

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 Flaws

Table of Contents

1 Introduction

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

2 Project

- Research Questions
- Methodology

3 Flaws

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)



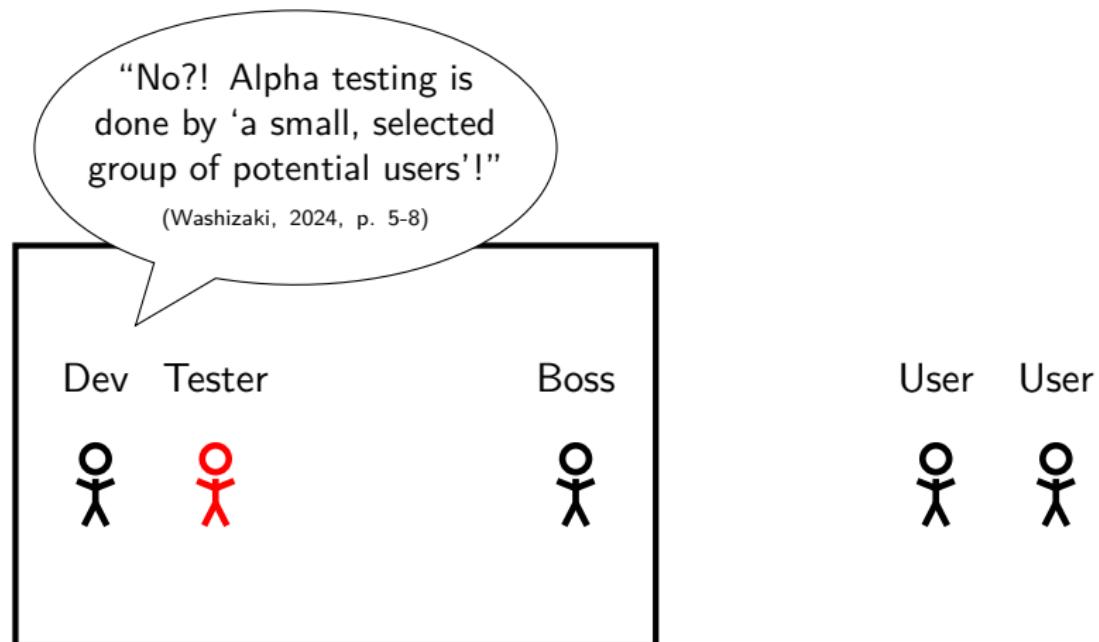
The Lack of Standardized Terminology

"The Problem" (cont.)



The Lack of Standardized Terminology

"The Problem" (cont.)



The Lack of Standardized Terminology

“The Problem” (cont.)



Tester User User



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)

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 Flaws

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
- ② Identifying all test approaches from each source and recording all relevant data, comprised of:

① Names	③ Definitions	⑤ Parents
② Categories	④ Synonyms	⑥ Flaws
- ③ Alongside step 2, identifying and recording related testing terms that:
 - ① Imply related test approaches
 - ② Are used repeatedly
 - ③ Have complex definitions
- 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 2.6
- 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 (p. 22)	Testing “that allows testers to determine which of two systems or components performs better” (p. 1)	Statistical Testing (pp. 1, 35), ...	Split-Run Testing (pp. 1, 35)

Information from (ISO/IEC and IEEE, 2022)

Methodology

Procedure

- A row is created for each test approach

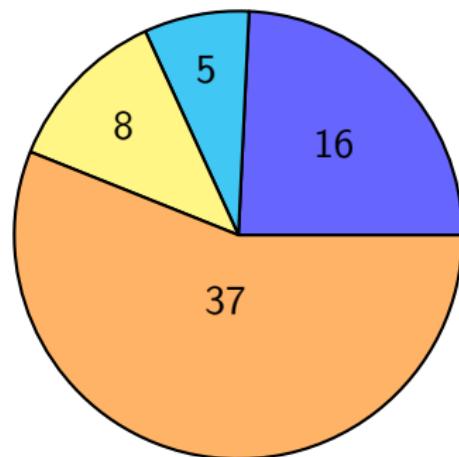
Name	Category	Definition	Parent(s)	Synonym(s)
A/B Testing	Practice (p. 22)	Testing “that allows testers to determine which of two systems or components performs better” (p. 1)	Statistical Testing (pp. 1, 35), ...	Split-Run Testing (pp. 1, 35)

Information from (ISO/IEC and IEEE, 2022)

- This information is gathered from sources by looking for
 - Glossaries
 - Testing-related terms
 - Terms described *by* other approaches
 - Terms that *imply* other approaches

Methodology

Sources



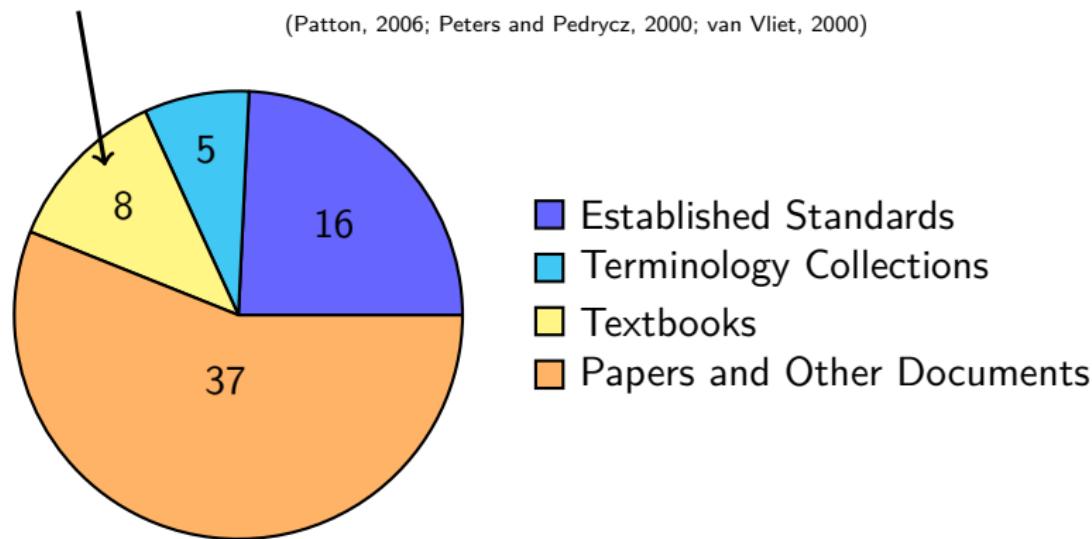
- Established Standards
- Terminology Collections
- Textbooks
- Papers and Other Documents

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; 2021, 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 “defined” and “systematic” (ISO/IEC and IEEE, 2017, p. 464) “procedure used to create or select a test model, identify test coverage items, and derive corresponding test cases” (2022, p. 11)

Methodology

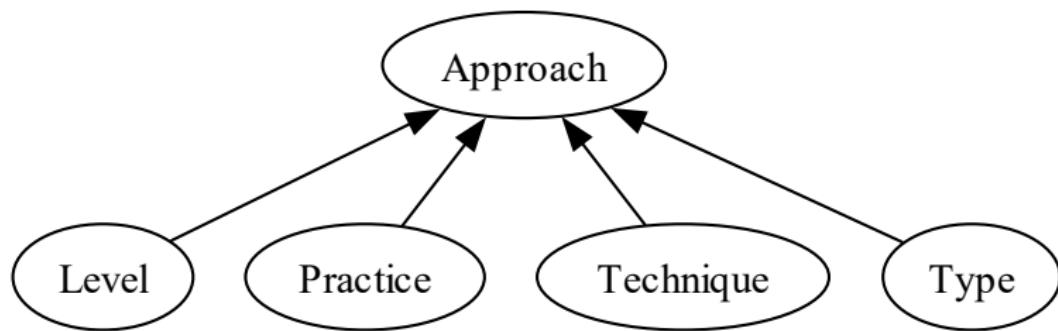
Categories



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

Methodology

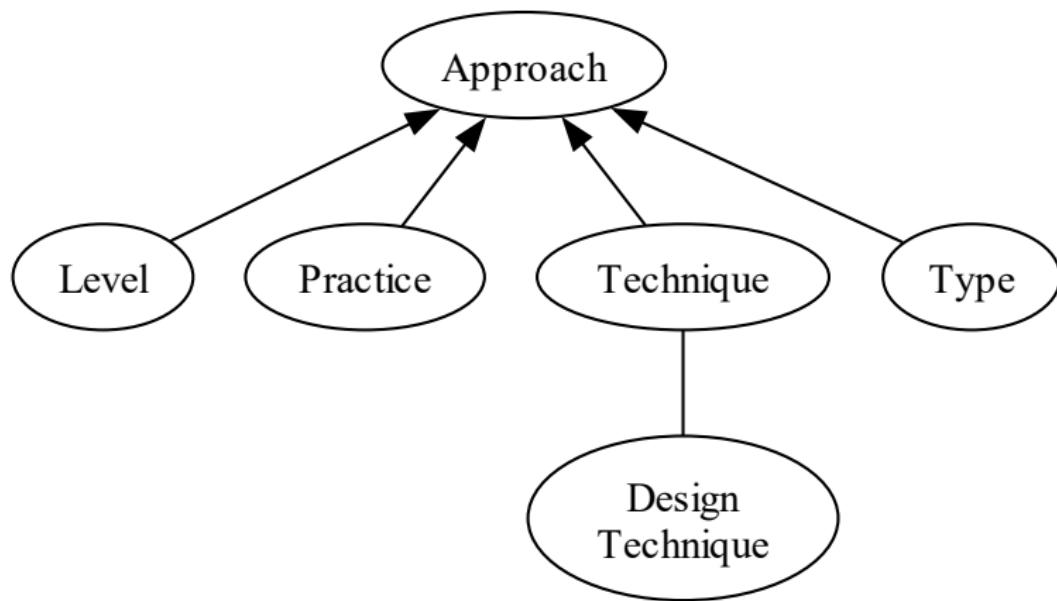
Graph Notation



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

Methodology

Graph Notation



Lines without arrowheads connect *synonyms*.

Methodology

Graph Notation



Dashed lines indicate a relationship is *implicit*.

Methodology

Graph Notation



Dashed outlines indicate a term is *implied*.

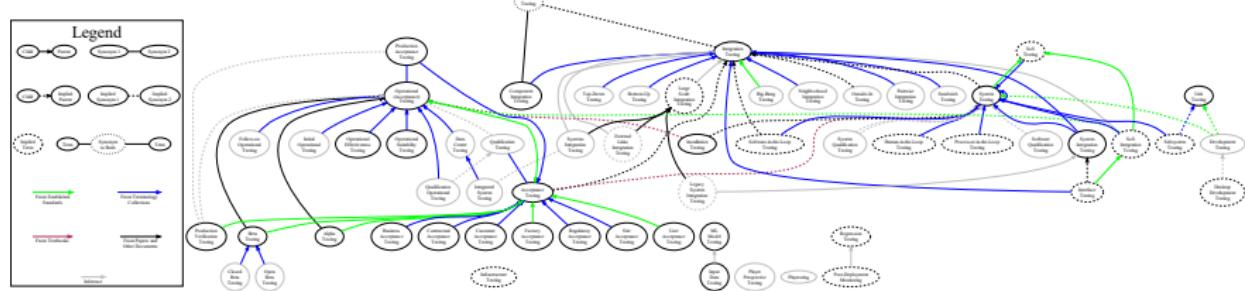
Dotted outlines indicate a term is a *synonym* to more than one term.

Graph of Test Approaches

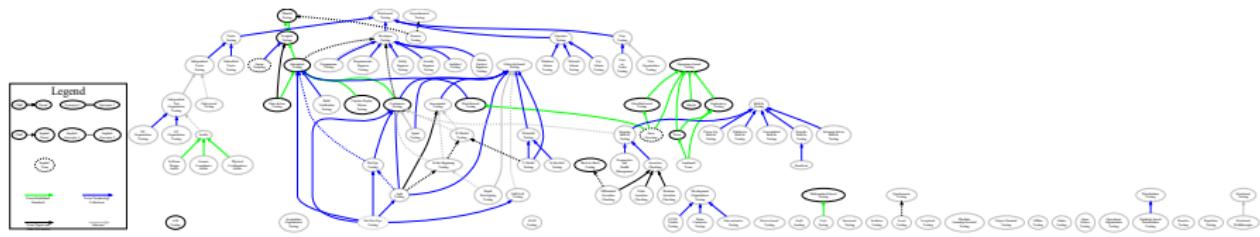
Graph of Test Approaches

! Dimension too large.

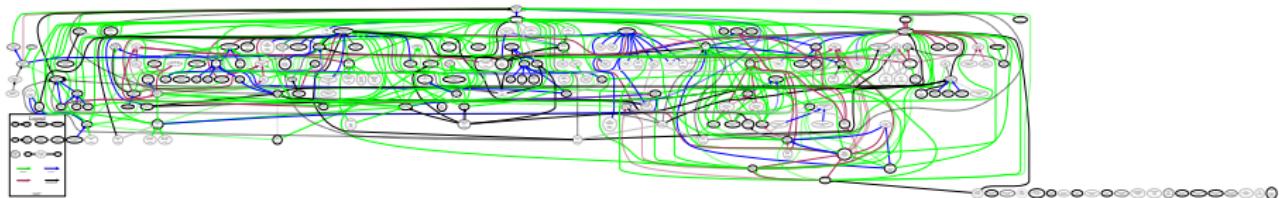
Graph of Test Levels



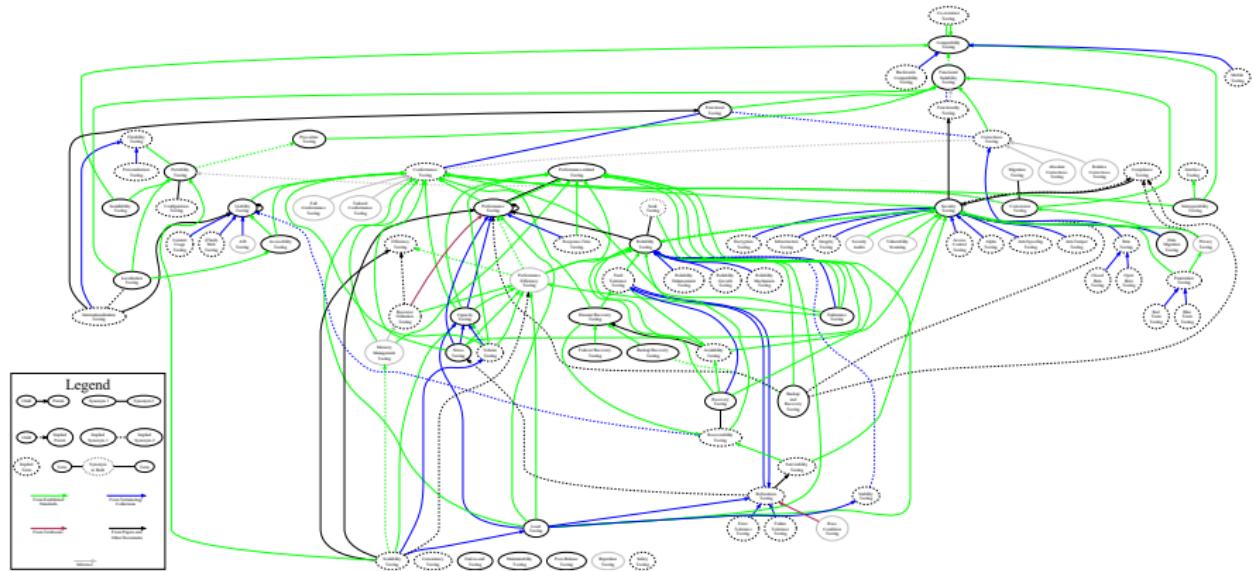
Graph of Test Practices



Graph of Test Techniques



Graph of Test Types



Methodology

Graph Notation



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

Methodology

Graph Notation



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

Methodology

Graph Notation



- Quite distinct but not necessarily orthogonal

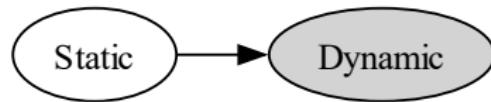
Adapted from (ISO/IEC and IEEE, 2022, Fig. 2)

Methodology

Graph 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

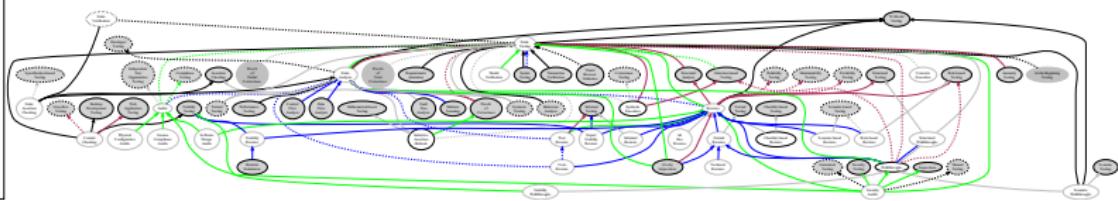
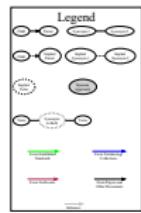


Table of Contents

1 Introduction

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

2 Project

- Research Questions
- Methodology

3 Flaws

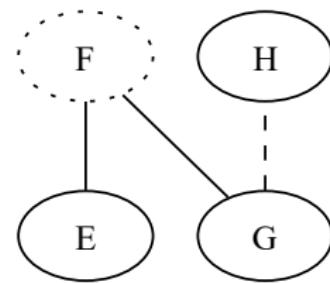
Automated Flaws

- 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 graphs automatically

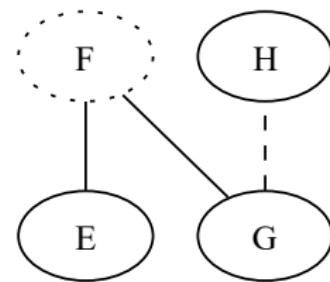
Name	Synonym(s)
E	F (Author, 0000; implied by 0001)
G	F (Author, 0002), H (implied by 0000)
H	X



Automated Flaws

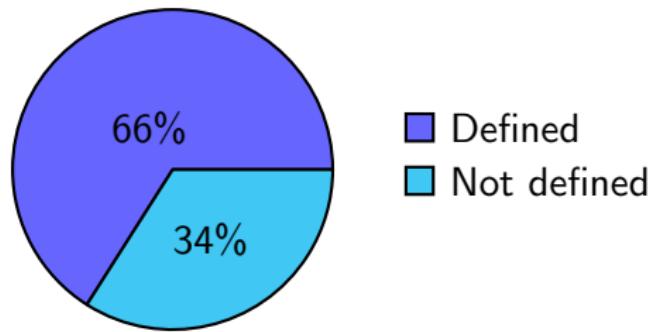
- Some terms are given as a synonym to two (or more) disjoint, unrelated terms, making the relation between the given synonyms ambiguous
- These are included in generated graphs automatically

Name	Synonym(s)
E	F (Author, 0000; implied by 0001)
G	F (Author, 0002), H (implied by 0000)
H	X



Results

- 564 test approaches →
- 75 software qualities
(may imply test approaches)



Automated Flaws

Prominent examples of these “multi-synonyms”:

① Invalid Testing:

- Error Tolerance Testing
- Negative Testing

Source(s)

(Kam, 2008, p. 45)

(Hamburg and Mogyorodi, 2024)

Automated Flaws

Prominent examples of these “multi-synonyms”:

- | | |
|---|---|
| <p>① Invalid Testing:</p> <ul style="list-style-type: none">● Error Tolerance Testing● Negative Testing <p>② Soak Testing:</p> <ul style="list-style-type: none">● Endurance Testing● Reliability Testing | <p>Source(s)</p> <p>(Kam, 2008, p. 45)
(Hamburg and Mogyorodi, 2024)</p> <p>(ISO/IEC and IEEE, 2021, p. 39)
(Gerrard, 2000a, Tab. 2; 2000b, Tab. 1, p. 26)</p> |
|---|---|

Automated Flaws

Prominent examples of these “multi-synonyms”:

- | | |
|--|---|
| <p>① Invalid Testing:</p> <ul style="list-style-type: none">● Error Tolerance Testing● Negative Testing <p>② Soak Testing:</p> <ul style="list-style-type: none">● Endurance Testing● Reliability Testing <p>③ Link Testing:</p> <ul style="list-style-type: none">● Branch Testing● Component Integration Testing● Integration Testing | <p>Source(s)</p> <p>(Kam, 2008, p. 45)
(Hamburg and Mogyorodi, 2024)</p> <p>(ISO/IEC and IEEE, 2021, p. 39)
(Gerrard, 2000a, Tab. 2; 2000b, Tab. 1, p. 26)</p> <p>(implied by ISO/IEC and IEEE, 2021, p. 24)
(Kam, 2008, p. 45)
(implied by Gerrard, 2000a, p. 13)</p> |
|--|---|

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
 - Dr. Smith first suggested generating test cases back in 2020!

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
 - Dr. Smith first suggested generating test cases back in 2020!
- The format of this presentation was *heavily* based on a previous presentation by Jason Balaci, who also provided a great thesis template

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
 - Dr. Smith first suggested generating test cases back in 2020!
- The format of this presentation was *heavily* based on a previous presentation by Jason Balaci, who also provided a great thesis template
- 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
<https://apps.dtic.mil/sti/pdfs/AD1147163.pdf>.
- Paul Gerrard. Risk-based E-business Testing - Part 1: Risks and Test Strategy. Technical report, Systeme Evolutif, London, UK, 2000a. URL
https://www.agileconnection.com/sites/default/files/article/file/2013/XUS129342file1_0.pdf.
- Paul Gerrard. Risk-based E-business Testing - Part 2: Test Techniques and Tools. Technical report, Systeme Evolutif, London, UK, 2000b. URL
wenku.uml.com/document/test/EBTestingPart2.pdf.
- Matthias Hamburg and Gary Mogyorodi, editors. ISTQB Glossary, v4.3, 2024. URL https://glossary.istqb.org/en_US/search.

References II

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 4: Test techniques. *ISO/IEC/IEEE 29119-4:2021(E)*, October 2021. 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 III

- 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.

References IV

J.F. Peters and W. Pedrycz. *Software Engineering: An Engineering Approach*. Worldwide series in computer science. John Wiley & Sons, Ltd., 2000. ISBN 978-0-471-18964-0.

Erica Souza, Ricardo Falbo, and Nandamudi Vijaykumar. ROoST: Reference Ontology on Software Testing. *Applied Ontology*, 12:1–32, March 2017. doi: 10.3233/AO-170177.

Guido Tebes, Luis Olsina, Denis Peppino, and Pablo Becker. TestTDO: A Top-Domain Software Testing Ontology. pages 364–377, Curitiba, Brazil, May 2020. ISBN 978-1-71381-853-3.

Michael Unterkalmsteiner, Robert Feldt, and Tony Gorschek. A Taxonomy for Requirements Engineering and Software Test Alignment. *ACM Transactions on Software Engineering and Methodology*, 23(2):1–38, March 2014. ISSN 1049-331X, 1557-7392. doi: 10.1145/2523088. URL <http://arxiv.org/abs/2307.12477>. arXiv:2307.12477 [cs].

References V

Hans van Vliet. *Software Engineering: Principles and Practice*. John Wiley & Sons, Ltd., Chichester, England, 2nd edition, 2000. ISBN 0-471-97508-7.

Hironori Washizaki, editor. *Guide to the Software Engineering Body of Knowledge, Version 4.0*. January 2024. URL <https://waseda.app.box.com/v/SWEBOK4-book>.