Loan Default Risk Analysis

(Dataset : Loan Dataset)

(Last updated : 13-July-2025)

Project's Agenda

- Dataset Overview
- Conduct Exploratory Data Analysis (EDA)
- Visualization
- Chi² test & Cramér's V Test
- Loan Prediction
- Conclusions

Dataset Overview

01

Total Records:

32,586

02

Target Variable:

loan_status_clean

✅ Non-Default: 25,586 (~79%)

❌ Default: 6,819 (~21%)

03

Features:

Numerical: age, income, loan amount, interest rate, employment years

Categorical: home ownership, loan intent, loan grade, etc

Exploratory Data Analysis (EDA)

01

Target Variable Distribution:

Default: 6,819 (≈ 21%)

Non-Default: 25,589 (≈ 79%)

02

Distribution Checks:

customer_age, customer income, loan_amount, loan_int_rate.

Detected right skew in all except interest rate(normal)

03

Data Types:

Categorical: home ownership, loan intent, loan grade.

Numerical: age, income, interest rate, loan amount

04

Outliers detected:

In customer_income, loan_amnt, and customer_age

05

Initial Patterns Identified:

Younger borrowers = slightly higher default rate

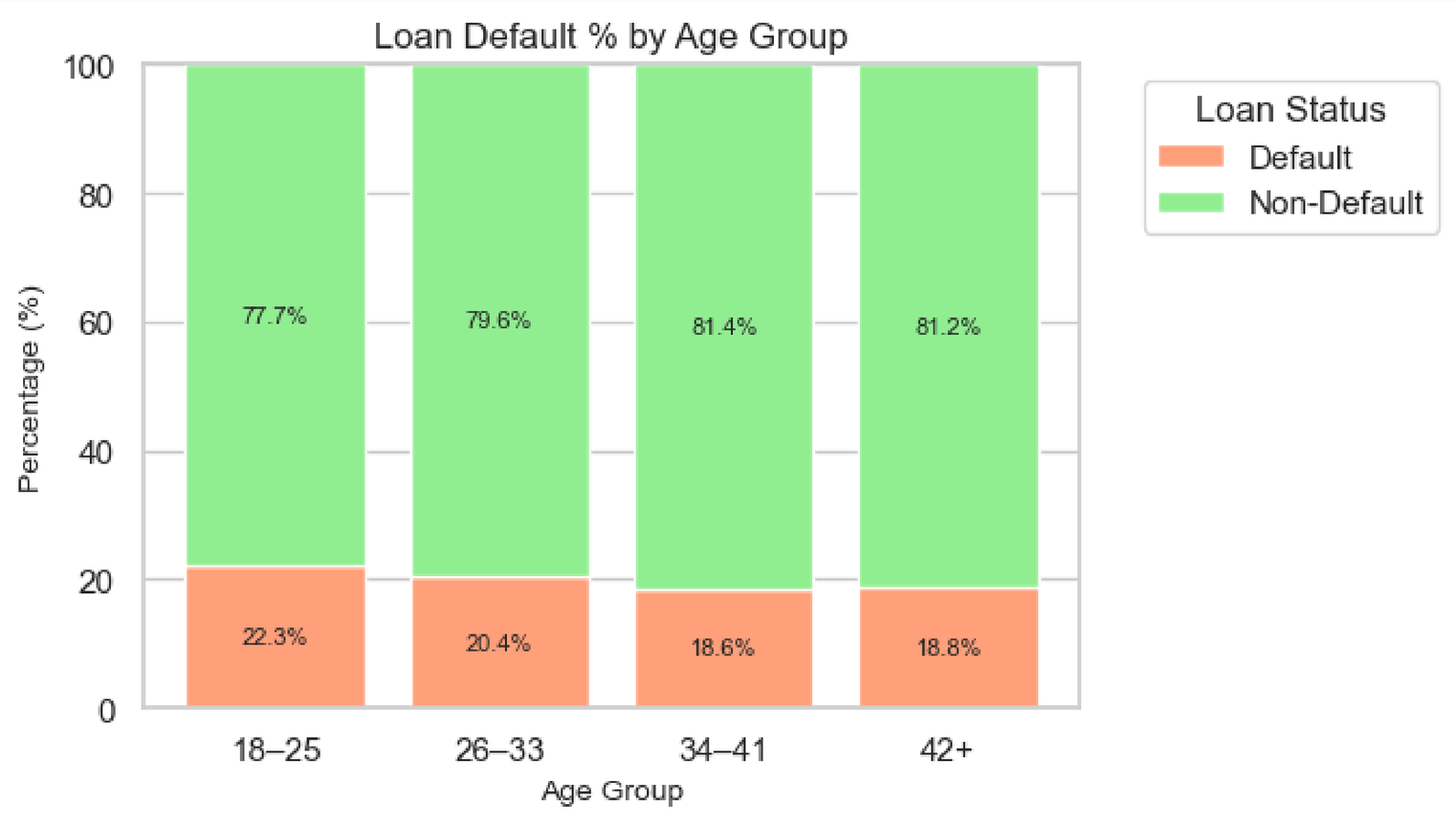
High income = lower risk of default

Larger loan amounts (20k+) associated with higher default

Loan Purpose affects risk — e.g., Medical & Debt Consolidation = high default

Visualization

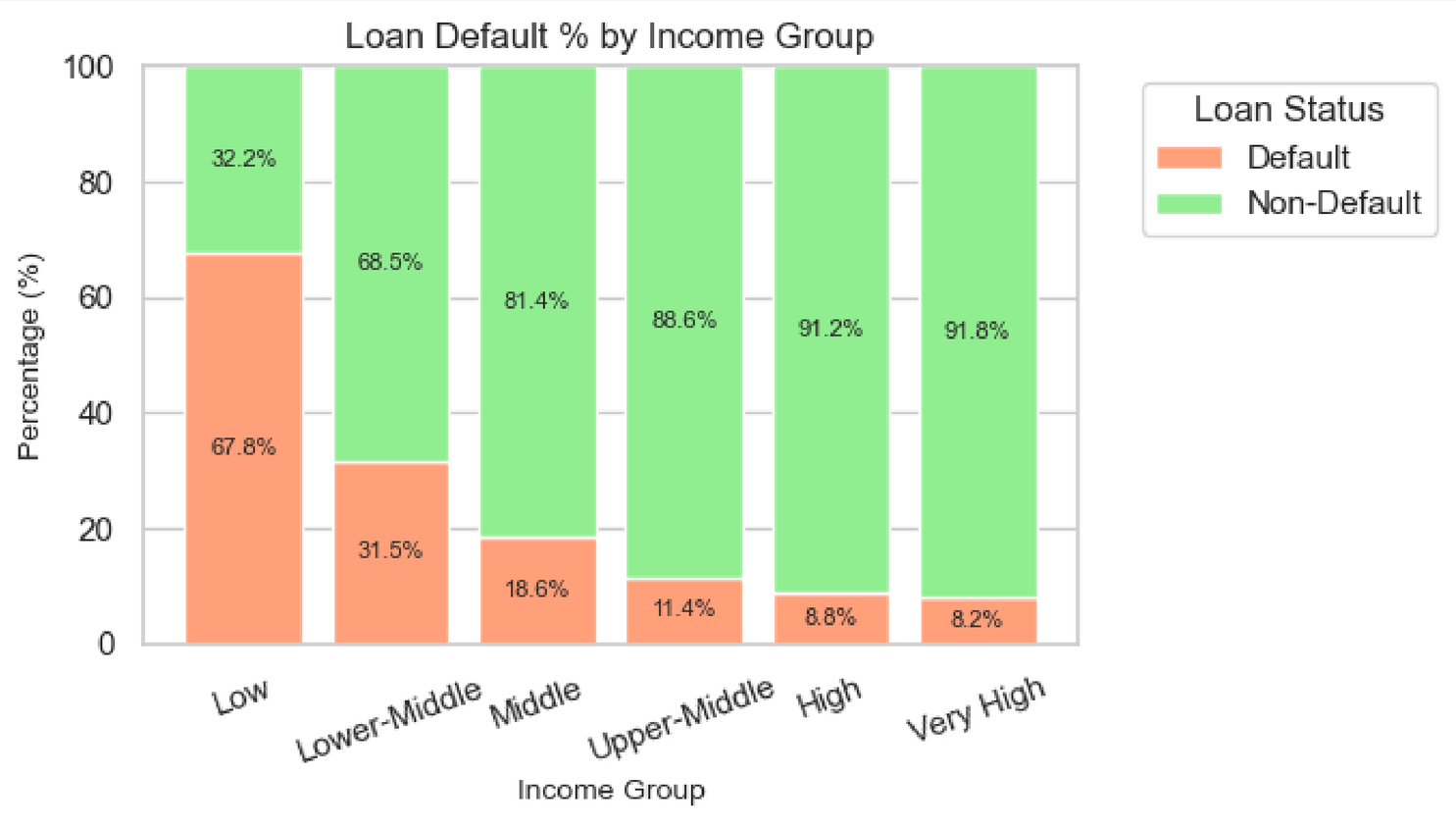
Age Group vs Loan Status



Insight:

- Default rate slightly decreases as age increases — younger borrowers (18–25) show highest risk.
- Borrowers aged 34+ are more stable — lowest default rates and better repayment behavior.

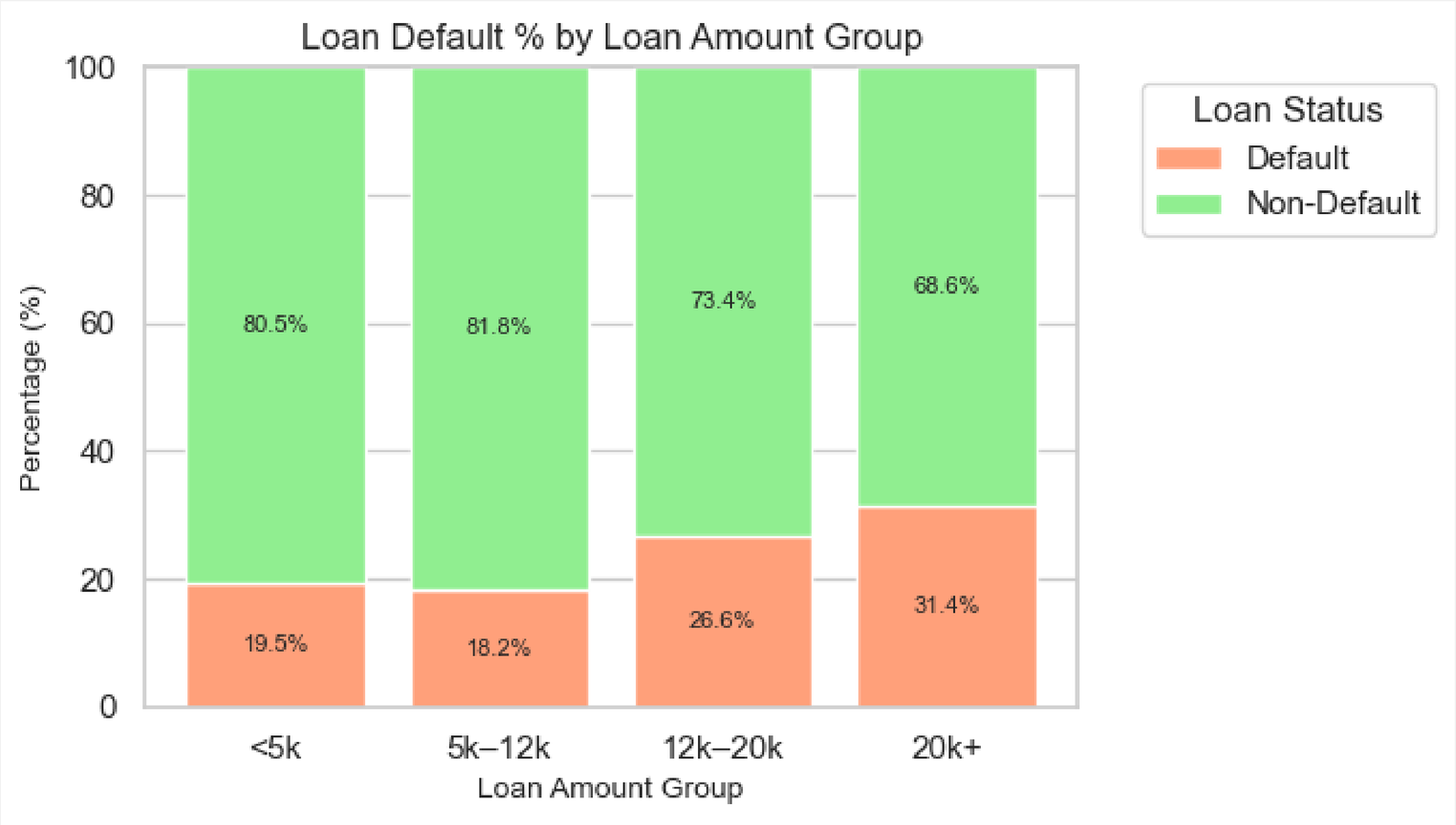
Income Group vs Loan Status



Insight:

- Default rate drops steadily as income increases.
- Low-income borrowers show highest defaults — financial stress.

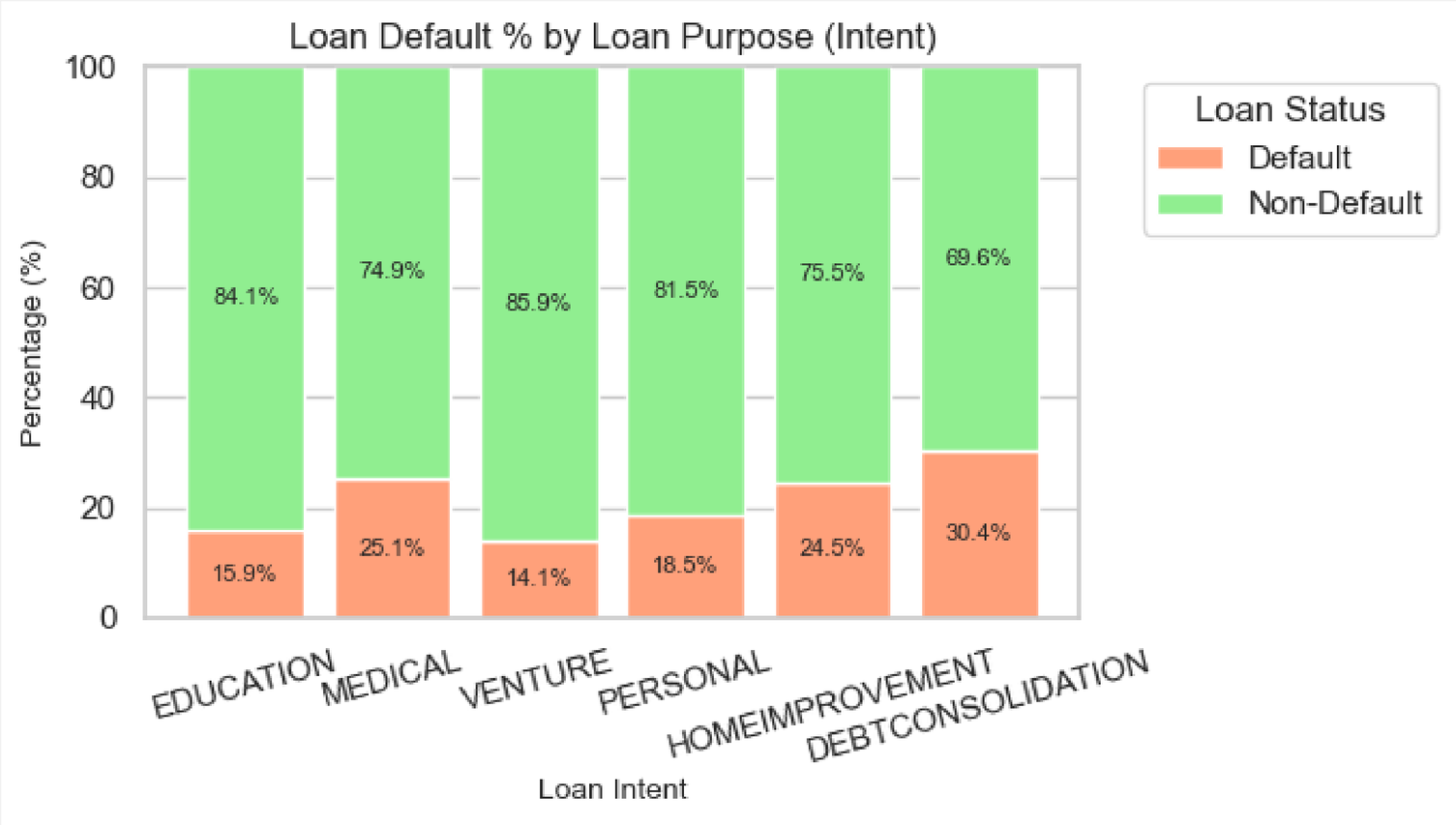
Loan Amount Group vs Loan Status



Insight:

- Up to 12k: Default rate stays low and steady — borrowers likely manage repayment well.
- Above 12k: Default risk rises quickly — larger loans bring more pressure and missed payments.

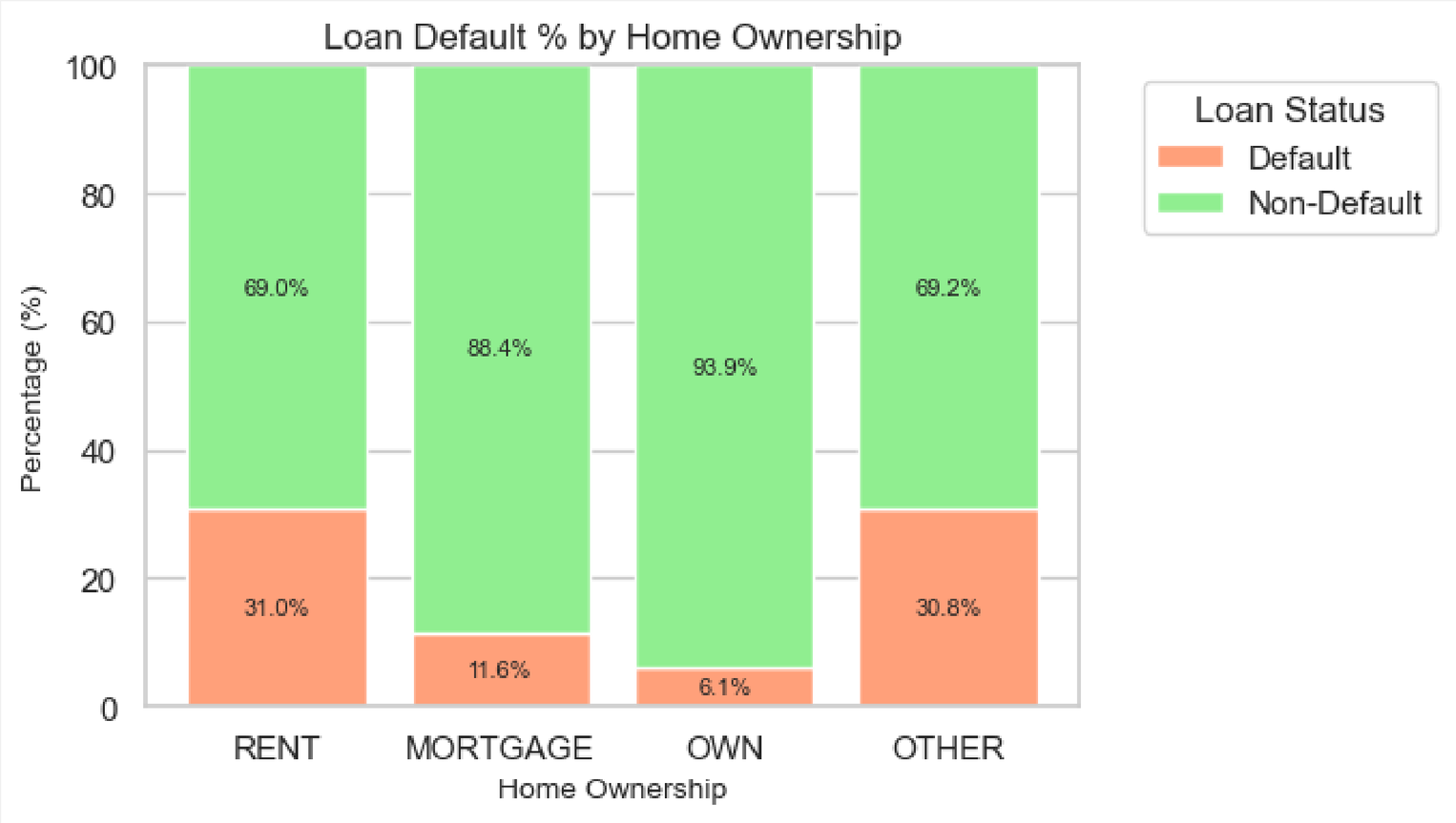
Loan Intent vs Loan Status



Insight:

- Lowest default rates in Education and Venture loans — borrowers tend to repay better.
- Highest risk seen in Debt Consolidation, Medical, and Home Improvement — likely tied to urgent or unstable financial situations.

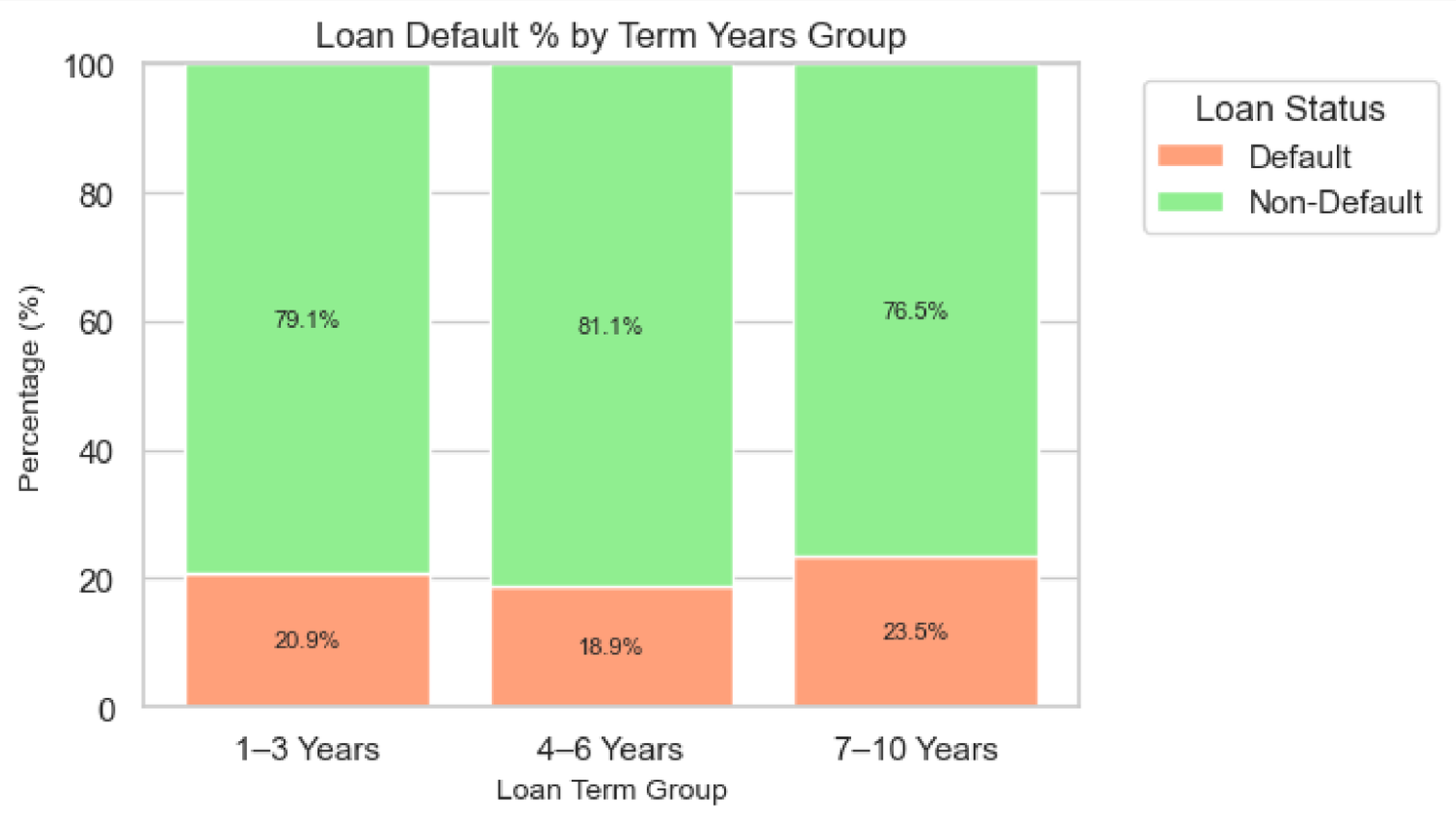
Home Ownership vs Loan Status



Insight:

- Own & Mortgage holders show the lowest default rates — stable living situations help repayment.
- Renters & Others face higher risk — financial uncertainty may impact loan reliability.

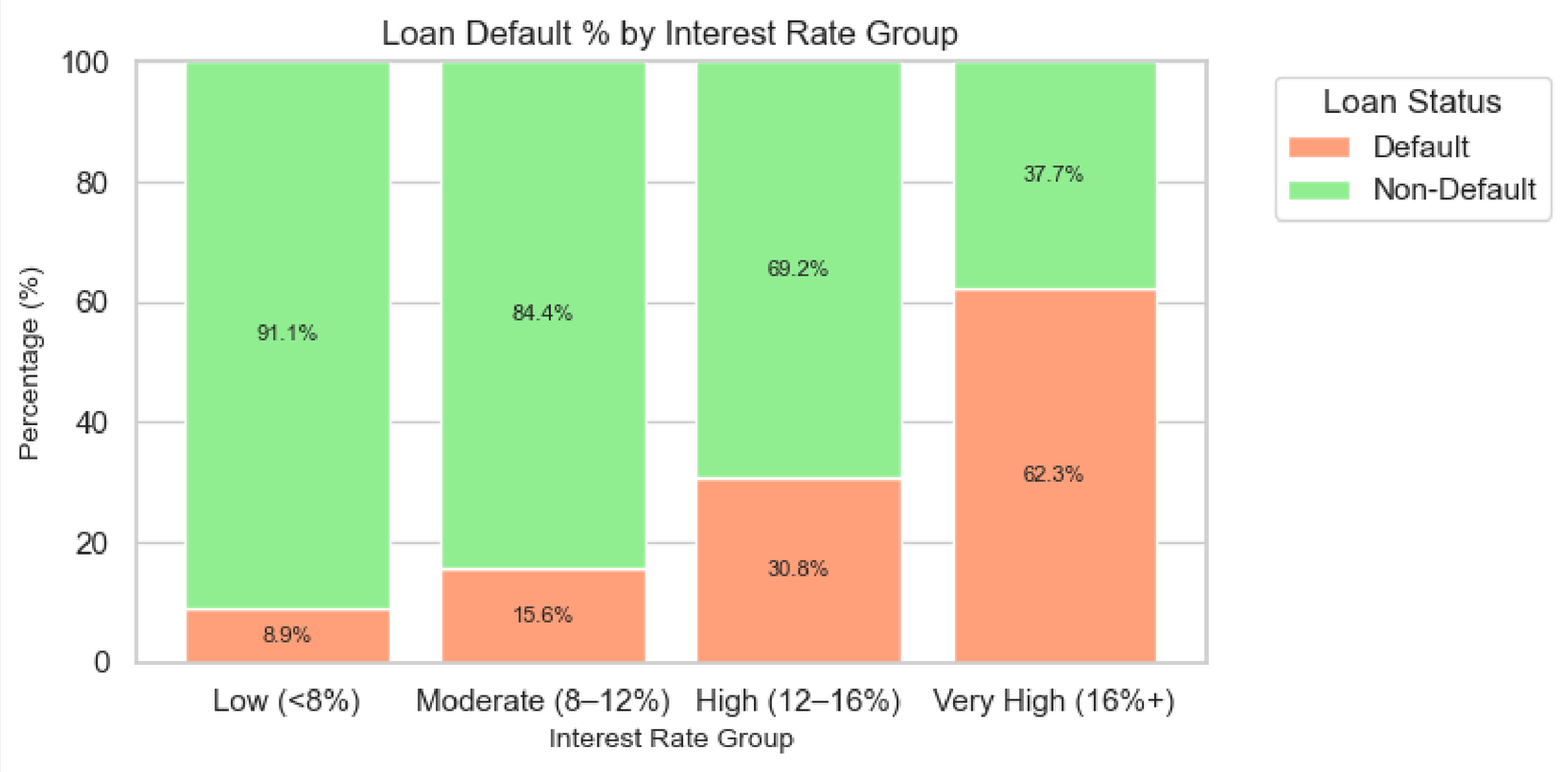
Term Years Group vs Loan Status



Insight:

- 4–6 year loans have the lowest default rate — repayment feels more balanced.
- Short (1–3 yrs) and long (7–10 yrs) terms show higher defaults — either too rushed or stretched too long.

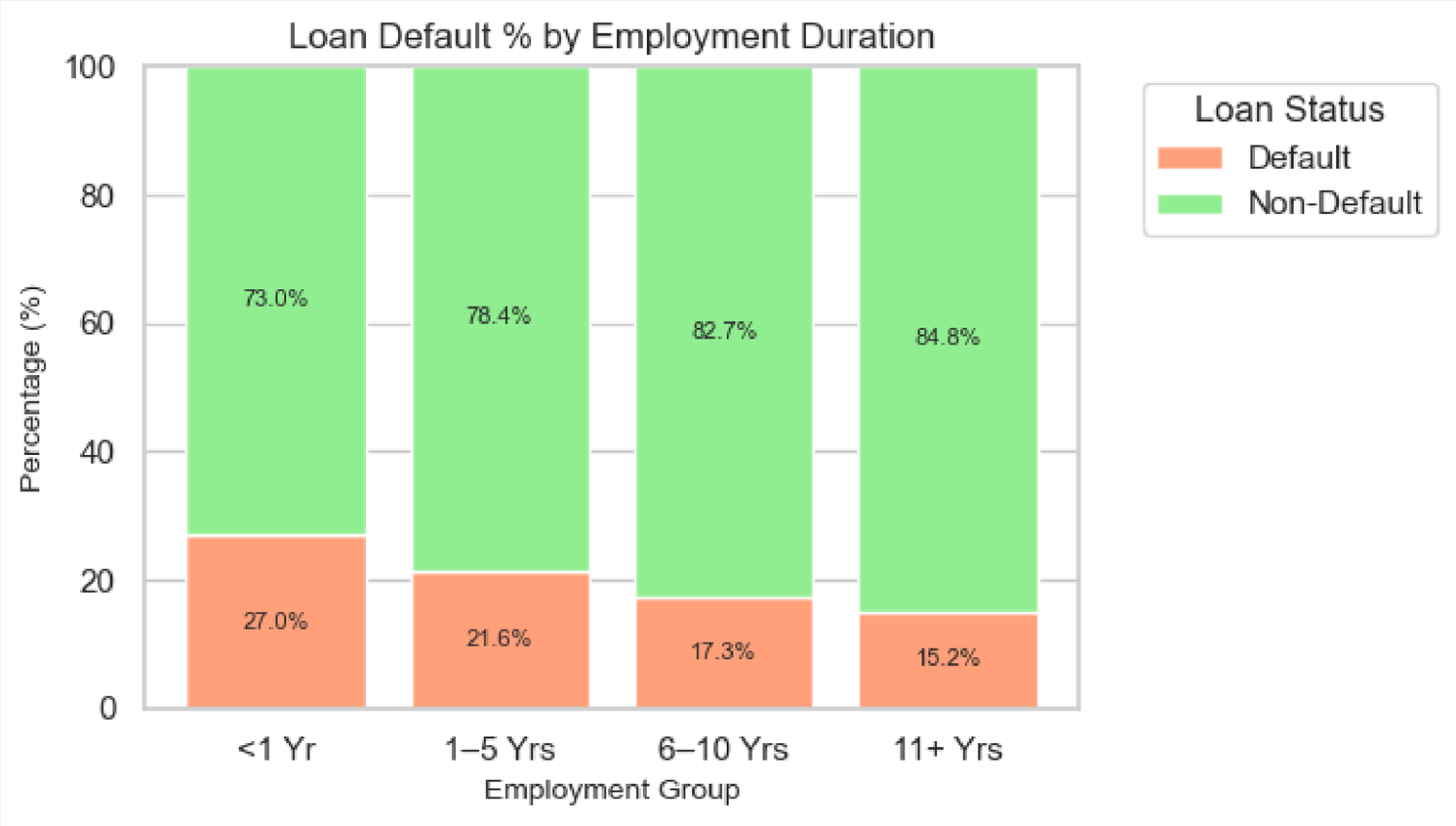
Interest Rate Group vs Loan Status



Insight:

- Borrowers with Very High interest rates are most likely to default.
- Suggests that higher rates may burden borrowers, especially those already flagged as risky

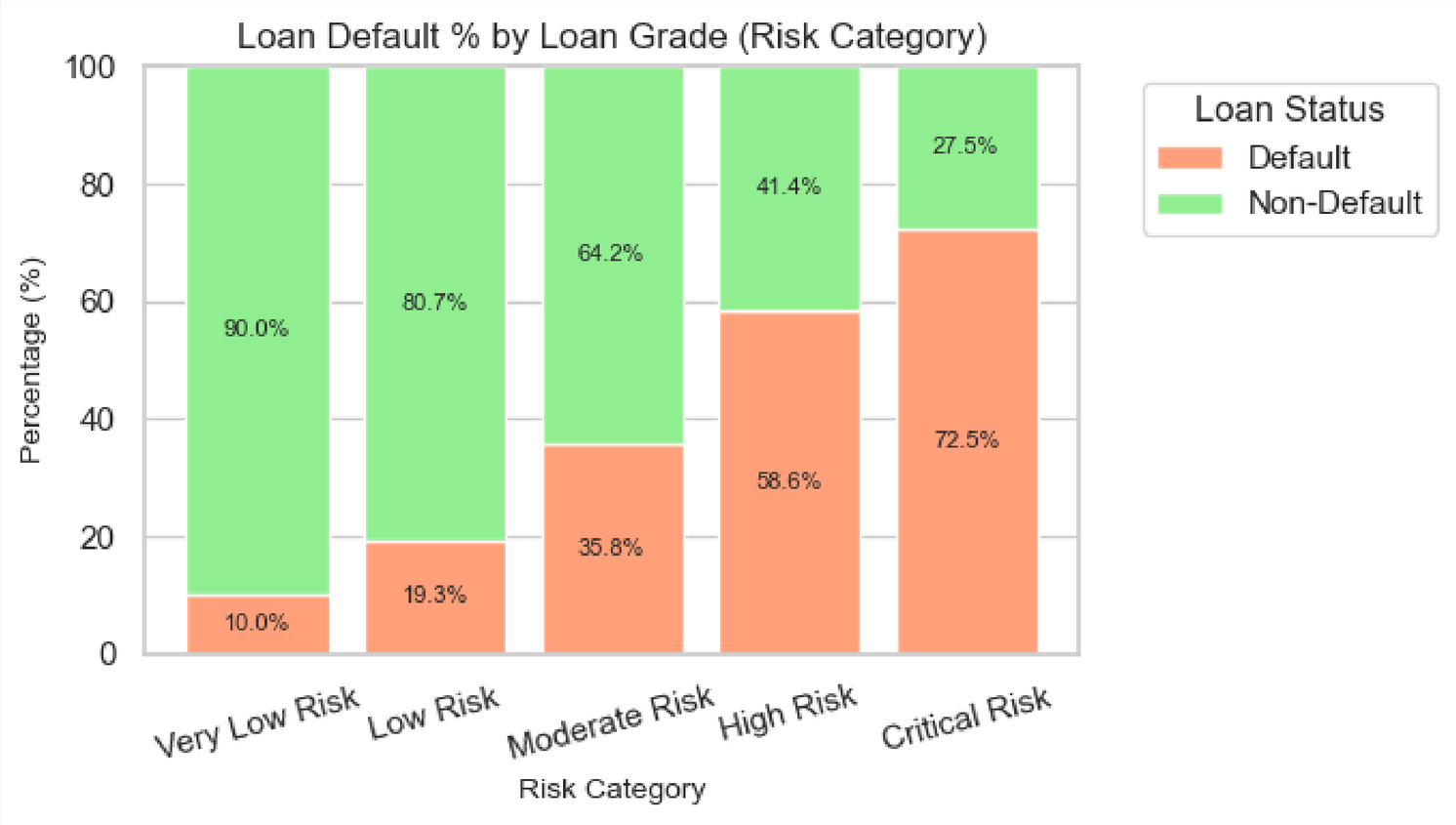
Employment Group vs Loan Status



Insight:

- Default rate decrease as job duration increases — people with longer work history repay more reliably.
- Shortest employment group (<1 year) shows highest risk — stability matters in financial commitments

Loan Grade Named vs Loan Status



Insight:

- Default risk rises sharply from Very Low to Critical grades — high-risk loans see over 70% defaults.
- Safer lending happens in Very Low and Low grades — borrowers repay reliably.

Chi-square Test

🔍 **Purpose:**
To check whether two categorical variables are independent or associated.

Basic Idea:
It compares the observed frequencies with the expected frequencies in a contingency table.

- If p-value < 0.05 → Reject Null Hypothesis → Relationship exists
- If p-value ≥ 0.05 → Fail to reject Null → No relationship

Cramer's V Test

🔍 **Purpose:**
After Chi-Square confirms the relationship, Cramér's V tells how strong that relationship is (magnitude).

Basic Idea:
It uses the Chi-Square statistic and adjusts it to give a value between 0 and 1.

- 0.00 → No association
- 0.01 – 0.10 → Weak association
- 0.10 – 0.30 → Moderate association
- 0.3–0.50 → Strong association
- >0.5 → Very strong association

Chi-Square Test & Cramér's V Test Results

Feature	p-value	Cramér's V	Association with Loan Status	Interpretation
Age Group	< 0.0001	0.032	Weak Association	Age has minimal impact on loan default; not a strong predictor.
Income Group	< 0.0001	0.293	Moderate Association	Borrower income is moderately associated with default behavior.
Loan Amount Group	< 0.0001	0.094	Weak Association	Loan amount has weak influence on default probability.
Loan Intent Group	< 0.0001	0.142	Moderate Association	Loan purpose moderately affects chances of default.
Loan Grade Named	< 0.0001	0.373	Strong Association	Loan grade is a strong predictor of loan default risk.
Home Ownership	< 0.0001	0.251	Moderate Association	Home ownership status shows strong relation to repayment behavior.
Employment Group	< 0.0001	0.093	Weak Association	Employment duration shows limited effect on default.
Term (Years) Group	< 0.0001	0.044	Weak Association	Loan term length has a weak association with default status.
Loan Interest Rate Group	< 0.0001	0.323	Strong Association	Higher interest rates strongly relate to increased default risk.

Loan Prediction

Model Selection

Two models used for classification:

- Logistic Regression (baseline)
- Random Forest (advanced, tree-based)

Both trained on:

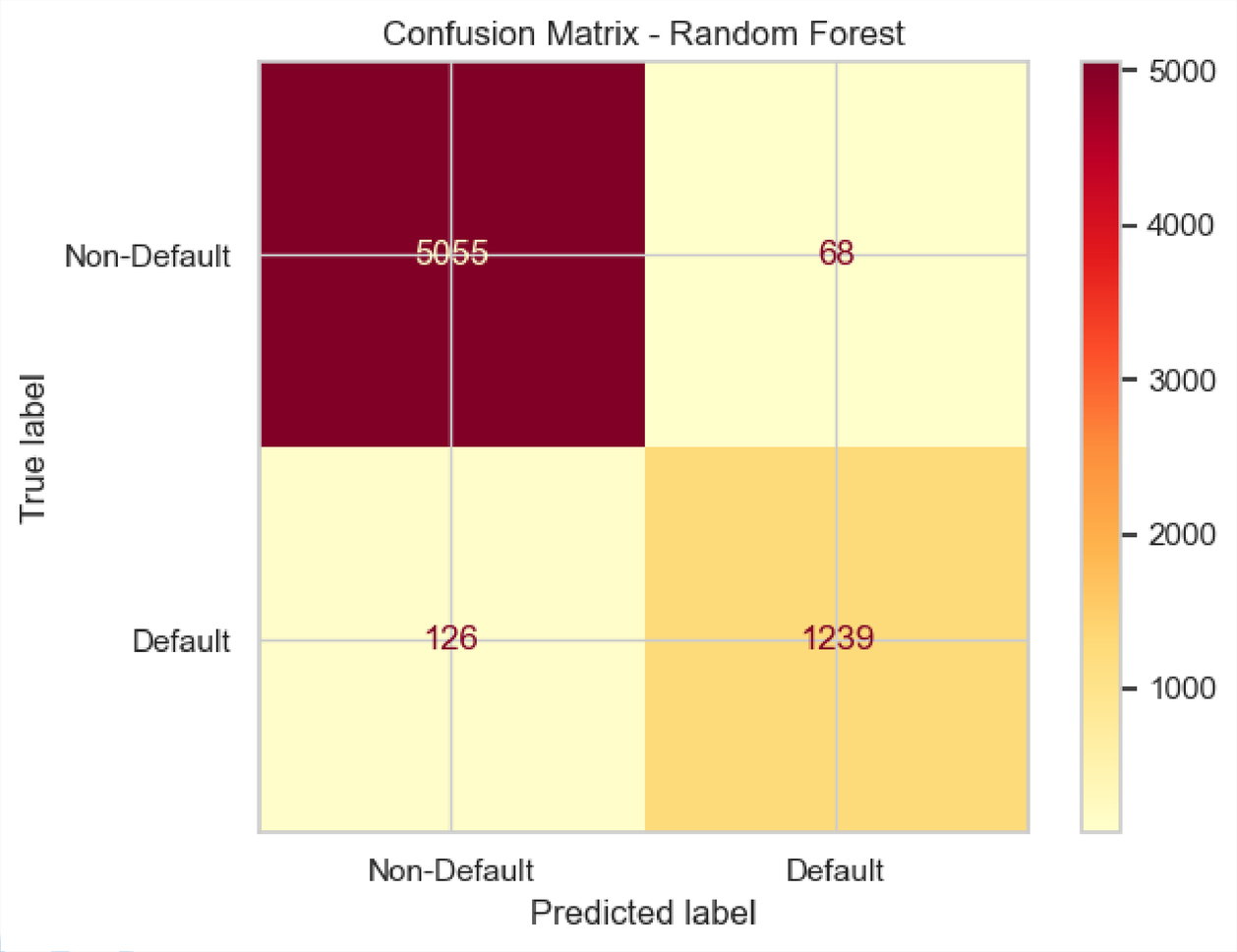
- Cleaned & engineered features
- OneHot + Scaled inputs
- 80/20 train-test split (32K+ records)

Model Evaluation Metrics & Performance comparison

- Accuracy → Overall correct predictions
- Precision → Out of predicted defaulters, how many were correct?
- Recall → Out of all actual defaulters, how many were caught?
- F1-Score → Balance between precision & recall (risk control)

Metric (on Test Set)	Logistic Regression	Random Forest
Accuracy	95%	✅ 97%
Default Precision	88%	✅ 95%
Default Recall	86%	✅ 91%
F1-Score (Default)	87%	✅ 93%

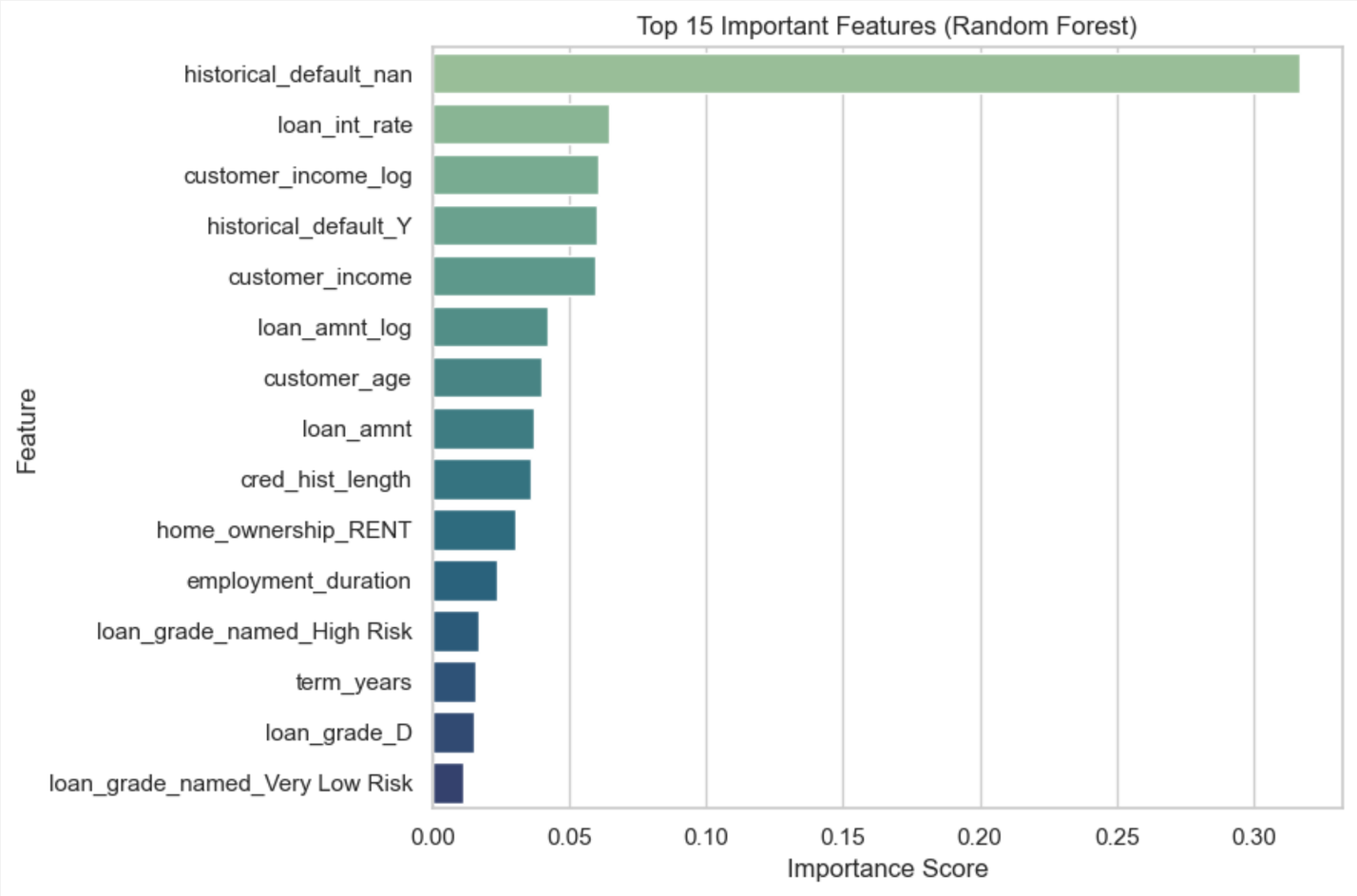
Confusion Matrix – Random Forest Model



Insights:

- Correct predictions: 6294 cases.
- Wrong predictions: 194 cases.

Top Predictive Features – Random Forest Model



Insights:

- Most important: historical_default_nan stands out as the key driver, holding nearly 30% of total importance.
- Next top group: Features like loan_int_rate, customer_income_log, and historical_default_Y each contribute around 10% importance.

Conclusion

EDA and Visualization revealed key risk groups, including low-income borrowers, young applicants, and larger loan amounts.

Statistical tests confirmed strong associations between default risk and features like loan grade, home ownership, and interest rate.

Random Forest model delivered 97% accuracy, correctly identifying 91% of actual defaulters with strong reliability.

The model is ready for real-world use to enhance loan approval processes and reduce financial risk exposure

Thank you

Any Question?