CodeScene

Refactoring vs Refuctoring

Code quality in the AI age

Enys Mones & Peter Anderberg

codescene.com

Over the coming decades, we'll have a hybrid of code written by both humans and machines. Who has the overall mental model in that context, and how do we ensure our AI generates human-readable code? To face the challenge, we need a safety net to enforce healthy code.

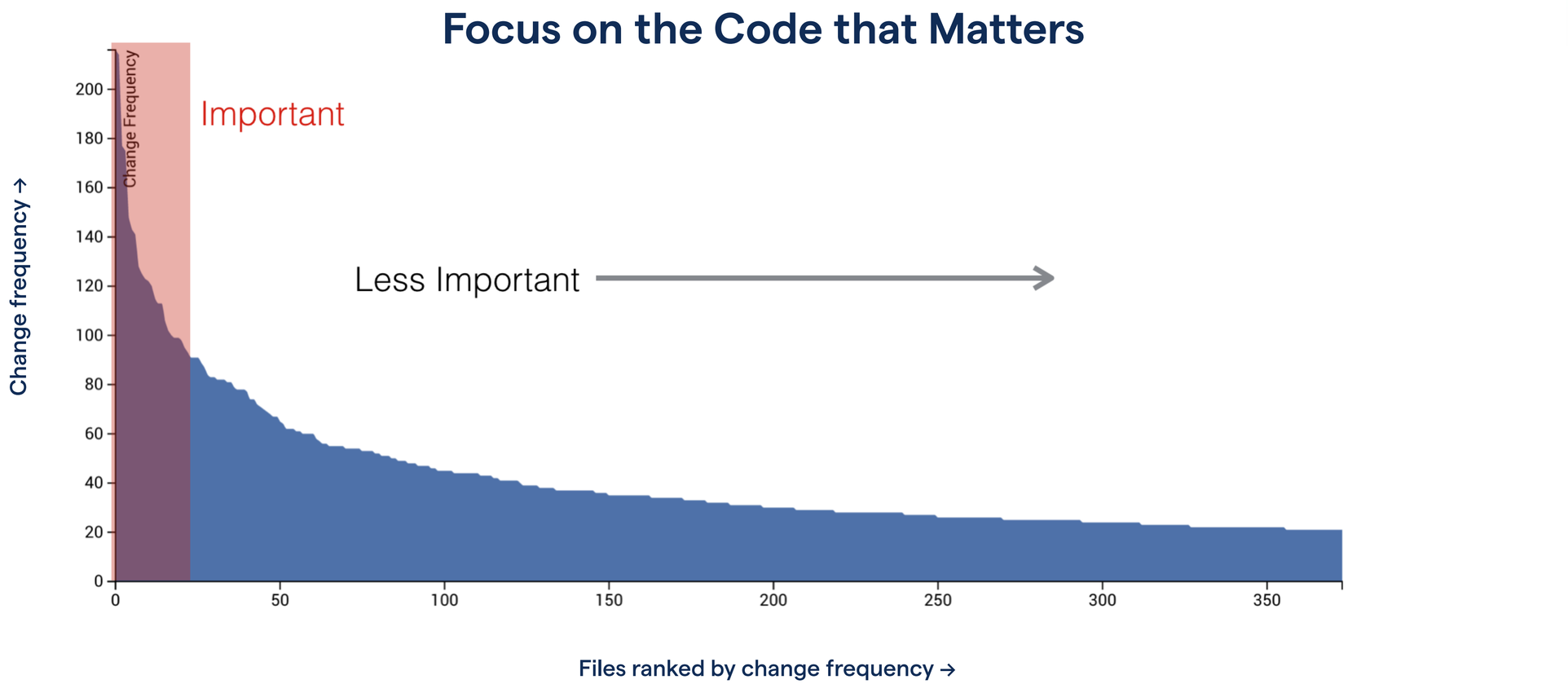
Adam Tornhill

Quality matters

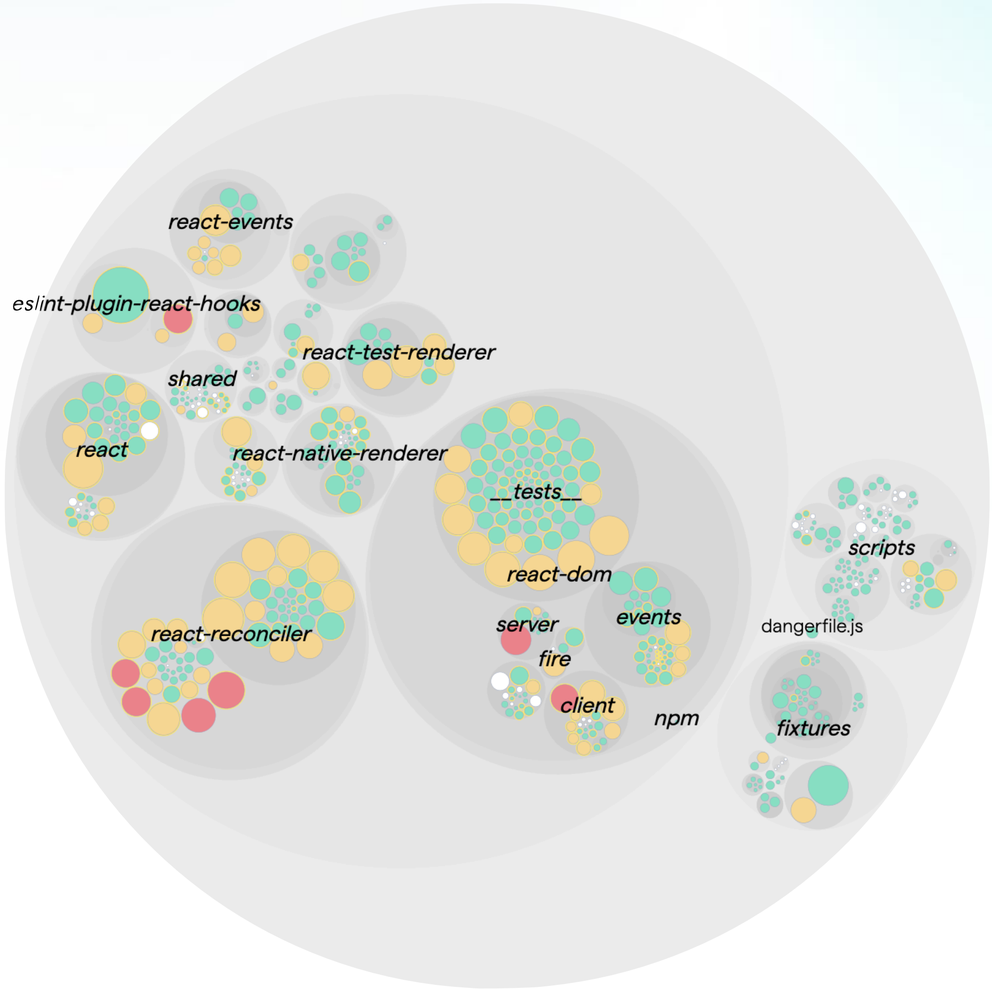
Code Health

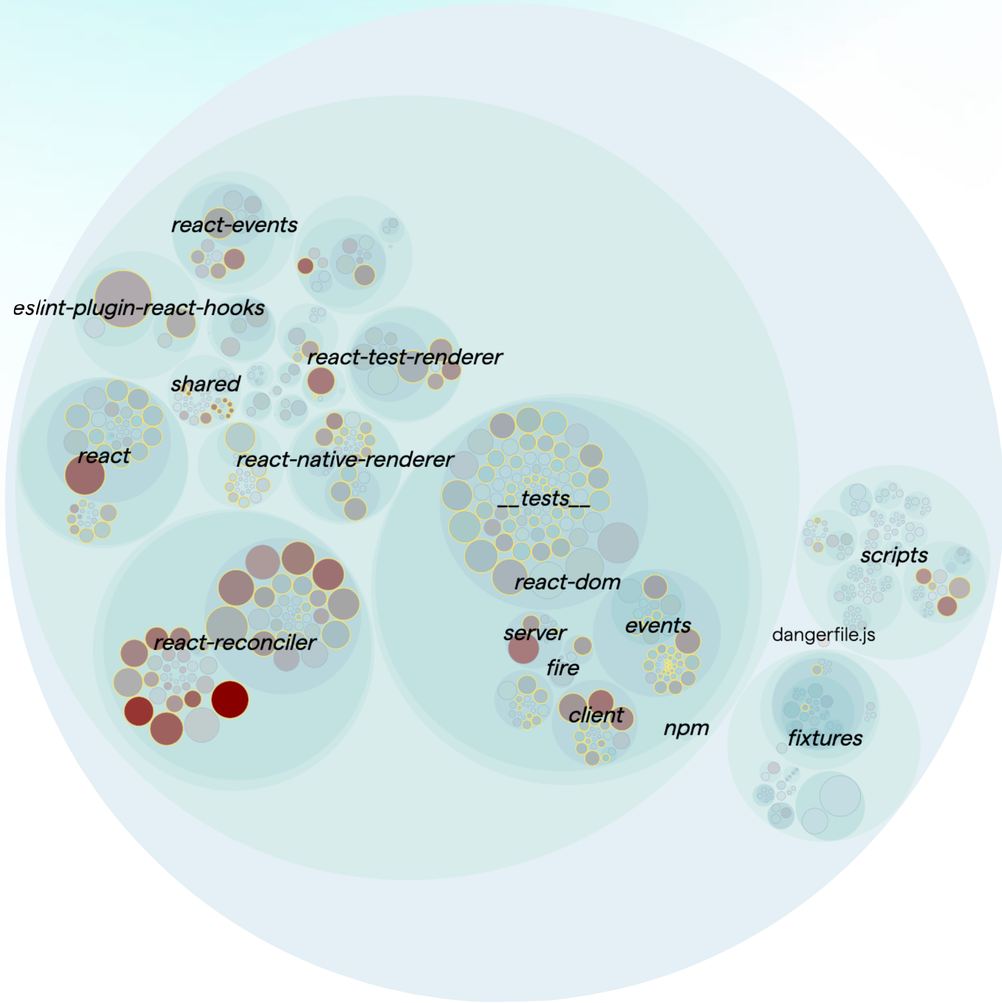

Source code
let inst;
if (isClass) {
inst = new Component(element.props, publicContext, u
if (typeof Component.getDerivedStateFromProps === '
if (__DEV__) {
if (inst.state === null || inst.state === undefined) {
const componentName = getComponentName(Cor
if (!didWarnAboutUninitializedState[componentName
warningWithoutStack(
false,
'%s' uses 'getDerivedStateFromProps' but its initia
'%s. This is not recommended. Instead, define the
'assigning an object to 'this.state' in the construc
'This ensures that 'getDrivedStateFromProps' arg
componentName,
);
didWarnAboutUninitializedState[componentName
}
}
}
let partialState = Component.getDerivedStateFrom
null,
element.props,
inst.state,
);
if (__DEV__) {
if (partialState === undefined) {
const ComponentName = getComponentName(C
Parser
Examples on unhealthy code
Module level issues:
Low Cohesion: many responsibilities
Brain Class: low cohesion + large class + at least one Brain Method
Lack of Modularity: too many business aspects
Function level issues:
Brain Methods: complex functions which centralize the behavior of the module
Copy-pasted logic: missing abstractions, DRY violations
Copy-pasted logic: lack domain language
Implementation level issues:
Deeply Nested Logic: if-statements inside if-statements
Primitive Obsession: missing a domain language
Complex Conditional: hard to understand
Score, aggregate and categorize
Code Health categories
Healthy code with low risk
Increased maintenance efforts
Unhealthy code with significant issues and risks

Important code



Code Health - Relevance





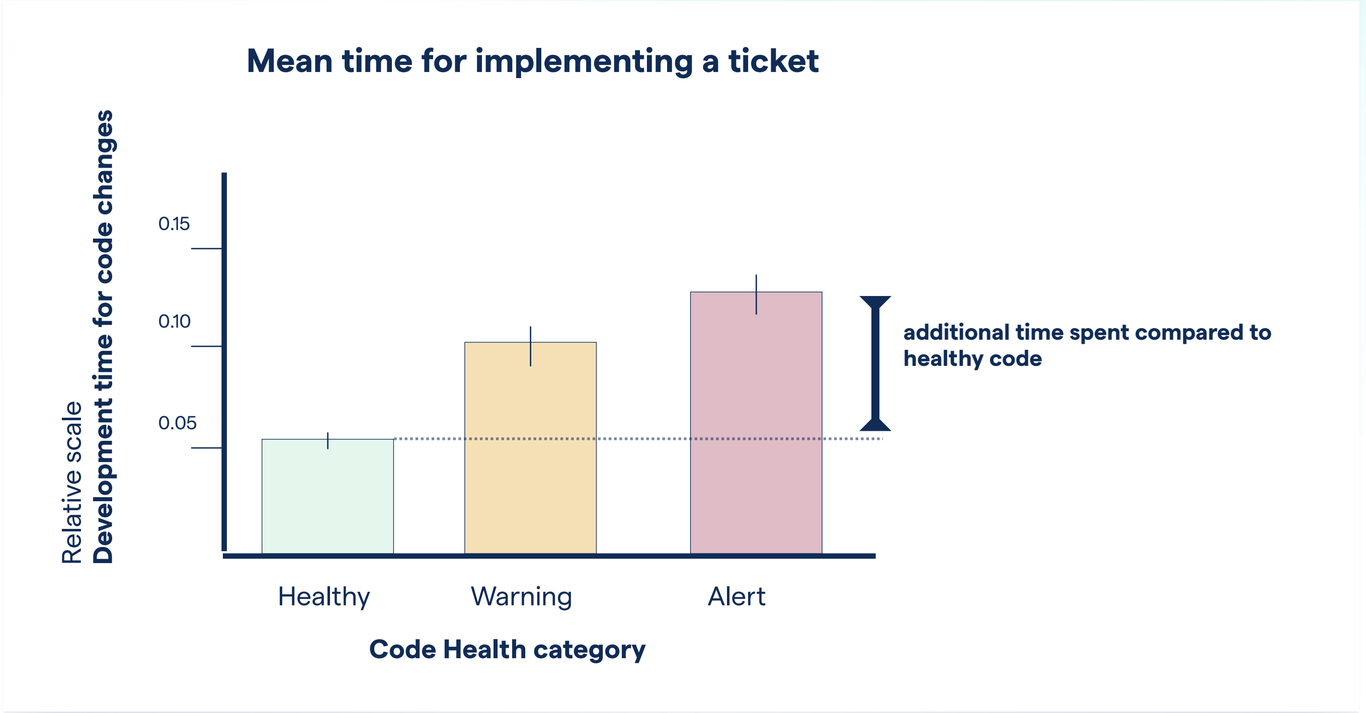
Healthy Problematic Unhealthy ...

Low development activity Hotspot

Why all of these matter after all? - Code Red

- Quantitative study of code quality impact
- Many different industry segments
- 39 commercial codebases
- 40k+ software modules
- 14 programming languages

Why all of these matter after all? - Code Red



Tornhill, A. & Borg, M. (2022) Code Red: The Business Impact of Code Quality
https://arxiv.org/abs/2203.04374

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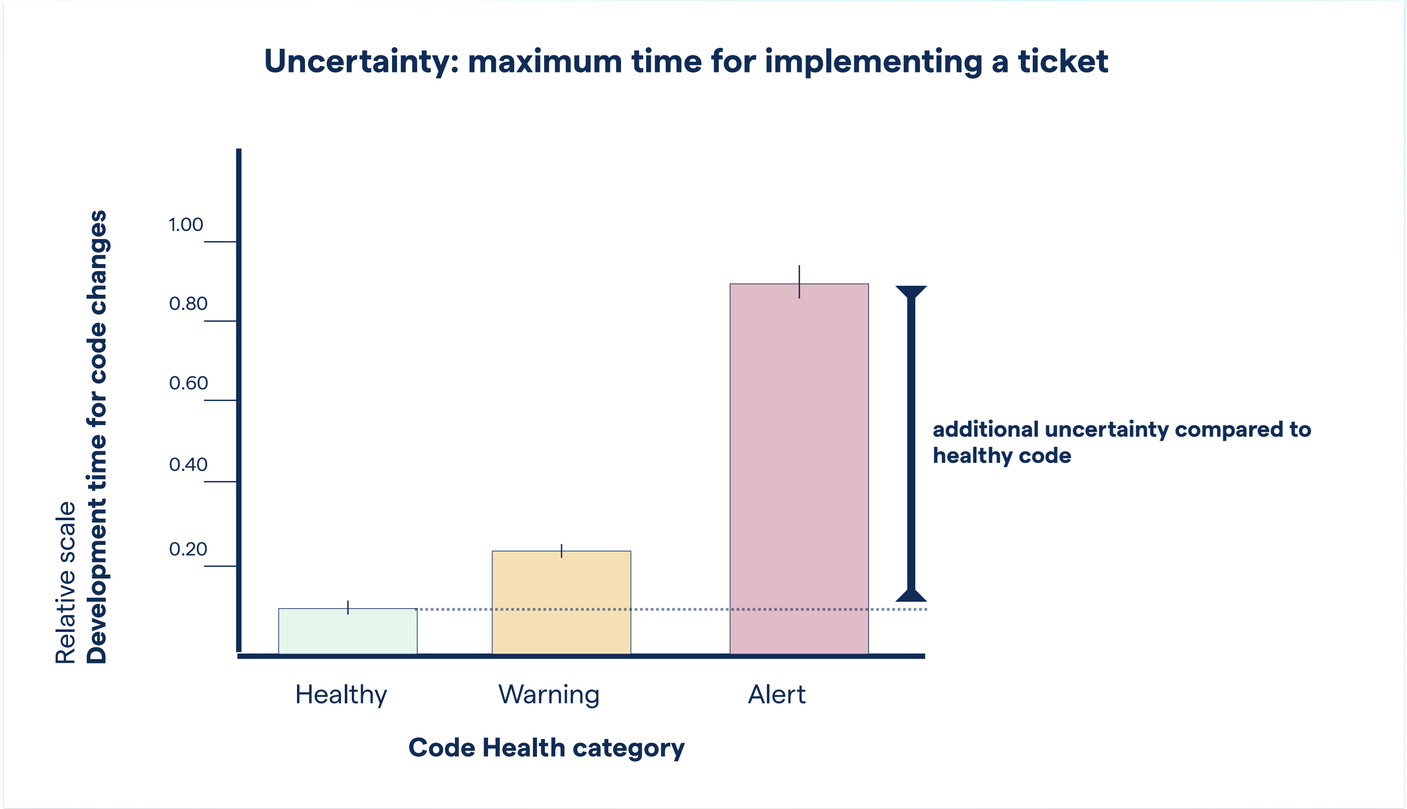

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Better code quality leads to faster development

Hybrid coding

The new era

Few years back, I started a new hobby...

ranjs

Requires statistically sound tests

Mathematically complex functions

The new era

Few years back, I started a new hobby...

build passing | coverage 98% | npm v1.24.5 | docs | license MIT | code style standard | code health 9.45

ranjs

Requires statistically sound tests

Mathematically complex functions

AI assisted coding

The Impact of AI on Developer Productivity: Evidence from GitHub Copilot

Sida Peng,[1*] Eirini Kalliamvakou,[2] Peter Cihon,[2] Mert Demirer[3]

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[2]GitHub Inc., 88 Colin P Kelly Jr St, San Francisco, USA
[3]MIT Sloan School of Management, 100 Main Street Cambridge, USA

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Abstract

Generative AI tools hold promise to increase human productivity. This paper presents results from a controlled experiment with GitHub Copilot, an AI pair programmer. Recruited software developers were asked to implement an HTTP server in JavaScript as quickly as possible. The treatment group, with access to the AI pair programmer, completed the task 55.8% faster than the control group. Observed heterogenous effects show promise for AI pair programmers to help people transition into software development careers.

"Productivity benefits may vary across specific tasks and programming languages, so **more research is needed to understand how our results generalizes** to other tasks."

https://arxiv.org/pdf/2302.06590.pdf

AI assisted coding

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"Our results suggest that **less experienced programmers benefit more** from Copilot."

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"Our results suggest that **less experienced programmers benefit more** from Copilot."

"Finally, this study does not examine the **effects of AI on code quality**."

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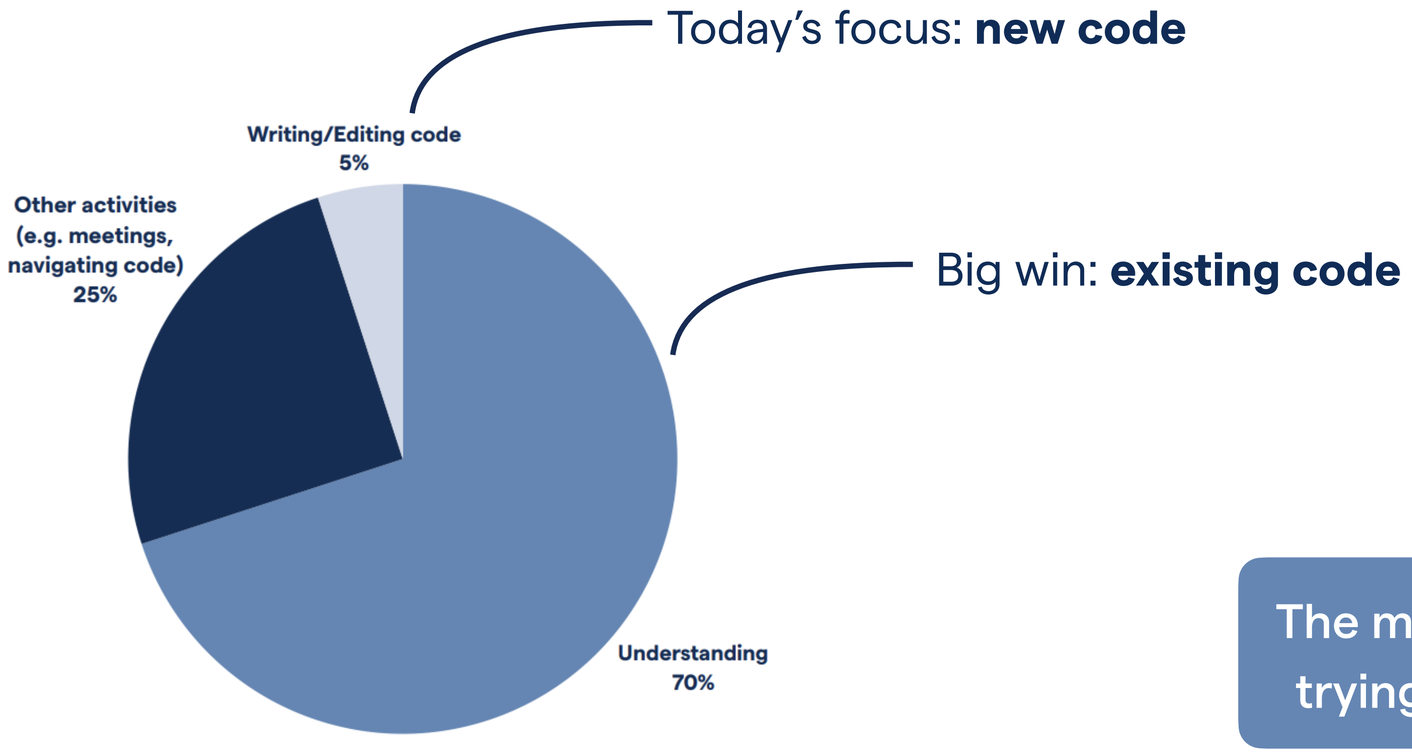
The bigger picture of time spent



55% faster on this part means ~1 hour saved per work week

The majority of a developer's time is spent trying to understand the existing system

Minelli et al., 2015

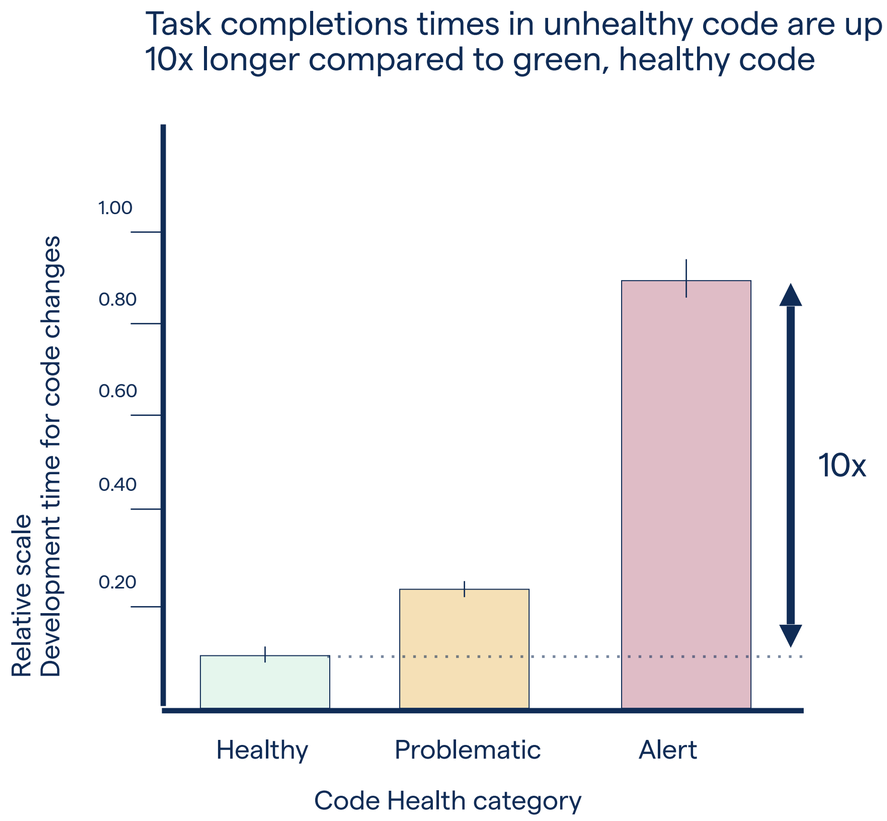
Are we outsourcing the fun and adding to the mundane?

> “We’ve all turned ourselves into maintenance programmers; we took the fun bit and we’re just going to give ourselves code that somebody else wrote.”

Kevlin Henney, 2024

The bigger picture

Yes, it’s possible to bring that +55% to 10X



AI accelerates the creation of new code — code quality is more important than ever!

Yellow & Red Code comes with a significant on-boarding cost:

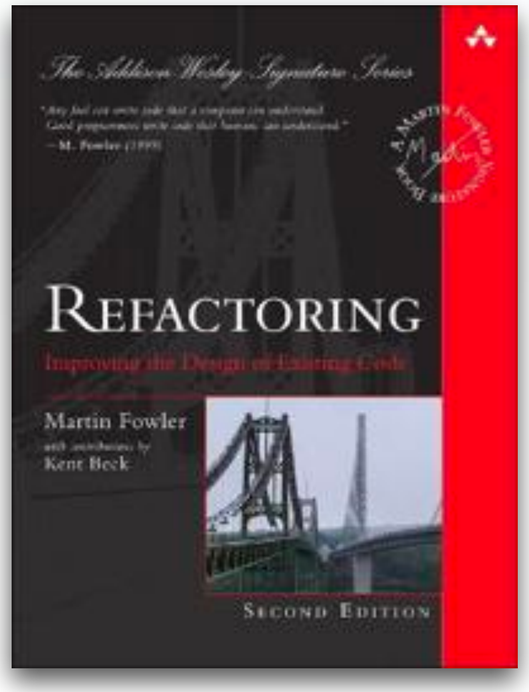
as a newcomer, you need

- **45% more time** for small tasks, and
- **93% more time** for large tasks compared to Green Code.

Tornhill, A. & Borg, M. (2022) Code Red: The Business Impact of Code Quality https://arxiv.org/abs/2203.04374

Borg, M., Tornhill, A., & Mones, E. (2023). U Owns the Code That Changes and How Marginal Owners Resolve Issues Slower in Low-Quality Source Code: https://arxiv.org/pdf/2304.11636.pdf

Refactoring and refuctoring

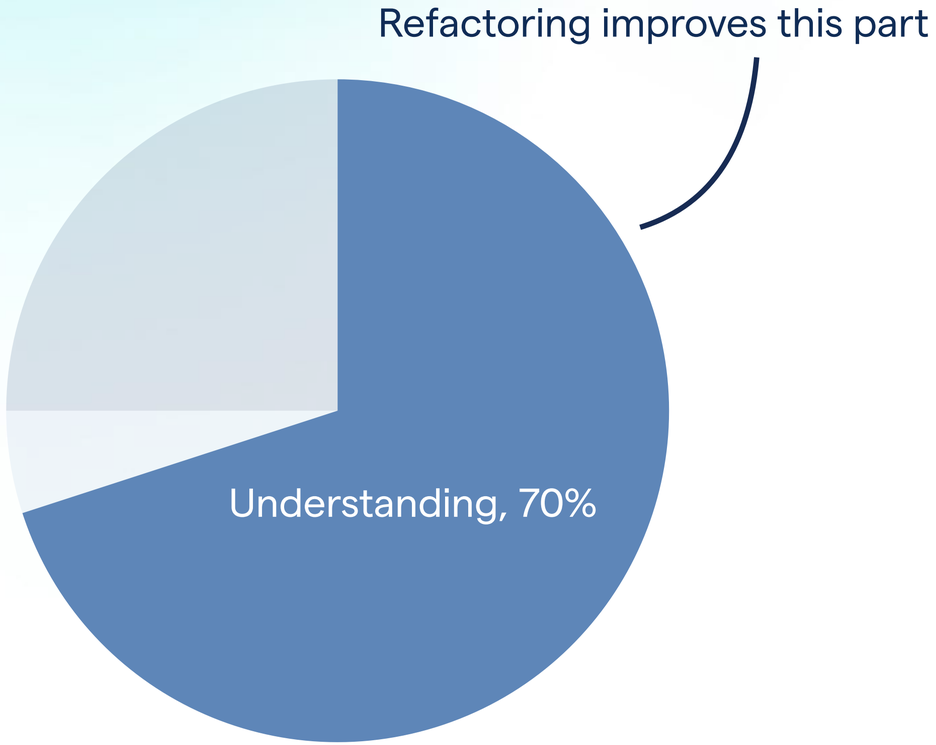


Refactoring is defined as **improving the design of existing code without changing its behavior**.

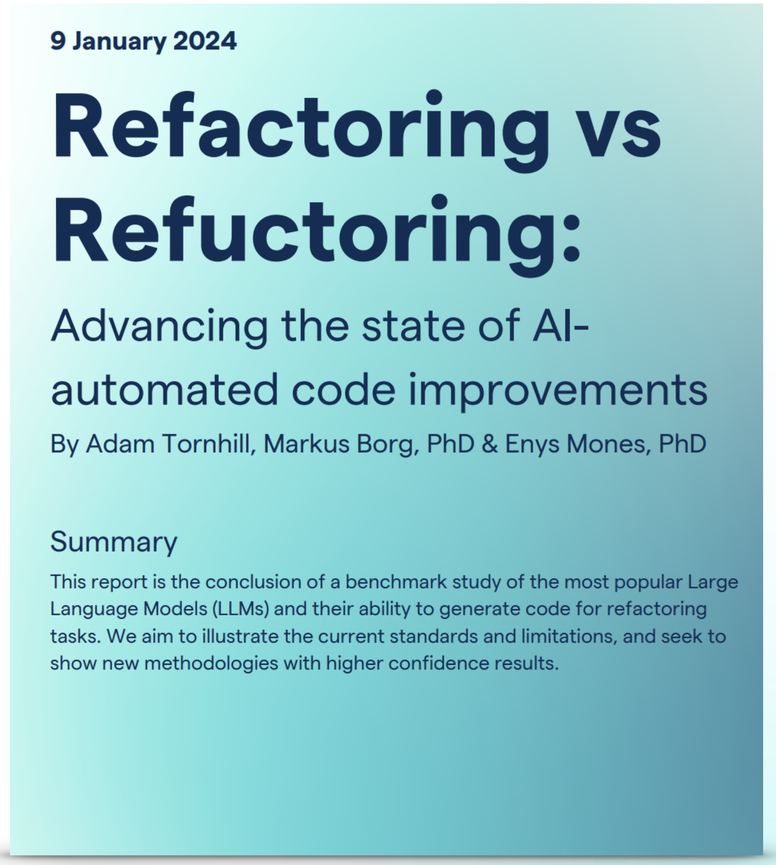
✓ It's not a refactoring unless we improve the design.

✓ It's not a refactoring if we fail to preserve the behavior of the original code, e.g. we introduce a bug.

⚠️ **Refuctoring**: the process of changing existing code while – involuntarily – altering the program's behavior



[Research:] **Let's use AI to automate refactoring**



100k+ refactorings generated with AI

Open source Javascript and Typescript

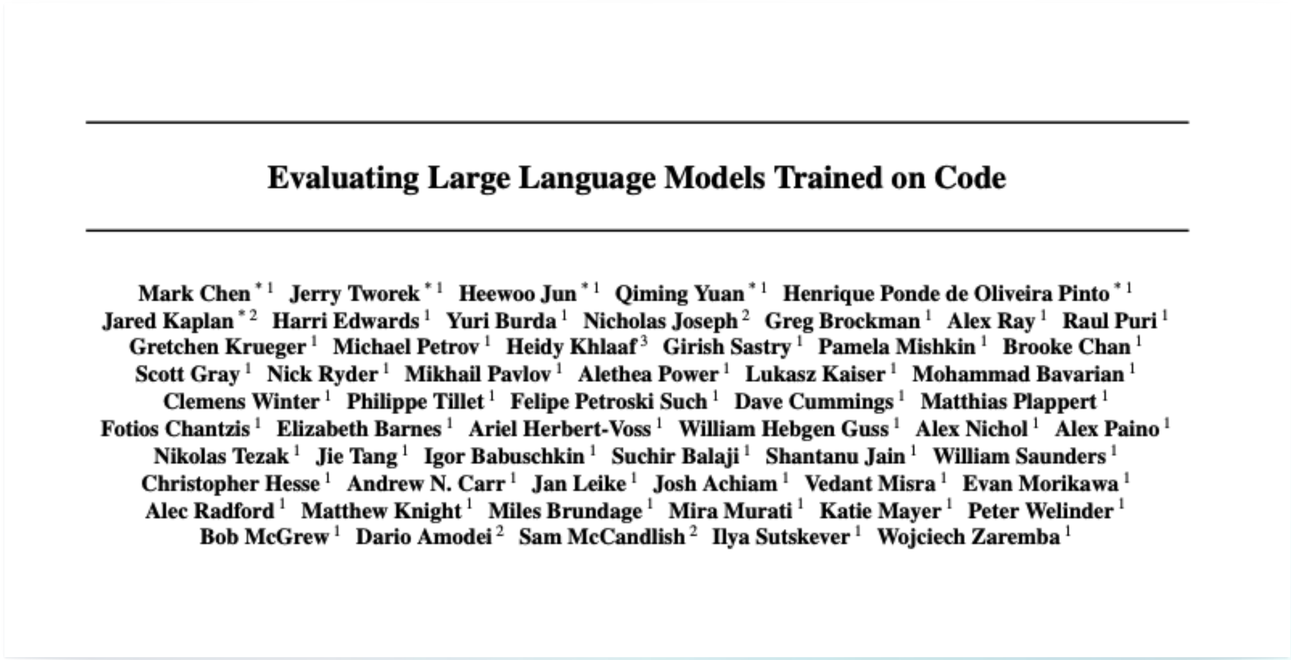
Benchmarking criteria: Code Health as the gold standard for code improvements

1 https://codescene.io/docs/guides/technical/code-health.html

[Research:] Can AI help us improve existing code?

AI model	Valid code? (check the syntax of the refactored code)	Code Health improved? (did the code change by the AI mitigate the code smell?)	Valid refactoring? (do the tests still pass after the AI changed the code?)
PaLM 2 code [Google]	**99.93%**	**68.75%**	**32.29%**
GPT 3.5 [OpenAI]	**100%**	**69.89%**	**30.26%**
PaLM 2 text [Google]	**100%**	**66.54%**	**34.73%**
phind-codellama-34b-v2 [Meta, Phind]	**100%**	**78.76%**	**18.14%**

The average code quality



Evaluating Large Language Models Trained on Code

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Bob McGrew [1] Dario Amodei [2] Sam McCandlish [2] Ilya Sutskever [1] Wojciech Zaremba [1]

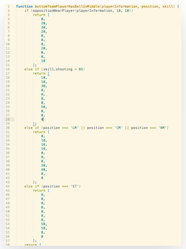
"We believe this is unlikely to be a large factor here, as **the GitHub dataset contains plenty of poor-quality code**.

The bugs are designed to be of the sort we'd expect to appear commonly in the dataset; code that compiles and often runs without errors but gives an incorrect answer."

[Innovation:] **Fact-checking the AI refactorings**

Developer

writes code



a minimal snippet of source code

Input: Request a refactoring.

Simpler code =>
better developer experience

```
function bottomTeamPlayerHasBallInMiddle(playerInformatio
    if (oppositionNearPlayer(playerInformation))
        return calculateScoresWhenOppositionNear();
    else if (highShootingSkill(skill))
        return calculateScoresWhenHighShootingSkill();
    else if (isMidfielder(position))
        return calculateScoresForMidfielder();
    else if (isStriker(position))
        return calculateScoresForStriker();

    return getDefaultScores();
}
```

the refactored code + our recommendations

Output: Propose a better way to write the code. Inspect and apply.

CodeScene ACE: auto-refactor code

Contextual AI model selection

Analyze the code, and select the best AI service for the job — the AI services have different strengths.

Fact-check the AI results

Validate the rewritten code to ensure the AI didn't break your code.

source code + contextual information + RAG AI

rewritten source code

GenAI Models

- OpenAI
- Google
- Anthropic
- Llama
- ...etc.

discard incorrect AI solutions

CodeScene

[Outcome:] Elevate AI to the level of human experts with a fact-checking model

	Complex Conditional	Deep, Nested Complexity	Bumpy Road	Complex Method
Raw GPT-3.5	**33.7%**	**26.0%**	**26.3%**	**28.2%**
GPT-3.5 with fact-checking	**96.7%**	**98.4%**	**97.8%**	**98.9%**

CodeScene ACE combines the results of multiple AIs and reject the incorrect solutions, **98%** of the remaining AI-generated refactorings improve the code without breaking it.

With fact-checking, we can elevate generative AI to achieve 10X

Demo

CodeScene

How do we refactor critical code with AI and witness immediate improvement in code quality and code health?

Q&A

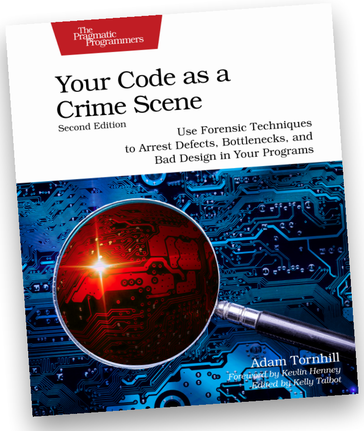
References

Code Red: The business impact of code quality

- https://codescene.com/hubfs/web_docs/Business-impact-of-low-code-quality.pdf

Refactoring vs Refuctoring: Advancing the state of AI automated code improvements

- https://codescene.com/hubfs/whitepapers/Refactoring-vs-Refuctoring-Advancing-the-state-of-AI-automated-code-improvements.pdf



Your Code as a Crime Scene, 2nd ed (2023)

https://twitter.com/AdamTornhill

[Free] Try the automated refactoring via CodeScene