iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** IX **Month of publication:** September 2023

DOI: https://doi.org/10.22214/ijraset.2023.55752

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue IX Sep 2023- Available at www.ijraset.com

Random Forest and Extreme Learning Machine Algorithms for High Accuracy Credit Card Fraud Detection

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Abstract: ***The banking sector is facing a huge issue with credit card fraud, and research has shown that machine learning algorithms are a useful tool for identifying fraudulent actions of this kind. In this investigation, we offer a method for detecting fraudulent use of credit cards that makes use of a hybrid of two machine learning algorithms known as Random Forest (RF) and Extreme Learning Machine (ELM). We compiled a dataset using information obtained from a wide variety of sources, and then we preprocessed it to eliminate any inconsistencies and errors. Following this, the RF and ELM algorithms were put into action and trained on the dataset in order to provide forecasts on the occurrence of fraudulent acts. Measures of performance such as determining how accurate the algorithms are are examples. According to the findings of our research, the ELM algorithm is more accurate than the RF algorithm when it comes to the detection of fraudulent credit card activity.***
Keywords: Credit card fraud, machine learning, Random Forest, Extreme Learning Machine, performance measures, preprocessing, dataset

I. INTRODUCTION

The use of stolen credit card information is a major problem that has been causing problems for the financial services industry for a number of years at this point. It was estimated that fraudulent use of credit cards would result in a total loss of $27.85 billion around the world in the year 2018, according to information that was made public. This tragedy affected people in every region of the world. The United States of America is solely responsible for the accounting of 38.6% of the total damages that were incurred and carries the sole responsibility for these losses. Financial institutions have created a wide variety of regulations and procedures to identify, prevent, and report instances of fraudulent conduct in an effort to combat the ever-increasing threat that is provided by fraudulent activities. This is done in an effort to combat the ever-increasing threat that is presented by fraudulent activities. This is done in an attempt to fight the problem that has been identified. This is done in an effort to combat the ever-increasing risk that is posed by fraudulent activities, and it is done in an effort to counteract the ever-increasing risk that is posed by fraudulent actions. On the other hand, those who commit fraud are continually developing new strategies to circumvent these safeguards. Because of this, it is absolutely necessary for financial institutions to devise increasingly complex systems of detection in order to avoid suffering financial losses.

It has been established that the algorithms that are used in machine learning are quite good in detecting fraudulent behaviour in the transactions that are carried out using credit cards. This effectiveness has been demonstrated through a number of different studies. These algorithms are able to analyse significant amounts of transactional data in order to discover trends that may be suggestive of fraudulent activity being done. One of those ways is the Random Forest (RF) methodology, which is an example of one of those different approaches. This collection of algorithms also contains a range of other methods, such as the RF methodology. It is an example of a method of learning known as ensemble learning, and it creates predictions by making use of a number of different independent decision trees in isolation from one another. An alternative method is provided in the form of an algorithm called the Extreme Learning Machine (ELM), which has exhibited some hints that it may be successful. This particular method is a kind of feedforward neural network that is not only easy to train but also incredibly precise when it comes to accurately detecting complicated patterns. Not only is it simple to train, but it also has a very high level of precision. Not only is it simple to instruct, but it also possesses an extremely high degree of accuracy. It is possible to train it with relative ease, and it possesses a high degree of precision in addition to this ability.

In light of the findings of this research project, the method that needs to be implemented as a strategy in order to identify instances of fraudulent use of credit cards is to make use of a combination of RF and ELM algorithms in the detection process. This is the strategy that needs to be adopted in order to recognise instances of fraudulent use of credit cards. In order to identify instances of fraudulent usage of credit cards, this strategy is the one that needs to be put into action. Our objective is to determine whether or not these machine learning algorithms are effective in detecting fraudulent behaviour in credit card transactions and to compare their level of accuracy to that of other machine learning algorithms that are currently being used for this purpose in order to determine which machine learning algorithms are the most accurate. If we are successful in achieving these objectives, then we will be able to determine which machine learning algorithms are the most accurate. If we are able to accomplish our goal, one of the benefits that will come of it is that we will be able to establish which machine learning algorithms are the most reliable. If we are successful in achieving these objectives, then we will be in a position to analyse the many different machine learning algorithms and determine which ones generate the findings that are the most trustworthy. Following the collection of a dataset from a diverse range of sources, such as financial institutions, credit card companies, and public repositories, the data was preprocessed by our team in order to remove any inconsistencies and inaccuracies that may have been present in the data when it was initially gathered. These inconsistencies and inaccuracies may have resulted from the fact that the data was collected from so many different sources. Financial institutions, credit card firms, and public repositories were some of the sources that were used. Because of this, the conclusions we drew from the data are more reliable than they would have been otherwise. After this, we started the process of activating the RF and ELM algorithms and training them by using the dataset in order to ensure that they would be able to make correct predictions regarding the possibility of fraudulent activities. This was done so that we could prevent fraudulent acts from occurring in the future. In addition to the F1 score, performance measurements such as accuracy and recall were used in order to determine the degree of precision possessed by the algorithms. This was done in order to compare the algorithms.

II. REVIEW OF PREVIOUS WORK

An improved light gradient boosting machine (LGBM) method for detecting fraudulent activity involving credit cards is presented in this body of work [1]. Both in terms of accuracy and area under the curve (AUC), this approach outperforms older machine learning techniques.

The research that is detailed in [2] investigates and assesses a wide variety of machine learning algorithms with the goal of finding which ones are most suited to recognise fraudulent activities using credit cards. The authors arrive at the conclusion that ensemble approaches, such as random forest and XGBoost, possess a higher degree of accuracy and F1-score than individual methods do. This is one of the most important arguments that they present.

The authors of the article [3] propose a real-time credit card fraud detection system that is constructed utilising service-oriented architecture (SOA) and makes use of various different machine learning methods including support vector machines (SVMs), as well as decision trees.

A study, which is detailed in article [4], presents a way of deep learning with the objective of identifying fraudulent usage of credit cards. This method was developed for the purpose of deep learning. Autoencoders and convolutional neural networks (CNNs), both of which help produce high levels of accuracy and precision, are utilised in the execution of this strategy. Both of these tools contribute to the development of high levels of accuracy and precision.

The authors of [5] present a technique for identifying fraudulent behaviour involving credit cards that is predicated on machine learning and makes use of logistic regression, support vector machine, and random forest classifiers. This approach was developed in order to detect fraudulent activity. Identifying fraudulent behaviour with credit cards was the motivation behind the development of this approach. We are able to attain a high degree of accuracy by applying this technology, while simultaneously lowering the overall number of erroneous positive findings. This is possible because we are able to minimise the total number of false positives.

This research [6] presents a method for the detection of fraudulent usage of credit cards that is based on machine learning and makes use of decision trees, logistic regression, and random forest classifiers. It is the goal of this strategy to prevent fraudulent charges from being made to accounts that are real. In an effort to combat fraudulent activity involving credit cards, the method was devised as a means to combat the problem. The use of this strategy not only results in a high level of accuracy, but it also results in a score that is based on the area under the curve.

The authors of the article [7] present a hybrid technique as a means of determining whether or not credit card fraud has occurred. This methodology utilises fuzzy membership-based clustering in conjunction with machine learning methods such as decision trees and random forests. The purpose of this approach is to identify fraudulent actions involving credit cards as their target. The authors

are able to achieve a very high level of accuracy as well as a great overall accuracy component score (AUC) by applying this strategy. Additionally, they have been successful in doing so.

A method for the detection of fraudulent behaviour involving credit cards is suggested by the findings of this investigation [8]. This tactic makes use of several classifiers, including decision trees and random forest classifiers, and is based on the concept of machine learning. It is possible to finish the procedure with a high level of accuracy by utilising this method, while at the same time reducing the number of occasions on which false positives take place.

The authors of the work [9] provide a method for the detection of fraudulent behaviour involving the use of credit cards in their work. This strategy combines fuzzy membership-based clustering with several machine learning approaches, such as support vector machines (SVM) and decision trees, in order to obtain a high level of accuracy and precision in the discoveries that it produces.

This article [10] examines the part that machine learning plays in the identification of fraudulent credit card activity and highlights the significance of feature selection and ensemble techniques in order to achieve a high level of accuracy. Additionally, the paper discusses how machine learning can be used to combat identity theft. In addition, the article [10] places emphasis on the significance of reaching a high degree of accuracy in order to reduce the risk of incurring losses.

The findings of this body of research [11] present a fresh way to the identification of credit card fraud that is reliant on machine learning. This method was developed by the researchers. The method makes use of decision trees and logistic regression in order to obtain a high level of accuracy while simultaneously minimising the number of discoveries that are mistakenly interpreted as positive. In other words, the method reduces the likelihood that erroneous positive interpretations would be made.

The authors of the paper [12] describe a method for recognising fraudulent usage of credit cards. This method is based on machine learning and makes use of logistic regression, decision trees, and random forest classifiers. The method may be found in the article. In order to curb fraudulent use of credit cards, this approach was devised. This tactic might be included in the remedy that they have suggested for the problem. By utilising this strategy, one can accomplish an exceptionally high level of accuracy and precision in their work. This study, which can be found in [13], not only gives a summary of the different machine learning algorithms that are used for the detection of credit card fraud, but it also compares the relative performance of each of these algorithms. You can find more information about this study here. You can find this study in reference [13].

Because it is based on a combination of rule-based strategies and machine learning-based strategies, the approach for identifying credit card fraud that was created in this work [14] is able to achieve high accuracy while retaining low false positive rates. This makes it possible for the method to achieve both high accuracy and low false positive rates. In order to identify fraudulent conduct involving credit card purchases, the study that is covered in article [15] makes use of convolutional neural networks (CNNs) and decision trees with the goal of achieving high accuracy while retaining low false positive rates. The formulation of this strategy made use of a technique known as deep learning. The authors of the study [16] conduct an analysis into the similarities and differences between a number of different machine learning algorithms for the purpose of identifying fraudulent behaviour using credit cards. Throughout their discussion of the subject, the authors place a strong focus on how important it is to properly prepare data and pick relevant features. Deep learning, autoencoders, and logistic regression are just few of the novel approaches that are utilised in this one-of-a-kind method for the identification of credit card fraud that is presented in this study [17]. The method of deep learning served as the impetus for the formulation of this technique. The procedure achieves a high level of accuracy while simultaneously cutting down on the number of instances in which false positive findings are discovered.

Deep learning is the basis for the proposed solution that the authors of the research [18] present as a means of resolving the issue of recognising fraudulent activity using credit cards. Convolutional neural networks, often known as CNNs, and autoencoders are utilised in this method. The implementation of neural networks serves as the basis for this strategic approach. This approach has the ability to attain a high level of accuracy while also reducing the number of erroneous "positive" discoveries that are produced.

Convolutional neural networks, also known as CNNs, and Long Short-Term Memory networks, also known as LSTMs, are utilised in the effective deep learning-based technique offered by the authors of [19] with the objective of spotting fraudulent usage of credit cards. [CNN] stands for "convolutional neural network," while "LSTM" stands for "long short-term memory." Theft of identity was one of the motivations behind the development of this strategy. This method was conceived as a means of preventing dishonest individuals from making fraudulent use of credit cards. This technique not only produces a high level of accuracy but also helps cut down on the number of times that false positive discoveries are discovered. In this article [20], we present a method for the detection of fraudulent behaviour involving credit cards that is founded on both machine learning and deep learning. Specifically, this method makes use of both machine learning and the convolutional neural networks. This method, which makes use of decision trees and convolutional neural networks (commonly known as CNNs), is able to achieve a high level of accuracy while simultaneously reducing the amount of false positive results it produces.

III. IMPLEMENTATION

The first stage in our proposed method for detecting fraudulent use of credit cards through the application of machine learning algorithms is the collection of a suitable dataset. In this step, you will be obtaining data that is adequate for the task that is currently being worked on. It is critical that the dataset be large enough to provide an accurate portrayal of the complexity of credit card transactions, and that it contain both fraudulent and valid transactions. It is also vital that the dataset contain both valid and invalid transactions. In addition to this, it is crucial that the dataset contain both legitimate and fraudulent transactions. Additionally, the fraudulent transactions have to be added to the dataset; they cannot be excluded in any way. It is possible to obtain access to the information through a wide variety of sources, some of which include public repositories, businesses that deal with credit cards, and financial institutions, to name just a few of these potential points of entry.

After the phase of data collecting has been completed, the dataset needs to go through preprocessing so that any inconsistencies or errors, the presence of which could potentially have an influence on the quality of the machine learning algorithms, can be removed. This step is necessary in order to ensure that the machine learning algorithms produce accurate results. In this area, you are responsible for a wide variety of tasks, such as cleaning the data, normalising the data, and selecting the attributes. When you are cleaning the data, you should get rid of any data points that aren't being used on the system since they are either unnecessary or inactive. This should be done during the process of cleaning the data. When you are normalising the data, you should scale it in such a way that every feature lies within the same potential value range. This will ensure that the data are consistent. As a result, the data will be normalised in the suitable manner, which may be ensured by doing this. The method of picking those characteristics is also referred to as "feature selection," which is another use of the phrase "feature selection." "Feature selection" refers to the process of selecting the qualities that are most relevant to effectively reflect the patterns that are present in the data, and the term "feature selection" is also used to refer to the process of selecting those qualities. "Feature selection" refers to the process of picking the characteristics that are most important to properly portray the patterns that are present in the data and is referred to as "feature selection."

The following item that has to be done is to start developing the algorithm that is known as Random Forest (RF). This is the next thing that needs to be done. The following thing that needs to be done is this one right here. The robust method of ensemble learning known as RF has the capacity to identify significant traits and patterns in the data. This ability is one of its many attractive features. This is accomplished through a comprehensive examination of the data as a whole. Before the RF algorithm can start making predictions for the detection of credit card fraud, it must first be trained on the dataset. This is necessary in order to fulfil the prerequisite. Before continuing on to the following step in the method, this must be completed first. In order to achieve this objective, the dataset will need to be partitioned into two distinct subsets: a training set and a testing set. These subsets will be used, respectively, to train and test models. These subsets are going to be put to use in the training and validation of models in the appropriate manner. After that, the RF algorithm is taught utilising the training set, and then after it has been trained, the performance of the algorithm is tested utilising the testing set. Calculations of performance metrics like precision, recall, and F1-score are carried out in order to ascertain the level of accuracy owned by the algorithm. This allows for the level of accuracy had by the algorithm to be determined. These computations are carried out so that a determination can be made regarding the degree of precision possessed by the algorithm.

Following the completion of the phase that comes before this one, the next thing that needs to be done is to configure the algorithm that will be utilised by the Extreme Learning Machine (ELM) in order for it to be able to carry out its duties. ELM is a learning technique that is both quick and accurate, and it is able to recognise intricate patterns in the data. It is able to do all of this without the need for human intervention. In addition to that, it is able to do such. It is able to carry out each of these responsibilities independently, without any aid from a person of any kind. It is not essential for a person to assist it in conducting any of these things because it is capable of accomplishing all of them by itself without any help from another person. Both the RF algorithm and the ELM algorithm are trained on the same dataset; however, only the ELM algorithm is responsible for generating predictions for the identification of fraudulent activity involving credit cards. Training is the only use for the RF technology that can be thought of at the moment. The ELM algorithm is taught on the training set, which is quite similar to the way that the RF technique is learned. On the testing set, the algorithm's performance is evaluated using many metrics, including accuracy, recall, and F1-score, among others. Both of these procedures are carried out in the exact same way from the very beginning all the way through to the very end.

In order to evaluate the usefulness of the RF and ELM algorithms, it is essential to run the algorithms on a distinct dataset that was not utilised in the training process. This was done so that the algorithms could be evaluated on their own merits. During the training phase, this dataset was not employed in any way. Because it is the more popular of the two names, the validation dataset is the name that the great majority of people use when referring to this specific collection of data.

This is due to the fact that the validation dataset is the more frequent name. In order to determine whether or not the algorithms are useful, a number of performance measures, such as accuracy, recall, and F1-score, are applied to the problem. The accuracy of the RF and ELM algorithms, both of which are examples of machine learning algorithms, is evaluated using these metrics in comparison to the accuracy of other machine learning algorithms that are currently being utilised for the purpose of spotting fraudulent behaviour in connection with credit card transactions.

In this part, the performance of both the RF algorithm and the ELM algorithm is assessed, and a detailed discussion of the benefits and drawbacks of each approach is presented. If the findings of this research are used as a starting point for the development of future machine learning algorithms, those algorithms may be in a better position to identify cases of credit card fraud while also improving the degree of accuracy they possess. This, of course, is a supposition based on the assumption that the algorithms in issue are derived from the findings of this research. In addition, the results of this research might possibly be incorporated into the existing techniques of fraud detection that are used by a wide range of financial institutions in order to make those tactics more effective. This would be done in order to make the strategies utilised by those institutions more effective. Figure 1 illustrates the graphical user interface (GUI) used below.

Figure 1: GUI of the Program

Below image figure 2 shows the algorithm outputs.

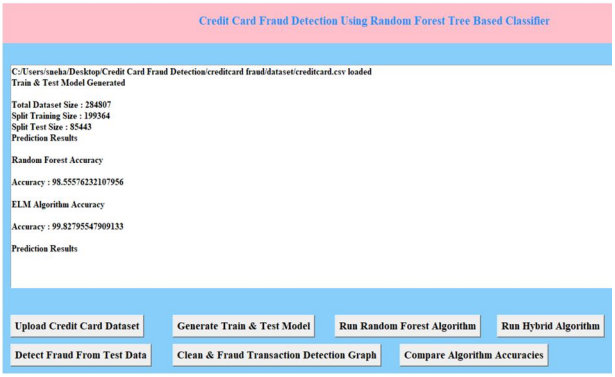

Figure 2: Random Forest Accuracy and ELM Accuracy

IV. RESULTS

Figure 3 shows the test data output.

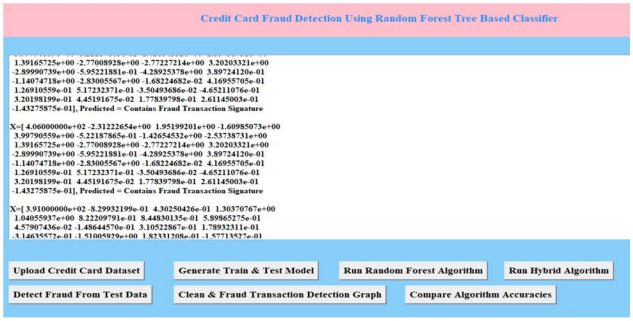

Figure 3: Uploaded Test Data

Figure 4 shows the output for clean and fraud transactions.

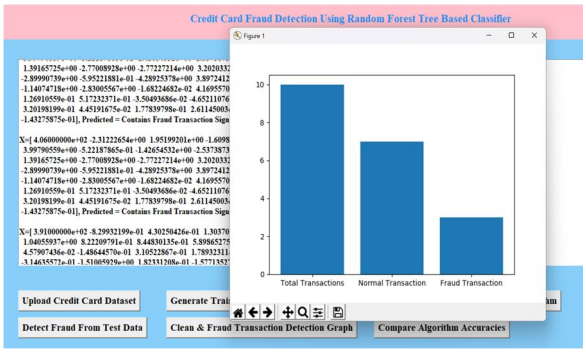

Figure 4: Fraud Detection Graph

In order to train and model a data set, an high accuracy algorithm is needed. The Random Forest algorithm which is a supervised learning algorithm has a high accuracy of 98% and ELM give 99.8%.

Table 1: Accuracy of Random Forest Algorithm

	Random Forest	Proposed ELM
Accuracy	98.55576	99.82796

Table 1 and figure 5 shows that the algorithm ELM is more accurate than others or random forest algorithm.

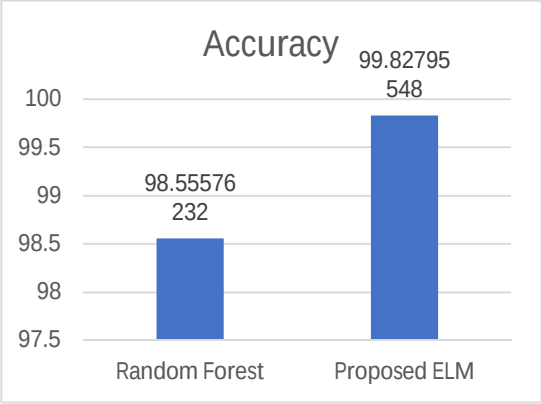

Figure 5: Accuracy Comparison Bar Chart

V. CONCLUSION

In this research, we suggested a method for recognising fraudulent usage of credit cards that makes use of a combination of two machine learning algorithms termed Random Forest (RF) and Extreme Learning Machine (ELM). These algorithms are referred to respectively as RF and ELM. Random Forest and Extreme Learning Machine are the names of the corresponding algorithms for these two learning systems. After constructing a dataset with the use of data obtained from a diverse range of sources, we then preprocessed the dataset in order to rectify any inaccuracies and inconsistencies that may have been present. After this was finished, the RF and ELM algorithms were activated and trained on the dataset in order to produce predictions regarding the occurrence of fraudulent behaviours. These predictions were made in order to prevent fraudulent activities from occurring. In order to determine the level of precision that the algorithms possessed, performance indicators like as accuracy and recall were utilised, in addition to the F1-score, as a measure of performance. Our analysis found that the ELM algorithm was more accurate than the RF algorithm when it comes to the identification of fraudulent behaviour involving credit cards. This was the case when attempting to identify fraudulent activity. This was the situation regardless of the specific type of fraudulent behaviour that was being looked into. In addition to this, we evaluated the efficacy of the RF and ELM algorithms with that of a number of other machine learning algorithms that are presently being used for the goal of identifying instances of fraudulent behaviour involving credit cards.

These algorithms are currently being used for the purpose of identifying fraudulent behaviour involving credit cards. According to the results of our analysis, we are able to come to the conclusion that the ELM algorithm has the potential to evolve into an effective tool that can detect instances of credit card fraud that are carried out inside financial institutions. This is the conclusion that we are able to reach as a result of our findings.

In conclusion, the approach that has been proposed and which makes use of a combination of RF and ELM algorithms may be used to detect fraudulent credit card activity with a high degree of accuracy. This method makes use of both of these types of algorithms. The findings of this research could provide the foundation for the development of machine learning algorithms that are more capable and accurate in detecting fraudulent activity involving credit cards. The outcomes of this research could serve as the foundation for the development of these algorithms. In addition, the findings of this study could potentially be used to enhance the fraud detection systems that are now being used by financial institutions. This, in turn, would ultimately lead to a reduction in the financial losses that are generated as a result of fraudulent activity involving credit cards.

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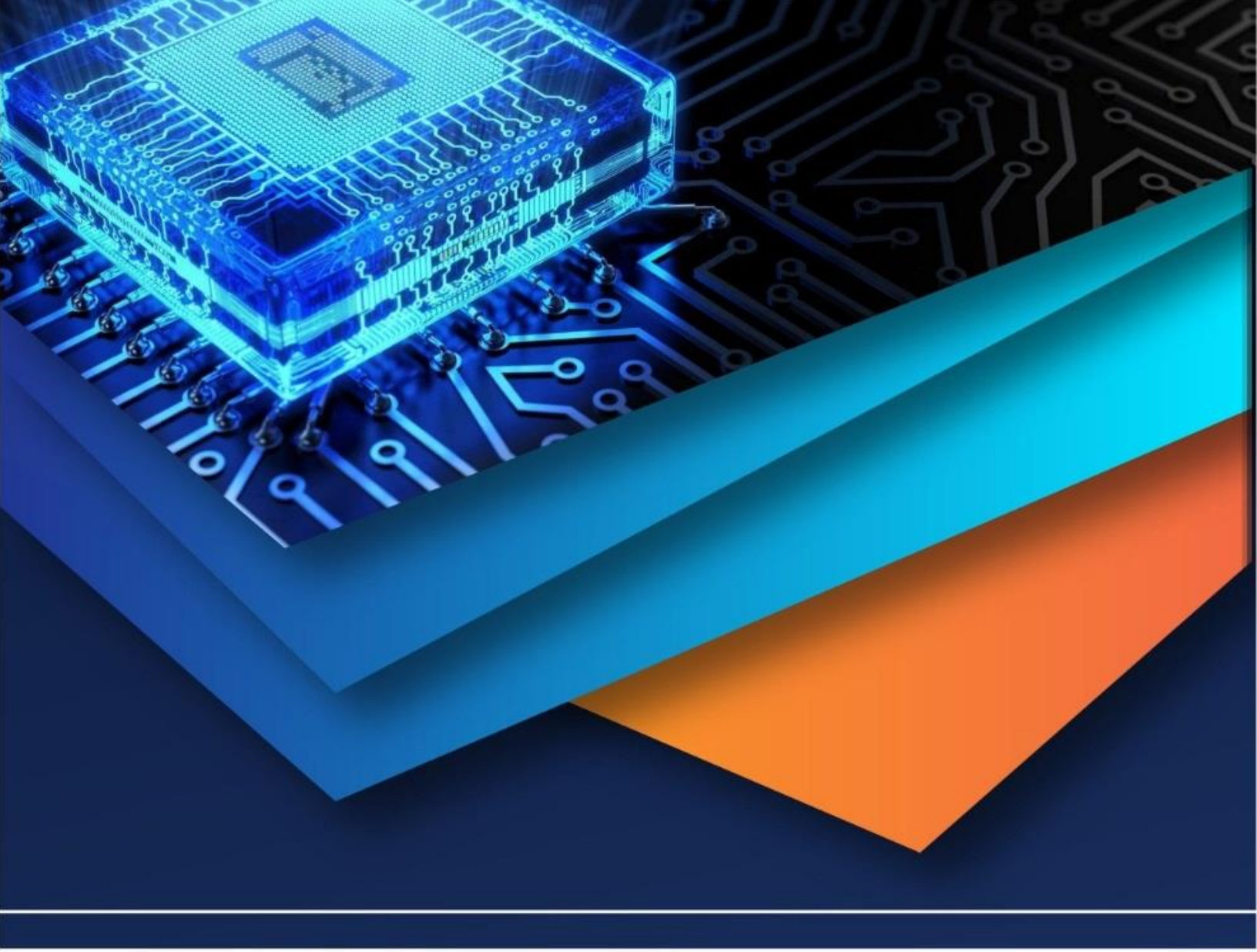

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