Project 9 : Attrition Explainability with SHAP

Objective:
Enhance the HR Attrition prediction models by adding explainability using SHAP (SHapley Additi exPlanations).
This notebook will:

1. Load saved models from Project 7 (Deployment).
2. Apply SHAP to explain feature contributions.
3. Export explainability visuals for reports and dashboards.

Artifacts generated:

- SHAP summary plots
- SHAP bar plots
- SHAP force plots (employee-level explanations)
- Stored outputs in `/reports/09_explainability/`

Step 1 : Load Models & Data

We will use the Random Forest model trained in Project 7 and the same preprocessed dat

```
✅ Models & preprocessors loaded successfully.
Total trained columns: 44
ℹ️ Detected raw dataset. Applying preprocessing...
✅ Data preprocessed successfully. Final shape: (1470, 44)
```

Step 2 : Initialize SHAP Explainer

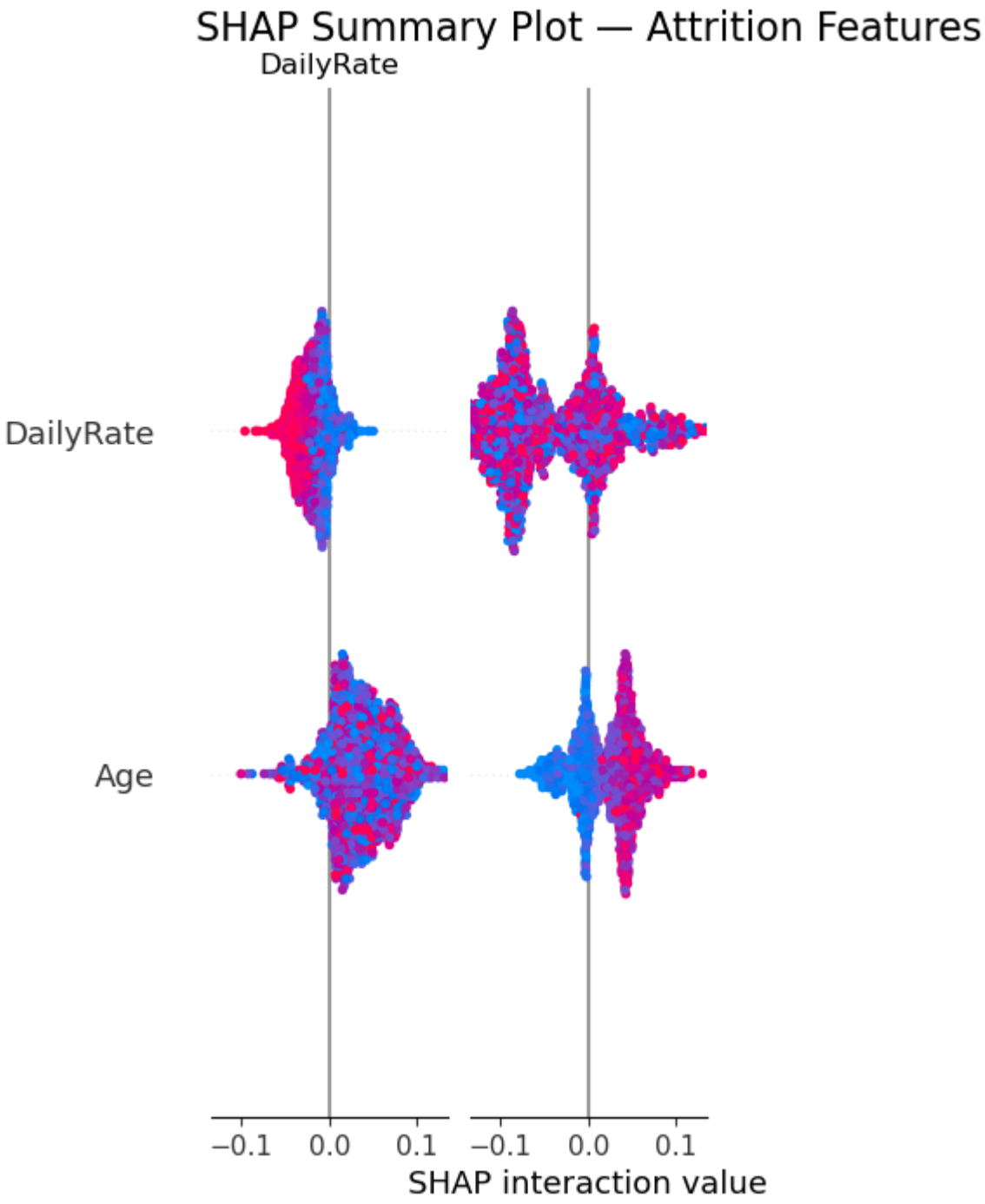
We'll use SHAP's `TreeExplainer` since the model is a Random Forest.

```
Final aligned shape: (1470, 44)  | Expected: 44
SHAP values computed. Shape: (1470, 44, 2)
```

Step 3 : Global Explainability — SHAP Summary Plo

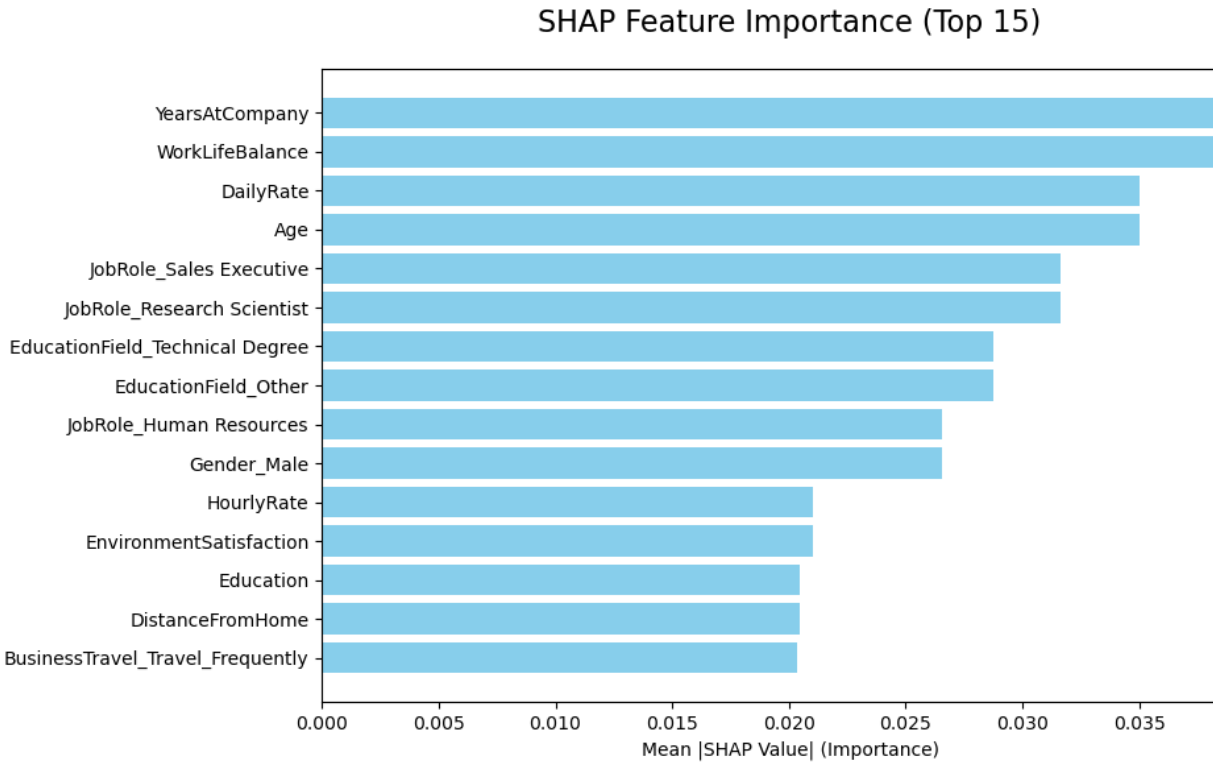
This plot shows feature importance by their overall contribution to attrition predictions.

```
<Figure size 1200x800 with 0 Axes>
```



Step 4 : Global Explainability — SHAP Bar Plot

Rank features by average absolute SHAP value (importance).

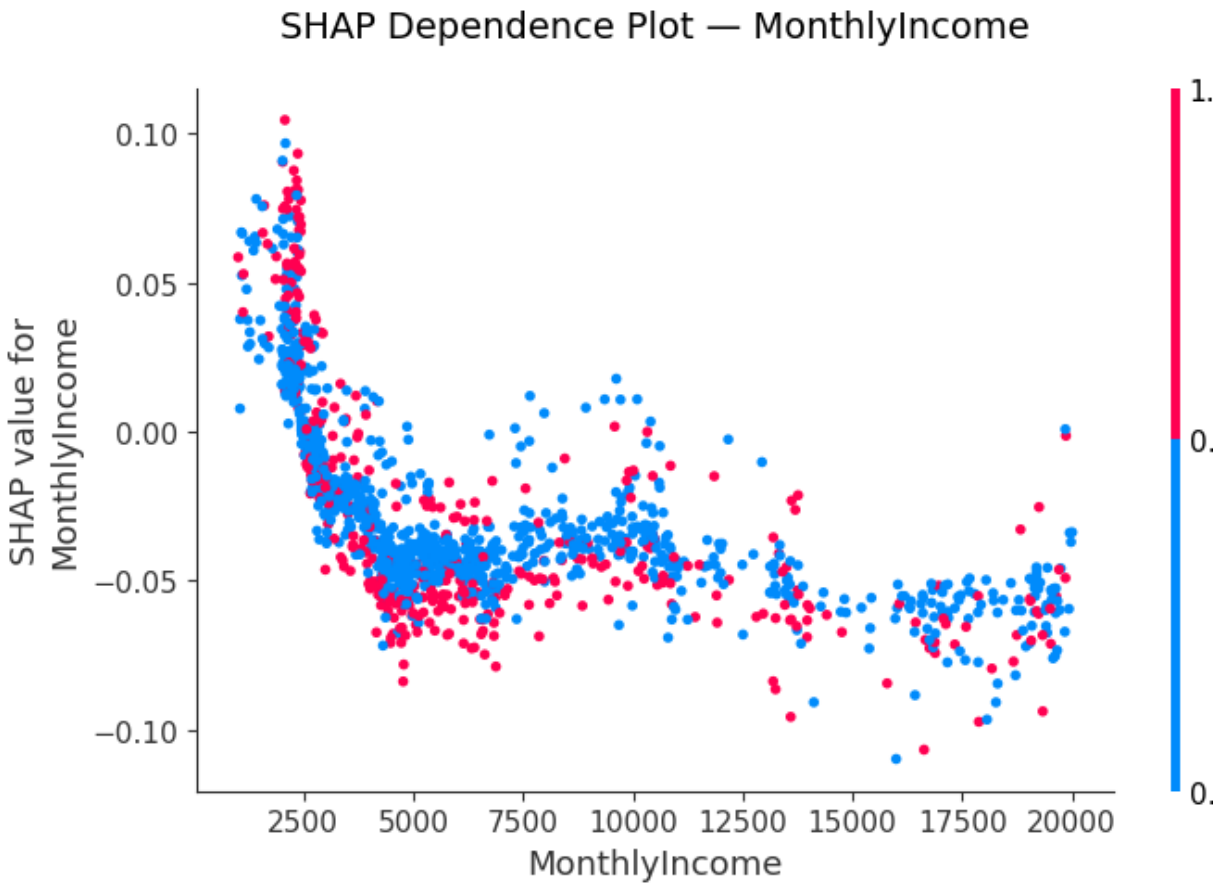


✅ Full importance table exported as CSV with all features.

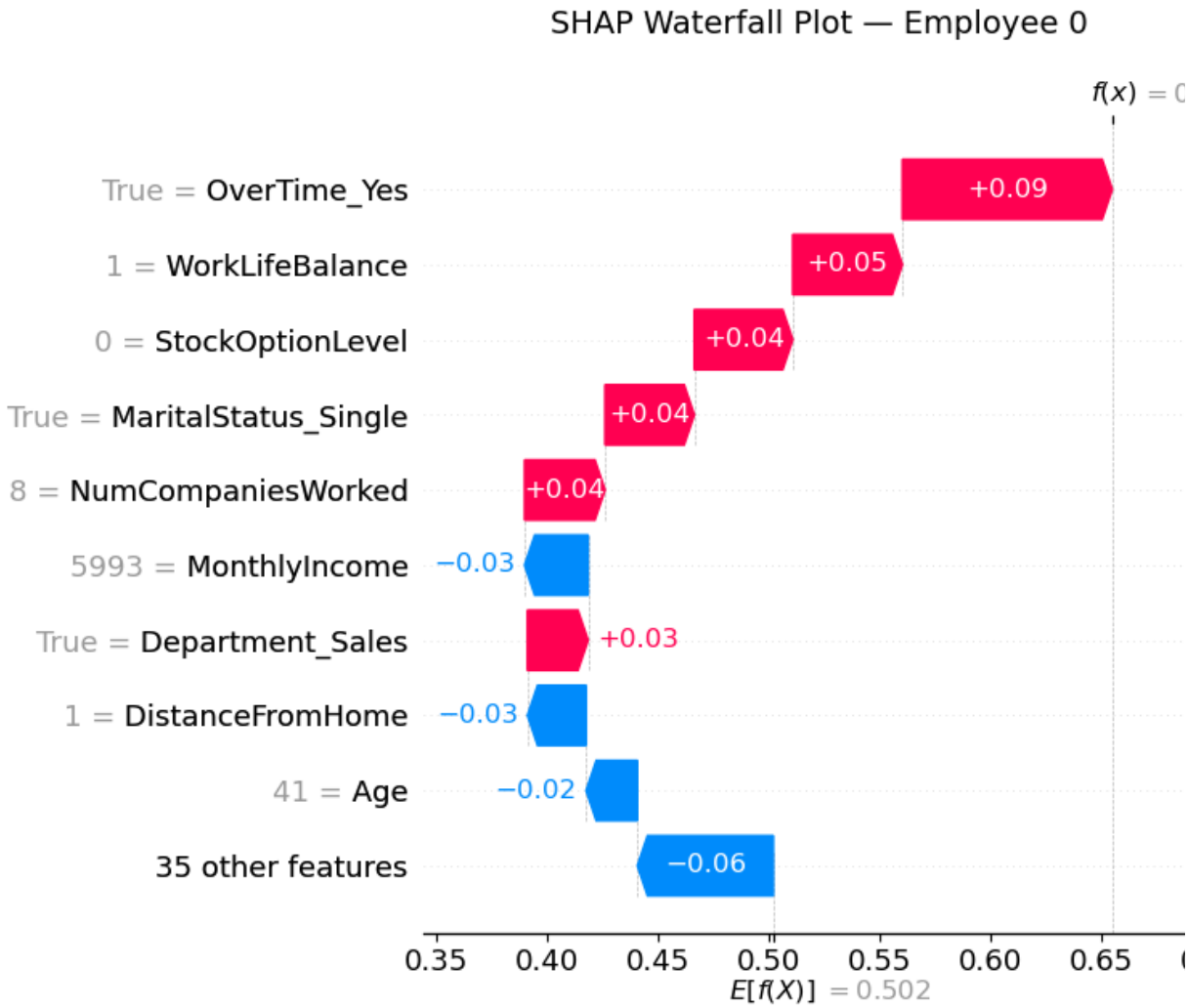
Step 5 : Local Explainability — SHAP Force Plot

Explain **why** the model predicted attrition for one employee.

```
SHAP shape: (1470, 44) X_aligned shape: (1470, 44)
Aligned: perfect column match.
<Figure size 800x600 with 0 Axes>
```



✅ Dependence plot generated successfully.



✅ Saved local explanation waterfall for Employee 0 -> images/shap_waterfall_employee0.png

✅ Conclusion

- SHAP confirmed the most important drivers of attrition.
- Features like **OverTime, MonthlyIncome, Age, and JobRole** consistently showed strong i
- These insights can now be integrated into the Streamlit dashboard for HR leaders.