Content Analysis of Conclusions of Empirical Studies in Software Engineering

Bachelors Thesis – Opening Presentation

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Original Goals

- Evaluate the quality of empirical studies in SE
- Are the conclusions „good“?
  - Do they contain generalization?
  - Is the generalization appropriate?
  - Do they just repeat results?

Goals

- Report on common structures in conclusions
  - Which codes often correlate
- Provide valuable insights for future lectures/tutorials on
  - Structure of the tutorials
  - Code system used for the Content Analysis

Content analysis – a quick overview

- Qualitative-quantitative method in empirical research
  - Qualitative input data, quantitative results
- Take or create a coding system
  - i.e. by open coding
- Search for all occurrences of each code in your material
- Count those occurrences
- This process should be conducted at least twice, by independent reviewers
- Calculate Inter-reviewer agreement
- Material is usually in written form or first transcribed

Lecture/Tutorial

- 10 Students working on the project
- Open Coding on some papers => MAXQDA
- Developing a unified code system
- Identify relevant papers from ICSE 2021 => 59 papers
- Code the conclusion + relevant parts
  - 18 papers per student
  - >=3 students per paper
- Data validation, clustering and code correlation
- Presentation and report

Final code system (excerpt)

- Generalization
  - Generalization_classification_by_reviewer
    - Adequate_generalization
    - Too_little_generalization
    - Too_strong_generalization
  - Generalization_degree
    - For_all_generalization
    - Limited_generalization
    - No_generalization
  - Generalization_kind
    - Recommendation_generalization
    - Speculative_generalization
    - Universal_statement_generalization
  - Generalization_relevance_evaluation_by_authors
    - …

Agreement by codes – Top 10

Code	Agreements	Disagreements	Agreement in %
state_first_of_a_kind	42	7	86
own_further_work	78	16	83
anyone_further_work	72	32	69
subsequent_further_work	72	40	64
repeat_research_process	224	141	61
no_classification_of_importance_further_work	55	35	61
mention_generalization	161	135	54
promising_further_work	39	35	53
universal_statement_generalization	104	96	52
unclassified_risk	4	5	44

Agreement by codes – Bottom 15

Code	Agreements	Disagreements	Agreement in %
relevant_result_without_specification	43	91	32
speculative_generalization	20	46	30
addressed_risk	2	5	29
relevant_result_for_research	17	56	23
too_strong_generalization	15	52	22
unclear_relevance	0	20	0
too_little_generalization	0	18	0
relevant_result_for_other_group	0	14	0
state_result	0	8	0
someone_further_work	0	7	0
untreated_risk	0	6	0
other_kind_further_work	0	4	0
distant_further_work	0	4	0
unimportant_further_work	0	1	0
major_risk	0	1	0

Example Sentence

“Our study shows that the use of bounding functions coincides with use scenarios where safety concerns of UAVs are addressed by UAV software developers”

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“Our study shows that the use of bounding functions coincides with use scenarios where safety concerns of UAVs are addressed by UAV software developers”

Codes used + reviewers:

- mention_generalization: a+b
- universal_statement_generalization: a+b
- relevant_result_for_practitioner: a
- too_strong_generalization: b
- no_generalization: c

Data quality

- Agreement between different reviewers limited (about 30%)
- Random tests show varying coding quality by most reviewers

=> Makes it hard to make strong statements about anything

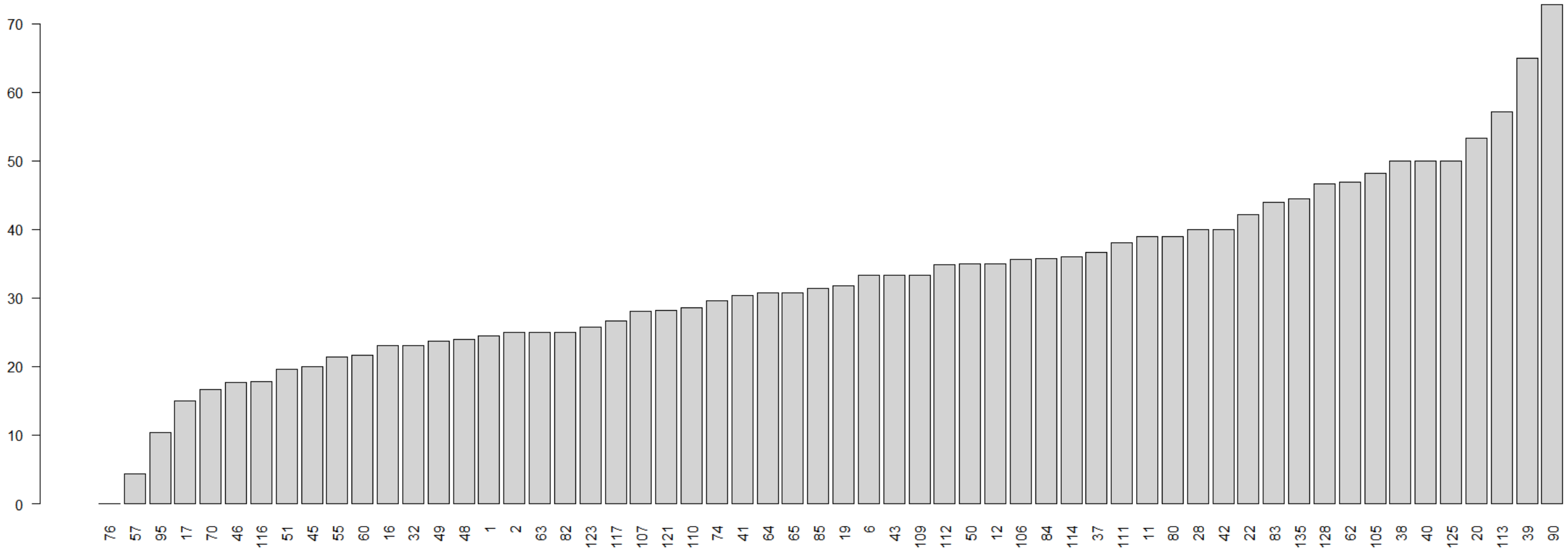
=> Can we improve data quality and salvage the data somehow?

Data quality improvements

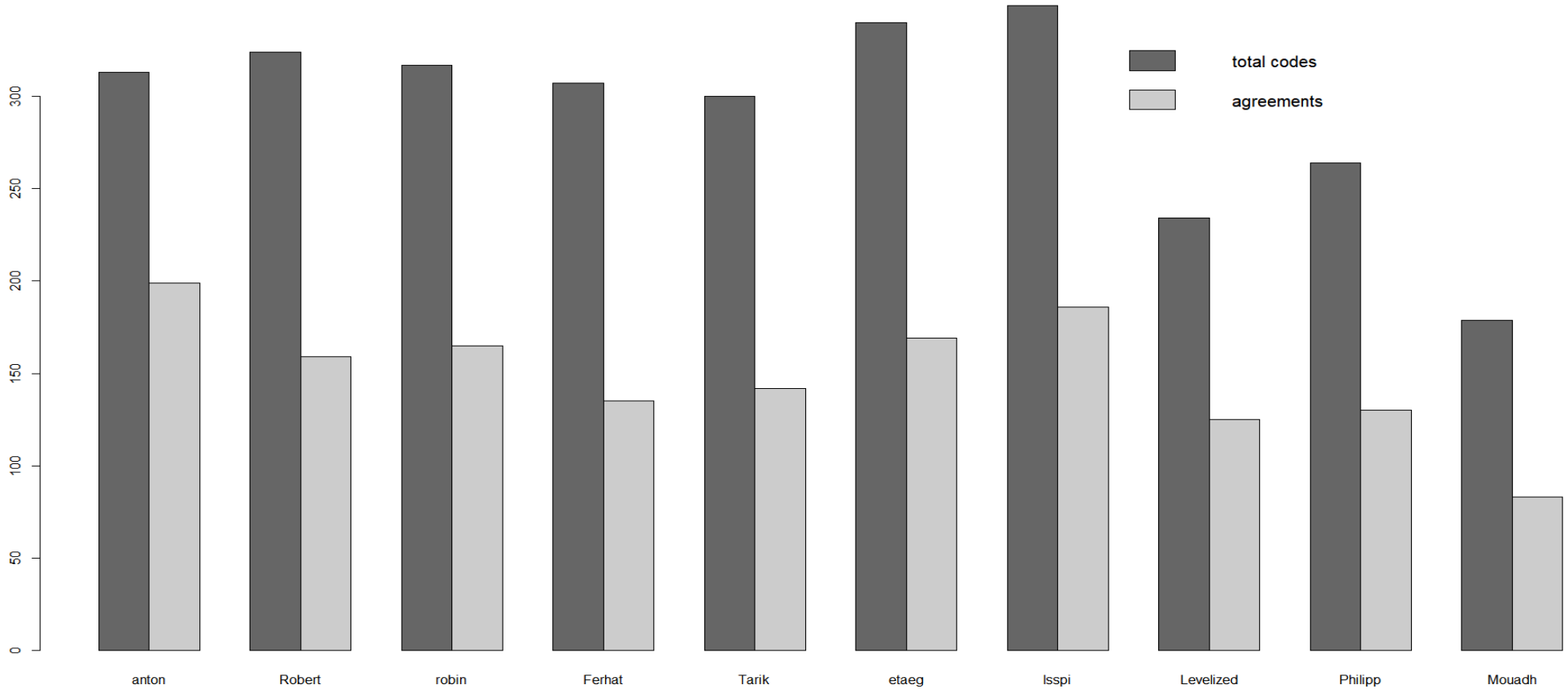
- Only consider conclusion
- Merge some codes with low agreement that fit together
  - i.e for_all_generalization + limited_generalization = mention_generalization
- Improve data validation/cleansing
  - Use a sequence matcher to find agreement
  - Check for outliers

=> Even after several improvements, agreement is still below 50%

Agreement over different papers (in %)



Codes and agreements per reviewer



Related Work

- It‘s hard to find any closely related work, my thesis is rather abstract
- Most „meta-work“ on empirical studies in SE focuses more on the content itself or on the methodology

- Perry D, et al (2000). “Empirical Studies of Software Engineering: A Roadmap”
- Höfer, A., Tichy, W.F. (2007). “Status of Empirical Research in Software Engineering”

Propositions for future lectures/tutorials

- Provide more time for the students
- Reduce the number of studies used
  - Reduces stress, improves quality of the data collected
- Reduce the complexity of the code system
  - Simplify by having more “black and white” codes
    => either code a must be used OR code b
- Have a stricter guide to coding
  - If a code is used, certain other code sub-trees must be covered as well

Thanks for your attention!

- Any questions?
- Any feedback?