SEED QUALITY CLASSIFICATION SYSTEM

Automated Pumpkin Seed Classification Using Machine Learning & Flask Web Application

1. PROJECT OVERVIEW

The Seed Quality Classification System is a machine learning–based web application designed to classify pumpkin seeds into predefined quality categories based on their physical and morphological characteristics. The system leverages supervised learning algorithms trained on a structured dataset containing seed attributes such as area, perimeter, axis lengths, solidity, roundness, and compactness.

The project integrates a trained ML model with a Flask-based web interface, allowing users to input seed parameters and instantly receive a prediction regarding the seed class. This automated approach assists agricultural analysts, researchers, and seed quality inspectors in making faster and more accurate classification decisions.

2. OBJECTIVES

- To develop an accurate machine learning model for pumpkin seed classification.
- To analyze and preprocess seed morphology data for effective training.
- To compare multiple supervised learning algorithms and select the best-performing model.
- To deploy the trained model using a Flask web framework.
- To design a clean, user-friendly web interface for data input and result visualization.
- To enable real-time prediction of seed class based on user inputs.

3.KEY FEATURES

- User-Friendly Web Interface: Simple and intuitive UI for entering seed parameters.
- Machine Learning–Based Prediction: Accurate classification using a trained ML model.
- Multiple Feature Inputs: Supports morphological attributes such as area, perimeter, eccentricity, and compactness.
- Real-Time Prediction: Instant classification results upon form submission.
- Model Persistence: Pre-trained model loaded using pickle for efficient inference.
- Clean UI Flow: Home page → Prediction page → Result display.

4. USE CASE SCENARIOS

Scenario 1: Agricultural Research

Researchers can input measured parameters of pumpkin seeds obtained from imaging systems. The system classifies the seeds into predefined categories, assisting in seed quality analysis and crop research.

Scenario 2: Seed Quality Inspection

Seed processing units can use the application to quickly verify the quality category of seeds before packaging and distribution, ensuring consistency and quality assurance.

Scenario 3: Educational Demonstration

Students and learners can use the project to understand how machine learning models are trained, evaluated, and deployed in real-world agricultural applications.

5.TECHNICAL APPROACH

Frontend: Flask + HTML/CSS

- **Framework:** Flask (Python)
- **Technologies:** HTML5, CSS3
- **Features:** Form-based input, responsive layout, conditional result rendering

Backend: Machine Learning Model

- **Algorithms Used:** Logistic Regression, Support Vector Machine, Random Forest (during experimentation)
- **Final Model:** Best-performing algorithm selected based on evaluation metrics
- **Libraries:** NumPy, Pandas, Scikit-learn

Data Processing

- Data cleaning and preprocessing
- Feature scaling using StandardScaler
- Label encoding for class labels

System Architecture

- **Presentation Layer:** HTML/CSS templates
- **Application Layer:** Flask routes and request handling
- **Model Layer:** Pre-trained ML model loaded via pickle

6. IMPLEMENTATION PLAN

Phase	Activities	Timeline
Requirement Analysis	Dataset understanding, feature selection	2 Days
Data Preprocessing	Cleaning, scaling, encoding	3 Days
EDA	Statistical & visual analysis	3 Days
Model Training	Train multiple ML models	3 Days
Model Evaluation	Accuracy comparison & tuning	3 Days
Deployment	Flask integration	3 Days
Testing	UI & prediction testing	3 Days

7.BENEFITS

For Agriculture Sector

- Faster and more consistent seed classification
- Reduced manual inspection effort
- Improved decision-making accuracy

For Researchers & Students

- Practical exposure to ML model deployment
- Understanding end-to-end ML workflow
- Real-world dataset usage

8. PROJECT FLOW

- User Input: User enters seed parameters through the web interface.
- Data Handling: Inputs are collected and formatted by Flask backend.
- Preprocessing: Input data is scaled using the same scaler used during training.
- Prediction: The ML model predicts the seed class.
- Result Display: Predicted seed category is shown on the prediction page.

9. REQUIREMENTS SPECIFICATION

System Requirements

- Python 3.8 or above
- Windows / Linux / macOS
- Web browser (Chrome, Edge, Firefox)

Python Packages

- flask
- numpy
- pandas
- scikit-learn
- pickle-mixin

Hardware Requirements

- Minimum 4 GB RAM
- Standard processor

10. RISKS AND MITIGATIONS

Risk	Impact	Mitigation
Incorrect Inputs	Wrong prediction	Display expected ranges in input fields
c	Poor generalization	Cross-validation & tuning
Deployment Errors	App failure	Modular code & testing
User Misunderstanding	Invalid data entry	Clear UI hints and placeholders

11. FUTURE ENHANCEMENTS

- Integration with image-based seed detection
- Support for multiple seed types
- Advanced visualization of prediction confidence
- Database storage for historical predictions
- REST API for third-party integration

12 . CONCLUSION

The Seed Quality Classification System successfully demonstrates the application of machine learning in agricultural quality analysis. By combining data preprocessing, model training, and Flask-based deployment, the project delivers a complete end-to-end solution for real-time seed classification. The system is scalable, educational, and practical, making it suitable for academic, research, and industry-level use.

REFERENCES

1. Scikit-learn Documentation – https://scikit-learn.org/
2. Flask Documentation – https://flask.palletsprojects.com/
3. UCI Machine Learning Repository – Pumpkin Seeds Dataset
4. Python Official Documentation – https://www.python.org/