Languages (+ end of code review)

Martin Kellogg

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> “In general it is the **developer’s responsibility** to fix a CL, not the reviewer’s”

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> “Explanations written only in the code review tool are not helpful to **future code readers**”

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Usually authors treat comments without a severity level as **must fix**

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  - **FYI**: I don't expect you to do this in this CL, but you may find this interesting to think about for the future.

Common mistakes to avoid as a reviewer

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If you get **pushback** on a suggestion, take the time to understand why

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Try to get back to the author within "**one business day**", whatever that means for your team

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Common mistake: "LGTM" everything for the sake of speed

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I've had reviewers ask for one thing, which I do, and then ask for something completely different a week later. **Read your previous review!**

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Doesn't usually happen! If the problem is serious, insist on fixing it now!

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- Respond to **every comment**

Making a code change counts as a response! Don’t write “fixed” or similar on every comment.

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- If you fix something in one place, **fix it everywhere**

As a reviewer, it is very tedious to point out every place that an author has made the same mistake.

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- Address comments **by changing the code**, not by explaining in the review tool

Empirical guidelines for code review

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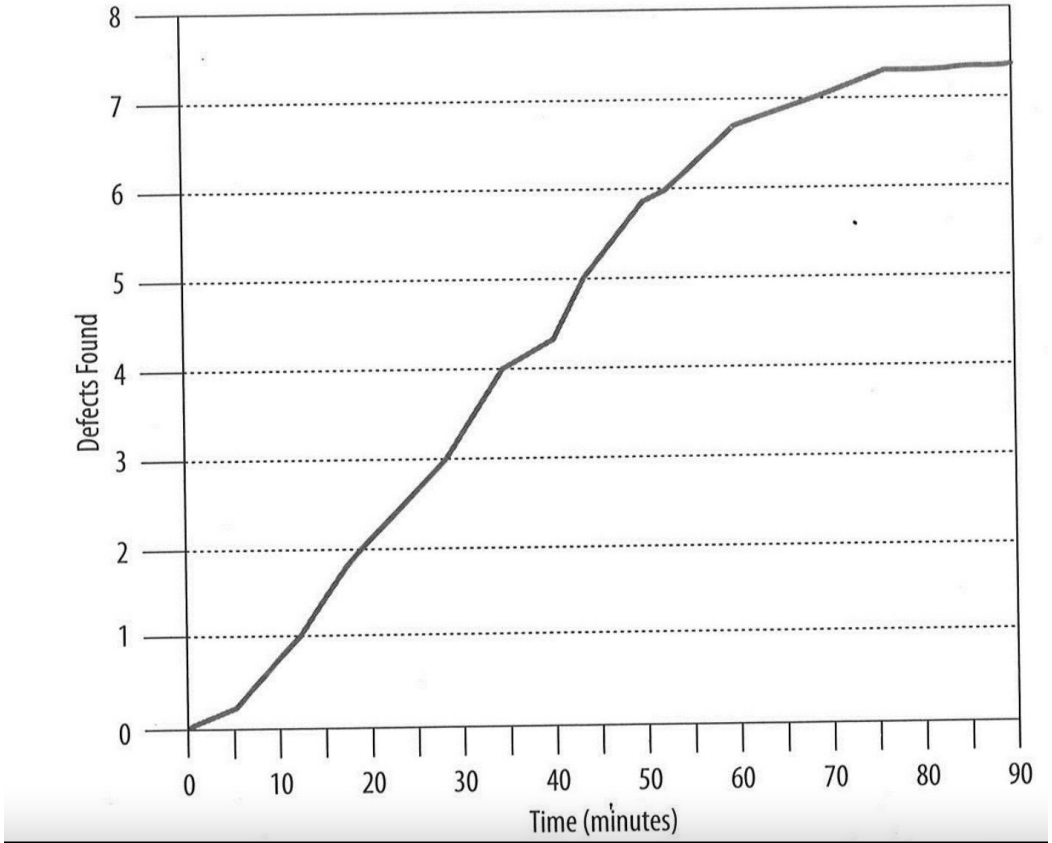
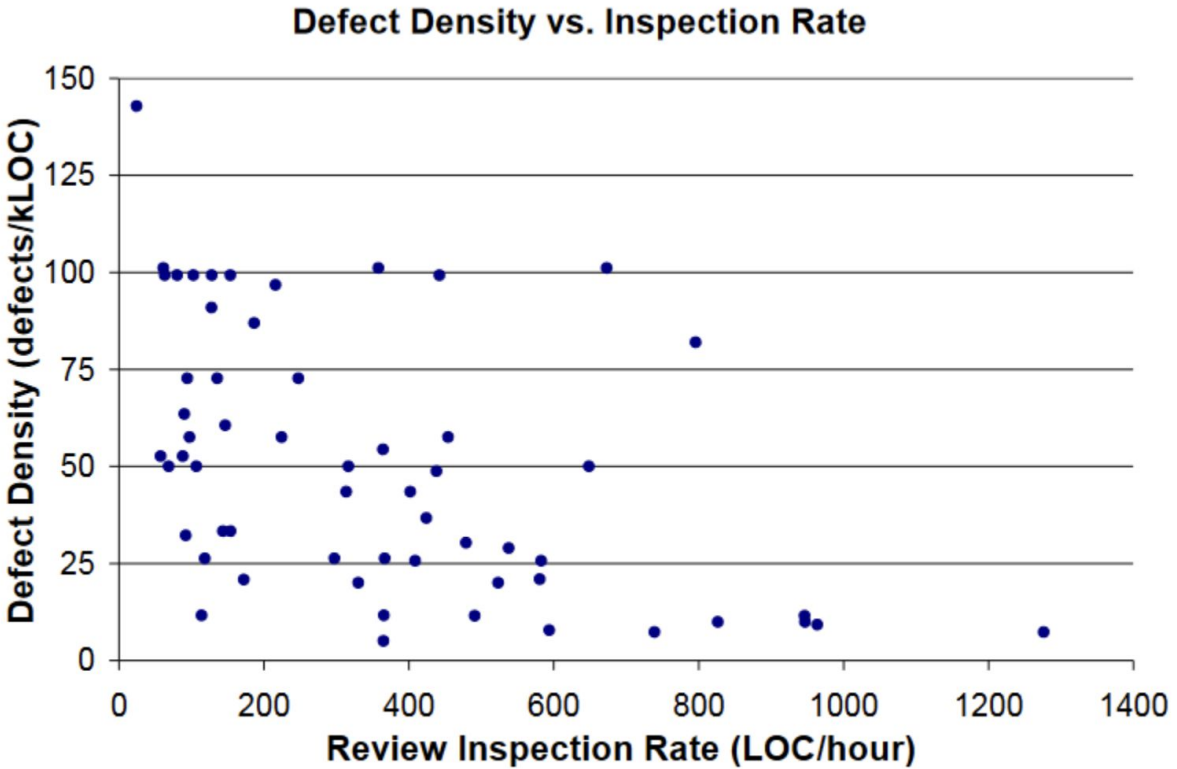
- **Recommendation**: Do not exceed 60 minute session
- **Reason**: focus fatigue



Empirical guidelines for code review

- **Recommendation**: Don’t review more than 400 LoC per hour
- **Reason**: at faster paces, reviews get too shallow



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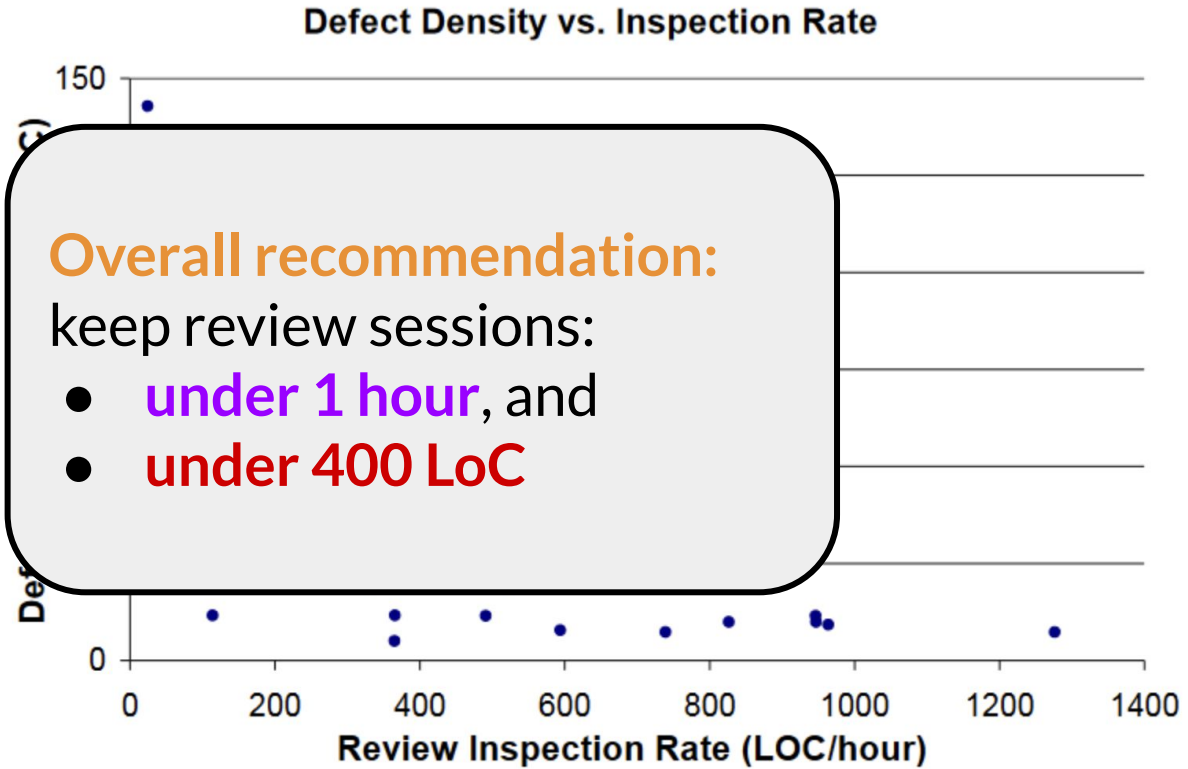

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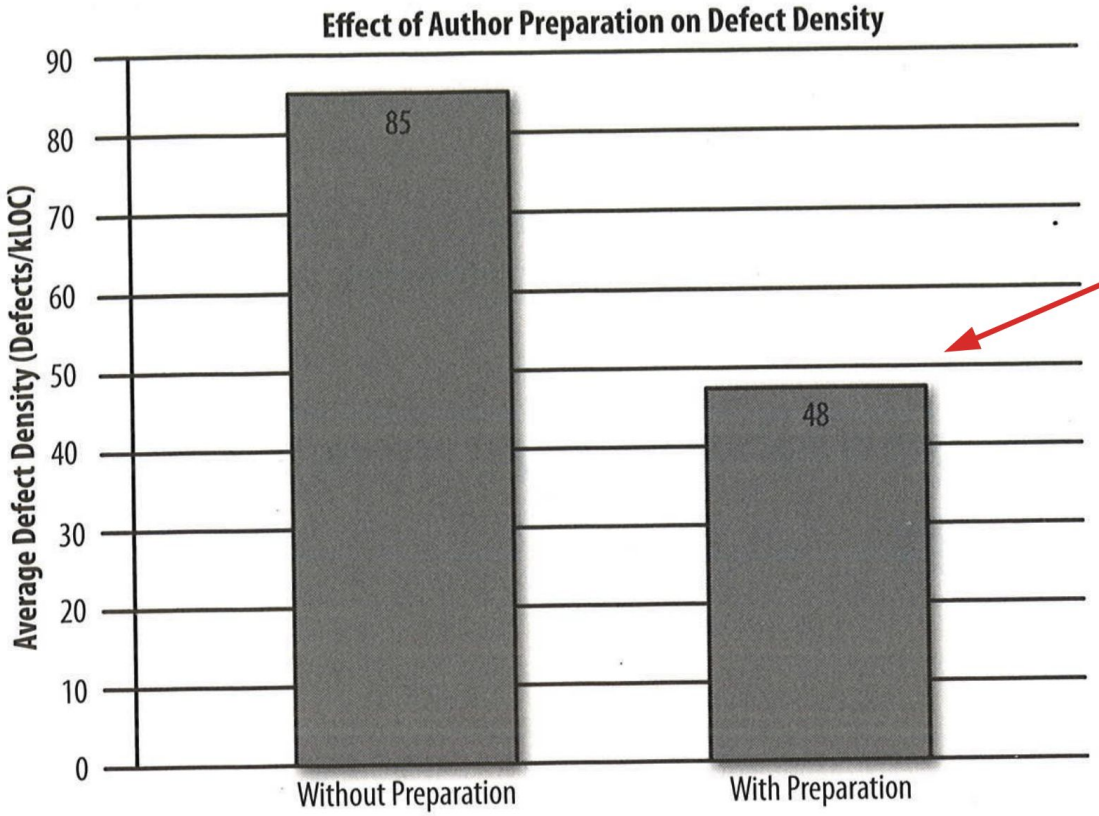

Important to review your own code before giving it to others

Code Review

Today's agenda:

- Finish slides on interviewing
- Reading Quiz
- What is code review (and why we do it)
- How to do a code review (with empirical evidence)
- **Good and bad examples of code review comments**

Example comment: good or bad?

[Many of the examples in the following slides borrowed from Sandya Sankarram's "Unlearning toxic behaviors in a code review culture"]

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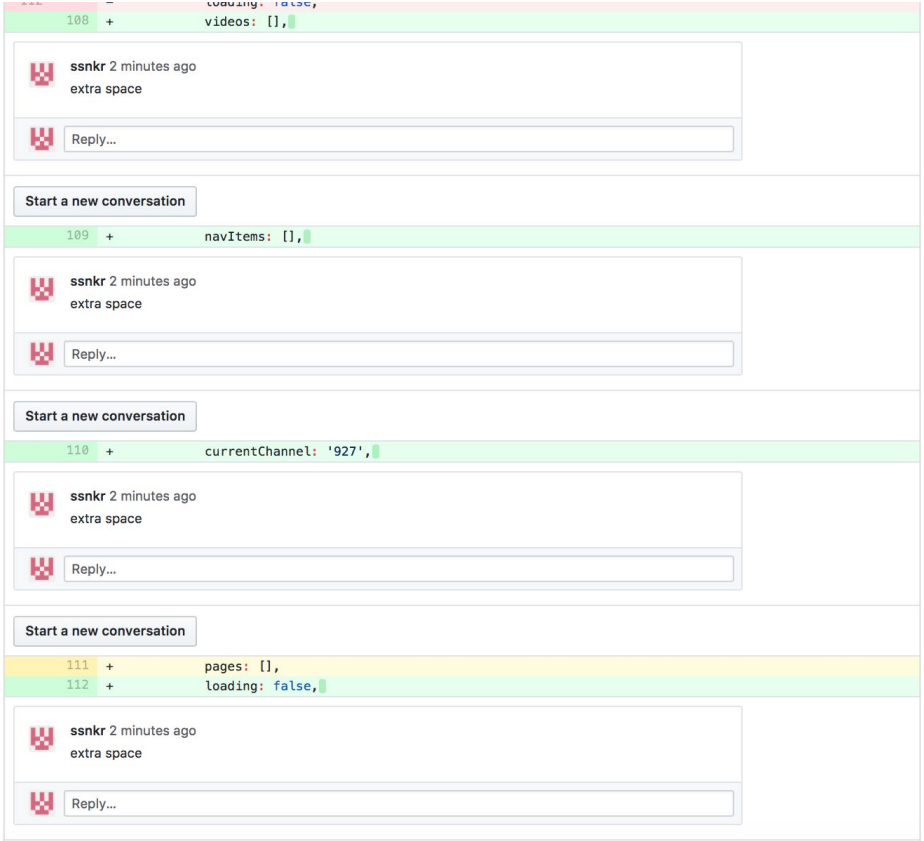

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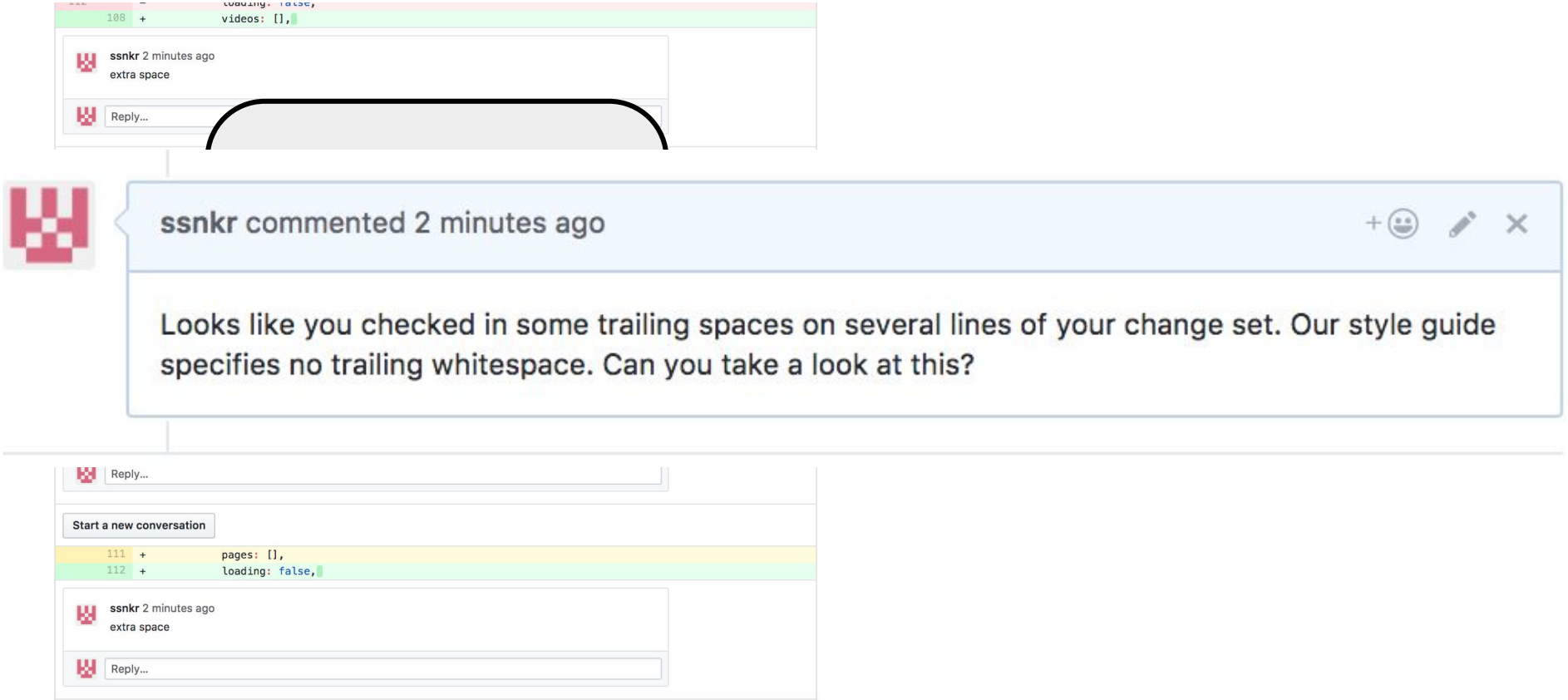

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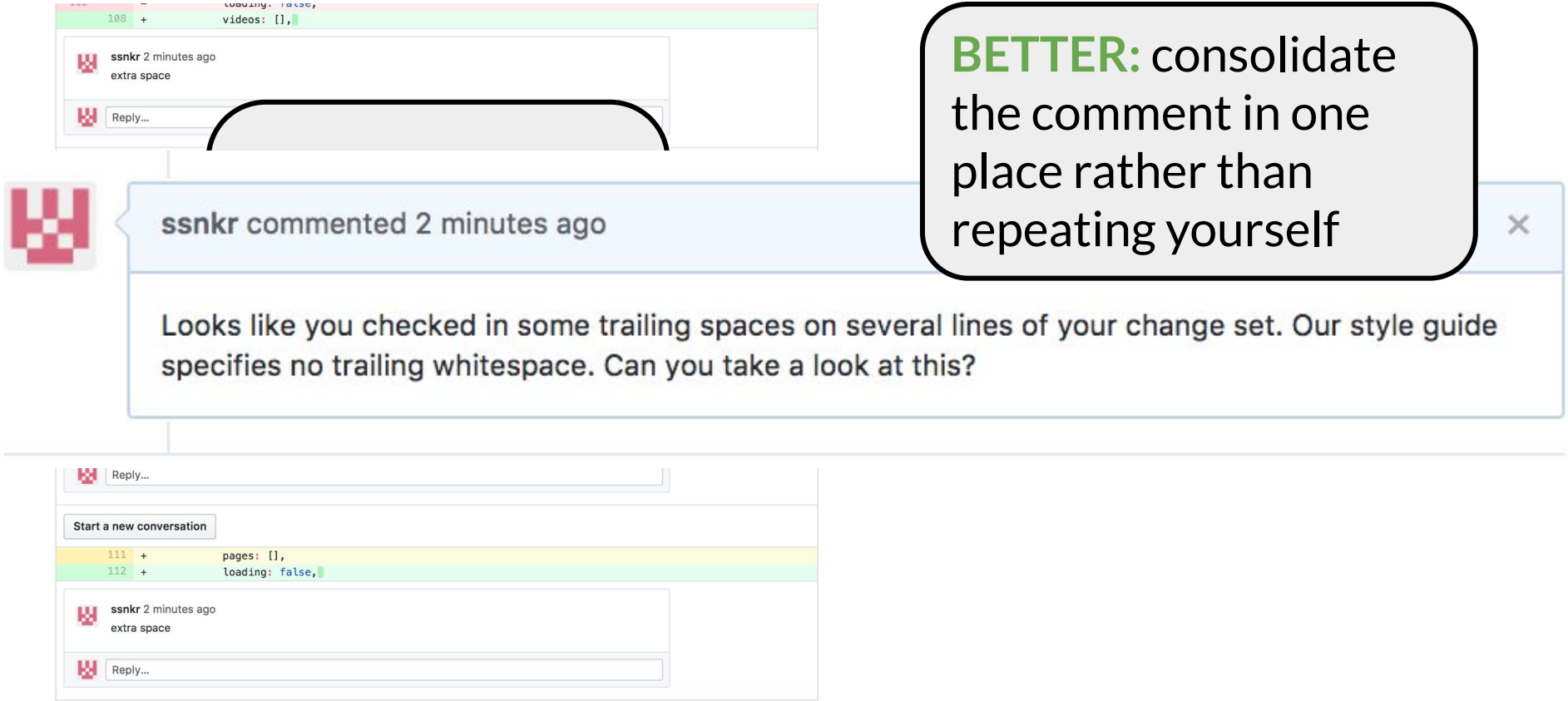

BETTER: consolidate the comment in one place rather than repeating yourself

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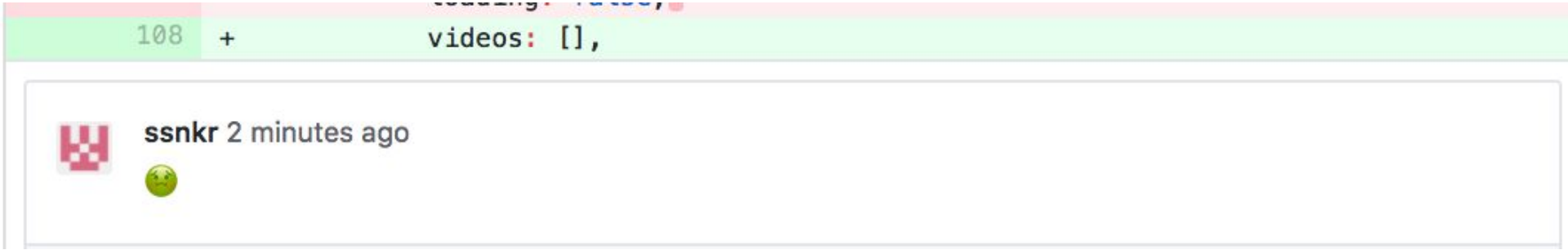

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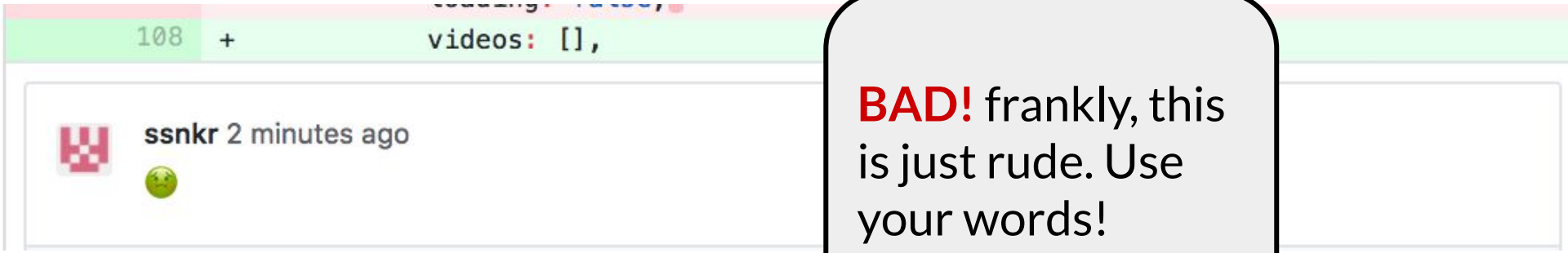

BAD! frankly, this is just rude. Use your words!

Example comment: good or bad?

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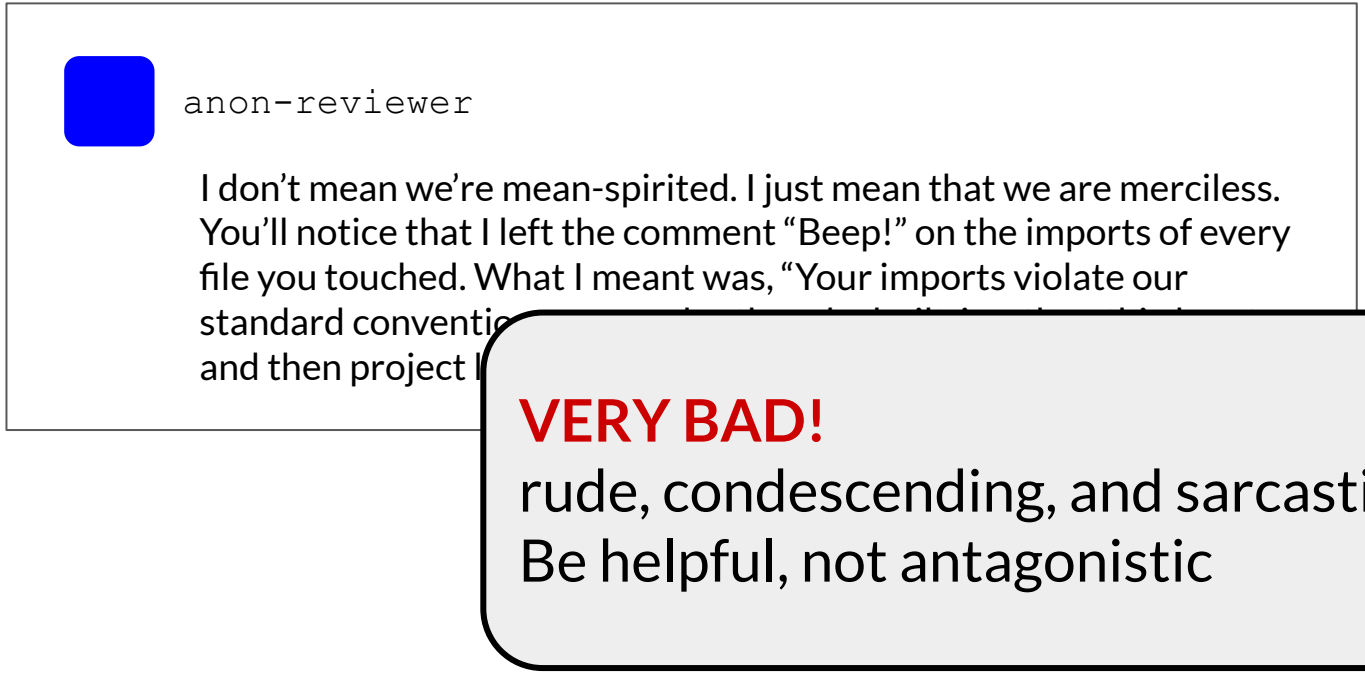
OK: emojis and similar “casual” language should only be used to praise, never to criticize

Example comment: good or bad?

anon-reviewer

I don’t mean we’re mean-spirited. I just mean that we are merciless. You’ll notice that I left the comment “Beep!” on the imports of every file you touched. What I meant was, “Your imports violate our standard convention — we order them by built-ins, then third party, and then project level,” but that was too much to type on every file.

Example comment: good or bad?

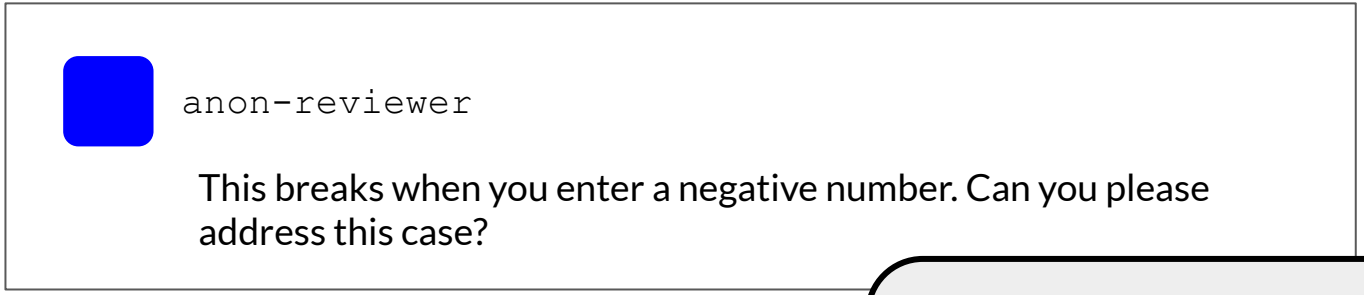


Example comment: good or bad?

`anon-reviewer`

This breaks when you enter a negative number. Can you please address this case?

Example comment: good or bad?



GOOD: straight to the point, politely points out a technical problem

Takeaways: code review

- Code review is one of the best ways to prevent defects
  - You must do it during the course project (I will check!)
- Be nice as both an author and a reviewer
  - Respect each other and each other's time
- One thing I'll look for when assessing your group project is the quality of your code reviews
  - If you're unsure, you can ask the course staff to review your reviews (in office hours)

Reading Quiz: Languages

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Q1: What was the source of the latency spikes in the original Go implementation of the Read States service?

A. Go's default hash table had too many collisions
B. Go is an interpreted language
C. Go arrays require expensive copy operations if they get too big
D. Go's garbage collector runs every 2 minutes

Q2: **TRUE** or **FALSE:** Even with just basic optimization, the Rust version of the Read States service outperformed the hyper hand-tuned Go version.

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Advice before we go further: when you inherit a code base, **don't try to rewrite** it right away in a "better" language: it's usually not worth it

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- programming paradigm
- whether they have a type system
  - and, if they do, what kind of type system they have
- library support
  - the standard library is especially important
- performance
- team/process factors
  - how well do you know the language
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- common, important paradigms we'll discuss today:
  - imperative
  - functional
  - object-oriented

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Imperative programming: examples

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Languages with imperative programming (non-exhaustive list):

- FORTRAN
- C
- C++
- Python
- Java
- JavaScript/TypeScript
- many, many others!

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Consider the following C program:

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semicolons separate commands, program is a list of commands

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destructive updates of memory cells

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- functional programming **models math** well
  - it is easier to formally reason about functional programs

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Let’s look at how imperative and functional languages **manage state** in a bit more detail

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- **Functional** programs yield **new similar states** over time.
  - `let x = y in …` , however, only changes `x`'s value **within** the scope of the …

Example: functional vs. imperative

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NOT the same as a semi-colon: commands vs expressions

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even the operators are type-safe (in OCaml)

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commands still exist, but limited to inherently "imperative" operations (I/O, saving to disk, etc.)

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no "return" statement, because everything is an expression

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let avg (x:int) (y:int) : float = begin
  let z = float_of_int (x + y) in
  let z = z /. 2.0 in
  printf "Answer: %g\n" z ;
  z
end
```

Examples of functional languages

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- OCaml/SML
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- Python
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- Closure
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15.27. Lambda Expressions

Here are some examples of lambda expressions:

```
() -> {}                  // No parameters; result is void
() -> 42                  // No parameters, expression body
() -> null                // No parameters, expression body
() -> { return 42; }      // No parameters, block body with return
() -> { System.gc(); }    // No parameters, void block body
```

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  - Procedures are functions (simplifies reasoning)
  - Formulate and prove assertions about code more easily
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- “No” side-effects
  - Fewer errors

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C (gcc)	1.0	1.1
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- Not appropriate for every program
  - Some programs are inherently stateful

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- **extraordinarily common**
- models **the real world** well
  - objects are good abstractions for real-world entities and concepts

Object-oriented programming gotchas

- classes vs prototypes

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Which of the two does Java use? What about JavaScript?

Object-oriented programming languages

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- Smalltalk
- Java
- C++
- C#
- Python
- JavaScript/TypeScript
- Swift
- R
- etc.

How can programming languages differ?

- programming paradigm
- **whether they have a type system**
  - and, if they do, what kind of type system they have
- library support
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- goal of a type system: **prevent errors** at run time due to unexpected values
- **type theory** is the discipline of math (yes!) that studies the formal properties of type systems
- most programming languages include some kind of type system
  - exceptions: assembly, Lisp, a few others

Kinds of type systems

- Static vs dynamic checking

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  - ***statically typed*** languages have their types checked before the program runs, typically **at compile time**

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- **Insight**: typechecking is just another program analysis

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  - Benefits of static typing:
    - early detection of errors, types are documentation
  - Benefits of dynamic typing:
    - faster prototyping, no false positives

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  - e.g., Kotlin **guarantees no null-pointer dereferences**, but Java doesn’t (both compile to Java bytecode)
  - stronger types can be added to a language (**ask me more**)
    - “pluggable types”

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Remember: **Don't Repeat Yourself**
If someone else has already built what you need, don't build it again

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- Tied to **language popularity**: languages that are more popular have better libraries, so people are more likely to use them
  - positive feedback loop!
- Common situation: you need library A and library B, but A is written in language L and B is written in language M
  - What to do?

Multi-language projects

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Multi-language projects are common!
Developer quote: ““My last 4 jobs have been apps that called: Java from C#, and C# from F#; Java from Ruby; Python from Tcl, C++ from Python, and C from Tcl; Java from Python, and Java from Scheme (And that's not even counting SQL, JS, OQL, etc.)””

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For example, concurrency might be better handled in F#/OCaml (immutable functional) or Ruby (designed to hide such details), while low-level OS or hardware access is much easier in C or C++, while rapid prototyping is much easier in Python or Lua, etc.

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C/C++ is a lingua franca

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- Examples:
  - .NET framework (Microsoft)
    - C++, C#, J#, F#, Visual Basic, etc.
  - Java bytecode + Java virtual machine
    - Java, Scala, Kotlin, Closure, etc.
  - LLVM bytecode
  - etc.

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- Most **tools are language specific**: testing frameworks (+ generation, coverage, etc.), static analysis, build systems, debuggers, etc.

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- Different languages choose different trade-offs. Examples:
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  - Python: easy to write, okay safety, slow
  - C: good performance, easy-ish to write, very unsafe

What impacts performance

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- Also relevant: **optimizations**
  - **interpreted** languages almost always slower: no optimizing compiler
  - JITs (***just-in-time compilers***) can produce surprisingly fast code
    - e.g., Java Virtual Machine

Trade-off: safety features

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  - bottom line: statically safe languages **can be faster**, but are **generally harder to program in**

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- performance
- **team/process factors**
  - how well do you know the language
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Implication: if you're going to need an expert, make sure you have one! This often seriously limits your choice of languages in practice :(

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- Implication: if all else is equal, **choose the more popular** language

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  - why?

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  - integration problems
  - will the benefits be worth it?

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Implication: rewriting is a good idea if you're confident that the benefits of the new language are worthwhile, but be cautious: it can expensive!

Takeaways

- there is a wider world of languages than just imperative and object-oriented (but those are the most popular)
  - learning to write functional code can make you a better programmer
- different programming languages have different trade-offs
  - performance vs safety vs ease of use vs …
- when starting a new project, think carefully about the requirements before choosing a language
- rewrite a project in a new language only after careful consideration