Cognitive Complexity

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Lecture #3 out of 24
80 minutes

The slidedeck was presented by the author in this YouTube Video

1. Cyclomatic complexity is highly inaccurate if being compared with code readability evaluated by a human.

“A guiding principle in the formulation of Cognitive Complexity has been that it should incent good coding practices. That is, it should either ignore or discount features that make code more readable”

— G. Ann Campbell, Sonar Source S.A., 2017

Cyclomatic Complexity

```
int sumOfPrimes(int max) {                    // +1
  int total = 0;
  OUT: for (int i = 1; i <= max; ++i) {       // +1
    for (int j = 2; j < i; ++j) {             // +1
      if (i % j == 0) {                       // +1
        continue OUT;
      }
    }
    total += i;
  }
  return total;
}                  // Cyclomatic Complexity 4
```

```
String getWords(int number) { // +1
    switch (number) {
      case 1:                 // +1
        return "one";
      case 2:                 // +1
        return "a couple";
      case 3:                 // +1
        return "a few";
      default:
        return "lots";
    }
  }      // Cyclomatic Complexity 4
```

"The mathematical model underlying Cyclomatic Complexity gives these two methods equal weight, yet it is intuitively obvious that the control flow of `sumOfPrimes` is more difficult to understand than that of `getWords`" — G. Ann Campbell

Cognitive Complexity (CoCo)

```
int sumOfPrimes(int max) {
  int total = 0;
  OUT: for (int i = 1; i <= max; ++i) { // +1
    for (int j = 2; j < i; ++j) {       // +2
      if (i % j == 0) {                 // +3
        continue OUT;                   // +1
      }
    }
    total += i;
  }
  return total;
}                  // Cognitive Complexity 7
```

```
String getWords(int number) {
    switch (number) {          // +1
      case 1:
        return "one";
      case 2:
        return "a couple";
      case 3:
        return "a few";
      default:
        return "lots";
    }
  }      // Cognitive Complexity 1
```

"The Cognitive Complexity algorithm gives these two methods markedly different scores, ones that are far more reflective of their relative understandability." — G. Ann Campbell

“Being able to find statistical correlations between code understandability and source code measures would be greatly beneficial for the software development process, which involves a great deal of activities involving program comprehension” — Luigi Lavazza et al., *An Empirical Evaluation of the “Cognitive Complexity” Measure as a Predictor of Code Understandability*, Journal of Systems and Software (197), 2023.

CoCo is supported in a few static analyzers:

- in PMD since 6.22.0
- in Rubocop since 0.25 (called “perceived complexity”)
- in ESLint via SonarSource plugin
- in Flake8 via this plugin
- in Clippy since 1.35.0
- in PHPCS via this plugin

> 2. “Perceived complexity” is human’s impression and conceptualization of a system as being complex.

Social Code Analysis

“Social code analysis enriches our understanding of the code quality by overlaying a developer’s behavior with the structural analysis of the code”
— Technology Radar of ThoughtWorks, March 2017

“BrainMaster Technologies (USA) sells this “Freedom 20R” EEG head set for $31,025. A similar device you can get from Neiry (Russia), for 3% of this price.”

Read this:

Cognitive complexity: an overview and evaluation, G. Ann Campbell, Proceedings of the International Conference on Technical Debt, 2018

Neural Software Analysis by Michael Pradel et al., Communications of the ACM 65(1), 2022

References