# Comparing Testability and Code Quality in Software Paradigms

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January 24, 2019

**Abstract**

This study's goal is to compare approaches to functional programs and object-oriented programs to find how it affects maintainability and code quality. By looking at 3 cases, we analyze, how does a functional approach to software architecture compare to an OOP (Object-oriented programming) approach when it comes to maintainability and code quality?

# 1 Introduction

This is time for all good men to come to the aid of their party!

# 2 Theory

## 2.1 Characteristics of Functional Programming

Expressions and functions

### 2.1.1 Iterator pattern

## 2.2 Object Oriented Programming

Uses variables, commands and procedures

### 2.2.1 SOLID principles

# 3 Methods

## 3.1 Cyclomatic Complexity

Cyclomatic complexity is a complexity measure that looks to control the number of paths through a program. The Cyclomatic complexity is an upper bound for the number of test cases required to obtain branch coverage of the code.

**Definition.** The cyclomatic number $v(G)$ of a graph G with $n$ vertices, $e$ edges and $p$ connected components is $v(G) = e - n + p$.

**Theorem.** *In a strongly connected graph $G$, the cyclomatic number is equal to the maximum number of linearly independent circuits. [2]*

Informally, we can think of cyclomatic complexity as a way to measure the amount tests a program needs. The edges of the graph represents the branches caused by a decision. We do this by creating a graph of the control flow of the program and calculate each node. If we have the code found in example figure 1.

```
public static boolean containsLetter(String s) {
  for (int i = 0; i < s.length(); i++) {
    if (Character.isLetter(s.charAt(i))) {
      return true;
    }
  }
  return false;
}
```

wever

Figure 1: Simple for loop code.

To calculate the complexity of this function we first construct a graph as seen in figure 2. We find that the cyclomatic number is 3.

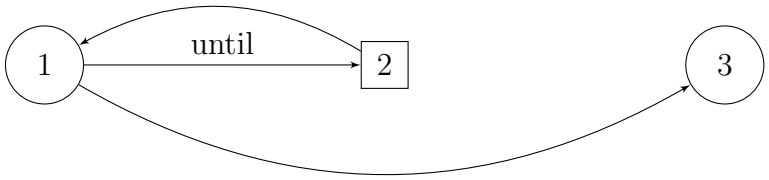


Figure 2: Cyclomatic complexity graph for figure 1

### 3.1.1 Cyclomatic Complexity in Functional Programming

The definition of cyclomatic complexity in Section 3.1 is not ideal for functional programming. Cyclomatic complexity is calculated by creating graphs based on control flow operations such as while loops and if statements. In functional programming everything is a function, thus the cyclomatic complexity will always tend to 0 using this definition. Thus we will define a different method of calculating the cyclomatic complexity for functional programs. [1]

## 3.2 Cognitive Dimensions

## 3.3 Case studies

### 3.3.1 Simplified chess game

Chess is a famous game and assumed that the reader know how it works. Aim is to implement a simplified variant of it. This is not ordinary chess but a simplified version:

- Only pawns and horses exist.
- You win by removing all the other players pieces.

The player should be able to do the following:

- List all available moves for a certain chess piece.
- Move the chess piece to a given space
- Switch player after move

- Get an overview of the board
- Get an error when making invalid moves

### 3.3.2 to-do List

A common task in programming is to create some kind of data store with information. A to-do list is a minimal example of that. It consists of a list of items that can be used to remember what to do later. The user should be able to:

- Create a new item in the to-do list.
- Remove an item from the to-do list.
- See all items in the to-do list.
- Update an item from the to-do list.

### 3.3.3 Chatbot engine

Oftentimes when developing applications we have to deal with complex information input. One of those cases is when we have chat bots. Chat bots are interactive programs that respond with a text answer to the users input. For this application we will implement the following:

- Interpretor that can handle semi-complex inputs and deal with errors.
- Give answers to those inputs in form of text messages.

# 4 Results

# 5 Conclusions

# 6 Limitations

## 6.1 Improvements to implementation

# References

[1] K. Berg. Software measurement and functional programming. *Current Sociology - CURR SOCIOL*, 01 1995.

[2] T. J. McCabe. A complexity measure. In *Proceedings of the 2Nd International Conference on Software Engineering*, ICSE '76, pages 407–, Los Alamitos, CA, USA, 1976. IEEE Computer Society Press.