Systematic Mapping Studies

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Presentation Overview

Studies in Software Engineering

- Task: Get an overview of a certain research area and how far it's covered in research.
- Approach: Study the research field by using methods from information retrieval and statistical analysis.

Systematic Review : History

- Creating systematic reviews is an established method in evidence based medicine.
- Common in the field of software engineering.[1]

[1] Kitchenham & Charters 2007

Systematic Review : Goal

- Go through existing primary reports
- Review the primary reports
- Describe their methodology and results

Systematic Mapping Studies : History[2]

- Systematic Mapping Studies are an established method in evidence based medicine.
- Even though it seems to be faithful there, it gets neglected a lot in the field of software engineering.
- Less common in the field of software engineering than systematic reviews.

[2]Petersen, Kai, et al. "Systematic mapping studies in software engineering." 12th International Conference on Evaluation and Assessment in Software Engineering. Vol 17. 2008.

Systematic Mapping Studies : Goals

- Build a classification scheme and structure a field of interest.
- Structure of the type of research and results by categorizing a field.
- Show frequencies of publications for categories in the scheme.
- Determine coverage in a certain field.
- Combine the results to answer more specific research questions.
- Provide a visual summary by mapping the results.
- In general it tries to provide a more coarsed grained overview

Systematic Mapping Studies: Example

Ex V. Elberzhager, Frank, Jürgen Münch, and Vi Tran Ngoc Nha. "A systematic mapping study on the combination of static and dynamic quality assurance techniques." Information and Software Technology 54.1 (2012): 1-15.

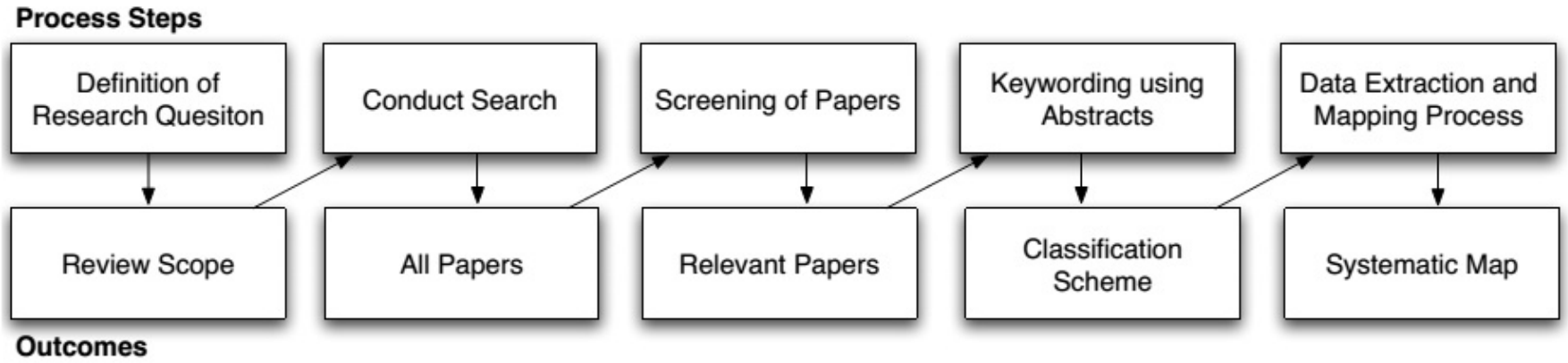
Systematic Mapping Studies: Example Context

- There exist various quality assurance techniques.
- Most of these are often applied in isolation.
- But a combination of various quality assurance techniques promises to exploit synergy effects.

Systematic Mapping Studies: Example Objective

- Classification and thematic analysis of existing approaches, which try to exploit a combination.
- Include reported effects, characteristics and constraints.
- Result is an overview of existing approaches and a suitable basis for identifying future research directions.

Systematic Mapping Studies: Process



Systematic Mapping Studies: Process

1. Define the research question
   $\Rightarrow$ Review Scope
2. Conduct a search
   $\Rightarrow$ All Papers
3. Screen the papers
   $\Rightarrow$ Relevant Papers
4. Assign keywords to each papers by using the abstract
   $\Rightarrow$ Classification scheme
5. Data extracting and mapping process
   $\Rightarrow$ Systematic map

Task 1: Define the research questions

- Find out, what you want to accomplish
- Find out, where you want to search for your informations.
  $\Rightarrow$ Identify forums for research areas.

Task 1: Example part 1

Nr.	Question	Rationale
RQ1	What are existing approaches that combine static and dynamic quality assurance techniques and how can they be classified?	The first research question defines the basis of this systematic mapping study and provides an overview of the existing approaches that combine static and dynamic quality assurance techniques.
RQ2	In which sources and in which years were approaches regarding the combination of static and dynamic quality assurance techniques published?	The second research question indicates whether there are specific publication channels and when effort regarding this research area was made.

Task 1: Example part 2

Nr.	Question	Rationale
RQ3	Is any kind of evidence presented with respect to the combination of quality assurance techniques and if so, which kind of evidence is given?	The third research question shows whether the approaches were empirically evaluated or whether just initial ideas are presented. This information was used to evaluate the maturity of the approaches.
RQ4	What are the objectives of combined quality assurance approaches?	The fourth research question provides detailed information what the purpose of each approach is and what is addressed and improved when applying a combined approach.

Task 1: Example part 3

Nr.	Question	Rationale
RQ5	Which static and dynamic quality assurance techniques are used in combined quality assurance approaches?	The fifth research question presents the concrete static and dynamic QA techniques that are combined.
RQ6	Which input is used for static and dynamic quality assurance techniques in combined quality assurance approaches?	The sixth research question gives information about the data or information needed to apply the combined approach, with respect to both static and dynamic QA techniques.

$\Rightarrow$ Four reference databases: Inspec, Compendex, IEEE Xplore, and ACM Digital Library

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Task 2: Search for primary studies

- Use information retrieval methods
- browse manually in journals etc.
- Use search strings in scientific databases
  - search-string creation by structuring in terms of population, intervention, comparison and outcome
  - search-string driven by research question
  - search-string from each aspect of the structure
- If one only considers certain types of studies, the overview will become biased and the result map is incomplete

Task 2: Example

- **Search-String:** (inspection or review or “static analysis” or “static quality assurance”) AND (test* or “dynamic quality assurance” or “dynamic analysis”) AND software AND (combin* or integrat* or synergy or “trade off”)
- Was applied to check keyword, title, and abstract fields within the corresponding databases.

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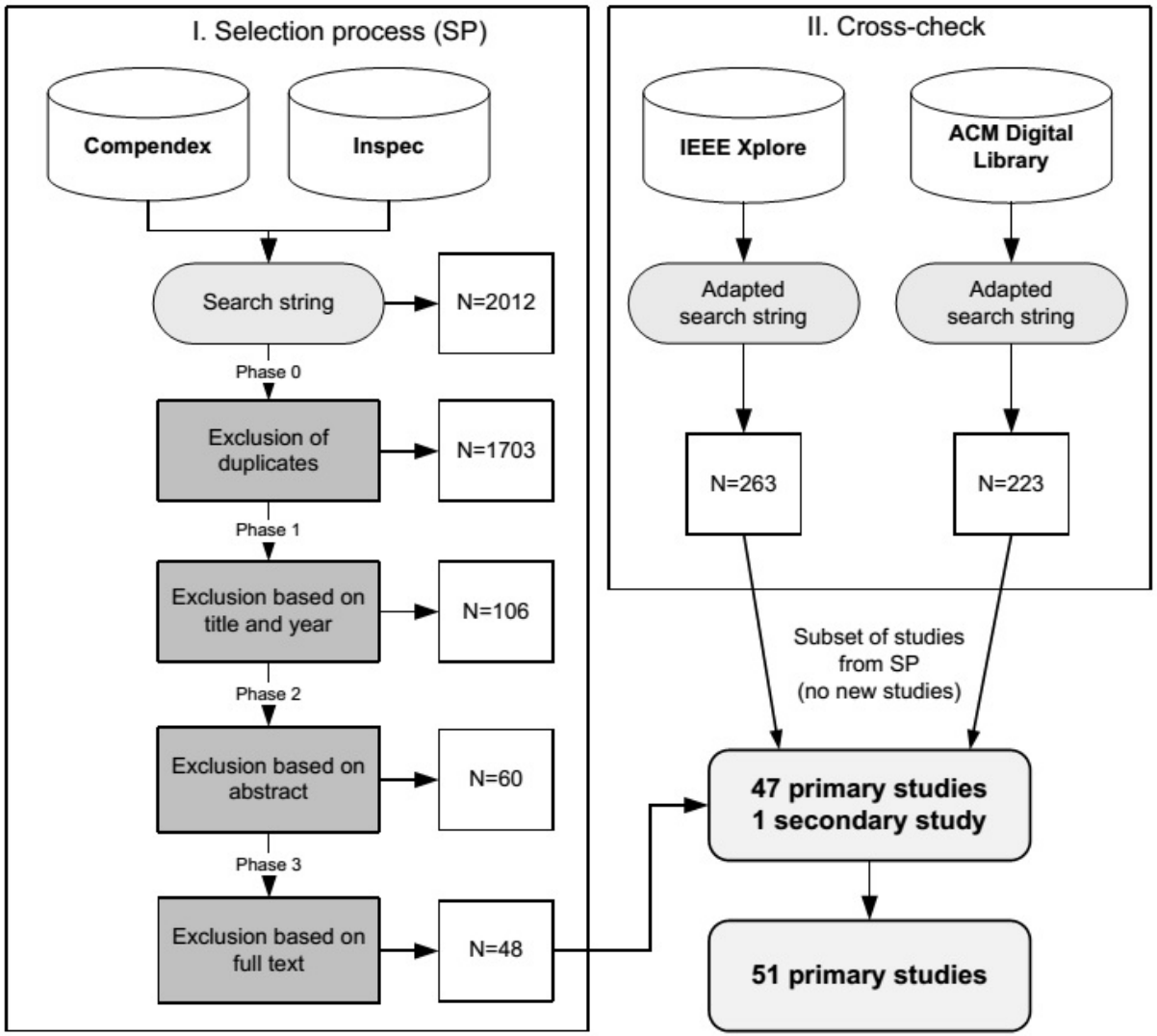
Task 3: Screening of papers

- Define inclusion and exclusion criteria
- The criteria should be derived from the research questions.

Task 3: Example



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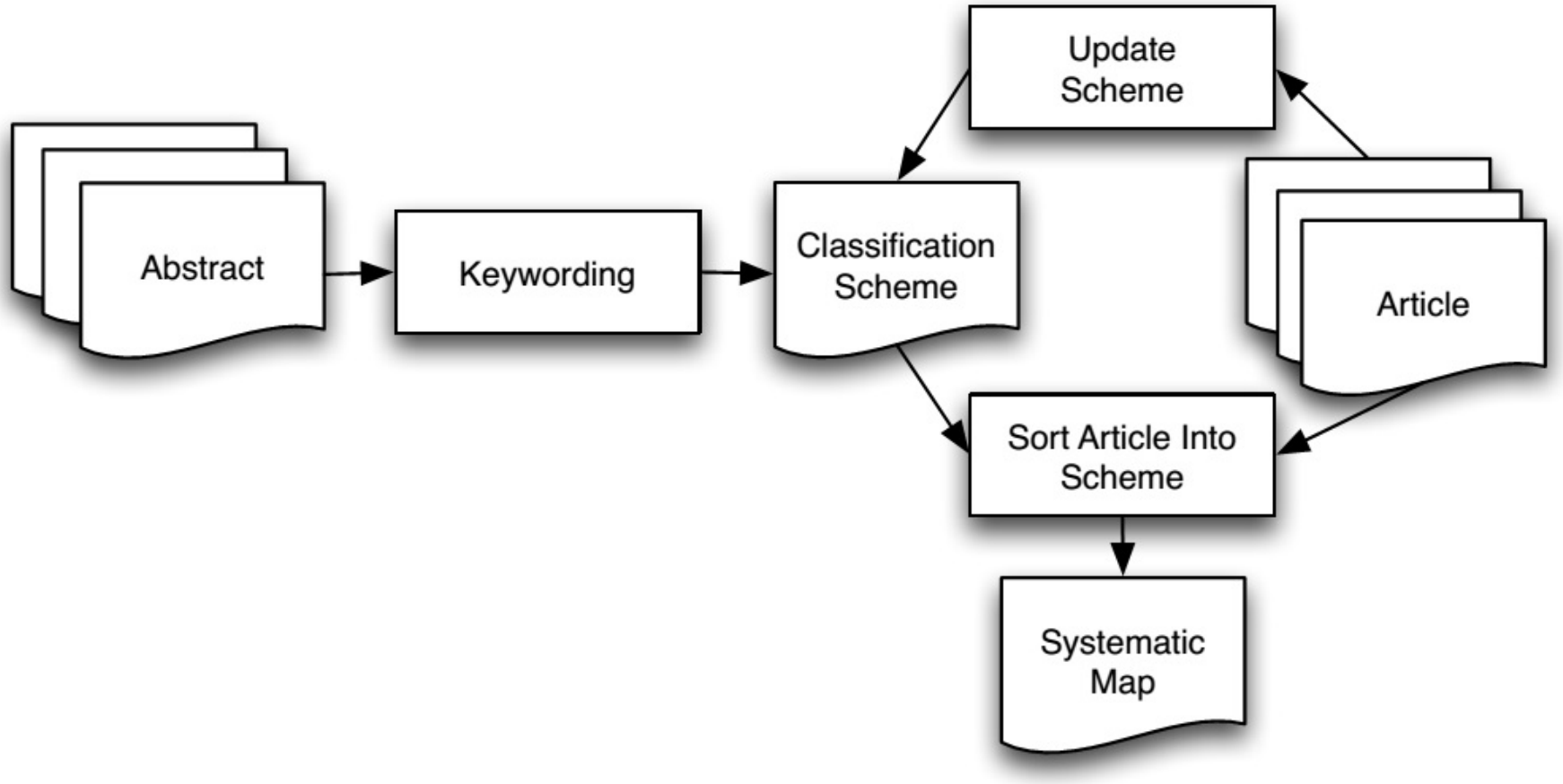
Task 4: Keywording of abstracts

- Reviewers read abstracts.
- Look for keywords and concepts
- Reflect the contribution of a paper
- Identify contexts

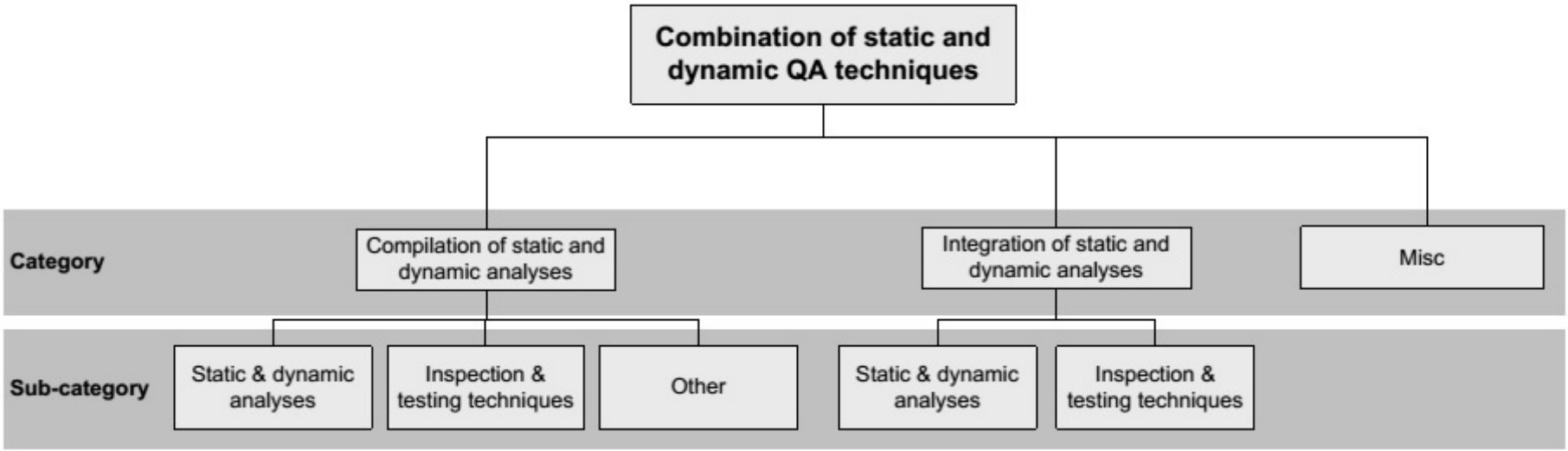
Task 4: Keywording of abstracts

- Put all keywords together from all found papers
- Develop higher level view on the research
- Helps with definining categories representing the underlying sets of papers
- When abstracts don't contain enough information, the introduction and conclusion are reviewed as well.
- The final set of keywords is used to cluster and form categories

Task 4: Building the classification scheme



Task 4: Example



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Task 5: Data Extraction and Mapping of studies

- Frequencies can be derived from a final classification table
- This shows the latest research focus and possible research for the future.
- Different facet combinations are possible
  $\rightarrow$ e.g. Context facet + research facet or contribution facet

Task 5: Example part 1

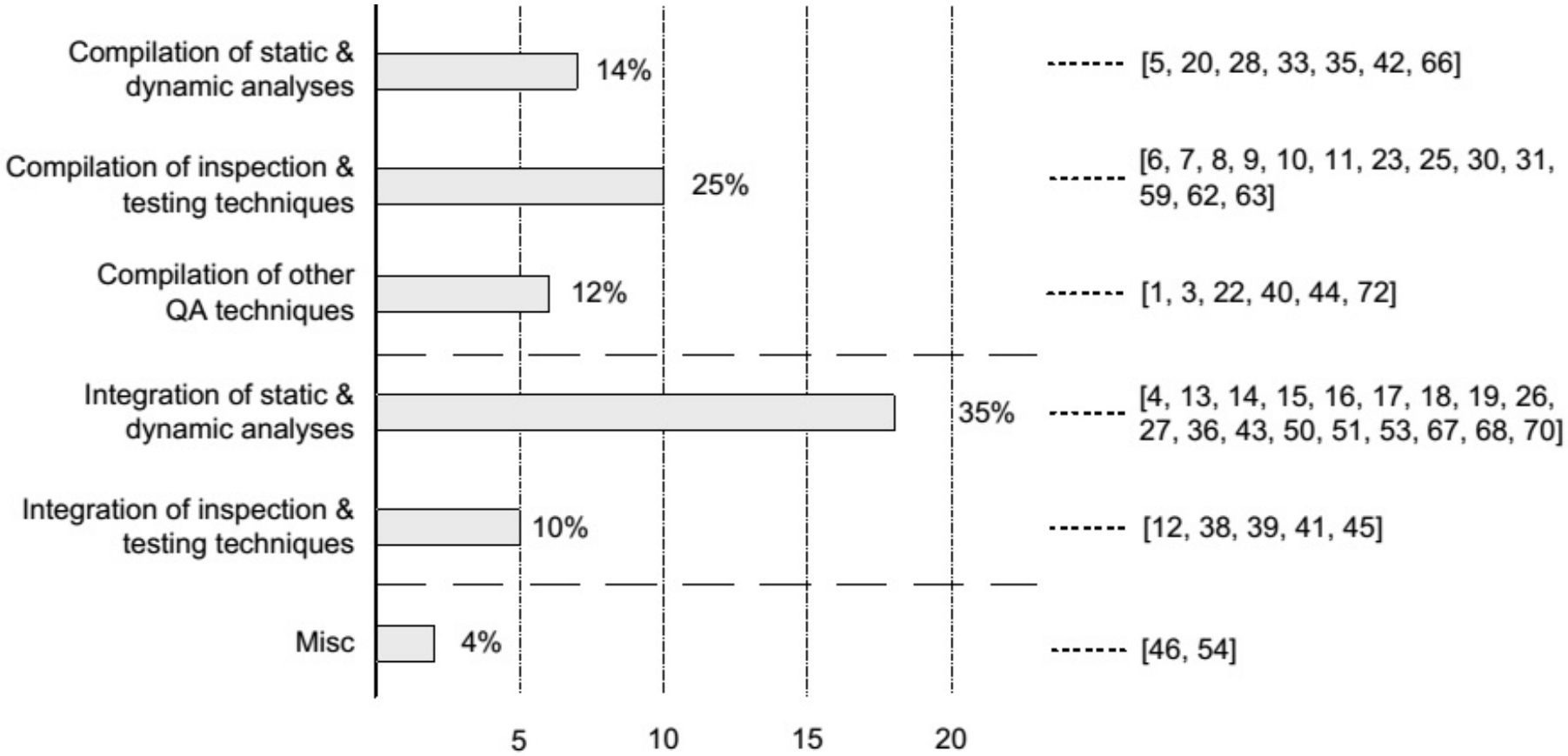

Figure 3: Number of articles per category and references

Task 5: Example part 2

Source	Publication channel	No.	%
International Conference on Software Engineering	Conference	3	5.9
Annual IEEE International Computer Software and Applications Conference	Conference	2	3.9
IEEE Software	Journal	2	3.9
International Symposium on Empirical Software Engineering and Measurement	Symposium	2	3.9
International Symposium on Software Reliability Engineering	Symposium	2	3.9
ACM Conference on Object-oriented Programming Systems Languages and Applications	Conference	1	2.0
Aerospace Software Engineering for Advanced Systems Architectures	Conference	1	2.0

Task 5: Example part 3

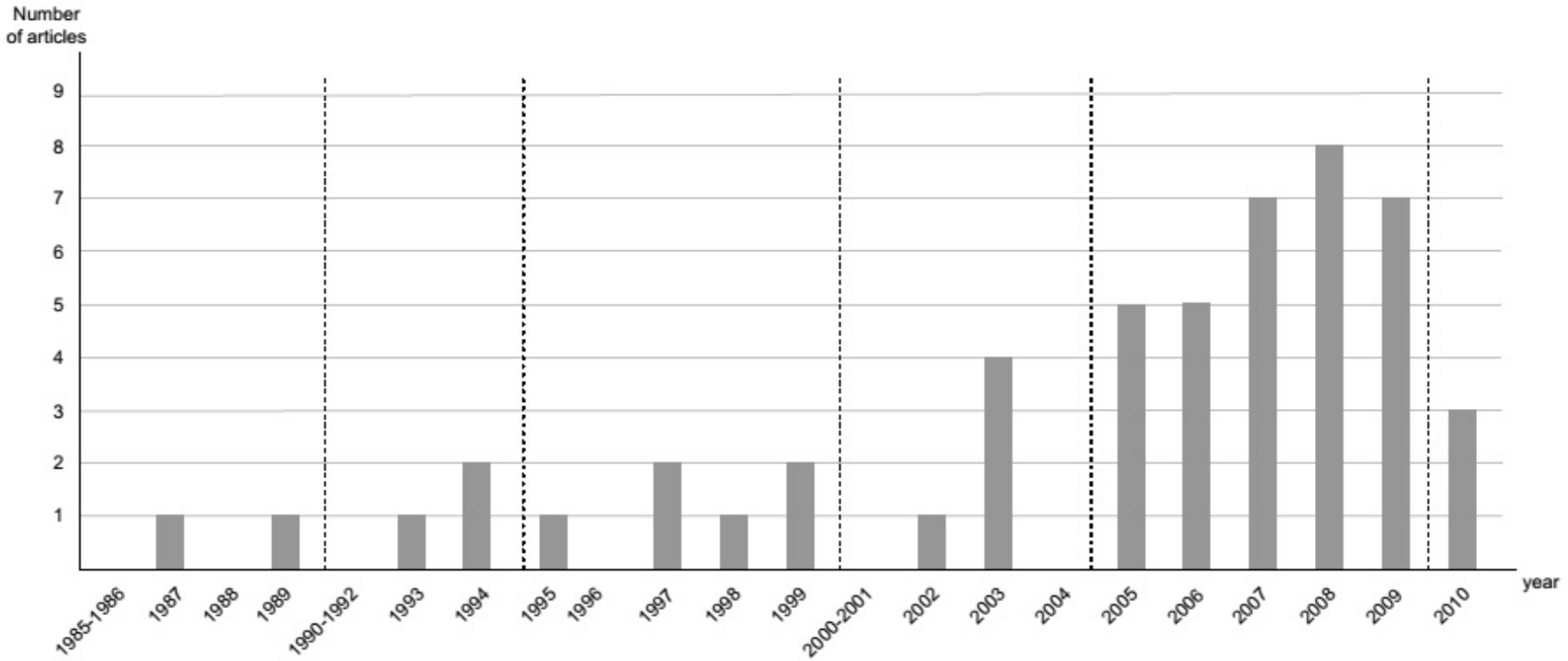

Figure 4: Number of articles published per year

Task 5: Example part 4

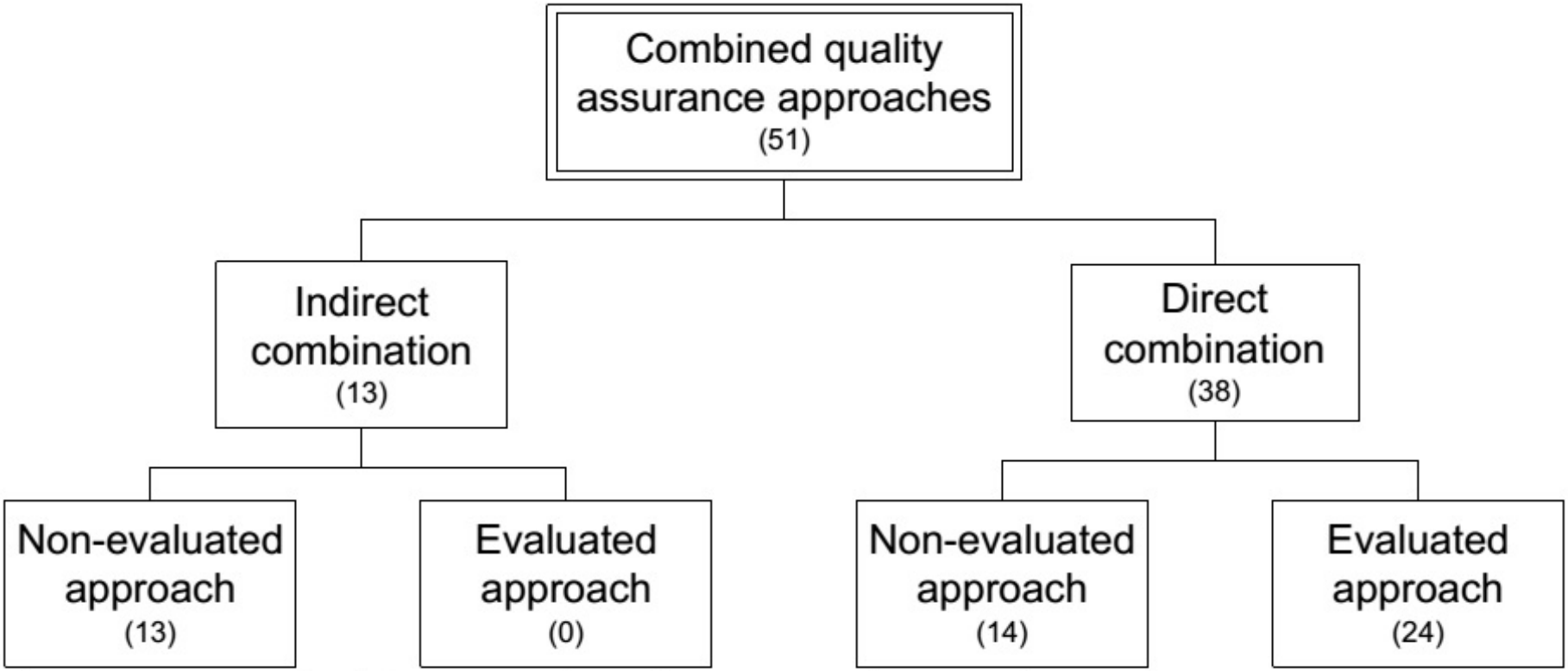

Figure 5: Number of articles that provide evidence, respectively provide no evidence

Task 5: Example part 5

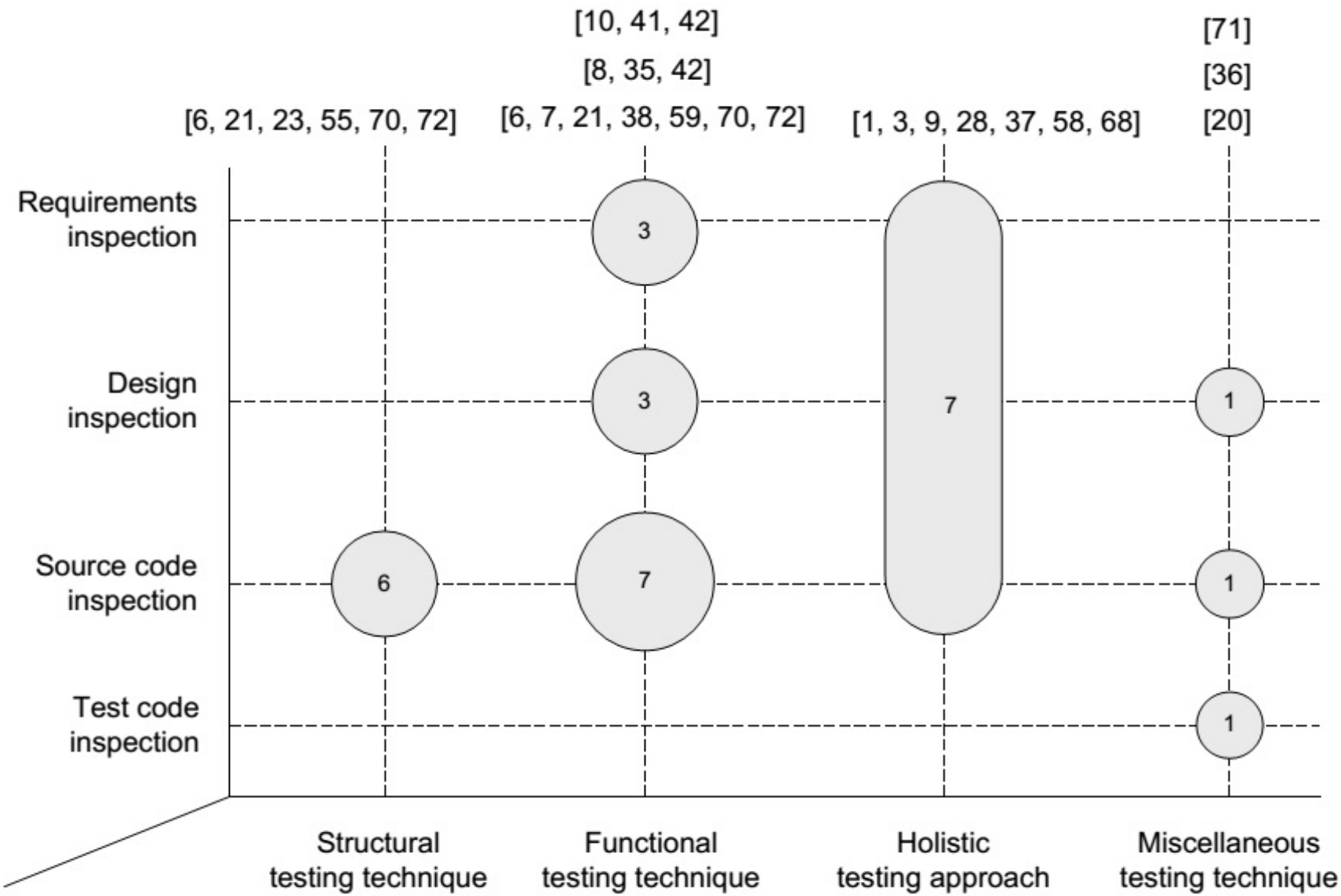

Figure 9: Overview of inspection and testing techniques that are applied in combination

Comparison to Systematic Reviews

Discussion !

What are your thoughts on a comparison?

Comparison - Overview

- The methods are different in terms of goals, breadth, validity issues and implications.
- They should be used complementarily.

Comparing the goals

SR	SMS
- Focus on establishing the state of evidence - Mostly used to identify best practises based on empirical evidence	- Focus on classification, thematic analysis and identifying publication fora
- Shows where evidence is missing or where it's insufficient	- Can't show, that evidence is missing or insufficient
- Identify research gaps	- Identify research gaps

Comparing the process

SR	**SMS**
- Quality is evaluated - Meta analysis	- Quality is not evaluated - Thematic analysis

$\Rightarrow$ Both require a different level of data extraction.

Comparing breadth and depth

SR	**SMS**
- States outcome and quality as its major focus - Increased depth and effort - Fewer studies can be included	- Reflects based on search strings and inclusion criteria - Covers a higher breadth. More articles can be covered - Can structure a larger field

Comparing classification

SR	SMS
- Mentions lack of methodological precision in primary studies[3]	- Doesn't restrict itself to such small portions
- A bias might be introduced by a SR	- Overview is more complete
-More fine grained categories are possible	-High level categories
-Especially concerning e.g. research methods and research approaches	

[3] Mendes2005

Comparing validity

A major problem

Some terms might be used in different meanings. (e.g.: "experiment")

SR	**SMS**
-Takes details into account. The thread of false classification is minimized.	- Doesn't go into details, which might lead to wrong classification.

Comparing industrial accessibility and relevance

Background

We want to give a good introduction to a field.

SR	**SMS**
- It's more difficult to access results - Results might be too detailed, though details might be important to practicioners. - The visual appeal should be changed	- Easier to spark interest - It is probably visually more appealing

User's guide

- Complementary use is helpful
- Take an adaptive reading depth for classification
- Also Classify papers based on evidence and novelty
- Visualize your data

Summary

1. Motivation
2. Systematic Mapping Studies
3. Comparison to Systematic Reviews
4. Guidelines