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Machine Learning Algorithm Evaluation for Detection of Fake Bank Currency

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Abstract

The presence of counterfeit banknotes in the financial market poses a significant challenge to the integrity of a country's currency system. Differentiating between genuine and forged notes manually is a daunting task due to the high precision employed by miscreants in creating fake currency. To address this issue, arandom system is proposed for banks and ATM machines which predicts the authenticity of banknotes. In this research paper, we will explore the application of Supervised Machine Learning Algorithm.Dataset was sourced from the UCI machine learning system. Additionally, we introduce the Light-GBM algorithm and analysed its performance against the other algorithms.

Introduction

The rise in counterfeit banknotes poses a significant threat to the integrity of the financesector. With advancements in technology, fraudsters can create fake notes that closely mimic genuine ones, designing it difficult to discern between the two. The government has incorporated security features into banknotes, but counterfeiters have adapted and replicated these features with remarkable accuracy. To overcome these challenges, AI/ML usage, specifically supervised learning algorithms, has shown promise in various fields. However, their application in banknote authentication requires further exploration and development.

Literature Survey

1. S. Desai, S. Kabade, A. Bakshi, A. Gunjal, and M. Yeole, propose a system based on Multiple-Kernel Support Vector Machines (SVM) for recognizing counterfeit banknotes. The system divides each banknote into partitions and uses the luminance histograms of these partitions as input. Multiple kernels are combined using linear weighting to create a combined matrix.
2. C. Gigliaranoa, S. Figini, and P. Muliere, the authors address the challenge of selecting the best classifier when ROC curves intersect. The authors provide a simulation study and application to credit risk data to demonstrate the use of their methodological approach.

3. H. Hassanpour and E. Hallajian proposed a new technique that utilizes the texture characteristic of paper currencies and employs the concept of Markov chains to model the texture as a random process. The method is designed to recognize paper currencies from different countries and achieves a recognition rate of 95% in the authors' experiments.
4. Z. Huang, H. Chen, C. J. Hsu, W. H. Chen, and S. Wuc, the authors explore techniques to corporate credit rating analysis. The study shows that both SVM and BNN achieve prediction accuracies of around 80% for the United States and Taiwan markets. The authors also discuss the interpretability of AI-based models and conduct a comparative analysis of determining factors in the two markets.

Existing System

Supervised Learning approaches have gained significant popularity, particularly in the field of medical diseases. However, the use of SML algorithms for bank note relatively limited, and there is a need for the development of automated systems in this domain.

The goal of this system is to verify a banknote is original or false based on an input. To achievevarious image processing units can be employed to extract relevant features from the note images. Once they are extracted from images, they used algorithms for classification. 1The SML algorithms where each banknote image is associated with a class label indicating whether it is acceptable or not. The unseen banknotes based on the learned patterns are from the training data.

The choice of SML algorithms for this task depends on various factors, including the nature of the problem, the size and quality of the available dataor computational resources available.These algorithms have proven to be effective in a large amount of classification problems and can serve as a baseline for the bank currency authentication system.

As they mentioned in the review, there appears to be limited work done specifically on applying algorithms to bank currency authentication. This indicates a potential research gap which can be explored further. 2Considering discussing the limited existing literature, the specific challenges and requirements of bank currency authentication, and the potential impact and practical applications of developing an automated system in this domain.

Developing aself-acting system for authenticating banknotes using SML algorithms and image processing techniques can contribute and provide practical solutions for banks and financial institutions.

Proposed System

In the proposed system, the author used a number of well-known algorithms. 7As an add-on, we used the LightGBM algorithm. We have taken some key steps to deploy our work:

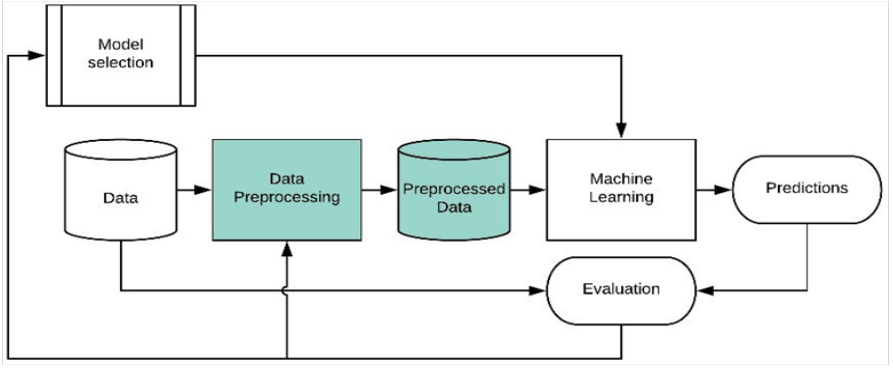

Figure 1 Proposed Architecture

1. **Data Preparation**: Ensuring that having a well-prepared dataset. This involved preprocessing steps such as handling missing values, encoding categorical variables, and scaling features. Pay attention to maintaining the same steps for algorithms to ensure fairness.
2. **Train-Test Split**: The training dataset is utilized to train the models, while the testing set is used to evaluate their performance. 8We used techniques like stratified sampling to preserve the class distribution, especially while working with imbalanced data.
3. **Model Training**: Trained each algorithm for using the training data. For LightGBM, we used its specific implementation, which often involves tuning hyperparameters such as the learning rate, tree depth, and estimators.
4. **Model Evaluation**: The model provides different aspects of model performance. Additionally, we can consider other metrics like training time, memory usage, or model complexity to compare the algorithms comprehensively.
5. **Statistical Analysis**: To assess the statistical significance of the results, we employ appropriate statistical tests such as t-tests or ANOVA.

This analysis helps determine if the performance differences observed between algorithms are statistically significant or merely due to random chance.

Implementation

The following is the deployment diagram:

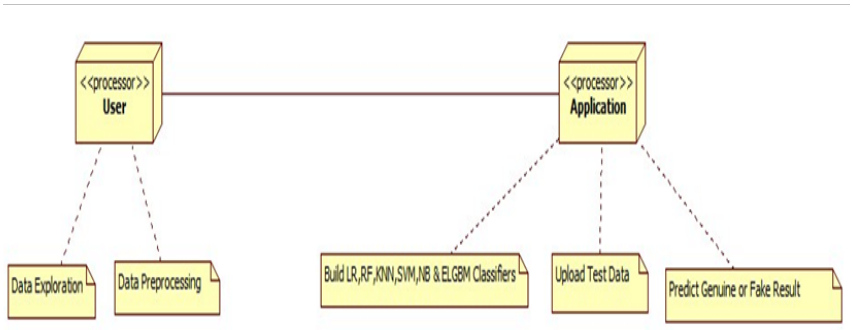

Figure 2 Deployment diagram

1. **Data preprocessing**: Preprocessing the data involves cleaning, normalizing, and transforming the input features to prepare them for the machine learning algorithms. 9This includes outliers, handling missing values, and scaling the features.
2. **Feature selection**: Selecting relevant features is crucial for building an effective model. Feature selection techniques such as correlation analysis, information gain, or recursive feature elimination are employed.
3. **Algorithm selection**: There are numerous algorithms thatmight be used in this task, including random forests, decision trees, neural networks, and ensemble methods. Wechose them for the problem and the available data.
4. **Model training**: The selected algorithm is used to train labeled datasets containing both genuine and counterfeit banknotes.
5. **Performance metrics**: These models' ability to correctly classify genuine and counterfeit banknotes.
6. **Cross-validation**: To access this model's robustness and generalize its performance, a cross-validation system like k-fold cross-validation or stratified cross-validation can be applied.

5These techniques involve splitting the data into multiple subsets and iteratively training and evaluating the model.

7. **Hyperparameter tuning**: Hyperparameters are to be optimized to target the best performance. Techniques are used to explore different combinations of hyperparameter values and find the optimal settings for the model.
8. **Model evaluation**: This evaluation provides an unbiased estimate of the model's performance and its ability to detect fake bank currency in real-world scenarios.

Conclusion

In this research, Supervised Algorithms are used to banknote validation dataset. As an extension, we added LIGHTGBM algorithms whichgive better prediction accuracy compared to other algorithms.3In conclusion, algorithms play a vital role in the detection of fake bank currency. Through the evaluation of various algorithms, it is evident that their accuracy, efficiency, and reliability are crucial factors in combating counterfeit currency. 6By harnessing the power of machine learning, authorities, and financial institutions can enhance their fraud detection systems, ensuring the security of monetary transactions and safeguarding the economy. Continued research and development in this area hold great value for the future, creating a robust against counterfeit banknotes.

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