# QR Code Authentication: Detecting Original vs Counterfeit Prints

## 1. Introduction

a) Counterfeiting poses a major threat across industries such as pharmaceuticals, finance, and ticketing.
b) This project aims to develop a machine learning model to differentiate between first prints (original QR codes) and second prints (counterfeit QR codes) using both traditional machine learning (SVM) and deep learning (CNN) approaches.

## 2. Dataset & Preprocessing

The dataset consists of :

a) **First Prints:** Authentic QR codes with embedded copy detection patterns (CDPs).
b) **Second Prints:** Counterfeit versions created by scanning and reprinting first prints.

**Preprocessing steps included:**
a. Image resizing (128x128 pixels for CNN input).
b. Grayscale conversion for feature extraction.
c. Normalization to scale pixel values for CNN training.

## 3. Feature Engineering & Model Selection

To capture subtle differences between original and counterfeit QR codes:-
a. **SVM Model:** Extracted handcrafted features using edge detection (Sobel filter) and texture analysis (GLCM).
b. **CNN Model**: Used convolutional layers to automatically learn patterns and differences in QR codes.

## 4. Model Training & Evaluation

Models were trained using an 80-20 train-test split. The CNN model was trained using binary cross-entropy loss and the Adam optimizer over 5 epochs.

Evaluation metrics:-

a) **Accuracy:** Measures overall correct predictions.
b) **Precision & Recall:** Determines false positives/negatives.
c) **F1-score:** Balances precision and recall for fair evaluation.

## 5. Results & Analysis

Model Performance Summary:

| Model | Accuracy | Precision | Recall | F-1 Score |
|---|---|---|---|---|
| **SVM** | 67.5 | 68.75% | 57.89% | 62.85% |
| **CNN** | 95.0% | 94.05% | 96.01% | 95.02% |

The CNN model significantly outperformed SVM, achieving 95% accuracy with minimal misclassifications.

## 6. Deployment Considerations For real-world implementation:-

a. **Efficiency:** CNN should be optimized for mobile devices.
b. **Robustness:** Data augmentation can improve performance under varying conditions.
c. **Security:** Future improvements should consider adversarial attack detection.

## 7. Conclusion and Future Scope

This project successfully demonstrated that CNN-based models significantly outperform traditional machine learning for counterfeit detection in QR codes. Future work should focus on transfer learning and real-time deployment