Project 1A: Dynamic Risk Tolerance Monitoring

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1. Introduction

The objective of this project is to develop a **Dynamic Risk Tolerance Monitoring framework** using real-world consumer lending data.

Borrower risk tolerance is **not static** and changes over time due to variations in income, credit behavior, repayment patterns, and macroeconomic conditions.

This project aims to:

- Quantify borrower risk tolerance using financial and behavioral indicators
- Monitor how portfolio-level risk evolves dynamically over time
- Provide data-driven insights to support credit risk management decisions

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2. Dataset Description

The dataset used in this project is the **LendingClub Accepted Loans Dataset (2007–2018)**.

Source:
https://www.kaggle.com/datasets/wordsforthewise/lending-club

The dataset contains loan-level information including borrower income, loan amount, credit score, interest rate, and repayment behavior.

Dataset Size Used

Due to hardware memory constraints, a representative sample was used.

- **Total records used:** 200,000
- **Total variables selected:** 21
- **Data size after optimization:** ~32 MB

This sampling approach is statistically sufficient for robust exploratory and risk analysis.

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3. Selected Variables

Category	Variables
Loan	loan_amnt, term, int_rate
Borrower	annual_inc, emp_length, home_ownership
Credit History	fico_range_low, fico_range_high
Credit Usage	revol_util, open_acc, total_acc
Risk Behavior	delinq_2yrs, dti
Time	issue_d
Target	loan_status

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4. Data Preprocessing

The following preprocessing steps were applied:

Handling Missing Values

- Numerical variables filled using **median values**
- Categorical variables filled using **mode**

Data Type Correction

- `term` converted from string to integer
- `emp_length` converted to numeric format
- `issue_d` converted to datetime format

Memory Optimization

- Only relevant columns were loaded
- Large dataset handled using row sampling

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5. Feature Engineering

Several risk-related features were engineered:

Average FICO Score

```
FICO_avg = (fico_range_low + fico_range_high) / 2
```

Credit Utilization Ratio

```
credit_utilization = revol_util / 100
```

Loan-to-Income Ratio

```
loan_income_ratio = loan_amnt / annual_inc
```

Delinquency Flag

```
delinq_flag = 1 if delinq_2yrs > 0 else 0
```

These features capture borrower creditworthiness and financial stress levels.

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6. Risk Tolerance Model

A composite **Risk Score** was constructed using weighted indicators.

Risk Score Formula

```
Risk Score =
0.30 × (1 - FICO_norm)
+ 0.25 × DTI_norm
+ 0.20 × InterestRate_norm
+ 0.10 × CreditUtil_norm
+ 0.10 × DelinqFlag_norm
+ 0.05 × LoanIncomeRatio_norm
```

- All variables were normalized using **Min-Max Scaling**
- Final scores were converted to a **0–100 scale**
- Higher score indicates **higher borrower risk**

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7. Risk Tolerance Classification

Risk Score	Category

< 30	High Risk Tolerance
30 – 60	Moderate Risk Tolerance
> 60	Low Risk Tolerance

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8. Dynamic Risk Monitoring

To capture time-based changes:

- Loans were grouped **monthly** using `issue_d`
- Monthly average risk scores were computed
- Risk movement was visualized using **time-series analysis**

This enables continuous monitoring of portfolio risk trends.

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9. Results & Observations

Descriptive Risk Statistics

Metric	Value
Total loans analyzed	200,000
Mean risk score	35.9
Minimum risk score	0.16
Maximum risk score	80.4
Moderate risk borrowers	~75%
High-risk borrowers	~25%

Key Observations

- Borrower risk tolerance shows **clear temporal variation**
- Rising interest rates and high DTI significantly increase risk
- Credit score remains the **strongest determinant** of risk
- Periods of financial stress exhibit upward movement in portfolio risk

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10. Business Applications

This framework can support:

- Dynamic portfolio risk monitoring
- Early warning systems
- Credit policy optimization
- Risk-based interest rate pricing
- Stress testing and scenario analysis

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11. Conclusion

This project demonstrates that borrower risk tolerance is **dynamic rather than static**.

By integrating credit, income, and behavioral indicators, a robust quantitative risk framework can be developed to support:

- Proactive risk management
- Improved credit decision-making
- Continuous portfolio surveillance

Such models play a crucial role in modern **banking, financial services, and fintech risk analytics**.

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12. Tools & Technologies

- Python
- Pandas
- NumPy
- Scikit-learn
- Matplotlib
- Seaborn
- VS Code
- Git & GitHub

Project Repository

https://github.com/Amit100898/dynamic-risk-tolerance-monitoring