# Code Style

Yegor Bugayenko

Lecture #22 out of 24
80 minutes

The slidedeck was presented by the author in this YouTube Video

1. The aesthetics of code is a highly subjective matter…or is it?

# Which One Looks Better for You?

C:

```c
int f(int n)
{
  if (n == 1 || n < 2)
    return 1;
  int r = f (n-1);
  int r2 = f(n - 2);
  return r +r2;
  }
```

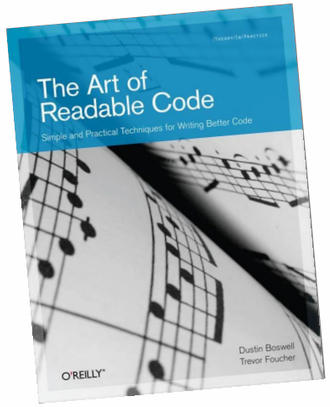
Java:

```java
int fibonacci(int n) {
  if (n <= 2) {
    return 1;
  }
  return fibonacci(n - 1)
    + fibonacci(n - 2);
}
```

Ruby:

```ruby
def fibonacci(int n)
  return 1 if n <= 2
  fibonacci(n - 1)
    + fibonacci(n - 2)
end
```

Hint: it's *not* only a matter of *taste*.




Dustin Boswell

"If one of these styles is chosen over the other, it doesn't substantially affect the readability of the codebase. But if these two styles are mixed throughout the code, it does affect the readability. Consistent style is more important than the 'right' style."

— Dustin Boswell and Trevor Foucher. The Art of Readable Code, 2011

Kristín Fjóla Tómasdóttir

"Every single interview participant mentioned that one of the reasons why they use a linter is to maintain code consistency."

— Kristín Fjóla Tómasdóttir, Mauricio Aniche, and Arie Van Deursen. The Adoption of JavaScript Linters in Practice: A Case Study on ESLint. *IEEE Transactions on Software Engineering*, 46(8):863–891, 2018. doi:10.1109/tse.2018.2871058

# Why do JavaScript developers use linters?

- Prevent Errors
- Augment Test Suites
- Avoid Ambiguous and Complex Code
- Maintain Code Consistency
- Faster Code Review
- Spare Developers' Feelings
- Save Discussion Time
- Learn About JavaScript

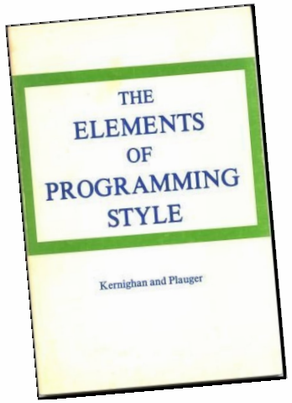
Source: Kristín Fjóla Tómasdóttir, Mauricio Aniche, and Arie Van Deursen. Why and How JavaScript Developers Use Linters. In *Proceedings of the 32nd International Conference on Automated Software Engineering (ASE)*, pages 578–589. IEEE, 2017. doi:10.1109/ase.2017.8115668

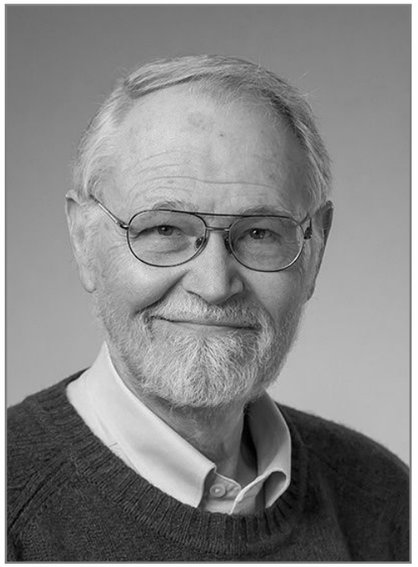
| Category | Description | Available rules |
|---|---|---|
| Possible Errors | Possible syntax or logic errors in JavaScript code | 31 |
| Best Practices | Better ways of doing things to avoid various problems | 69 |
| Strict Mode | Strict mode directives | 1 |
| Variables | Rules that relate to variable declarations | 12 |
| Node.js and CommonJS | For code running in Node.js, or in browsers with CommonJS | 10 |
| Stylistic Issues | Stylistic guidelines where rules can be subjective | 81 |
| ECMAScript 6 | Rules for new features of ES6 (ES2015) | 32 |
| **Total** | | **236** |

TABLE 1: ESLint rule categories with ordering and descriptions from the ESLint documentation [28]

Source: Kristín Fjóla Tómasdóttir, Mauricio Aniche, and Arie Van Deursen. The Adoption of JavaScript Linters in Practice: A Case Study on ESLint. *IEEE Transactions on Software Engineering*, 46(8):863–891, 2018. doi:10.1109/tse.2018.2871058

2. Which matters more: code clarity or efficiency?

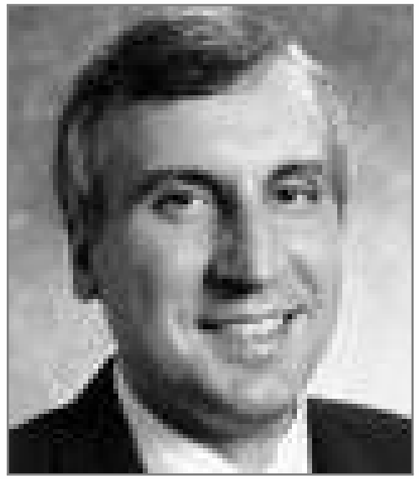


Brian Kernighan

“The harder it is for people to grasp the intent of any given section, the longer it will be before the program becomes operational. Trying to outsmart a compiler defeats much of the purpose of using one. Write clearly — don’t sacrifice clarity for ‘efficiency.’”

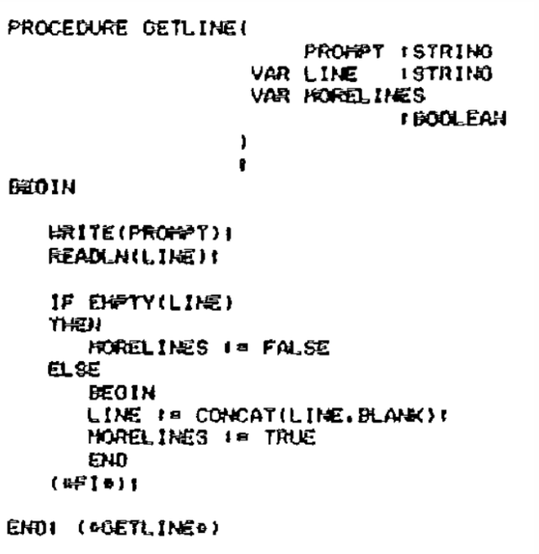
— Brian W. Kernighan and Phillip James Plauger. *The Elements of Programming Style.* McGraw-Hill, Inc, 1974. doi:10.5555/601121



David Marca

"The effective utilization of extra spaces, blank lines, or special characters can illuminate the logical structure of a program. So we should not be afraid to: indent, indent consistently (3 is a readable minimum), start each statement on a new line, put only one word on a line, use extra pages to visually collect code, put blank lines between code, align keywords, separate code from comments with white space."

— David Marca. Some Pascal Style Guidelines. *ACM SIGPLAN Notices*, 16(4): 70–80, 1981. doi:10.1145/988131.988140



```
PROCEDURE GETLINE(
                      PROMPT :STRING
                  VAR LINE   :STRING
                  VAR MORELINES
                             :BOOLEAN
                 )
                 ;
BEGIN

   WRITE(PROMPT);
   READLN(LINE);

   IF EMPTY(LINE)
   THEN
      MORELINES := FALSE
   ELSE
      BEGIN
      LINE := CONCAT(LINE,BLANK);
      MORELINES := TRUE
      END
   (*FI*);

END; (*GETLINE*)
```

"The best style enforcer is the computer … but only if we can easily cope with its ever-present restrictions."

Source: David Marca. Some Pascal Style Guidelines. *ACM SIGPLAN Notices*, 16(4):70–80, 1981. doi:10.1145/988131.988140

> 3. We can measure the quality of code formatting with a discrete metric, can't we?

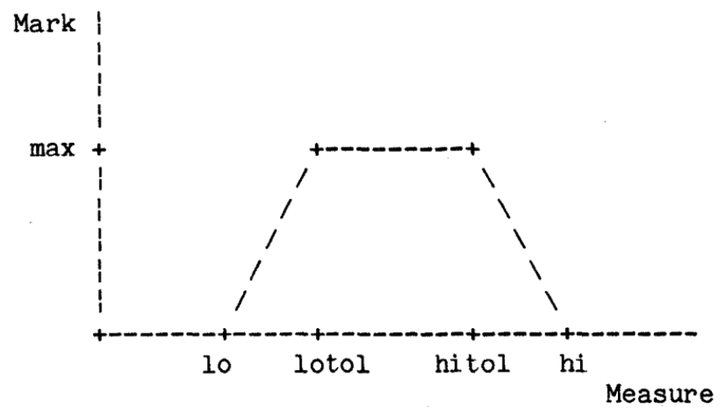
Michael J. Rees

"STYLE was designed to input the source of a syntactically correct Pascal program, make simple measurements on a one-pass line-by-line basis, and yield a style mark out of 100%."

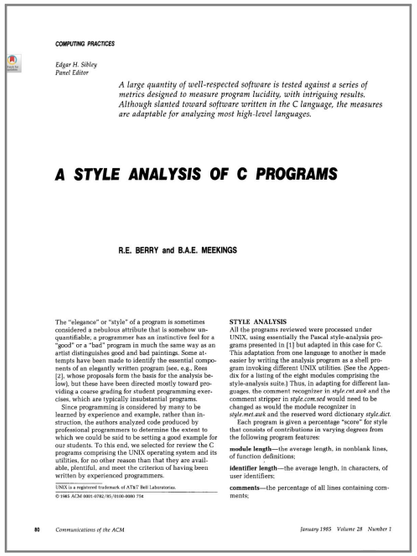
— Michael J. Rees. Automatic Assessment Aids for Pascal Programs. *ACM SIGPLAN Notices*, 17(10):33–42, 1982. doi:10.1145/948086.948088

# Rees Score, for Pascal

| Measure | max | lo | hi | lotol | hitol |
|---|---|---|---|---|---|
| chars/line | 15 | 12 | 30 | 15 | 25 |
| % comments | 10 | 15 | 35 | 20 | 25 |
| % indent | 12 | 60 | 90 | 70 | 80 |
| % blank lines | 5 | 8 | 20 | 10 | 15 |
| % spaces | 8 | 8 | 20 | 12 | 18 |
| proc/fn length | 20 | 10 | 50 | 20 | 35 |
| # res. words | 10 | 22 | 41 | 26 | 40 |
| id. length | 20 | 7 | 16 | 9 | 15 |
| # ids | 0 | 0 | 0 | 0 | 0 |
| --- | | | | | |
| labels & gotos | 20 | 1 | 200 | 3 | 199 |




Source: Michael J. Rees. Automatic Assessment Aids for Pascal Programs. *ACM SIGPLAN Notices*, 17(10): 33–42, 1982. doi:10.1145/948086.948088



COMPUTING PRACTICES

Edgar H. Sibley
Panel Editor

*A large quantity of well-respected software is tested against a series of metrics designed to measure program lucidity, with intriguing results. Although slanted toward software written in the C language, the measures are adaptable for analyzing most high-level languages.*

**A STYLE ANALYSIS OF C PROGRAMS**

R.E. BERRY and B.A.E. MEEKINGS

The "elegance" or "style" of a program is sometimes considered a nebulous attribute that is somehow unquantifiable; a programmer has an instinctive feel for a "good" or a "bad" program in much the same way as an artist distinguishes good and bad paintings. Some attempts have been made to identify the essential components of an elegantly written program [see, e.g., Rees [2], whose proposals form the basis for the analysis below], but these have been directed mostly toward providing a coarse grading for student programming exercises, which are typically insubstantial programs.

Since programming is considered by many to be learned by experience and example, rather than instruction, the authors analyzed code produced by professional programmers to determine the extent to which we could be said to be setting a good example for our students. To this end, we selected for review the C programs comprising the UNIX operating system and its utilities, for no other reason than that they are available, plentiful, and meet the criterion of having been written by experienced programmers.

UNIX is a registered trademark of AT&T Bell Laboratories.



**STYLE ANALYSIS**

All the programs reviewed were processed under UNIX, using essentially the Pascal style-analysis programs presented in [1] but adapted in this case for C. This adaptation from one language to another is made easier by writing the analysis program as a shell program invoking different UNIX utilities. (See the Appendix for a listing of the eight modules comprising the style-analysis suite.) Thus, in adapting for different languages, the *comment recognizer* in *style.ext.awk* and the comment stripper in *style.com.sed* would need to be changed as would the module recognizer in *style.met.awk* and the reserved word dictionary *style.dict*.

Each program is given a percentage "score" for style that consists of contributions in varying degrees from the following program features:

**module length**—the average length, in nonblank lines, of function definitions;

**identifier length**—the average length, in characters, of user identifiers;

**comments**—the percentage of all lines containing comments;



“The ‘elegance’ or ‘style’ of a program is sometimes considered a nebulous attribute that is somehow unquantifiable; a programmer has an instinctive feel for a ‘good’ or a ‘bad’ program in much the same way as an artist distinguishes good and bad paintings.”

— R. E. Berry and B. A. E. Meekings. A Style Analysis of C Programs. *Communications of the ACM*, 28(1):80–88, 1985. doi:10.1145/2465.2469

# Berry-Meekings Score, for C Programs

**TABLE I. Metric Boundary Values**

| Metric | % | L | S | F | H |
|---|---|---|---|---|---|
| Module length | 15 | 4 | 10 | 25 | 35 |
| Identifier length | 14 | 4 | 5 | 10 | 14 |
| Comment lines (%) | 12 | 8 | 15 | 25 | 35 |
| Indentation (%) | 12 | 8 | 24 | 48 | 60 |
| Blank lines (%) | 11 | 8 | 15 | 30 | 35 |
| Characters per line | 9 | 8 | 12 | 25 | 30 |
| Spaces per line | 8 | 1 | 4 | 10 | 12 |
| Defines (%) | 8 | 10 | 15 | 25 | 30 |
| Reserved words | 6 | 4 | 16 | 30 | 36 |
| Include files | 5 | 0 | 3 | 3 | 4 |
| Gotos | −20 | 1 | 3 | 99 | 99 |

Source: R. E. Berry and B. A. E. Meekings. A Style Analysis of C Programs. *Communications of the ACM*, 28(1):80–88, 1985. doi:10.1145/2465.2469

"An individual score for each metric is determined by reference to the value in this table for

1. the point $L$, below which no score is obtained;
2. the point $S$, the start of the "ideal" range for the metric;
3. the point $F$, the end of the ideal range;
4. the point $H$, above which no score is obtained."

Henry Ledgard

"An individual's body language helps clarify the spoken word. In a similar sense, the programmer relies on white space—what is not said directly—in the code to communicate logic, intent, and understanding."

— Robert Green and Henry Ledgard. Coding Guidelines: Finding the Art in the Science. *Communications of the ACM*, 54(12):57–63, 2011. doi:10.1145/2043174.2043191

**Figure 9. Examples of K&R, ANSI, and Whitesmiths coding styles.**

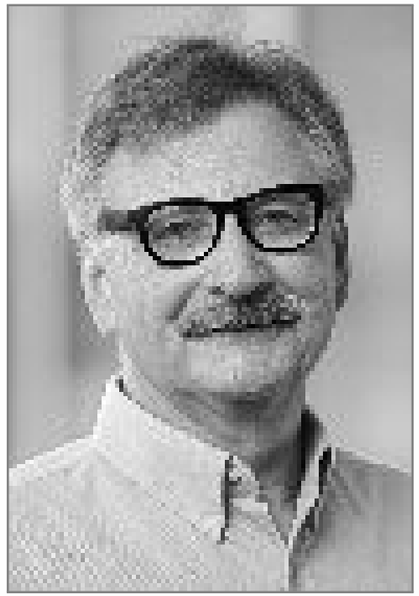
```
if (expression) {
    statements
}
```

```
if (expression)
{
    statements
}
```

```
if (expression)
    {
    statements
    }
```

Source: Robert Green and Henry Ledgard. Coding Guidelines: Finding the Art in the Science. *Communications of the ACM*, 54(12):57–63, 2011. doi:10.1145/2043174.2043191

## 4. What are the practical implications of using style checkers?



Warren Harrison

"To determine the relationship (if any) between the style metric and error proneness of each module, we performed a simple correlation analysis. The results were discouraging in the sense that a correlation of only -0.052 existed between the observed error frequency and the style metric, suggesting that the style metric bore little relationship to the error frequency encountered in our data."

— Warren Harrison and Curtis R. Cook. A Note on the Berry-Meekings Style Metric. *Communications of the ACM*, 29(2):123–125, 1986. doi:10.1145/5657.5660

Christian Collberg

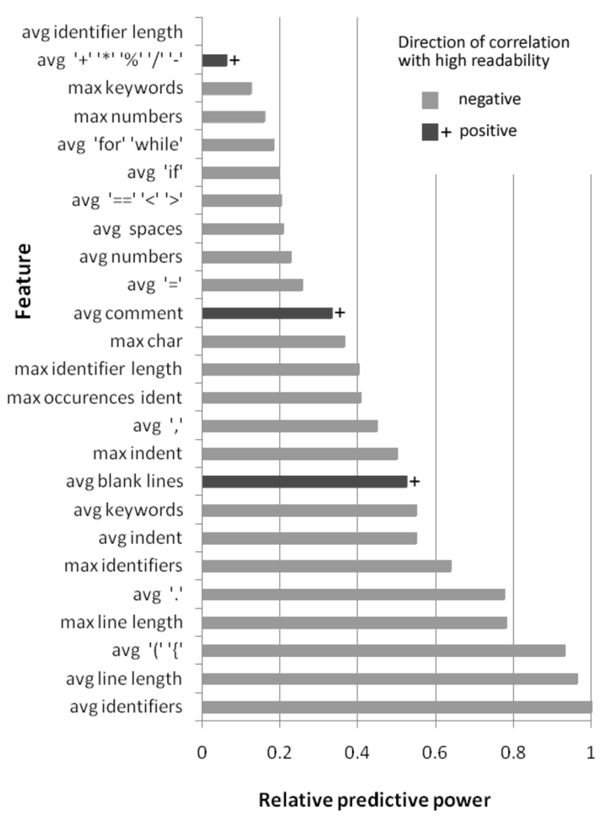
"Code obfuscation means one user runs an application through an obfuscator, a program that transforms the application into one that is functionally identical to the original but which is much more difficult for another user to understand."

— Christian Collberg, Clark Thomborson, and Douglas Low. A Taxonomy of Obfuscating Transformations, 1997

Raymond Buse

"Formally, we can characterize software readability as a mapping from a code sample to a finite score domain. We presented human annotators with a sequence of short code selections, called snippets. The annotators were asked to individually score each snippet based on their personal estimation of readability. Our metric for readability is derived (using ML) from these judgments."

— Raymond P. L. Buse and Westley R. Weimer. Learning a Metric for Code Readability. *IEEE Transactions on Software Engineering*, 36(4):546–558, 2009. doi:10.1109/TSE.2009.70




"We find, for example, that factors like 'average line length' and 'average number of identifiers per line' are very important to readability. Conversely, 'average identifier length' is not, in itself, a very predictive factor,"

Source: Raymond P. L. Buse and Westley R. Weimer. Learning a Metric for Code Readability. *IEEE Transactions on Software Engineering*, 36(4):546–558, 2009. doi:10.1109/TSE.2009.70

Cathal Boogerd

"First, there are 9 out of 72 rules for which violations were observed that perform significantly better than a random predictor at locating fault-related lines. Second, we observed a negative correlation between MISRA rule violations and observed faults. In addition, 29 out of 72 rules had a zero true positive rate. This makes it possible that adherence to the MISRA standard as a whole would have made the software less reliable."

— Cathal Boogerd and Leon Moonen. Assessing the Value of Coding Standards: An Empirical Study. In *Proceedings of the International Conference on Software Maintenance*, pages 277–286. IEEE, 2008. doi:10.1109/icsm.2008.4658076

Peter C. Rigby

"We list the reasons why our interviewees rejected a patch or required further modification before accepting it: Poor quality, Violation of style, Gratuitous changes mixed with 'true' changes, Code does not do or fix what it claims to or introduces new bugs, Fix conflicts with existing code, Use of incorrect API or library."

— Peter C. Rigby and Margaret-Anne Storey. Understanding Broadcast Based Peer Review on Open Source Software Projects. In *Proceedings of the 33rd International Conference on Software Engineering*, pages 541–550, 2011. doi:10.1145/1985793.1985867

Vipin Balachandran

"Through a user study, we show that integrating static analysis tools (Checkstyle, PMD, and FindBugs) with code review process can improve the quality of code review. The developer feedback for a subset of comments from automatic reviews shows that the developers agree to fix 93% of all the automatically generated comments."

— Vipin Balachandran. Reducing Human Effort and Improving Quality in Peer Code Reviews Using Automatic Static Analysis and Reviewer Recommendation. In *Proceedings of the 35th International Conference on Software Engineering (ICSE)*, pages 931–940. IEEE, 2013. doi:10.1109/ICSE.2013.6606642

Moritz Beller

> “Most Automated Static Analysis Tools configurations deviate slightly from the default, but hardly any introduce new custom analyses. ”

— Moritz Beller, Radjino Bholanath, Shane McIntosh, and Andy Zaidman. Analyzing the State of Static Analysis: A Large-Scale Evaluation in Open Source Software. In *Proceedings of the 23rd International Conference on Software Analysis, Evolution, and Reengineering (SANER)*, volume 1, pages 470–481. IEEE, 2016. doi:10.1109/saner.2016.105

TABLE V
SUMMARY OF RULE CHANGES FROM DEFAULT CONFIGURATIONS.

| Tool | Changed | Reconfigured | No Deviations | Total |
|---|---|---|---|---|
| ESLINT | 80.5% | 5.7% | 13.8% | 4,274 |
| FINDBUGS | 93.0% | — | 7.0% | 2,057 |
| JSHINT | 89.6% | 0.7% | 9.7% | 104,914 |
| JSL | 94.6% | — | 5.4% | 848 |
| PYLINT | 53.3% | — | 46.7% | 3,951 |
| RUBOCOP | 79.1% | 3.2% | 17.7% | 9,579 |

Source: Moritz Beller, Radjino Bholanath, Shane McIntosh, and Andy Zaidman. Analyzing the State of Static Analysis: A Large-Scale Evaluation in Open Source Software. In *Proceedings of the 23rd International Conference on Software Analysis, Evolution, and Reengineering (SANER)*, volume 1, pages 470–481. IEEE, 2016. doi:10.1109/saner.2016.105

TABLE VI
AVERAGE MEAN OF CUSTOM RULES IN ASAT CONFIGURATIONS.

| Tool | Percentage of Custom Rules |
|---|---|
| CHECKSTYLE | 0.2% |
| ESLINT | 4.1% |
| FINDBUGS | 1.3% |
| JSCS | 4.7% |
| JSHINT | 0.1% |
| PMD | 2.9% |
| PYLINT | 1.1% |
| RUBOCOP | 0.9% |

Source: Moritz Beller, Radjino Bholanath, Shane McIntosh, and Andy Zaidman. Analyzing the State of Static Analysis: A Large-Scale Evaluation in Open Source Software. In *Proceedings of the 23rd International Conference on Software Analysis, Evolution, and Reengineering (SANER)*, volume 1, pages 470–481. IEEE, 2016. doi:10.1109/saner.2016.105

Fiorella Zampetti

"Results indicate that build breakages due to static analysis tools are mainly related to adherence to coding standards, and there is also some attention to missing licenses. Build failures related to tools identifying potential bugs or vulnerabilities occur less frequently, and in some cases such tools are activated in a 'softer' mode, without making the build fail."

— Fiorella Zampetti, Simone Scalabrino, Rocco Oliveto, Gerardo Canfora, and Massimiliano Di Penta. How Open Source Projects Use Static Code Analysis Tools in Continuous Integration Pipelines. In *Proceedings of the 14th International Conference on Mining Software Repositories (MSR)*, pages 334–344. IEEE, 2017. doi:10.1109/msr.2017.2

Jennifer Bauer

"While the perceptual processing of code is required to understand it, higher level processing, such as understanding its semantics and reasoning about its functionality, affect program comprehensibility more strongly. The influence of indentation could have been masked by these side effects, so it might well be that the effect of indentation comes more into play when the code is longer and more complex."

— Jennifer Bauer, Janet Siegmund, Norman Peitek, Johannes C. Hofmeister, and Sven Apel. Indentation: Simply a Matter of Style or Support for Program Comprehension? In *Proceedings of the 27th International Conference on Program Comprehension (ICPC)*, pages 154–164. IEEE, 2019. doi:10.1109/icpc.2019.00033

Weiqin Zou

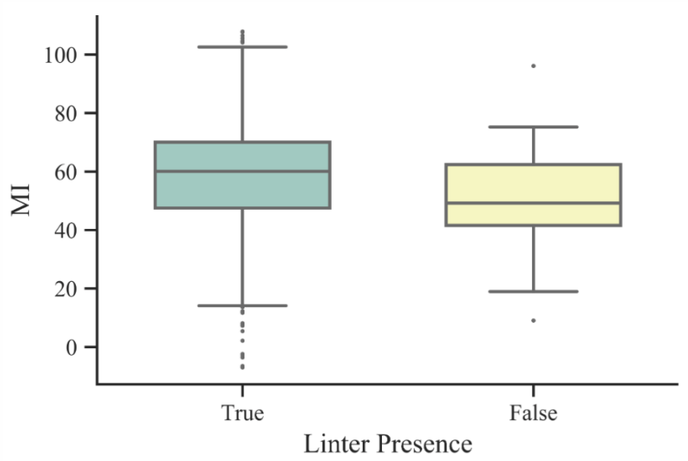
"A pull request that is consistent with the current code style tends to be merged into the codebase more easily (faster)."

— Jennifer Bauer, Janet Siegmund, Norman Peitek, Johannes C. Hofmeister, and Sven Apel. Indentation: Simply a Matter of Style or Support for Program Comprehension? In *Proceedings of the 27th International Conference on Program Comprehension (ICPC)*, pages 154–164. IEEE, 2019. doi:10.1109/icpc.2019.00033

Tjaša Heričko

"The findings suggest a very weak to strong negative correlation between ESLint warning density and the value of Maintainability Index at a project- and a module- level. Changes in warning density between projects only slightly inversely correspond to changes in maintainability."

— Tjaša Heričko and Boštjan Šumak. On the Relationship Between Linter Warning Density and Software Maintainability: An Empirical Study of JavaScript Projects. In *Proceedings of the 6th International Conference on Software Engineering and Information Management*, pages 86–91, 2023. doi:10.1145/3584871.3584884




"Although there is a tendency for the shift in maintainability to be positive when the change in warning density is negative and vice versa, the strength of the relationship is negligible."

Source: Tjaša Heričko and Boštjan Šumak. On the Relationship Between Linter Warning Density and Software Maintainability: An Empirical Study of JavaScript Projects. In *Proceedings of the 6th International Conference on Software Engineering and Information Management*, pages 86–91, 2023. doi:10.1145/3584871.3584884

5. What style checkers do you use in your projects?

## My Favorite Style Checkers

- ESLint (2013) for JavaScript
- Clang-Tidy (2007?) for C++
- Pylint (2006) for Python
- Rubocop (2012) for Ruby
- PHP_CodeSniffer (2011) for PHP
- rustfmt (2015) for Rust
- Qulice by Bugayenko [2014] for Java: Checkstyle (2001) + PMD (2022)

## How Many Rules in Style Checkers?

- 690+ in Clang-Tidy (C++)
- 550+ in Rubocop (Ruby)
- 400+ in PMD (Java)
- 130+ in Checkstyle (Java)
- 120+ in Pylint (Python)

Some/most of the rules no only check style, but also find bugs.

## Some Exotic Style Checkers

- Shellcheck for Bash
- Hadolint for Dockerfile
- markdownlint for Markdown
- Checkmake for Makefile
- xcop for XML

# Bibliography


Vipin Balachandran. Reducing Human Effort and Improving Quality in Peer Code Reviews Using Automatic Static Analysis and Reviewer Recommendation. In *Proceedings of the 35th International Conference on Software Engineering (ICSE)*, pages 931–940. IEEE, 2013. doi:10.1109/ICSE.2013.6606642.

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