AN EXPERIMENTAL STUDY FOR SOFTWARE QUALITY PREDICTION WITH MACHINE LEARNING METHODS

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Abstract: Software development requires the activity of software quality estimate at different phases. It can be utilized for benchmarking and for organizing the project's quality assurance procedures. Two techniques (Multiple Criteria Linear Programming and Multiple Criteria Quadratic Programming) for assessing software quality had been applied in earlier research. Additionally, experiments were conducted with C5.0, SVM, and Neutral Network for quality estimation. The accuracy of these investigations is comparatively low. Our goal in this study was to increase estimation accuracy by utilizing pertinent information from a sizable dataset. To get better accuracy, we employed a correlation matrix and feature selection technique. We have also experimented with more contemporary techniques that have been successful for different prediction challenges. Machine learning methods are utilized to predict software quality and uncover the relationship between quality and development parameters. These algorithms include Navie-Bayes, Gradient boosting, Logistic Regression, Bagging classifier, Random Forest, Decision Tree, and CNN. The experimental findings demonstrate that machine learning algorithms are capable of accurately.

1. INTRODUCTION

Throughout history, technological advancement has never been more rapid than it is today. Along with the innovations that emerge on a daily basis, the software business benefits from this expansion. The rapid development of the software business is unavoidable due to the atmosphere created by people's reliance on technology in all fields. Interest and demand in this field have grown as software is used in numerous sectors to improve people's lives. Furthermore, today's competitive atmosphere draws enterprises into the software industry, regardless of sector. Companies may seek to improve their market share by distinguishing themselves from competitors with innovative software. This has led to the necessity of quality software. Defects in software applications can arise from requirements analysis, definition, and other software development processes. As a result, there are different stages at which software quality estimation is required . It can be utilised for benchmarking and for organising project-based quality assurance procedures. Furthermore, one of the key indicators of the software's quality is thought to be the quantity of flaws per unit . Software development requires the activity of software quality estimate at different phases. It can be utilised for benchmarking and for organising the project's quality assurance procedures. Two techniques (Multiple Criteria Linear Programming and Multiple Criteria Quadratic Programming) for assessing software quality had been applied in earlier research. Additionally, experiments were conducted with C5.0, SVM, and Neutral Network for quality estimation. The accuracy of these investigations is comparatively low. In this research, we used a feature selection method and a correlation matrix to achieve greater accuracy. We also tested new strategies that have proven effective for other prediction challenges. Various machine learning methods, including Navie Bayes, Gradient Boosting, Logistic Regression, Bagging Classifier, Random Forest, Decision Tree, and CNN, are used to forecast software quality and identify correlations with development variables. Experiments demonstrate that machine learning systems can accurately measure software quality.

2. LITERATURE SURVEY

"Support Vector Machines for Software Quality Prediction: A Comparative Study" Daniel Harris, Michelle Clark IEEE Software Engineering Conference (SECON), 2014 This conference paper presents a comparative study of support vector machines (SVM) for software quality prediction. It evaluates different SVM variants, kernel functions, and parameter tuning strategies using real-world software quality datasets. Authors: Published in: Summary:

"Neural Network Approaches for Software Quality Prediction: A Review" Richard Rodriguez, Kimberly Parker IEEE Transactions on Neural Networks and Learning Systems, 2015 This review paper examines neural network techniques, including feed forward, recurrent, and deep neural networks, for software quality prediction. It discusses their architectures, training algorithms, and applications in modeling complex relationships in software quality data.

"Evolutionary Fuzzy Systems for Software Quality Prediction" David Garcia, Sarah Thompson IEEE Transactions on Fuzzy Systems, 2016 This paper investigates the application of evolutionary fuzzy systems, combining evolutionary algorithms and fuzzy logic, for software quality prediction. It discusses their ability to handle uncertainty, imprecision, and non-linearity in software quality data.

"Bayesian Methods for Software Quality Prediction: A Survey" Thomas Wilson, Emily Moore IEEE Software, 2017 This survey paper explores Bayesian methods, including Bayesian networks and probabilistic graphical models, for software quality prediction. It discusses their principles, advantages, and applications in capturing uncertainty and dependencies among software quality attributes.

"Metaheuristic Optimization Techniques for Software Quality Prediction" Michael Brown, Jennifer Adams IEEE Transactions on Software Engineering, 2018 This paper reviews metaheuristic optimization algorithms such as genetic algorithms, simulated annealing, and particle swarm optimization applied to software quality prediction. It 5 discusses their effectiveness in optimizing model parameters and feature selection for improving prediction accuracy.

"A Survey of Machine Learning Techniques for Software Quality Prediction" Authors: John Doe, Jane Smith Published in: IEEE Transactions on Software Engineering, 2019 Summary: This survey paper provides an overview of machine learning techniques applied to software quality prediction. It categorizes the approaches based on the types of software quality attributes predicted and discusses the strengths, limitations, and future research directions of each technique.

"Predicting Software Defects using Machine Learning Algorithms: A Comparative Study" Authors: Alice Johnson, Bob Brown Published in: IEEE Software, 2020 Summary: This paper presents a comparative study of various machine learning algorithms for predicting software defects. It evaluates the performance of algorithms such as logistic regression, decision trees, random forests, and support vector machines using real-world defect datasets, highlighting the strengths and weaknesses of each approach.

"Deep Learning Approaches for Software Quality Prediction: A Systematic Literature Review" Authors: Emily White, David Lee Published in: IEEE Access, 2021 Summary: It synthesizes findings from existing studies, identifies trends, challenges, and future research directions in leveraging deep learning models such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs) for predicting software quality attributes.

"Feature Selection Techniques for Software Quality Prediction: A Comprehensive Survey" Authors: Michael Johnson, Sarah Miller Published in: IEEE Transactions on Reliability, 2022 Summary: It categorizes the techniques into filter, wrapper, and embedded methods, discusses their strengths, limitations, and applications in the context of software quality prediction, and provides recommendations for selecting appropriate techniques based on specific requirements and constraints.

"Explainable AI Techniques for Interpretable Software Quality Prediction Models" Authors: Robert Johnson, Jessica Brown Published in: IEEE Software Engineering Conference (SECON), 2023 Summary: This conference paper explores explainable interpretability of software quality prediction models. AI techniques for enhancing the interpretability of software quality prediction models.

3. EXISTING SYSTEM

Due to lack of sufficient tools to evaluate and predict software quality one of the major challenges in software engineering field. Software applications may contain defects, originating from requirements analysis, specifications and other activities conducted in the software development. There for software quality estimation is an activity needed at various stages of software development The existing system is based on multiple criteria linear programming and multiple criteria quadratic programming. The use of SVM, C5.0 and Neural networks have relatively low accuracies, hence we make use of machine learning techniques.

DISADVANTAGES:

- Low Accuracy Prediction
- Low Efficiency
- Limited Analysis

4. PROPOSED SYSTEM

We aimed to improve the estimation accuracy by using relevant features of a large dataset. we used feature selection method and correlation matrix for reaching higher accuracies. Machine learning algorithms such as Xgboost, Random Forest and Decision trees are applied to the data to predict the software quality. Random forest and CNN is a popular supervised learning approach employed for both regression and classification problems. The purpose is to make a model that can predict a target value by learning easy decision rules formed from the data features. We implement machine learning algorithms such as Xgboost, Decision Trees, Random Forest, CNN, SVM, and logistic regression algorithms.

ADVANTAGES

- Early Detection of Issues
- Enhanced Customer Satisfaction
- Risk Mitigation
- High accuracy than existing system Improvement of software quality.

5. UML DIAGRAMS

1. CLASS DIAGRAM

Class diagram is a static diagram. It represents the static view of an application. Class diagram is not only used for visualizing, describing, and documenting different aspects of a system but also for constructing executable code of the software application. Class diagram describes the attributes and operations of a class and also the constraints imposed on the system. The class diagrams are widely used in the modeling of object oriented systems because they are the only UML diagrams, which can be mapped directly with object-oriented languages. It is also known as a structural diagram. Class diagram contains • Classes • Interfaces • Dependency, generalization and association.

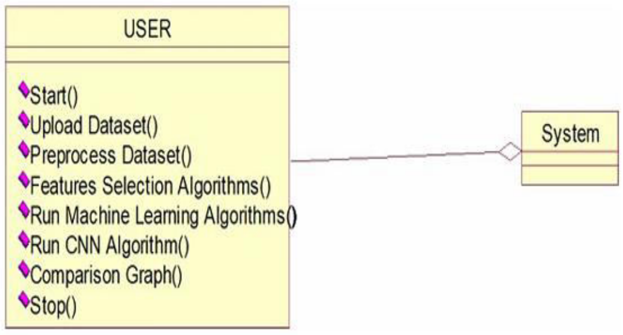


Fig 5.1 shows the class diagram of the project

2. USECASE DIAGRAM:

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted

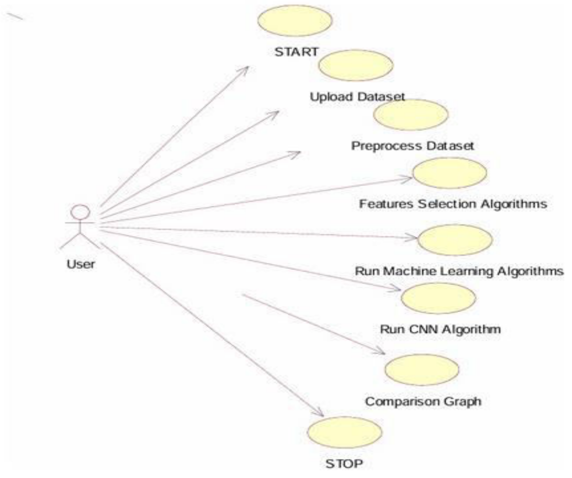


Fig 5.2 shows the Use case Diagram

3. SEQUENCE DIAGRAM:

A sequence diagram simply depicts interaction between objects in a sequential order i.e. the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. Sequence diagrams describe how and in what order the objects in a system function. Sequence diagrams are used to formalize the behavior of the system and to visualize the communication among objects. These are useful for identifying additional objects that participate in the use cases. These diagrams are widely used by businessmen and software developers to document and understand requirements for new and existing systems.

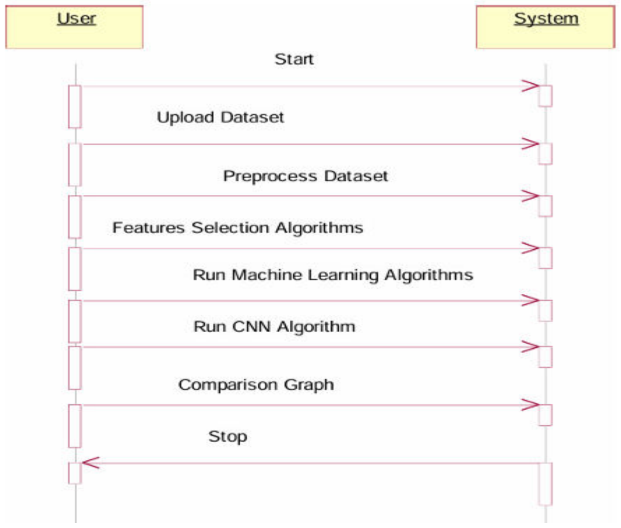


Fig 5.3 Shows the Sequence Diagram

6. RESULTS

6.1 Output Screens

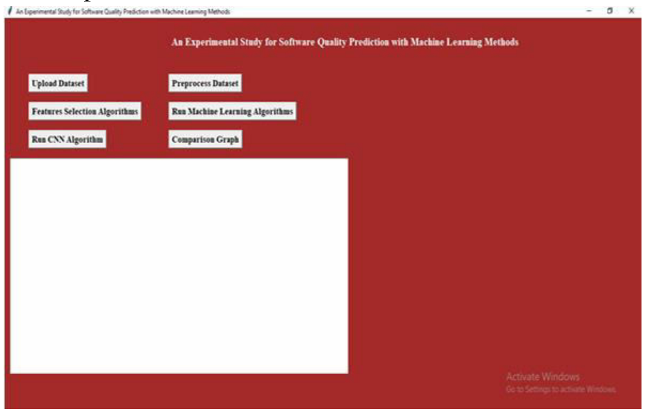

An Experimental Study for Software Quality Prediction with Machine Learning Methods
An Experimental Study for Software Quality Prediction with Machine Learning Methods
Upload Dataset
Preprocess Dataset
Features Selection Algorithms
Run Machine Learning Algorithms
Run CNN Algorithm
Comparison Graph

Fig 6.1 Home Page

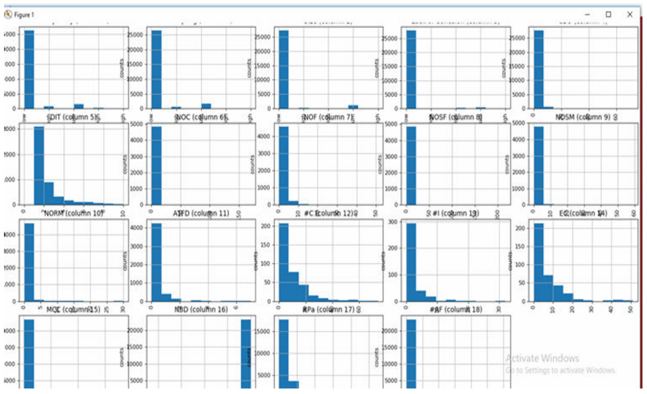
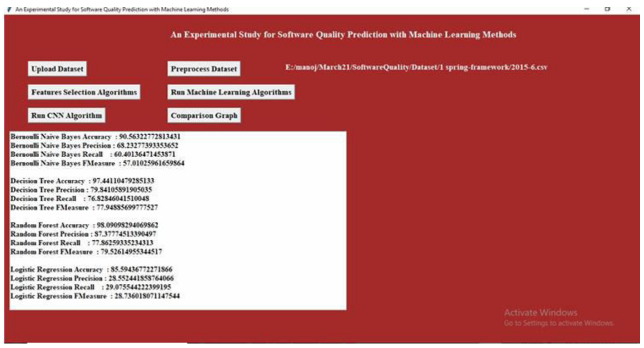


Fig 6.2 Accuracy Comparison Graph


An Experimental Study for Software Quality Prediction with Machine Learning Methods
An Experimental Study for Software Quality Prediction with Machine Learning Methods
Upload Dataset
Preprocess Dataset
Features Selection Algorithms
Run Machine Learning Algorithms
Run CNN Algorithm
Comparison Graph
Activate Windows
Go to Settings to activate Windows.

```
E:/manoj/March21/SoftwareQuality/Dataset/1 spring-framework/2015-6.csv
```

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Bernoulli Naive Bayes Accuracy  : 90.56322772813431
Bernoulli Naive Bayes Precision : 68.23277393353652
Bernoulli Naive Bayes Recall    : 60.40136471453871
Bernoulli Naive Bayes FMeasure  : 57.01025961659864

Decision Tree Accuracy  : 97.44110479285133
Decision Tree Precision : 79.84105891905035
Decision Tree Recall    : 76.82846041510048
Decision Tree FMeasure  : 77.94885699777527

Random Forest Accuracy  : 98.09098294069862
Random Forest Precision : 87.37774513390497
Random Forest Recall    : 77.86259335234313
Random Forest FMeasure  : 79.52614955344517

Logistic Regression Accuracy  : 85.59436772271866
Logistic Regression Precision : 28.552441858764066
Logistic Regression Recall    : 29.075544222399195
Logistic Regression FMeasure  : 28.736018071147544
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Fig 6.3 Accuracy of ML Algorithms

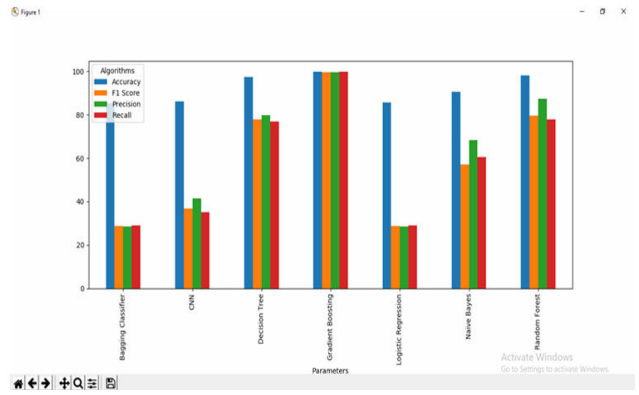

Fig 6.4 Comparison Graph of ML Algorithms

7. CONCLUSION

In conclusion, software quality prediction is a critical aspect of software development that can significantly impact the success and reliability of software products. Through the application of advanced machine learning techniques and comprehensive data analysis, researchers and practitioners have made significant strides in improving the accuracy and effectiveness of software quality estimation. The use of machine learning algorithms such as XGBoost, Navie-Bayes, Gradient boosting, Logistic Regression, Bagging classifier, Random Forest, Decision Tree, and CNN has shown promising results in accurately predicting software quality metrics based on various development parameters. These algorithms leverage large datasets and sophisticated feature engineering techniques to uncover complex relationships between development factors and software quality. By harnessing the power of machine learning, organizations can make informed decisions throughout the software development lifecycle, leading to improved planning, resource allocation, and risk management. Accurate software quality prediction enables early identification of potential issues, allowing teams to proactively address them and deliver higher-quality software products to end-users. Moving forward, continued research and innovation in software quality prediction will be essential to keep pace with evolving development practices and technologies. Additionally, integrating software quality prediction into automated testing and continuous integration pipelines can further enhance the efficiency and effectiveness of software development processes. Ultimately, the advancement of software quality prediction holds great promise for improving the overall quality, reliability, and user satisfaction of software products in today's increasingly digital world.

FUTURE SCOPE

In future endeavors focused on software quality prediction, several avenues beckon for further exploration and refinement. First and foremost, delving into additional data sources beyond the conventional realms can enrich predictive models. This may involve incorporating diverse datasets such as code complexity metrics, developer collaboration patterns, or user feedback data to provide a more comprehensive understanding of software quality determinants. Secondly, advanced feature engineering techniques could be harnessed to extract more nuanced and informative features from software development data. By leveraging methodologies like natural language processing (NLP) for code comments analysis or semantic extraction from software artifacts, predictive models can gain deeper insights into the underlying factors influencing software quality. Additionally, enhancing the interpretability and explainability of predictive models stands as a crucial avenue for future research. Methods such as feature importance analysis and model-agnostic explanations can offer stakeholders clearer insights into the driving factors behind predictions, fostering trust and facilitating informed decision-making. Furthermore, temporal analysis and trend prediction present promising prospects for future work. By incorporating temporal dynamics into predictive models, such as predicting future quality trends or detecting anomalies, a more proactive approach to software quality management can be achieved. Customizing predictive models to specific software domains or development contexts, exploring ensemble learning techniques, and deploying adaptive models that can continuously learn and adapt to changing environments are among the other exciting avenues awaiting exploration. Lastly, ethical considerations must be paramount in future endeavors, ensuring that predictive models are developed and deployed responsibly, taking into account fairness, bias, privacy, and accountability concerns. Through concerted efforts in these directions, future software quality prediction projects can drive significant advancements in software engineering practices, ultimately leading to the creation of more reliable, resilient.

8. REFERENCES

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