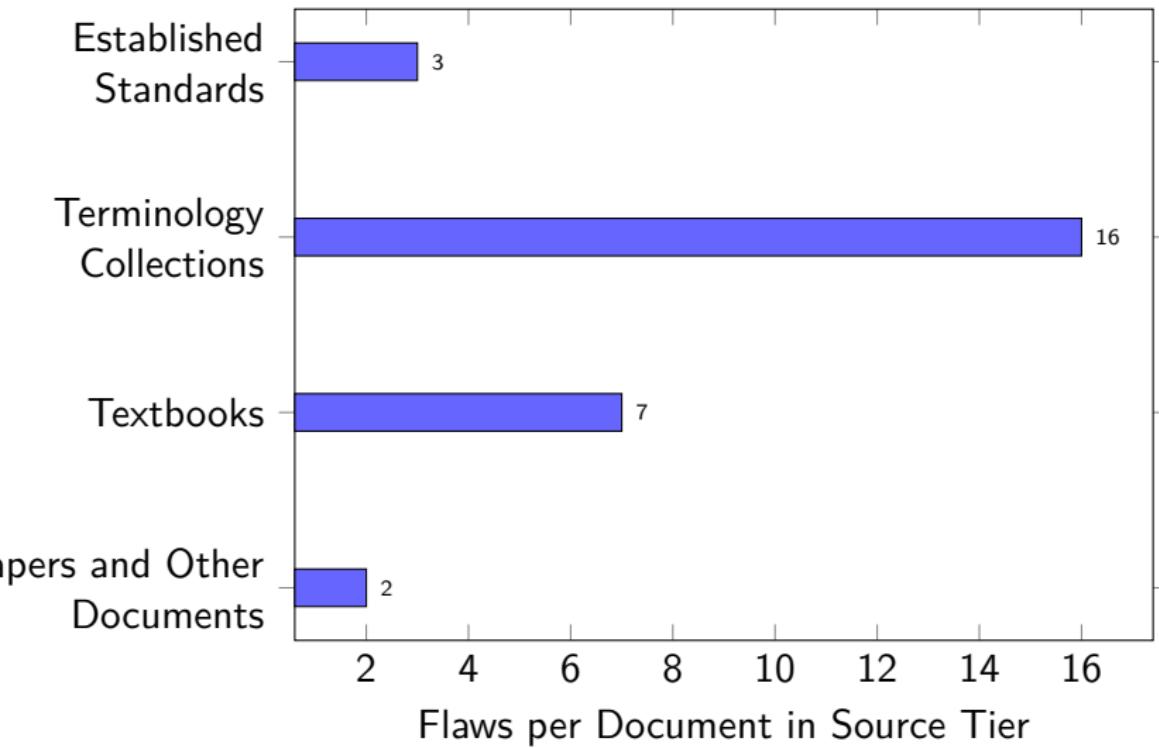
Flaw Summary by Domain



Flaw Summary by Source Tier



Normalized Flaw Summary



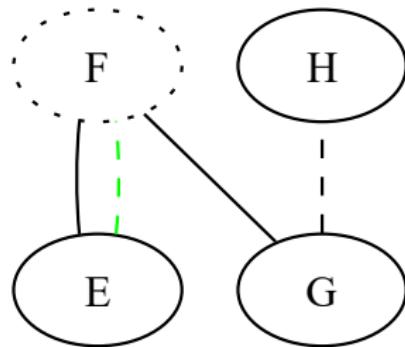
Automated Flaws

- 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

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- Specification-based Testing

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(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
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https://www.agileconnection.com/sites/default/files/article/file/2013/XUS129342file1_0.pdf.
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