A CONCEPTUAL REPLICATION OF CONTINUOUS INTEGRATION PAIN POINTS

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DAVID WIDDER

MICHAEL HILTON

CHRISTIAN KÄSTNER

BOGDAN VASILESCU

WHAT WILL I TALK ABOUT?

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1. WHAT IS CONTINUOUS INTEGRATION? WHY DO PEOPLE USE IT?

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2. WHY DO A REPLICATION?

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1. WHAT IS CONTINUOUS INTEGRATION? WHY DO PEOPLE USE IT?

2. WHY DO A REPLICATION?

3. OUR MIXED METHOD

WHAT WILL I TALK ABOUT?

1. WHAT IS CONTINUOUS INTEGRATION? WHY DO PEOPLE USE IT?

2. WHY DO A REPLICATION?

3. OUR MIXED METHOD

4. HIGHLIGHTS OF FINDINGS: WHAT REPLICATES + WHAT DOESN'T?

WHAT IS CONTINUOUS INTEGRATION?

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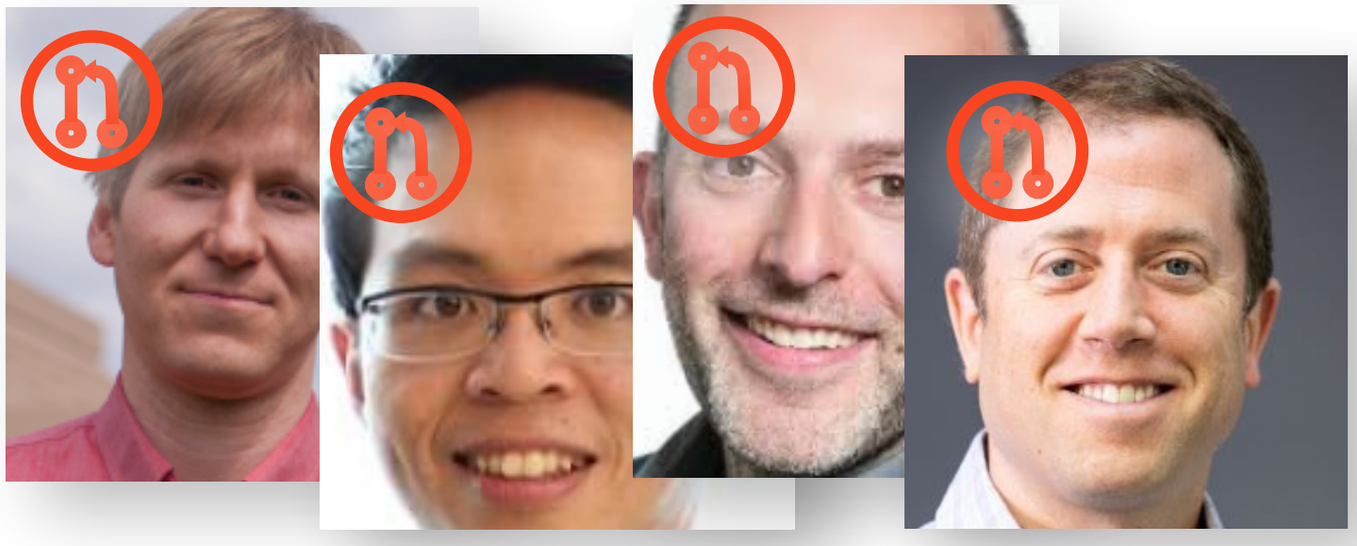
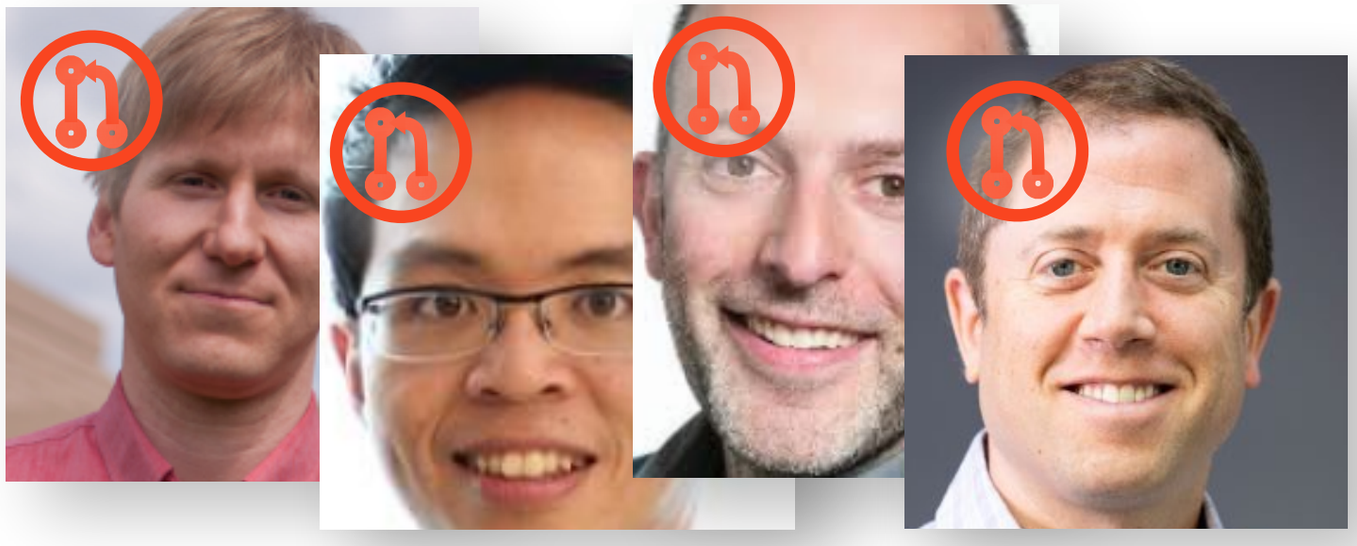


WHAT IS CONTINUOUS INTEGRATION?



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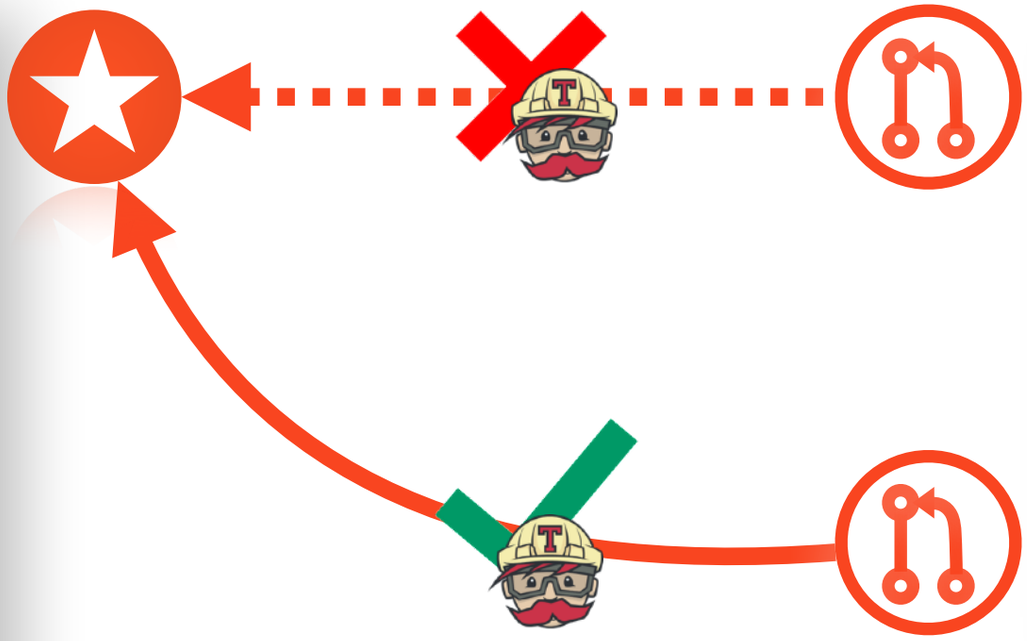

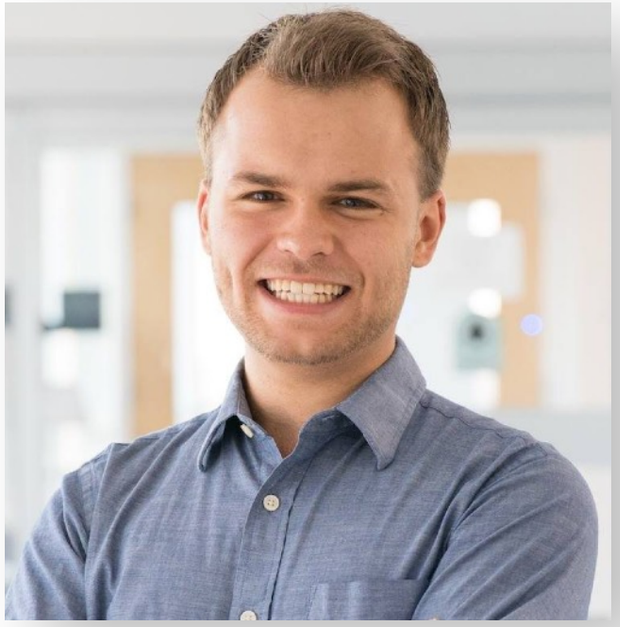

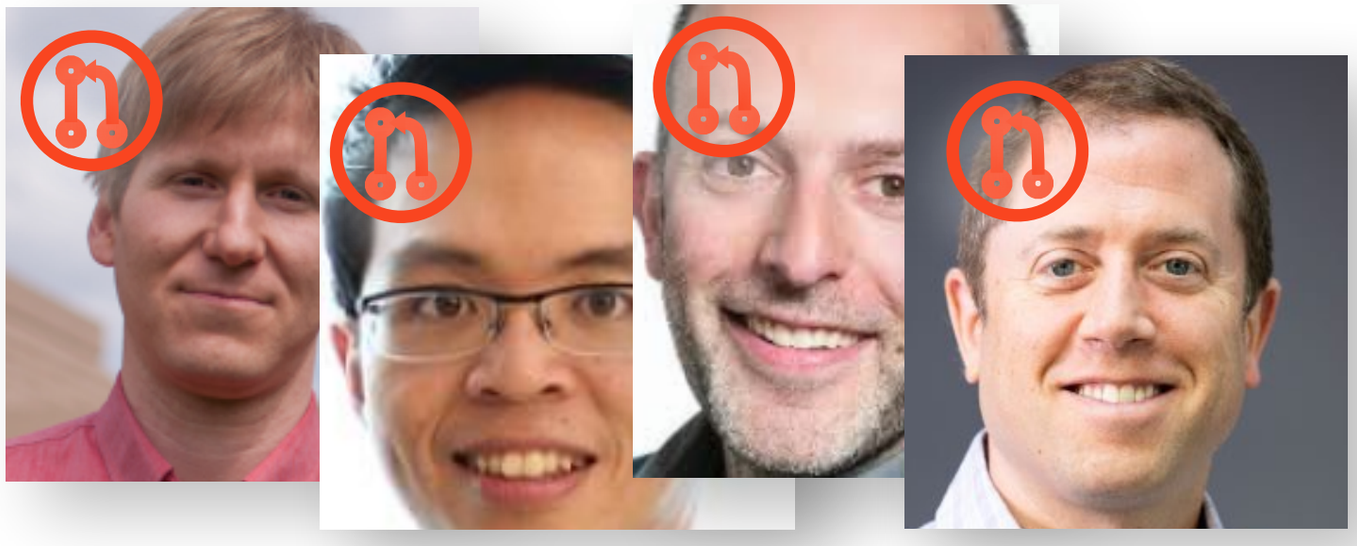

CI IS A BEST PRACTICE

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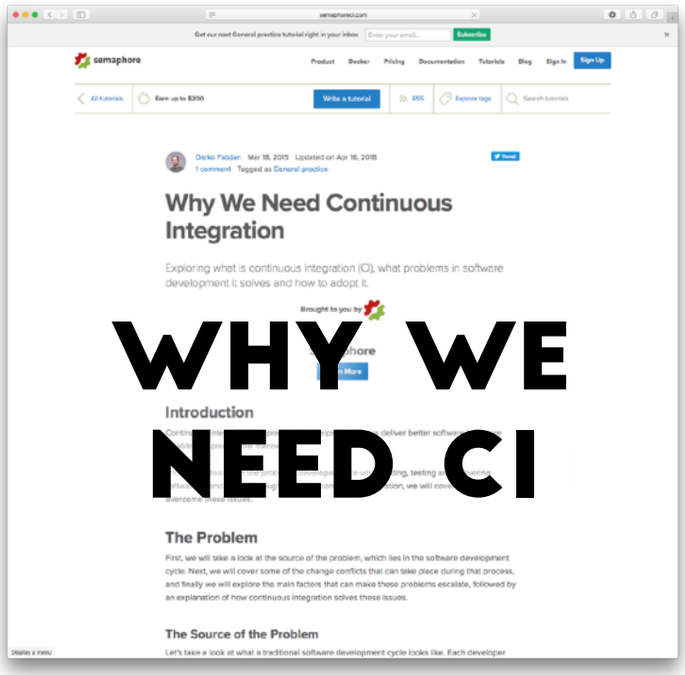
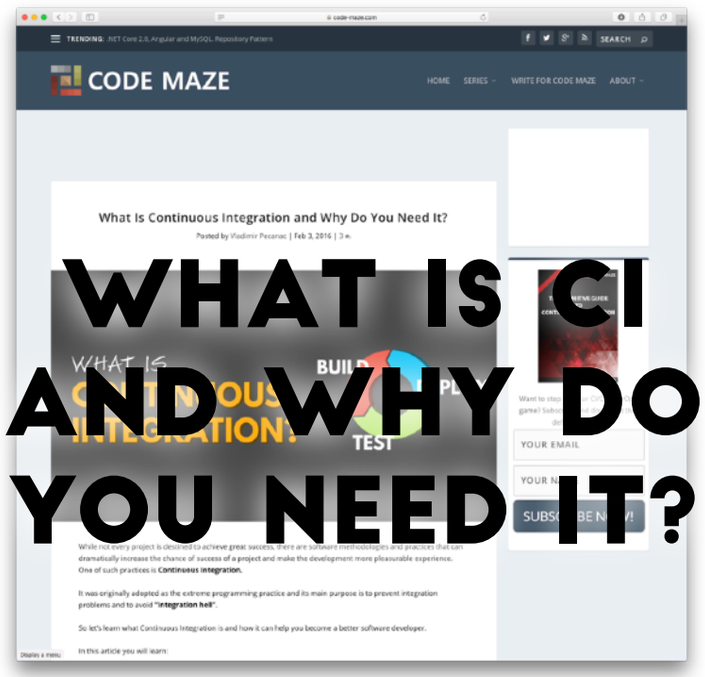
6 REASONS TO USE CI



WHY WE NEED CI

WHAT IS CI AND WHY USE IT?



WHAT IS CI AND WHY DO YOU NEED IT?

7 REASONS YOU SHOULD USE CI

WHY CI IS IMPORTANT

LOTS OF RESEARCH SHOWING CI BENEFITS

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HELPS CATCH BUGS FASTER

RELEASE TWICE AS OFTEN

FEWER PULL REQUESTS REJECTED

HIGHER PULL REQUEST THROUGHPUT

ENCOURAGES PEOPLE TO WRITE TESTS

ALSO, LOTS OF RESEARCH SHOWING CI PAIN POINTS

ALSO, LOTS OF RESEARCH SHOWING CI PAIN POINTS

HARD TO CONFIGURE

UNSUPPORTED FEATURES

TOO MANY OPTIONS

LONG BUILDS

INSECURE

WE BELIEVE IT IS TIME TO REVIEW AND REPLICATE CI PAIN POINTS

WHY REVIEW AND REPLICATE CI PAIN POINTS?

WHY REVIEW AND REPLICATE CI PAIN POINTS?

- EVALUATE & SYNTHESIZE PAST RESEARCH

WHY REVIEW AND REPLICATE CI PAIN POINTS?

- EVALUATE & SYNTHESIZE PAST RESEARCH
- PROVIDE REPLICATED GUIDANCE TO PRACTITIONERS

WHY REVIEW AND REPLICATE CI PAIN POINTS?

- EVALUATE & SYNTHESIZE PAST RESEARCH
- PROVIDE REPLICATED GUIDANCE TO PRACTITIONERS
- FOCUS FUTURE RESEARCH ON AREAS OF UNCERTAINTY

WHAT'S A CONCEPTUAL REPLICATION?

CURRENT CI USERS

SWITCHERS & ABANDONERS

WHAT'S A **CONCEPTUAL REPLICATION?**

CURRENT CI USERS

SWITCHERS & ABANDONERS

WHY STUDY LEAVERS INSTEAD OF CURRENT USERS?

WHY STUDY LEAVERS INSTEAD OF CURRENT USERS?

CURRENT CI USERS
INDUSTRY & OSS

TRAVISCI LEAVERS
OSS

LIT REVIEW

SURVEY & INTERVIEWS

TRIANGULATION LAYER

PAIN POINTS REPLICATED (OR NOT)

PAIN POINTS

LOGISTIC REGRESSIONS

CURRENT CI USERS
INDUSTRY & OSS

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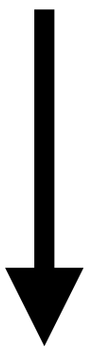

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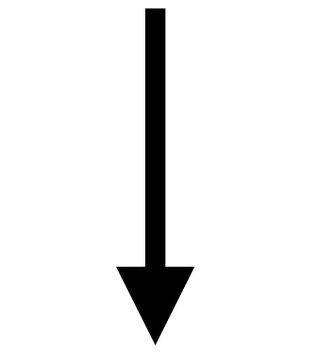

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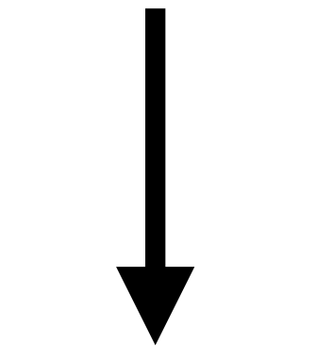

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PAIN POINTS

LOGISTIC REGRESSIONS

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LIT REVIEW
37 PAPERS
35 PAIN POINTS

132 SURVEY RESPONSES

“Why did your project stop using Travis CI, and what has the CI situation been like since then?”

David 🦆 Widder
@davidthewid

🚨🚨🚨 Science in progress! 🚨🚨🚨
Afternoon spent card sorting ~140 survey responses w @michaelhilton
📸: @b_vasilescu #mixedmethods

132 SURVEY RESPONSES + 12 INTERVIEWS

132 SURVEY RESPONSES + 12 INTERVIEWS

WHY LOGISTIC REGRESSION?

PEOPLE WHO LEAVE CI VS THOSE WHO DON'T

ABANDONMENT VS SWITCHING

Commits on Aug 7, 2019

[maven-release-plugin] prepare for next development iteration

kohsuke committed 4 days ago ✕

[maven-release-plugin] prepare re

kohsuke committed 4 days ago

[maven-release-plugin] prepare for next development iteration

All checks have failed

1 failing check

✕ **continuous-integration/jenkins/branch** — This c... Details

ABANDONMENT VS SWITCHING

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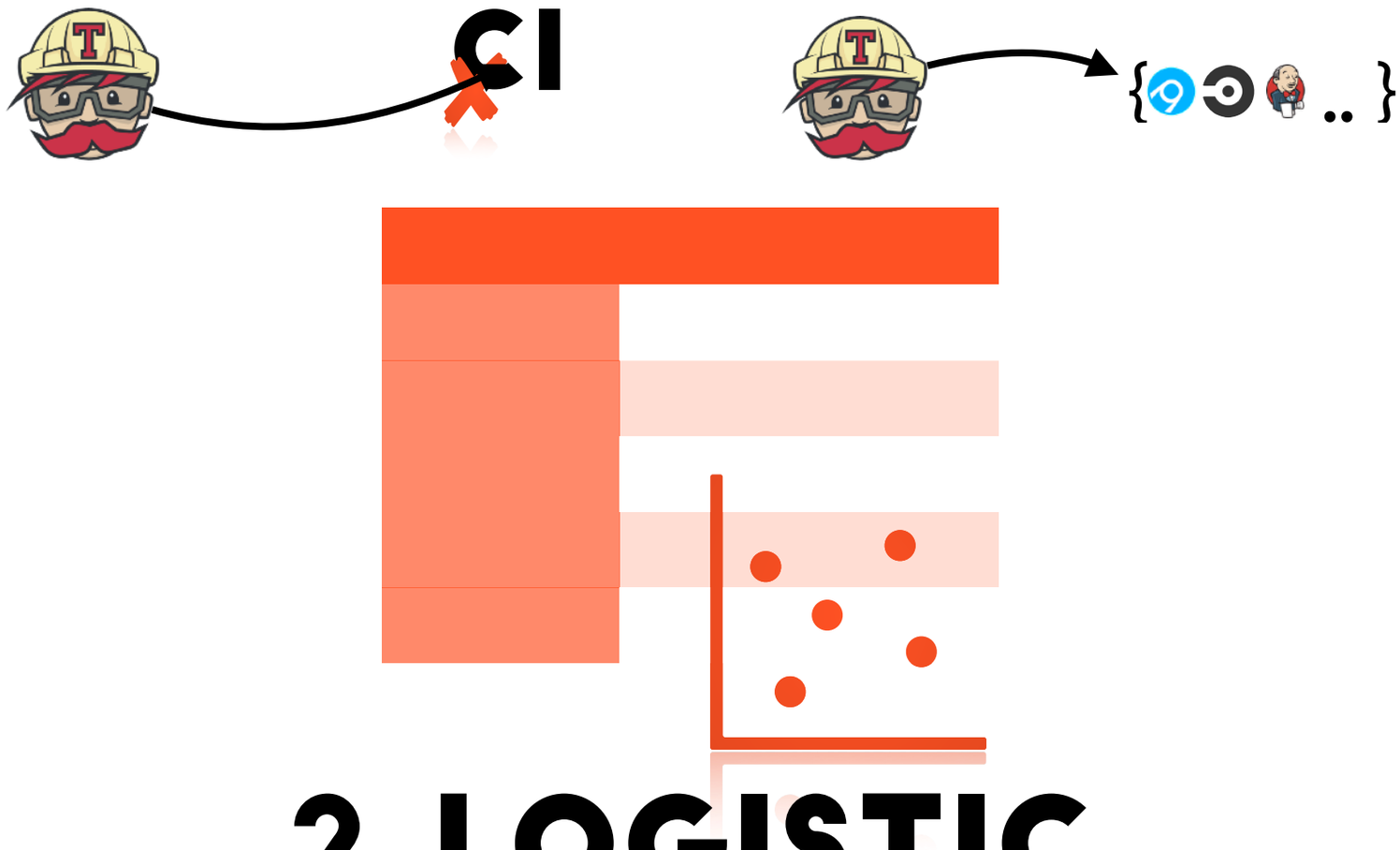
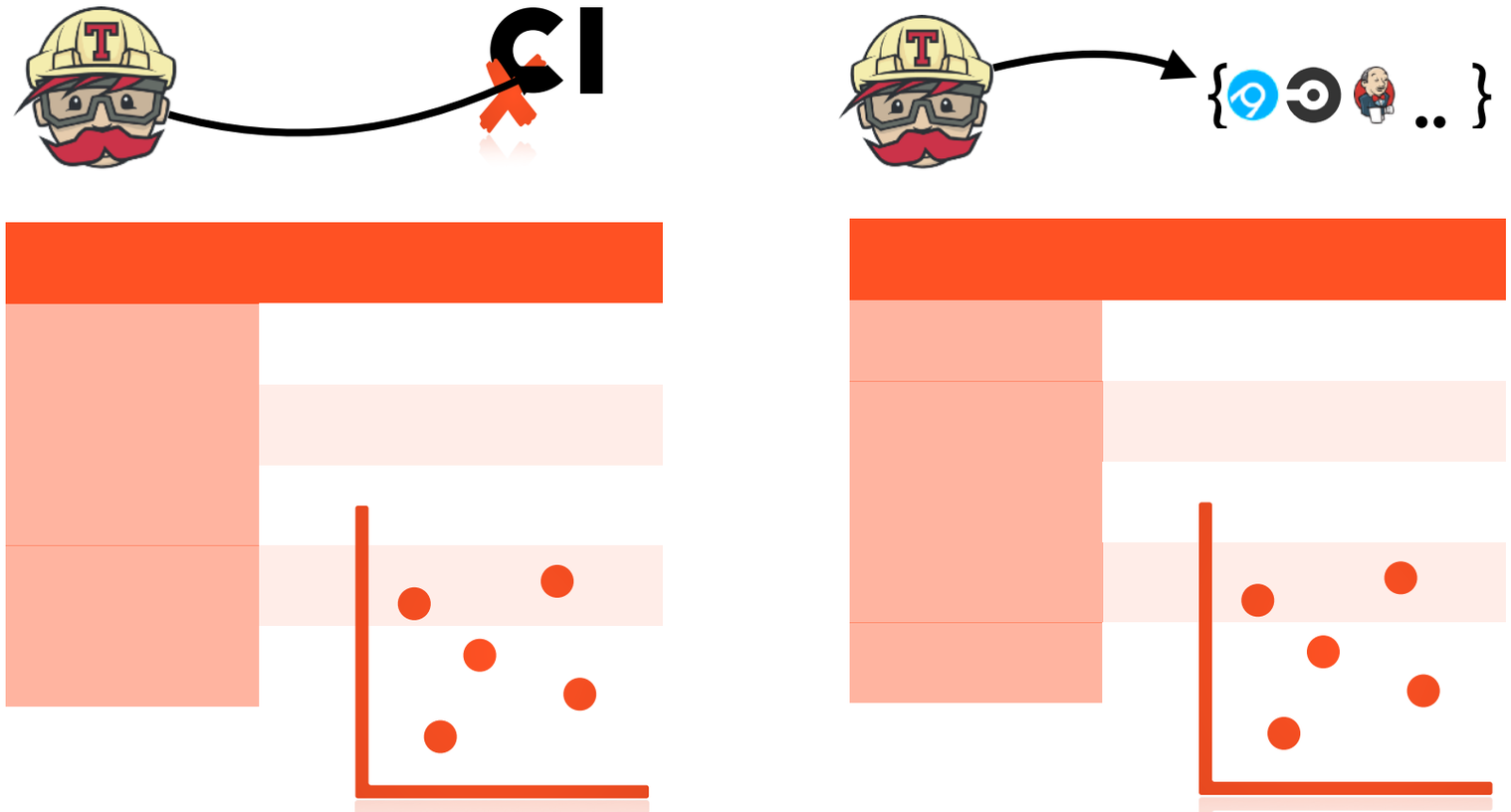


2 LOGISTIC REGRESSIONS, 6,239 REPOS

ABANDONMENT VS SWITCHING



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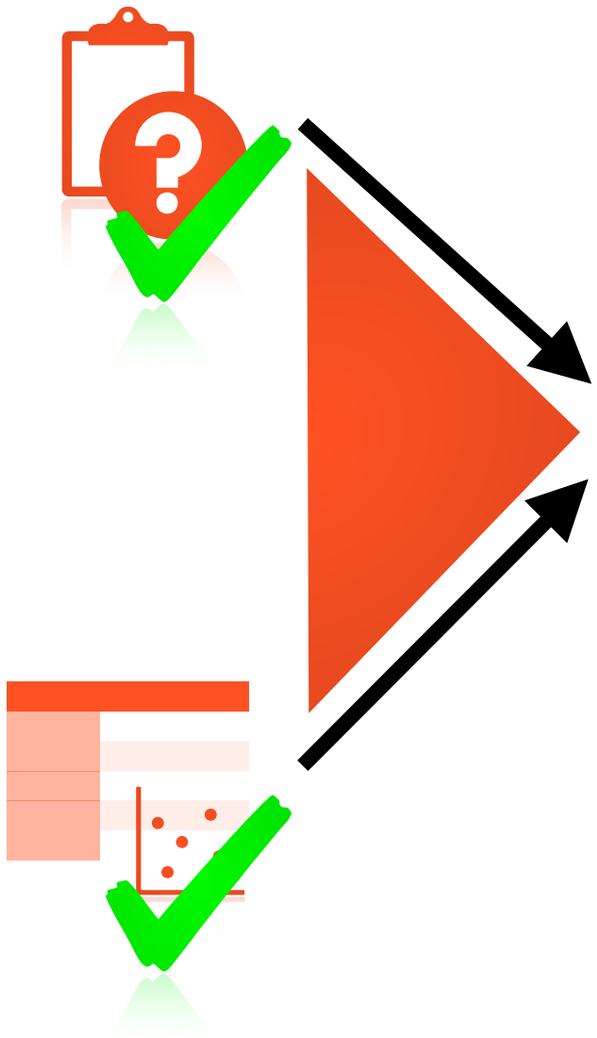
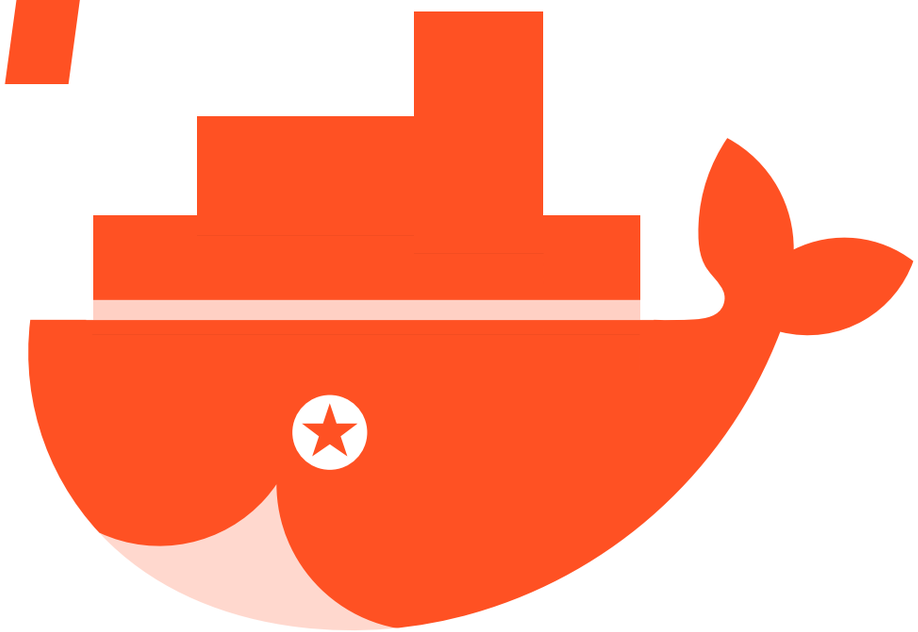
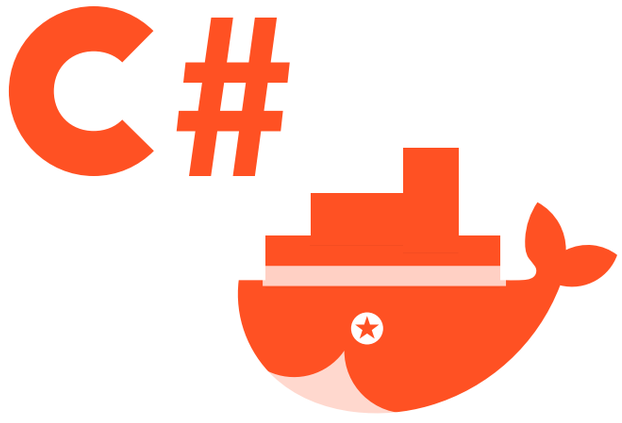


TRIANGULATED RESULTS

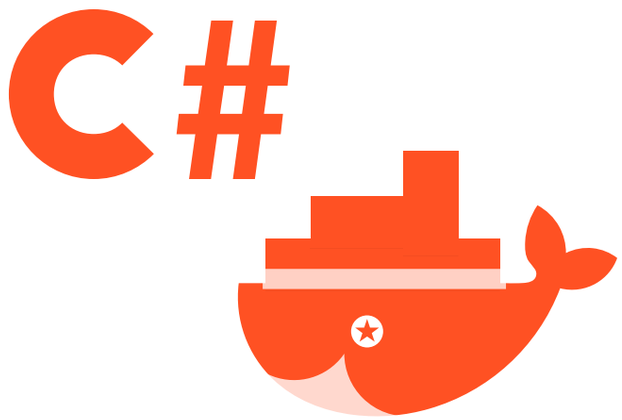
C#



UNSUPPORTED TECHNOLOGIES

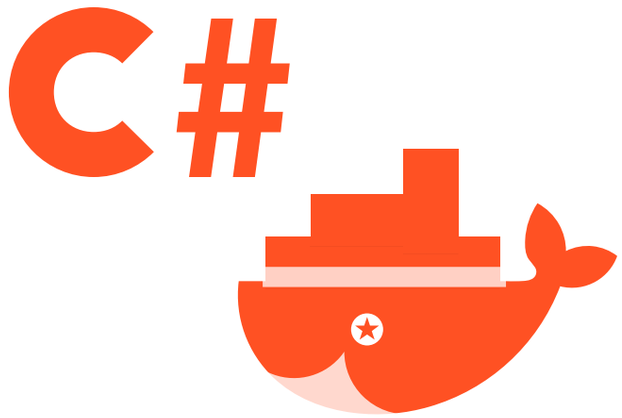


UNSUPPORTED TECHNOLOGIES



UNSUPPORTED TECHNOLOGIES

“I switched to Wercker, a container based CI pipeline, which means it can execute any scripts with much more flexibility.” (P89)



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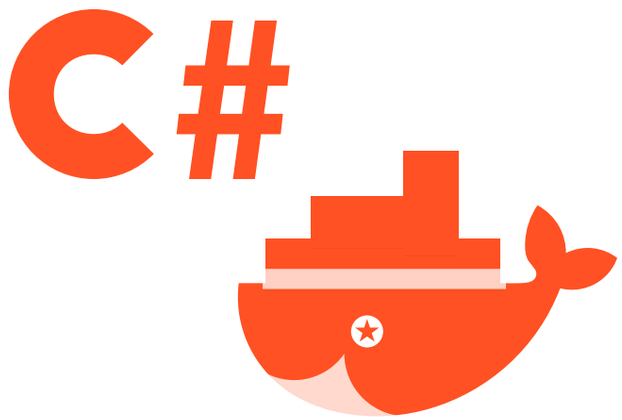
NEEDING DOCKER:
9.5X INCREASE IN SWITCHING,
5.25X INCREASE IN ABANDONING



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NEEDING DOCKER:
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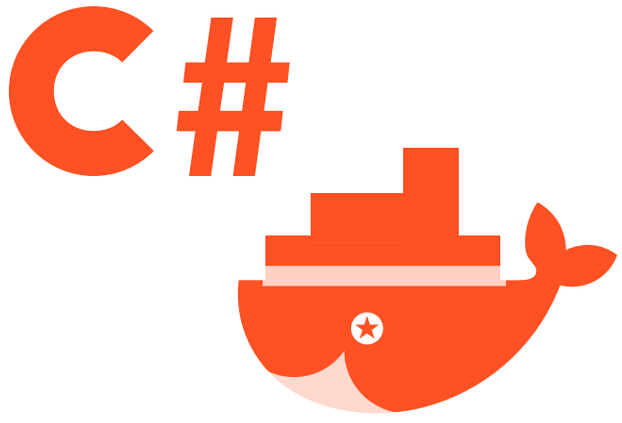
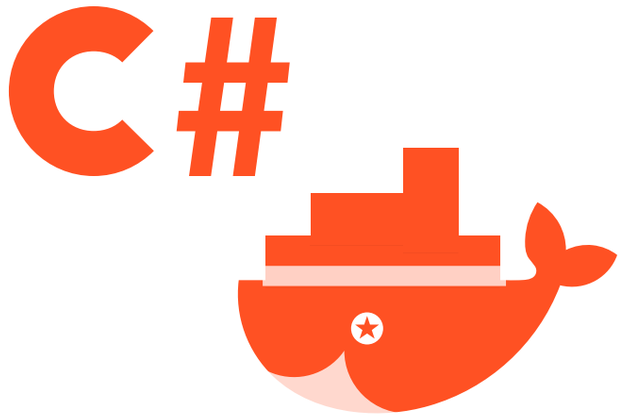
LACKING LANGUAGE SUPPORT:
1.5X INCREASE IN SWITCHING AND ABANDONING



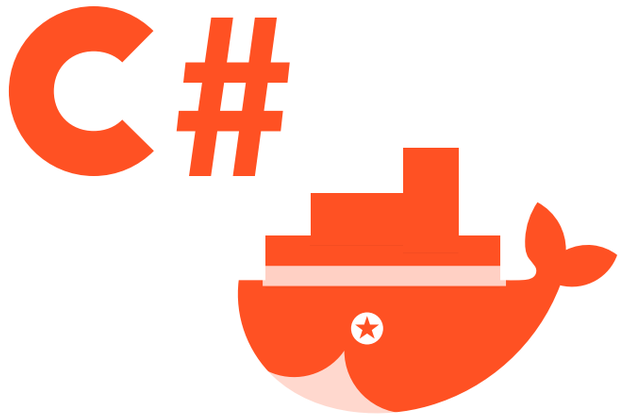
UNSUPPORTED TECHNOLOGIES



UNSUPPORTED TECHNOLOGIES

NEEDING DOCKER AFFECTS

NEW TRAVISCI USERS ONLY



UNSUPPORTED TECHNOLOGIES

NEEDING DOCKER AFFECTS NEW TRAVISCI USERS ONLY

WHEN CAN PEOPLE HACK THROUGH TECHNOLOGY SUPPORT CHALLENGES, AND WHEN ARE THE NOT ABLE TO?

LACK OF TESTS

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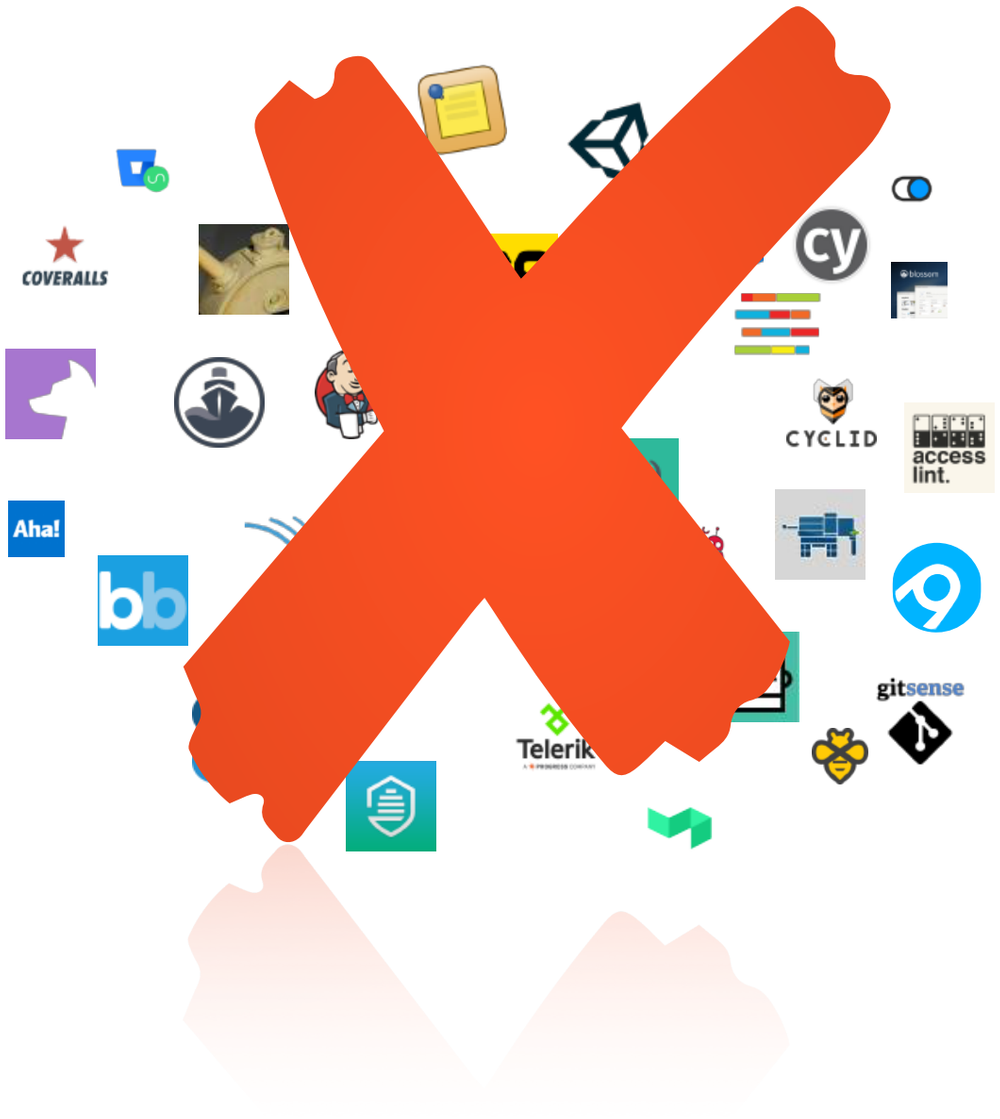
“The goal [of adopting Travis] was to ‘force’ myself to add some real tests (to have green Travis badge again!) but this failed so far :)” (P111)

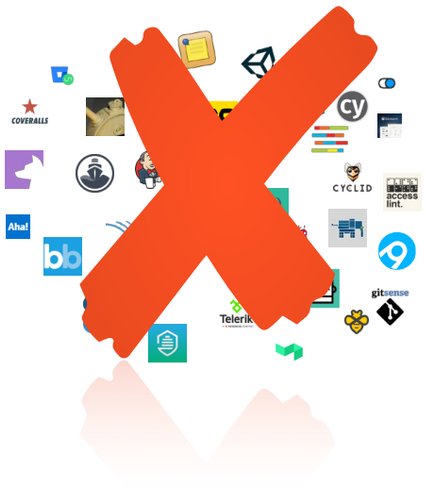
LACK OF TESTS

"The goal [of adopting Travis] was to 'force' myself to add some real tests (to have green Travis badge again!) but this failed so far :)" (P111)

1% INCREASE IN TESTS =
16% LOWER CHANCE OF ABANDONING
(NO EFFECT ON SWITCHING)



CI CONSISTENCY



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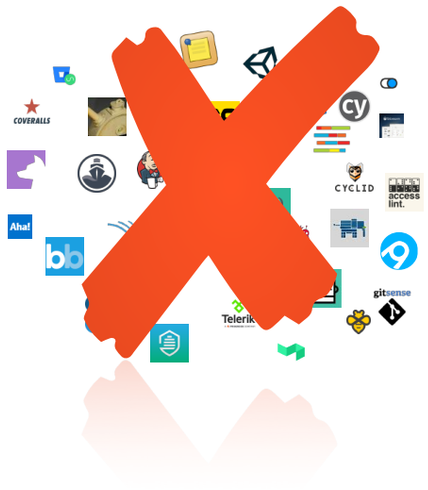
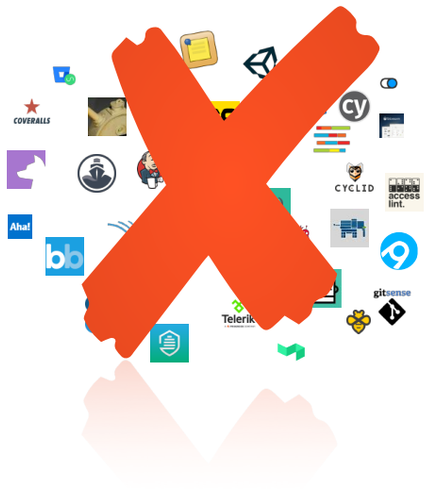


CI CONSISTENCY

“I had some open source projects running in TravisCI and some in CircleCI. I just wanted to consolidate the project to one place and I’m sorry to say that at that time TravisCI lost the battle.” (P57)



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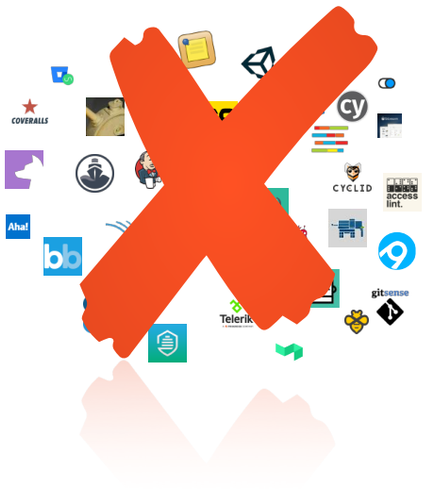
EXPOSURE TO LEAVERS:
~1.5X INCREASE IN CHANCES OF SWITCHING & ABANDONING



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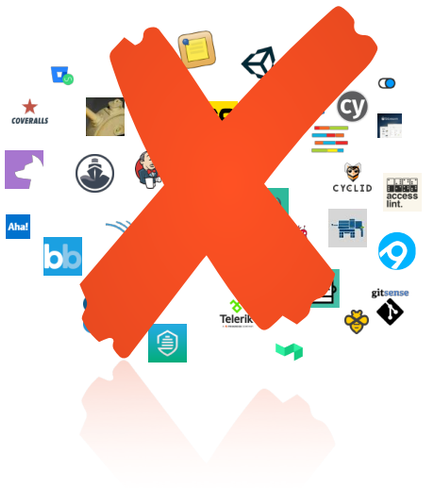
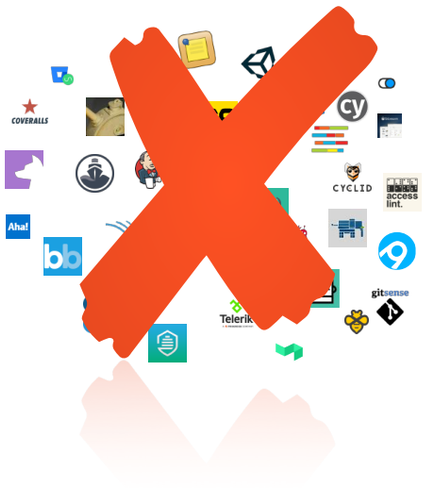


CI CONSISTENCY

PEOPLE'S PAST EXPERIENCE IS VERY IMPORTANT IN DETERMINING BEHAVIOR ON FUTURE PROJECTS!

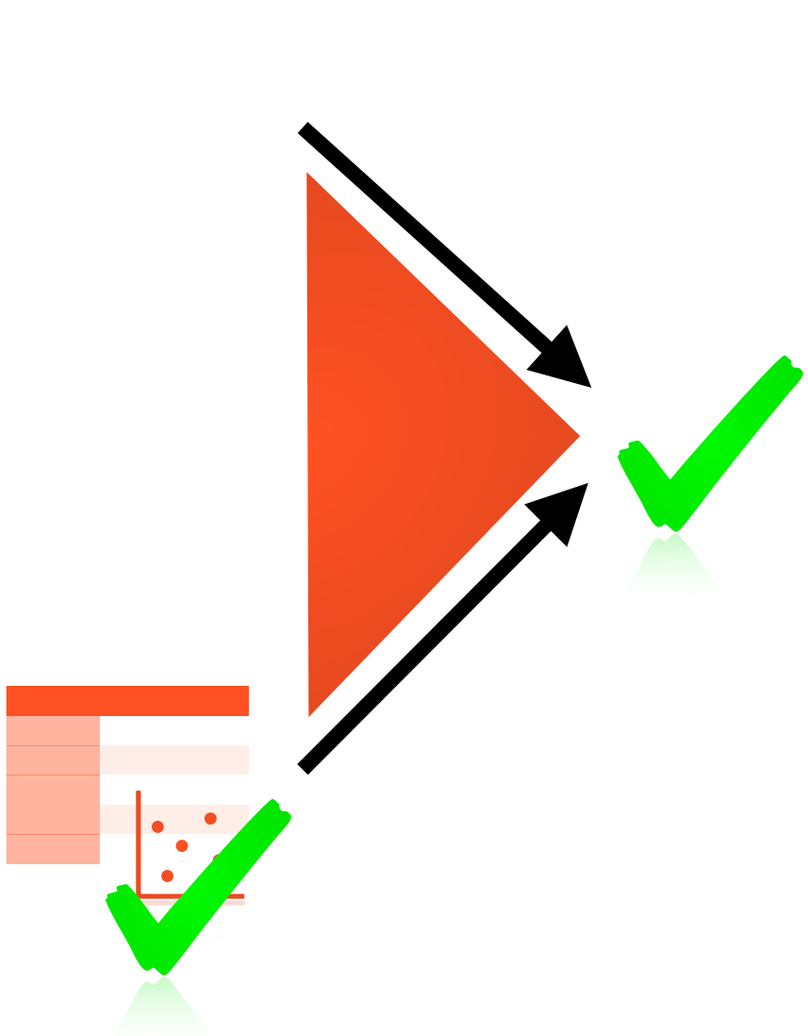


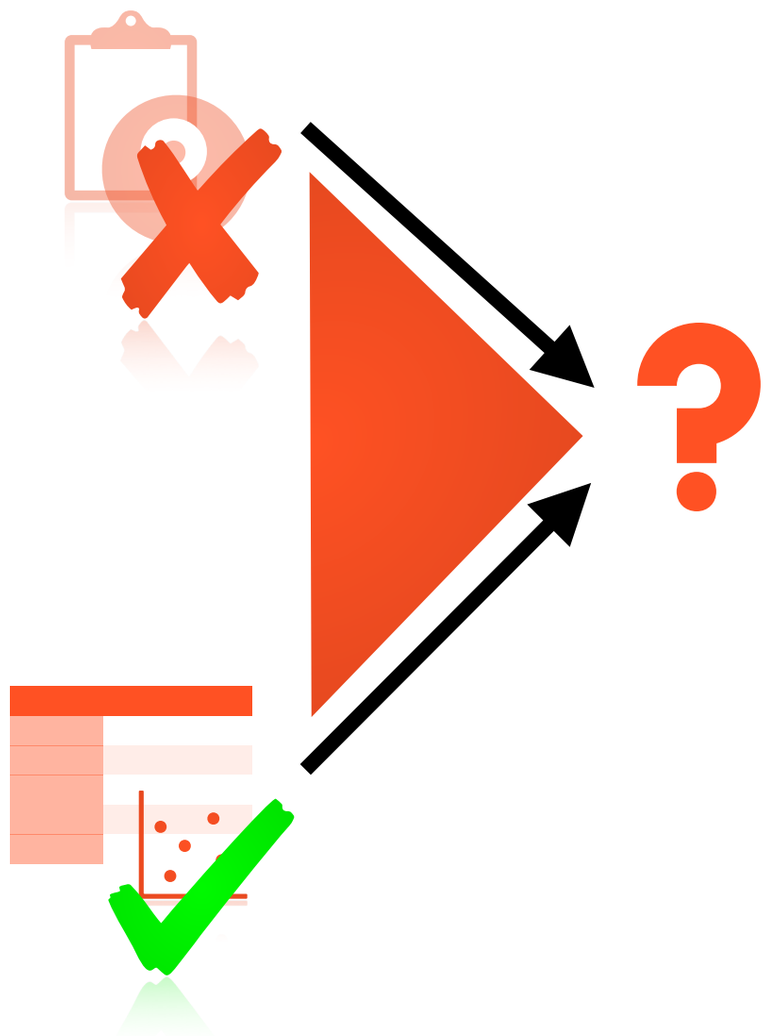
CI CONSISTENCY

PEOPLE'S PAST EXPERIENCE IS VERY IMPORTANT IN DETERMINING BEHAVIOR ON FUTURE PROJECTS!

BUT NOT OBSERVED IN PAST LITERATURE, SO NEEDS REPLICATION.

SINGLE METHOD OR CONFLICTING RESULTS





LONG BUILD TIMES

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"We stopped using Travis CI because it was too slow for us." (P125)

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LONGER BUILD TIMES ASSOCIATED WITH A DECREASED CHANCE OF SWITCHING AND ABANDONING.

LONG BUILD TIMES

"We stopped using Travis CI because it was too slow for us." (P125)

LONGER BUILD TIMES ASSOCIATED WITH A DECREASED CHANCE OF SWITCHING AND ABANDONING.

PRESENCE OF VERY LONG BUILDS ASSOCIATED WITH INCREASED RISK OF ABANDONING.

LONG BUILD TIMES

LONG BUILD TIMES

SO, WHEN DO LONG BUILDS STOP PROVIDING VALUE, AND START BECOMING ANNOYING?

FULL RESULTS IN THE PAPER

A Conceptual Replication of Continuous Integration Pain Points in the Context of Travis CI

David Gray Widder
dwidder@cmu.edu
Carnegie Mellon

Michael Hilton
mhilton@cmu.edu
Carnegie Mellon

Christian Kästner
Carnegie Mellon

Bogdan Vasilescu
vasilescu@cmu.edu
Carnegie Mellon

ABSTRACT

Continuous integration (CI) is an established software quality assurance practice, and the focus of much prior research with a diverse range of methods and populations. In this paper, we first conduct a literature review of 37 papers on CI pain points. We then conduct a conceptual replication study on results from these papers using a triangulation design consisting of a survey with 132 responses, 12 interviews, and two logistic regressions predicting Travis CI abandonment and switching on a dataset of 6,239 GitHub projects. We report and discuss which past results we were able to replicate, those for which we found conflicting evidence, those for which we did not find evidence, and the implications of these findings.

CCS CONCEPTS

• **Software and its engineering** → *Software maintenance tools.*

KEYWORDS

Continuous integration, open source software, replication

ACM Reference Format:
David Gray Widder, Michael Hilton, Christian Kästner, and Bogdan Vasilescu. 2019. A Conceptual Replication of Continuous Integration Pain Points in the Context of Travis CI. In *Proceedings of the 27th ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE '19), August 26–30, 2019, Tallinn, Estonia.* ACM, New York, NY, USA, 12 pages. https://doi.org/10.1145/3338906.3338922

1 INTRODUCTION

Continuous integration (CI) has enjoyed tremendous popularity as a quality assurance mechanism during software development, by automating the execution of builds, tests, and other tasks. CI adoption was primarily driven by practitioners,[1] but research has shown that CI practices have a positive effect on software quality and productivity [28, 69, 76].

Despite the widespread adoption of CI, it has long been established by contingency theory [50, 66] that a single "universal best practice" is unlikely, whatever the actual practice. Moreover, for CI specifically, the literature abounds with studies (we counted 37 papers; Section 3) that each touch on some CI pain points. For example, research has shown that it can take significant effort to set up and customize CI infrastructure [27, 34], and reports from CI systems require effort to process and can cause unwanted interruptions [39], especially without developer buy-in and in the presence of frequent false positives from flaky tests and platform instabilities [37]. Bad experiences or frustration with a specific CI tool can turn developers away from CI as a practice, even when more customized tool solutions exist [86].

Given the number of studies, conducted using a multitude of methods, on diverse populations, we argue that it is the right time for a *thorough review of the pain points and context mismatches that turn people away from CI.* This can help practitioners adopt CI with realistic expectations and in a way that fits their needs, and researchers and tool builders focus on the most severe CI barriers.

In this paper we *review the CI literature* from the perspective of pain points to adoption and usage, and perform a mixed-methods *conceptual replication* [32, 65] of previously observed findings, on a new population (GitHub open-source developers using Travis CI), and using a robust study design. As particular strengths of our study design, we note: ❶ the mixed qualitative (survey with 132 developers and interviews with 12; Sec. 4) and quantitative (large-scale multivariate statistical modeling of trace data from 6,239 projects; Sec. 5) analyses, which enable us to *triangulate* our results; and ❷ the focus on CI *leavers* (rather than current CI users), *i.e.*, those who either switched the Travis CI tool or abandoned the CI practice altogether, which, similarly to customer exit surveys in market research [70], enable us to identify the most acute of Travis CI pain points, since they caused users to leave.

Our main results (Sec. 6), confirming past literature, are that many developers find troubleshooting build failures difficult, desire consistency in CI tools across their projects, find it difficult to use CI with complex tool setups including Docker or to use CI with unsupported languages, find long build times annoying, and find CI less useful without enough tests.

In summary, we contribute: (1) a literature review of general CI pain points; (2) an analysis of 132 survey responses about reasons for abandoning or switching Travis CI; (3) regression models on a dataset of 6,239 GitHub Travis CI projects, testing observations from literature; and (4) a discussion of results and implications.

2 STUDY DESIGN

What are the major pain points that turn people away from CI? To answer this research question, we conduct a **conceptual replication** [32, 65], *i.e.*, we attempt to corroborate observations from past research using a different experimental design, on a different population. The importance of replication studies in software engineering is increasingly recognized.[2] Our *conceptual* replication, as opposed to an *exact* replication, represents a more robust design:

[1] www.martinfowler.com/articles/continuousIntegration.html

[2] E.g., see the ROSE (Recognizing and Rewarding Open Science in Software Engineering) panel at FSE 2018: https://tinyurl.com/y4m2uzsp

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LIT REVIEW

SURVEYS, INTERVIEWS

TRIANGULATION

PAIN POINTS

2 LOGISTIC REGRESSIONS

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DAVIDTHEWID

LIT REVIEW

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2 LOGISTIC REGRESSIONS

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