FINANCE AND RISK ANALYSIS PROJECT

BUSINESS REPORT

PGP DSBA – APR 2023

Submitted by:

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Problem 1: Finance and Risk analytics

Businesses or companies can fall prey to default if they are not able to keep up their debt obligations. Defaults will lead to a lower credit rating for the company which in turn reduces its chances of getting credit in the future and may have to pay higher interests on existing debts as well as any new obligations. From an investor's point of view, he would want to invest in a company if it is capable of handling its financial obligations, can grow quickly, and is able to manage the growth scale.

A balance sheet is a financial statement of a company that provides a snapshot of what a company owns, owes, and the amount invested by the shareholders. Thus, it is an important tool that helps evaluate the performance of a business.

Data that is available includes information from the financial statement of the companies for the previous year (2015). Also, information about the Net worth of the company in the following year (2016) is provided which can be used to drive the labelled field.

- Data Frame:

	Co_Code	Co_Name	Networth Next Year	Equity Paid Up	Networth	Capital Employed	Total Debt	Gross Block	Net Working Capital	Current Assets	...	PBIDTM (%) [Latest]	PBITM (%) [Latest]	PBDTM (%) [Latest]	CPM (%) [Latest]
0	16974	Hind.Cables	-8021.60	419.36	-7027.48	-1007.24	5936.03	474.30	-1076.34	40.50	...	0.00	0.00	0.00	0.00
1	21214	Tata Tele. Mah.	-3986.19	1954.93	-2968.08	4458.20	7410.18	9070.86	-1098.88	486.86	...	-10.30	-39.74	-57.74	-57.74
2	14852	ABG Shipyard	-3192.58	53.84	506.86	7714.68	6944.54	1281.54	4496.25	9097.64	...	-5279.14	-5516.98	-7780.25	-7723.67
3	2439	GTL	-3054.51	157.30	-623.49	2353.88	2326.05	1033.69	-2612.42	1034.12	...	-3.33	-7.21	-48.13	-47.70
4	23505	Bharati Defence	-2967.36	50.30	-1070.83	4675.33	5740.90	1084.20	1836.23	4685.81	...	-295.55	-400.55	-845.88	379.79
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3581	4987	HDFC Bank	72677.77	501.30	62009.42	590576.00	496009.19	8463.30	0.00	444633.50	...	0.00	0.00	0.00	0.00
3582	502	Vedanta	79162.19	296.50	34057.87	71906.06	37643.79	29848.44	2503.86	11554.45	...	39.92	32.17	29.81	30.52
3583	12002	I O C L	88134.31	2427.95	67969.97	140686.75	55245.01	121643.45	6376.84	89609.82	...	8.09	6.69	7.31	5.69
3584	12001	NTPC	91293.70	8245.46	81657.35	173099.14	85995.34	128477.59	11449.79	42353.59	...	28.12	20.55	23.39	19.55
3585	15542	Bharti Airtel	111729.10	1998.70	78270.80	104241.00	21569.70	100084.90	-12145.30	11947.10	...	42.47	22.88	34.04	25.97

3586 rows × 67 columns

Figure 1 : Data frame

- Head – Top 5 rows of data frame

	Co_Code	Co_Name	Networth Next Year	Equity Paid Up	Networth	Capital Employed	Total Debt	Gross Block	Net Working Capital	Current Assets	...	PBIDTM (%) [Latest]	PBITM (%) [Latest]	PBDTM (%) [Latest]	CPM (%) [Latest]	APATM (%) [Latest]
0	16974	Hind.Cables	-8021.60	419.36	-7027.48	-1007.24	5936.03	474.30	-1076.34	40.50	...	0.00	0.00	0.00	0.00	0.00
1	21214	Tata Tele. Mah.	-3986.19	1954.93	-2968.08	4458.20	7410.18	9070.86	-1098.88	486.86	...	-10.30	-39.74	-57.74	-57.74	-87.18
2	14852	ABG Shipyard	-3192.58	53.84	506.86	7714.68	6944.54	1281.54	4496.25	9097.64	...	-5279.14	-5516.98	-7780.25	-7723.67	-7961.51
3	2439	GTL	-3054.51	157.30	-623.49	2353.88	2326.05	1033.69	-2612.42	1034.12	...	-3.33	-7.21	-48.13	-47.70	-51.58
4	23505	Bharati Defence	-2967.36	50.30	-1070.83	4675.33	5740.90	1084.20	1836.23	4685.81	...	-295.55	-400.55	-845.88	379.79	274.79

5 rows × 67 columns

Figure 2: Head (top 5)

- Tail – Bottom 5 of the dataframe

	Co_Code	Co_Name	Networth Next Year	Equity Paid Up	Networth	Capital Employed	Total Debt	Gross Block	Net Working Capital	Current Assets	...	PBIDTM (%) [Latest]	PBITM (%) [Latest]	PBDTM (%) [Latest]	CPM (%) [Latest]	A [L
3581	4987	HDFC Bank	72677.77	501.30	62009.42	590576.00	496009.19	8463.30	0.00	444633.50	...	0.00	0.00	0.00	0.00	
3582	502	Vedanta	79162.19	296.50	34057.87	71906.06	37643.79	29848.44	2503.86	11554.45	...	39.92	32.17	29.81	30.52	
3583	12002	I O C L	88134.31	2427.95	67969.97	140686.75	55245.01	121643.45	6376.84	89609.82	...	8.09	6.69	7.31	5.69	
3584	12001	NTPC	91293.70	8245.46	81657.35	173099.14	85995.34	128477.59	11449.79	42353.59	...	28.12	20.55	23.39	19.55	
3585	15542	Bharti Airtel	111729.10	1998.70	78270.80	104241.00	21569.70	100084.90	-12145.30	11947.10	...	42.47	22.88	34.04	25.97	

5 rows × 67 columns

Figure 3: Tail (bottom 5)

- Shape – (3586,67)
  There are a total of 3586 rows and 67 columns.
- Describe

	count	mean	std	min	25%	50%	75%	max
Co_Code	3586.0	16065.388734	19776.817379	4.00	3029.2500	6077.500	24269.5000	72493.00
Networth Next Year	3586.0	725.045251	4769.681004	-8021.60	3.9850	19.015	123.8025	111729.10
Equity Paid Up	3586.0	62.966584	778.761744	0.00	3.7500	8.290	19.5175	42263.46
Networth	3586.0	649.746299	4091.988792	-7027.48	3.8925	18.580	117.2975	81657.35
Capital Employed	3586.0	2799.611054	26975.135385	-1824.75	7.6025	39.090	226.6050	714001.25
...	...	...	...	...	...	...	...	...
Debtors Velocity (Days)	3586.0	603.894032	10636.759580	0.00	8.0000	49.000	106.0000	514721.00
Creditors Velocity (Days)	3586.0	2057.854992	54169.479197	0.00	8.0000	39.000	89.0000	2034145.00
Inventory Velocity (Days)	3483.0	79.644559	137.847792	-199.00	0.0000	35.000	96.0000	996.00
Value of Output/Total Assets	3586.0	0.819757	1.201400	-0.33	0.0700	0.480	1.1600	17.63
Value of Output/Gross Block	3586.0	61.884548	976.824352	-61.00	0.2700	1.530	4.9100	43404.00

66 rows × 8 columns

Figure 4: Describe

- For Networth, the minimum is -7027 units and maximum is 81657 units. This shows a large deviation which is seen in the standard deviation as its median net worth is 18.

- Info – There are 63 float variables, 3 integers and 1 float.
- There are no duplicates in the data.
- There are a few null values present in the data.
- For ease, all the data variables are renamed as in the data dictionary.

	Co_Code	Co_Name	Networth_Next_Year	Equity_Paid_Up	Networth	Capital_Employed	Total_Debt	Gross_Block	Net_Working_Capital	Curr_Assets
0	16974	Hind.Cables	-8021.60	419.36	-7027.48	-1007.24	5936.03	474.30	-1076.34	40.50
1	21214	Tata Tele. Mah.	-3986.19	1954.93	-2968.08	4458.20	7410.18	9070.86	-1098.88	486.86
2	14852	ABG Shipyard	-3192.58	53.84	506.86	7714.68	6944.54	1281.54	4496.25	9097.64
3	2439	GTL	-3054.51	157.30	-623.49	2353.88	2326.05	1033.69	-2612.42	1034.12
4	23505	Bharati Defence	-2967.36	50.30	-1070.83	4675.33	5740.90	1084.20	1836.23	4685.81

Figure 5: Renamed dataset

- Co_Code, Co_Name columns have been dropped. So now there are 65 columns present.
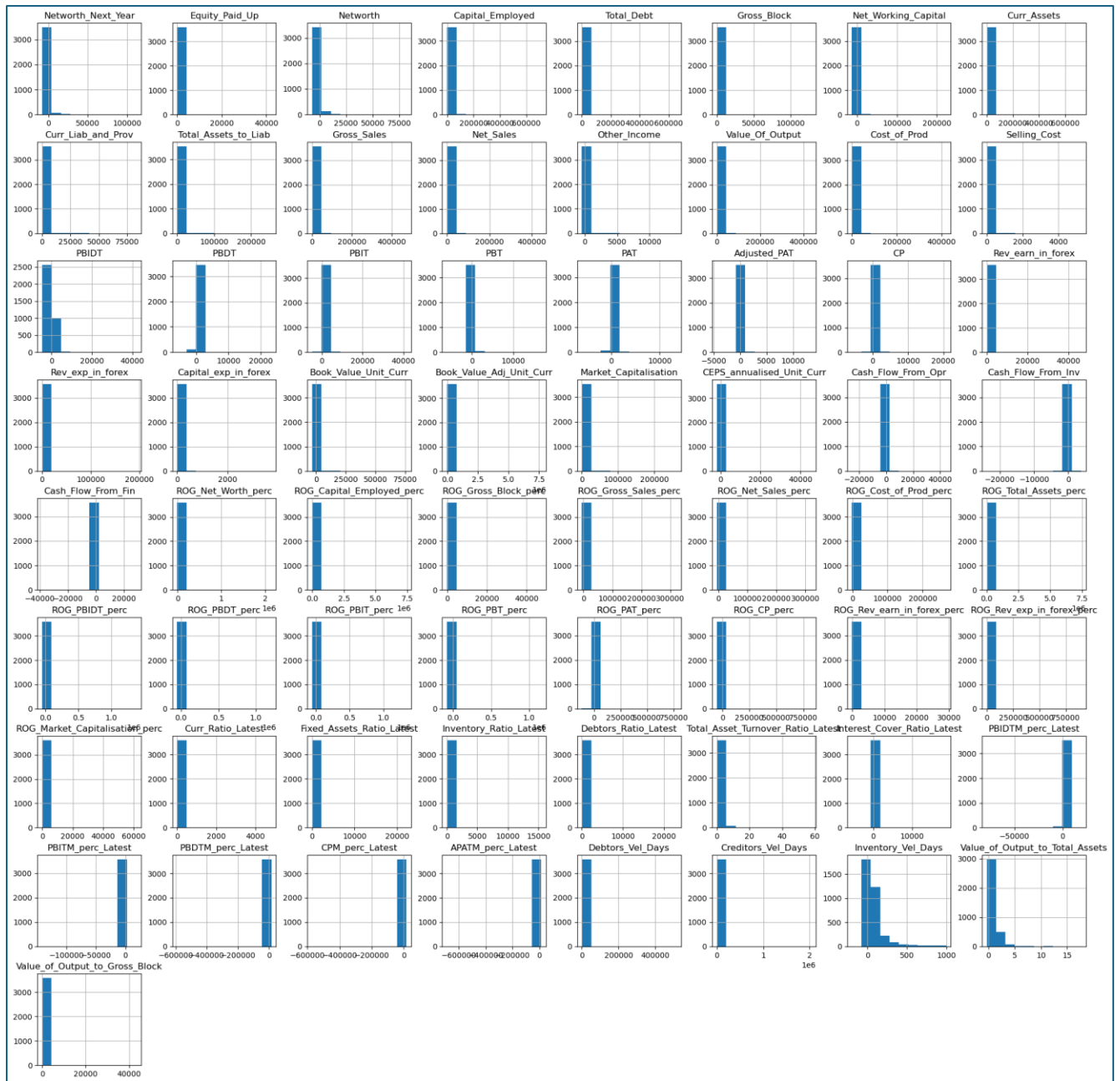
Univariate analysis:
- **Histogram**

Figure 6: Histogram

- **Boxplot**
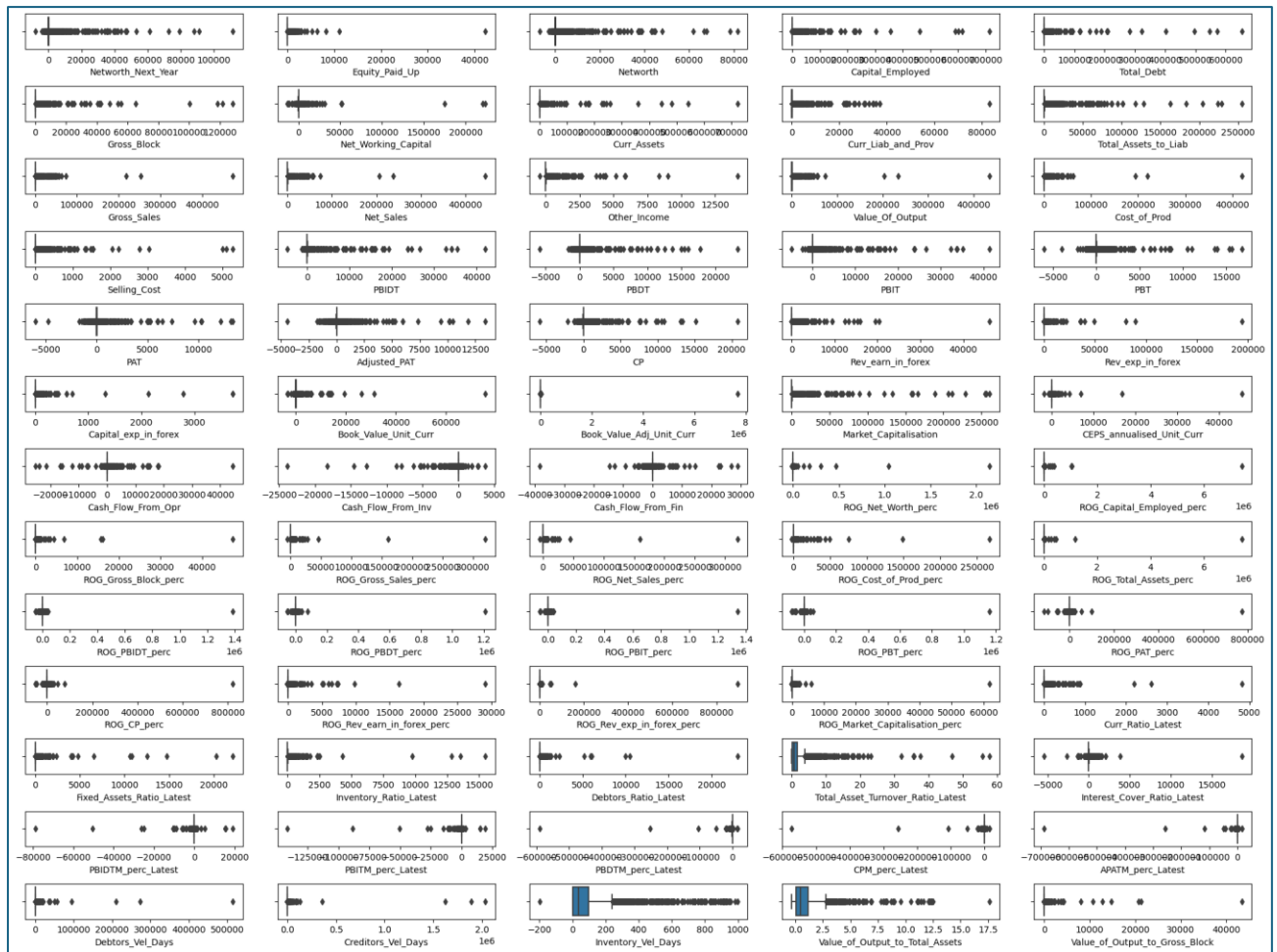
Figure 7: Bloxplot with outliers

Most of them have outliers. We must treat them.

1. Outlier treatment.

After treating outliers:

The outliers are treated with inter quartile range technique. The upper and lower most values are capped using Quartile 1-(1.5*IQR) and Quartile 3+(1.5*IQR) respectivelty.
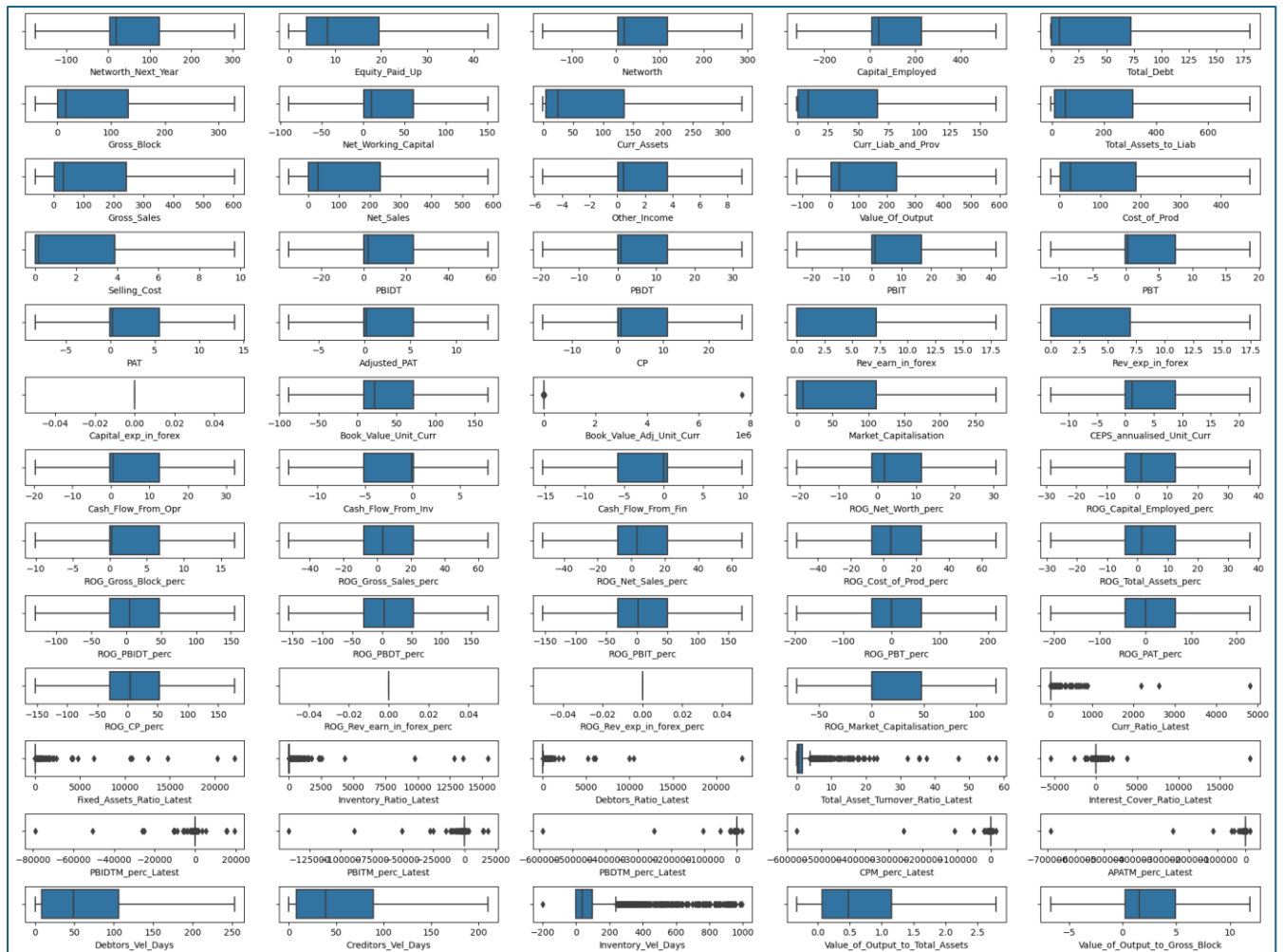
Figure 8: Boxplot after treating outliers

2. Missing values treatment

There are a total of 118 missing values. We filled the null values with KNN imputer with n=10.

After imputing null values:


```
Equity_Paid_Up                   0
Networth                         0
Capital_Employed                 0
Total_Debt                       0
Gross_Block                      0
                                ..
Creditors_Vel_Days               0
Inventory_Vel_Days               0
Value_of_Output_to_Total_Assets  0
Value_of_Output_to_Gross_Block   0
default                          0
Length: 65, dtype: int64
```

Figure 9: After imputing null values

3. Transform target variable into 0 and 1

We create a new variable called default that takes a value of 1 when networth next year is negative and 0 in case its positive.

	default	Networth_Next_Year
0	1	-175.74125
1	1	-175.74125
2	1	-175.74125
3	1	-175.74125
4	1	-175.74125

```
0    3198
1     388
Name: default, dtype: int64
```

Figure 10: Value counts of 0 and 1

So now the default variable contains 3198 0's and 388 1's.

4. Univariate (4 marks) & Bivariate (6marks) analysis with proper interpretation. (You may choose to include only those variables which were significant in the model building)

Kde plot:
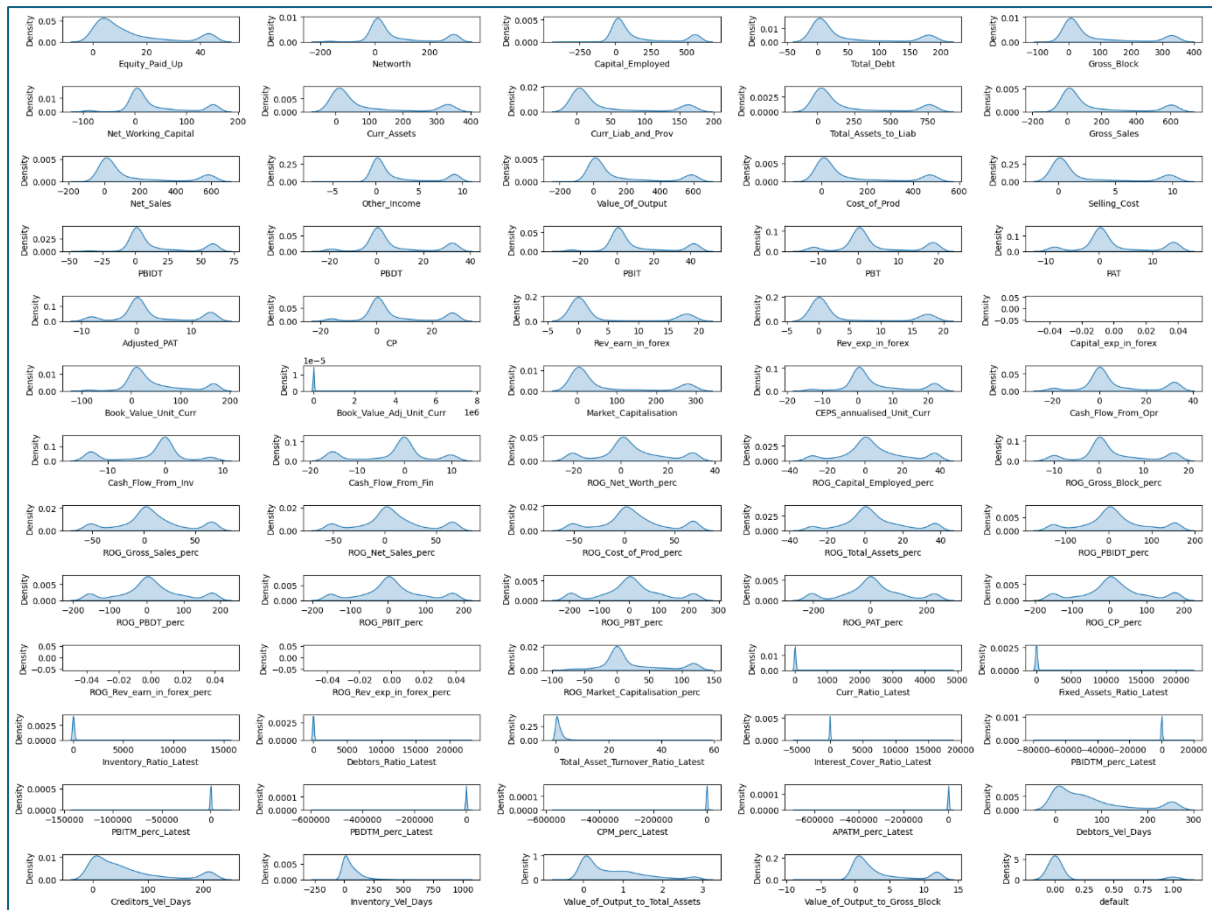
Figure 11: KDE plot

- The peaks indicate the presence on net worth values.
- The width represents the variability/spread of net worth values.
- KDE helps in interpreting the distribution of net worth values.

Scatter plot
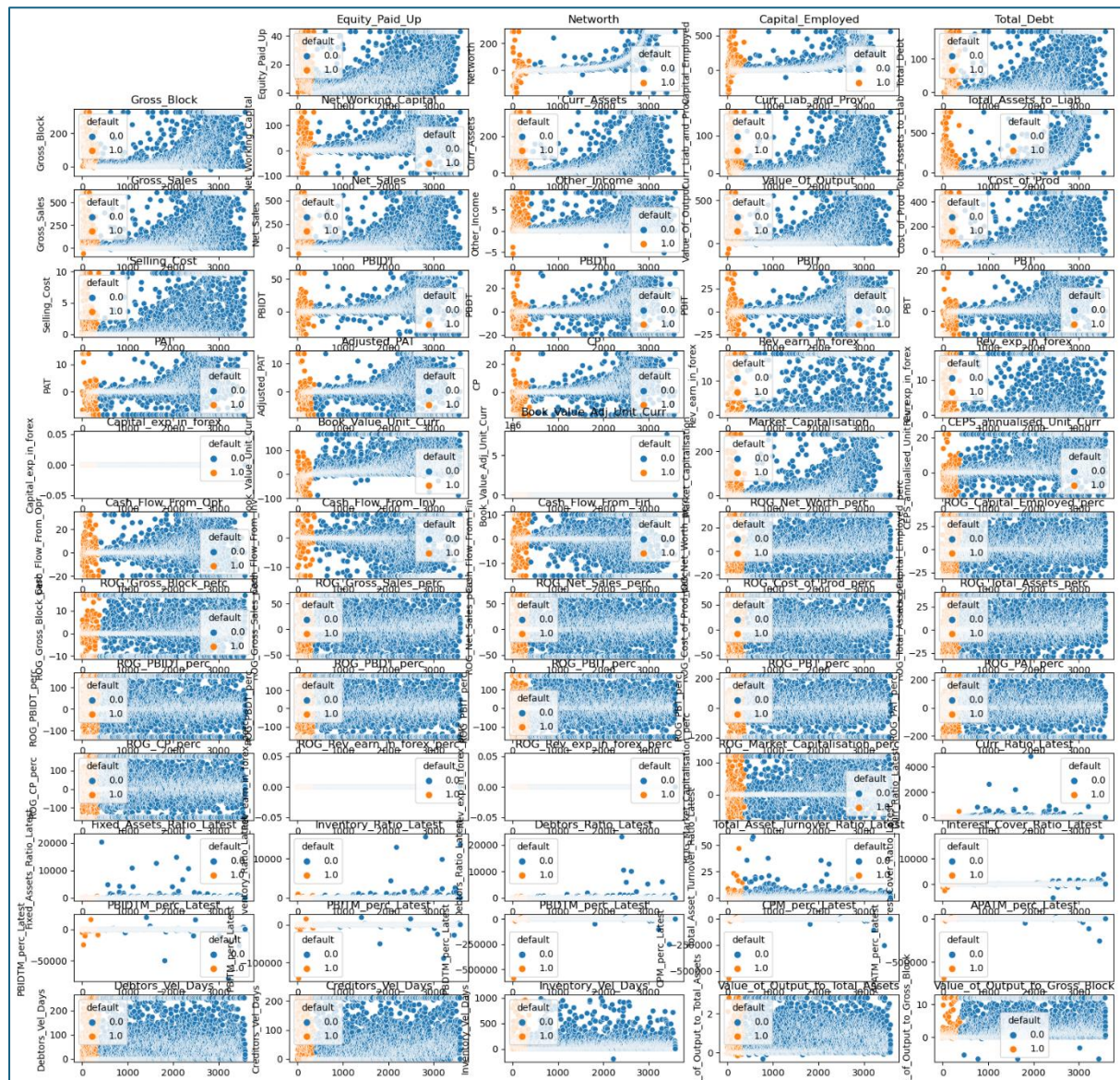
Figure 12: Scatter plot

- Scatter plot helps in understanding relationships between two variables and helps in interpretation of the correlation between them.
- If the points are randomly spread out, it indicates very little to no correlation.
- If the points are above the straight line, it suggests a positive corrrelation

Heatmap:
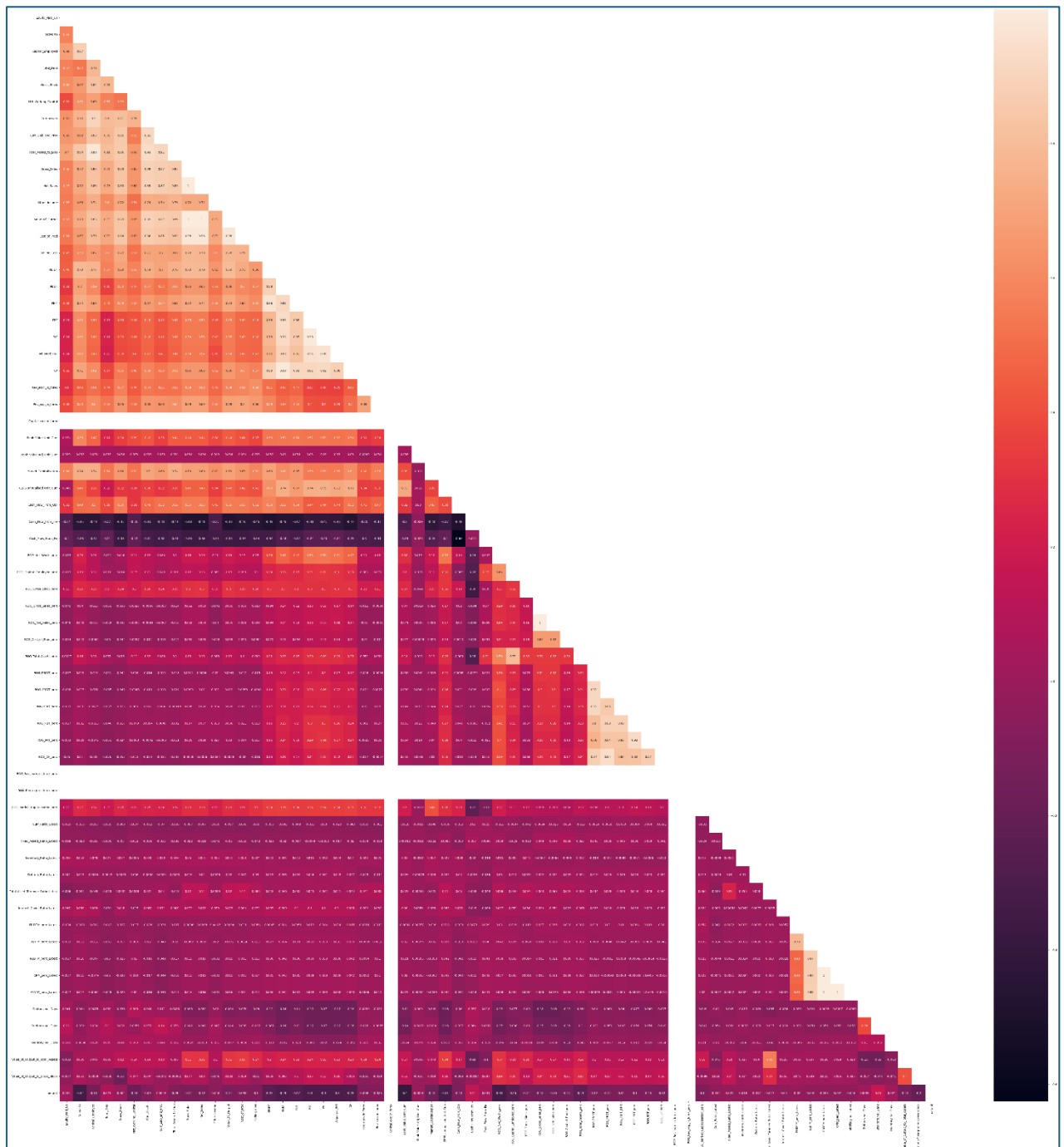
Figure 13: Heatmap

- Least correlated are Interest coverage ratio and total debt;
- Selling cost and total debt is positively correlated.
- CPES annualised Unit Curr is highly correlated with Book Value adjusted Unit Curr.

We now remove the unnecessary columns and replot the heatmap.
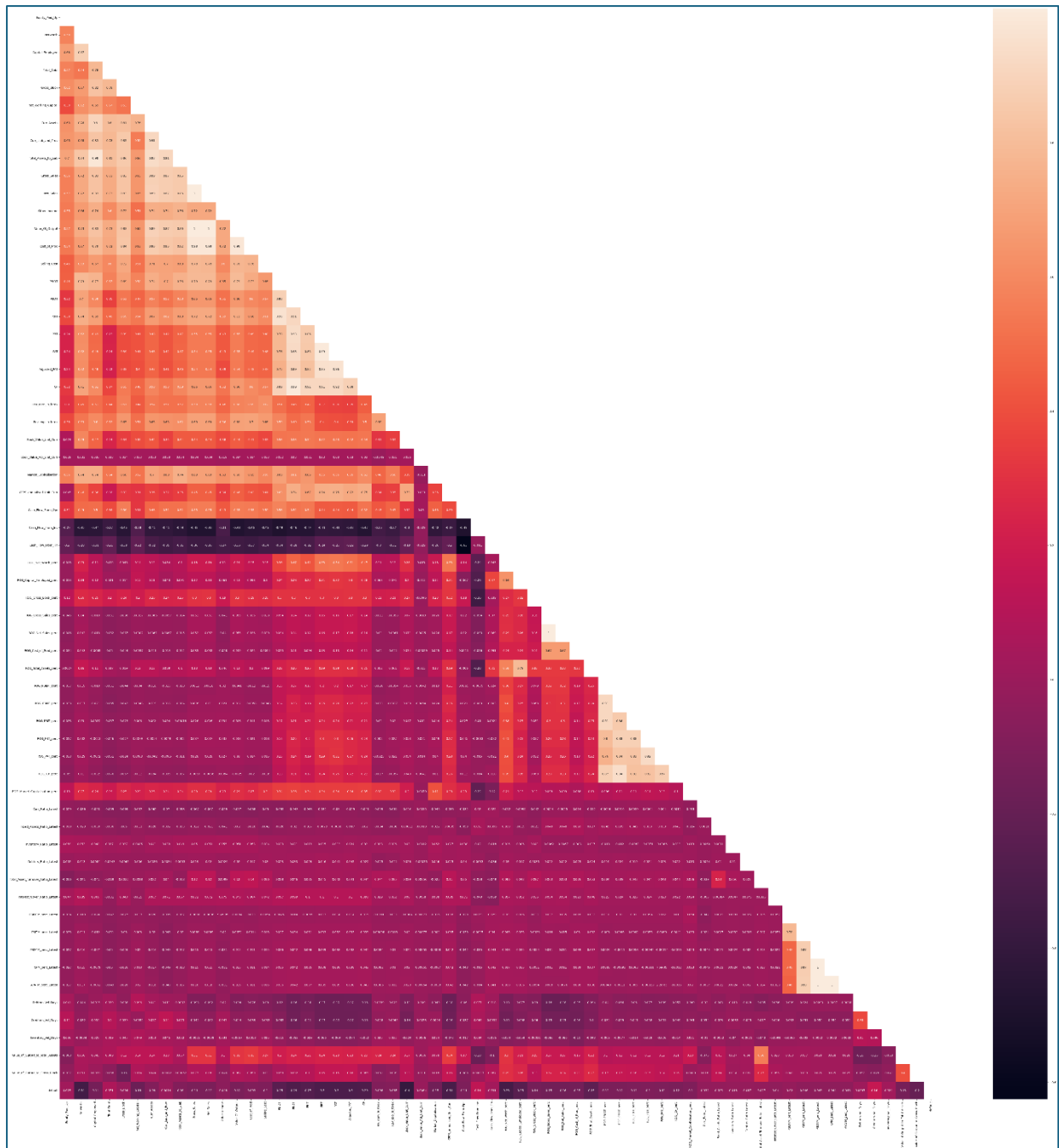
We now drop out columns that have more than 90% correlation. They are:

```
['Curr_Assets', 'Curr_Liab_and_Prov', 'Total_Assets_to_Liab', 'Net_Sales', 'Value_Of_Output', 'Cost_of_Prod', 'PBIT', 'PBT', 'PAT', 'Adjusted_PAT', 'CP', 'ROG_Net_Sales_perc', 'ROG_PBDT_perc', 'ROG_PBIT_perc', 'ROG_PAT_perc', 'ROG_CP_perc', 'CPM_perc_Latest', 'APATM_perc_Latest']
```

We now have 3586 rows and 44 columns.

Now the heatmap is:
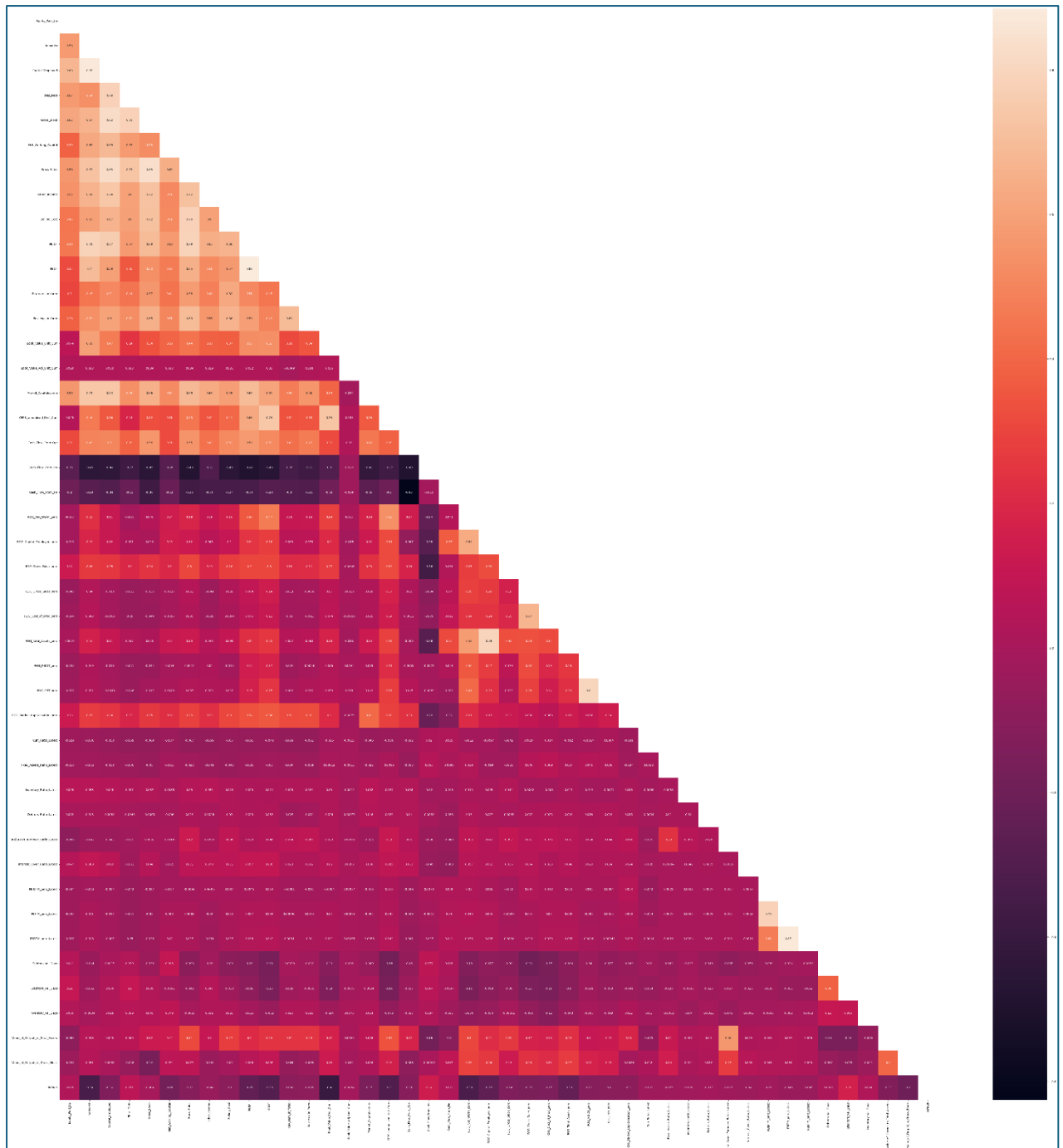
Figure 14: Corrected Heatmap

5. Train test split.

We created a new variable called 'default' that takes the value of 1 when net worth next year is negative, otherwise 1.

We then scale the data.

	Equity_Paid_Up	Networth	Capital_Employed	Total_Debt	Gross_Block	Net_Working_Capital	Gross_Sales	Other_Income	Selling_Cost	PBIDT	...
0	2.08394	-2.124536	-2.277679	1.955653	2.011189	-2.126873	-0.711425	1.501295	-0.666143	-2.077966	...
1	2.08394	-2.124536	1.937167	1.955653	2.011189	-2.126873	1.980032	1.924923	1.942957	1.877612	...
2	2.08394	1.892586	1.937167	1.955653	2.011189	1.933358	1.037488	1.924923	1.942957	-2.077966	...
3	2.08394	-2.124536	1.937167	1.955653	2.011189	-2.126873	1.980032	1.924923	0.231669	-2.077966	...
4	2.08394	-2.124536	1.937167	1.955653	2.011189	1.933358	-0.538733	1.924923	-0.136595	-2.077966	...

Figure 15: Scaled data

We then split the data into train and test in the ratio of 67:33 with random_state=42.

```
Number of rows in train data = 2402
Number of rows in test data = 1184
```

6. Build Logistic Regression Model (using stats model library) on most important variables on Train Dataset and choose the optimum cutoff. Also showcase your model building approach

<u>MODEL 1:</u>

```
                            Logit Regression Results
==============================================================================
Dep. Variable:               default   No. Observations:             2402
Model:                         Logit   Df Residuals:                 2359
Method:                          MLE   Df Model:                       42
Date:              Sun, 10 Mar 2024   Pseudo R-squ.:             -0.4642
Time:                       00:24:18   Log-Likelihood:            -1158.7
converged:                      True   LL-Null:                   -791.34
Covariance Type:            nonrobust   LLR p-value:                 1.000
==============================================================================
                                    coef    std err       z    P>|z|    [0.025    0.975]
------------------------------------------------------------------------------
Equity_Paid_Up                   -0.0492      0.088   -0.559    0.576    -0.221     0.123
Networth                         -1.3999      0.250   -5.589    0.000    -1.891    -0.909
Capital_Employed                  0.8814      0.307    2.873    0.004     0.280     1.483
Total_Debt                        0.1893      0.136    1.390    0.165    -0.078     0.456
Gross_Block                       0.0478      0.149    0.321    0.748    -0.244     0.339
Net_Working_Capital              -0.1384      0.086   -1.519    0.129    -0.299     0.038
Gross_Sales                       0.4023      0.161    2.499    0.012     0.087     0.718
Other_Income                      0.2676      0.093    2.885    0.004     0.086     0.449
Selling_Cost                     -0.0332      0.100   -0.331    0.741    -0.230     0.163
PBIDT                            -0.6175      0.199   -3.098    0.002    -1.008    -0.227
PBDT                              0.4121      0.176    2.337    0.019     0.066     0.758
Rev_earn_in_forex                -0.0512      0.081   -0.633    0.527    -0.210     0.108
Rev_exp_in_forex                  0.0664      0.089    0.749    0.454    -0.187     0.240
Book_Value_Unit_Curr             -0.5837      0.111   -5.269    0.000    -0.801    -0.367
Book_Value_Adj_Unit_Curr          0.0008      0.052    0.015    0.988    -0.101     0.103
Market_Capitalisation             0.0147      0.098    0.151    0.880    -0.177     0.207
CEPS_annualised_Unit_Curr         0.1408      0.126    1.117    0.264    -0.106     0.388
Cash_Flow_From_Opr               -0.1413      0.102   -1.387    0.166    -0.341     0.058
Cash_Flow_From_Inv               -0.0147      0.083   -0.178    0.859    -0.177     0.147
Cash_Flow_From_Fin               -0.0371      0.092   -0.404    0.686    -0.217     0.143
ROG_Net_Worth_perc               -0.2137      0.082   -2.619    0.009    -0.374    -0.054
ROG_Capital_Employed_perc         0.0271      0.096    0.282    0.778    -0.161     0.216
ROG_Gross_Block_perc             -0.0220      0.060   -0.365    0.715    -0.140     0.096
ROG_Gross_Sales_perc             -0.0577      0.073   -0.790    0.429    -0.201     0.085
ROG_Cost_of_Prod_perc             0.0116      0.069    0.167    0.867    -0.124     0.147
ROG_Total_Assets_perc            -0.0813      0.088   -0.924    0.355    -0.254     0.091
ROG_PBIDT_perc                   -0.1638      0.087   -1.874    0.061    -0.335     0.008
ROG_PBT_perc                      0.1041      0.088    1.186    0.236    -0.068     0.276
ROG_Market_Capitalisation_perc   -0.0229      0.060   -0.381    0.703    -0.141     0.095
Curr_Ratio_Latest                -0.0819      0.116   -0.707    0.479    -0.309     0.145
Fixed_Assets_Ratio_Latest        -0.0195      0.059   -0.332    0.740    -0.134     0.095
Inventory_Ratio_Latest           -0.0122      0.058   -0.211    0.833    -0.125     0.101
Debtors_Ratio_Latest              0.0497      0.092    0.540    0.589    -0.131     0.230
Total_Asset_Turnover_Ratio_Latest 0.0269     0.063    0.425    0.671    -0.097     0.151
Interest_Cover_Ratio_Latest       0.0031      0.049    0.063    0.950    -0.093     0.099
PBIDTM_perc_Latest               45.4381      2.210   20.559    0.000    41.106    49.770
PBITM_perc_Latest               -68.2743      3.306  -20.652    0.000   -74.754   -61.795
PBDTM_perc_Latest                -2.1555      0.175  -12.318    0.000    -2.498    -1.813
Debtors_Vel_Days                 -0.1271      0.057   -2.222    0.026    -0.239    -0.015
Creditors_Vel_Days                0.1424      0.056    2.545    0.011     0.033     0.252
Inventory_Vel_Days               -0.0041      0.049   -0.084    0.933    -0.099     0.091
Value_of_Output_to_Total_Assets  -0.0539      0.079   -0.687    0.492    -0.208     0.100
Value_of_Output_to_Gross_Block   -0.0707      0.066   -1.069    0.285    -0.200     0.059
==============================================================================
```

Training performance:

	Accuracy	Recall	Precision	F1
1	0.915487	0.591837	0.584677	0.588235

Test performance:

	Accuracy	Recall	Precision	F1
1	0.894426	0.601399	0.558442	0.579125

Figure 17: Train and test performance of Model 1

The train data shows an accuracy of 0.91 and test data shows an accuracy of 0.89.

We now check for Variance Inflation Factor (VIF) for all these variables.

Equity_Paid_Up	2.489536
Networth	8.336749
Capital_Employed	13.252177
Total_Debt	4.457268
Gross_Block	6.202431
Net_Working_Capital	2.213461
Gross_Sales	7.553685
Other_Income	2.675127
Selling_Cost	3.136792
PBIDT	9.185975
PBDT	8.024183
Rev_earn_in_forex	2.159881
Rev_exp_in_forex	2.642721
Book_Value_Unit_Curr	3.463897
Book_Value_Adj_Unit_Curr	1.017833
Market_Capitalisation	3.092892
CEPS_annualised_Unit_Curr	4.848268
Cash_Flow_From_Opr	3.003937
Cash_Flow_From_Inv	2.129351
Cash_Flow_From_Fin	2.596206
ROG_Net_Worth_perc	2.507760
ROG_Capital_Employed_perc	3.793706
ROG_Gross_Block_perc	1.333903
ROG_Gross_Sales_perc	2.095138
ROG_Cost_of_Prod_perc	1.953775
ROG_Total_Assets_perc	3.201595
ROG_PBIDT_perc	3.035164
ROG_PBT_perc	3.167835
ROG_Market_Capitalisation_perc	1.362240
Curr_Ratio_Latest	1.025870
Fixed_Assets_Ratio_Latest	1.109392
Inventory_Ratio_Latest	1.027842
Debtors_Ratio_Latest	1.029093
Total_Asset_Turnover_Ratio_Latest	1.673476
Interest_Cover_Ratio_Latest	1.053082
PBIDTM_perc_Latest	153.199156
PBITM_perc_Latest	152.672129
PBDTM_perc_Latest	1.739782
Debtors_Vel_Days	1.326068
Creditors_Vel_Days	1.289599
Inventory_Vel_Days	1.049593
Value_of_Output_to_Total_Assets	2.362658
Value_of_Output_to_Gross_Block	1.607997
dtype: float64	

Figure 18: VIF

We notice that most of the variables have VIF values more than 5. We now remove them one by one.

After removing a few variables:

```
Series before feature selection:

Equity_Paid_Up                       2.388745
Networth                             5.117331
Total_Debt                           3.186824
Gross_Block                          5.181582
Net_Working_Capital                  2.072313
Other_Income                         2.571153
Selling_Cost                         2.936973
PBDT                                 4.589283
Rev_earn_in_forex                    2.150185
Rev_exp_in_forex                     2.577269
Book_Value_Unit_Curr                 3.456293
Book_Value_Adj_Unit_Curr             1.017777
Market_Capitalisation                3.059429
CEPS_annualised_Unit_Curr            4.841075
Cash_Flow_From_Opr                   2.965848
Cash_Flow_From_Inv                   2.113421
Cash_Flow_From_Fin                   2.570920
ROG_Net_Worth_perc                   2.494410
ROG_Capital_Employed_perc            3.754463
ROG_Gross_Block_perc                 1.331168
ROG_Gross_Sales_perc                 2.081750
ROG_Cost_of_Prod_perc                1.951606
ROG_Total_Assets_perc                3.200680
ROG_PBIDT_perc                       2.944545
ROG_PBT_perc                         3.104580
ROG_Market_Capitalisation_perc       1.352256
Curr_Ratio_Latest                    1.022763
Fixed_Assets_Ratio_Latest            1.107324
Inventory_Ratio_Latest               1.025889
Debtors_Ratio_Latest                 1.025505
Total_Asset_Turnover_Ratio_Latest    1.659001
Interest_Cover_Ratio_Latest          1.046879
PBITM_perc_Latest                    1.703705
PBDTM_perc_Latest                    1.727680
Debtors_Vel_Days                     1.318582
Creditors_Vel_Days                   1.286359
Inventory_Vel_Days                   1.045216
Value_of_Output_to_Total_Assets      2.265869
Value_of_Output_to_Gross_Block       1.541443
dtype: float64
```

Figure 19: Corrected VIF

MODEL 2:

```
----------------------------------------------------------------------------------------------
Equity_Paid_Up                       0.1111    0.075    1.483    0.138   -0.036    0.258
Networth                            -1.1015    0.142   -7.783    0.000   -1.379   -0.824
Total_Debt                           0.3502    0.089    3.954    0.000    0.177    0.524
Gross_Block                          0.4096    0.117    3.514    0.000    0.181    0.638
Net_Working_Capital                 -0.0098    0.070   -0.140    0.889   -0.147    0.128
Other_Income                         0.3571    0.081    4.403    0.000    0.198    0.516
Selling_Cost                        -0.0471    0.080   -0.591    0.555   -0.203    0.109
PBDT                                 0.0153    0.101    0.151    0.880   -0.182    0.213
Rev_earn_in_forex                   -0.0561    0.068   -0.831    0.406   -0.188    0.076
Rev_exp_in_forex                     0.0893    0.074    1.203    0.229   -0.056    0.235
Book_Value_Unit_Curr                -0.4099    0.087   -4.736    0.000   -0.580   -0.240
Book_Value_Adj_Unit_Curr            -0.0076    0.039   -0.196    0.845   -0.083    0.068
Market_Capitalisation                0.0259    0.081    0.319    0.750   -0.133    0.185
CEPS_annualised_Unit_Curr            0.1299    0.101    1.290    0.197   -0.067    0.327
Cash_Flow_From_Opr                  -0.1042    0.081   -1.289    0.197   -0.263    0.054
Cash_Flow_From_Inv                  -0.0143    0.067   -0.214    0.830   -0.145    0.117
Cash_Flow_From_Fin                  -0.0186    0.075   -0.249    0.804   -0.165    0.128
ROG_Net_Worth_perc                  -0.2222    0.072   -3.098    0.002   -0.363   -0.082
ROG_Capital_Employed_perc           -0.0099    0.087   -0.115    0.909   -0.180    0.160
ROG_Gross_Block_perc                 0.0152    0.051    0.299    0.765   -0.085    0.115
ROG_Gross_Sales_perc                -0.0281    0.063   -0.446    0.656   -0.152    0.095
ROG_Cost_of_Prod_perc                0.0199    0.061    0.329    0.742   -0.099    0.139
ROG_Total_Assets_perc               -0.0638    0.078   -0.818    0.414   -0.217    0.089
ROG_PBIDT_perc                      -0.1610    0.078   -2.065    0.039   -0.314   -0.008
ROG_PBT_perc                         0.1023    0.078    1.306    0.191   -0.051    0.256
ROG_Market_Capitalisation_perc      -0.0370    0.051   -0.722    0.470   -0.137    0.063
Curr_Ratio_Latest                   -0.0330    0.049   -0.671    0.502   -0.130    0.063
Fixed_Assets_Ratio_Latest           -0.0303    0.043   -0.706    0.480   -0.115    0.054
Inventory_Ratio_Latest              -0.0147    0.044   -0.334    0.738   -0.101    0.072
Debtors_Ratio_Latest                 0.2039    0.115    1.770    0.077   -0.022    0.430
Total_Asset_Turnover_Ratio_Latest    0.0484    0.064    0.759    0.448   -0.077    0.173
Interest_Cover_Ratio_Latest          0.0172    0.038    0.459    0.646   -0.056    0.091
PBITM_perc_Latest                   -0.0205    0.074   -0.276    0.782   -0.166    0.125
PBDTM_perc_Latest                   -0.0701    0.116   -0.606    0.545   -0.297    0.157
Debtors_Vel_Days                    -0.1258    0.050   -2.498    0.013   -0.225   -0.027
Creditors_Vel_Days                   0.1477    0.051    2.899    0.004    0.048    0.248
Inventory_Vel_Days                  -0.0331    0.043   -0.772    0.440   -0.117    0.051
Value_of_Output_to_Total_Assets     -0.0938    0.067   -1.397    0.162   -0.225    0.038
Value_of_Output_to_Gross_Block      -0.0264    0.054   -0.487    0.626   -0.133    0.080
==============================================================================================
```

Figure 20: Model-2

Since p-value have a significance in the model,we now start removing variables with p-value greater than 0.05.

After removing such variables:

MODEL 3:

```
                        Logit Regression Results
================================================================================
Dep. Variable:               default   No. Observations:              2402
Model:                         Logit   Df Residuals:                  2394
Method:                          MLE   Df Model:                         7
Date:               Sun, 10 Mar 2024   Pseudo R-squ.:              -0.8620
Time:                       00:30:16   Log-Likelihood:             -1473.5
converged:                      True   LL-Null:                    -791.34
Covariance Type:           nonrobust   LLR p-value:                  1.000
================================================================================
                         coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------
Networth              -0.9899      0.103     -9.595      0.000      -1.192      -0.788
Total_Debt             0.3270      0.079      4.114      0.000       0.171       0.483
Gross_Block            0.4034      0.097      4.143      0.000       0.213       0.594
Other_Income           0.3614      0.077      4.667      0.000       0.210       0.513
Book_Value_Unit_Curr  -0.3723      0.058     -6.408      0.000      -0.486      -0.258
ROG_Net_Worth_perc    -0.2802      0.048     -5.842      0.000      -0.374      -0.186
Debtors_Vel_Days      -0.1269      0.049     -2.615      0.009      -0.222      -0.032
Creditors_Vel_Days     0.1632      0.050      3.286      0.001       0.066       0.260
================================================================================
```

Figure 21: Model-3

Training performance:

	Accuracy	Recall	Precision	F1
1	0.650708	0.959184	0.220865	0.359053

Test performance:

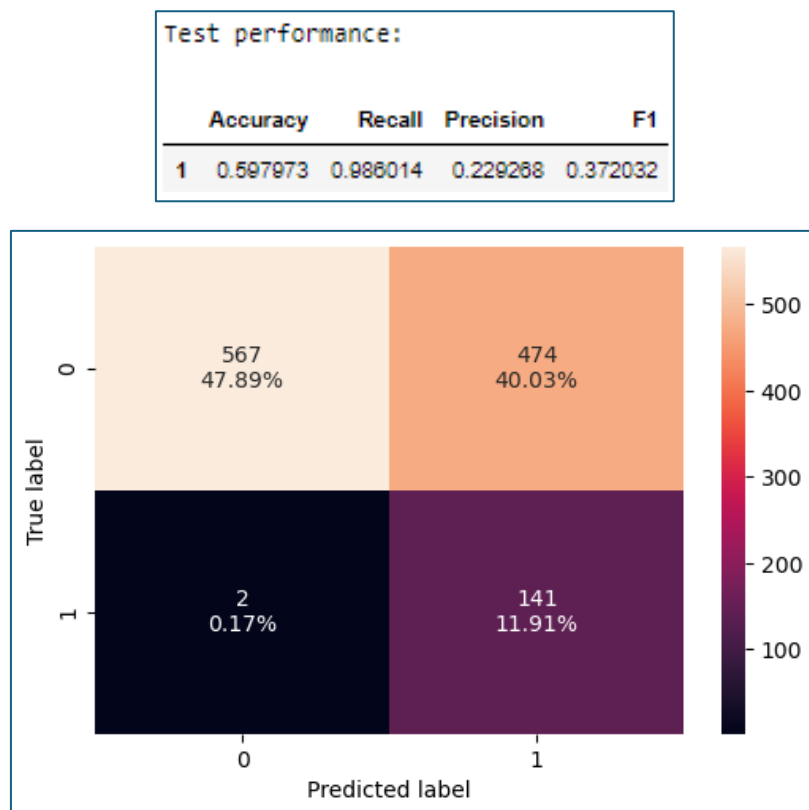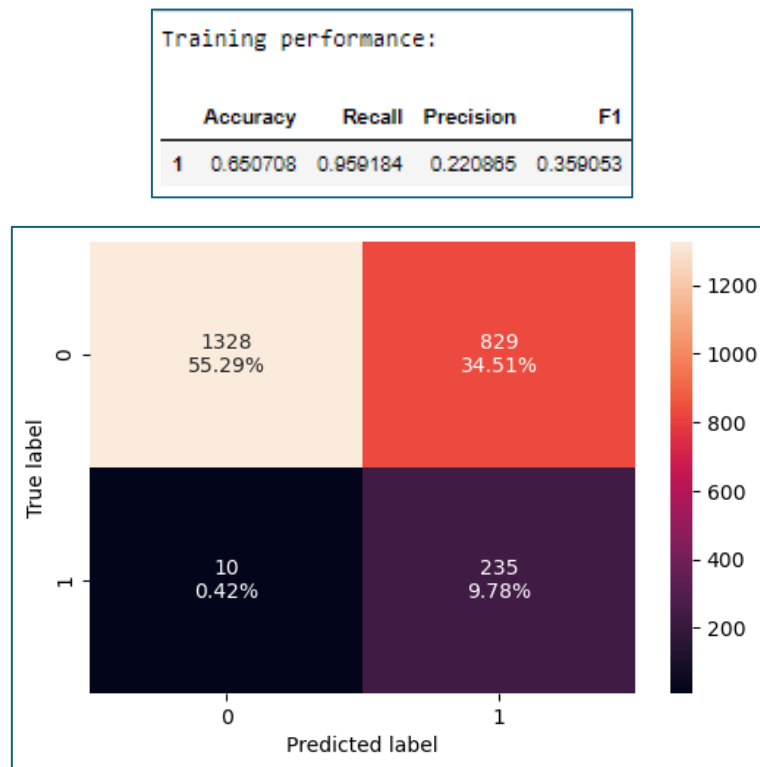|	Accuracy	Recall	Precision	F1
1	0.597973	0.986014	0.229268	0.372032

Figure 22: Train and test performance Model-3

We now notice that the test data has an accuracy of 0.59 and train data with accuracy of 0.65.

7. Validate the Model on Test Dataset and state the performance matrices. Also state interpretation from the model

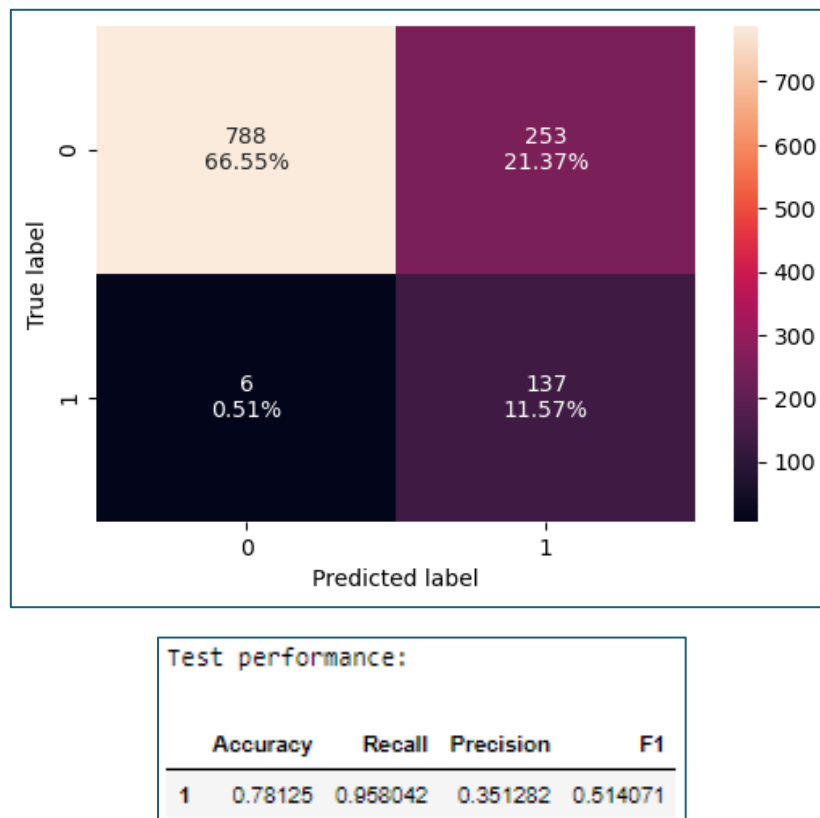We find that optimal threshold according to ROC-AUC curve is 0.55. On applying that to the data.

Test performance:

	Accuracy	Recall	Precision	F1
1	0.78125	0.958042	0.351282	0.514071

Figure 23: Test performance by optimum threshold method

We now notice that the accuracy has slightly increased to 0.78.