# Bankruptcy

January 12, 2023

Prepare dataset

[ ]:
```
import pandas as pd
import numpy as np

df = pd.read_csv("data/data.csv") # https://www.kaggle.com/datasets/fedesoriano/
 ↪company-bankruptcy-prediction

df["y"] = df["Bankrupt?"]
df.drop("Bankrupt?", axis=1, inplace=True)

df.head()
```

[ ]:

| | ROA(C) before interest and depreciation before interest | ROA(A) before interest and % after tax | ROA(B) before interest and depreciation after tax | Operating Gross Margin | Realized Sales Gross Margin |
|---|---|---|---|---|---|
| 0 | 0.370594 | 0.424389 | 0.405750 | 0.601457 | 0.601457 |
| 1 | 0.464291 | 0.538214 | 0.516730 | 0.610235 | 0.610235 |
| 2 | 0.426071 | 0.499019 | 0.472295 | 0.601450 | 0.601364 |
| 3 | 0.399844 | 0.451265 | 0.457733 | | |
| 4 | 0.465022 | 0.538432 | 0.522298 | | |

```
3                 0.583541                      0.583541
4                 0.598783                      0.598783

    Operating Profit Rate   Pre-tax net Interest Rate  \
0                0.998969                    0.796887
1                0.998946                    0.797380
2                0.998857                    0.796403
3                0.998700                    0.796967
4                0.998973                    0.797366

    After-tax net Interest Rate   Non-industry income and expenditure/revenue  \
0                      0.808809                                       0.302646
1                      0.809301                                       0.303556
2                      0.808388                                       0.302035
3                      0.808966                                       0.303350
4                      0.809304                                       0.303475

    Continuous interest rate (after tax)  …   Total assets to GNP price  \
0                               0.780985  …                    0.009219
1                               0.781506  …                    0.008323
2                               0.780284  …                    0.040003
3                               0.781241  …                    0.003252
4                               0.781550  …                    0.003878

    No-credit Interval   Gross Profit to Sales  \
0             0.622879                0.601453
1             0.623652                0.610237
2             0.623841                0.601449
3             0.622929                0.583538
4             0.623521                0.598782

    Net Income to Stockholder's Equity   Liability to Equity  \
0                             0.827890              0.290202
1                             0.839969              0.283846
2                             0.836774              0.290189
3                             0.834697              0.281721
4                             0.839973              0.278514

    Degree of Financial Leverage (DFL)  \
0                             0.026601
1                             0.264577
2                             0.026555
3                             0.026697
4                             0.024752

    Interest Coverage Ratio (Interest expense to EBIT)   Net Income Flag  \
0                                             0.564050                 1
```

```
1                                                 0.570175                  1
2                                                 0.563706                  1
3                                                 0.564663                  1
4                                                 0.575617                  1

    Equity to Liability  y
0              0.016469  1
1              0.020794  1
2              0.016474  1
3              0.023982  1
4              0.035490  1

[5 rows x 96 columns]
```

Calculate imbalance in dataset

[ ]:
```
X, y = df.drop("y", axis=1), df["y"]

y.value_counts()[0] / len(y)
```

[ ]:
```
0.967737204868749
```

Split data into test and validation sets

[ ]:
```
from sklearn.model_selection import train_test_split

X_train, X_val, y_train, y_val = train_test_split(X, y, test_size=0.30,␣
 ↪random_state=0, shuffle=True, stratify=y)
```

Oversampling the training data

[ ]:
```
from imblearn.over_sampling import SMOTE

oversample = SMOTE()

X_train, y_train = oversample.fit_resample(X_train, y_train)
```

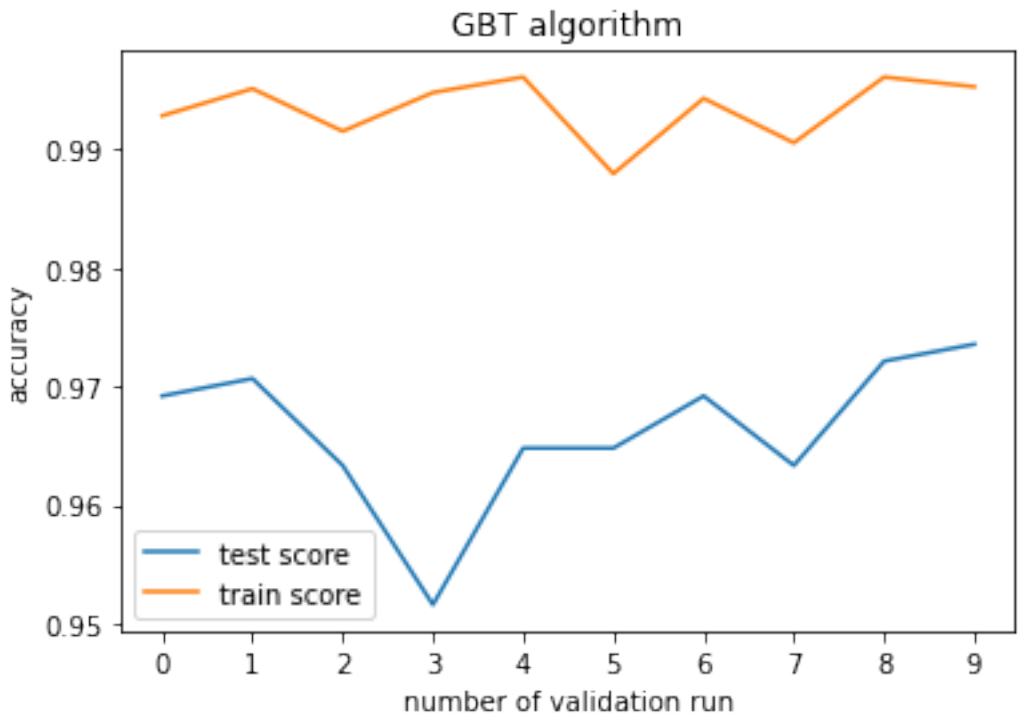
GBT Algorithm

[ ]:
```
from sklearn.metrics import classification_report
from sklearn.ensemble import GradientBoostingClassifier

model_gbt = GradientBoostingClassifier(learning_rate=0.1, max_depth=6,␣
 ↪criterion="friedman_mse", n_estimators=100, n_iter_no_change=5, tol=0.001,␣
 ↪random_state=0)

model_gbt.fit(X_train, y_train)
y_pred = model_gbt.predict(X_val)
```

```
print(classification_report(y_true=y_val, y_pred=y_pred))
```

```
              precision    recall  f1-score   support

           0       0.98      0.97      0.97      1980
           1       0.32      0.45      0.37        66

    accuracy                           0.95      2046
   macro avg       0.65      0.71      0.67      2046
weighted avg       0.96      0.95      0.95      2046
```

[ ]:
```
from sklearn.model_selection import cross_validate
import matplotlib.pylab as plt

cv = cross_validate(model_gbt, X, y, return_train_score=True, cv=10)
plt.plot(cv["test_score"], label="test score")
plt.plot(cv["train_score"], label="train score")
plt.legend(loc="lower left")
plt.xlabel("number of validation run")
plt.xticks(np.arange(0, len(cv["test_score"]), 1))
plt.ylabel("accuracy")
plt.title("GBT algorithm")
plt.show()
```

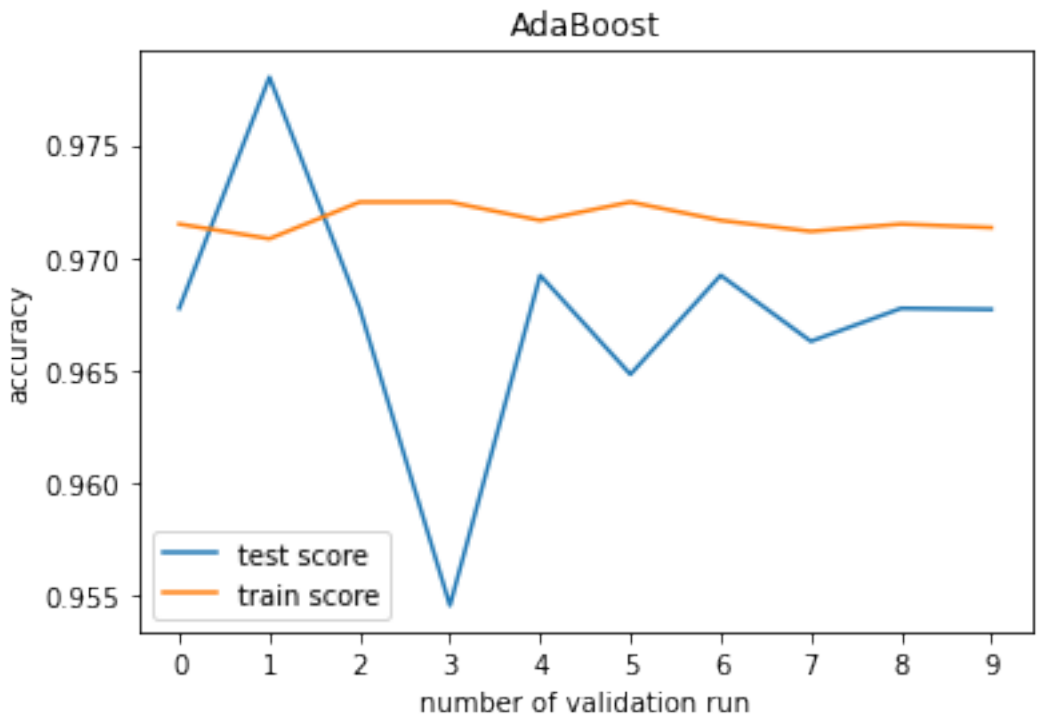


AdaBoost

[ ]:
```
from sklearn.ensemble import AdaBoostClassifier

model_ada = AdaBoostClassifier(learning_rate=0.1, n_estimators=100,␣
 ↪random_state=0)

model_ada.fit(X_train, y_train)
y_pred = model_ada.predict(X_val)
print(classification_report(y_true=y_val, y_pred=y_pred))
```

```
              precision    recall  f1-score   support

           0       0.99      0.90      0.94      1980
           1       0.22      0.83      0.34        66

    accuracy                           0.90      2046
   macro avg       0.61      0.87      0.64      2046
weighted avg       0.97      0.90      0.93      2046
```

[ ]:
```
cv = cross_validate(model_ada, X, y, return_train_score=True, cv=10)
plt.plot(cv["test_score"], label="test score")
plt.plot(cv["train_score"], label="train score")
plt.legend(loc="lower left")
plt.xlabel("number of validation run")
plt.xticks(np.arange(0, len(cv["test_score"]), 1))
plt.ylabel("accuracy")
plt.title("AdaBoost")
plt.show()
```



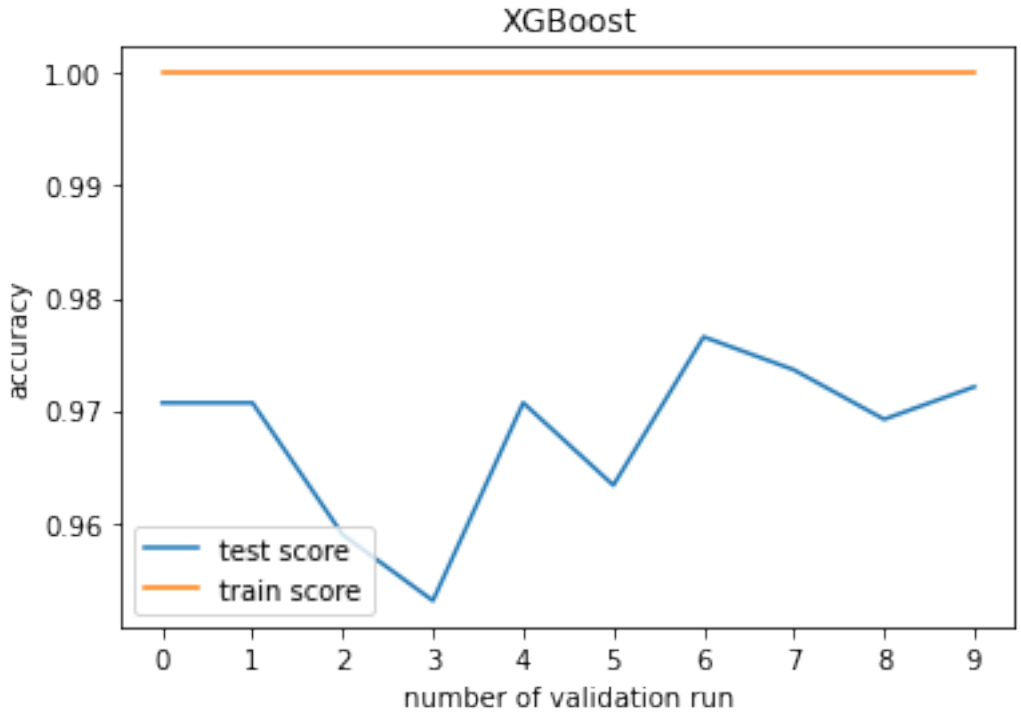

XGBoost

[ ]:
```
import xgboost as xgb

model_xgb = xgb.XGBClassifier(learning_rate=0.1, max_depth=6, n_estimators=100)
model_xgb.fit(X_train, y_train)
y_pred = model_xgb.predict(X_val)
print(classification_report(y_true=y_val, y_pred=y_pred))
```

```
              precision    recall  f1-score   support

           0       0.98      0.97      0.98      1980
           1       0.37      0.53      0.43        66

    accuracy                           0.96      2046
   macro avg       0.68      0.75      0.71      2046
weighted avg       0.96      0.96      0.96      2046
```

[ ]:
```
cv = cross_validate(model_xgb, X, y, return_train_score=True, cv=10)
plt.plot(cv["test_score"], label="test score")
plt.plot(cv["train_score"], label="train score")
plt.legend(loc="lower left")
plt.xlabel("number of validation run")
```

```
plt.xticks(np.arange(0, len(cv["test_score"]), 1))
plt.ylabel("accuracy")
plt.title("XGBoost")
plt.show()
```




[ ]:
```
from sklearn.ensemble import RandomForestClassifier

model_rf = RandomForestClassifier(max_depth=9, n_estimators=100)
model_rf.fit(X_train, y_train)
y_pred = model_rf.predict(X_val)
print(classification_report(y_true=y_val, y_pred=y_pred))
```

```
              precision    recall  f1-score   support

           0       0.99      0.94      0.97      1980
           1       0.28      0.68      0.40        66

    accuracy                           0.93      2046
   macro avg       0.64      0.81      0.68      2046
weighted avg       0.97      0.93      0.95      2046
```

[ ]:
```
cv = cross_validate(model_rf, X, y, return_train_score=True, cv=10)
plt.plot(cv["test_score"], label="test score")
plt.plot(cv["train_score"], label="train score")
plt.legend(loc="lower left")
plt.xlabel("number of validation run")
plt.xticks(np.arange(0, len(cv["test_score"]), 1))
plt.ylabel("accuracy")
plt.title("Random Forest")
plt.show()
```