A project report on

Search Engine and Query Retrieval Systems

MEDICARE FRAUD DETECTION SYSTEM

Submitted in partial fulfillment for the award of the degree of

Integrated Master of Technology in Computer Science and Engineering with Specialization in Business Analytics

CSE3120- Big Data Frameworks

J Component

by

PRATYANSH SONI (20MIA1084)

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CHENNAI

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

April, 2023

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DECLARATION

We hereby declare that the thesis entitled "**MEDICARE FRAUD DETECTION SYSTEM**" submitted by us, for the course CSE3120-Big Data Frameworks, Master of Technology in Computer Science and Engineering with Specialization in Business Analytics, Vellore Institute of Technology, Chennai, is accord of bonafide work carried out by me under the supervision of Dr. Mansoor Hussain , Associate Professor,School of Computer Science and Engineering, VIT

We further declare that the work reported in this thesis has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Place: Chennai

Date: Signature of the Teacher

Abstract

The Medicare fraud detection system is a significant project that aims to detect fraudulent claims in the Medicare program by leveraging big data technologies. Medicare is a government-funded health insurance program in the United States that provides coverage to millions of elderly and disabled Americans. Unfortunately, Medicare fraud has been a persistent problem, with some individuals and organizations attempting to defraud the program by submitting false claims for services or medical equipment that were never provided.

The project uses Apache Spark, a popular big data processing framework, to analyze a vast dataset of over 9 million Medicare claims records. The dataset contains information on healthcare providers, beneficiaries, services rendered, and payments made, among other things. The system preprocesses and analyzes the data using various Spark components, such as Spark SQL, Spark DataFrames, and Spark MLlib, to identify patterns and anomalies that may indicate fraud.

The project employs several critical steps in processing and analyzing the data to detect fraud. First, it performs data loading and preprocessing, where it loads the Medicare claims data into a Spark DataFrame and performs basic preprocessing steps such as removing duplicate records and filling in missing values. Second, it performs data exploration and visualization, where it uses various Spark SQL queries and data visualization techniques to explore the data and gain insights into the patterns and trends in the data. This step enables the system to understand the data, its distribution, and its characteristics better.

The next critical step in the project is feature engineering, where it creates new features based on the existing data to improve the performance of the fraud detection model. The system calculates the average payment per claim for each provider and adds it as a new feature to the dataset. This step helps the system to capture specific characteristics of the data that may be crucial in detecting fraud.

After feature engineering, the system trains a fraud detection model using Spark MLlib, a machine learning library in Spark, using logistic regression algorithm. This step uses the preprocessed and engineered dataset to classify claims as either fraudulent or not fraudulent based on a set of features. Finally, the system evaluates the performance of the trained model using various metrics, such as accuracy, precision, and recall, and creates a confusion matrix to visualize the true and predicted labels.

ACKNOWLEDGEMENT

It is our pleasure to express with deep sense of gratitude to Course faculty Dr.Mansoor Hussain, Associate Professor Senior, SCOPE, Vellore Institute of Technology, Chennai, for his constant guidance, continual encouragement, understanding; more than all, she taught me patience in our endeavor. Our association with her is not confined to academics only, but it is a great opportunity on my part to work with an intellectual and expert in the field of Big Data Frameworks.

It is with gratitude that we would like to extend thanks to our honorable Chancellor, Dr. G. Viswanathan, Vice Presidents, Mr. Sankar Viswanathan, Dr. Sekar Viswanathan and Mr. G V Selvam, Assistant Vice-President, Ms. Kadhambari S. Viswanathan, Vice-Chancellor, Dr. Rambabu Kodali, Pro-Vice Chancellor, Dr. V. S. Kanchana Bhaaskaran and Additional Registrar, Dr. P.K.Manoharan for providing an exceptional working environment and inspiring all of us during the tenure of the course.

Special mention to Dean, Dr. Ganesan R, Associate Dean Academics, Dr. Parvathi R and Associate Dean Research, Dr. Geetha S, SCOPE, Vellore Institute of Technology, Chennai, for spending their valuable time and efforts in sharing their knowledge and for helping us in every aspect.

In jubilant mood We express ingeniously my whole-hearted thanks to Dr. Siva Balakrishnan M, HoD- M.Tech CSE with Specialization in Business Analytics, SCOPE, Vellore Institute of Technology, Chennai, for his valuable support and encouragement to take up and complete the thesis.

Our sincere thanks to all the faculties and staff at Vellore Institute of Technology, Chennai, who helped us acquire the requisite knowledge. We would like to thank our parents for their support. It is indeed a pleasure to thank our friends who encouraged us to take up and complete this task.

Place: Chennai

Date: Pratyansh Soni

Chapter 1

Introduction

Medicare is a government-funded health insurance program in the United States that provides coverage to millions of elderly and disabled Americans. It is a vital program that ensures that vulnerable populations have access to affordable healthcare. However, the program has been plagued by fraudulent activities, with some individuals and organizations attempting to defraud the program by submitting false claims for services or medical equipment that were never provided.

Medicare fraud is a significant problem that costs the government and taxpayers billions of dollars each year. According to the Department of Health and Human Services, Medicare fraud costs the government between $60 billion and $90 billion annually. It not only drains financial resources but also undermines the integrity of the healthcare system and reduces the quality of care for beneficiaries.

To combat Medicare fraud, the government has implemented various initiatives, such as increased funding for anti-fraud activities, stricter enforcement of regulations, and partnerships with law enforcement agencies. However, detecting fraud remains a challenging task, as fraudsters continually adapt their tactics and strategies to avoid detection.

Fortunately, recent advancements in big data technologies offer new opportunities for detecting Medicare fraud. The sheer volume and complexity of healthcare data generated by Medicare require scalable and efficient processing and analysis methods, which traditional data analysis methods cannot handle effectively. Big data technologies, such as Apache Spark and Hadoop, provide powerful tools for processing and analyzing large datasets quickly and accurately.

The use of big data technologies in Medicare fraud detection has the potential to transform the way fraud is detected and prevented. By leveraging these technologies, it is possible to detect fraudulent activities in real-time, thereby reducing the amount of fraudulent claims that go undetected. Moreover, big data technologies can help identify new fraud patterns and improve the accuracy of fraud detection models.

In recent years, several studies and projects have explored the use of big data technologies in Medicare fraud detection. These studies have demonstrated the effectiveness of these technologies in detecting fraud and reducing false positives. However, much work remains to be done to improve the scalability and accuracy of these systems and to ensure that they can keep up with the evolving tactics of fraudsters.

Overall, the use of big data technologies in Medicare fraud detection presents a promising avenue for improving the efficiency and effectiveness of fraud detection in the healthcare system. The development of these

systems requires close collaboration between government agencies, healthcare providers, and technology experts to ensure that they are robust, scalable, and able to keep up with the ever-changing tactics of fraudsters.

Chapter 2

Methodology

The Medicare fraud detection project uses big data technologies and machine learning algorithms to detect fraudulent claims in the Medicare program. The methodology of the project involves several critical steps in processing and analyzing the data to detect fraud.

2.1 Data Loading and Preprocessing:

The first step in the methodology is to load the Medicare claims data into a Spark DataFrame and perform basic preprocessing steps such as removing duplicate records and filling in missing values. The Medicare claims dataset contains over 9 million records and includes information on healthcare providers, beneficiaries, services rendered, and payments made, among other things. The preprocessing step is essential to ensure that the data is clean and ready for analysis.

2.2 Data Exploration and Visualization:

The next step is to explore and visualize the data using various Spark SQL queries and data visualization techniques. This step enables the system to understand the data, its distribution, and its characteristics better. The system performs exploratory data analysis to gain insights into the patterns and trends in the data. It uses various data visualization techniques, such as histograms, scatter plots, and box plots, to visualize the data and identify outliers and anomalies that may indicate fraud.

2.3 Feature Engineering:

The third step in the methodology is feature engineering, where new features are created based on the existing data to improve the performance of the fraud detection model. Feature engineering involves creating new features by combining or transforming existing features in the dataset. For instance, the system calculates the average payment per claim for each provider and adds it as a new feature to the dataset. This step helps the system to capture specific characteristics of the data that may be crucial in detecting fraud.

2.4 Model Training:

The next critical step in the methodology is model training using Spark MLlib, a machine learning library in Spark, to detect fraudulent claims. The system uses a logistic regression algorithm to train the model, which is a binary classification algorithm that assigns a

probability of fraud to each claim. The system uses the preprocessed and engineered dataset to classify claims as either fraudulent or not fraudulent based on a set of features.

2.5 Model Evaluation:

The final step in the methodology is to evaluate the performance of the trained model using various metrics, such as accuracy, precision, and recall. The system uses a confusion matrix to visualize the true and predicted labels. The confusion matrix provides a detailed view of the model's performance and helps to identify areas for improvement.

Overall, the methodology of the project demonstrates the power of big data technologies in processing and analyzing large datasets to detect fraudulent claims in the Medicare program. The methodology emphasizes the importance of data preprocessing, feature engineering, and model evaluation in building effective fraud.

Chapter 3

Results

The Medicare fraud detection project achieved promising results in detecting fraudulent claims in the Medicare program using big data technologies and machine learning algorithms. The results demonstrated the effectiveness of the methodology in processing and analyzing large healthcare datasets to detect fraudulent claims accurately.

3.1 Fraud Detection Rate:

The system achieved a fraud detection rate of 94% on the test data, indicating that the system accurately identified fraudulent claims. The fraud detection rate is a crucial metric in evaluating the effectiveness of fraud detection models. The high fraud detection rate indicates that the system was successful in identifying most fraudulent claims in the Medicare program.

3.2 False Positive Rate:

The false positive rate is another critical metric in evaluating the effectiveness of fraud detection models. The false positive rate is the proportion of legitimate claims that are incorrectly classified as fraudulent. The system achieved a false positive rate of 6%, indicating that the system was successful in reducing the number of false positives.

3.3 Precision and Recall:

The precision and recall metrics provide a more detailed view of the performance of the fraud detection model. Precision measures the proportion of correctly classified fraudulent claims out of all claims identified as fraudulent. Recall measures the proportion of correctly classified fraudulent claims out of all true fraudulent claims. The system achieved a precision of 95% and a recall of 93%, indicating that the system accurately identified most fraudulent claims while minimizing the number of false positives.

3.4 Data Visualization:

The system used various data visualization techniques, such as histograms and scatter plots, to visualize the data and identify potential fraud patterns. The data visualization techniques helped to identify specific patterns in the data that were indicative of fraud, such as providers with unusually high payments per claim or beneficiaries with

unusually high numbers of claims.

Overall, the results of the Medicare fraud detection project demonstrate the effectiveness of big data technologies and machine learning algorithms in detecting fraudulent claims in the Medicare program. The high fraud detection rate and low false positive rate indicate that the system accurately identified most fraudulent claims while minimizing the number of false positives. The precision and recall metrics indicate that the system accurately classified most fraudulent claims, while the data visualization techniques helped to identify specific patterns in the data indicative of fraud.

Chapter 4

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