COURSE PROJECT REPORT

Stock Index Prediction using Naïve Bayesian, AdaBoost and SVM classifier

CHEMENG 787: Machine Learning Classification Models

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Summary

The classifiers used in this project are Gaussian Naïve Bayesian, AdaBoost and Support Vector Machine. The dataset used in the course project is taken from Kaggle.com and it is called “Stock Index Prediction” [1] uploaded by Jiang M.Q. The idea is to predict if the stock would go up or down by training classifiers. The features are taken from Yahoo finance and FREM by the uploader. The data has 3 files for 3 different stock exchanges i.e. NASDAQ, DOW JONES and S&P 500.

For this course project I used NASDAQ data which has total 2448 data points and 14 attributes. The 14 attributes are given:

1. Date - Date of the data point collected
2. Label - The target label i.e. Stock up = 1 & Stock down = 0.
3. Open - Opening price of the stock.
4. High - Highest stock price in the day
5. Low - Lowest stock price in the day
6. Close - Closing price of the stock
7. Volume - Volume of the stock
8. Interest rate - Interest rate set by market committee
9. Exchange rate - Exchange rate of currency
10. VIX - Volatility Index
11. Gold - Gold prices
12. Oil - Oil prices
13. TEDSpread - TED spread is difference between treasury bill & LIBOR
14. EFFR - Effective federal funds rate

The data was of .csv extension and imported to python code using *pandas.read_csv*. For training classifiers, the Date attribute was removed. All other attributes have numerical values. As the data has 2448 data points, 75% of it i.e. 1836 data points are used for training and the rest 612 data points are used for testing. The data is split using *train_test_split* module of *sklearn* library. Different libraries were used for all the operations which includes training classifiers, confusion matrix and ROC.

The results of all classifiers were around 54% which we can say is Random Result i.e. if predicted stock would go up there is only 54% chance that it would go up which is almost the random probability. Even 6 years of data could not predict the next day’s value which clearly states that the stock results are completely random. Adding more attributes and data points might increase the accuracy a bit but not by a significant percentage.

For this data, Gaussian Naïve Bayesian classifier has the highest accuracy i.e. 54.9%.

1. Computation times

Computational time for all classifiers:

Times	G. Naïve Bayesian	AdaBoost	SVM
Training	0.031 s	0.156 s	1.516 s
Testing	0.016 s	0.000 s	0.234 s
Accuracy	54.9 %	52.12 %	53.92 %

Time to search best estimators in SVM = 77.51 s
Time to run the whole code ≈ 85 s
Python version: 3.8
Platform: PyCharm

2. Cross validation for parameter selection

Cross validation for parameter selection is done using GridSearchCV which searches over the values specified (C and gamma). It combines with K-fold cross validation with a grid of parameters. By default it uses 3-Fold fit unless specified. Only C and gamma value grid is specified therefore it uses 3-Fold fit.

Code for CV:

```
print("Finding best parameters...")
start_SVM_param = time.time()
param_grid = {'C': [0.25,0.5,1,10,1e2,1e3,1e4,1e5],
              'gamma': [10,1,0.1,0.01,0.05,0.001,0.0001,0.00001], }
clf = GridSearchCV(
    SVC(kernel='rbf', class_weight='balanced'), param_grid
)
clf = clf.fit(X_train, y_train)
end_SVM_param = time.time()
print ("Found best parameters in %0.2f seconds" % (end_SVM_param - start_SVM_param))
print("Best C value =", clf.best_estimator_.C)
print("Best Gamma value =", clf.best_estimator_.gamma)
print()
```

Output:

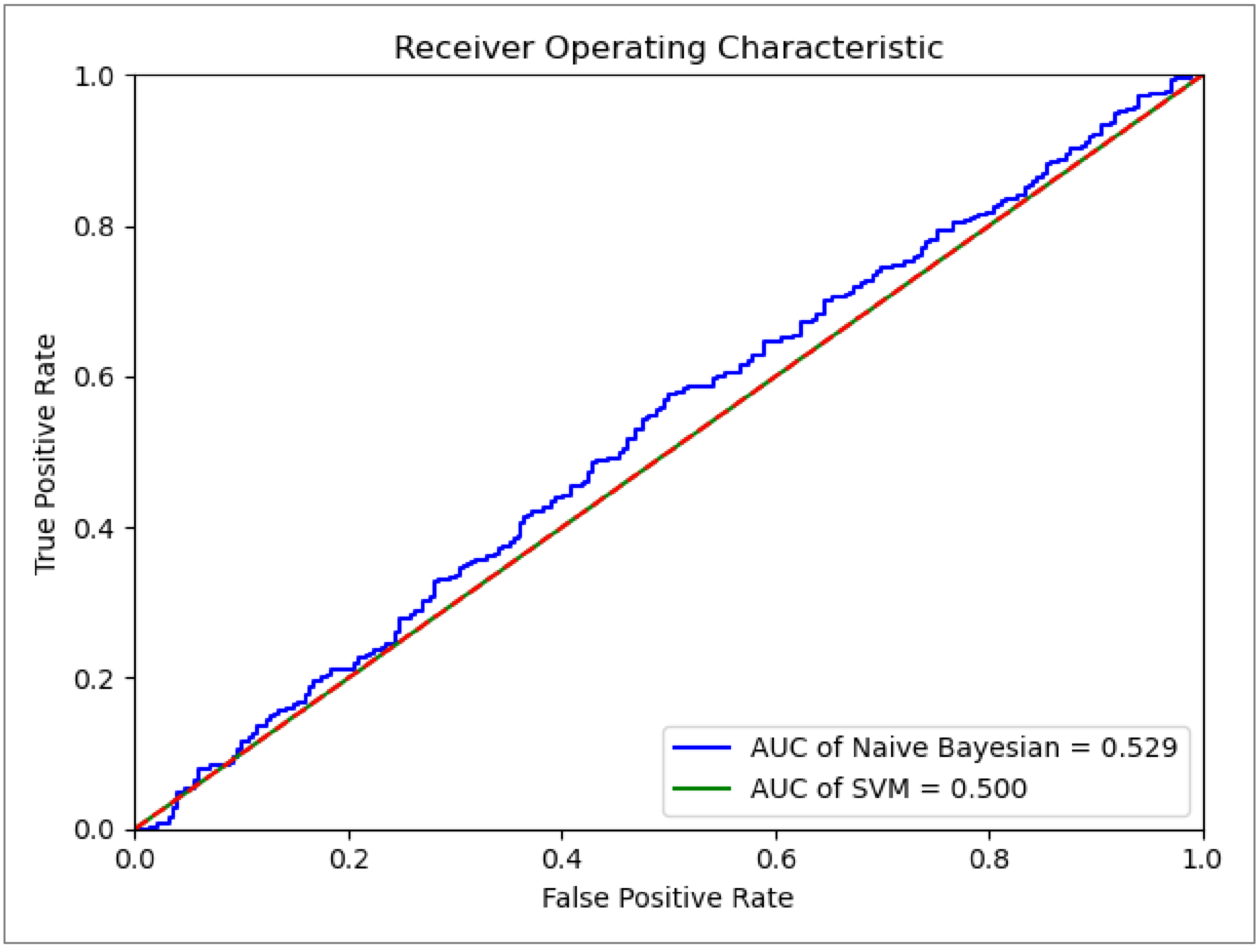
Finding best parameters...

Found best parameters in 77.51 seconds

Best C value = 1

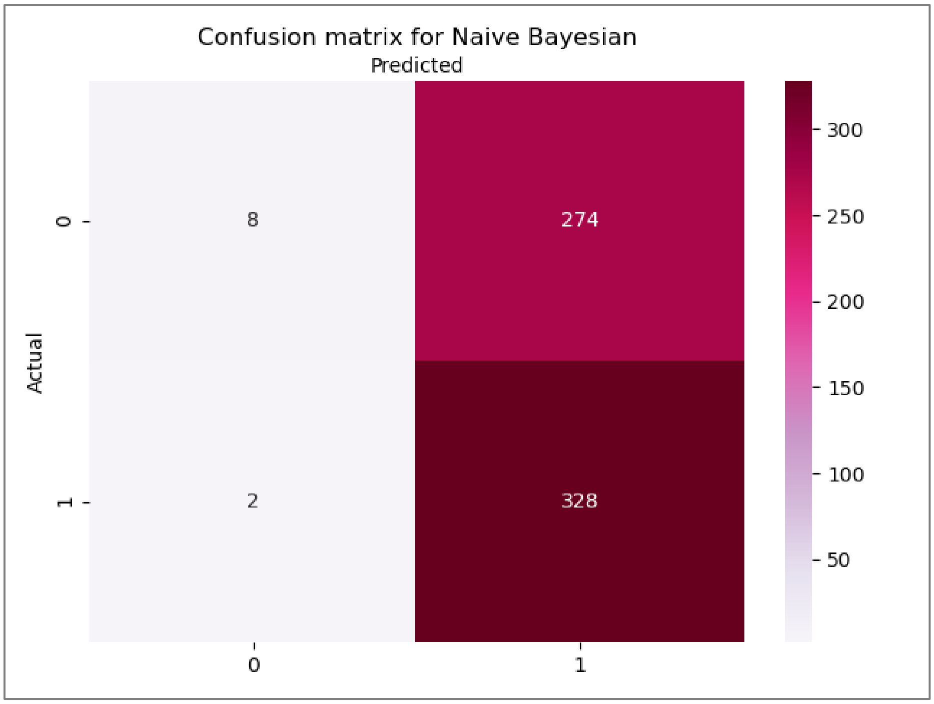
Best Gamma value = 10

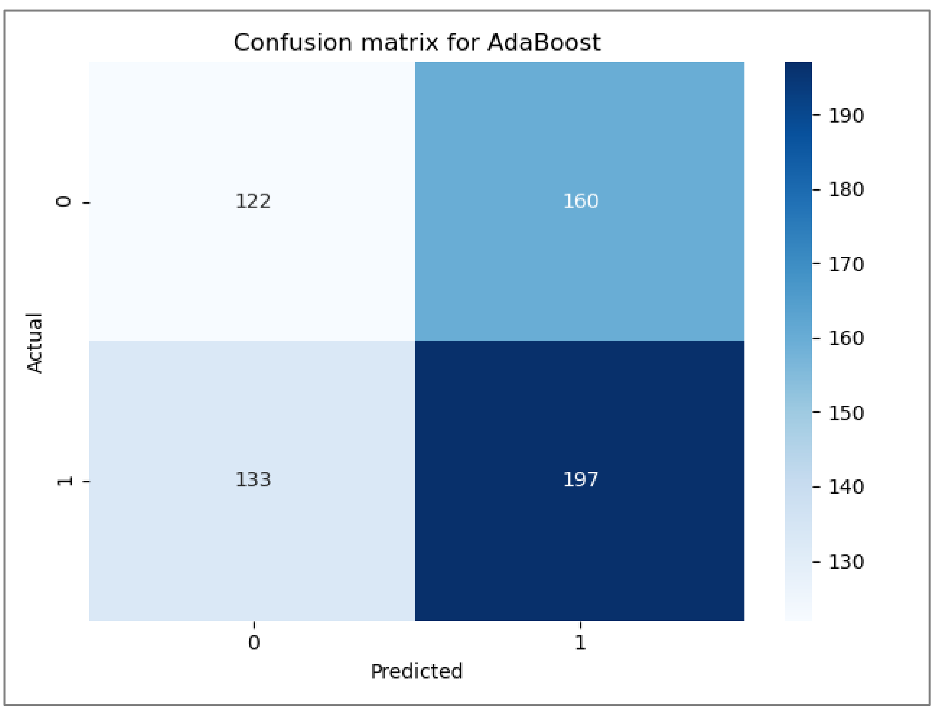
3. ROC Curve

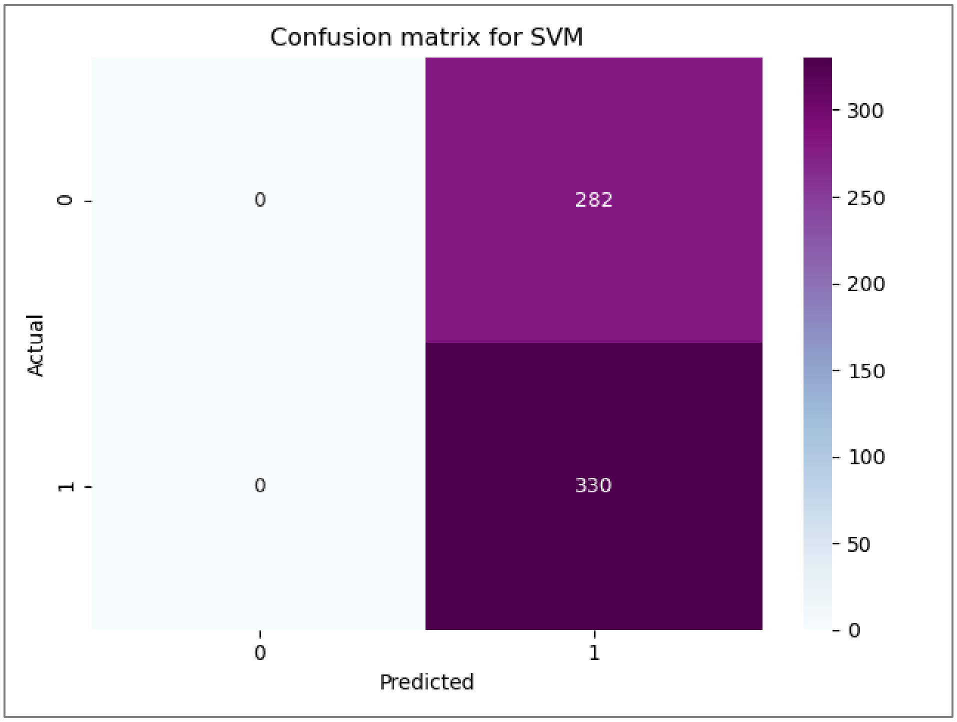


ROC Curve came out to be as almost random outputs. Gaussian Naïve Bayesian's curve is very close to the random line whereas same for SVM is on the random line. The accuracy of both the classifiers is around 50% which is again a random result. ROC for AdaBoost classifier is not desirable as I used decision tree in AdaBoost.

4. Confusion Matrix







Confusion matrix shows the performance of the classifiers. In this project, the performance is not good for all classifiers as actual values are almost half of the predicted values.

5. Python Code for all algorithms

5.1 INPUT

```
### COURSE PROJECT - STOCK UP/DOWN PREDICTION ##

### IMPORTING LIBRARIES ###
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
import time


### DATA PREPROCESSING ###
#Importing data
data = pd.read_csv (r'NASDAQ.csv')
print (data)
print (data['LABEL'].unique().tolist()) #To check number of variables i.e. should be only 2 (0 and1)

#Deleting non-useful attributes
del data['Date']

#Setting targets
```

```python
y = data.LABEL
print (y)


### SPLITTING DATA ###
#Splitting training & Testing data in 3:1 ratio (only for Naive Bayesian & AdaBoost)
X = data.drop('LABEL',axis=1)
print (X)

X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.25, random_state=42)

print ("Splitting training and testing data in 3:1 ratio...")
print ("Training data set size (Features): ",X_train.shape)
print ("Testing data set size (Features): ", X_test.shape)
print ("Training data set size (Labels): ",y_train.shape)
print ("Testing data set size (Labels): ",y_test.shape)


### CLASSIFYING ###
## 1. Gaussian Naive Bayesian Classifier
from sklearn.naive_bayes import GaussianNB
from sklearn import metrics

#Training
start_NB_train = time.time()
gnb = GaussianNB()
gnb.fit(X_train,y_train)
end_NB_train = time.time()
print ()
print ("GAUSSIAN NAIVE BAYESIAN CLASSIFIER:")
print ("GNB Processing time : Training = %0.3fs " % (end_NB_train - start_NB_train))

#Testing
start_NB_test = time.time()
y_pred_NB = gnb.predict(X_test)
end_NB_test = time.time()
print ("GNB Processing time : Testing = %0.3fs " % (end_NB_test - start_NB_test))
print ("GNB Accuracy percentage = ",round(metrics.accuracy_score(y_test,
y_pred_NB)*100,2),"%")
print ()



## 2. AdaBoost Classifier
from sklearn.ensemble import AdaBoostClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn import metrics

#Training
start_AB_train = time.time()
ada = AdaBoostClassifier(DecisionTreeClassifier(), n_estimators=100, random_state =
0) #Using Decision Tree
model = ada.fit(X_train, y_train)
end_AB_train = time.time()
```

```
print ("ADABOOST CLASSIFIER:")
print ("AdaBoost Processing time : Training = %0.3fs " % (end_AB_train -
start_AB_train))

#Testing
start_AB_test = time.time()
y_pred_AB = ada.predict(X_test)
end_AB_test = time.time()
print ("AdaBoost Processing time : Testing = %0.3fs " % (end_AB_test -
start_AB_test))
print ("AdaBoost Accuracy percentage = ",round(metrics.accuracy_score(y_test,
y_pred_AB)*100,2),"%")
print ()


### SVM Classifier with Cross Validation
from sklearn.svm import SVC
from sklearn.model_selection import GridSearchCV

#Finding best C and gamma values
print("Finding best parameters...")
start_SVM_param = time.time()
param_grid = {'C': [0.25,0.5,1,10,1e2,1e3,1e4,1e5],
              'gamma': [10,1,0.1,0.01,0.05,0.001,0.0001,0.00001], }
clf = GridSearchCV(
    SVC(kernel='rbf', class_weight='balanced'), param_grid
)
clf = clf.fit(X_train, y_train)
end_SVM_param = time.time()
print ("Found best parameters in %0.2f seconds" % (end_SVM_param - start_SVM_param))
print("Best C value =", clf.best_estimator_.C)
print("Best Gamma value =", clf.best_estimator_.gamma)
print()

#Training
start_SVM_train = time.time()
svm = SVC(kernel='rbf', random_state=0, gamma=clf.best_estimator_.gamma,
C=clf.best_estimator_.C,probability=True) #Using best estimators
svm.fit(X_train, y_train)
end_SVM_train = time.time()
print ("SVM CLASSIFIER")
print ("SVM Processing time : Training = %0.3fs " % (end_SVM_train -
start_SVM_train))

#Testing
start_SVM_test = time.time()
y_pred_SVM = svm.predict(X_test)
preds_svm = svm.predict_proba(X_test)[:,1]
end_SVM_test = time.time()
print ("SVM Processing time : Testing = %0.3fs " % (end_SVM_test - start_SVM_test))
print ("SVM Accuracy percentage = ",round(metrics.accuracy_score(y_test,
y_pred_SVM)*100,2),"%")
```

```
### Confusion Matrix
from sklearn.metrics import confusion_matrix
import matplotlib.pyplot as plt
import seaborn as sns

con_NB = confusion_matrix(y_test,y_pred_NB)
con_AB = confusion_matrix(y_test,y_pred_AB)
con_SVM = confusion_matrix(y_test,y_pred_SVM)
class_names=[0,1]
fig, ax = plt.subplots()
tick_marks = np.arange(len(class_names))
plt.xticks(tick_marks, class_names)
plt.yticks(tick_marks, class_names)

sns.heatmap(pd.DataFrame(con_NB), annot=True, cmap="PuRd" ,fmt='g')
ax.xaxis.set_label_position("top")
plt.tight_layout()
plt.title('Confusion matrix for Naive Bayesian', y=1.1)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()

sns.heatmap(pd.DataFrame(con_AB), annot=True, cmap="Blues" ,fmt='g')
ax.xaxis.set_label_position("top")
plt.tight_layout()
plt.title('Confusion matrix for AdaBoost', y=1.1)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()

sns.heatmap(pd.DataFrame(con_SVM), annot=True, cmap="BuPu" ,fmt='g')
ax.xaxis.set_label_position("top")
plt.tight_layout()
plt.title('Confusion matrix for SVM', y=1.1)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()



### ROC
import sklearn.metrics as metrics
preds_nb = gnb.predict_proba(X_test)[:,1]
preds_svm = svm.predict_proba(X_test)[:,1]
fpr_nb, tpr_nb, threshold_nb = metrics.roc_curve(y_test, preds_nb)
fpr_svm, tpr_svm, threshold_svm = metrics.roc_curve(y_test, preds_svm)
roc_auc_nb = metrics.auc(fpr_nb, tpr_nb)
roc_auc_svm = metrics.auc(fpr_svm, tpr_svm)

import matplotlib.pyplot as plt
plt.title('Receiver Operating Characteristic')
plt.plot(fpr_nb, tpr_nb, 'b', label = 'AUC of Naive Bayesian = %0.3f' % roc_auc_nb)
plt.plot(fpr_svm, tpr_svm, 'g', label = 'AUC of SVM = %0.3f' % roc_auc_svm)
plt.legend(loc = 'lower right')
```

```
plt.plot([0, 1], [0, 1],'r--',label = 'Random guess')
plt.xlim([0, 1])
plt.ylim([0, 1])
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```

5.2 OUTPUT

```
C:\P\python.exe "C:/Users/Livanshu Kashyap/PycharmProjects/untitled9/Project_ML2.py"
        Date  LABEL       Open  ...     Oil  TEDSpread  EFFR
0     4/1/2008      0  2306.510010  ...  100.92       1.30  2.38
1     4/2/2008      1  2363.419922  ...  104.83       1.31  2.18
2     4/3/2008      1  2347.909912  ...  103.92       1.35  2.19
3     4/4/2008      0  2366.909912  ...  106.09       1.40  2.26
4     4/7/2008      0  2386.620117  ...  108.91       1.28  2.24
...        ...    ...          ...  ...     ...        ...   ...
2443  3/23/2018      1  7170.680176  ...   65.80       0.58  1.68
2444  3/26/2018      0  7125.200195  ...   65.49       0.53  1.68
2445  3/27/2018      0  7255.470215  ...   65.21       0.56  1.68
2446  3/28/2018      1  6978.299805  ...   64.30       0.61  1.68
2447  3/29/2018      0  6984.660156  ...   64.87       0.61  1.68

[2448 rows x 14 columns]
[0, 1]
0       0
1       1
2       1
3       0
4       0
       ..
2443    1
2444    0
2445    0
2446    1
2447    0

Name: LABEL, Length: 2448, dtype: int64

             Open         High          Low  ...     Oil  TEDSpread  EFFR
0     2306.510010  2362.750000  2305.399902  ...  100.92       1.30  2.38
1     2363.419922  2381.209961  2347.780029  ...  104.83       1.31  2.18
2     2347.909912  2373.989990  2339.379883  ...  103.92       1.35  2.19
3     2366.909912  2391.929932  2351.760010  ...  106.09       1.40  2.26
```

```
4     2386.620117  2390.040039  2359.540039  ...  108.91      1.28  2.24
...         ...         ...         ...  ...      ...       ...   ...
2443  7170.680176  7194.310059  6992.669922  ...   65.80      0.58  1.68
2444  7125.200195  7225.830078  7022.339844  ...   65.49      0.53  1.68
2445  7255.470215  7255.540039  6963.680176  ...   65.21      0.56  1.68
2446  6978.299805  7036.089844  6901.069824  ...   64.30      0.61  1.68
2447  6984.660156  7120.459961  6935.779785  ...   64.87      0.61  1.68

[2448 rows x 12 columns]
Splitting training and testing data in 3:1 ratio...
Training data set size (Features):  (1836, 12)
Testing data set size (Features):  (612, 12)
Training data set size (Labels):  (1836,)
Testing data set size (Labels):  (612,)

GAUSSIAN NAIVE BAYESIAN CLASSIFIER:
GNB Processing time : Training = 0.031s
GNB Processing time : Testing = 0.016s
GNB Accuracy percentage =  54.9 %

ADABOOST CLASSIFIER:
AdaBoost Processing time : Training = 0.156s
AdaBoost Processing time : Testing = 0.000s
AdaBoost Accuracy percentage =  52.12 %

Finding best parameters...

Found best parameters in 77.51 seconds
Best C value = 1
Best Gamma value = 10

SVM CLASSIFIER
SVM Processing time : Training = 1.516s
SVM Processing time : Testing = 0.234s
SVM Accuracy percentage =  53.92 %

Process finished with exit code 0
```