

# Putting Software Testing Terminology to the Test

## M.A.Sc. Seminar

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## 1 Introduction

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

## 2 Project

- Research Questions
- Methodology

## 3 Flaws

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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



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.)

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# 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)



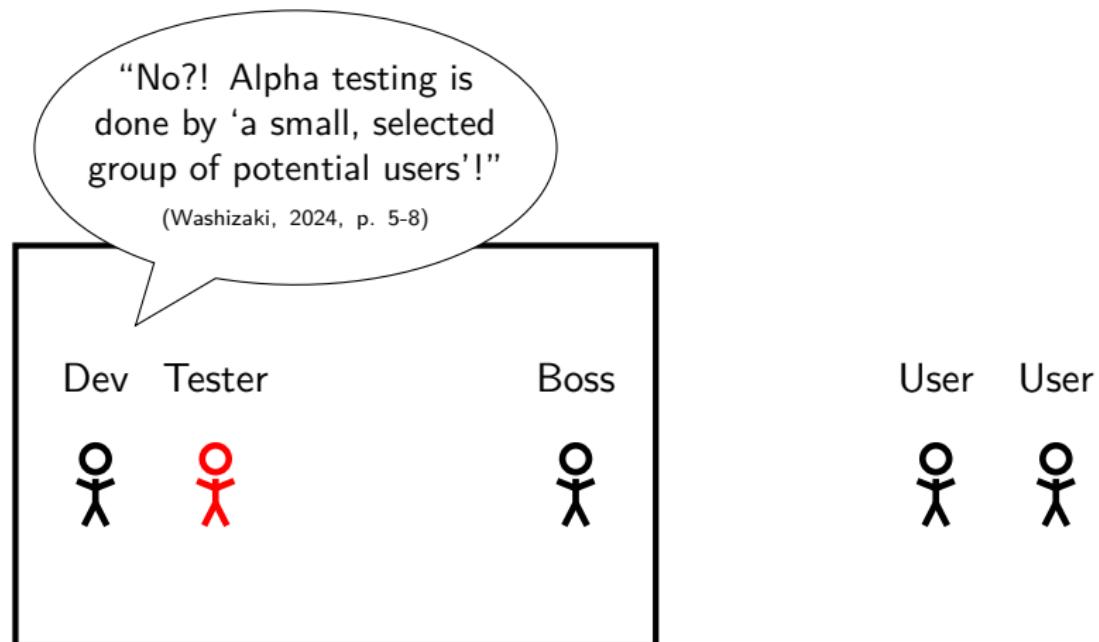
# The Lack of Standardized Terminology

## "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.)

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- 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 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 for each term identified in step 2; for test approaches, these 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 (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

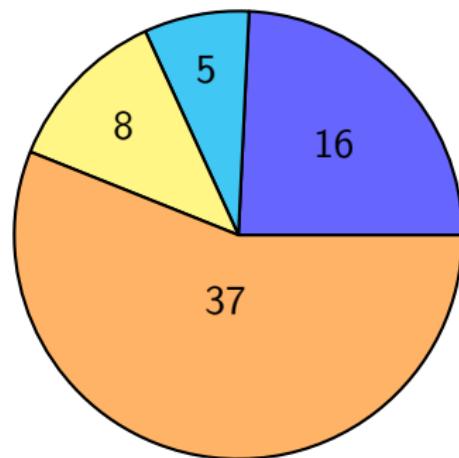
Name	Category	Definition	Parent(s)	Synonym(s)
A/B Testing	Practice (p. 22)	Testing “that allows testers to determine which of two systems or components performs better” (p. 1)	Statistical Testing (pp. 1, 35), ...	Split-Run Testing (pp. 1, 35)

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



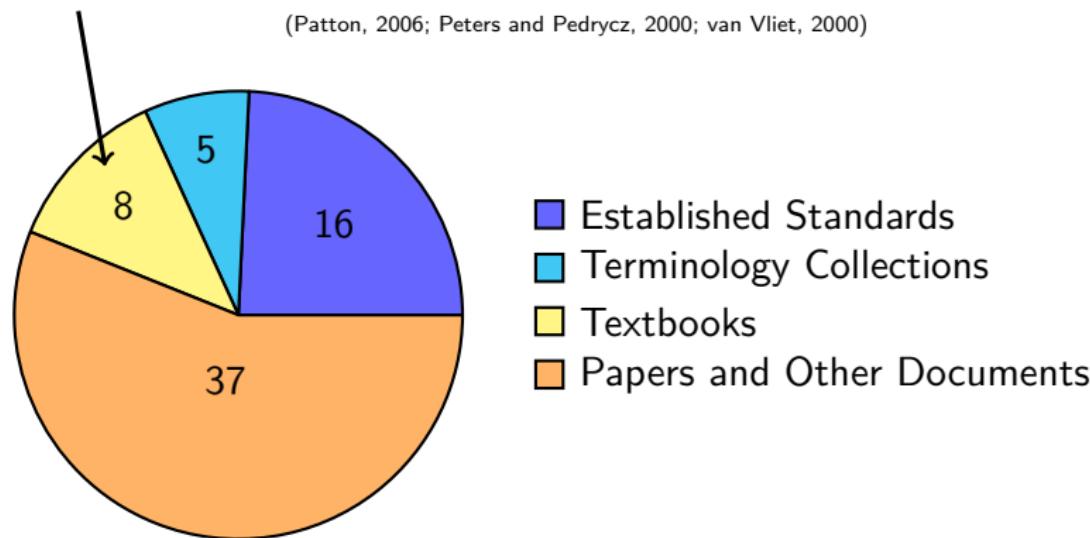
- Established Standards
- Terminology Collections
- Textbooks
- Papers and Other Documents

# 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*.

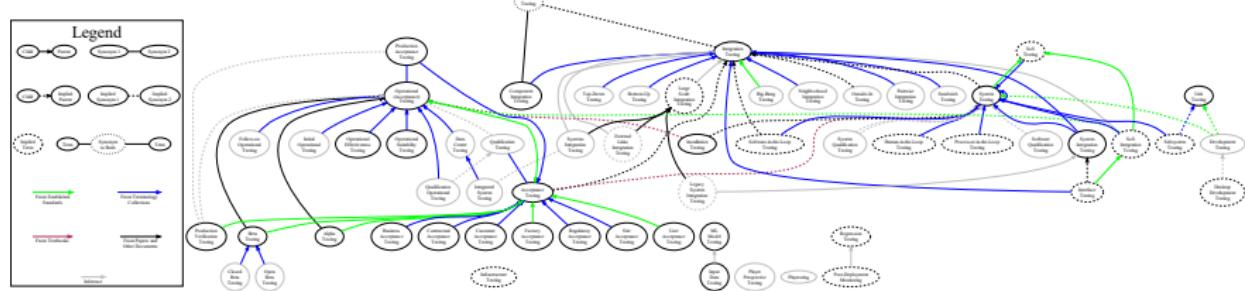
Dotted outlines indicate a term is a *synonym* to more than one term.

# Graph of Test Approaches

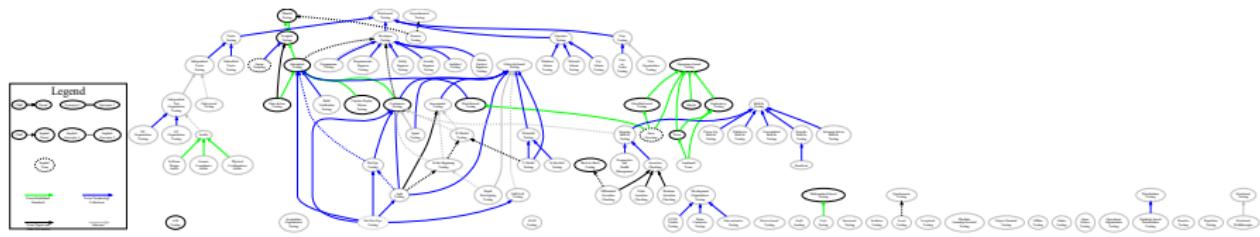
# Graph of Test Approaches

! Dimension too large.

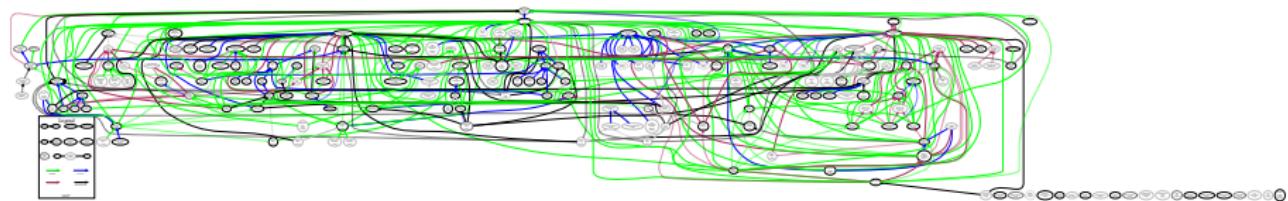
## Graph of Test Levels



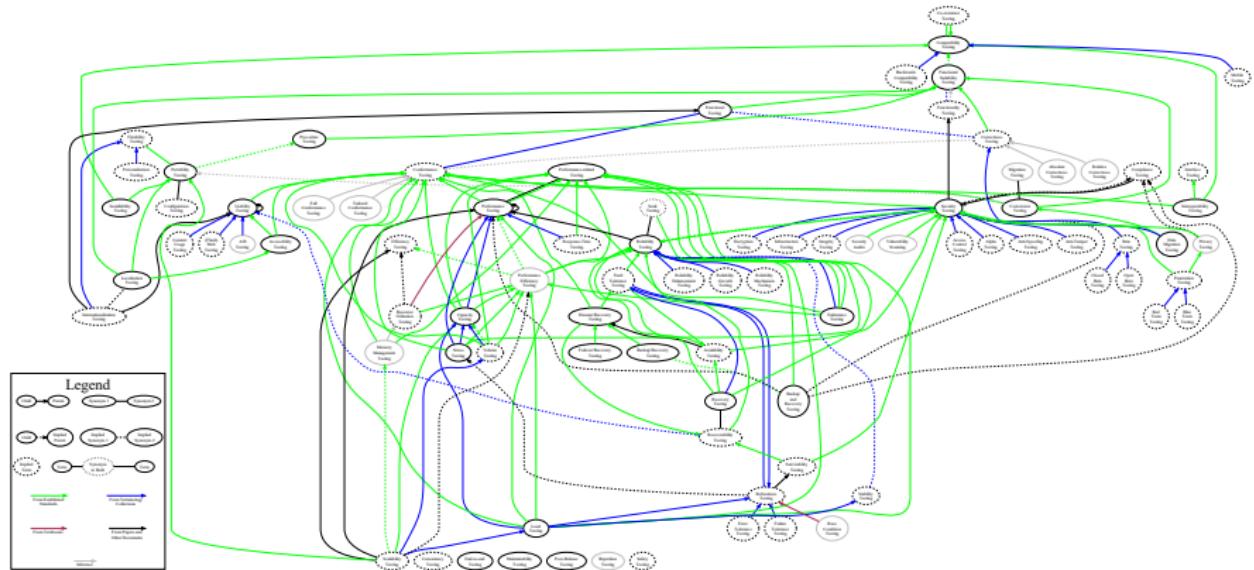
# Graph of Test Practices



# 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

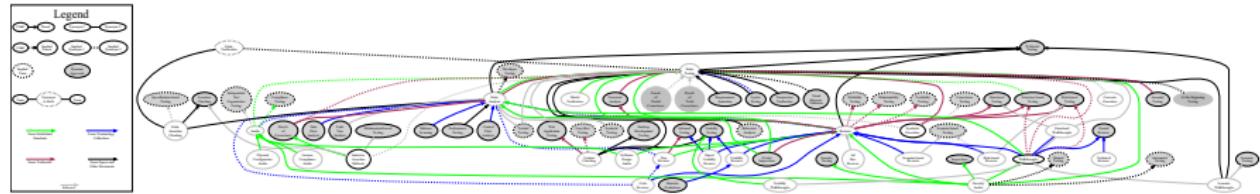


- Quite distinct but not necessarily orthogonal
- When considering static testing in isolation, related *dynamic approaches* have grey backgrounds



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

# Graph of *Static* Test Approaches



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# Automated Flaws

- Some terms are given as a synonym to two (or more) disjoint, unrelated terms, making the relation between the given synonyms ambiguous

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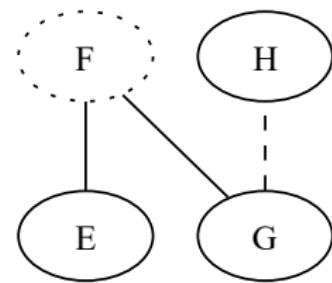
Name	Synonym(s)
E	F (Author, 0000; implied by 0001)
G	F (Author, 0002), H (implied by 0000)
H	X



# Automated Flaws

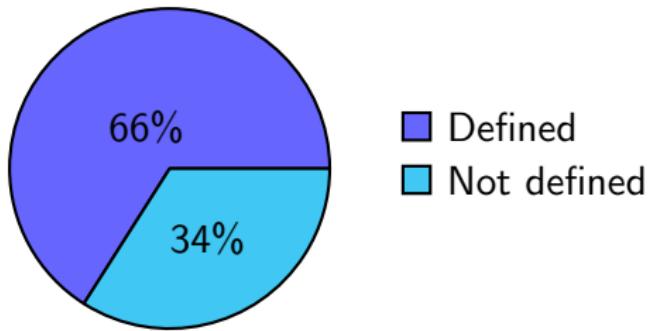
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G	F (Author, 0002), H (implied by 0000)
H	X



# Results

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

# Acknowledgment

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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  
<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 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](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>.