

Effects of Negative Testing on Test Driven Development

An Industrial Experiment



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About me

- *PhD Student @ Mälardalen University, Sweden*
- *First conference attended:*
 - *XP2008 in Limerick, Ireland*
- *Last conference (as PhD student):*
 - *XP2013 in Vienna, Austria*

- *Research topic: “Agile Testing” or “Testing in Agile”*
- *Specific focus on “developer’s testing skills”*

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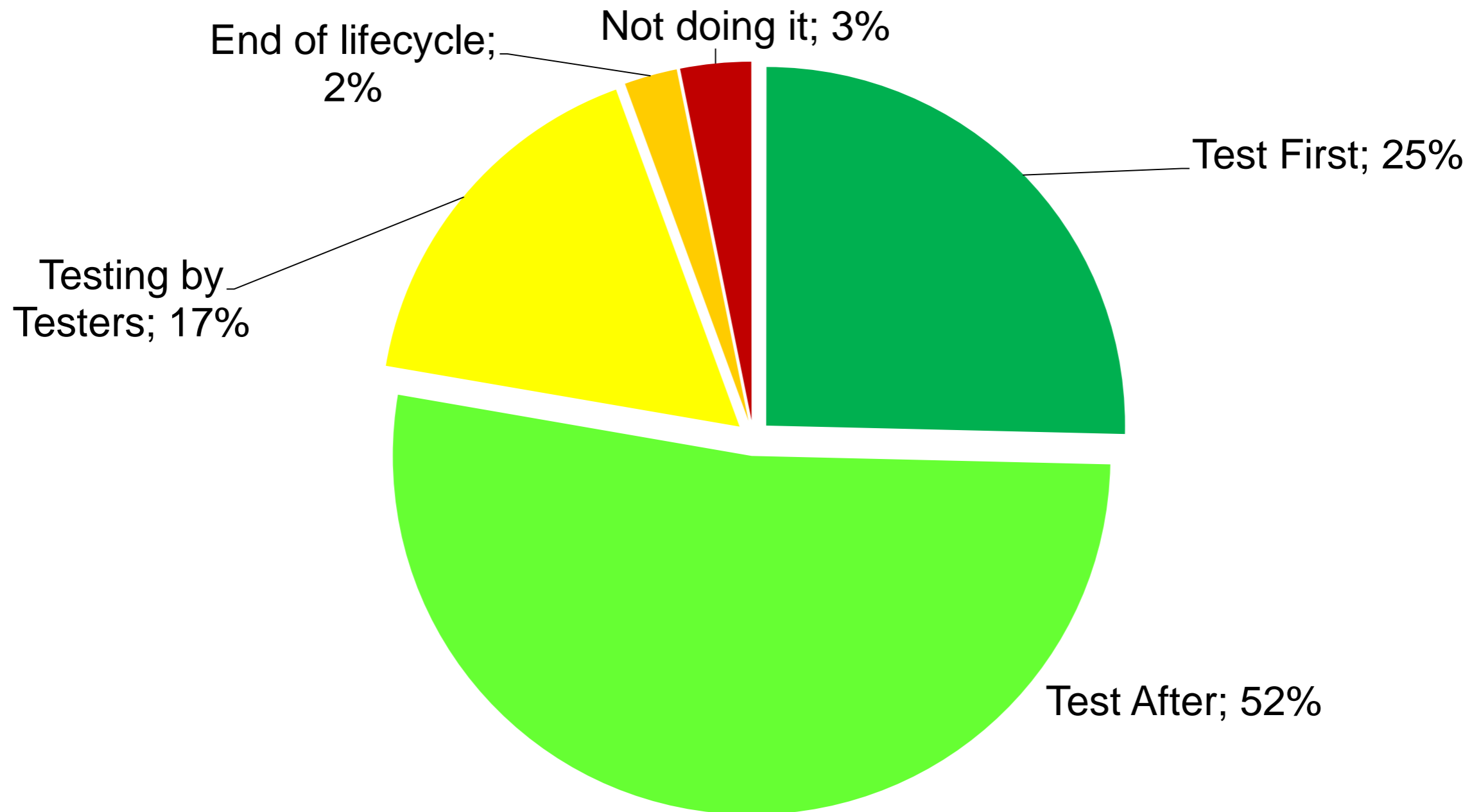
Research Flow

“Respondents would like to use TDD to a significantly higher extent than they actually do currently.”

A. Causevic, D. Sundmark, and S. Punnekkat, “**An Industrial Survey on Contemporary Aspects of Software Testing**,” in Proceedings of the 3rd International Conference on Software Testing, Verification and Validation (ICST), 2010



Primary Approach to Developer Testing





Research Flow

“Developers inability to write efficient and effective automated test cases is considered to be one of the limiting factors of full TDD adoption.”

A. Causevic, D. Sundmark, and S. Punnekkat, **“Factors Limiting Industrial Adoption of Test Driven Development: A Systematic Review,”** in Proceedings of the 4th International Conference on Software Testing, Verification and Validation (ICST), 2011



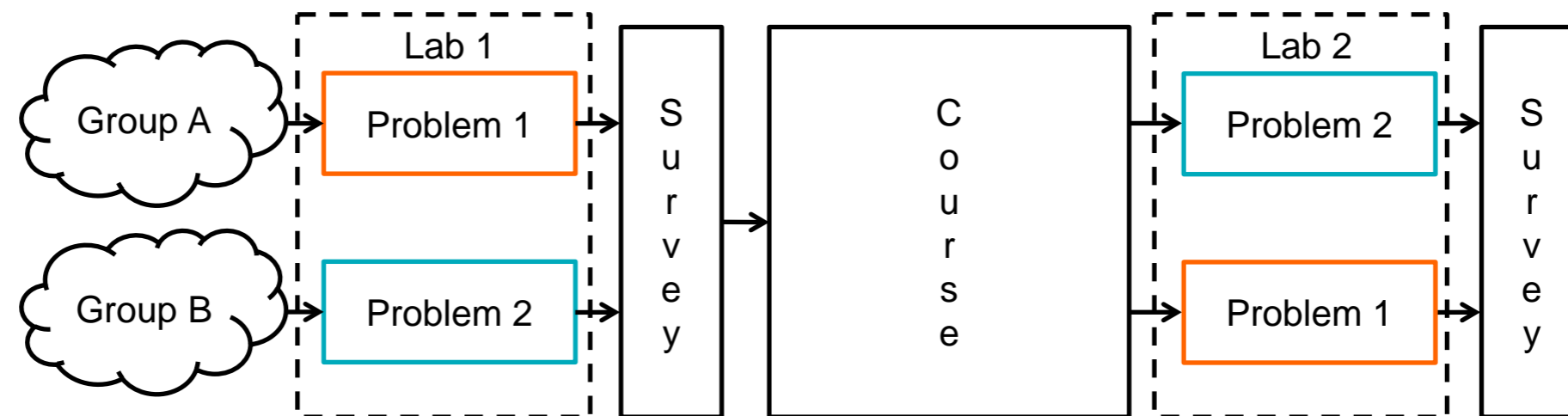
Challenges Adopting Agile Testing Approaches

- *What has your team found to be the most difficult challenges when adopting agile testing approaches?*
- *50% Getting all testing done in the current iteration/sprint*
- **37% Adopting test-driven approaches**
- *33% Validating non-functional requirements*
- *33% Getting stakeholders/customers involved with testing*
- **27% Getting developers to test their own code**
- *21% User interface testing*
- *16% Learning to test throughout the lifecycle*
- *13% Adopting new agile testing tools*
- *12% Migrating existing testing and quality professionals to agile*
- *8% Using our existing testing tools to support agile development*
- *8% Remaining regulatory compliant*



Developer's Testing Skills

- *Does improvements in testing knowledge leads to efficient TDD?*



- *Empirical Study at MDU within course on Software V&V*
- *General testing knowledge provided to students*
- *No significant difference observed*
- *Analysis pointed out lack of “negative” test cases*

A. Causevic, D. Sundmark, and S. Punnekkat, “**Impact of Test Design Technique Knowledge on Test Driven Development: A Controlled Experiment,**” in Proceedings of the 13th International Conference on Agile Software Development (XP), 2012



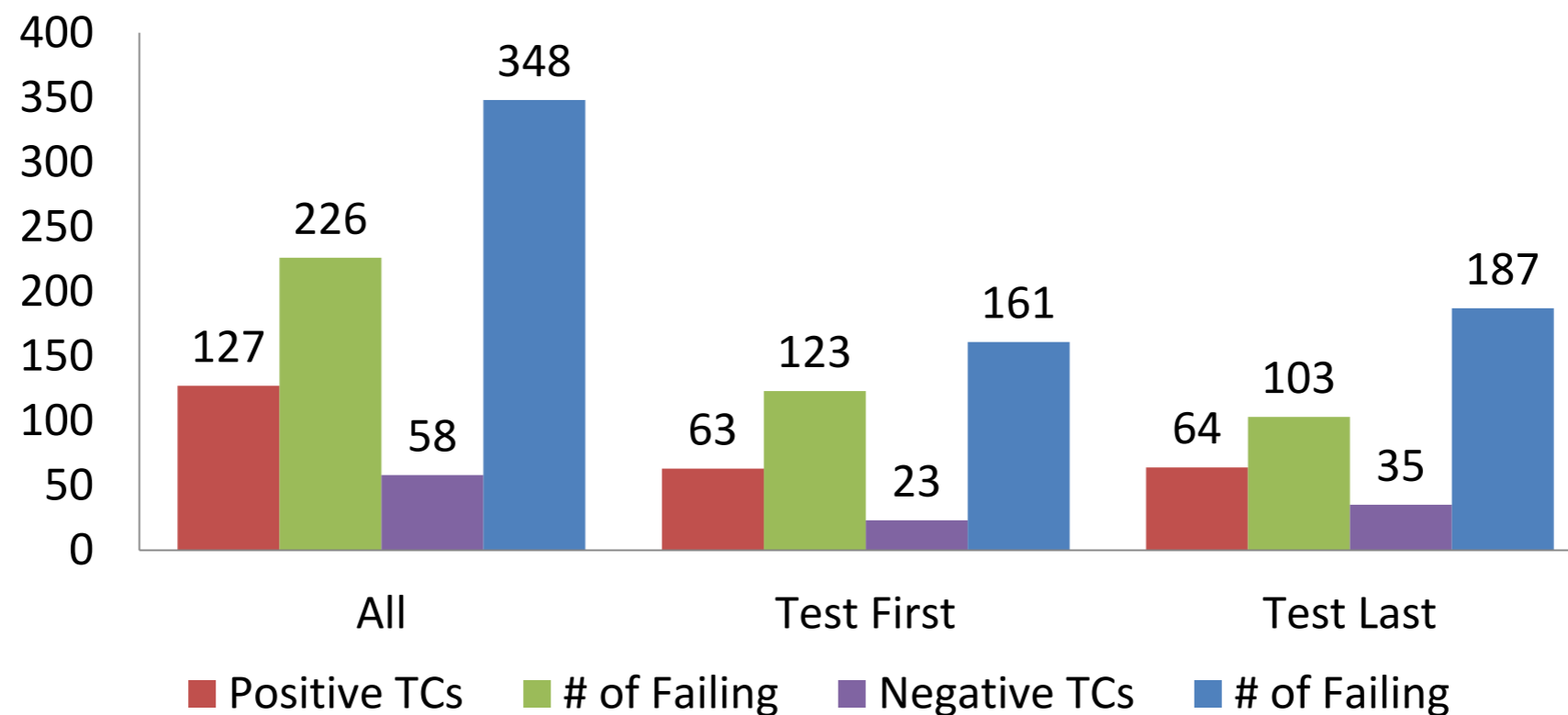
Negative testing?

- *“... created for the purpose of exercising a program in a way that was not explicitly specified in the requirement.”*
- *Opposite of positive testing*
 - *“... exercises a program behaviour as it is specified in the requirement.”*



Effect of Negative Testing on TDD

- *Study performed at MDU, Software V&V Course*
- *Existence of “positive test bias” acknowledged*
- *Importance of “negative” test cases (defect detecting ability is as much as **65%** higher than the positive ones)*



A. Causevic, D. Sundmark, and S. Punnekkat, “**Test Case Quality in Test Driven Development: A Study Design and a Pilot Experiment,**” in Proceedings of the 16th International Conference on Evaluation & Assessment in Software Engineering (EASE), 2012



Experiment Design



P1-Test Case 1	✓	✓
P1-Test Case 2	✓	✗
P1-Test Case 3	✓	✓



P2-Test Case 1	✓	✓
P2-Test Case 2	✗	✓
P2-Test Case 3	✗	✓

Infosys®





Infosys InStep Internship program

Infosys® | InStep

- *infosys.com/instep*
- *Internship opportunities for students*
- *8-12 weeks duration*
- *Covering travel expenses, accommodation, monthly allowance, taxi, gym, etc...*

- *Perfect for visiting India 😊*



My Infosys Internship

- *Placed in Bangalore DC, Infosys, India*
- *4 weeks in September 2012*
- *“Best Intern” award*

- *No time to visit anything ☹*



Preparations for the Study

- *Started in May 2012*
- *Introduction to “Project Mentor” @ Infosys*
- *Original idea: Perform study on the specific day*
- *Mentor suggestion: Make study “open access” for at least 2 weeks*

- *Employees are distributed*
- *Employees will use their own workstations*
 - *Set of tools and instructions have to be provided*
 - *Internal server infrastructure setup*

- *Video training material for jUnit and TDD*
- *Internal promotion of the study*



Research Questions

- ***RQ1:*** *Does the effect of positive test bias exist in an industrial context?*
- ***RQ2:*** *Is the defect detecting ability of negative test cases the same as the positive ones?*
- ***RQ3:*** *Is the quality of negative test cases the same as that of positive test cases?*
- ***RQ4:*** *Is there a difference in the quality of produced tests based on the usage of a specific development practice?*



Study Execution

- *Experiment executed from 10th to 21st of Sept. 2012*
- *Around 100 participants placed in three groups*
 - *Test Last*
 - *Test Driven Development*
 - *Test Driven Development with the Support of Negative Testing*
- *Participants from: Bangalore, Beaverton, Brussels, Chennai, Hyderabad, Mangalore, Melbourne, Mysore, Pune, Trivandrum*



Data collection

- *Solutions submitted by 60 participants*
- *Done when it's done*

- *Still, some removal was done:*
 - *Incomplete solutions*
 - *Own failing test cases*
 - *Small number of test cases (≤ 3)*
 - *Wrong test cases*
 - *Different programming interface*

- *33 solutions used for the analysis*

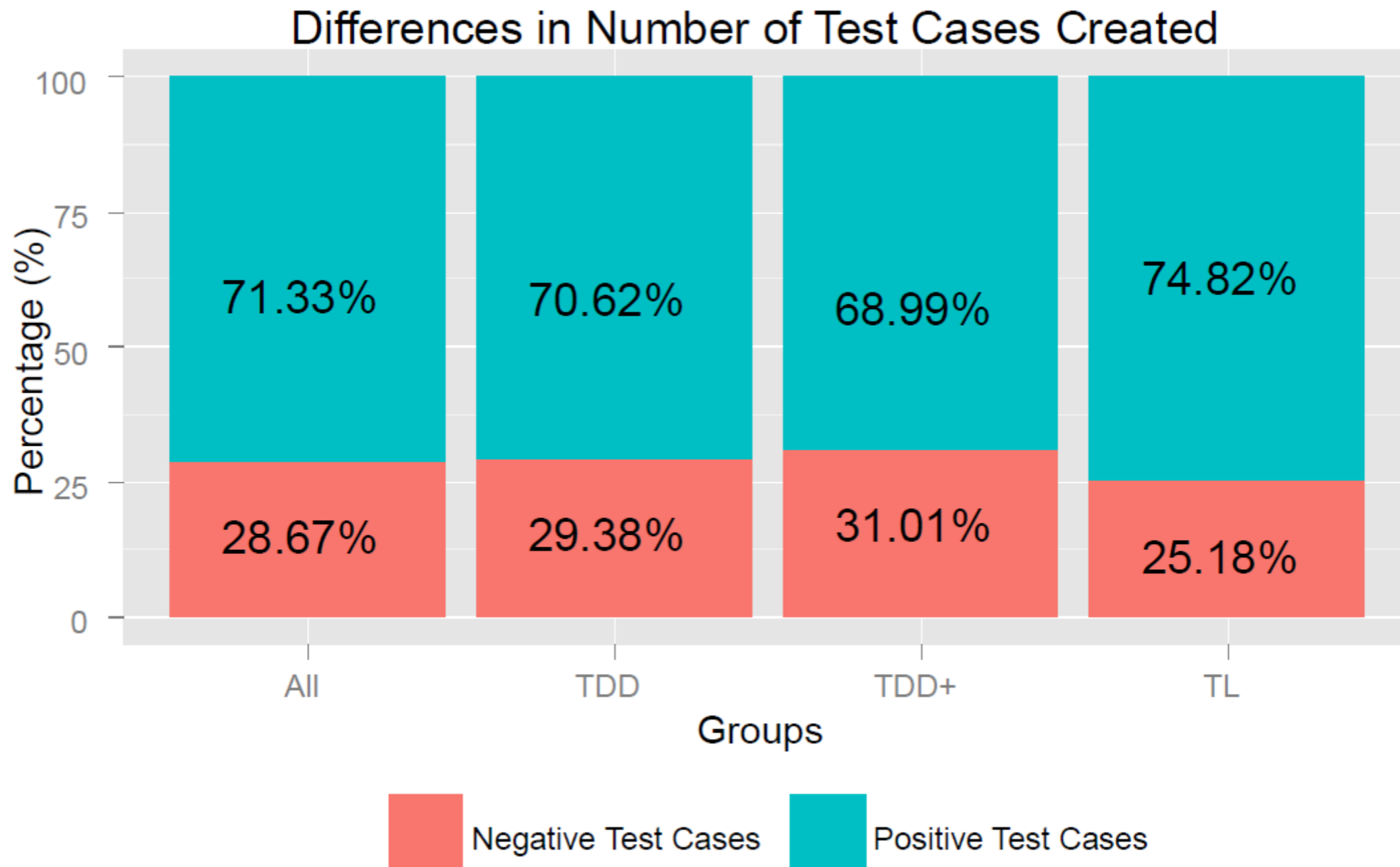


Analysis

- ***RQ1:** Does the effect of positive test bias exist in an industrial context?*
 - p-value = 0.00000731
- ***RQ2:** Is the defect detecting ability of negative test cases the same as the positive ones?*
 - p-value = 0.00000302
- ***RQ3:** Is the quality of negative test cases the same as that of positive test cases?*
 - p-value = 0.00000277
- ~~***RQ4:** Is there a difference in the quality of produced tests based on the usage of a specific development practice?*~~
 - p-value = 0.4102955

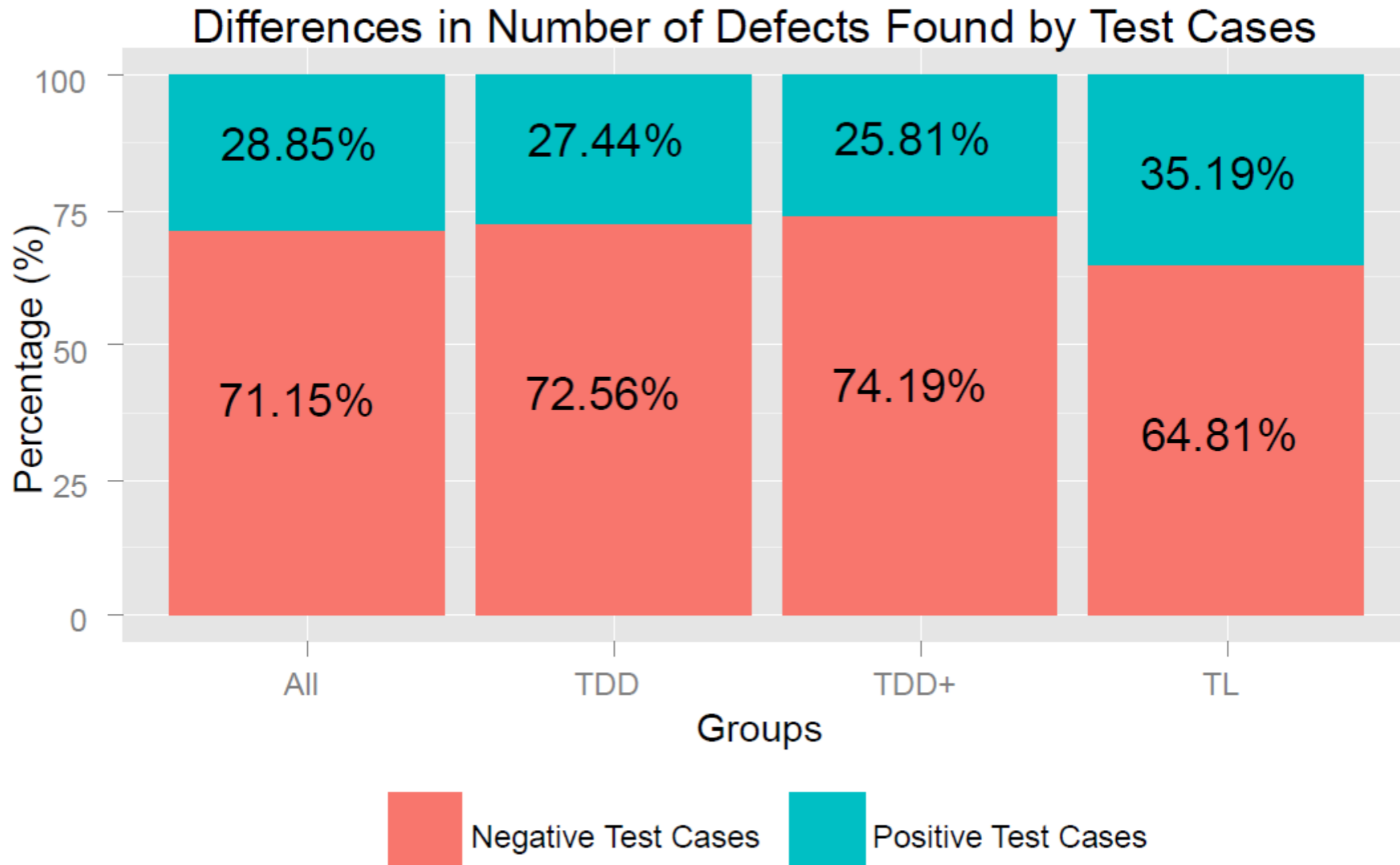


Results





Results





Limitations

- *Inability to have a full controlled experiment*
- *Small scale problem (3 hours needed on average)*
- *Participants' (in)experience with TDD*
- *Narrowed sample size (only Infosys employees)*
- ...



Benefits of the Study

- *Industrial perspective*
 - *Training provided to employees*
 - *Video tutorial currently used by training division*
 - *Corporate researchers collaborated with academia*
- *Academic perspective*
 - *Direct access to high number of employees*
 - *Collaboration with industry*
 - *Costs of performing the study*



Lessons Learned

- *Employees are busy, use their time wisely!*
- *Curiosity and wiliness to learn something new*
- *Suspicion about being evaluated*



Future Work

- *Further enhancements to TDD*
 - *Combining TDD with an appropriate test design techniques*
- *Empirical evaluation*
 - *Trial in academia*
 - *Full study in industry*

Thank you!

Questions?



www.mrtc.mdh.se/~acc01/infosys-experiment

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