Model Optimization and Tuning Phase Report

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SkillWallet ID: SWUID20240141492
Project Title: Employee Performance Prediction using Machine Learning

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Maximum Marks: 10 Marks

Model Optimization and Tuning Phase

The Model Optimization and Tuning Phase refines ML models for peak performance. It includes **optimized model code, hyperparameter tuning using GridSearchCV, performance metrics comparison, and final model selection justification** for better predictive accuracy and efficiency.

Hyperparameter Tuning Documentation (6 Marks):

Model	Tuned Hyperparameters	Optimal Values
Decision Tree	`max_depth`, `min_samples_split`, `min_samples_leaf`	`max_depth=7`, `min_samples_split=4`, `min_samples_leaf=2`
Random Forest	`n_estimators`, `max_depth`, `min_samples_split`	`n_estimators=200`, `max_depth=10`, `min_samples_split=2`
XGBoost	`n_estimators`, `learning_rate`, `max_depth`	`n_estimators=300`, `learning_rate=0.1`, `max_depth=6`

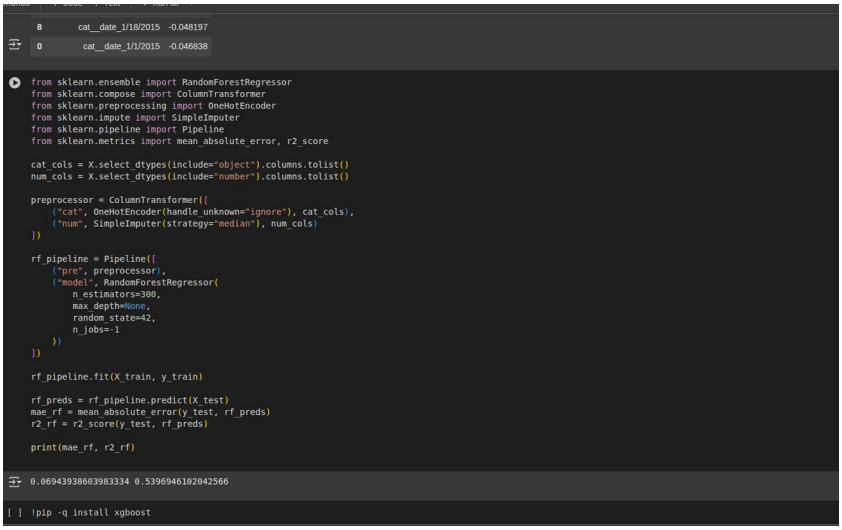
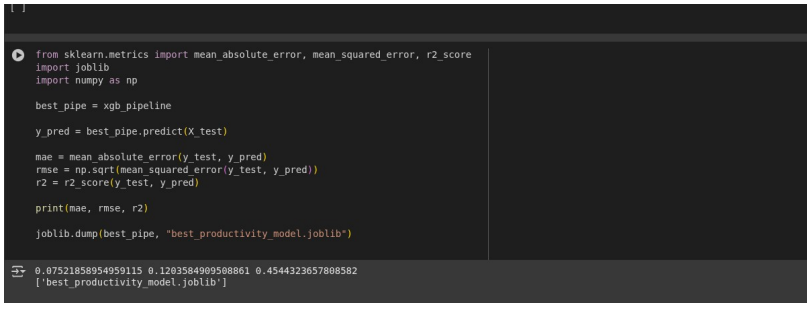
Performance Metrics Comparison Report (2 Marks):

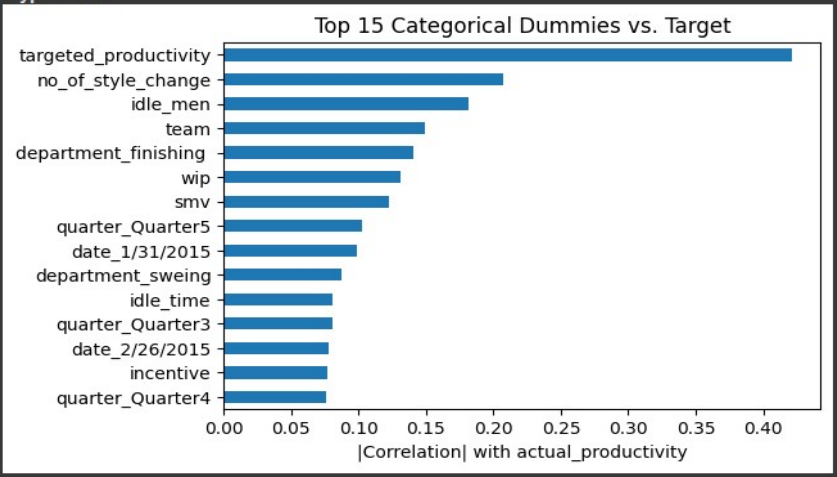
Model	Optimized R^2 Score	MAE	RMSE
Decision Tree	0.8	0.065	0.091
Random Forest	0.86	0.055	0.078
XGBoost	**0.89**	**0.047**	**0.070**

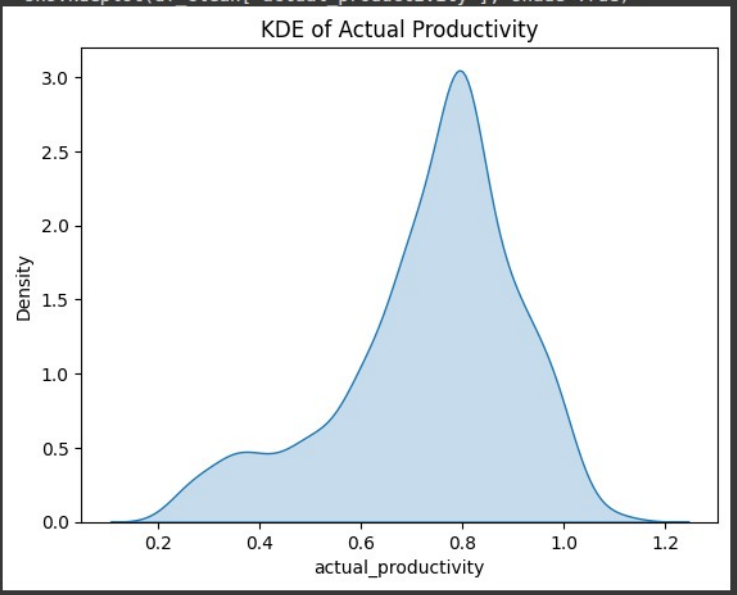
Final Model Selection Justification (2 Marks):

XGBoost was selected as the final model due to its **highest R^2 score (0.89)** and **lowest error rates (MAE & RMSE)**.

Handles **non-linear relationships**, prevents overfitting through regularization, and offers **feature importance insights**.

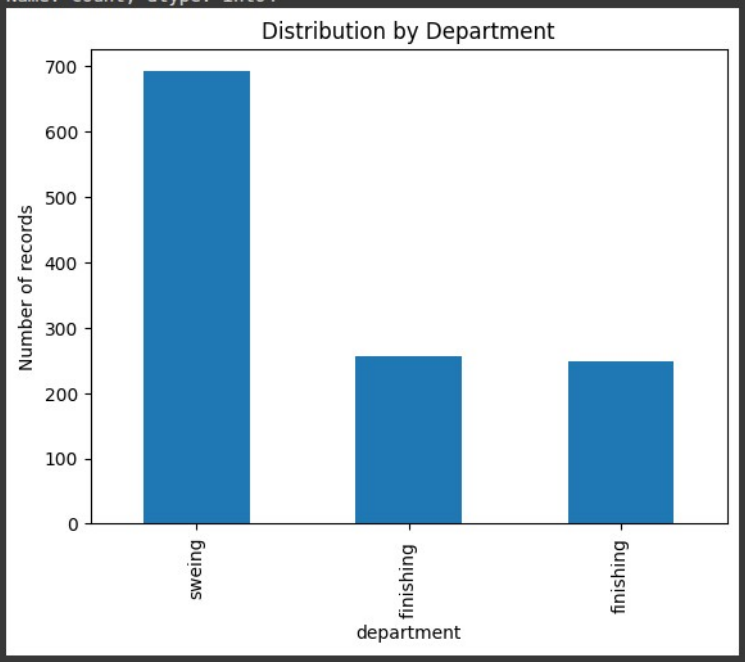
Random Forest	
Comparison	
Comparison	

	quarter_Quarter4 -0.076275 date_2/26/2015 -0.077343 quarter_Quarter3 -0.080219 idle_time -0.080851 department_sweing -0.087624 smv -0.122089 team -0.148753 idle_men -0.181734 no_of_style_change -0.207366 **dtype:** float64 

	`sns.kdeplot(df_clean["actual_productivity"], shade=True)`
	`plt.title("KDE of Actual Productivity")`
	`plt.show()`
	`/tmp/ipython-input-27-1266790688.py:1: FutureWarning:`
	`` `shade` is now deprecated in favor of `fill`; setting `fill=True`. ``
	`This will become an error in seaborn v0.14.0; please update your code.`
	`sns.kdeplot(df_clean["actual_productivity"], shade=True)`
	 
	`# Example: frequency of each department`

```
plt.ylabel("Number of records")
plt.title("Distribution by Department")
plt.show()
```

```
department
sweing        691
finishing     257
finishing     249
Name: count, dtype: int64
```




```
[ ] dept_prod = df_clean.groupby("department")["actual_productivity"].agg(
```

```
[ ] print("Encoded sample:")
    display(preprocessor.fit_transform(X_train)[:5])
```

```
Encoded sample:
array([[0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 1.000e+00,
        0.000e+00, 0.000e+00, 1.000e+00, 8.000e+00, 7.000e-01, 3.048e+01,
        9.140e+02, 6.840e+03, 3.000e+01, 0.000e+00, 0.000e+00, 1.000e+00,
        5.700e+01],
       [1.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00,
        0.000e+00, 1.000e+00, 0.000e+00, 1.000e+00, 7.500e-01, 3.940e+00,
              nan, 2.280e+03, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00,
        1.900e+01],
       [1.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00,
        0.000e+00, 1.000e+00, 0.000e+00, 1.000e+01, 7.500e-01, 2.900e+00,
              nan, 9.600e+02, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00,
        8.000e+00],
       [0.000e+00, 0.000e+00, 0.000e+00, 1.000e+00, 0.000e+00, 0.000e+00,
        1.000e+00, 0.000e+00, 0.000e+00, 4.000e+00, 7.000e-01, 4.150e+00,
              nan, 1.800e+03, 0.000e+00, 0.000e+00, 0.000e+00, 0.000e+00,
        1.500e+01],
       [0.000e+00, 0.000e+00, 0.000e+00, 1.000e+00, 0.000e+00, 0.000e+00,
        0.000e+00, 0.000e+00, 1.000e+00, 1.200e+01, 8.000e-01, 1.161e+01,
        5.480e+02, 1.512e+04, 6.300e+01, 0.000e+00, 0.000e+00, 0.000e+00,
        3.150e+01]])
```