

**Model Optimization and Tuning Phase Report**

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| Date | 23 June 2025 |
| Team ID | SWTID1749709340 |
| Project Title | Predicting Co2 Emission by countries Using Machine Learning |
| Maximum Marks | 10 Marks |

**Model Optimization and Tuning Phase**

The Model Optimization and Tuning Phase involves refining machine learning models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

| **Model** | **Tuned Hyperparameters** | **Optimal Values** |
| --- | --- | --- |
| **Decision Tree** | random\_state | DecisionTreeRegressor(random\_state=42) |
| **Random Forest** | n\_estimators, random\_state | RandomForestRegressor(n\_estimators=100, random\_state=42) |
| **KNN** | *(none explicitly tuned)* | KNeighborsRegressor() |
| **Gradient Boosting** | n\_estimators, random\_state | GradientBoostingRegressor(n\_estimators=100, random\_state=42) |

**Hyperparameter Tuning Documentation (6 Marks)**

**Performance Metrics Comparison Report (2 Marks):**

The **optimized metrics** such as **R² Score** and **RMSE** (Root Mean Squared Error) are calculated using this section:

**r2 = r2\_score(y\_test, y\_pred)**

**rmse = np.sqrt(mean\_squared\_error(y\_test, y\_pred))**

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| **Model** | **Optimized Metric** |
| **Decision Tree** | R² Score: e.g., 0.86 RMSE: e.g., 45.32 |
| **Random Forest** | R² Score: e.g., 0.92 RMSE: e.g., 32.54 |
| **KNN** | R² Score: e.g., 0.79 RMSE: e.g., 52.80 |
| **Gradient Boosting** | R² Score: e.g., 0.91 RMSE: e.g., 34.12 |