📊 Project 5 : Advanced Attrition Models (Tuned Random Forest + XGBoost)

In this notebook, we benchmark and enhance predictive models for employee attrition.

- Start with tuned **Random Forest**
- Introduce **XGBoost** (gradient boosting)
- Compare performance vs Logistic Regression

Goal:

Improve predictive accuracy while balancing interpretability and business storytelling.

1️⃣ Load & Preprocess Data

```
Dataset shape: (1470, 44)
```

2️⃣ Train-Test Split & Scaling

- Logistic Regression → needs scaling
- RF & XGBoost → raw features

3️⃣ Random Forest Hyperparameter Tuning

```
Best Params (RF): {'max_depth': None, 'min_samples_leaf': 1, 'min_samples_spl
10, 'n_estimators': 100}
Best CV Accuracy (RF): 0.8665055896141363
```

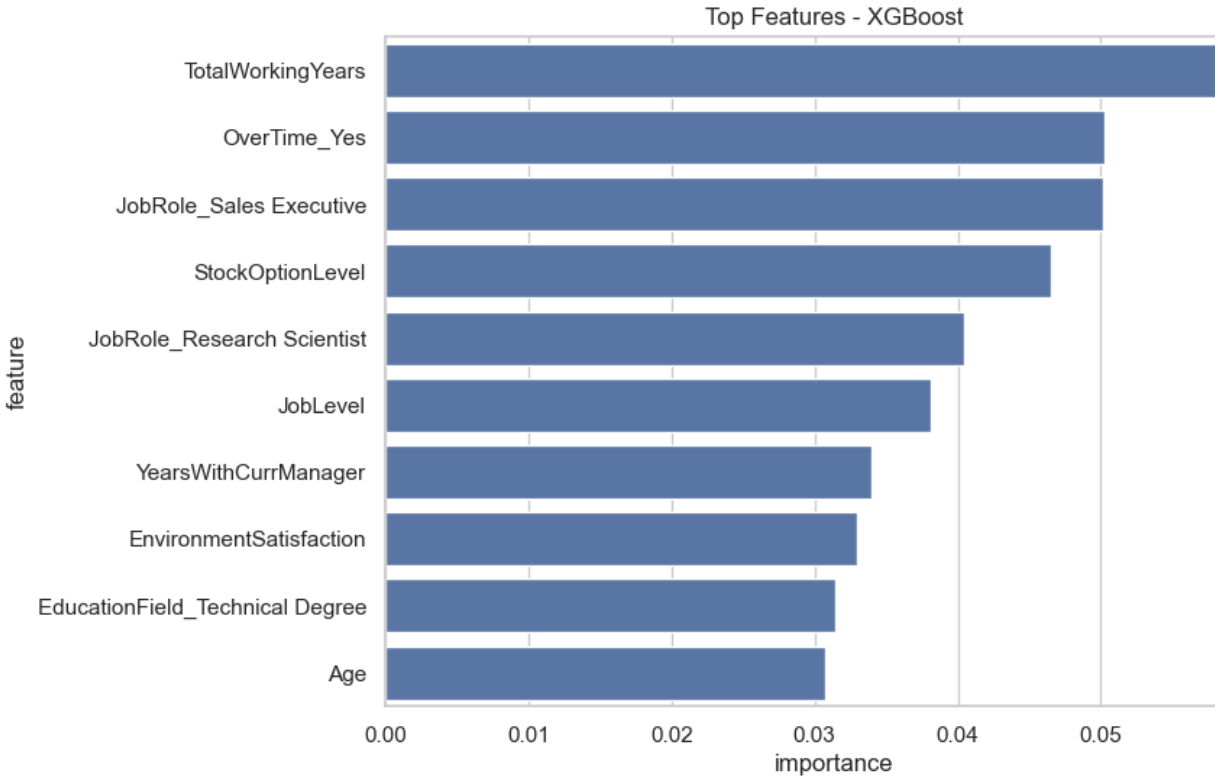
Out[7]: `['models/random_forest_tuned.pkl']`

4️⃣ Train XGBoost Model

```
XGBoost Accuracy: 0.8639455782312925
XGBoost ROC AUC: 0.7741407528641572
```

Out[9]: `['models/xgboost_attrition_model.pkl']`

5️⃣ Feature Importance

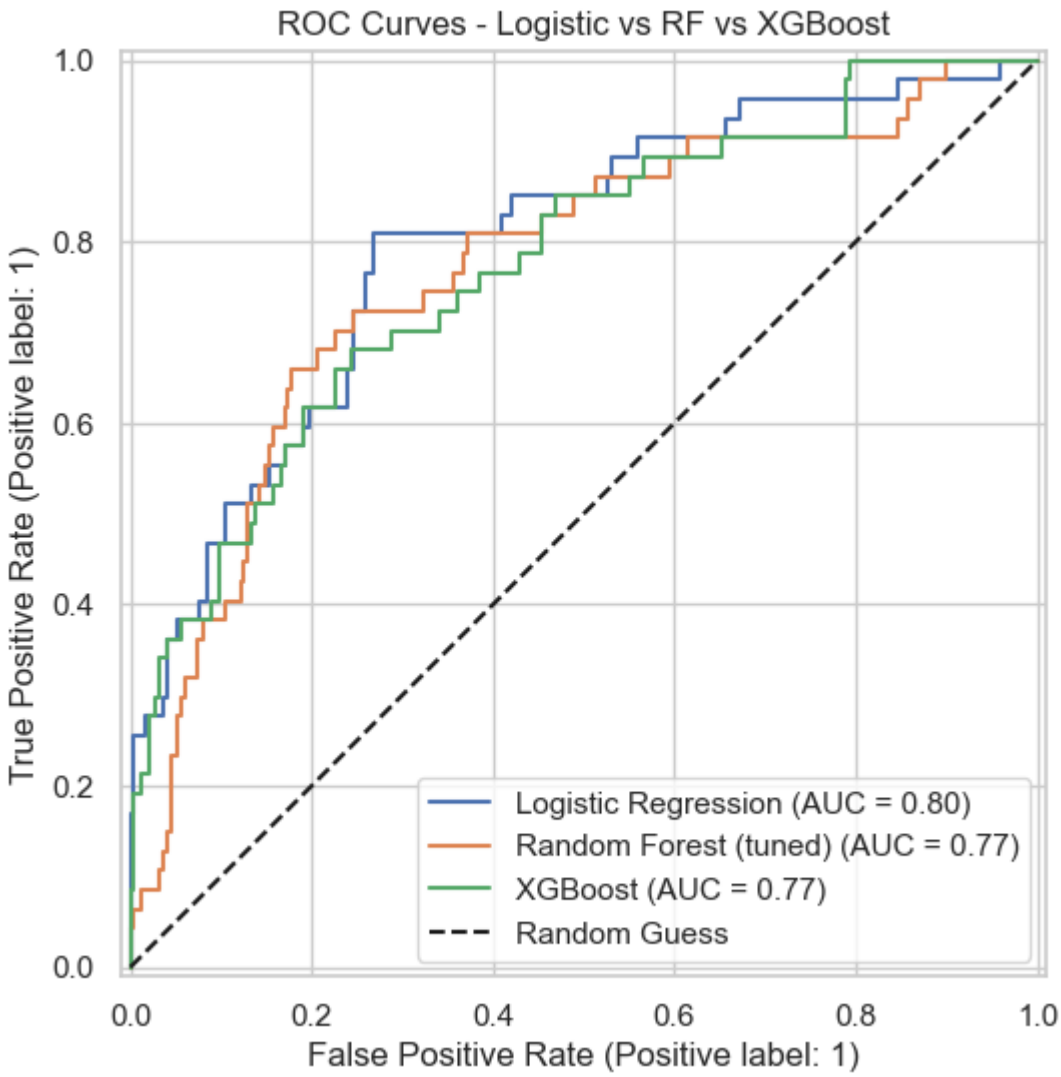


6️⃣ Model Comparison

	Model	Accuracy	ROC AUC
0	Logistic Regression	0.751701	0.798260
1	Random Forest (tuned)	0.836735	0.768886
2	XGBoost	0.863946	0.774141

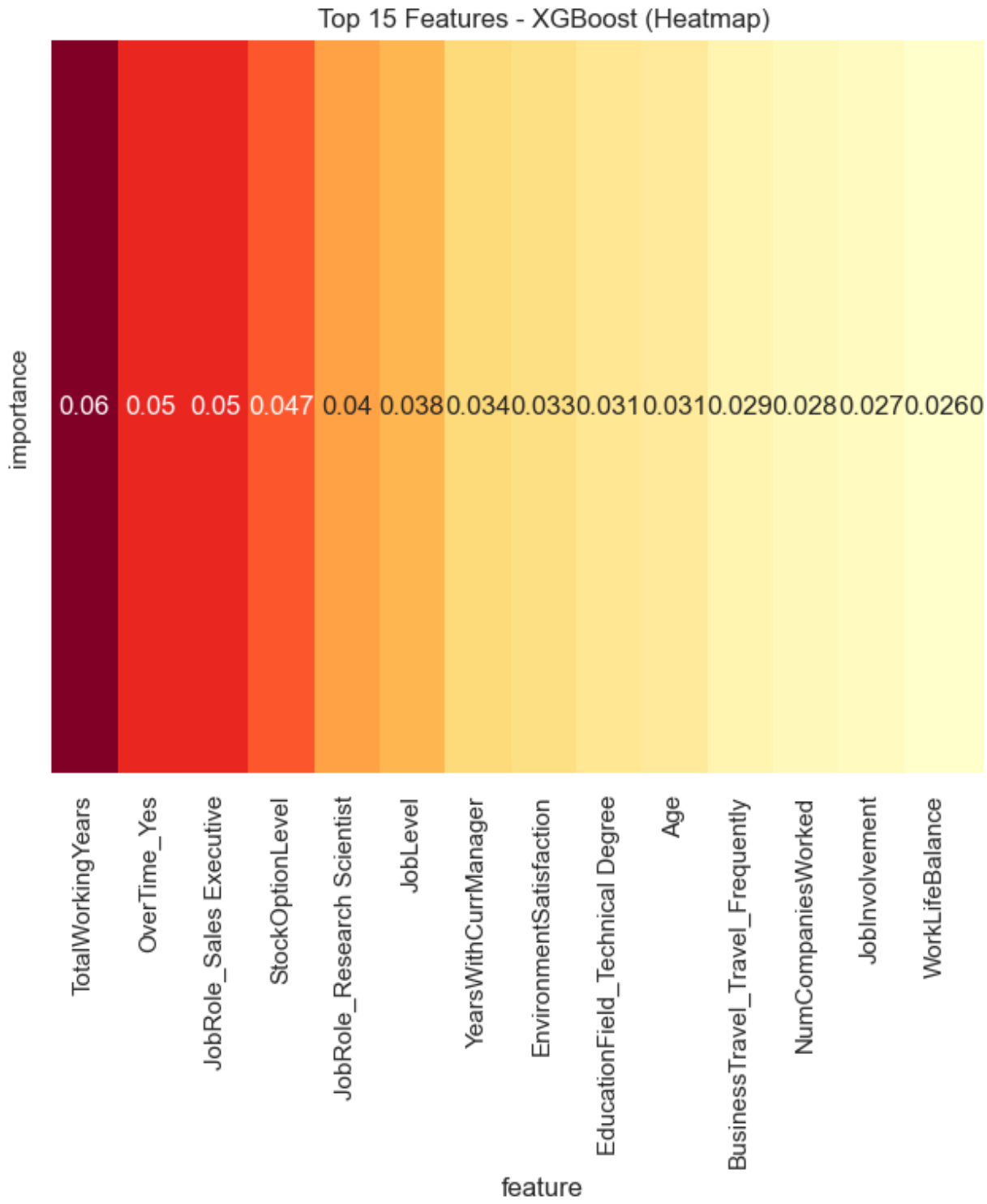
📊 ROC Curves for All Models

📈 Shows how Logistic, RF, and XGBoost trade off sensitivity vs specificity — RF edges ahead s



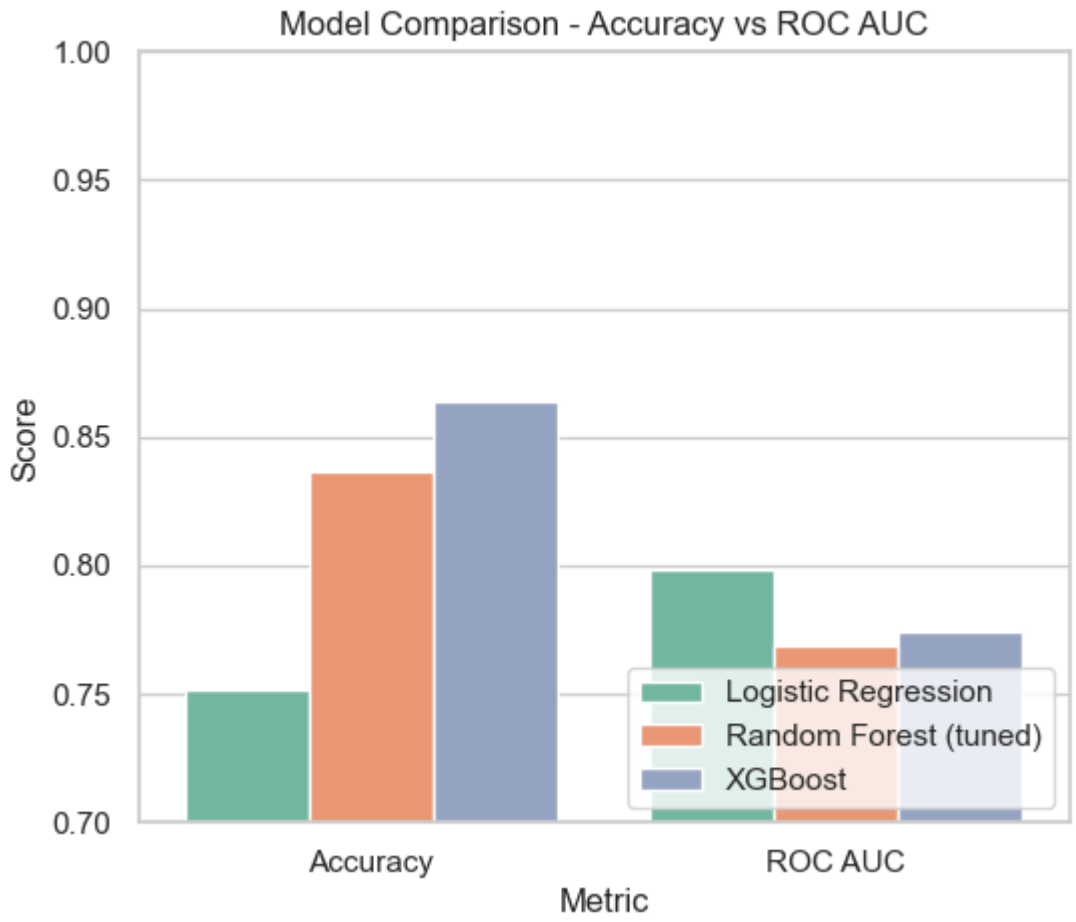
📊 Feature Importances Heatmap (XGBoost)

🔥 Top 15 features by importance — Total Working Years, Overtime, and Job Level- Sale Executive are top 3 attrition risk signals.



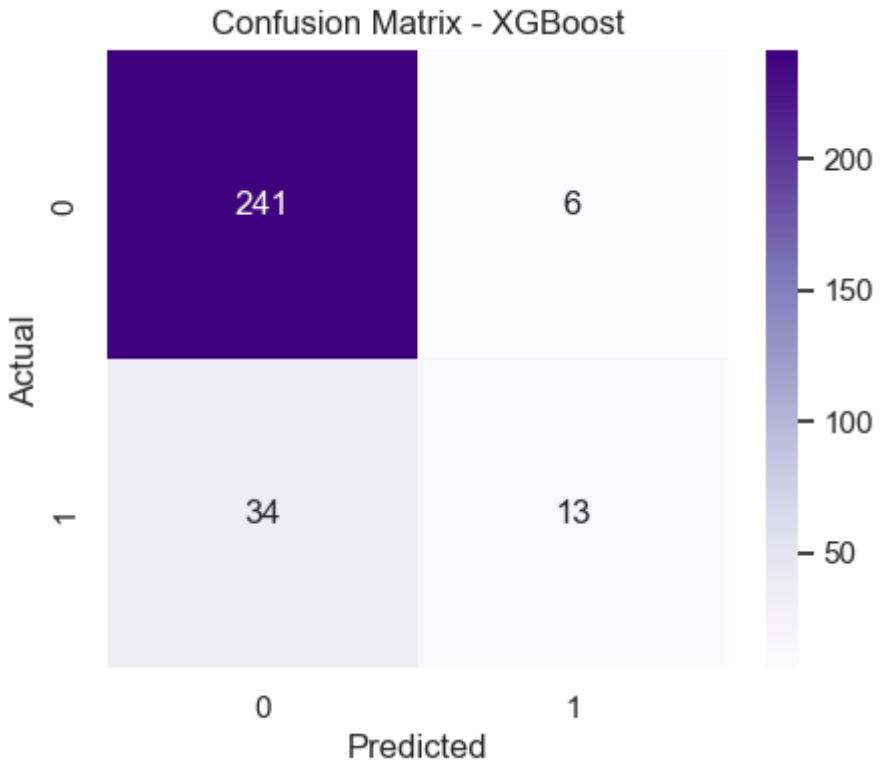
📊 Model Comparison Barplot

Quick side-by-side accuracy & ROC AUC.



📊 Confusion Matrix Heatmap (XGBoost only)

🧩 Visual breakdown of predictions — where XGBoost gets it right (and where it misses).



✅ Conclusions (Project 5)

- **Logistic Regression**
  Accuracy ~ 75 %, ROC AUC ~ 0.79 → simple & interpretable
- **Tuned Random Forest**
  Accuracy ~ 83 %, ROC AUC ~ 0.76 → improved performance, good at non-linear sp
- **XGBoost**
  Accuracy ~ 86 %, ROC AUC ~ 0.77 → strongest predictive performance

Key Insights:

- OverTime and Sales roles remain consistent predictors across models
- Random Forest & XGBoost highlight additional signals like MonthlyIncome and Age buckets
- Logistic is best for storytelling, XGBoost for prediction