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
- Therefore, the same should be true of software engineering!

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  - Force
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- Therefore, the same should be true of software engineering!
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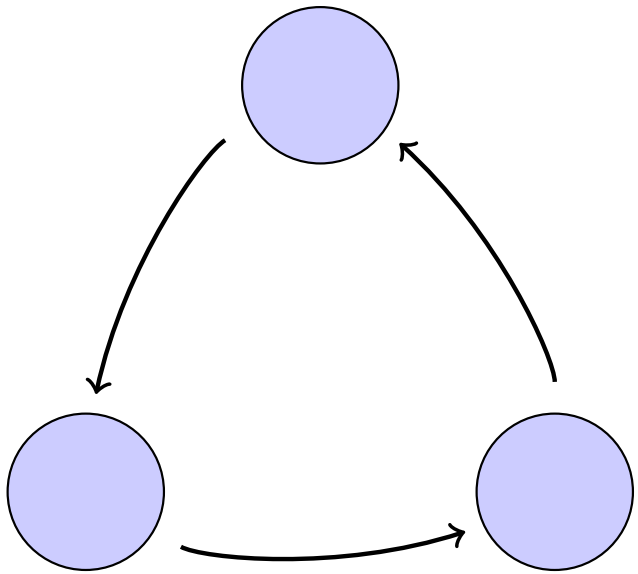
If software engineering holds code to high standards of clarity, consistency, and robustness, the same should apply to its supporting literature!

Improved Communication

Interorganizational

Schools, companies, etc.



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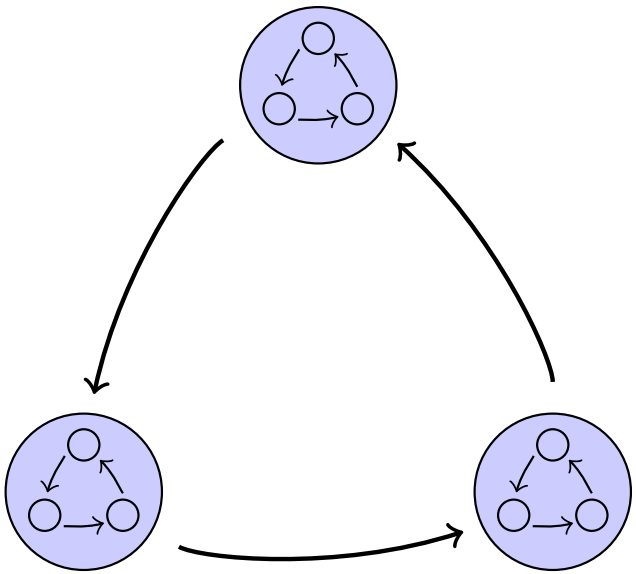

Intraorganizational

Kaner et al. (2011, p. 7) say "complete testing" could require the tester to:

- discover "every bug",
- exhaust the time allocated,
- implement every planned test,
- ...

The Lack of Standardized Terminology

"The Problem"

- Unfortunately, a search for a systematic, rigorous, and complete taxonomy for software testing revealed that the existing ones are inadequate and mostly focus on the high-level testing process rather than the testing approaches themselves:
  - Tebes et al. (2020) focus on *parts* of the testing process (e.g., test goal, test plan, testing role, testable entity) and how they relate to one another,
  - Souza et al. (2017) prioritize organizing testing approaches over defining them, and
  - Unterkalmsteiner et al. (2014) focus on the "information linkage or transfer" (p. A:6) between requirements engineering and software testing and "do[] not aim at providing a systematic and exhaustive state-of-the-art survey of [either domain]" (p. A:2).

Unstandardized Standards

"The Problem" (cont.)

- Tours "guide[] testers through the paths of an application" by following a structure that is:
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- Load testing is "conducted to evaluate the behaviour of a test item under anticipated conditions of varying load" (ISO/IEC and IEEE, 2022, p. 5; 2017, p. 253), such as:
  - loads "between anticipated conditions of low, typical, and peak usage" (2022, p. 5)

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  - loads "between anticipated conditions of low, typical, and peak usage" (2022, p. 5)
  - loads that are as large as possible (Patton, 2006, p. 86)

Unstandardized Standards

"The Problem" (cont.)

- Alpha testing is the "first stage of testing before a product is considered ready for commercial or operational use" (ISO/IEC and IEEE, 2017, p. 17) performed by:
  - "users within the organization developing the software" (p. 17)

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"Okay testing team, we want to conduct alpha testing on our product. What's our timeline? Budget? Sample size?"

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Research Questions

Research Question 1

What testing approaches does the literature describe?

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Research Question 3

Is it possible to resolve/reduce any of these discrepancies systematically?

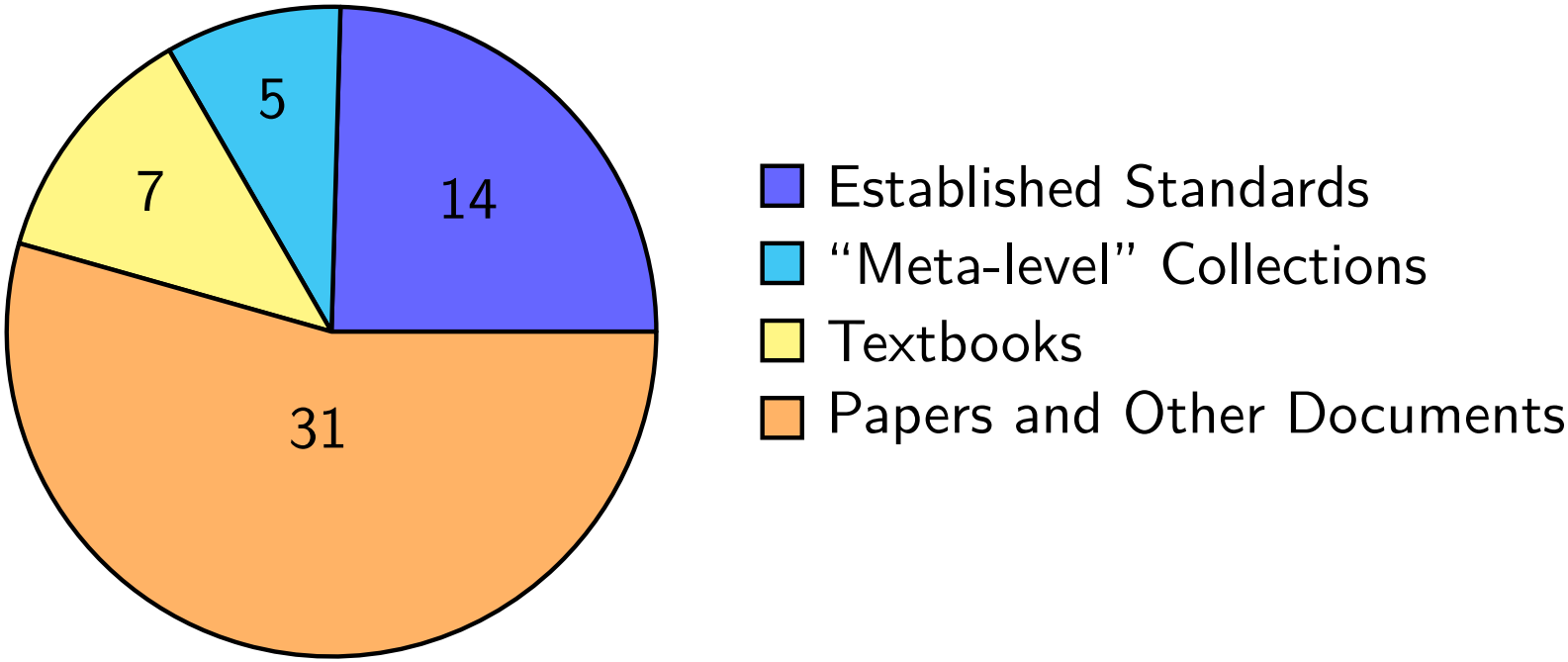
Research Questions

Research Question 1

What testing approaches does the literature describe?

Literature Review Time!

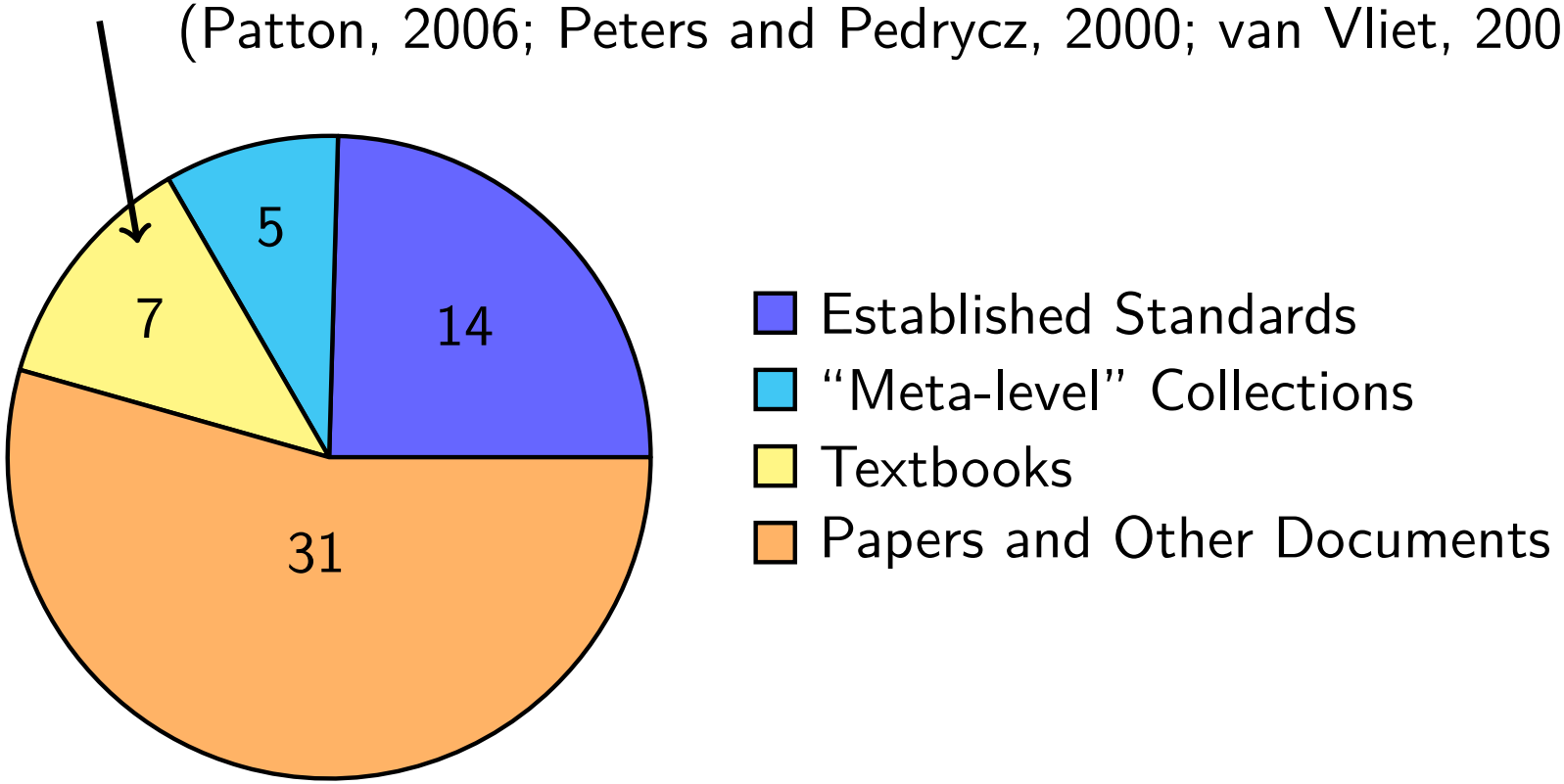
Methodology: Sources



Summary of how many sources comprise each source category.

Methodology: Sources

Textbooks trusted at McMaster were our ad hoc starting points (Patton, 2006; Peters and Pedrycz, 2000; van Vliet, 2000)



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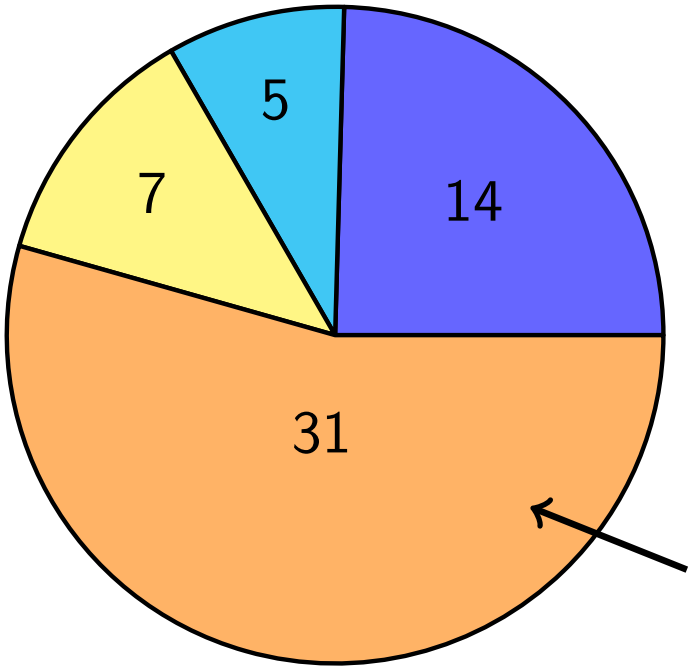
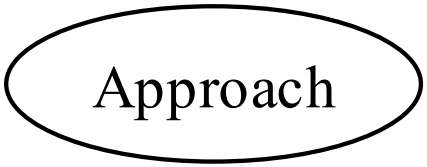


- Established Standards
- "Meta-level" Collections
- Textbooks
- Papers and Other Documents

Includes websites (LambdaTest, 2024; Pandey, 2023) and a booklet (Knüvener Mackert GmbH, 2022)

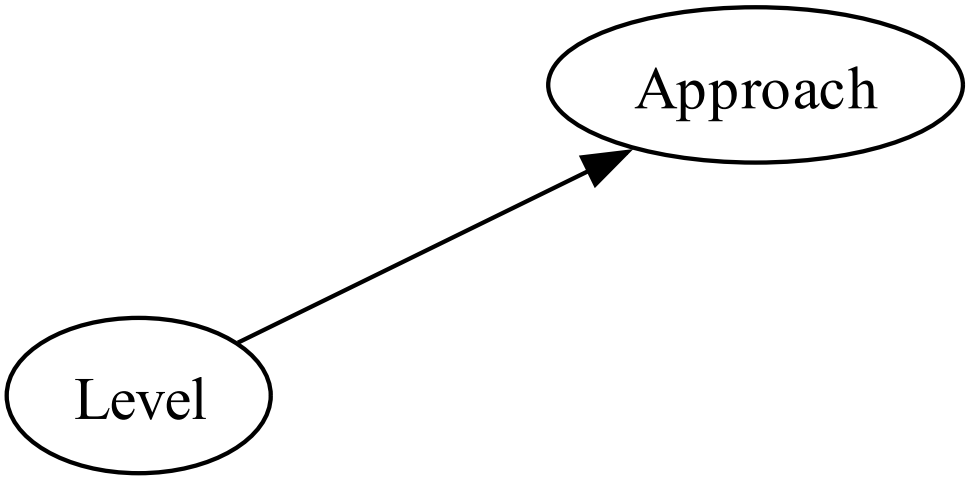
Summary of how many sources comprise each source category.

Methodology: Categories



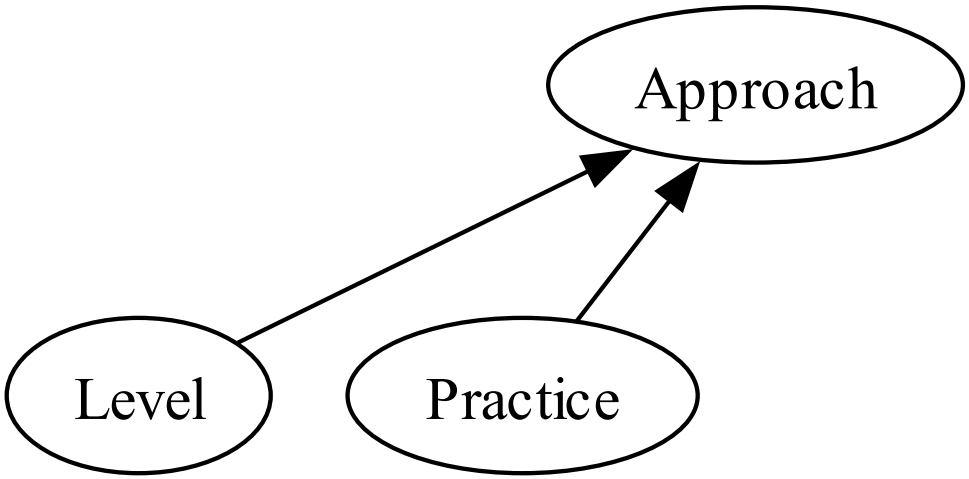
Approach: a "high-level test implementation choice" (ISO/IEC and IEEE, 2022, p. 10) used to "pick the particular test case values" (2017, p. 465)

Methodology: Categories



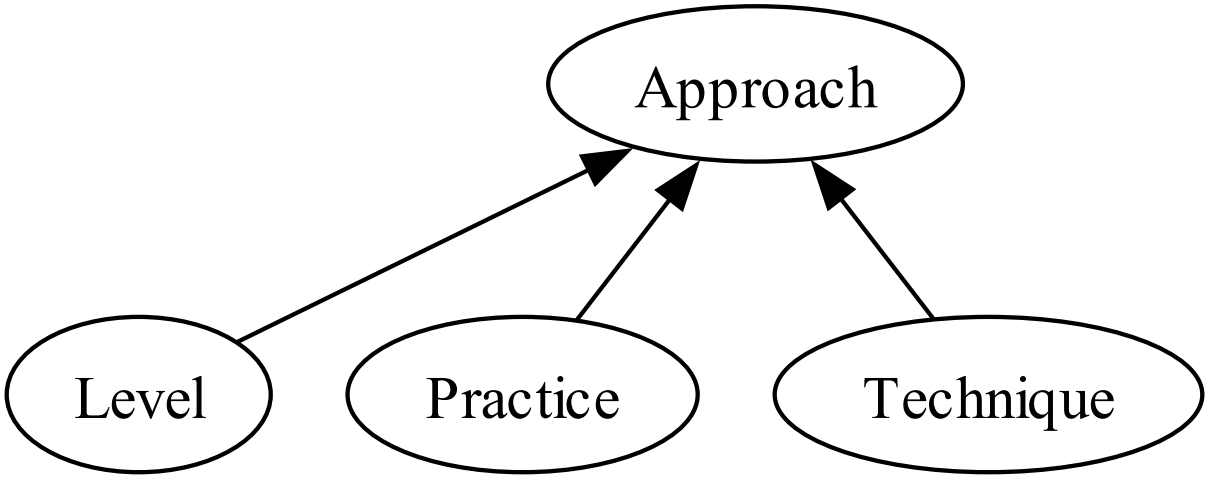
Level: a stage of testing with "particular objectives and . . . risks", each performed in sequence (ISO/IEC and IEEE, 2022, p. 12; 2021, p. 6)

Methodology: Categories



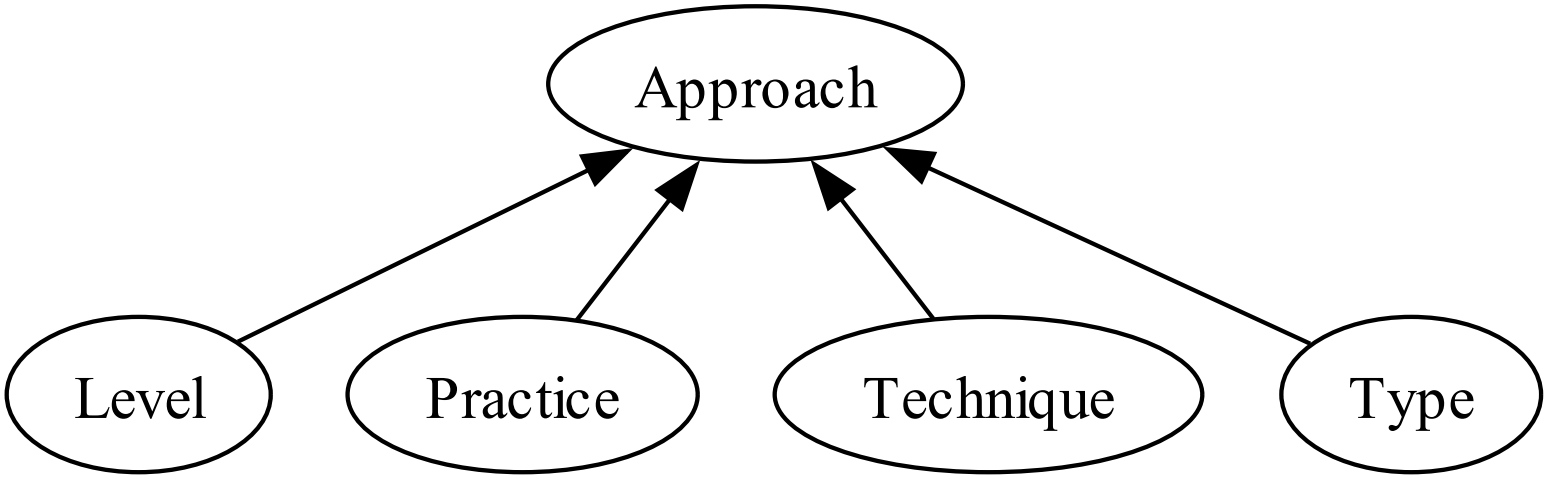
Practice: a "conceptual framework that can be applied to . . . [a] test process to facilitate testing" (ISO/IEC and IEEE, 2022, p. 14; 2017, p. 471)

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)

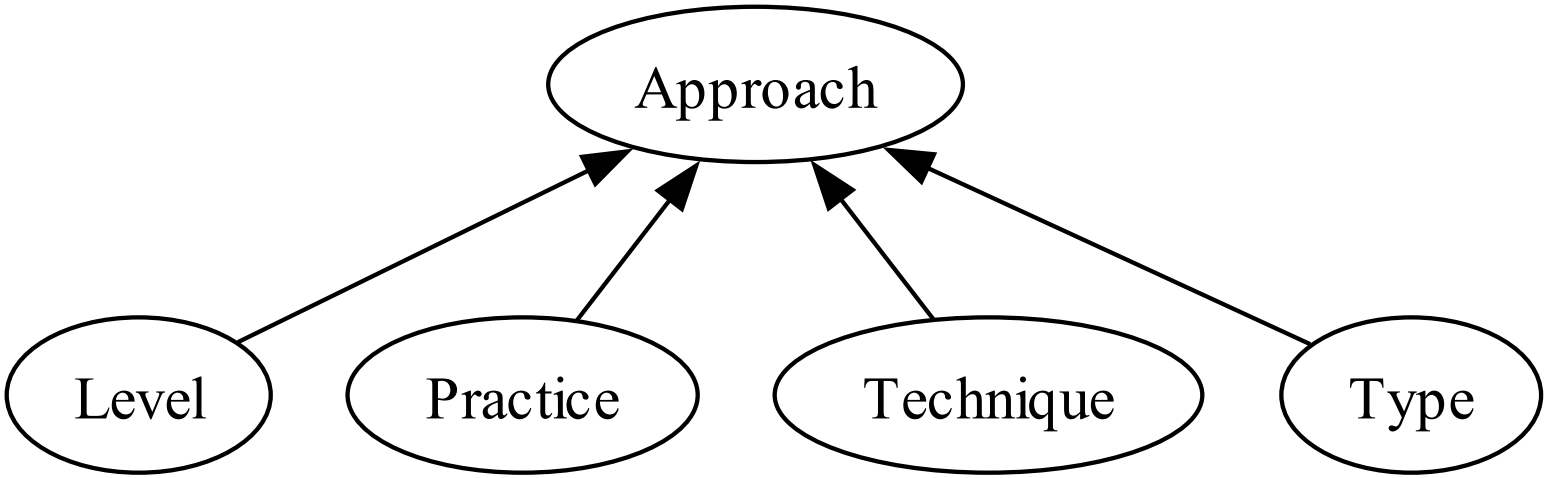
Methodology: Categories



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

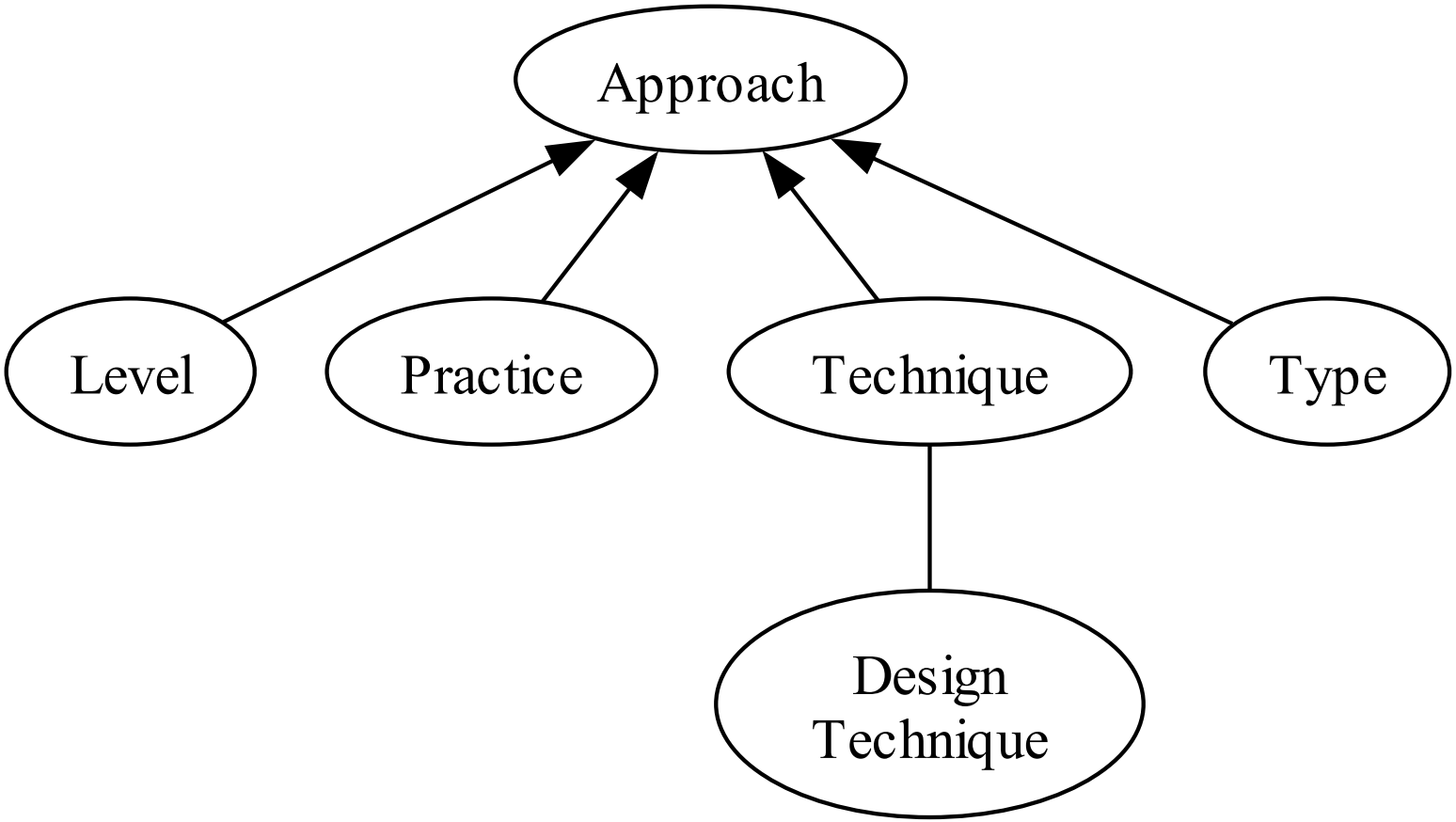
Relations



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

Methodology: Graph Notation

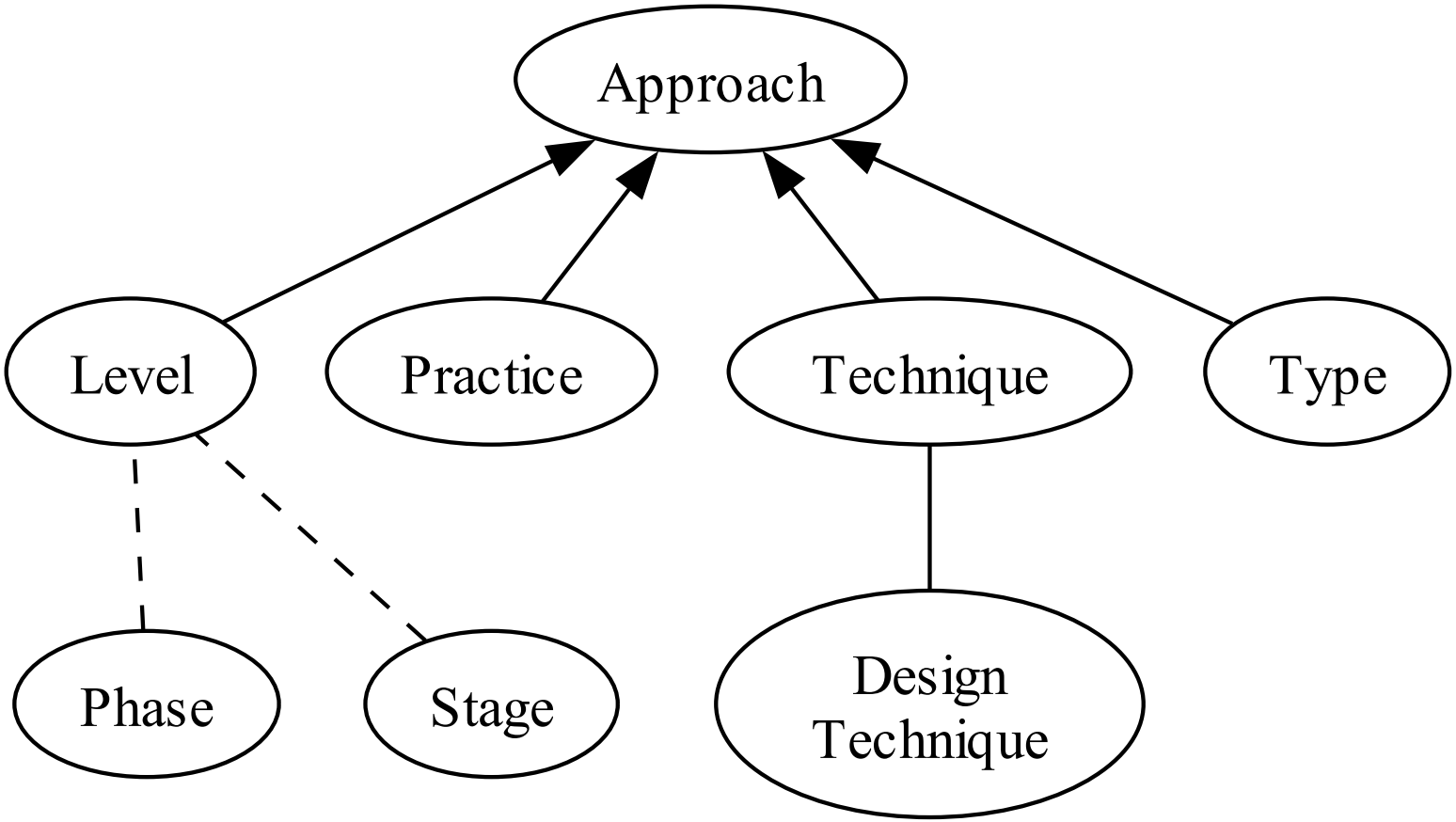
Relations



Lines without arrowheads connect *synonyms*.

Methodology: Graph Notation

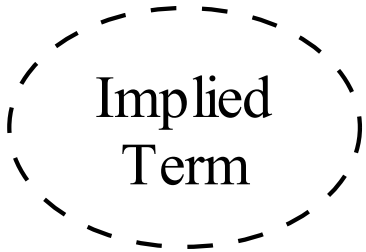
Relations



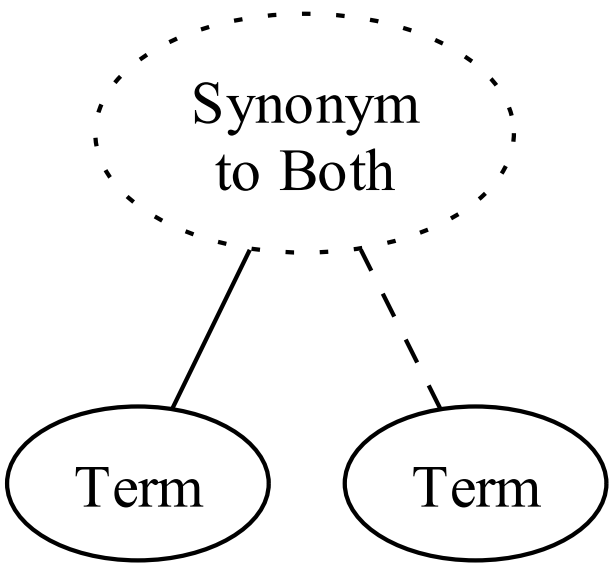
Dashed lines indicate a relationship is *implied*.

Methodology: Graph Notation

Terms

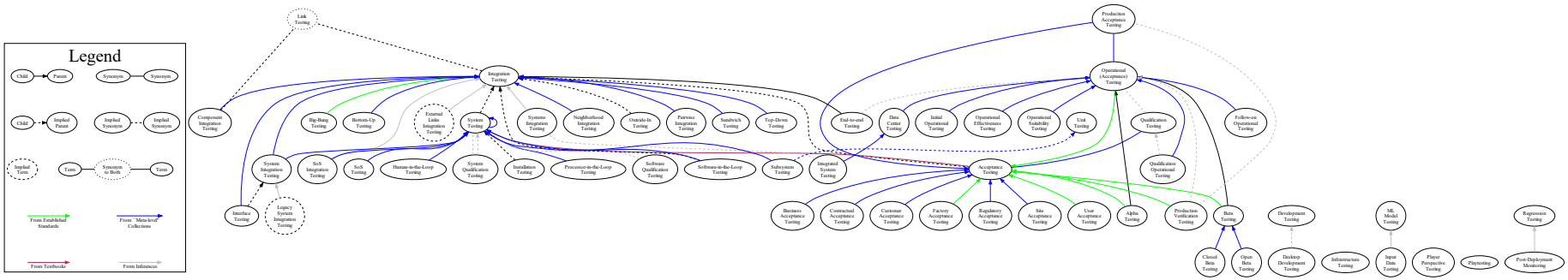


Dashed outlines indicate a term is *implied*.

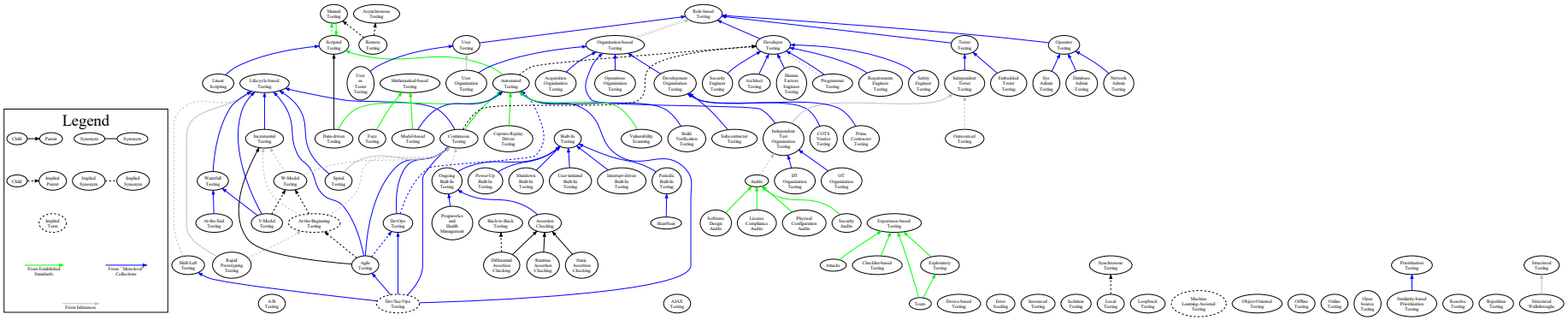


Dotted outlines indicate a term is a *synonym* to more than one term.

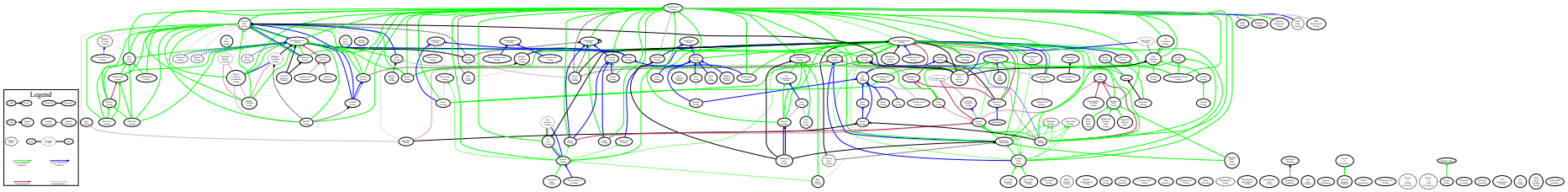
Graph of Test Levels



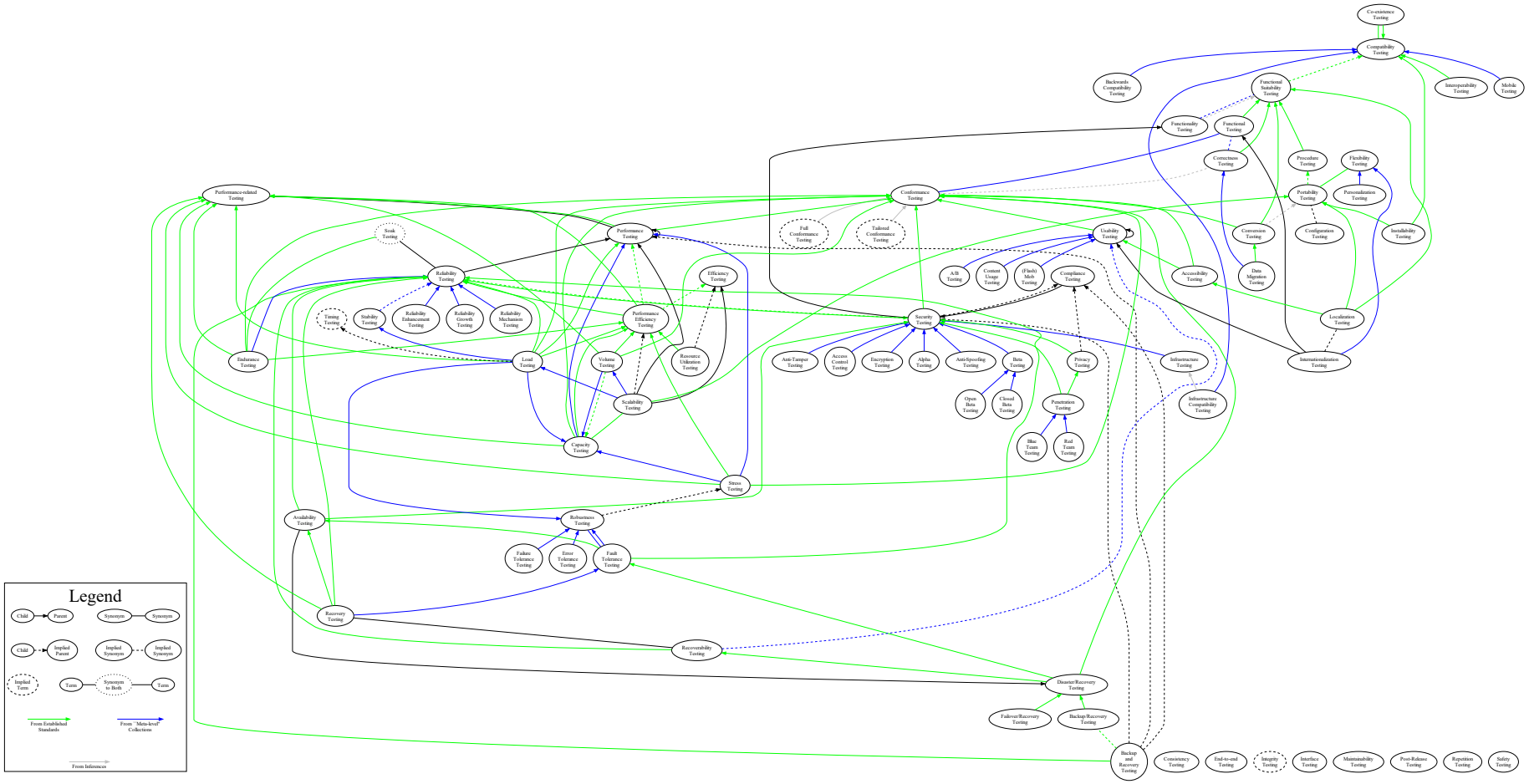
Graph of Test Practices



Graph of Test Techniques

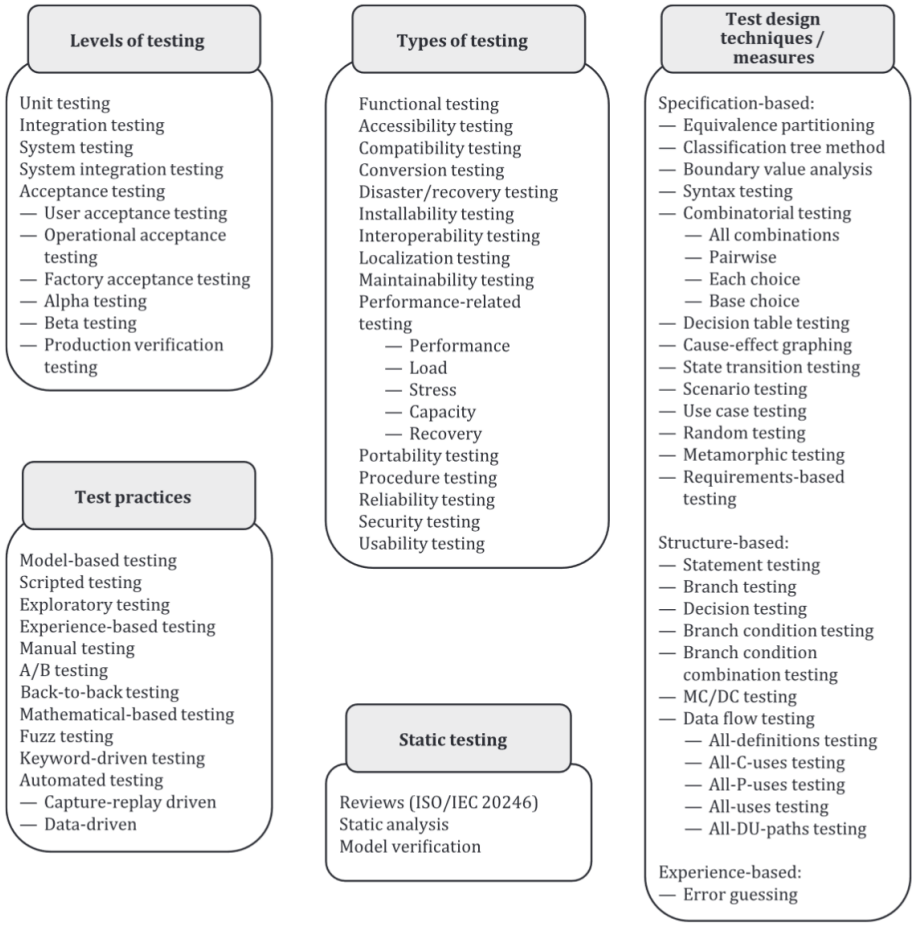


Graph of Test Types



Methodology: Graph Notation

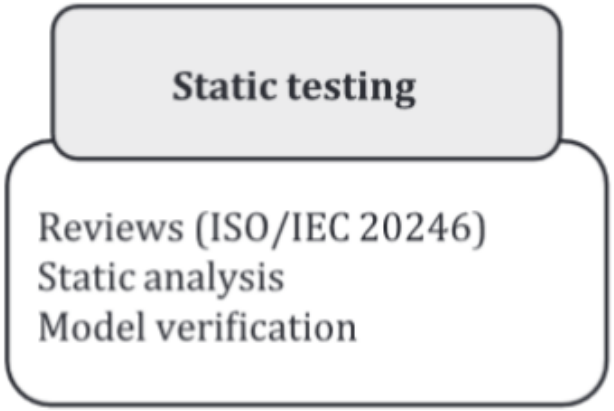
Static Testing



Example test approach choices (ISO/IEC and IEEE, 2022, Fig. 2).

Methodology: Graph Notation

Static Testing



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Methodology: Graph Notation

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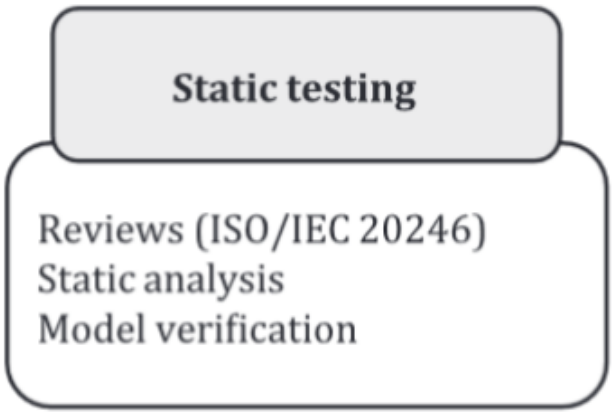

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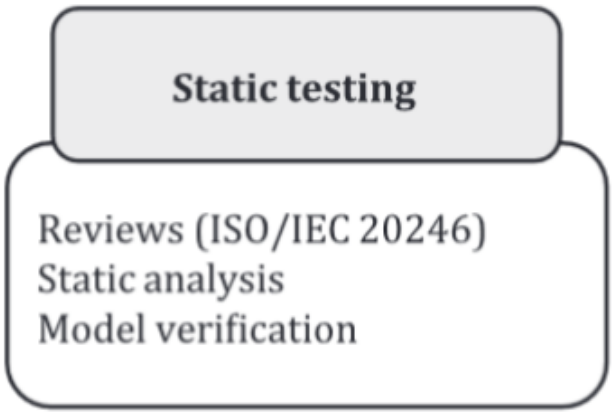

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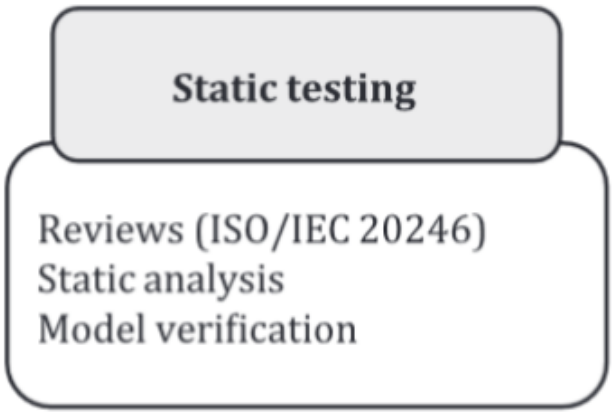

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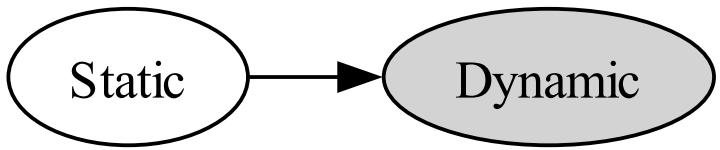
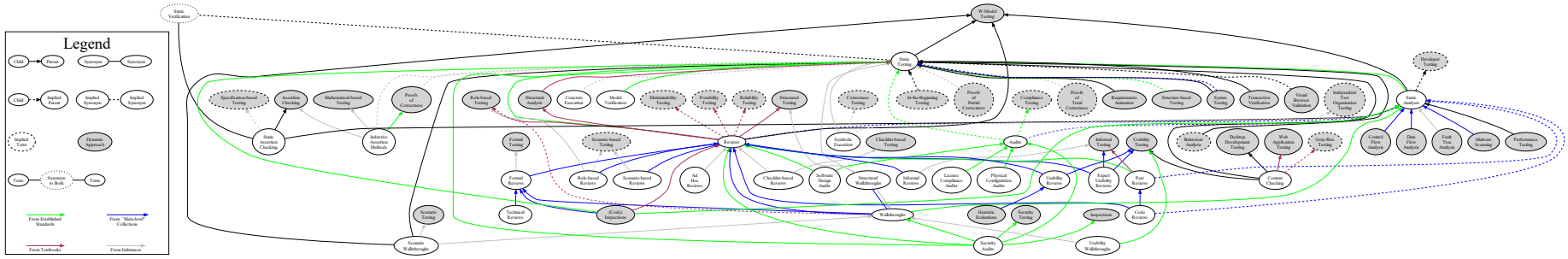
- While our focus is on dynamic testing, we include static testing in our research for completeness
- Static testing *is* quite distinct from dynamic testing, but this does not necessarily make it an orthogonal category
- When considering static testing in isolation, terms with gray backgrounds are related *dynamic approaches*



Graph of *Static* Test Approachs



Methodology: Procedure

Approaches

- A row is created for each test approach, such as the following which is based on (ISO/IEC and IEEE, 2022)

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)

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

Methodology: Procedure

Other Information

- It seems that the existence of a software quality implies the existence of a test type associated with it

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Methodology: Procedure

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- It seems that the existence of a software quality implies the existence of a test type associated with it
- Some test approaches use shared or complicated terminology
- For each of these, we record its
  - Name
  - Definition
  - Precedence for a related test type (only for qualities)
  - Synonym(s)

Methodology: Procedure

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Research Question 2

What discrepancies exist between descriptions of these testing approaches?

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Automated Discrepancies

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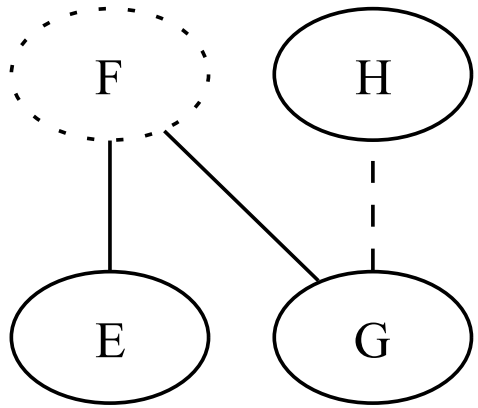
G	F (Author, 0002), H (implied by 0000)
H	X



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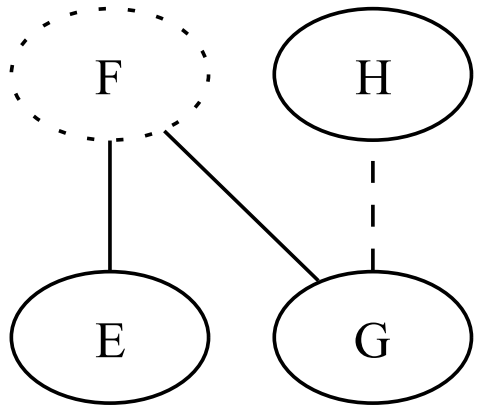

- The following four are the most prominent examples of the ten identified automatically:

Automated Discrepancies

1. **Invalid Testing:**
   - Error Tolerance Testing (Kam, 2008, p. 45)
   - Negative Testing (Hamburg and Mogyorodi, 2024; implied by ISO/IEC and IEEE, 2021, p. 10)
2. **Soak Testing:**
   - Endurance Testing (ISO/IEC and IEEE, 2021, p. 39)
   - Reliability Testing (Gerrard, 2000a, Tab. 2; 2000b, Tab. 1, p. 26)
3. **User Scenario Testing:**
   - Scenario Testing (Hamburg and Mogyorodi, 2024)
   - Use Case Testing (Kam, 2008, p. 48) (although "an actor can be a user or another system" (ISO/IEC and IEEE, 2021, p. 20))
4. **Link Testing:**
   - Branch Testing (implied by ISO/IEC and IEEE, 2021, p. 24)
   - Component Integration Testing (Kam, 2008, p. 45)
   - Integration Testing (implied by Gerrard, 2000a, p. 13)

Acknowledgment

- Dr. Smith and Dr. Carette have been great supervisors in the past and have, both then and now, provided me with valuable guidance and feedback
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- The past and current Drasil team have created a truly amazing framework!

Thank you!

Questions?

References I

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.cn/document/test/EBTestingPart2.pdf.

Matthias Hamburg and Gary Mogyorodi, editors. ISTQB Glossary, v4.3, 2024. URL https://glossary.istqb.org/en_US/search.

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.

References II

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.

Knüvener Mackert GmbH. *Knüvener Mackert SPICE Guide*. Knüvener Mackert GmbH, Reutlingen, Germany, 7th edition, 2022. ISBN 978-3-00-061926-7. URL https://knuevenermackert.com/wp-content/uploads/2021/06/SPICE-BOOKLET-2022-05.pdf.

LambdaTest. What is Operational Testing: Quick Guide With Examples, 2024. URL https://www.lambdatest.com/learning-hub/operational-testing.

Pranav Pandey. Scalability vs Elasticity, February 2023. URL https://www.linkedin.com/pulse/scalability-vs-elasticity-pranav-pandey/.

References IV

Ron Patton. *Software Testing*. Sams Publishing, Indianapolis, IN, USA, 2nd edition, 2006. ISBN 0-672-32798-8.

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.

References V

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].

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.