

Predicting Loan Defaults: A Data-Driven Approach to Credit Risk Analysis

BEE2041 - Data Science in Economics

Student Number - 720017170

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1. Introduction

2. Data

Table 1: Variable Information

Variable	Data Type	Definition
Age	int64	Age of the borrower
Income	int64	Income of the borrower
LoanAmount	int64	Loan amount requested by the borrower
CreditScore	int64	Credit score of the borrower
MonthsEmployed	int64	Number of months the borrower has been employed
NumCreditLines	category	Number of credit lines the borrower has
InterestRate	float64	Interest rate of the loan
LoanTerm	category	Term of the loan in months
DTIRatio	float64	Debt-to-Income ratio of the borrower
Education	object	Education level of the borrower
EmploymentType	object	Employment type of the borrower
MaritalStatus	object	Marital status of the borrower
HasMortgage	object	Whether the borrower has a mortgage
HasDependents	object	Whether the borrower has dependents
LoanPurpose	object	Purpose of the loan
HasCoSigner	object	Whether the borrower has a co-signer
Default	category	Whether the borrower defaulted on the loan

2.1 Descriptive Statistics

Table 2: Summary Statistics of Numeric Variables

Variable	N	Mean	Median	SD	Min	Max
Age	5930.0	40.5	39.0	14.9	18.0	69.0
Income	5930.0	78831.0	76708.0	40289.1	15014.0	149944.0
LoanAmount	5930.0	134944.3	137330.5	70970.4	5000.0	249929.0
CreditScore	5930.0	568.9	568.0	158.7	300.0	849.0
MonthsEmployed	5930.0	55.6	54.0	34.8	0.0	119.0
InterestRate	5930.0	14.7	15.3	6.6	2.0	25.0
DTIRatio	5930.0	0.5	0.5	0.2	0.1	0.9

2.2 Distribution Analysis

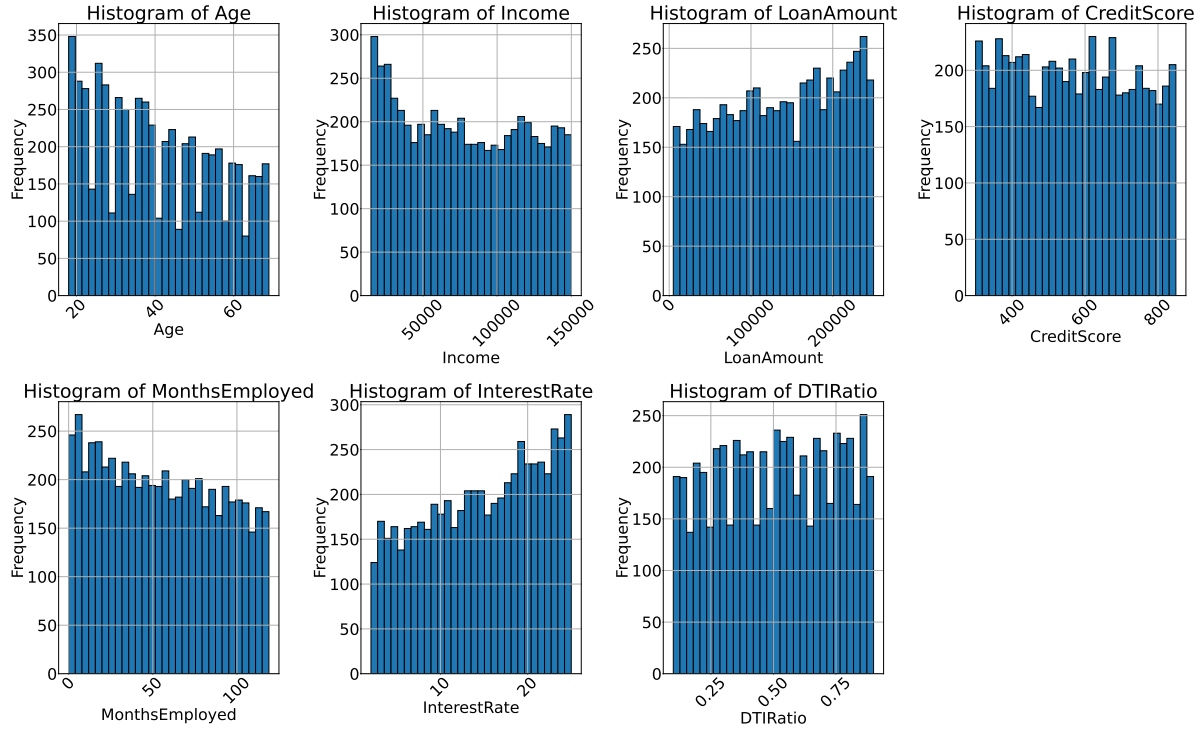


Figure 2: Histograms of all Numeric Variables

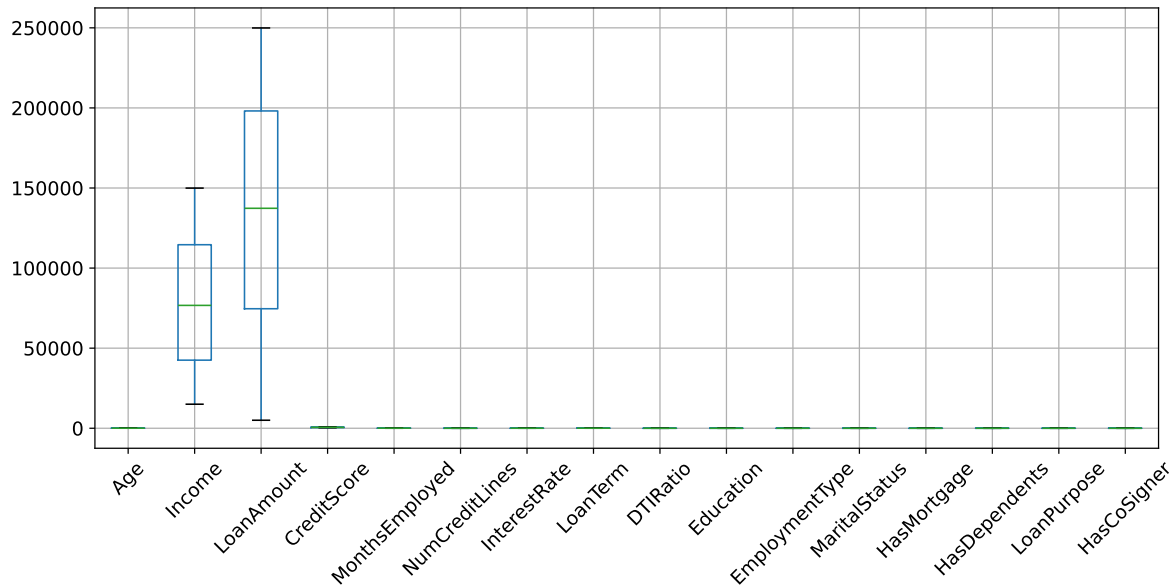


Figure 3: Box Plots of All Variables Before Normalisation

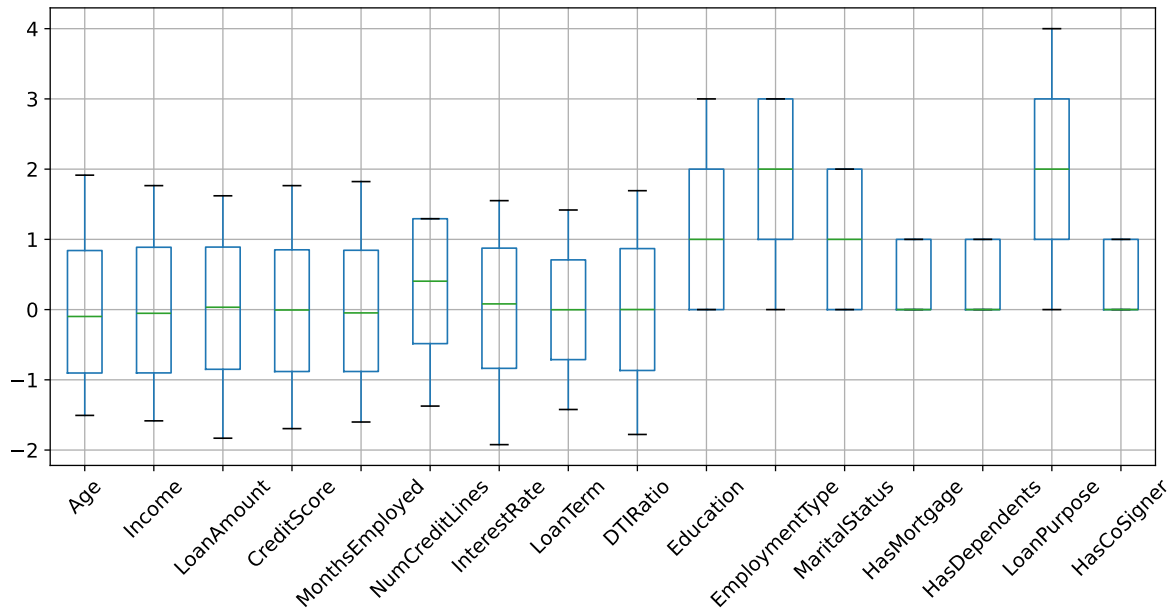


Figure 7: Box Plots of All Variables After Normalisation

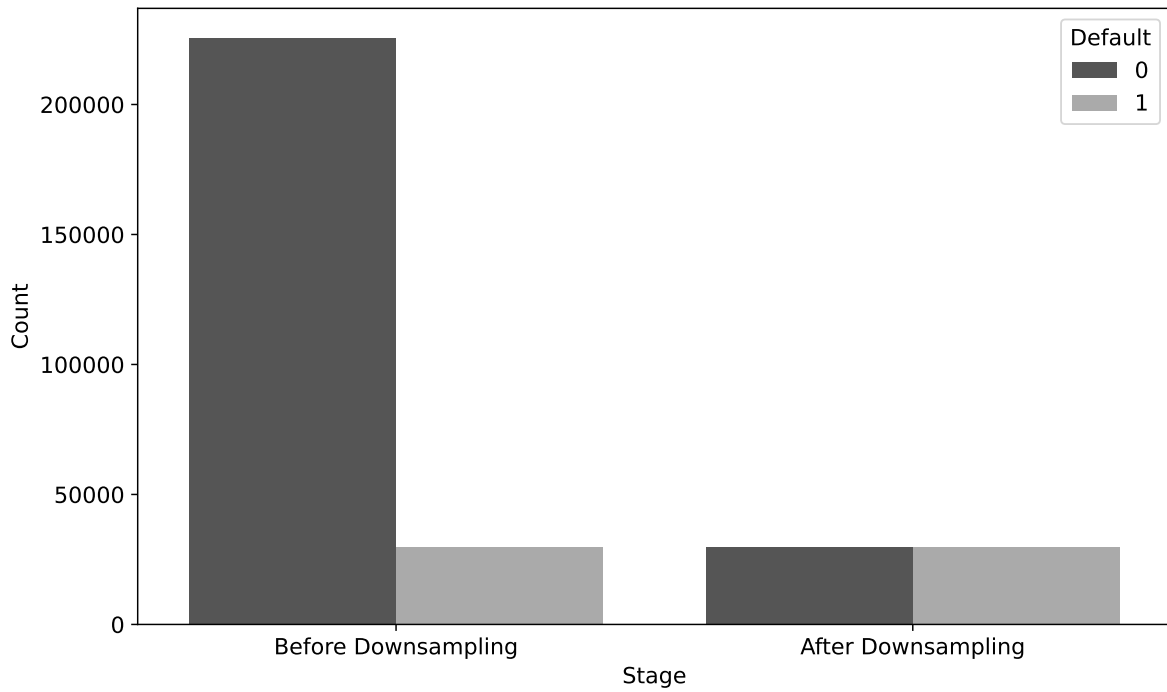


Figure 8: Distribution of Default Before and After Downsampling

2.3 Correlation Analysis

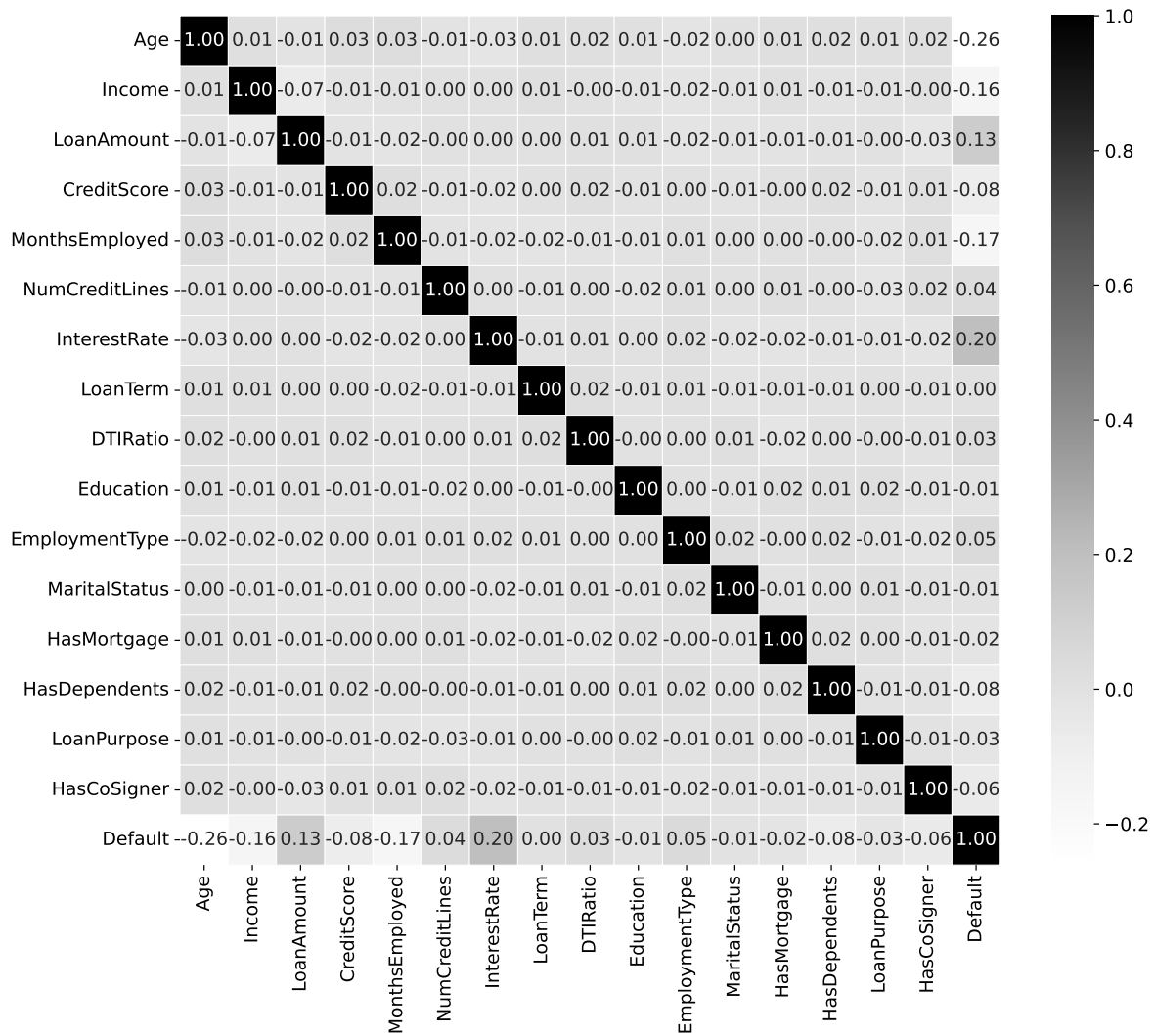


Figure 7: Correlation Plot of All Variables

Table 3: Variance Inflation Factor (VIF) Values

Feature	VIF
Age	1.004797
Income	1.006811
LoanAmount	1.008369
CreditScore	1.002868
MonthsEmployed	1.003494
NumCreditLines	1.002799
InterestRate	1.005943
LoanTerm	1.001839
DTIRatio	1.003853
Education	1.002508
EmploymentType	1.002343
MaritalStatus	1.002549
HasMortgage	1.004015
HasDependents	1.003485
LoanPurpose	1.002860
HasCoSigner	1.004757

3. Results and Discussion

3.1 Logistic Regression

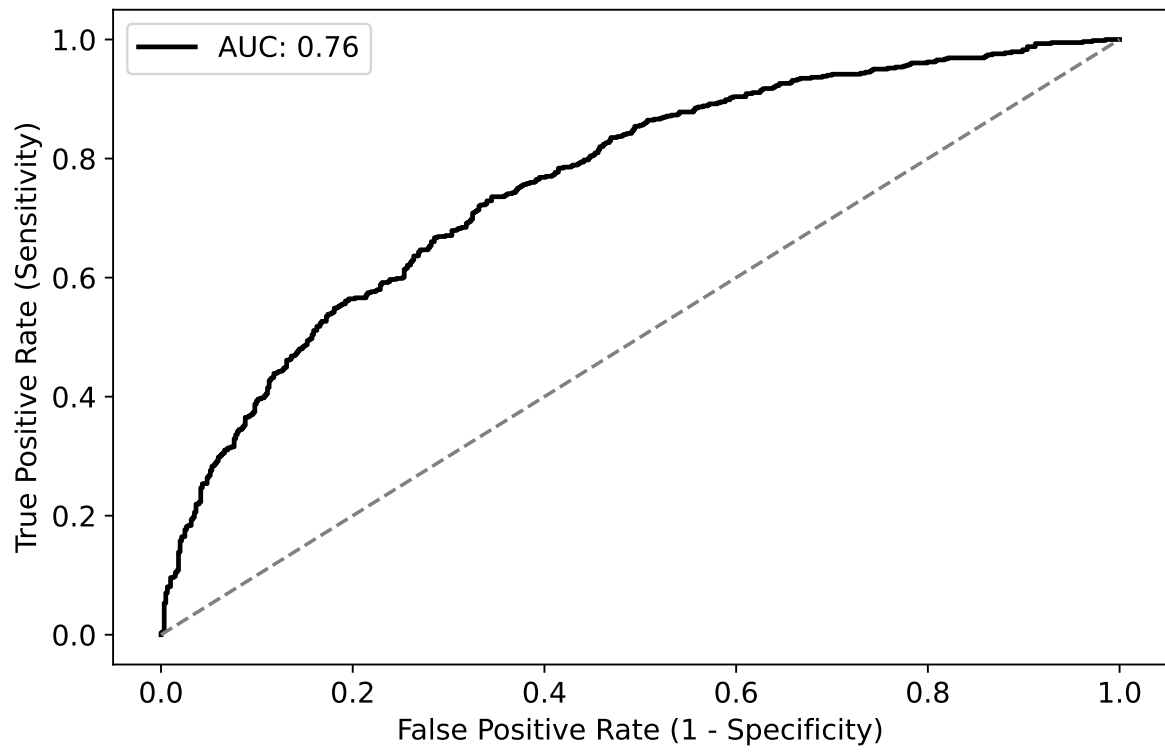


Figure ? : ROC Curve for Logistic Regression Mod

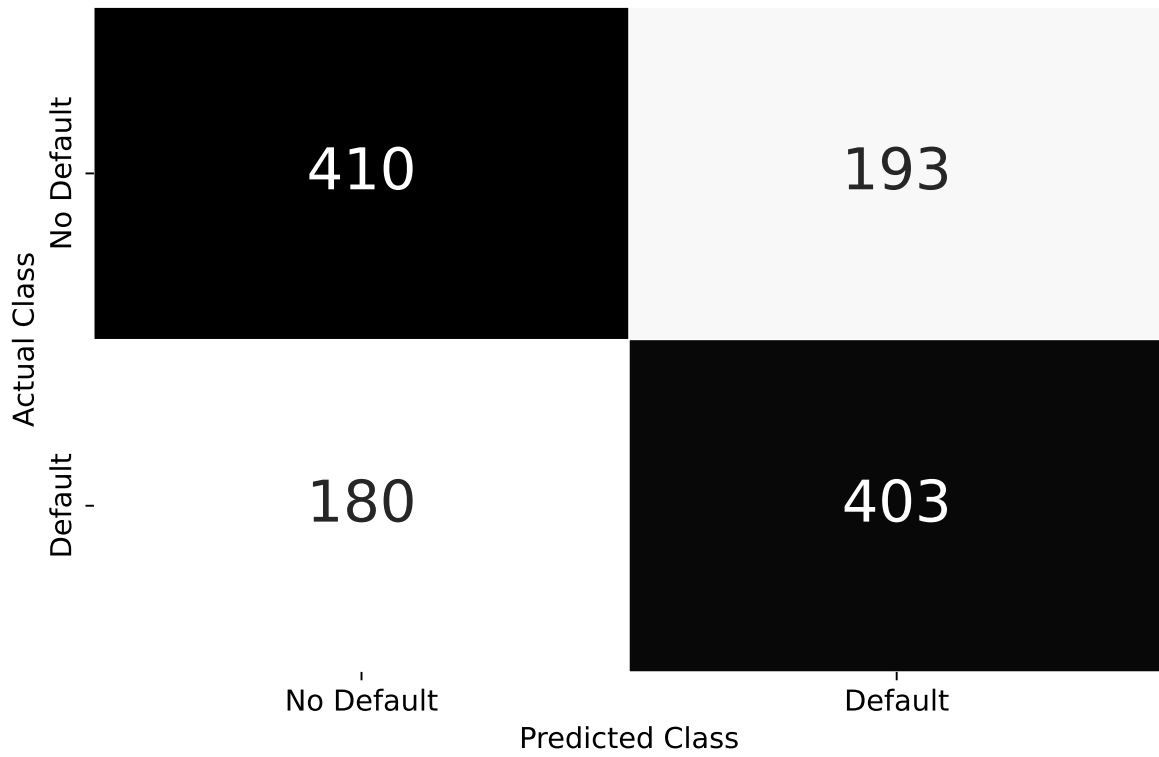


Figure ? : Confusion Matrix for Logistic Regression Model

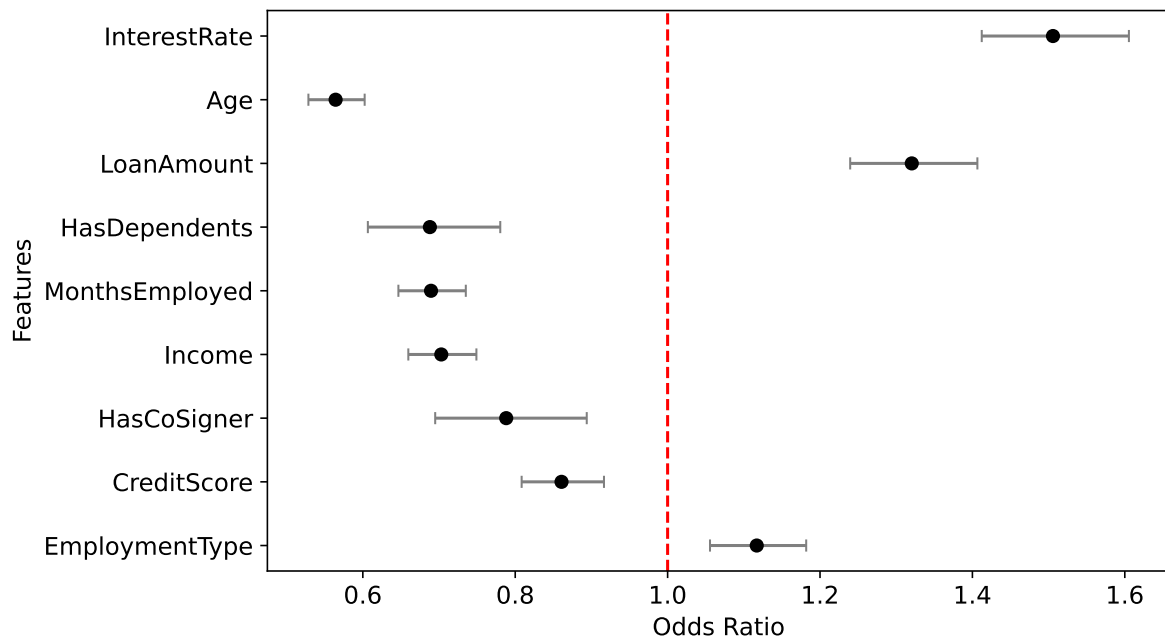


Figure ? : Odds Ratios with 95% Confidence Intervals

3.2 Random Forest

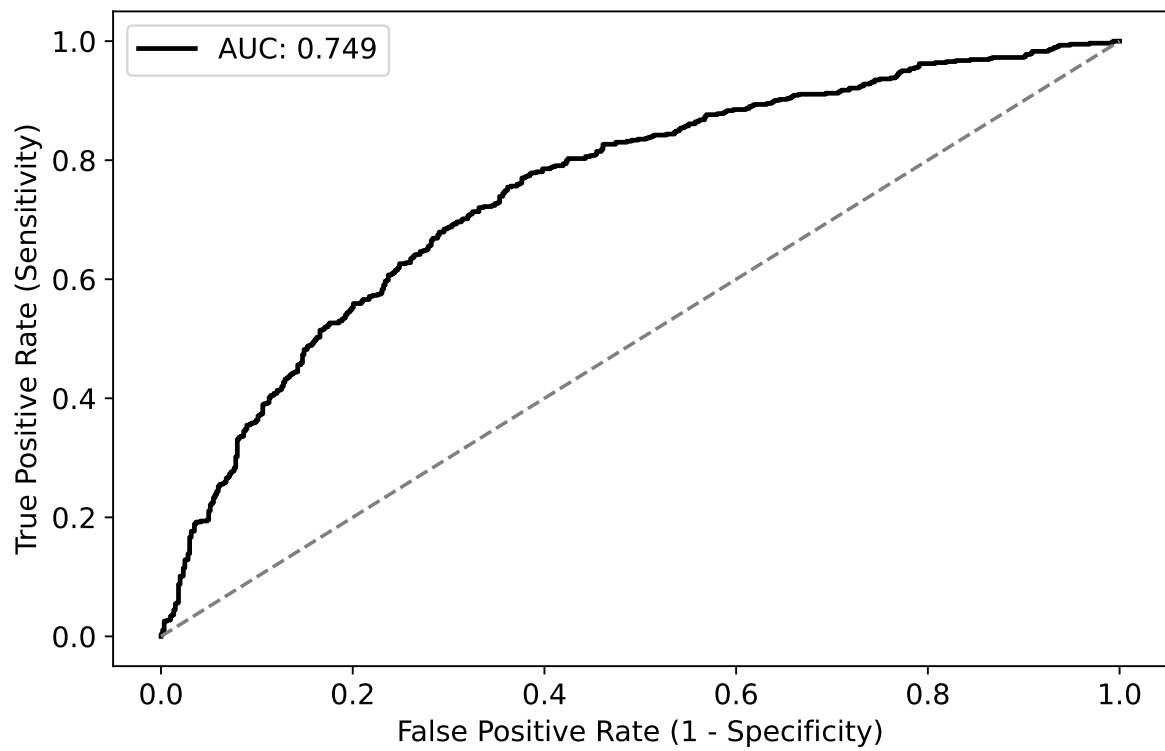


Figure 7: ROC Curve for Random Forest Model

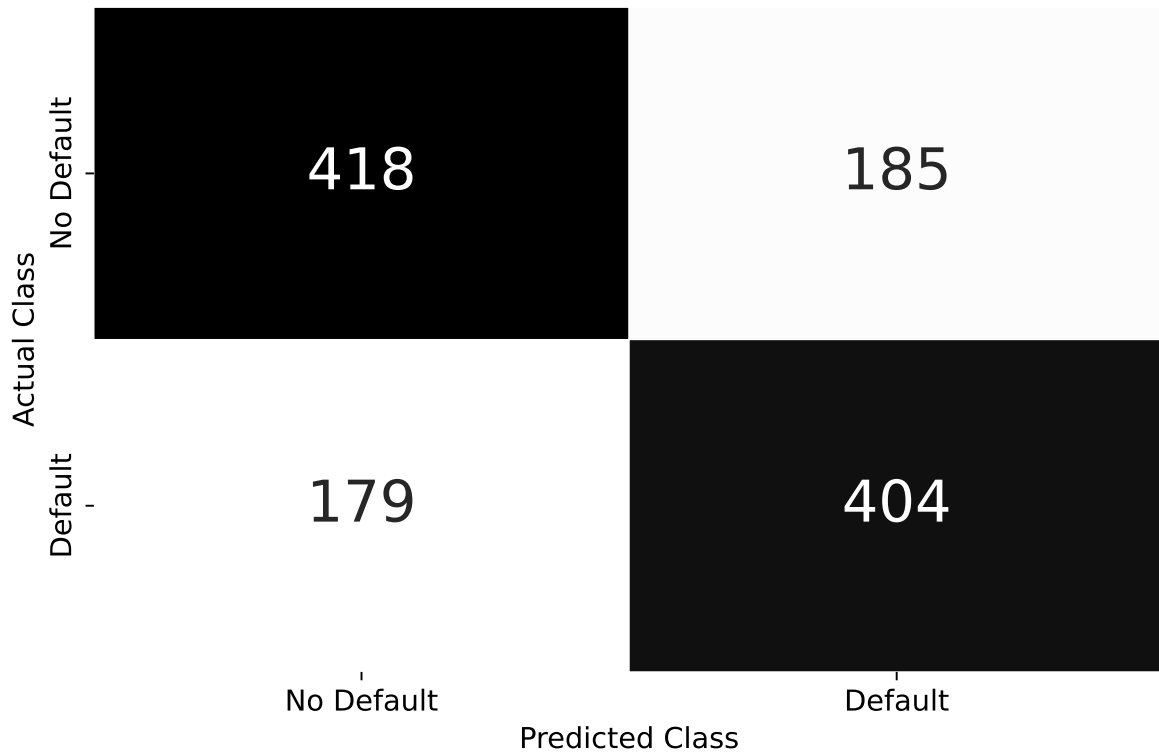


Figure 7: Confusion Matrix for Random Forest Model

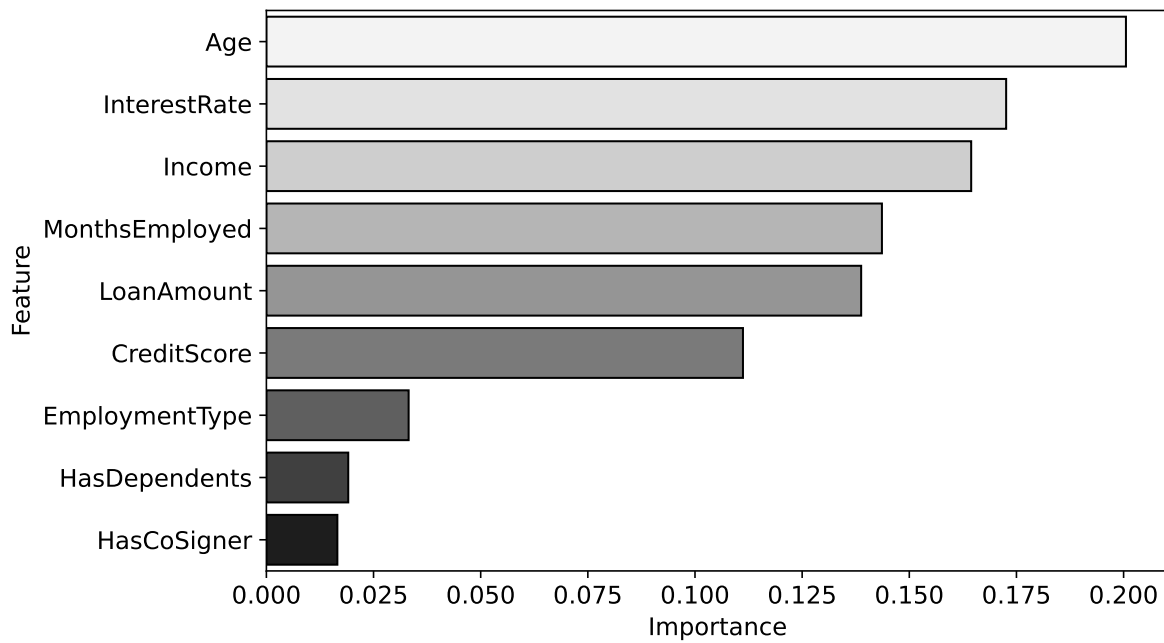


Figure 8: Feature Importances from Random Forest Model

3.3 XGBoost

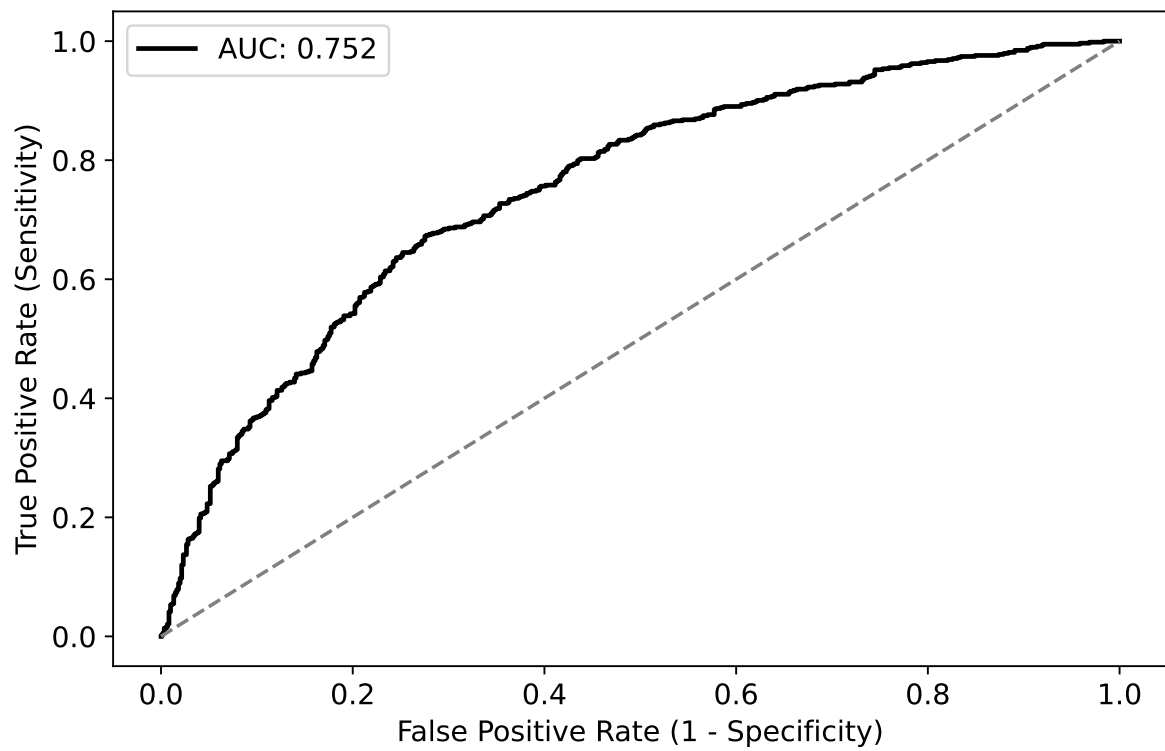


Figure 7: ROC Curve for XGBoost Model

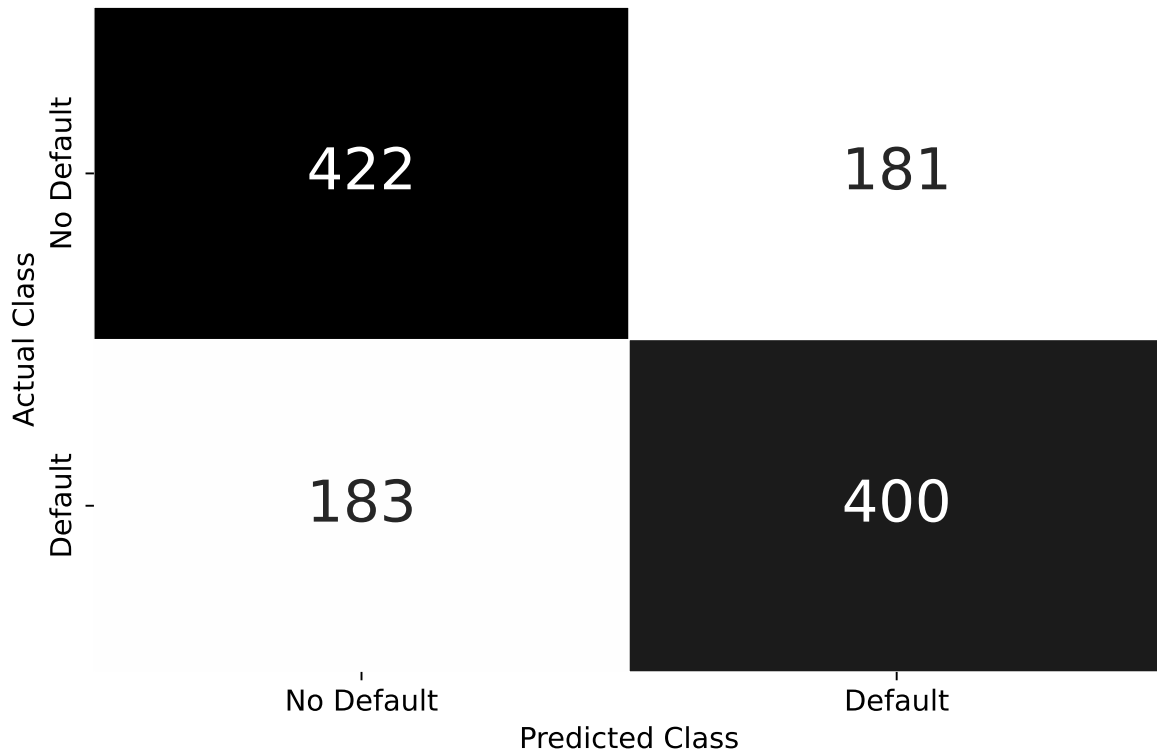


Figure 7: Confusion Matrix for XGBoost Model

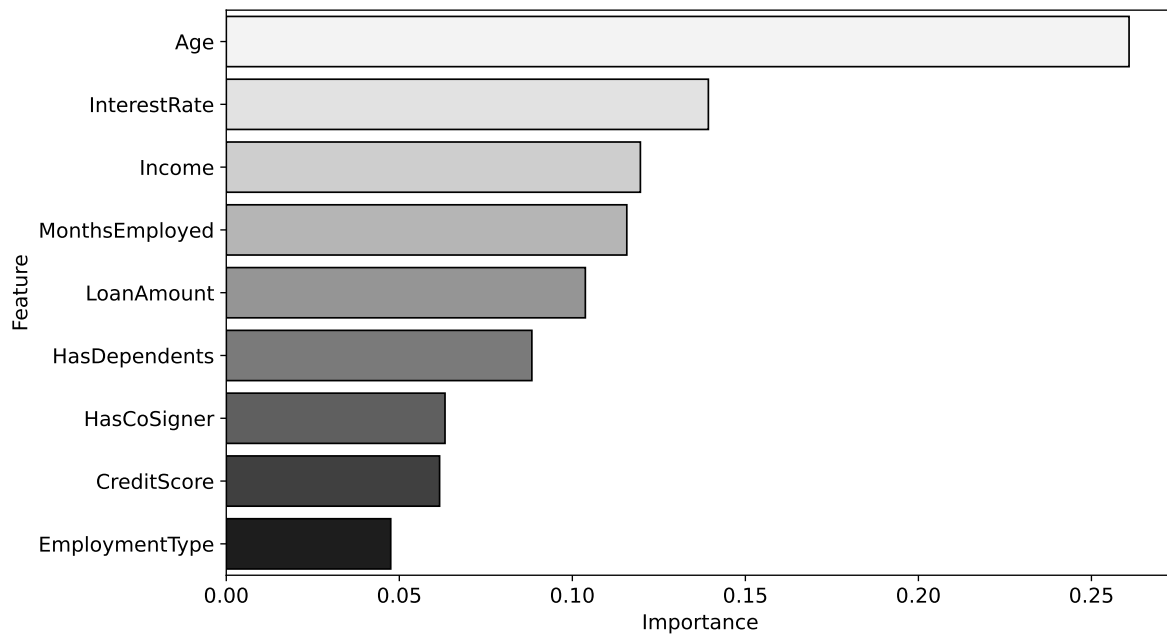


Figure 8: Feature Importances from XGBoost Model

3.4 Light Gradient Boosting Machine (LGBM)

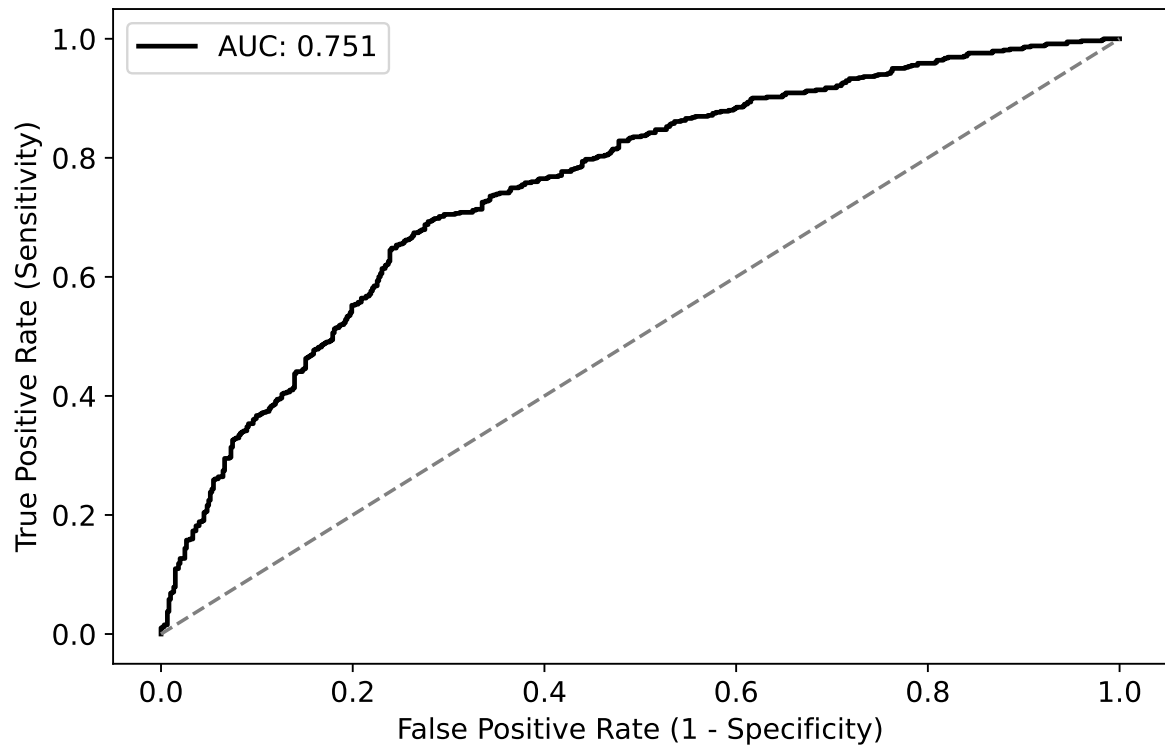


Figure 7: ROC Curve for LightGBM Model

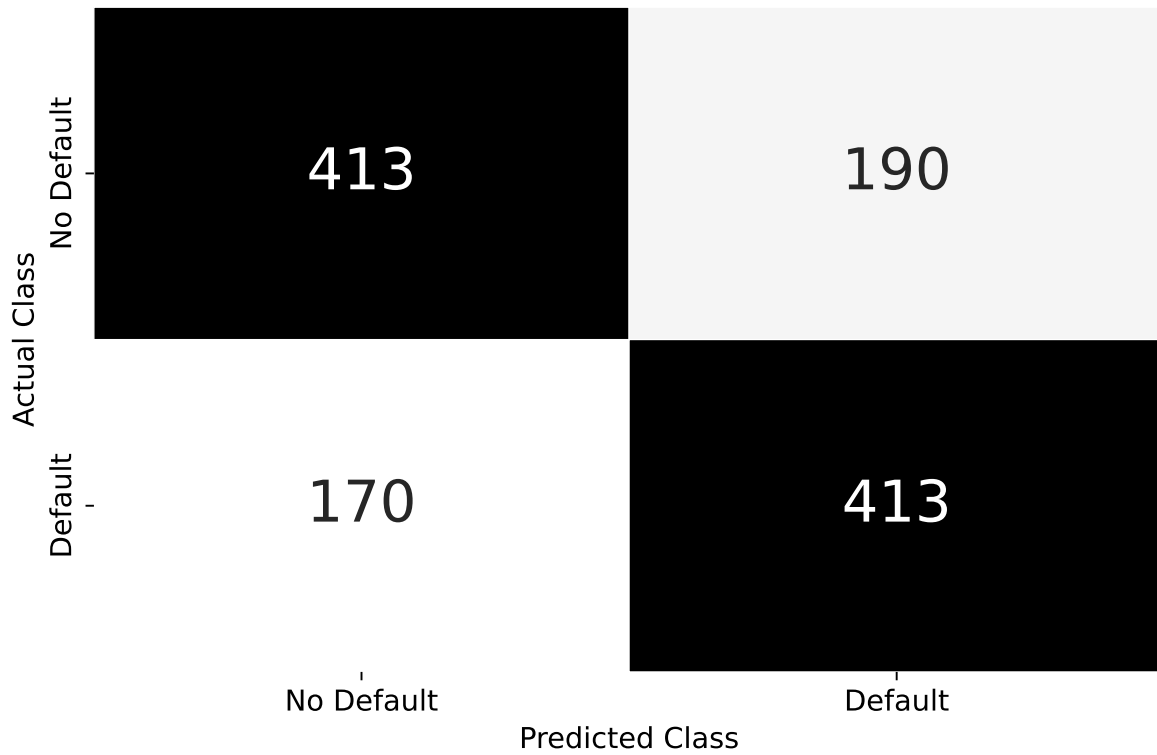


Figure ?: Confusion Matrix for LightGBM Model

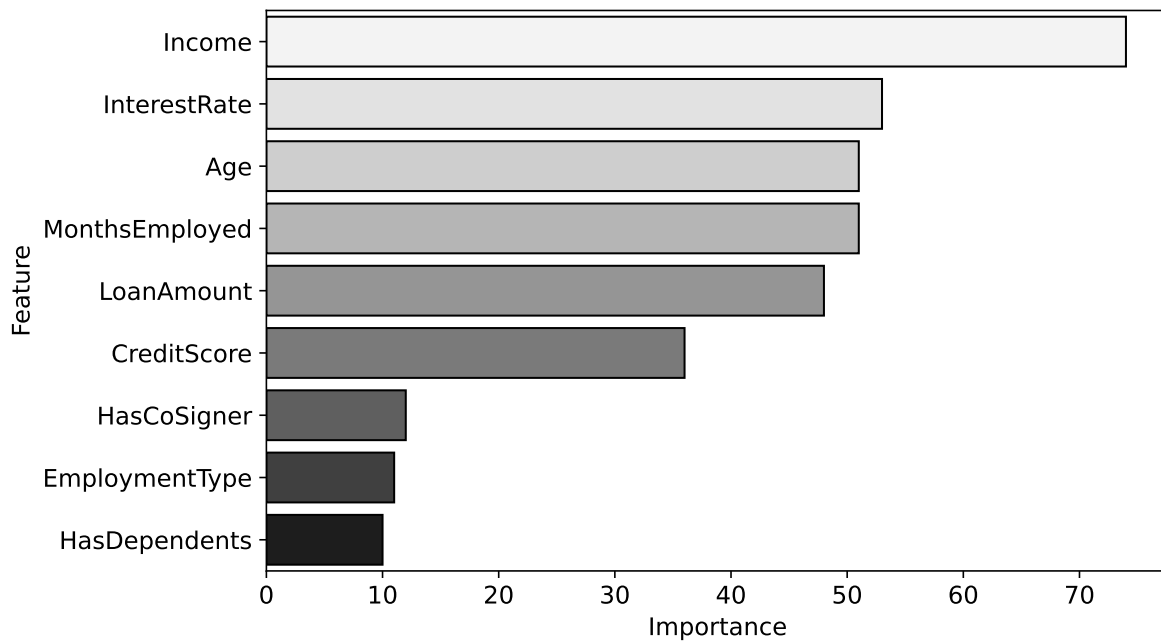


Figure ?: Feature Importances from LightGBM Model

3.5 Model Evaluation and Comparisons

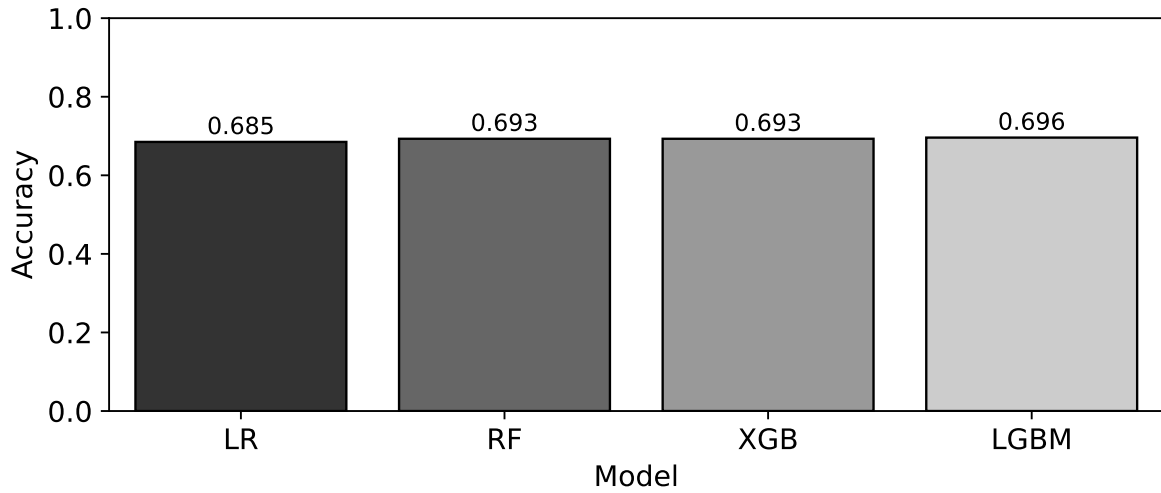


Figure 7: Accuracy for Each Model

Table 4: Performance Metrics for Each Model

Model	Accuracy	Precision	Recall	F1 Score	AUC	Log Loss
LR	0.685	0.676	0.691	0.684	0.76	11.336
RF	0.693	0.686	0.693	0.689	0.749	11.062
XGB	0.693	0.688	0.686	0.687	0.752	11.062
LGBM	0.696	0.685	0.708	0.696	0.751	10.941

4. Conclusion

Link to Github Repository = <https://github.com/JoshLG18/DSE-EMP-Project>