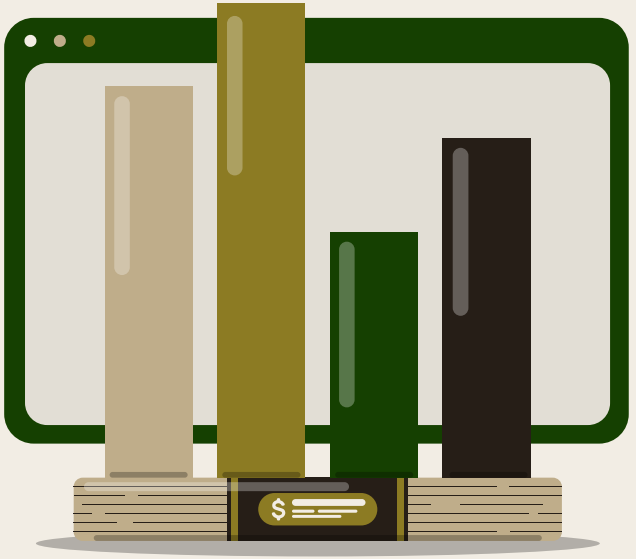
Counterfeit Currency Detection

Team Members:
Dhruv Gupta - Taahaa Dawe - Ghizlane Rehioui

TABLE OF CONTENTS

01

INTRODUCTION - PROBLEM STATEMENT



INTRODUCTION - PROBLEM STATEMENT

What is counterfeit currency?

Counterfeit currency refers to forged or imitation money produced with the intent to deceive and resemble genuine banknotes.

Why is this a problem?

Counterfeit currency jeopardizes stability, erodes trust, fostering illegal activities, risking societal well-being.

How common is the problem?

The U.S. Department of Treasury estimates **$70 million** counterfeit bills in circulation, and upper bound of **$200 million**.

Research Questions

Ethical Deployment

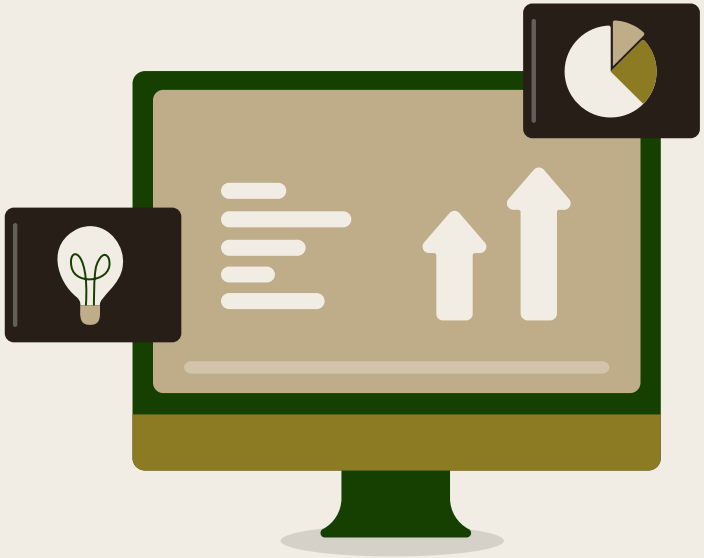
Ethics in deploying Python-based counterfeit currency detection models explored briefly.

Detection Synergies

Exploring computer vision and traditional methods for robust counterfeit detection.

Real-Time Dynamics

Analyzing challenges, requirements, and solutions for real-time counterfeit detection systems.



02

DATA & METHODS

Methods 1. Data Description

Dataset Features

1372 rows, 5 columns

Variance	How each pixel varies from the neighboring pixels and classifies them into different regions
Skewness	Measures the lack of symmetry
Kurtosis	Measures whether the data are heavy-tailed or light-tailed relative to a normal distribution
Entropy	The amount of information which must be coded for, by a compression algorithm.
Class	0 representing genuine note 1 representing fake note

Continuous

Integer

	variance	skewness	kurtosis	entropy	class
0	3.62160	8.6661	-2.8073	-0.44699	0
1	4.54590	8.1674	-2.4586	-1.46210	0
2	3.86600	-2.6383	1.9242	0.10645	0
3	3.45660	9.5228	-4.0112	-3.59440	0
4	0.32924	-4.4552	4.5718	-0.98880	0

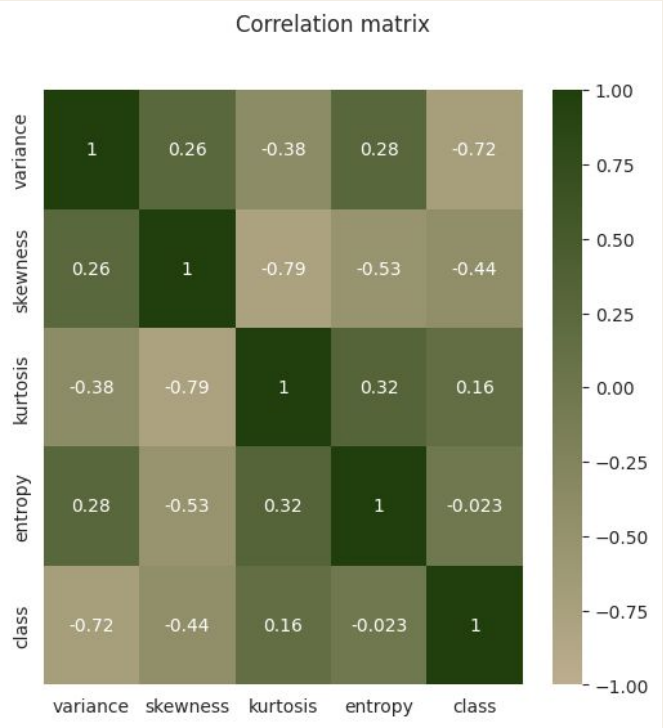
Methods 1. Data Description

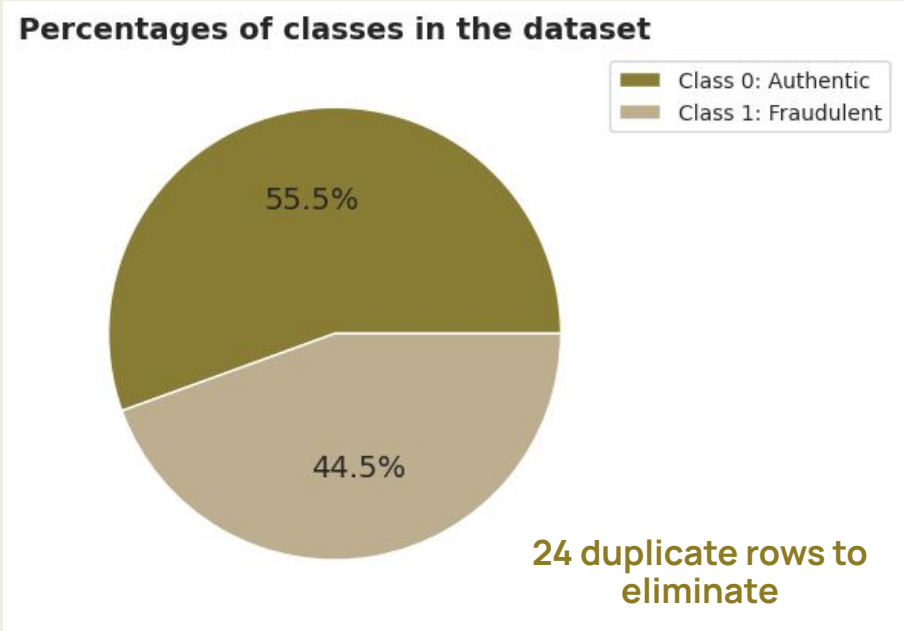
How data was obtained

- **Digitization:** 400×400 pixels gray scale images with 660 dpi resolution, captured with an industrial camera
- **Wavelet Transform:** a mathematical algorithm designed to turn a waveform (from an image, i.e. in the space domain) into a sequence of coefficients based on an orthogonal basis of small finite waves, or wavelets.

	variance	skewness	kurtosis	entropy	class
0	3.62160	8.6661	-2.8073	-0.44699	0
1	4.54590	8.1674	-2.4586	-1.46210	0
2	3.86600	-2.6383	1.9242	0.10645	0
3	3.45660	9.5228	-4.0112	-3.59440	0
4	0.32924	-4.4552	4.5718	-0.98880	0

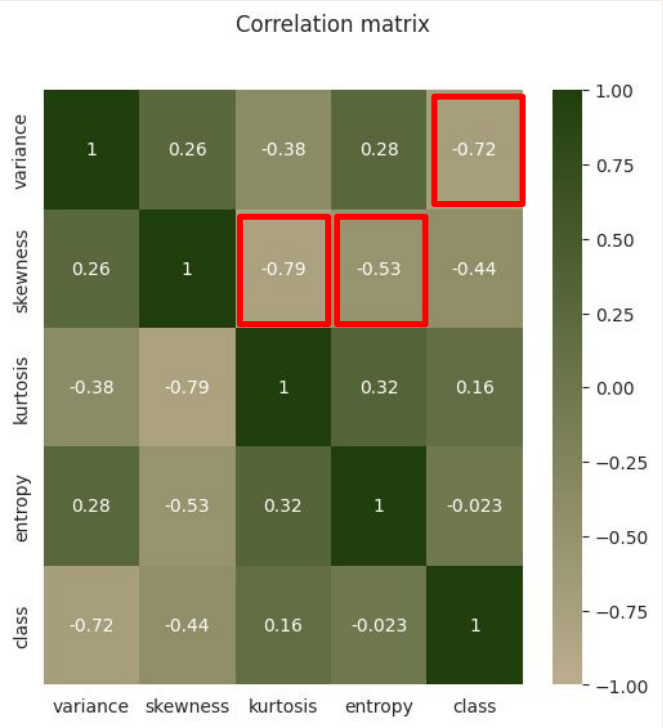
Data Exploration

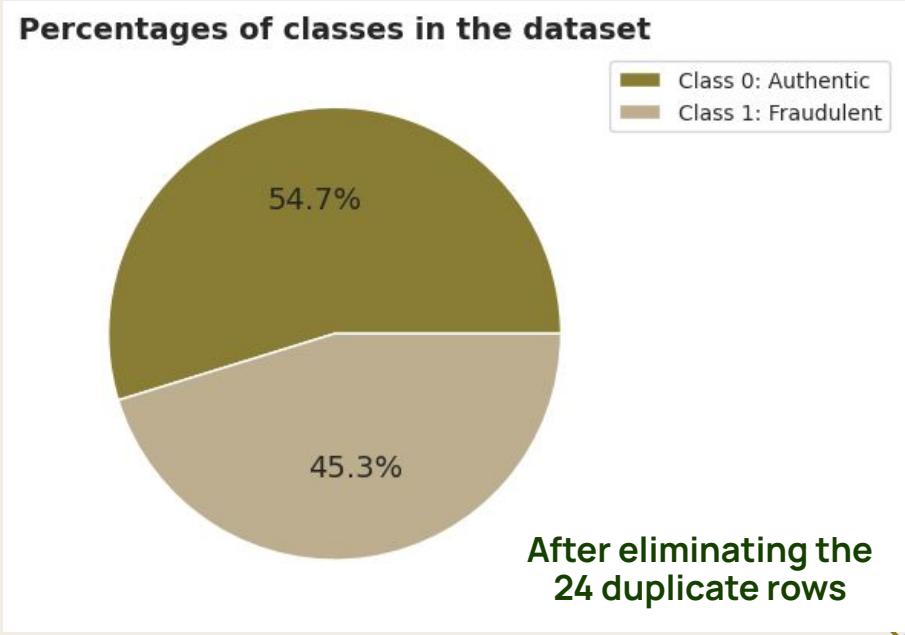




24 duplicate rows to eliminate

Data Exploration

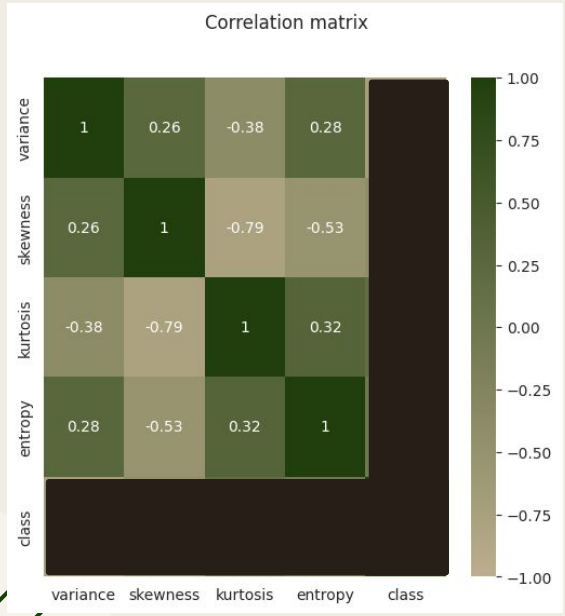


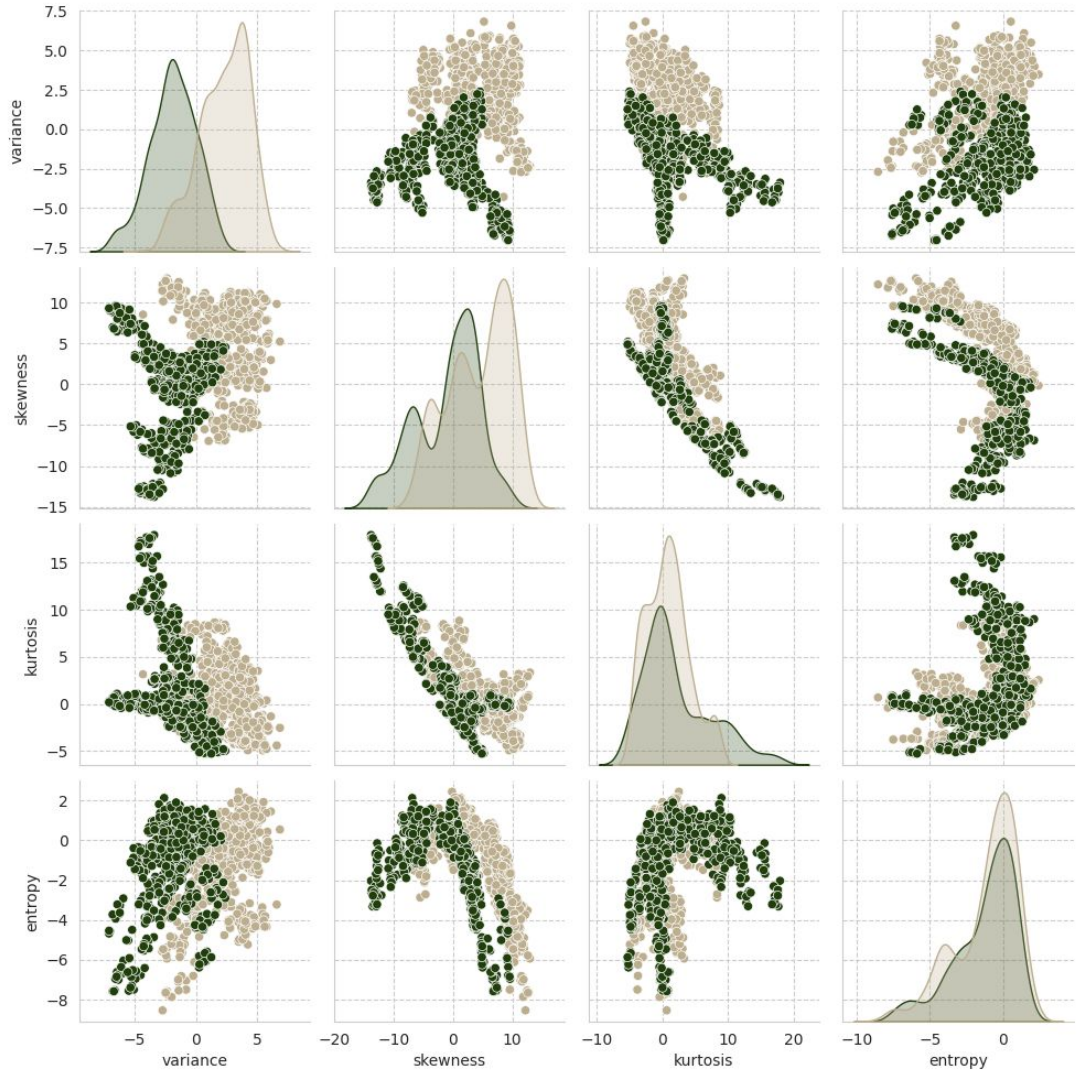


After eliminating the 24 duplicate rows

Pair Plot:

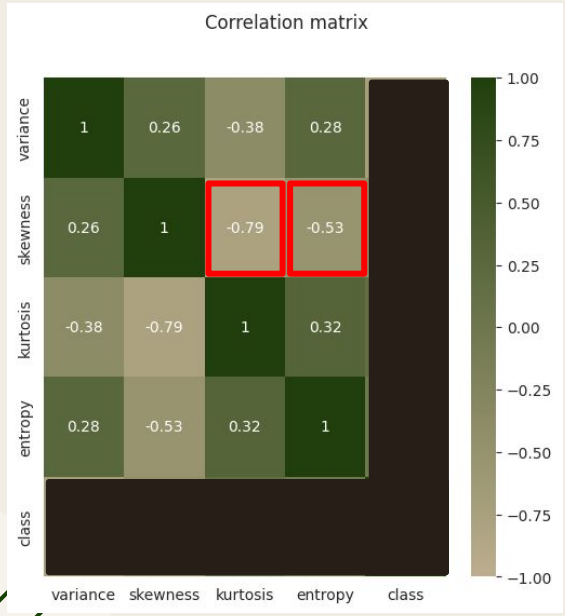
- Features by class are more distinct.
- Distribution and range for each feature.
- Relationships between features

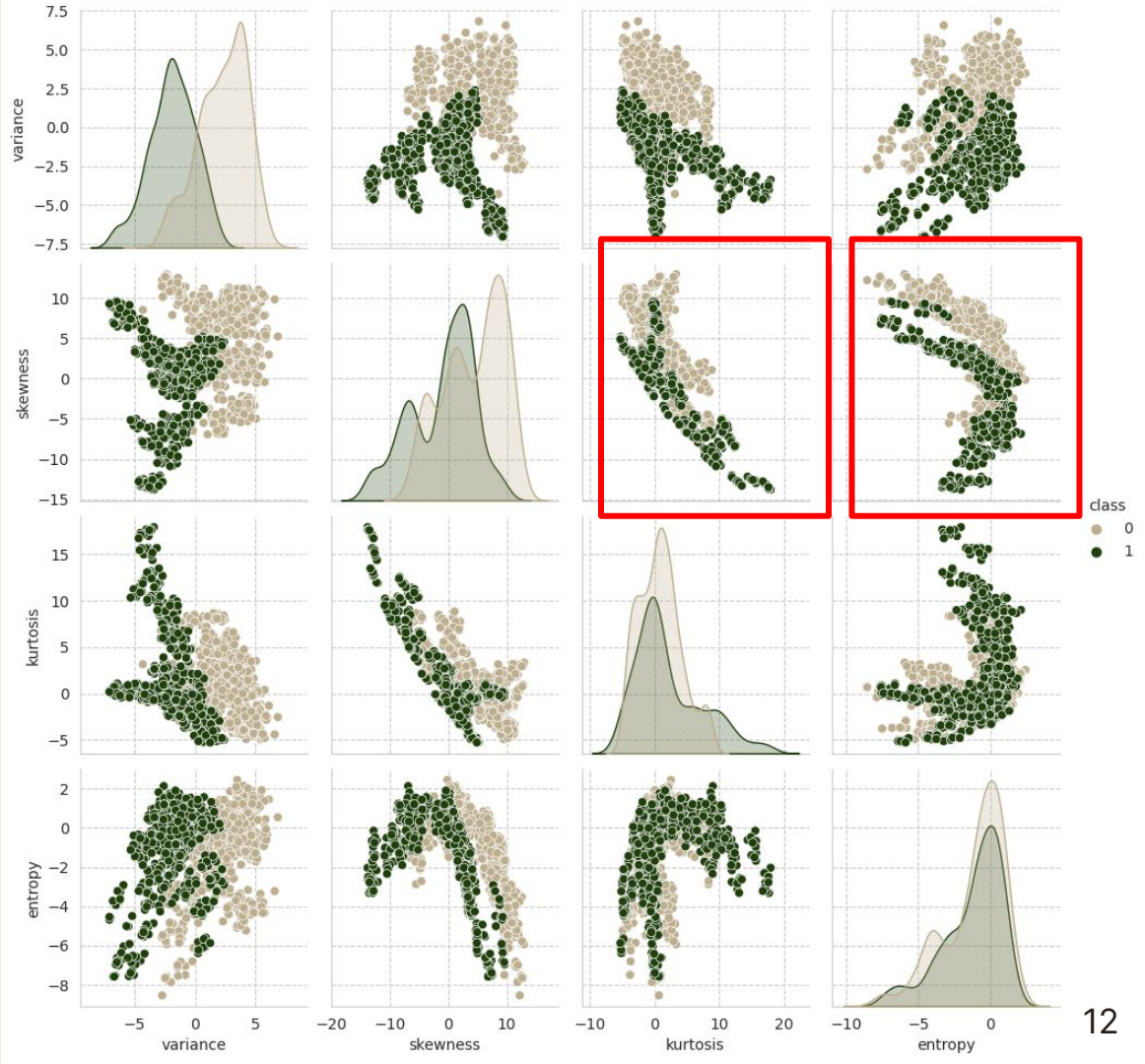




Pair Plot:

- Features by class are more distinct.
- Distribution and range for each feature.
- Relationships between features





Methods 2. Statistical Methods & Software

sklearn: LogisticRegression, RandomForestClassifier, SVM, classification_report, confusion_matrix, accuracy_score

pickle: dump, load

joblib, PIL, cv2, scipy, pywt, streamlit

Classification Algorithms:

1. Logistic Regression

Machine learning method that takes data and categorizes data into 2 categories: ***P(Y=1|X) or P(Y=0|X)***

2. Random Forest

Machine learning algorithm which combines the output of multiple decision trees to reach a single result.

3. Support Vector Machines (SVM)

Machine algorithm that aims to find a hyperplane in an N-dimensional space (N is the number of features) that distinctly classifies the data points.

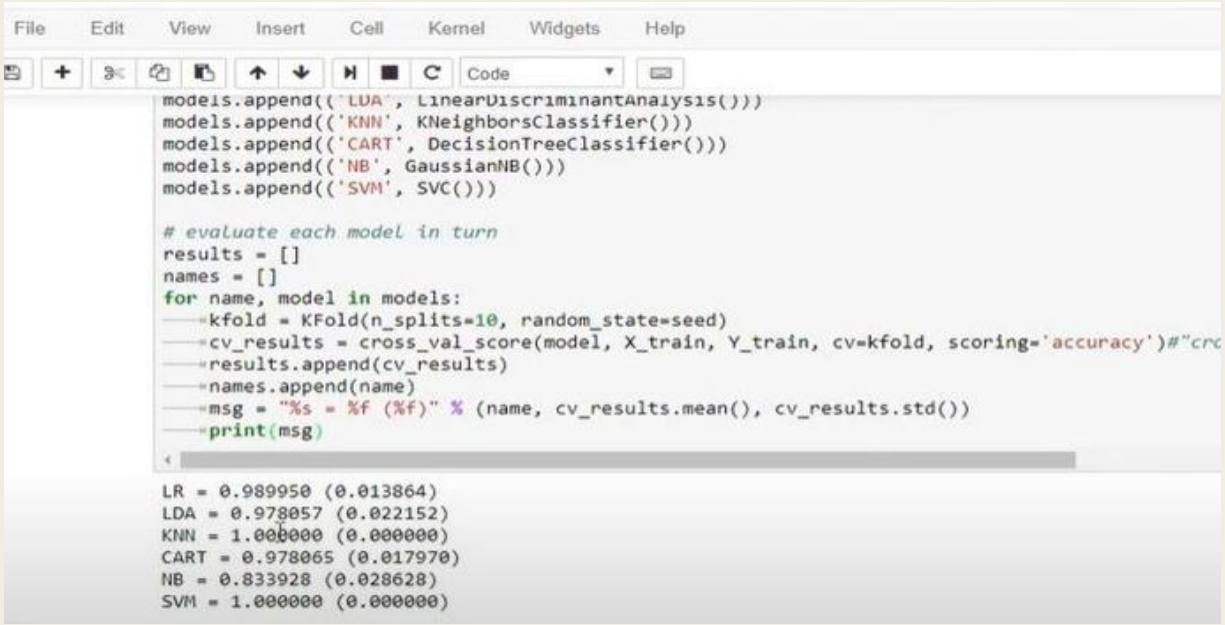
03

RESULTS

Algorithm Selection

Spot-Check Algorithm

It involves rapidly testing a large suite of diverse machine learning algorithms on a problem in order to quickly discover what algorithms might work and where to focus attention.



Accuracy

98.30%	98.54%	100%
Logistic Regression	Random Forest	SVM

04 CONCLUSION

1. SVM was the best algorithm for this dataset.

2. The quality of image is critical while generating the dataset.

3. The amount of study being done in this sector is growing all the time, and various image processing techniques are being used to produce more accurate results.

4. The proposed techniques can be used to extract characteristics from other currencies as well.

LIMITATIONS

1. **High Image Quality for Input Image detection & classification:** Image taken by the camera must have the currency in the center & should occupy around 80% of the image area. The note should be front facing. The note should not be damaged or have any marks on it.

2. **Advancement of Technology** might make it difficult to identify the difference between a genuine & fake note. **E.g Supernotes**.

3. Dataset not very large. Different patterns may reduce accuracy.

FUTURE WORK

1. **Wearable Devices and Portable Detectors:**

The idea of materializing a wearable device , which can work with a camera mounted on it can be created. The device would capture the image & send it to the application which would classify the image.

2. **Using Neural Network** can give better accuracy if datasets become complex.

APPLICATION

Banknote Authentication

Upload a picture of a US Banknote and find out if it is authentic or fake.

Upload an image

Drag and drop file here
Limit 200MB per file • JPEG, JPG
Browse files

image.jpeg 217.7KB

Image Before Processing

Image After Processing


```
{
  "Variance" : 12179.853624893596
  "Skewness" : -0.6737604567267026
  "Kurtosis" : -0.9000889727769197
  "Entropy" : 10.540204558451546
}
```


	variance	skewness	kurtosis	entropy
0	12,179.8536	-0.6738	-0.9001	10.5402

The prediction is that:

value
0

Result of Counterfeit Analysis

The banknote you uploaded is **genuine!**

REFERENCES

Ashok, V., Balakumaran, T., Gowrishankar, C., Vennila, I., & Kumar, A. (2010). The Fast Haar Wavelet transforms for signal & image processing. *arXiv (Cornell University)*. https://doi.org/10.48550/arxiv.1002.2184

E, R. (2020). *Banknote authentication analysis using Python K-means clustering - IJISRT*. Banknote Authentication Analysis Using Python K-Means Clustering. https://ijisrt.com/assets/upload/files/IJISRT20OCT060.pdf.pdf

Gillich, E., & Lohweg, V. (2010). *Banknote authentication*. Banknote Authentication. https://www.researchgate.net/profile/Eugen-Gillich-2/publication/266673146_Banknote_Authentication/links/5436b8140cf2643ab9887bca/Banknote-Authentication.pdf

Kumar, C., & Dudyala, A. K. (2015). *Banknote authentication using decision tree rules and machine learning techniques*. Banknote authentication using decision tree rules and machine learning techniques. https://ieeexplore.ieee.org/document/7164721

UCI Machine Learning Repository. (n.d.). https://archive.ics.uci.edu/dataset/267/banknote+authentication

R, S. E. (2023, October 26). Understand random forest algorithms with examples (Updated 2023). Analytics Vidhya. https://www.analyticsvidhya.com/blog/2021/06/understanding-random-forest/

Shahani, S., R L, P., & Jagiasi, A. (2018). Analysis of banknote authentication system using machine learning. https://www.researchgate.net/publication/323223299_Analysis_of_Banknote_Authentication_System_using_Machine_Learning_Techniques

Support vector machines. (n.d.). Scikit-learn. https://scikit-learn.org/stable/modules/svm.html#:~:text=Support%20vector%20machines%20(SVMs)%20are,Effective%20in%20high%20dimensional%20spaces.

Wang, A., Goldsztein, G., & Sun, Z. (2023, December 4). *Banknote authentication using logistic regression and Artificial Neural Networks*. Journal of Student Research. https://www.jsr.org/hs/index.php/path/article/view/3777

Wolff, R. (2020, August 26). *5 types of classification algorithms in machine learning*. MonkeyLearn Blog. https://monkeylearn.com/blog/classification-algorithms/

Thank you!

Team Members:
Dhruv Gupta - Taahaa Dawe - Ghizlane Rehioui