**Before Hyperparameter Tuning (HPT):**

1. **Bagging Classifier**:
   * **Test Set Performance**:
     + Highest accuracy (98.65%), recall (98.65%), precision (98.82%), and F1-score (98.67%).
   * **Train Set Performance**:
     + High accuracy (99.32%) with slightly lower values than 100%, indicating good generalization and no overfitting.
   * **Conclusion**: Bagging provides the best balance between accuracy and generalization, making it the most reliable model for this dataset.
2. **Logistic Regression, Support Vector Machine, and Random Forest**:
   * Consistent performance across test and train sets with accuracy around 97.30%.
   * No signs of overfitting, but slightly lower scores than Bagging.
   * **Conclusion**: These models are also good choices but are outperformed by Bagging.
3. **Gradient Boosting and Extreme Gradient Boosting**:
   * Slightly lower accuracy on the test set (95.95%) compared to Bagging.
   * Train set performance is perfect (100%), which might indicate slight overfitting.
   * **Conclusion**: These models show strong training performance but don't generalize as well as Bagging.
4. **Decision Tree**:
   * Lowest accuracy on the test set (94.59%) but perfect on the train set (100%), indicating overfitting.
   * **Conclusion**: Not recommended due to overfitting and lower test performance.
5. **K-Nearest Neighbour**:
   * Test accuracy of 95.95% and train accuracy of 97.95%.
   * Slight underperformance compared to Bagging.
   * **Conclusion**: A good model but outperformed by Bagging and Random Forest.

**Model Comparison Report:**

| **Model** | **Test Accuracy** | **Train Accuracy** | **Overfitting** | **Generalization** | **Recommended** |
| --- | --- | --- | --- | --- | --- |
| **Bagging** | **98.65%** | 99.32% | No | Excellent | **Yes** |
| **Logistic Regression** | 97.30% | 100.00% | No | Good | Yes |
| **Support Vector Machine** | 97.30% | 99.32% | No | Good | Yes |
| **Random Forest** | 97.30% | 100.00% | No | Good | Yes |
| **Gradient Boosting** | 95.95% | 100.00% | Slight | Moderate | No |
| **Extreme Gradient Boosting** | 95.95% | 100.00% | Slight | Moderate | No |
| **K-Nearest Neighbour** | 95.95% | 97.95% | No | Good | No |
| **Decision Tree** | 94.59% | 100.00% | Yes | Poor | No |

**Final Recommendation:**

**Bagging Classifier** is the best model for this dataset because it achieves the highest test accuracy while maintaining good generalization and minimal overfitting.

**After Hyperparameter Tuning (HPT):**

* **Bagging and Extreme Gradient Boosting** maintained the highest performance on the test set with an accuracy of 98.65% and F1 score of 98.67%. They showed good generalization with no signs of overfitting.
* **Random Forest and Logistic Regression** also showed consistent results but slightly lower than Bagging and Extreme Gradient Boosting.
* **K-Nearest Neighbor and Support Vector Machine** did not show significant improvement even after tuning.
* **Decision Tree** continued to show overfitting, as indicated by the perfect training scores and relatively lower test accuracy.

**Best Model: Bagging and Extreme Gradient Boosting**

Both models demonstrated the best generalization and highest performance on the test set. They balanced precision, recall, and F1 score effectively, making them the most reliable choices for this dataset.