Machine Learning For Non-performing Loan Prediction: Enhancing Credit Risk Management

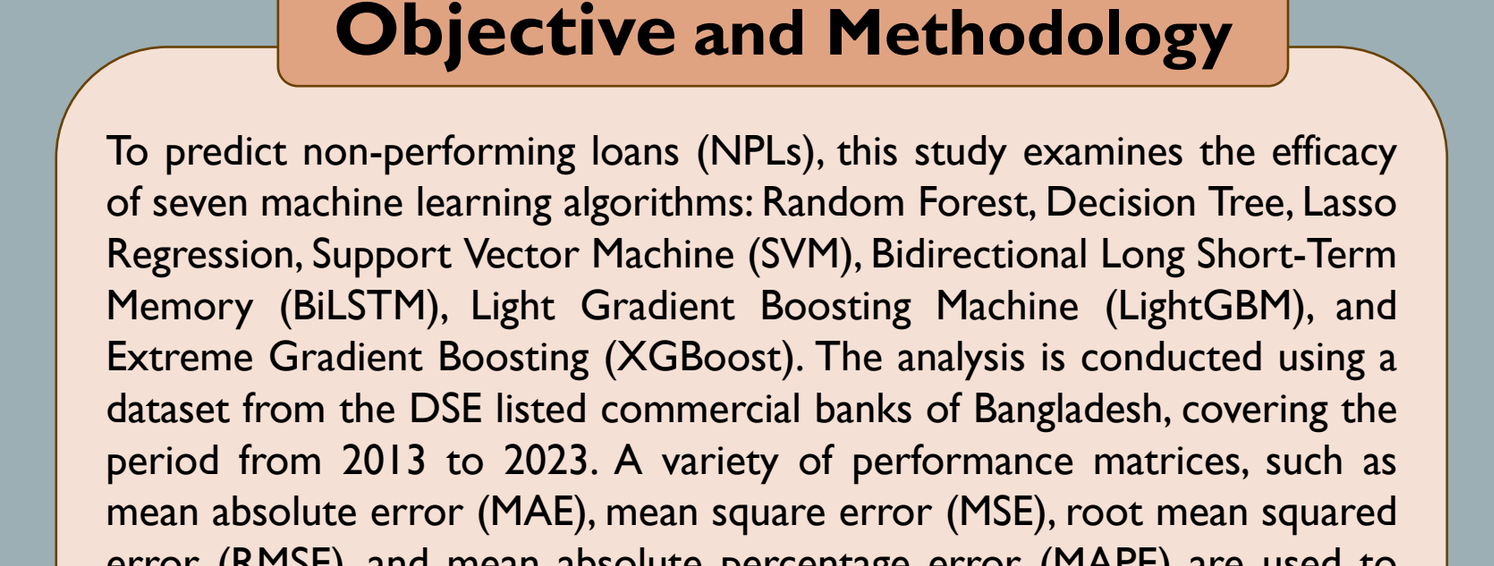
Introduction

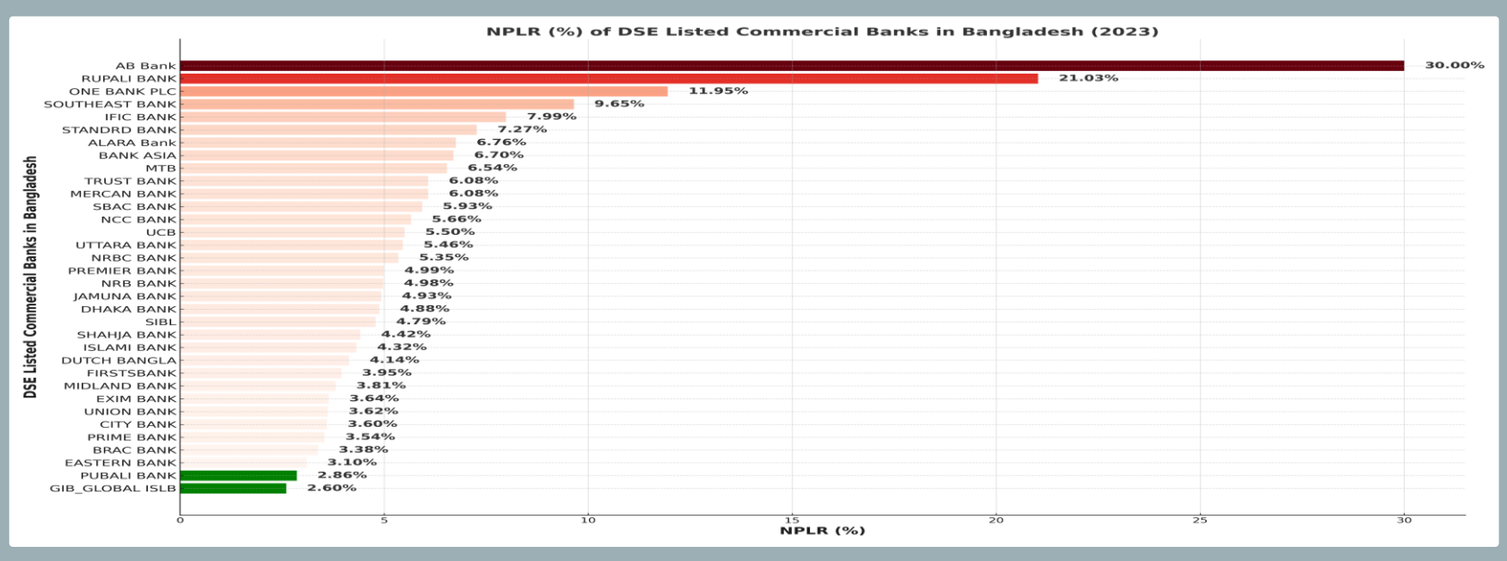
The stability and profitability of Bangladesh's banking industry have long been seriously threatened by non-performing loans (NPLs). With the aggregate NPL ratio frequently approaching 9% and in certain state-owned banks exceeding 20%, the percentage of non-performing loans (NPLs) in the banking system has been continuously high.

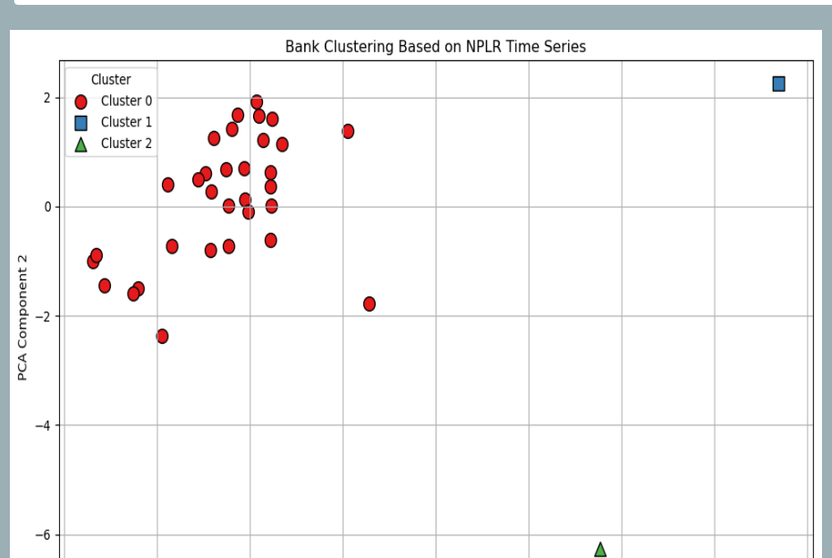
Manual credit evaluation is prone to human mistakes and subjective biases, which further compromise its validity. Researchers and practitioners have been pushing for the incorporation of machine learning (ML) and artificial intelligence (AI) methods into credit risk prediction in response to these constraints.

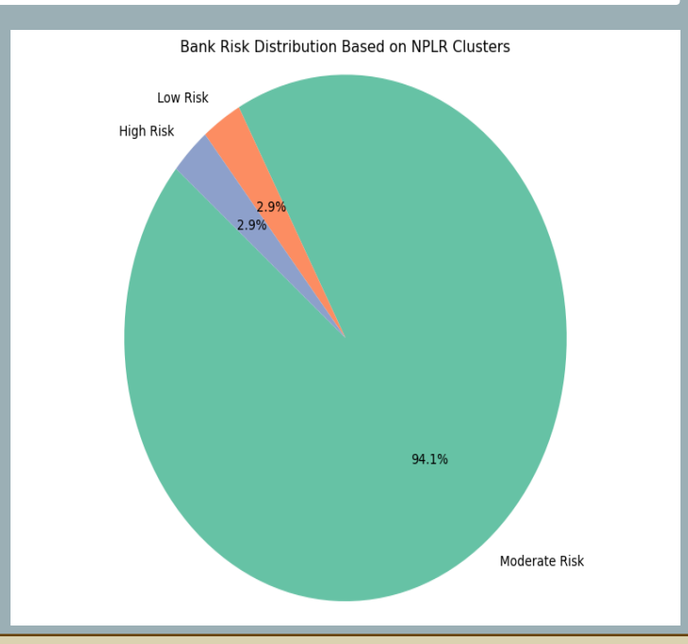
Objective and Methodology

To predict non-performing loans (NPLs), this study examines the efficacy of seven machine learning algorithms: Random Forest, Decision Tree, Lasso Regression, Support Vector Machine (SVM), Bidirectional Long Short-Term Memory (BiLSTM), Light Gradient Boosting Machine (LightGBM), and Extreme Gradient Boosting (XGBoost). The analysis is conducted using a dataset from the DSE listed commercial banks of Bangladesh, covering the period from 2013 to 2023. A variety of performance matrices, such as mean absolute error (MAE), mean square error (MSE), root mean squared error (RMSE), and mean absolute percentage error (MAPE) are used to train and assess the accuracy of the models.

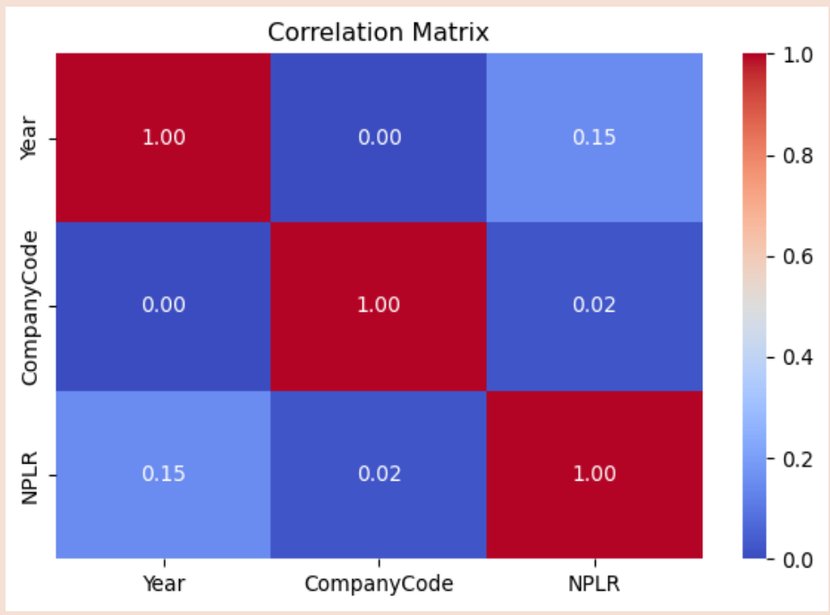








Correlation Matrix (Heatmap)



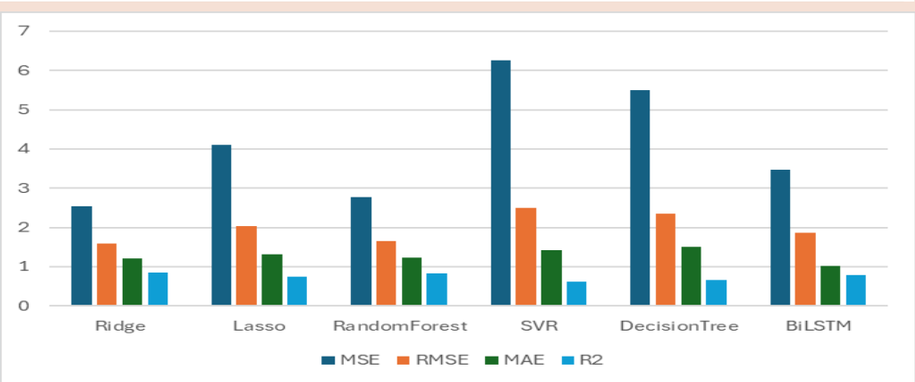
No strong multicollinearity exists, and temporal trends are subtle. However, specific banks do exhibit individual upward patterns that are better captured in the time series plots.

Forecasted values of NPLR of three years

Company	2023	2024	2025
AB Bank	28.61913	31.0367	33.45426
ALARA Bank	5.902545	6.114182	6.325818
BANK ASIA	5.035844	5.047125	5.058407
BRAC BANK	2.543815	2.2681	1.992385
CITY BANK	3.198178	2.814541	2.430904
DHAKA BANK	4.311132	4.265563	4.219995
DUTCH BANGLA	3.767043	3.717309	3.667576
EASTERN BANK	2.769793	2.710064	2.650335
EXIM BANK	3.736026	3.832052	3.928078
FIRSTSBANK	4.660238	4.911335	5.162433
GIB_GLOBAL ISLB	3.608362	3.965815	4.323268
IFIC BANK	6.676	6.848363	7.020727
ISLAMI BANK	3.622555	3.575546	3.528537
JAMUNA BANK	4.494291	4.25435	4.014409
MERCAN BANK	5.938696	6.096965	6.255234
MIDLAND BANK	3.627995	3.970839	4.313683
MTB	6.761805	7.123167	7.48453
NCC BANK	5.208142	5.103137	4.998132
NRB BANK	5.477984	5.975969	6.473953
NRBC BANK	5.927126	6.507855	7.088585
ONE BANK PLC	13.66177	14.63888	15.61599
PREMIER BANK	2.730458	2.317382	1.904306
PRIME BANK	3.130991	2.774087	2.417184
PUBALI BANK	2.260466	1.839145	1.417825
RUPALI BANK	19.48232	19.82247	20.16261
SBAC BANK	7.576518	8.351518	9.126518
SHAHJA BANK	3.869875	3.614859	3.359843
SIBL	4.736084	4.680653	4.625223
SOUTHEAST BANK	12.66085	15.70749	18.75413
STANDRD BANK	8.122513	8.532842	8.943172
TRUST BANK	6.014707	6.301139	6.587571
UCB	5.647535	5.794949	5.942363
UNION BANK	4.441041	4.901996	5.362951
UTTARA BANK	6.030131	5.837482	5.644833

ML models performance

Model	MSE	RMSE	MAE	R2
Ridge	2.542312	1.594463	1.208556	0.840457
Lasso	4.109554	2.027203	1.311873	0.742105
RandomForest	2.763667	1.662428	1.229785	0.826566
SVR	6.253136	2.500627	1.415053	0.607584
DecisionTree	5.505976	2.346482	1.512164	0.654472
BiLSTM	3.461862	1.860608	1.027843	0.79089



Ridge Regression offers the best trade-off between accuracy and robustness for NPLR forecasting. However, BiLSTM stands out for its low prediction error and adaptability to sequential data, making it a promising choice for time-dependent financial modeling tasks.

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