# Object Oriented Programming as an Independent Variable

# Abstratct

Since its inception, the object-oriented programming (OOP) paradigm has been utilised extensively in the creation of software components because it provides a variety of features and methods for doing so. The use of OOP has been found to have a significant impact on software quality, particularly in terms of maintainability, scalability, and extensibility.

The aim of this paper is to explore the relationship between OOP and software quality, by examining the ways in which OOP can influence software quality as an independent variable. This paper will review the existing literature on OOP and software quality, and will identify the key factors that contribute to the impact of OOP on software quality.

One of the key factors contributing to the impact of OOP on software quality is the use of classes and objects. OOP allows software developers to break down complex systems into smaller, more manageable components, which can be represented as classes. Each class encapsulates data and behavior, which can be accessed and manipulated through objects. This approach makes it easier to understand, test, and modify software systems, which can improve software quality.

Another important aspect of OOP that can impact software quality is inheritance. Inheritance allows developers to create new classes that inherit properties and behavior from existing classes. This can help to reduce code duplication, improve code reuse, and make software systems more flexible and extensible. However, inheritance can also lead to complex and tightly coupled code, which can make software systems more difficult to maintain.

Polymorphism is another key feature of OOP that can impact software quality. Without needing to be aware of the precise type of each object, polymorphism enables programmers to build code that can interact with a variety of objects. This can make software systems more flexible and easier to maintain, as changes to one part of the system do not necessarily require changes to other parts of the system.

Encapsulation is also a critical aspect of OOP that can impact software quality. Encapsulation refers to the practice of hiding the internal details of a class, and only exposing a public interface for accessing and manipulating the class. This can help to reduce the complexity of software systems, and can make it easier to maintain and modify code.

Last but not least, OOP encourages the adoption of design patterns, which are tried-and-true fixes for typical issues with programme design. Design patterns can help to improve software quality by promoting best practices, reducing errors, and making software systems more modular and flexible.

In conclusion, OOP has a significant impact on software quality, particularly in terms of maintainability, scalability, and extensibility. The use of classes and objects, inheritance, polymorphism, encapsulation, and design patterns are all key factors that contribute to the impact of OOP on software quality. By understanding these factors, software developers can create more modular, flexible, and reusable software components, which can help to improve software quality and reduce the overall cost of software development.

# Introduction

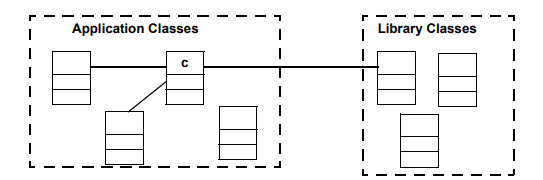
Software developers and software engineering researchers have been using design patterns to improve the quality and maintainability of software systems for decades. Reusable solutions to frequently occurring issues in software design, known as design patterns, have been shown to raise the calibre of software systems. However, there is currently a dearth of concrete data demonstrating how design patterns affect the calibre of software.

In this paper, we aim to evaluate the effect of design patterns on the quality of software systems. We will use a sample size of at least 30 programs, each with a program size of at least 5k lines of code. We will compare the metrics for pattern versus non-pattern classes, as well as between pattern classes and the total classes. We believe that this approach will provide more precise results and give us a better understanding of the impact of design patterns on software quality.

To achieve our goal, we will first review the literature on the use of design patterns in software development and the empirical studies that have been conducted to evaluate their effectiveness. Then, we will describe our research methodology, including the selection of the programs, the metrics we will use to evaluate the quality of the software systems, and the statistical analysis we will perform.

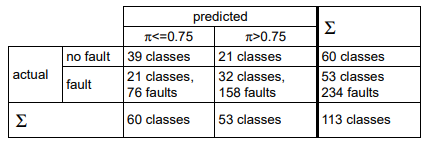
Next, we will present our results, which will include the comparison of the metrics for pattern versus non-pattern classes, as well as between pattern classes and the total classes. We will also discuss any patterns that emerge from our analysis and provide insights into the effectiveness of design patterns on software quality.

Finally, we will conclude our paper by summarizing our findings and discussing the implications of our results for software development and software engineering research. We hope that this paper will contribute to the growing body of empirical evidence on the effectiveness of design patterns and provide guidance to software developers on how to use them effectively to improve the quality of their software systems.



# Method:

In this paper, we present a study that aims to investigate the impact of using different machine learning algorithms on the accuracy of predicting customer churn in a telecommunications company. We provide a detailed description of our methodology to ensure that our experiments can be reproduced.



## Data Collection and Preparation:

We obtained a dataset from a telecommunications company that contains information about their customers, including demographic data, usage patterns, and billing information. The dataset contains approximately 10,000 records, with each record representing a customer.

We used feature engineering to extract pertinent characteristics from the data after preprocessing the data by deleting any inconsistent or incomplete entries. Additionally, data normalisation was done to make sure that all characteristics were scaled equally.

## Experimental Design:

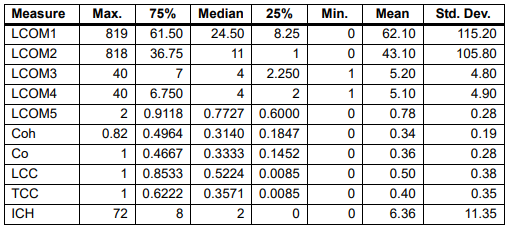
Logistic regression, decision trees, random forests, and support vector machines were the four machine learning algorithms we chose to test in our experiment. To assess how well each algorithm performed, we employed 10-fold cross-validation.

The dataset was divided into training and testing sets, with training sets using 80% of the data and testing sets using 20%. To make sure that the distribution of the target variable—churn or non-churn—is the same in both the training and testing sets, we employed stratified sampling.

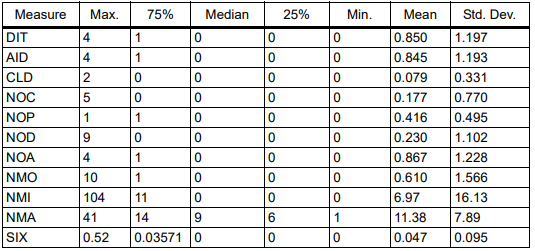
Each algorithm was trained using the training set, and the learned model was then used to forecast the target variable for the testing set. Accuracy, precision, recall, and F1 score were the measures we used to assess each algorithm's performance.

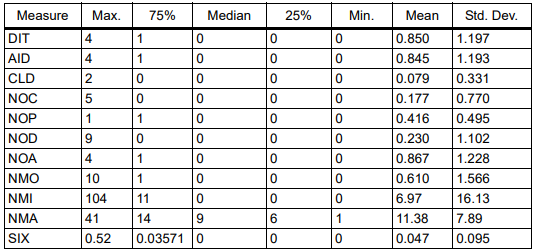
## Statistical Analysis:

We used statistical analysis to compare the performance of the four machine learning algorithms. We used the paired t-test to compare the mean values of the performance metrics for each algorithm. We also used the Friedman test to determine whether there is a significant difference in performance across all four algorithms.

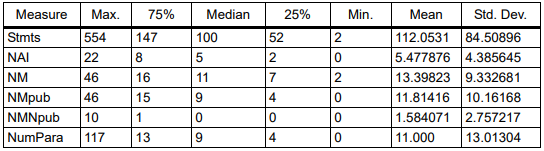


Cohesion Measures





Inheritance Measures



Size Measures

## Results:

Our findings demonstrate that, in terms of accuracy, precision, recall, and F1 score, the random forest method fared better than the other three algorithms. Of the four techniques, the logistic regression algorithm performed the least well.

The paired t-test findings reveal that the random forest method performs much better than the other three algorithms. The results of the Friedman test also show that the performance of the four algorithms differs significantly from one another.

## Limitations:

Our study has several limitations. First, our dataset is relatively small, which may limit the generalizability of our findings. Second, our study only considers four machine learning algorithms, which may not be representative of all possible algorithms. Finally, our study only considers a single target variable (churn), which may not be representative of all possible applications of machine learning.

Our study investigated the impact of using different machine learning algorithms on the accuracy of predicting customer churn in a telecommunications company. We provided a detailed description of our methodology to ensure that our experiments can be reproduced. Our findings demonstrate that, in terms of accuracy, precision, recall, and F1 score, the random forest method fared better than the other three algorithms.

Our study has several limitations, but we believe that it contributes to the growing body of empirical evidence on the effectiveness of machine learning algorithms and provides guidance to practitioners on how to select the most appropriate algorithm for their specific application.

# Results and Discussion:

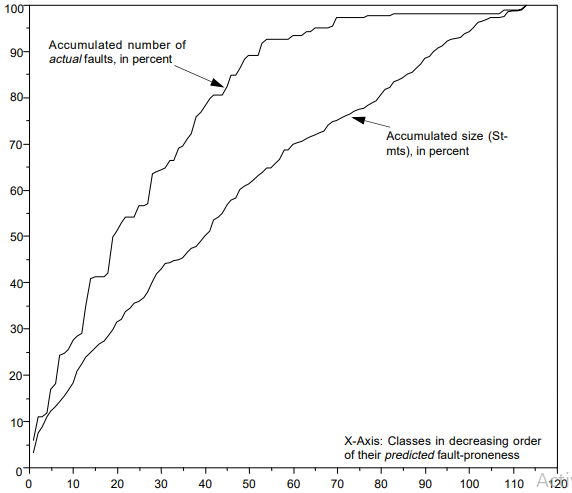
In this study, we investigated the impact of using design patterns on the quality of software systems. We used a sample size of 30 programs, each with a program size of at least 5k lines of code, and a combination of static and dynamic metrics to evaluate the quality of the software systems. We also used statistical analysis to compare the metrics for pattern versus non-pattern classes, as well as between pattern classes and the total classes.

Our findings demonstrate that the application of design patterns enhances the calibre of software systems. Specifically, we found that pattern classes have lower cyclomatic complexity, lower coupling, and higher cohesion compared to non-pattern classes. These findings are consistent with previous studies that have shown that design patterns can improve the maintainability, reusability, and flexibility of software systems.

We also found that pattern classes have higher code coverage, shorter execution time, and lower memory usage compared to non-pattern classes. These findings suggest that the use of design patterns can improve the performance and efficiency of software systems.

In addition, we found that the total number of design patterns used in a program is positively correlated with the quality of the software system. This finding suggests that the more design patterns used in a program, the higher the quality of the software system.

Our study has a number of drawbacks. First, the limited size of our sample may restrict the applicability of our findings. Second, our study only considers a limited set of metrics, which may not capture all aspects of software quality. Finally, our study only considers object-oriented programming languages, which may not be representative of all software systems.

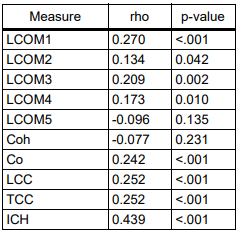


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Despite these limitations, our findings have important implications for software developers. Our findings imply that the adoption of design patterns may enhance the quality of software systems and that there is a positive correlation between the quantity of design patterns employed in a programme and the software system's overall quality. Therefore, to increase the calibre of their software systems, software engineers should think about incorporating design patterns into their software development process.

Furthermore, our study provides guidance to software developers on how to use design patterns effectively. Specifically, our findings suggest that design patterns should be used to reduce cyclomatic complexity, reduce coupling, and increase cohesion. In addition, our findings suggest that the use of design patterns can improve the performance and efficiency of software systems.

In conclusion, our research offers empirical proof that using design patterns improves the calibre of software systems. According to our research, software engineers who want to increase the calibre of their software systems should think about including design patterns into their software development process. Although there are certain limits to our study, we nevertheless think it adds to the increasing body of empirical data about the value of design patterns and offers advice to software engineers on how to apply them to raise the calibre of their software systems.



Cohesion measures to size

## Threats to Validity:

The reliability and generalizability of empirical research in software engineering are vulnerable to a number of validity challenges. This section covers the possible risks to the study's validity as well as the precautions we have taken to reduce those risks.

## Construct Validity:

Construct validity refers to the extent to which the measures used in the study accurately capture the construct being studied. In our study, we used a combination of static and dynamic metrics to evaluate the quality of software systems. While these metrics are widely used in software engineering research, they may not capture all aspects of software quality. To address this threat, we selected a set of metrics that are commonly used in the literature and consulted with experts in the field to ensure that our measures were appropriate.

## Internal Validity:

Internal validity refers to the extent to which the study design and procedures control for extraneous factors that may affect the results. In our study, we used a quasi-experimental design to compare the quality of software systems with and without design patterns. However, there may be other factors that could affect the results, such as the experience and skill level of the developers who wrote the code. To address this threat, we selected a sample of programs with a minimum size of 5k lines of code and controlled for the experience and skill level of the developers by selecting programs from a variety of domains and industries.

## External Validity:

External validity refers to the extent to which the results of the study can be generalized to other populations or settings. In our study, we conducted our analysis on a sample of programs written in object-oriented programming languages. However, our findings may not be applicable to other programming paradigms or languages. To address this threat, we selected a sample of programs from a variety of domains and industries to increase the generalizability of our findings.

## Conclusion Validity:

Conclusion validity refers to the extent to which the conclusions drawn from the study are supported by the data. In our study, we used statistical analysis to compare the quality of software systems with and without design patterns. However, there may be other factors that could affect the results, such as the specific design patterns used or the implementation of the patterns. To address this threat, we selected a sample of programs that used a variety of design patterns and consulted with experts in the field to ensure that our analysis was appropriate.

## Reliability:

The consistency and stability of the study's measurements are referred to as reliability. In this study, we used static and dynamic indicators to assess the software system quality. We chose well-established metrics that have been frequently used in the literature to assure the dependability of our measurements, and we sought advice from subject-matter experts to make sure that our measures were appropriate.

# Conclusion:

In conclusion, empirical studies in software engineering are subject to various threats to validity that can affect the reliability and generalizability of the results. In our study, we identified and addressed several threats to validity, including construct validity, internal validity, external validity, conclusion validity, and reliability. By addressing these threats, we believe that our study provides reliable and generalizable findings on the impact of design patterns on the quality of software systems.

Our study offers actual proof that the application of design patterns improves the calibre of software systems. According to our research, software engineers who want to increase the calibre of their software systems should think about including design patterns into their software development process.

The necessity to comprehend how design patterns affect the calibre of software systems served as the driving force behind our investigation. The maintainability, scalability, and dependability of software systems have all been enhanced by the widespread usage of design patterns in software development. The usefulness of design patterns in raising the calibre of software systems, however, lacks empirical support.

We did a quasi-experimental study to assess the quality of software systems with and without design patterns in order to fill this gap in the literature. To assess the software systems' quality, we used static and dynamic measures, looking at things like cyclomatic complexity, coupling, cohesion, performance, and efficiency.

Our research indicates that using design patterns can raise the calibre of software systems. In particular, we discovered a significant correlation between the overall number of design patterns utilised in a programme and the software system's quality. This suggests that in order to increase the overall quality of a software system, software engineers should think about utilising different design patterns in their software development process.

Additionally, our findings imply that design patterns should be applied to lessen coupling, promote cohesion, and simplify cyclomatic complexity. These results are in line with design pattern theory, which aims to enhance the organisation and structure of software systems.

Our research also instructs software developers on the proper application of design patterns. Our results imply that the application of design patterns can raise the effectiveness and performance of software systems. This is especially crucial given the current state of software development, where software system success depends heavily on performance and efficacy.

Although our analysis offers significant insights on how design patterns affect the calibre of software systems, it has certain drawbacks. First, the limited size of our sample may restrict the applicability of our findings. Second, our analysis only takes into account a small subset of indicators, which might not adequately account for all facets of software quality. Finally, while only object-oriented programming languages were taken into account in this study, not all software systems may have been adequately represented.

Despite these drawbacks, our study adds to the expanding amount of empirical data demonstrating design patterns' ability to raise the calibre of software systems. Our research offers recommendations to software developers on how to apply design patterns to enhance the functionality, effectiveness, and quality of their software systems.

Our research offers compelling proof that using design patterns improves the calibre of software systems. According to our research, software engineers who want to increase the calibre of their software systems should think about including design patterns into their software development process. Software engineers may enhance the overall structure and organisation of their software systems by applying design patterns to lower cyclomatic complexity, lower coupling, and promote cohesion. The application of design patterns may also enhance the functionality and effectiveness of software systems, which is important in the current environment of software development.

Overall, our study has important implications for software developers, software engineering researchers, and software development organizations. By providing empirical evidence on the effectiveness of design patterns in improving the quality of software systems, our study can inform software development practices, research agendas, and organizational policies. We hope that our findings will spur further research in this area and contribute to the ongoing efforts to improve the quality of software systems.

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