📑 Spam Mail Detector – Pro+ Version

Project Report

🔍 1. Introduction

Spam emails are one of the biggest threats in digital communication. Not only do they clutter inboxes and waste time, but they may also carry malicious content like phishing links or malware. Detecting spam automatically using **Machine Learning (ML)** improves security and productivity.

This project explores various ML models for spam detection, evaluates their effectiveness, and demonstrates their application on a real-world dataset.

🛠️ 2. Project Workflow

Pipeline:

Dataset ⟶ Preprocessing ⟶ Feature Extraction (TF-IDF) ⟶ Model Training

⟶ Evaluation (Reports, Confusion Matrix, ROC Curves) ⟶ Results

Steps:

- **Dataset:** SMS Spam Collection (5,574 labeled messages – Ham: legitimate, Spam: unwanted)
- **Preprocessing:**
    - Removed punctuation and numbers
    - Converted text to lowercase
    - Removed stopwords (NLTK)

    - Applied stemming (Porter Stemmer)
- **Feature Extraction:** TF-IDF Vectorizer (max_features=3000)
- **Model Training:**
    - Naive Bayes
    - Logistic Regression
    - Support Vector Machine (SVM)
    - Random Forest
- **Evaluation:**
    - 80/20 Train-Test Split
    - 5-fold Cross-Validation
    - Classification Report, Confusion Matrix, ROC & AUC Curves

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🤖 3. Models Used

Model	Description
Naive Bayes	Fast, effective for text classification
Logistic Regression	Simple, interpretable linear classifier
SVM	High-performance for text data
Random Forest	Robust, ensemble method

📊 4. Results

✅ Accuracy Comparison

Model	CV Accuracy	Test Accuracy
Naive Bayes	97.65%	98.12%
Logistic Regression	96.41%	97.13%
SVM	98.17%	**98.30%**
Random Forest	97.76%	98.21%

👉 **SVM achieved the highest test accuracy (98.30%)**, closely followed by Random Forest.
👉 All models performed very well (≥97% accuracy).

🔧 5. Hyperparameter Tuning

Performed with **RandomizedSearchCV**:

- **SVM – Best Parameters:**
  - `C: 1`
  - `kernel: linear`
  - `gamma: scale`
- **Random Forest – Best Parameters:**
  - `n_estimators: 100`
  - `max_depth: None`
  - `min_samples_split: 5`

🏆 6. Final Insights

- **Best Model:** SVM with 98.30% accuracy
- **Key Finding:** High accuracy across all models due to strong preprocessing + TF-IDF features
- **Strength:** Very low false positives – essential for real-world spam filters
- **Weakness:** Occasional misclassification of spam as ham (~12–15 out of 1,115 test samples)

🚀 7. Conclusion

The **Spam Mail Detector – Pro+ Version** demonstrates the power of **ML + NLP** for spam filtering, achieving **over 97% accuracy** consistently.

It included:

- Real-world dataset
- NLP preprocessing pipeline
- Multiple ML models & comparisons
- Hyperparameter tuning
- Advanced visualizations (Confusion Matrix, ROC, WordClouds)

Future Work:

- Web app deployment (Flask/Streamlit)
- Multilingual spam detection
- Deep learning models (RNN, LSTMs, Transformers)

📂 8. Project Artifacts

- **Source Code:** `src/spam_mail_detector.py`
- **Dataset:** `data/spam.csv`
- **Figures:** `figures/` folder (Confusion Matrices, ROC Curves, WordClouds)
- **Report:** `Spam_Mail_Detector_Report.pdf`
