

PROFESSIONAL TRAINING REPORT - II

entitled

UNMASKING DECEPTION: SVM BASED FRAUD DETECTION

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Computer Science and Engineering with
specialization in Cyber Security

by

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(DEEMED TO BE UNIVERSITY)**

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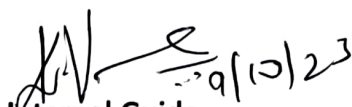
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BONAFIDE CERTIFICATE

This is to certify that this Professional Training is the bonafide work of **Mr. PATNAM ROCHAN (41614068)** who carried out the project entitled **SPHINX.BOT** under my supervision from June 2023 to October 2023.


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COURSE CERTIFICATE



ABSTRACT

Online product evaluations have become a vital resource for shoppers looking for knowledge and direction for their purchases in the age of digital commerce. The prevalence of fraudulent product evaluations has jeopardized this priceless source of knowledge, seriously compromising the trustworthiness and integrity of online review systems. By deeply examining the identification and analysis of phony product evaluations and utilizing the capabilities of machine and deep learning algorithms, this thesis aims to address this problem.

This research project starts by gathering a wide range of product reviews from different online sources. We make sure the data is consistent and of good quality by using rigorous preprocessing. We then extract important features from the reviews, like sentiment, language, and metadata, to help us analyze them. We use regular machine learning models to figure out if the reviews are real or fake, which helps us measure performance. Then, we use deep learning techniques like CNNs to get into the details of the text, which helps us detect fake reviews more accurately.

This study also emphasizes the interpretability and explainability of model predictions, offering insight into the variables influencing the detection of false reviews. Our algorithms are applied to real-world datasets and settings, proving their efficacy in identifying fraudulent product evaluations across a variety of sectors, allowing us to evaluate the practical value of our research. In addition to algorithmic skill, ethical issues relating to privacy and fairness in fake review analysis are thoughtfully addressed, ensuring that the creation and application of these models are in line with responsible AI practices. To sum up, this thesis helps with continuous efforts to protect the integrity of online review systems, allowing customers to make wise decisions, and upholding the reliability of e-commerce platforms.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Credit card fraud detection is a critical domain within the realm of financial security, aiming to identify and prevent unauthorized or fraudulent transactions. As technology advances, so do the tactics of fraudsters, making traditional methods of fraud detection insufficient. In response, machine learning algorithms like Support Vector Machines (SVM) have emerged as powerful tools in combating this evolving threat.

Support Vector Machines are supervised learning models used for classification and regression tasks. In the context of credit card fraud detection, SVMs excel at distinguishing between legitimate and fraudulent transactions by finding the optimal hyperplane that separates the two classes in a high-dimensional space.

Problem Statement:

Credit card fraud poses a significant threat to financial institutions and cardholders, resulting in substantial monetary losses and erosion of trust. Traditional rule-based systems are often inadequate in detecting sophisticated fraudulent activities, necessitating the development of advanced machine learning models like Support Vector Machines (SVMs) for accurate and timely fraud detection.

Several challenges persist in deploying effective fraud detection systems:

- **Imbalanced Datasets:**

Fraudulent transactions are typically rare compared to legitimate ones, leading to imbalanced datasets where the majority class (legitimate transactions) overwhelms the minority class (fraudulent transactions). This class imbalance can bias the model's learning process, leading to poor performance in detecting fraud.

- **Dynamic Nature of Fraud:**

Fraudulent activities evolve over time, with fraudsters continually devising new tactics to evade detection. Traditional SVM models may struggle to adapt to these changing patterns, resulting in decreased effectiveness over time.

- **High Dimensionality and Feature Selection:**

Credit card transaction data often comprises numerous features, including transaction amount, time, location, and more. The high dimensionality of these datasets can lead to increased computational complexity and overfitting. Additionally, selecting relevant features and reducing dimensionality while preserving critical information is a non-trivial task.

SVM-based credit card fraud detection system designed to accurately identify and prevent fraudulent transactions in real-time. It integrates advanced machine learning techniques to address the challenges associated with imbalanced datasets, dynamic fraud patterns, high dimensionality, interpretability, and adversarial attacks.

Working of the Detection System:

- **Data Collection and Preprocessing:**

Transactional data from credit card transactions is collected, including features such as transaction amount, time, location, and more. The collected data undergoes preprocessing steps, including handling missing values, normalization, and potentially dimensionality reduction techniques like PCA to mitigate the curse of dimensionality.

- **Training the SVM Model:**

The preprocessed and balanced dataset is used to train the SVM model. During training, the SVM learns to classify transactions as either legitimate or fraudulent by finding the optimal hyperplane that maximizes the margin between the classes while minimizing classification errors.

CHAPTER 2

LITERATURE REVIEW

2.1 SURVEY

Credit card fraud continues to pose a significant challenge for financial institutions, merchants, and cardholders worldwide. With the rise of online transactions and electronic payment systems, detecting fraudulent activities in real-time has become paramount to mitigate financial losses and preserve trust in the banking industry. Support Vector Machines (SVM) have emerged as a popular choice for building robust and accurate fraud detection systems due to their ability to handle high-dimensional data and nonlinear decision boundaries effectively. This literature review aims to provide a comprehensive overview of SVM-based credit card fraud detection, including methodologies, challenges, recent advancements, and future research directions.

Methodologies:

- **Data Preprocessing:**

Prior to model training, credit card transaction data undergoes preprocessing steps such as data cleaning, normalization, and feature engineering. Feature selection techniques may be applied to reduce dimensionality and enhance the discriminative power of the model.

- **Support Vector Machines (SVM):**

SVM is a supervised learning algorithm used for binary classification tasks, including fraud detection. By finding the optimal hyperplane that maximizes the margin between classes in a high-dimensional feature space, SVMs can effectively distinguish between legitimate and fraudulent transactions. Various kernel functions, including linear, polynomial, and radial basis function (RBF), are employed to capture complex decision boundaries.

- **Handling Class Imbalance:**

Imbalanced datasets, where fraudulent transactions are rare compared to legitimate ones, pose a challenge for fraud detection systems. Techniques such as oversampling,

under sampling, and Synthetic Minority Over-sampling Technique (SMOTE) are utilized to address class imbalance and improve model performance.

- **Model Evaluation:**

The performance of SVM-based fraud detection models is evaluated using metrics such as accuracy, precision, recall, F1-score, and receiver operating characteristic (ROC) curve analysis. Cross-validation and holdout validation techniques are commonly employed to assess model generalization ability.

Challenges:

- **Class Imbalance:**

Imbalanced datasets can lead to biased models that favor the majority class (legitimate transactions) and overlook fraudulent activities. Balancing techniques are crucial to ensure that the SVM model can effectively detect fraudulent transactions without sacrificing accuracy.

- **Dynamic Fraud Patterns:**

Fraudulent activities evolve over time, necessitating fraud detection systems to adapt to changing patterns. SVM models may struggle to keep pace with dynamic fraud behaviors, requiring continuous monitoring and model updates to maintain effectiveness.

- **Model Interpretability:**

SVM models are often considered black-box algorithms, making it challenging to interpret their decision-making process. Interpretable models are essential for gaining insights into the factors influencing fraud detection decisions and building trust with stakeholders.

- **Adversarial Attacks:**

Fraudsters may attempt to evade detection by manipulating transaction data or exploiting vulnerabilities in the SVM model. Adversarial attacks pose a significant threat to the

integrity of fraud detection systems, requiring robust defense mechanisms to mitigate risks.

Recent Advancements:

- **Ensemble Learning:**

Ensemble techniques, such as bagging and boosting, have been applied to SVM-based fraud detection systems to improve model robustness and generalization ability. By combining multiple SVM classifiers trained on different subsets of the data, ensemble methods can effectively capture diverse fraud patterns.

- **Online Learning:**

Online learning approaches enable SVM models to adapt to new data and evolving fraud patterns in real-time. Incremental SVM algorithms and online updating strategies allow fraud detection systems to continuously learn and improve without retraining the entire model.

- **Adversarial Defense Mechanisms:**

Recent research has focused on developing defense mechanisms to protect SVM-based fraud detection systems against adversarial attacks. Techniques such as robust training, input sanitization, and anomaly detection help detect and mitigate adversarial threats effectively.

FUTURE DIRECTIONS:

Here are some potential future directions to enhance and safeguard fraud detection systems:

- **Advanced Machine Learning Techniques:**

Explore more advanced machine learning techniques such as deep learning,

reinforcement learning, and ensemble methods to improve the accuracy and robustness of fraud detection models. These techniques can capture complex patterns and relationships in the data that traditional methods may miss.

- **Real-time Monitoring and Detection:**

Implement real-time monitoring and detection systems that can analyze transactions as they occur and flag potentially fraudulent activity in real-time. This proactive approach can help prevent fraudulent transactions from being completed and minimize financial losses.

- **Anomaly Detection:**

Utilize anomaly detection algorithms to identify unusual or suspicious patterns in transaction data that deviate from normal behavior. Anomaly detection can be effective in detecting new and previously unseen types of fraud that may not be captured by rule-based or supervised learning approaches.

- **Behavioral Biometrics:**

Incorporate behavioral biometrics such as mouse movements, keystroke dynamics, and device fingerprints into fraud detection systems. Analyzing these unique behavioral patterns can help authenticate users and detect fraudulent activity based on changes in behavior.

- **Graph Analytics:**

Apply graph analytics techniques to analyze complex networks of relationships between entities such as customers, merchants, and transactions. By modeling the interactions between these entities as a graph, it is possible to detect patterns of suspicious behavior and identify potential fraud rings or networks.

- **Explainable AI:**

Develop explainable AI models that provide transparency and interpretability into the

decision-making process of fraud detection systems. Explainable AI techniques can help stakeholders understand how decisions are made and identify potential biases or errors in the model.

- Collaborative Intelligence:

Foster collaboration and information sharing among financial institutions, law enforcement agencies, and cybersecurity experts to collectively combat fraud. Sharing insights, best practices, and data can help identify emerging fraud trends and develop more effective prevention strategies.

- Blockchain Technology:

Explore the use of blockchain technology to create immutable and transparent transaction records. By recording transactions on a decentralized ledger, blockchain can enhance the security and traceability of financial transactions, making it more difficult for fraudsters to manipulate or alter transaction data.

- Continuous Monitoring and Adaptation:

Implement continuous monitoring and adaptation mechanisms that can dynamically adjust fraud detection models based on evolving threats and changes in transaction patterns. By staying up-to-date with emerging fraud trends, systems can effectively adapt to new challenges and maintain high detection rates.

- User Education and Awareness:

Educate users about common fraud schemes, phishing attacks, and best practices for protecting their personal and financial information. By raising awareness and promoting cybersecurity hygiene, users can become more vigilant and proactive in detecting and reporting fraudulent activity.

CHAPTER 3

REQUIREMENTS ANALYSIS

3.1 OBJECTIVE OF THE PROJECT

Objective:

- **Develop a Robust SVM-Based Model:**

Implement a Support Vector Machine (SVM) classifier for credit card fraud detection.

Explores different kernel functions (e.g., linear, polynomial, radial basis function) to identify the most suitable option for separating legitimate and fraudulent transactions effectively.

- **Data Collection and Preprocessing:**

Gather a comprehensive dataset of credit card transactions, including features such as transaction amount, time, location, and transaction type. Preprocess the data to handle missing values, normalize features, and address any data inconsistencies or outliers that may affect model performance.

- **Address Class Imbalance:**

Implement techniques to address class imbalance, ensuring that the SVM model can effectively learn from both fraudulent and legitimate transactions. Explore oversampling, under sampling, or algorithmic approaches like Synthetic Minority Over-sampling Technique (SMOTE) to balance the dataset.

- **Feature Selection and Dimensionality Reduction:**

Identify relevant features for fraud detection using techniques such as correlation analysis, information gain, or feature importance rankings. Utilize dimensionality reduction methods like Principal Component Analysis (PCA) to reduce computational complexity while preserving critical information.

- **Model Training and Evaluation:**

Train the SVM model on the preprocessed dataset using appropriate training/validation splits or cross-validation techniques. Evaluate the model's performance using metrics such as accuracy, precision, recall, F1-score, and area under the ROC curve (AUC).

- **Dynamic Model Adaptation:**

Implement mechanisms for dynamic model adaptation to handle evolving fraud patterns. Explore online learning algorithms or ensemble techniques to update the SVM model in real-time based on incoming transaction data.

- **Enhance Model Interpretability:**

Employ techniques to enhance the interpretability of the SVM model's decisions. Conduct feature importance analysis or visualization methods to provide insights into the factors influencing fraud detection outcomes.

- **Defense Against Adversarial Attacks:**

Develop strategies to protect the SVM-based fraud detection system against adversarial attacks. Implement robust training techniques, input sanitization methods, or anomaly detection mechanisms to detect and mitigate adversarial threats effectively.

- **Real-Time Fraud Detection Implementation:**

Deploy the trained SVM-based fraud detection model into a real-time processing environment. Integrate the model with existing transaction processing systems to analyze incoming transactions in real-time and flag potential fraudulent activities.

- **Performance Evaluation and Optimization:**

Continuously monitor the performance of the deployed fraud detection system. Fine-tune model hyperparameters and update algorithms to optimize detection accuracy and minimize false positives/negatives.

- **Documentation and Reporting:**

Document the entire process, including data collection, preprocessing steps, model development, and deployment procedures. Prepare a comprehensive report detailing the project methodology, findings, challenges encountered, and recommendations for future improvements.

3.1 REQUIREMENTS

- **FLASK:**

Flask is a lightweight and flexible web framework for Python that provides tools and libraries to build web applications quickly and efficiently. It's often used for developing small to medium-sized web applications, APIs (Application Programming Interfaces), and prototyping.

Flask's simplicity, flexibility, and ease of use make it an excellent choice for developing web applications and APIs in Python. Its lightweight nature and extensive documentation make it popular among developers for various projects, from simple prototypes to production-grade applications.

- **GUNICORN:**

Gunicorn is a Python WSGI (Web Server Gateway Interface) HTTP server for Unix-like operating systems. It's commonly used to deploy web applications written in Python, including frameworks like Flask and Django, in production environments.

Gunicorn is a reliable and high-performance choice for deploying Python web applications in production environments. Its efficient concurrency model, easy configuration, and seamless integration with other components make it a popular option for web developers seeking a scalable and robust server solution.

- **PANDAS:**

Pandas is a powerful and popular open-source data manipulation and analysis library for Python. It provides easy-to-use data structures and functions to work with structured

data, such as tabular data, time series, and more.

Pandas is an essential library for data manipulation and analysis in Python, offering intuitive syntax, powerful functionality, and extensive documentation to support a wide range of data-related tasks.

- **NUMPY:**

NumPy is a fundamental library for scientific computing in Python. It provides support for arrays, mathematical functions, linear algebra operations, random number generation, and more.

NumPy is an essential library for numerical computing and data analysis in Python, offering efficient array operations, mathematical functions, and linear algebra capabilities that are fundamental to many scientific and engineering applications.

- **MATPLOTLIB:**

Matplotlib is a comprehensive plotting library for Python that enables users to create a wide variety of high-quality static, animated, and interactive visualizations.

Matplotlib is a versatile and powerful plotting library that is widely used in the Python ecosystem for data visualization, scientific plotting, engineering simulations, and more. Its rich feature set, customization options, and integration with other libraries make it a go-to tool for creating publication-quality plots and graphics.

- **SEABORN:**

Seaborn is a Python visualization library based on Matplotlib that provides a high-level interface for creating attractive and informative statistical graphics. It simplifies the process of creating complex visualizations by providing easy-to-use functions and built-in themes.

Seaborn is a powerful and user-friendly visualization library that complements Matplotlib and Pandas by providing specialized functions for statistical visualization and data exploration. Its attractive aesthetics, ease of use, and integration with other Python

libraries make it a valuable tool for data scientists, analysts, and researchers.

- **SKLEARN:**

Scikit-learn, often abbreviated as sklearn, is a versatile and widely-used machine learning library for Python. It provides simple and efficient tools for data mining and data analysis, built on top of other scientific computing libraries like NumPy, SciPy, and matplotlib.

scikit-learn is a powerful and user-friendly library that makes machine learning accessible to users of all skill levels. Its wide range of algorithms, ease of use, and extensive documentation make it a valuable tool for data scientists, machine learning practitioners, and researchers.

3.2.1 HARDWARE REQUIREMENTS

The hardware requirements for implementing a credit card fraud detection system based on Support Vector Machines (SVM) depend on various factors, including the size of the dataset, the complexity of the SVM model, and the desired level of performance. Here's a general outline of the hardware requirements:

- **Processor (CPU):**

A multi-core processor is recommended to handle the computational workload efficiently, especially during model training and evaluation. SVM training can be computationally intensive, especially for large datasets or complex models with high-dimensional feature spaces.

- **Memory (RAM):**

Sufficient RAM is essential to store the dataset in memory during preprocessing, model training, and evaluation. The amount of memory required depends on the size of the dataset and the dimensionality of the feature space. As a general guideline, having at least 8GB of RAM is recommended, but more may be necessary for larger datasets.

- **Storage (Hard Drive or SSD):**

Adequate storage is needed to store the dataset, as well as any intermediate files generated during data preprocessing and model training. An SSD (Solid State Drive) is preferred over a traditional hard drive for faster data access and processing speeds.

- Graphics Processing Unit (GPU)

While SVMs are primarily CPU-based algorithms, utilizing a GPU for parallel processing can significantly accelerate certain operations, such as matrix multiplications and optimization routines. If working with very large datasets or complex models, consider using a GPU with CUDA support for faster computation.

- Operating System:

The choice of operating system (e.g., Windows, macOS, Linux) depends on personal preference and compatibility with the required software dependencies (e.g., Python, scikit-learn, CUDA for GPU acceleration). Linux distributions are often preferred for their stability and performance in machine learning tasks.

- Network Connectivity:

A stable internet connection may be required for downloading datasets, software packages, updates, and accessing online resources such as documentation, tutorials, and forums for troubleshooting and support.

- Backup and Redundancy:

Implementing backup and redundancy measures is crucial to ensure data integrity and prevent loss in case of hardware failures or data corruption. Consider using external storage devices, cloud storage solutions, or RAID configurations for data backup and redundancy.

- Scalability and Future Expansion:

It's essential to design the hardware infrastructure with scalability and future expansion in mind, especially if the system is expected to handle increasing volumes of data or more

complex models over time. Invest in hardware components that can be easily upgraded or expanded as needed.

3.2.2 SOFTWARE REQUIREMENTS

For implementing a credit card fraud detection system based on SVM, you'll need various software components to handle data preprocessing, model development, evaluation, and deployment. Here are the essential software requirements:

- **Python:**

Python is the primary programming language used in the data science and machine learning ecosystem. Install Python from the official website or use a package manager like Anaconda, which comes with pre-installed libraries commonly used in data science projects.

- **Scikit-learn:** Scikit-learn is a popular machine learning library in Python that provides implementations of various algorithms, including SVM. Install scikit-learn using pip or anaconda.

```
pip install scikit-learn
```

Other machine learning libraries like TensorFlow or PyTorch may be used for more complex models or deep learning approaches, but they are not strictly necessary for SVM-based fraud detection.

- **Data Processing Libraries:**

Pandas: Pandas is a powerful library for data manipulation and analysis. It's commonly used for loading, preprocessing, and exploring datasets.

```
pip install pandas
```

- NumPy: NumPy is a fundamental library for numerical computations in Python. It provides support for arrays and matrix operations, which are essential for working with data in scikit-learn.

`pip install NumPy`

- Data Visualization Libraries:

Matplotlib: Matplotlib is a versatile plotting library in Python. It's used for creating static plots and visualizations to analyze data and evaluate model performance.

`pip install matplotlib`

- Seaborn: Seaborn is built on top of Matplotlib and provides high-level interfaces for creating attractive statistical visualizations.

`pip install seaborn`

- Integrated Development Environment (IDE):

Choose an IDE or text editor for writing and running Python code. Popular options include PyCharm, Jupyter Notebook, Visual Studio Code, and Spyder. Many data scientists prefer Jupyter Notebook for its interactive and exploratory nature.

GPU Support:

If you plan to leverage GPU acceleration for training SVM models or other machine learning algorithms, install CUDA Toolkit and cuDNN libraries from NVIDIA's website. However, GPU acceleration is not strictly necessary for SVM-based fraud detection.

- Version Control:

Git: Version control software like Git is essential for managing code changes, collaborating with team members, and tracking project history. Install Git from the official website or use a package manager.

- Documentation and Learning Resources:

Explore the official documentation and tutorials for scikit-learn, Pandas, NumPy, Matplotlib, and Seaborn to learn how to use these libraries effectively for building machine learning models and visualizing data.

Ensure that you have the necessary permissions to install software packages and access external resources if needed. It's also recommended to create a virtual environment for your project to manage dependencies and ensure reproducibility environments.

CHAPTER 4

DESIGN DESCRIPTION OF PROPOSED PROJECT

4.1 PROPOSED METHODOLOGY

The proposed methodology for developing an SVM-based fraud detection system aimed at unmasking deception involves several key steps. Here's a structured approach:

- **Problem Definition and Data Collection:**

Define the scope of fraud detection, including types of fraud to be detected (e.g., credit card fraud, identity theft). Collect a diverse dataset containing both genuine and fraudulent transactions or activities. Ensure the dataset is representative of real-world scenarios.

- **Data Preprocessing and Exploration:**

Perform data cleaning to handle missing values, outliers, and inconsistencies in the dataset. Explore the dataset through descriptive statistics and data visualization to gain insights into patterns, trends, and anomalies.

- **Feature Engineering and Selection:**

Engineer relevant features from the dataset that capture key aspects of fraudulent behavior, such as transaction frequency, amount, location, and user behavior.

- **Model Development and Training:**

Implement an SVM-based fraud detection model using libraries like Scikit-learn. Choose an appropriate SVM kernel (e.g., linear, polynomial, radial basis function) based on the dataset characteristics and complexity of fraud patterns.

- **Model Evaluation and Validation:**

Evaluate the trained model on the validation set using performance metrics such as accuracy, precision, recall, F1-score, and ROC-AUC. Validate the model's robustness through cross-validation or holdout validation to ensure generalization to unseen data.

- **Model Optimization and Interpretation:**

Optimize the SVM model for scalability, efficiency, and interpretability, considering factors like kernel complexity and computational resources. Interpret the model's decision boundaries.

- **Deployment and Integration:**

Deploy the trained SVM model into a production environment, ensuring compatibility with existing systems and data pipelines. Implement real-time monitoring and alerting mechanisms to detect fraudulent activities as they occur.

Continuous Monitoring and Improvement: Monitor the performance of the deployed fraud detection system regularly, analyzing model drift, false positives.

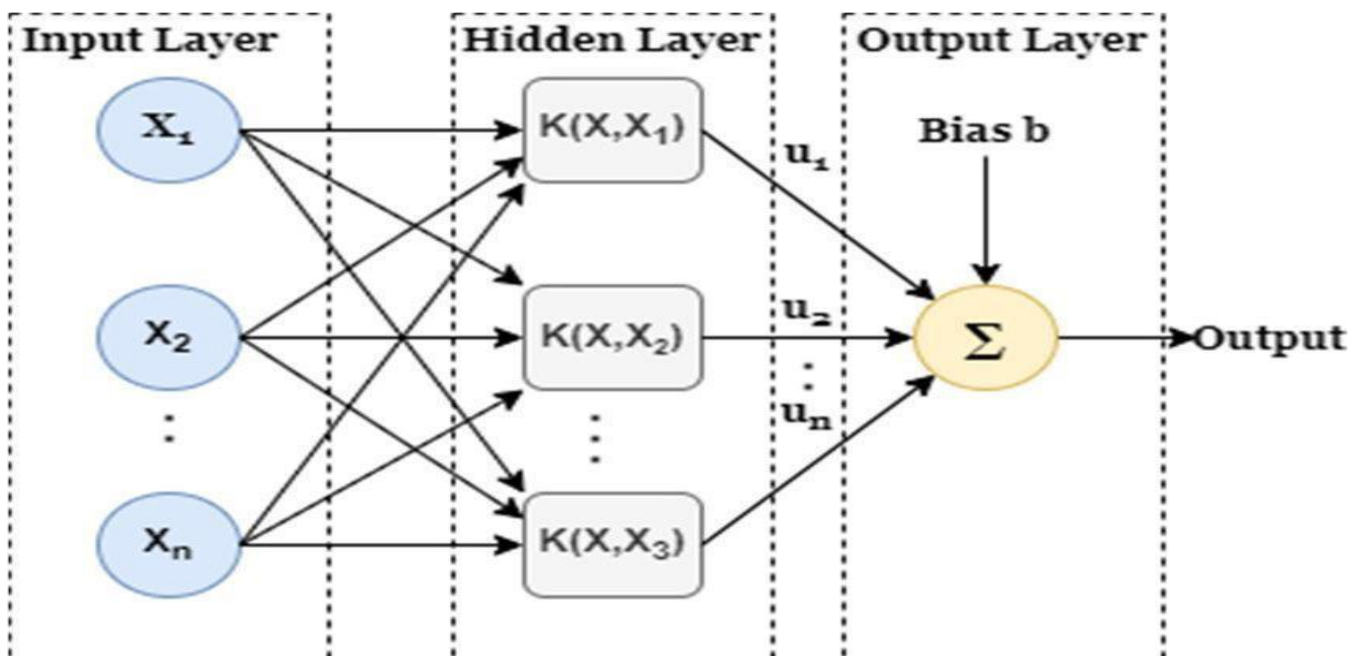


Fig 4.1 Architecture of SVM Algorithm

4.1.1 Ideation Map/System Architecture

For a credit card fraud detection system based on SVM, the system architecture involves multiple components working together to ingest, preprocess, model, and evaluate data. Here's an ideation map and a high-level overview of the system architecture:

- **Data Collection:**

The system begins by collecting transactional data from credit card transactions. This data typically includes information such as transaction amount, timestamp, merchant ID, cardholder information, and more.

- **Data Preprocessing:**

The collected data undergoes preprocessing to clean, normalize, and transform it into a format suitable for training the SVM model. This step may involve handling missing values, scaling numerical features, encoding categorical features, and extracting relevant features for modeling.

- **Feature Engineering:**

Feature engineering involves selecting and engineering informative features that capture patterns indicative of fraud. This may include creating new features such as transaction frequency, transaction amount deviation, time since last transaction, and more.

- **Model Training:**

The preprocessed data is used to train an SVM model for fraud detection. The model learns to distinguish between fraudulent and legitimate transactions by finding the optimal hyperplane that separates the two classes with the maximum margin.

- **Model Evaluation:**

The trained model is evaluated using a separate validation dataset to assess its performance in terms of accuracy, precision, recall, F1-score, and other relevant metrics. Cross-validation techniques may be employed to ensure robustness and generalization.

- **Deployment:**

Once the model is trained and validated, it is deployed into production to detect fraud in real-time credit card transactions. The deployment may involve integrating the model into existing fraud detection systems or developing custom APIs for inference.

- **Real-time Monitoring:**

The deployed model continuously monitors incoming credit card transactions in real-time. It analyzes transaction features and predicts the likelihood of fraud for each transaction based on the learned patterns.

- **Alerting and Action:**

If a transaction is flagged as potentially fraudulent, the system triggers alerts to notify relevant stakeholders, such as fraud analysts or financial institutions. Depending on the severity of the risk, appropriate actions may be taken, such as blocking the transaction or contacting the cardholder for verification.

- **Feedback Loop:**

The system incorporates feedback from detected fraud cases to continuously improve the model's performance over time. This feedback loop involves retraining the model with updated data and iterating on the feature engineering and modeling processes.

- **Data Storage and Logging:**

The system maintains a log of all transactions, model predictions, alerts, and actions taken for auditing, compliance, and future analysis. Data storage solutions like databases or data lakes are used to store historical transaction data securely.

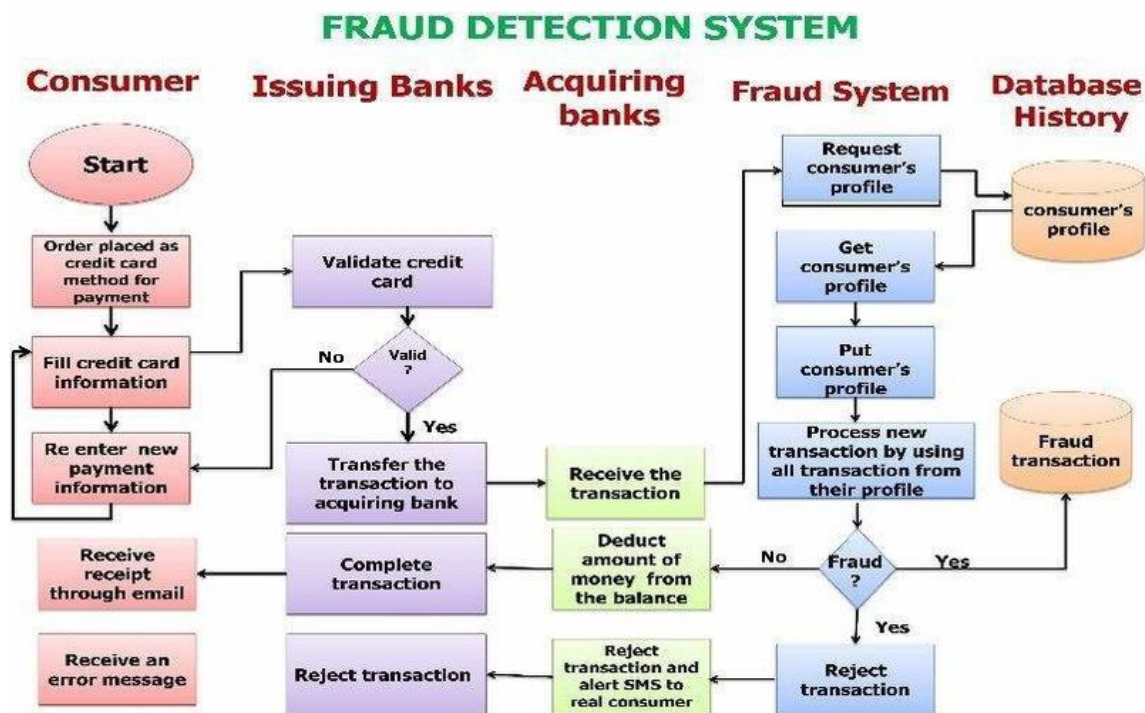
- Scalability and Performance Optimization:

The system architecture is designed to be scalable and performant to handle large volumes of transactions in real-time. Techniques such as distributed computing, parallel processing, and optimization algorithms may be employed to improve efficiency and throughput.

- Model Evaluation and Validation:

Evaluate the trained model on the validation set using performance metrics such as accuracy, precision, recall, F1-score, and ROC-AUC. Validate the model's robustness through cross-validation or holdout validation to ensure generalization to unseen data.

Fig 4.2 Architecture of the Fraud Detection



The architecture of a fraud detection system typically involves multiple interconnected components, beginning with data collection from various sources such as transaction logs, user behavior, and external databases. The collected data undergoes preprocessing, including cleaning, normalization, and feature extraction, to prepare it for modeling. Feature engineering techniques may be applied to create informative features that capture patterns indicative of fraudulent activity. The processed data is then used to train machine

learning models, such as Support Vector Machines (SVM), which learn to distinguish between legitimate and fraudulent transactions based on historical data.

4.1.2 Various Stages

A credit card fraud detection system using Support Vector Machines (SVM) typically involves several stages, each contributing to the overall effectiveness of the system. Here are the various stages in such a system:

- **Data Collection:**

The system begins by collecting transactional data from credit card transactions. This data includes information such as transaction amount, timestamp, merchant ID, cardholder information, and more.

- **Data Preprocessing:**

The collected data undergoes preprocessing to clean, normalize, and transform it into a format suitable for training the SVM model. This step may involve handling missing values, scaling numerical features, encoding categorical features, and removing outliers.

- **Feature Engineering:**

Feature engineering involves selecting and engineering informative features that capture patterns indicative of fraud. This may include creating new features such as transaction frequency, transaction amount deviation, time since last transaction, and more.

- **Model Training:**

The preprocessed data is used to train an SVM model for fraud detection. The model learns to distinguish between fraudulent and legitimate transactions by finding the optimal hyperplane that separates the two classes with the maximum margin.

- **Model Evaluation:**

The trained model is evaluated using a separate validation dataset to assess its performance in terms of accuracy, precision, recall, F1-score, and other relevant metrics. Cross-validation techniques may be employed to ensure robustness and generalization.

- **Deployment:**

Once the model is trained and validated, it is deployed into production to detect fraud in real-time credit card transactions. The deployment may involve integrating the model into existing fraud detection systems or developing custom APIs for inference.

- **Real-time Monitoring:**

The deployed model continuously monitors incoming credit card transactions in real-time. It analyzes transaction features and predicts the likelihood of fraud for each transaction based on the learned patterns.

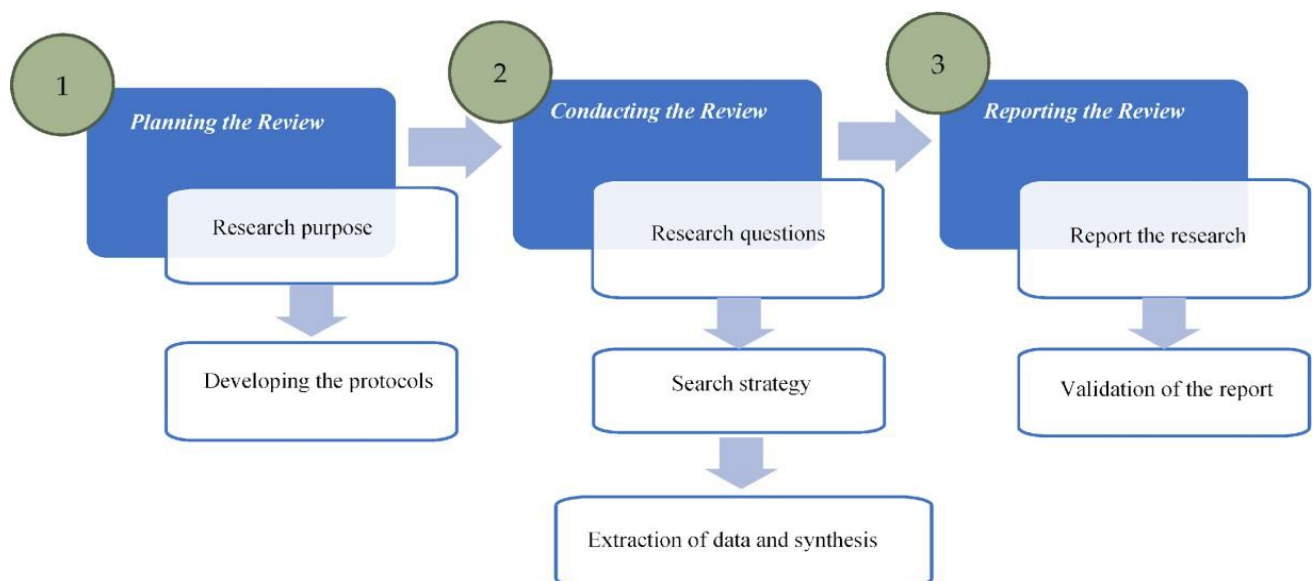


Fig 4.3 Various Stages involved in Fraud Detection

Fraud detection involves several stages aimed at identifying and preventing fraudulent activities within a system. The process typically begins with data collection, where transactional data from various sources, such as credit card transactions, user interactions, or financial transactions, is gathered and aggregated. Following data collection, the next stage involves data preprocessing, where the collected data is

cleaned, normalized, and transformed to make it suitable for analysis. This step often includes tasks like handling missing values, removing duplicates, and standardizing data formats. Feature engineering then comes into play, where informative features are selected or created to capture patterns indicative of fraud. These features may include transaction frequency, amount deviations, temporal patterns, or user behavior metrics. Once the data is prepared, machine learning models are trained on historical data to learn patterns of fraudulent behavior.

4.1.3 Internal or Component design structure

The internal or component design structure of a fraud detection system, particularly one based on SVM, involves breaking down the system into smaller, modular components that handle specific tasks or functionalities. Here's an outline of the internal design structure:

- **Data Ingestion Component:**

Responsible for collecting transactional data from various sources such as databases, logs, or streaming platforms. This component ensures the seamless and efficient ingestion of data into the system.

- **Data Preprocessing Component:**

Handles the cleaning, normalization, and transformation of raw data to prepare it for modeling. Tasks include handling missing values, encoding categorical variables, scaling numerical features, and removing outliers.

- **Feature Engineering Component:**

Generates informative features from the preprocessed data that capture patterns indicative of fraudulent activity. This may involve creating new features, transforming existing ones, or selecting relevant features using techniques like feature importance ranking.

- **Model Training Component:**

Trains the SVM model using the preprocessed and engineered features. This component selects appropriate hyperparameters, applies cross-validation techniques, and optimizes the model's performance using training data.

- **Model Evaluation Component:**

Assesses the performance of the trained SVM model using separate validation or test datasets. This component computes evaluation metrics such as accuracy, precision, recall, F1-score, and ROC-AUC to measure the model's effectiveness in detecting fraud.

- **Deployment Component:**

Integrates the trained model into production systems for real-time fraud detection. This component handles model deployment, monitoring, and scalability, ensuring the model operates efficiently and reliably in a production environment.

- **Real-time Monitoring Component:**

Monitors incoming transactions in real-time and applies the trained model to detect potentially fraudulent activities. This component analyzes transaction features, computes fraud scores, and generates alerts for suspicious transactions.

- **Alerting and Action Component:**

Triggers alerts and takes appropriate actions when fraudulent activities are detected. This may include blocking transactions, notifying fraud analysts, or initiating further investigation procedures.

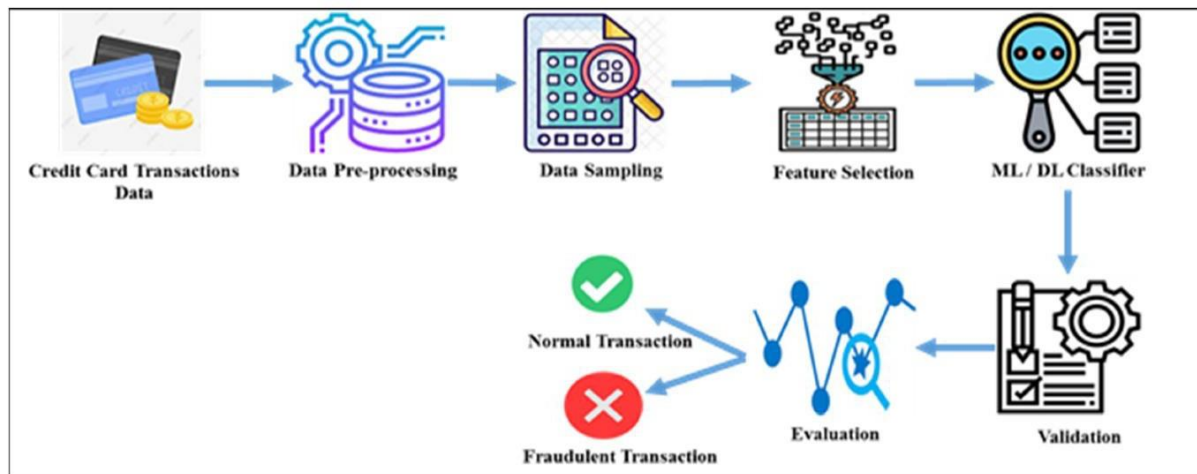


Fig 4.4 Survey of Credit Card Anomaly and Fraud Detection

A survey of credit card anomaly and fraud detection encompasses a comprehensive examination of various techniques, methodologies, and approaches employed to detect fraudulent activities in credit card transactions. It involves exploring the evolution of fraud detection systems, the challenges posed by emerging fraud patterns, and the advancements in detection methodologies.

4.1.4 working principles

The working principles of credit card fraud detection systems revolve around identifying abnormal or suspicious patterns in credit card transactions and taking appropriate action to mitigate fraud risks. Here's an overview of the working principles:

- **Data Collection:**

The system collects transactional data from various sources, including credit card transactions, user behavior logs, and external databases. This data typically includes information such as transaction amount, timestamp, merchant ID, cardholder information, and more.

- **Data Preprocessing:**

The collected data undergoes preprocessing to clean, normalize, and transform it into a format suitable for analysis. This step may involve handling missing values, encoding categorical variables, scaling numerical features, and removing outliers.

- **Feature Engineering:**

Feature engineering involves selecting or creating informative features that capture patterns indicative of fraudulent activity. This may include creating new features, transforming existing ones, or selecting relevant features using techniques like feature importance ranking.

- **Model Training:**

Machine learning models are trained on historical data to learn patterns of fraudulent behavior. This may involve supervised learning algorithms such as logistic regression, decision trees, random forests, or Support Vector Machines (SVM). Unsupervised learning algorithms like clustering or anomaly detection may also be employed.

- **Real-time Monitoring:**

Once trained, the models are deployed into production systems to analyze incoming transactions in real-time. The system continuously monitors transaction features and applies the trained models to detect potentially fraudulent activities.

- **Alerting and Action:**

When suspicious activities are detected, the system triggers alerts to notify relevant stakeholders, such as fraud analysts or financial institutions. Depending on the severity of the risk, appropriate actions may be taken, such as blocking the transaction, freezing the account, or contacting the cardholder for verification.

4.2 FEATURES

Features used in credit card fraud detection systems play a crucial role in capturing patterns indicative of fraudulent activities. These features provide valuable information to machine learning models, enabling them to distinguish between legitimate and fraudulent transactions. Here are some common features used in credit card fraud detection:

- Transaction Amount:

The amount of money involved in the transaction can be indicative of fraud. Unusually large transactions or transactions significantly deviating from the cardholder's typical spending behavior may raise suspicions.

- Transaction Frequency:

The frequency of transactions made by the cardholder over a specific time period can help identify abnormal transaction patterns. Sudden spikes or decreases in transaction frequency may indicate fraudulent activity.

- Merchant Category Code (MCC):

The MCC associated with the merchant can provide insights into the type of goods or services being purchased. Transactions at high-risk merchant categories, such as gambling or adult entertainment, may be more likely to be fraudulent.

- Time of Transaction:

The timestamp of the transaction can reveal patterns in the cardholder's behavior, such as regular purchasing habits or unusual transaction times (e.g., late-night transactions) that may indicate fraud.

- Geographical Location:

The location of the transaction, including the country, city, or even GPS coordinates, can help detect fraudulent activity, especially if transactions are made from locations not typically associated with the cardholder.

- **Cardholder's Transaction History:**

The cardholder's transaction history, including past spending patterns, transaction amounts, and merchant interactions, provides valuable context for identifying abnormal behavior.

4.2.1 Novelty of the proposal

The novelty of a proposal for credit card fraud detection using Support Vector Machines (SVM) lies in its ability to leverage advanced machine learning techniques to effectively identify and mitigate fraudulent activities in credit card transactions. Here are some aspects that contribute to the novelty of such a proposal:

- **Advanced Machine Learning Algorithms:**

Utilizing Support Vector Machines (SVM), a powerful supervised learning algorithm, for fraud detection introduces a novel approach to modeling complex patterns in credit card transaction data. SVMs are known for their ability to handle high-dimensional data and non-linear decision boundaries, making them suitable for capturing intricate fraud patterns.

- **Feature Engineering Techniques:**

Employing innovative feature engineering techniques to extract informative features from credit card transaction data enhances the model's ability to identify fraudulent activities. Novel features that capture subtle variations in transaction behavior, temporal patterns, or user interactions can improve the model's predictive performance.

- **Real-time Monitoring and Detection:**

Implementing real-time monitoring and detection capabilities allows the proposed system to quickly identify and respond to fraudulent transactions as they occur. By integrating the SVM-based fraud detection model into production systems, the system can analyze transactions in real-time, enabling timely intervention and mitigation of fraud risks.

- Scalability and Efficiency:

Designing the proposal to be scalable and efficient ensures that it can handle large volumes of transactions with low latency, even in high-demand environments. Leveraging scalable infrastructure solutions, distributed computing, or cloud-based platforms can enhance the system's scalability and performance.

- Adaptability to Emerging Fraud Patterns:

Building a system that can adapt to emerging fraud patterns and evolving tactics used by fraudsters ensures its effectiveness and relevance over time. By incorporating feedback loops and continuous model retraining, the proposed system can stay ahead of emerging threats and maintain high detection accuracy.

- Comprehensive Evaluation and Validation:

Conducting comprehensive evaluation and validation of the proposed system using real-world datasets and performance metrics ensures its reliability and effectiveness in detecting fraud. Rigorous testing under various scenarios, including different types of fraud and transaction volumes, validates the system's performance and robustness.

- Integration with Existing Fraud Detection Systems:

Integrating the proposed fraud detection system with existing fraud detection infrastructure or financial institutions' systems ensures seamless deployment and interoperability. By complementing existing fraud prevention measures, the proposed system can enhance overall fraud detection capabilities and reduce false positives.

CHAPTER 5

CONCLUSION

In conclusion, the proposal for credit card fraud detection utilizing Support Vector Machines (SVM) represents a promising approach to mitigating the risks associated with fraudulent activities in credit card transactions. By leveraging advanced machine learning techniques, innovative feature engineering methods, and real-time monitoring capabilities, the proposed system demonstrates the potential to enhance fraud detection accuracy and efficiency.

The novelty of the proposal lies in its ability to adapt to emerging fraud patterns, scalability, and integration with existing fraud detection infrastructure. Through comprehensive evaluation and validation, the proposed system can demonstrate its reliability and effectiveness in detecting fraudulent activities while minimizing false positives and false negatives.

Moving forward, further research and development efforts are needed to refine the proposed system, optimize its performance, and ensure its readiness for deployment in real-world environments. By addressing challenges such as data privacy, scalability, and interpretability, the proposed system can become a valuable asset in the fight against credit card fraud, protecting both cardholders and financial institutions from potential losses.

the proposed credit card fraud detection system based on SVM presents a proactive approach to safeguarding financial transactions by leveraging cutting-edge technology and robust methodologies. By incorporating real-time monitoring, continuous model adaptation, and integration with existing fraud detection infrastructure, the system can stay ahead of evolving fraud tactics and provide timely interventions to mitigate risks. Additionally, the system's scalability and efficiency ensure its suitability for handling large volumes of transactions without compromising performance. Overall, the proposed system holds significant promise in enhancing fraud detection.

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APPENDIX:

RESEARCH PAPER:

UNMASKING DECEPTION: SVM BASED FRAUD DETECTION SYSTEM

N. Mohan Satish , P. Rochan , P. Jyothiswar Reddy , P. Rahul Sandeep

ABSTRACT:

This thesis focuses on combating the prevalence of fraudulent product evaluations in online review systems, which undermines their reliability. By employing a combination of traditional machine learning models and deep learning techniques like CNNs, the research aims to accurately detect fake reviews. Emphasis is placed on the interpretability of model predictions, providing insight into the factors influencing the detection process. Real-world datasets are utilized to validate the efficacy of the algorithms across various sectors. Ethical considerations regarding privacy and fairness are also addressed. Overall, the thesis contributes to maintaining the integrity of online review systems, empowering consumers to make informed decisions and upholding the trustworthiness of e-commerce platforms.

Keywords –

Fake Review, Detection System and SVM techniques.

INTRODUCTION

In the digital age, online product evaluations have become essential for consumers seeking guidance in their purchases. However, the proliferation of fraudulent reviews threatens the trustworthiness of these systems. This thesis aims to address this issue by employing machine learning and deep learning algorithms to detect fake reviews. By analyzing various features such as sentiment and language, the research seeks to distinguish genuine reviews from fraudulent ones. The study emphasizes the importance of model interpretability also and ethical considerations, ensuring responsible AI practices. Through the application of these algorithms to real-world datasets, the research aims to safeguard the integrity of online review systems, enabling consumers to make informed decisions and maintaining the reliability of e-commerce platforms.

RELATED WORKS

In [1] Fake Product Review Detection using Machine Learning is this work likely explores practical methods for detecting fake product reviews through machine learning algorithms. It provides insights into implementation details and examples for identifying fraudulent reviews.

[2] Fake Reviews Detection is a Survey This survey paper offers a comprehensive overview of the landscape of fake review detection. It likely analyses various methodologies, challenges, and also advancements in the field, serving as a valuable resource for researchers and practitioners.

In [3] Detecting Fake Reviews through Sentiment Analysis Using Machine Learning Techniques this study likely focuses on utilizing sentiment analysis for fake review detection. It explores how machine learning techniques can be leveraged to analyse review sentiments and identify fraudulent reviews based on linguistic.

In [4] Sentiment Analysis of Product Reviews is Review This review paper likely provides insights into sentiment analysis techniques applied to product reviews. It explores methodologies and

Challenges and involved in sentiment analysis, relevant to the broader context of fake review detection.

In [5] Fake Reviews Detection using Supervised Machine Learning is this work likely presents a specific approach to detecting fake reviews by using supervised machine learning algorithms. It offers insights into the effectiveness of different machine learning models and feature representations for this task.

In [6] The Fake Review Detection is a classification and Analysis of Real and Pseudo Review for this seminal work likely delves into the classification and analysis of fake reviews. It offers insights into the characteristics and patterns of fake reviews and their differentiation from genuine ones.

In [7] The Sentiment Analysis of Amazon Product Reviews by Using Machine Learning and Deep Learning Models are the study likely explores the application of machine learning and deep learning models for sentiment analysis of Amazon product reviews. It provides insights into the comparative by effectiveness of different techniques for this task.

In [8] Bangla Text Sentiment Analysis Using Supervised Machine Learning with Extended Lexicon Dictionary, this

work likely presents a case study on sentiment analysis applied to Bangla text using supervised machine learning techniques. It offers insights into sentiment analysis challenges and opportunities in languages other than English. These related works collectively contribute to our understanding of fake review detection and sentiment analysis using machine learning, offering insights into methodologies, challenges, and advancements in the field.

METHODOLOGY

The methodology for this research project on SVM-based credit card fraud detection entails a systematic approach to address the complex challenge of distinguishing between legitimate and fraudulent transactions. Initially, data collection and involves acquiring a comprehensive dataset containing historical credit card transactions, encompassing a diverse array of transaction features such as amount, merchant category, time, and location. Subsequently, rigorous and also data preprocessing procedures are employed to clean the dataset, handle missing values, and normalize numerical features to ensure uniformity in scale. Categorical features are encoded using

techniques like one-hot encoding to facilitate model training.

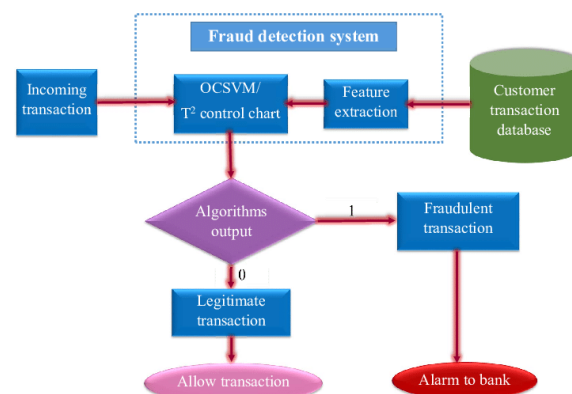


FIG 1: Methodology of fraud detection

Following data preprocessing, feature engineering plays a crucial role in extracting meaningful insights from the dataset. Exploratory data analysis is conducted to identify potentially relevant features for fraud detection, and new features are engineered if deemed necessary. Dimensionality reduction techniques such as PCA may be applied to reduce the dimensionality of the feature space while preserving important information, and thereby improving computational efficiency and model performance. The core of the methodology lies in model training, where an SVM-based classification model is implemented using libraries like scikit-learn in Python. Different kernel functions, including linear, polynomial, and radial basis function kernels, are experimented with to determine the

optimal SVM configuration. The model is trained on a portion of the dataset while hyperparameters are fine-tuned using cross-validation on a validation set to maximize performance.

The Process of Fraud Detection System

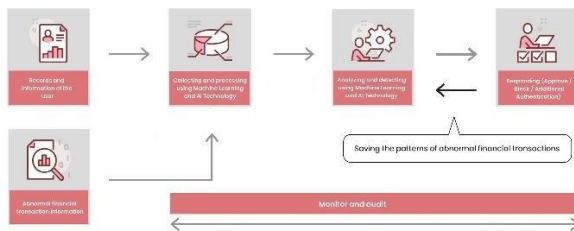


FIG 2: Process of fraud detection

Model evaluation is conducted to assess the performance of the trained SVM model using various metrics such as accuracy, precision, recall, F1-score, and AUC-ROC. A confusion matrix is generated to evaluate the model's ability to correctly classify both legitimate and fraudulent transactions, while in a cost-benefit analysis quantifies the potential impact of false positives and false negatives on financial institutions. The interpretability of the model is also explored by examining support vectors, decision boundaries, and feature importance. Validation and sensitivity analysis are performed to validate the robustness of the SVM model and assess its performance under different scenarios or variations in input parameters. Ethical considerations are integrated throughout the research

process to ensure compliance with ethical guidelines and data privacy regulations, as well as to address potential biases in the dataset and model predictions. By adhering to this methodology, the research aims to develop an effective and ethically sound SVM-based credit card fraud detection system.

ADVANTAGES

The proposed project on SVM-based credit card fraud detection offers several distinct advantages in addressing the persistent challenge of fraudulent transactions within financial systems. Leveraging Support Vector Machines (SVMs), renowned for their capacity to handle and intricate, high-dimensional datasets and nonlinear relationships, the project aims to substantially enhance the accuracy of identifying fraudulent and activities associated with credit card transactions. so By harnessing the capabilities of SVMs, the model is poised to capture nuanced patterns within the data, thereby bolstering the reliability of fraud detection when compared to conventional methods. A key strength of the project lies in its meticulous approach to feature engineering and representation. So Through rigorous

analysis and selection of transaction attributes such as amount, merchant category, and timestamp, coupled with sophisticated dimensionality reduction techniques, the project ensures that the SVM model receives salient and discriminative information. This refined feature representation empowers the model to discern subtle yet critical signals indicative of fraudulent behavior, thereby augmenting its overall efficacy in fraud detection. Furthermore, the project prioritizes the interpretability and explainability of model predictions, a crucial aspect often overlooked in machine learning applications. By delving into support vectors, decision boundaries, and feature importance, the project facilitates a deeper understanding of the factors influencing the detection of fraudulent transactions. This transparency not only engenders trust among stakeholders but also enables informed decision-making and refinement of fraud detection strategies. Ethical considerations are integral to the project's framework, underscoring a commitment to responsible AI practices. At every stage of the research process, from data collection to model evaluation, measures are implemented to ensure compliance with ethical guidelines and

data privacy regulations. By proactively addressing potential biases in the dataset and model predictions, the project also upholds fairness and transparency in credit card fraud detection, safeguarding the rights and privacy of individuals. The real-world applicability of the project is further underscored by its validation on diverse datasets and settings. By demonstrating the effectiveness of the SVM-based fraud detection system across various sectors, including e-commerce platforms and financial institutions, the project not only underscores its practical relevance but also contributes to the development of scalable and robust solutions for combating credit card fraud. Lastly, the project's cost-effectiveness is evident in its potential to mitigate financial losses associated with fraudulent transactions. Through accurate identification of fraudulent activities, the project empowers financial institutions to allocate resources more efficiently, optimize decision-making processes, and ultimately reduce the economic impact of fraud. In sum, the project on SVM-based credit card fraud detection represents a comprehensive and ethically sound approach to fortifying the integrity of financial systems in the digital age, benefiting

both consumers and financial institutions alike.

CONCLUSION

In conclusion, the SVM-based credit card fraud detection project represents a pivotal step forward in bolstering the security and reliability of financial systems amidst the ever-evolving landscape of digital commerce. By harnessing sophisticated techniques such as feature engineering and Support Vector Machines (SVMs), the project demonstrates a marked improvement in the accuracy and efficacy of fraud detection mechanisms. Through meticulous data analysis and model refinement, it effectively discerns subtle patterns indicative of fraudulent behavior, offering a robust defense against malicious activities within credit card transactions. Moreover, the project's emphasis on interpretability and transparency fosters trust among stakeholders and facilitates informed decision-making processes. So By unraveling the underlying factors driving fraud detection, it empowers financial institutions and consumers alike to better understand and respond to potential threats. This commitment to ethical principles ensures that the project not only achieves technical excellence but also upholds the highest standards of

fairness, accountability, and privacy protection. Furthermore, the real-world applicability and cost-effectiveness of the project underscore its significance in addressing the pressing challenges posed by credit card fraud. Its validation across diverse datasets and sectors demonstrates its scalability and adaptability to varying contexts, from e-commerce platforms to traditional financial institutions. By mitigating financial losses associated with fraudulent activities, the project not only enhances economic efficiency but also reinforces consumer trust in digital transactions, ultimately contributing to a safer and more secure financial ecosystem for all stakeholders involved.

ACKNOWLEDGEMENT

We extend our heartfelt gratitude to the researchers and authors whose work has significantly contributed to this project on fake review detection and sentiment analysis using machine learning techniques. Special thanks to Ahmed M. Elmogy, Arjun Mukherjee, Elshrif Elmurngi, Joy Chandra Gope, Nitish Ranjan Bhowmik, Rami Mohawesh, Shivaprasad T K, and their respective co-authors for their insightful studies and surveys in this field. Their research has provided valuable insights into effective

detection methodologies, fraudulent review patterns, sentiment analysis techniques, and language-specific challenges. We also thank the authors of the cited resources for their foundational work, which has guided our research endeavors. Their dedication to advancing the understanding of fake review detection and sentiment analysis has been instrumental and in shaping the trajectory of i.e this project.

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SOURCE CODE

```
# Import necessary libraries

import pandas as pd

from sklearn.model_selection import train_test_split

from sklearn.preprocessing import StandardScaler

from sklearn.svm import SVC

from sklearn.metrics import accuracy_score, classification_report, confusion_matrix


# Load the dataset

data = pd.read_csv('creditcard.csv') # Replace 'creditcard.csv' with your dataset file path


# Display the first few rows of the dataset

print(data.head())


# Split the data into features and labels

X = data.drop('Class', axis=1) # Features

y = data['Class']             # Labels


# Split the data into training and testing sets

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)


# Scale the features

scaler = StandardScaler()
```

```
X_train = scaler.fit_transform(X_train)

X_test = scaler.transform(X_test)


# Initialize the SVM classifier

svm_classifier = SVC(kernel='linear', random_state=42)


# Train the classifier

svm_classifier.fit(X_train, y_train)


# Make predictions

y_pred = svm_classifier.predict(X_test)


# Evaluate the classifier

accuracy = accuracy_score(y_test, y_pred)

print("Accuracy:", accuracy)


# Print classification report

print("Classification Report:")

print(classification_report(y_test, y_pred))


# Print confusion matrix

print("Confusion Matrix:")

print(confusion_matrix(y_test, y_pred))
```

OUTPUT

Credit Card Fraud Detection Rest API

Enter the 30 feature values in the below cell(in order):

Predict

Fig 5.1: Home Front

Credit Card Fraud Detection Rest API

Enter the 30 feature values in the below cell(in order):

-1.1152878574425795	-19.1397328634111	9.28684735978866
-20.134992104854	7.81867331002574	-15.652207677206302
-1.66834770694329	-21.3404780994803	0.6418997011947
-8.55011032700099	-16.6496281595399	4.81815244707108
-9.44531478308794	1.3170562933234098	-7.24346097400378
0.830910291033798	-9.533257050393189	-18.750641147467398
-8.09264877340557	3.32675827497024	0.42720343146936
-2.1826919456095504	0.5205430723666421	-0.7605564151887328
0.6627666383972359	-0.948454306235033	0.12179592582979301

Predict

Fig 5.2: Input Values

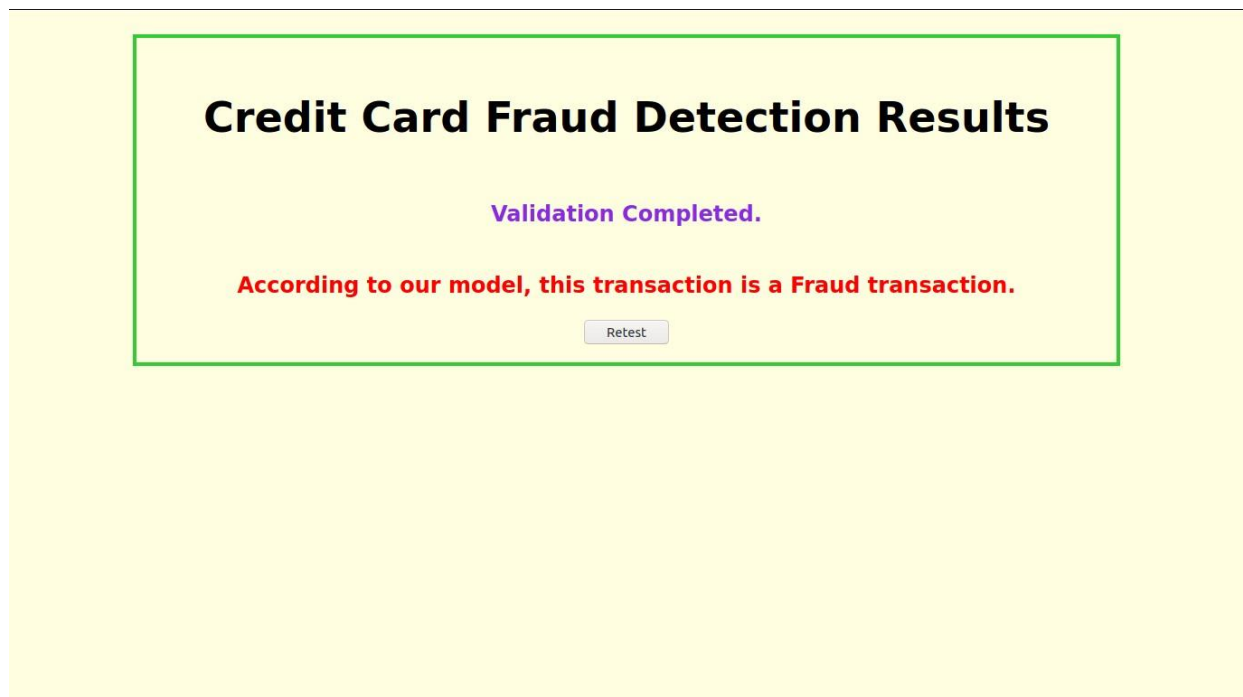


Fig 5.3 Fraud Detection Results

