

Project 8 : SQL + ML Integration

Objective:

Combine **SQL querying power** with **Machine Learning models** to analyze attrition risk.

This project demonstrates how HR teams can query their employee database directly and run predictions on-the-fly, bridging People Analytics with HRIS-like systems.

Why It Matters:

- HR data often lives in databases (HRIS, payroll systems).
- Analysts should be able to run queries and pipe results into ML models.
- This integration makes predictive attrition analytics more practical in enterprise contexts.

✓ SQL + ML Integration

This project demonstrated how SQL queries can be seamlessly combined with Machine Learning to run real-time attrition predictions.

Key Takeaways:

- **Database Integration:** HR data stored in SQL (SQLite) was queried directly inside Python.
- **Leakage Prevention:** Attrition labels were properly excluded from inference data.
- **Predictions:** Logistic/XGBoost models predicted attrition risk per employee.
- **Visuals:**
 - Donut Chart → At Risk vs Safe employees.
 - Department-level bar chart → attrition distribution across functions.
 - Probability distribution → highlights prediction spread & threshold sensitivity.
- **Threshold Optimization:** Added adaptive cutoffs to balance risk prediction and reduce false positives.

Artifacts Produced:

- `hr_dataset.db` → SQLite database with IBM HR data (table = employees).
- SQL utility module → `sql_utils.py` for safe querying & reusable functions.
- Visual charts (saved in `/charts/`):
 - `donut_chart.png`
 - `department_attrition.png`
 - `probability_distribution.png`
- Notebook → with integrated SQL + ML pipeline.

Business Value:

- HR leaders can **query directly** for attrition insights without touching Python code.
 - Predictive analytics embedded into HRIS-like SQL workflows.
 - Foundation for **real dashboards** (Streamlit / BI tools) where HR managers can pull SQL → predictions → export reports.
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✓ Created C:\Users\amlanmishra2\data\hr_dataset.db with table 'employees' (1 rows).

Setup & DB Creation

✓ Created C:\Users\amlanmishra2\data\hr_dataset.db with table 'employees' (1 rows).

Quick Database Check

📋 Tables: [('employees',)]

Helper Function Run Query

Sample Queries

Out[5]:

| | Department | total | left_count |
|---|------------------------|-------|------------|
| 0 | Research & Development | 9 6 1 | 1 3 3 |
| 1 | Sales | 4 4 6 | 9 2 |
| 2 | Human Resources | 6 3 | 1 2 |

ML Integration & Visualization

⚠ Dropped 'Attrition' column from inference data to avoid leakage.

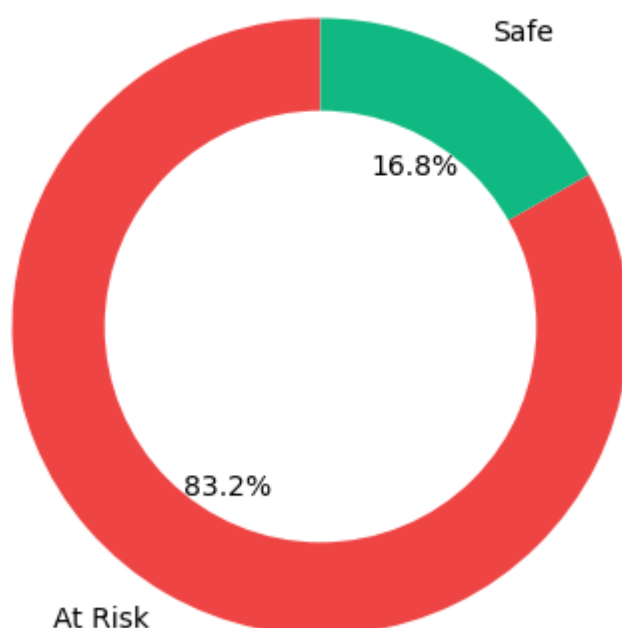
🔍 Prediction Debug

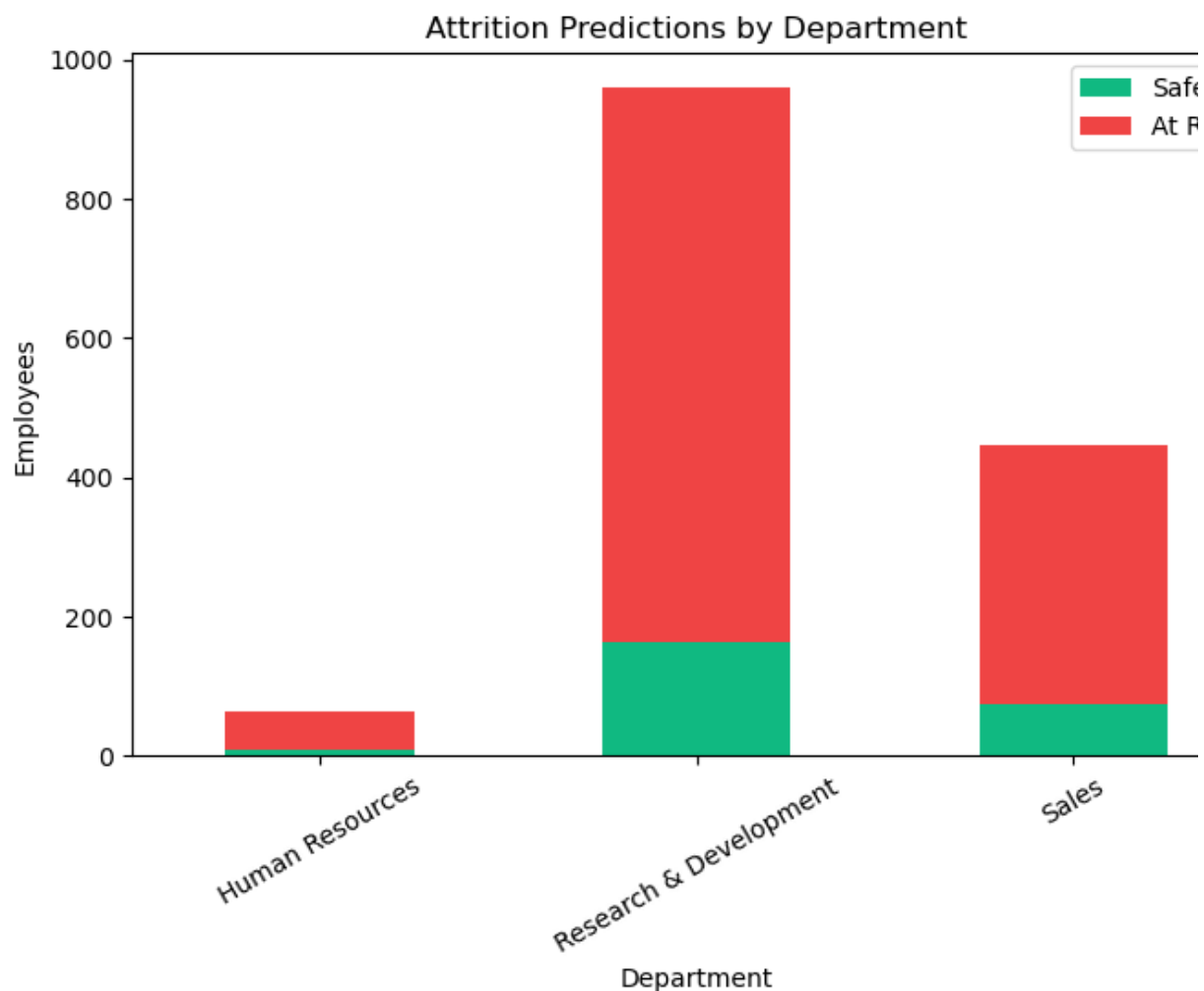
Probability range: 0.0 to 1.0

Sample stats: [0.46418643 0.7870295 0.95263028 0.95263028 0.96479201]

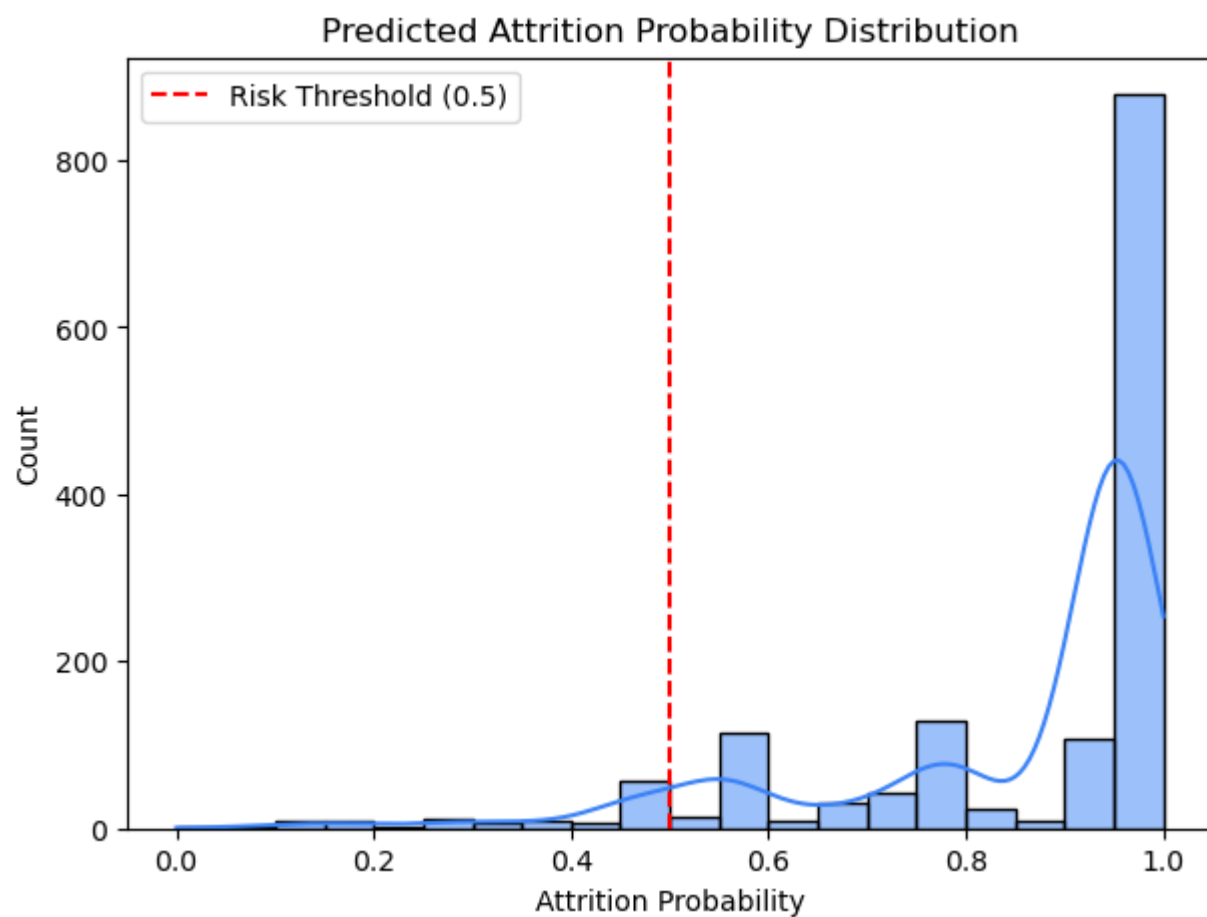
✓ Using threshold 0.65 → At Risk: 1223, Safe: 247

At Risk vs Safe (Predictions from SQL data)





Out[9]: <function matplotlib.pyplot.show(close=None, block=None)>



📁 Exported artifacts:

- Predictions CSV → data\Attrition_SQL_Predictions.csv
- Charts → images/sql_pred_donut.png, images/sql_pred_dept.png