

## Crop classification project

### Comparison of Machine Learning Techniques

The table below provides a summary of the machine learning techniques applied in the crop classification project, their corresponding accuracies, and key remarks about their performance:

Model	Accuracy	Description	Remarks
<b>Logistic Regression</b>	92.05%	A linear model using a sigmoid function for binary and multi-class classification.	Reliable for linear relationships but struggles with complex, non-linear patterns.
<b>Naive Bayes</b>	99.54%	A probabilistic model based on Bayes' Theorem, assuming feature independence.	Exceptional accuracy but may degrade with correlated features.
<b>Support Vector Machine</b>	96.81%	Constructs hyperplanes for classification, excelling in high-dimensional datasets.	Robust performance but computationally expensive for large datasets.
<b>Feedforward Neural Network (FNN)</b>	95.68%	A deep learning model with multiple layers for capturing complex non-linear relationships.	Excellent for intricate patterns but computationally intensive with significant preprocessing.
<b>K-Nearest Neighbors (KNN)</b>	97.04%	Classifies data points based on the majority vote of their neighbors.	Effective but computationally demanding and sensitive to the choice of k.
<b>Decision Tree</b>	98.86%	A tree-structured model splitting datasets into subsets based on feature values.	Reliable but prone to overfitting without proper tuning.
<b>Random Forest</b>	99.31%	An ensemble method averaging outputs of multiple decision trees.	Robust against overfitting, handles complex datasets well, and provides feature importance.
<b>Bagging</b>	98.86%	Combines predictions from multiple base models trained on different subsets of data.	Comparable to Random Forest but less effective due to lack of feature randomization.

<b>AdaBoost</b>	14.09%	Sequentially combines weak classifiers to build a strong model.	Performed poorly, likely due to weak learners' inefficacy for this dataset.
<b>Gradient Boosting</b>	98.18%	Incrementally minimizes a loss function to optimize classification accuracy.	Strong performance but computationally more expensive than Random Forest.
<b>Extra Trees</b>	88.41%	A variant of Random Forest with randomized splits for building decision trees.	Lower accuracy compared to Random Forest, likely due to simplified splitting criteria.

## Final Model Selection

Considering accuracy, computational efficiency, and robustness, **Random Forest** was identified as the optimal model with an accuracy of **99.31%**. It offers a balance of high accuracy, resistance to overfitting, and adaptability to complex patterns in the data. Additionally, its ability to provide feature importance enhances its interpretability, making it a suitable choice for deployment.

While Naive Bayes achieved the highest accuracy (99.54%), it may struggle with datasets containing correlated features. Random Forest remains the preferred choice due to its consistency and versatility.

In summary, **Random Forest** is recommended as the most effective model for this project, owing to its superior performance and practical benefits.