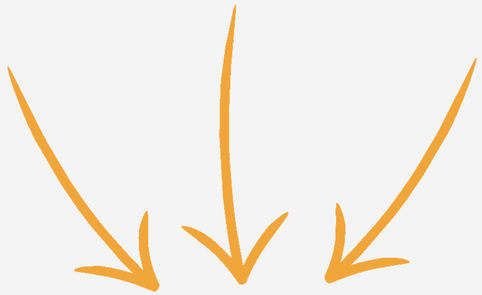
ANDREEA STROIA
HALA ALBAHLOUL
HRITIKA KATHURIA

SUPERVISED CLASSIFICATION METHODS

Overview

3 datasets



Diabetes prediction

Heart attak prediction

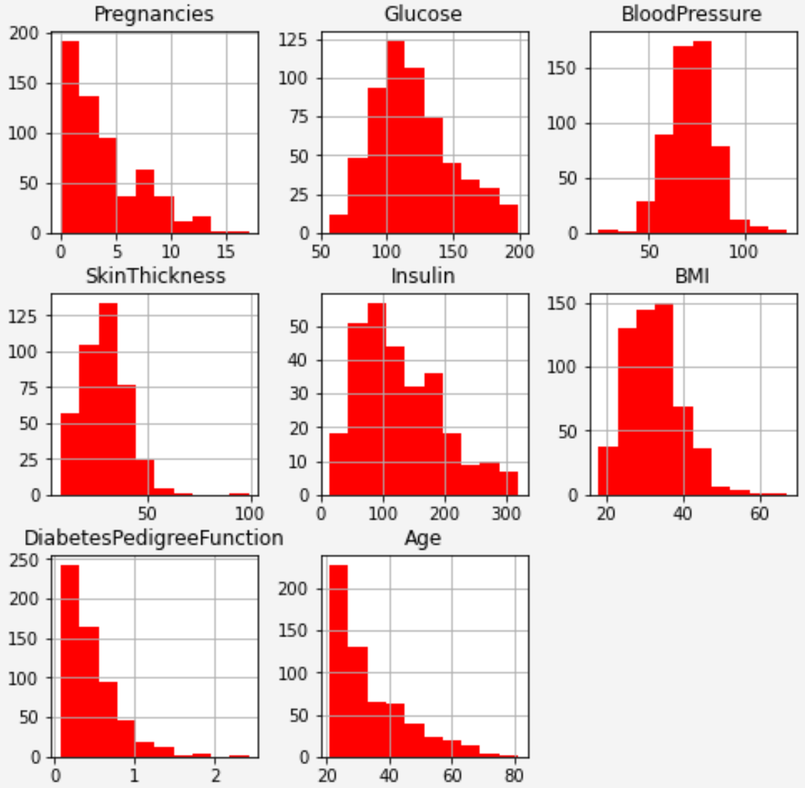
MNIST

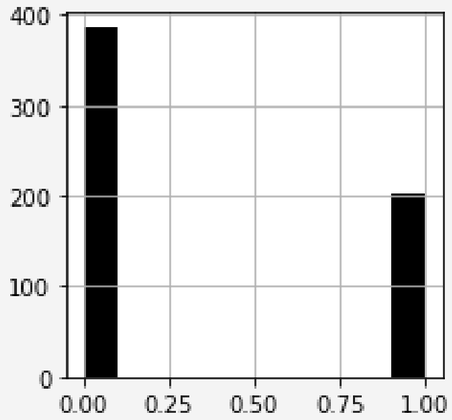
- EDA
- Classical method of classification
- SVM
- Random forest

Diabetes prediction

768 observations
9 variables

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1



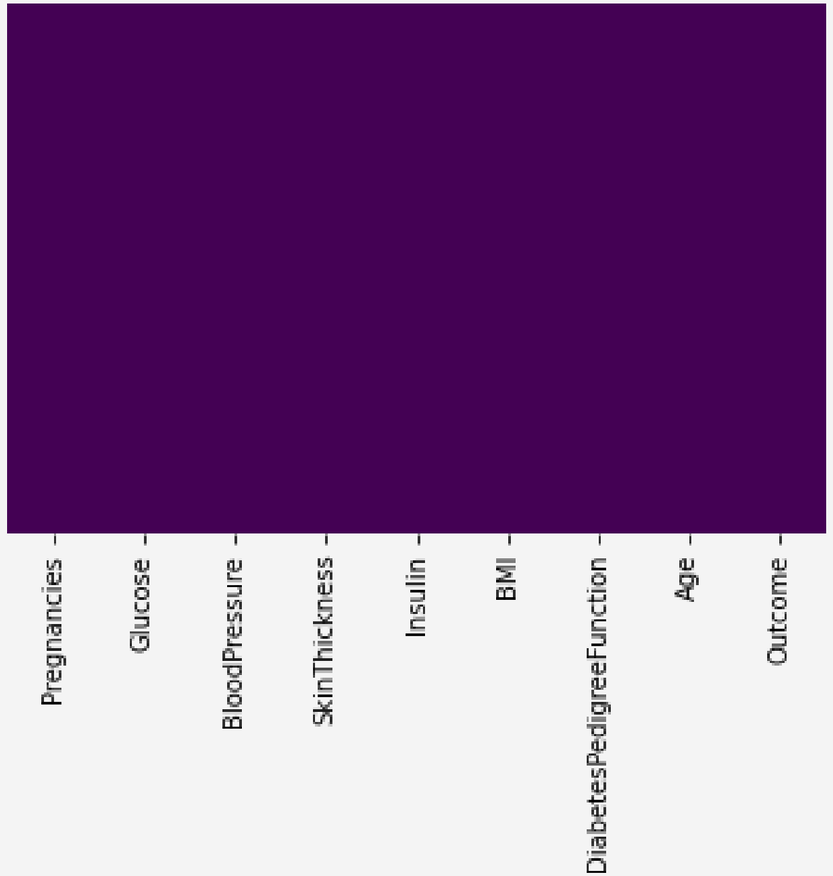


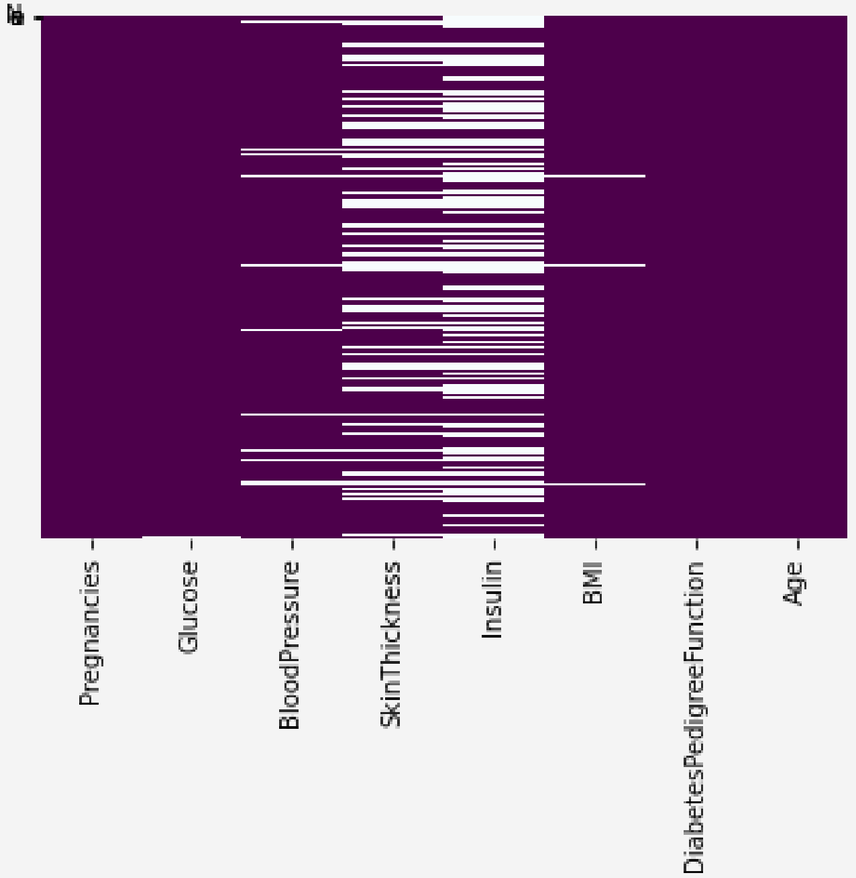
EDA

- Removing outliers
- Filling the missing values

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
count	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000
mean	3.845052	120.894531	69.105469	20.536458	79.799479	31.992578	0.471876	33.240885	0.348958
std	3.369578	31.972618	19.355807	15.952218	115.244002	7.884160	0.331329	11.760232	0.476951
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.078000	21.000000	0.000000
25%	1.000000	99.000000	62.000000	0.000000	0.000000	27.300000	0.243750	24.000000	0.000000
50%	3.000000	117.000000	72.000000	23.000000	30.500000	32.000000	0.372500	29.000000	0.000000
75%	6.000000	140.250000	80.000000	32.000000	127.250000	36.600000	0.626250	41.000000	1.000000
max	17.000000	199.000000	122.000000	99.000000	846.000000	67.100000	2.420000	81.000000	1.000000

Missing values

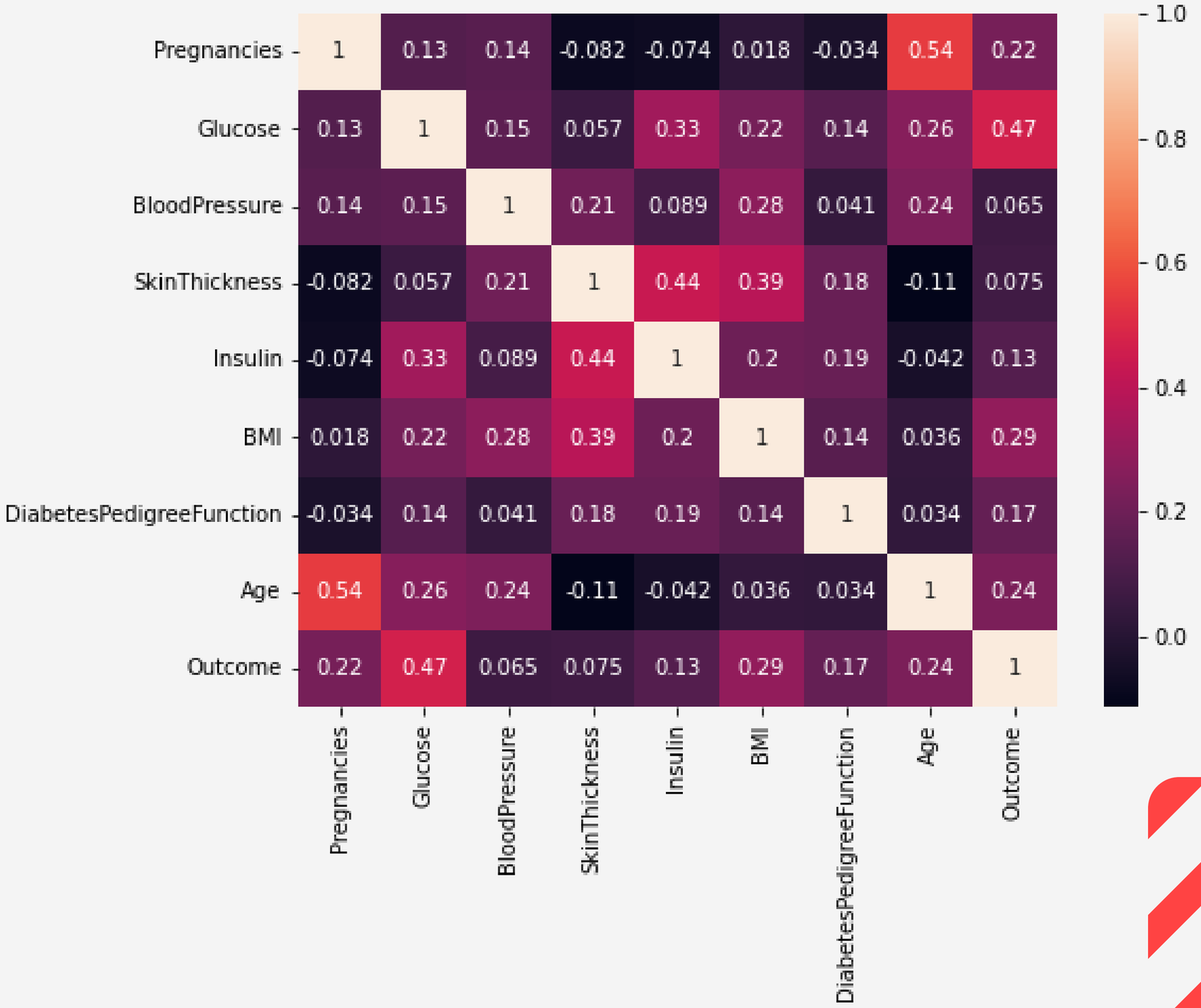




Standardization

```
[-0.53498699, -0.27205017, -0.53415007, ..., -1.08499402,
 -0.48781118, -0.77557037],
[-1.12751031, -0.40593694, -0.36341983, ..., -0.75115541,
  0.97088533, -0.09493526],
[ 1.53884464,  0.66515725,  1.85607334, ...,  0.03263958,
  0.80982093,  1.01109679],
```

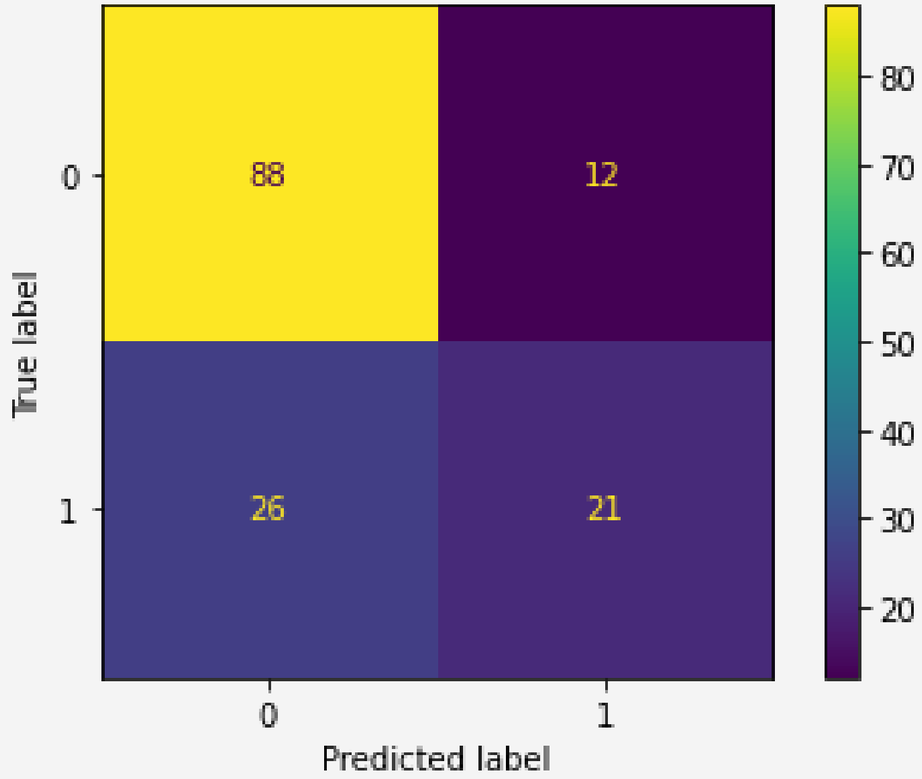
CORRELATION



Logistic Regression

Predict if a person has diabetes or not

	precision	recall	f1-score	support
0	0.77	0.88	0.82	100
1	0.64	0.45	0.52	47
accuracy			0.74	147
macro avg	0.70	0.66	0.67	147
weighted avg	0.73	0.74	0.73	147



SVM

linear	0.787
poly	0.798
rbf	0.827
sigmoid	0.674

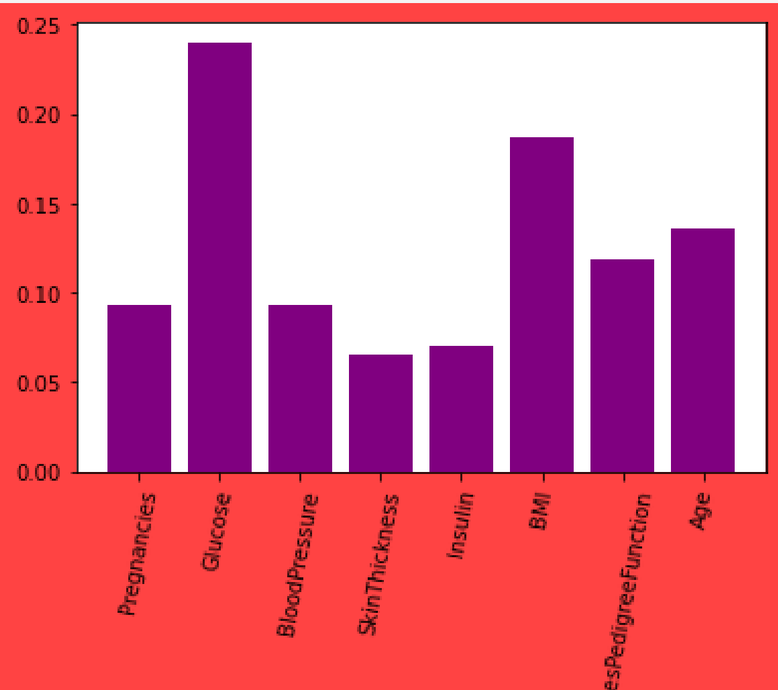
Accuracy scores for train

	precision	recall	f1-score	support
0	0.72	0.93	0.81	100
1	0.61	0.23	0.34	47
accuracy			0.71	147
macro avg	0.67	0.58	0.58	147
weighted avg	0.69	0.71	0.66	147

Random forest

	precision	recall	f1-score	support
0	0.72	0.92	0.81	135
1	0.77	0.43	0.55	86
accuracy			0.73	221
macro avg	0.74	0.67	0.68	221
weighted avg	0.74	0.73	0.71	221

Feature importance

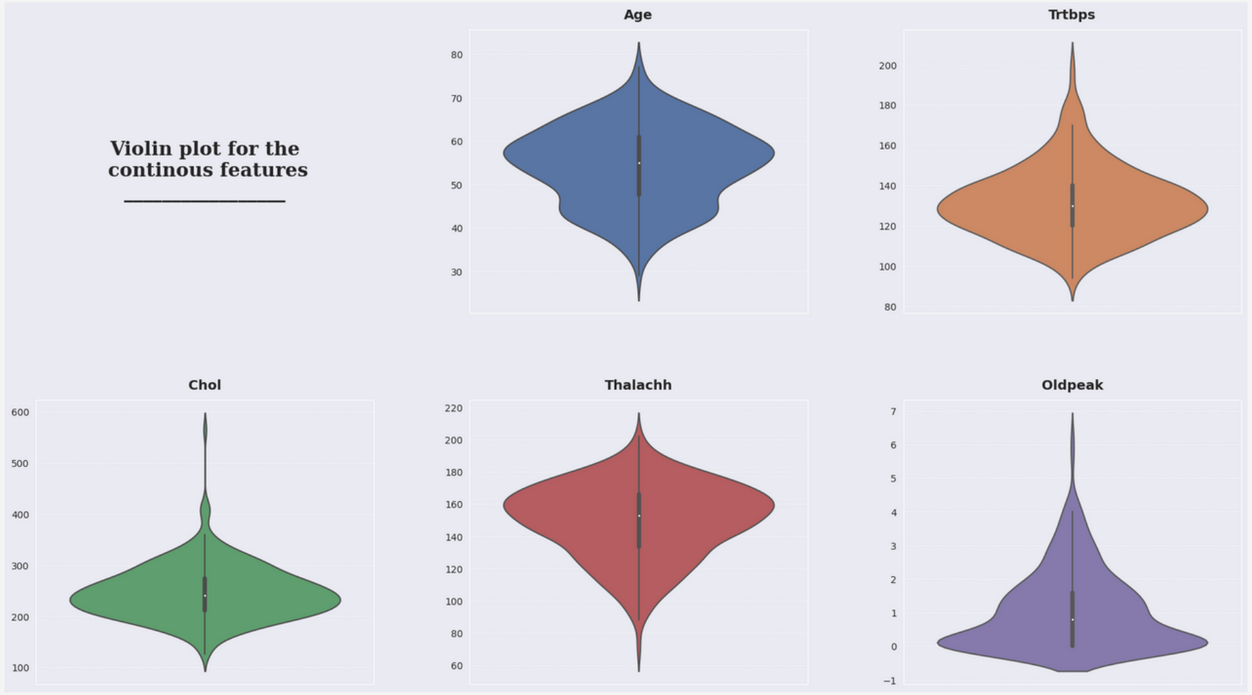


Feature	Importance
Pregnancies	0.09
Glucose	0.23
BloodPressure	0.09
SkinThickness	0.06
Insulin	0.06
BMI	0.18
DiabetesPedigreeFunction	0.11
Age	0.13

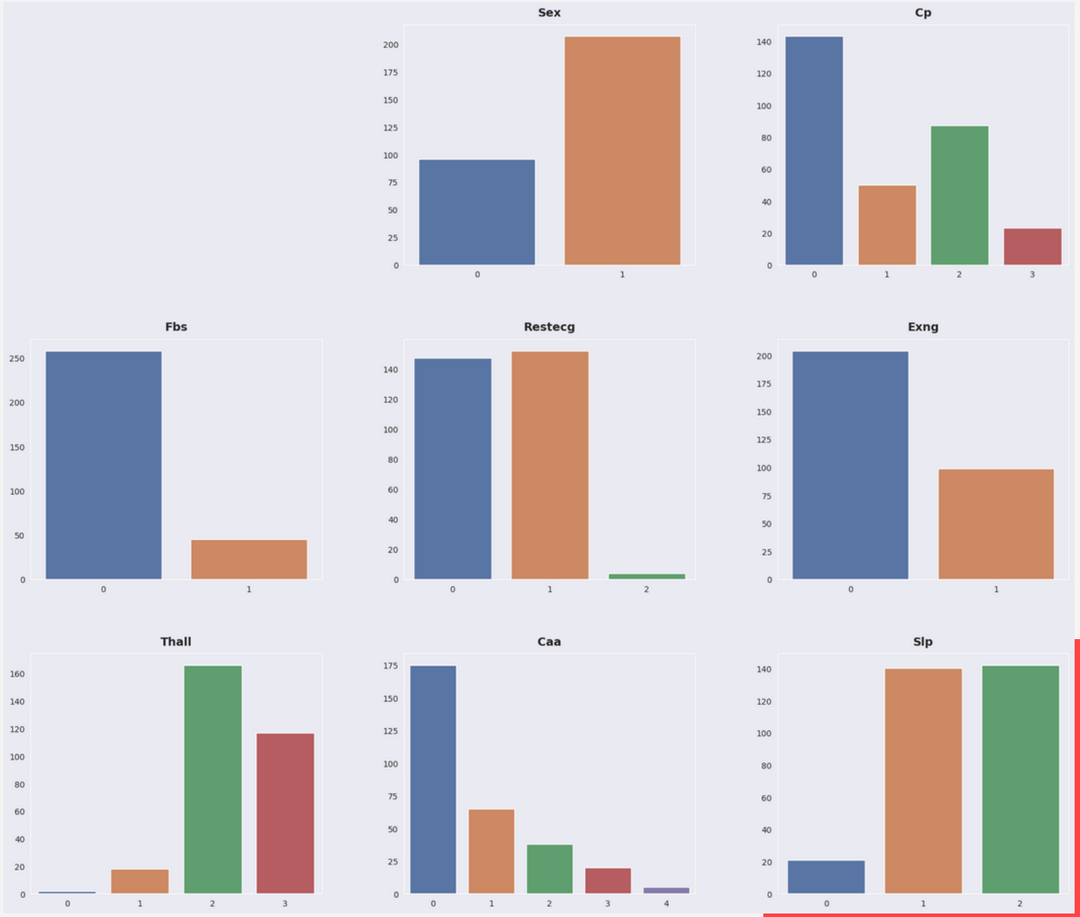
Heart attak prediction

303 observations
14 variables

	age	sex	cp	trtbps	chol	fbs	restecg	thalachh	exng	oldpeak	slp	caa	thall	output
0	63	1	3	145	233	1	0	150	0	2.3	0	0	1	1
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2	1
2	41	0	1	130	204	0	0	172	0	1.4	2	0	2	1
3	56	1	1	120	236	0	1	178	0	0.8	2	0	2	1
4	57	0	0	120	354	0	1	163	1	0.6	2	0	2	1



EDA



`cp` - Chest pain type

`trtbps` - Resting blood pressure (in mm Hg)

`chol` - Cholestoral in mg/dl

`fbs` - (fasting blood sugar > 120 mg/dl)

`restecg` - Resting electrocardiographic

`thalachh` - Maximum heart rate achieved

`oldpeak` - Previous peak

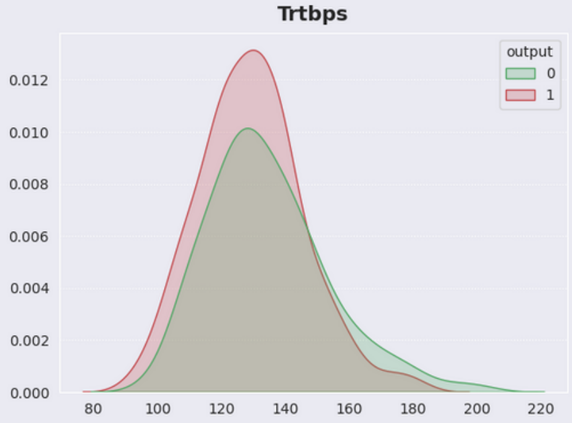
`slp` - Slope

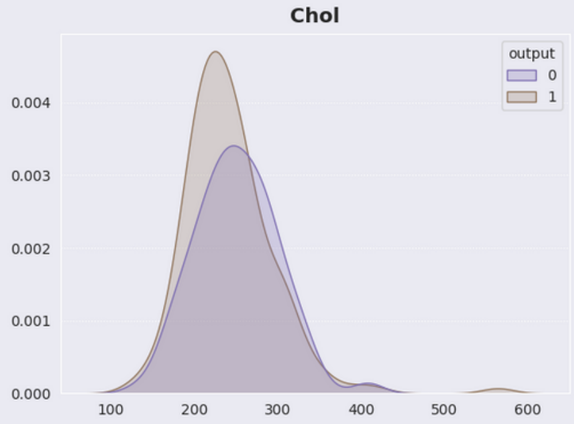
`caa` - Number of major vessels

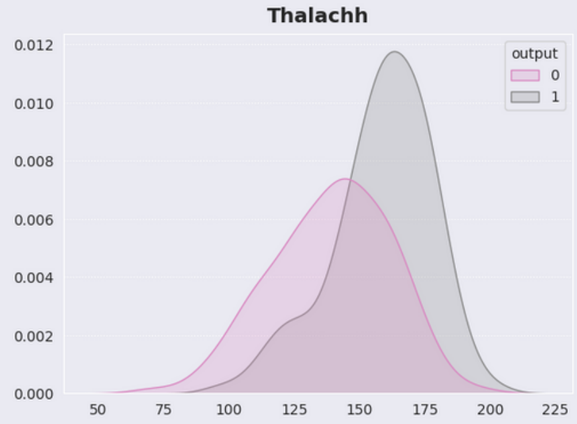
`thall` - Thalium Stress Test

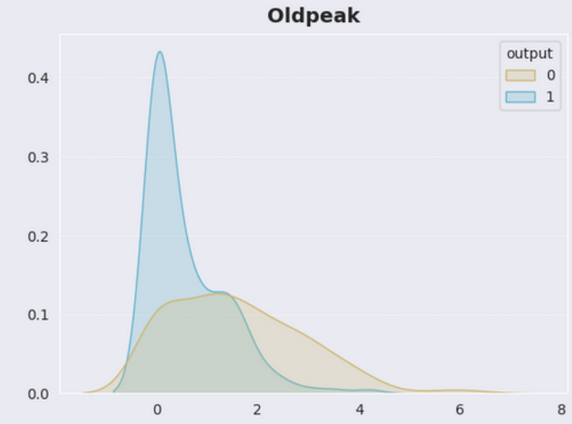
`exng` - Exercise induced angina

Distribution of continous variables by output

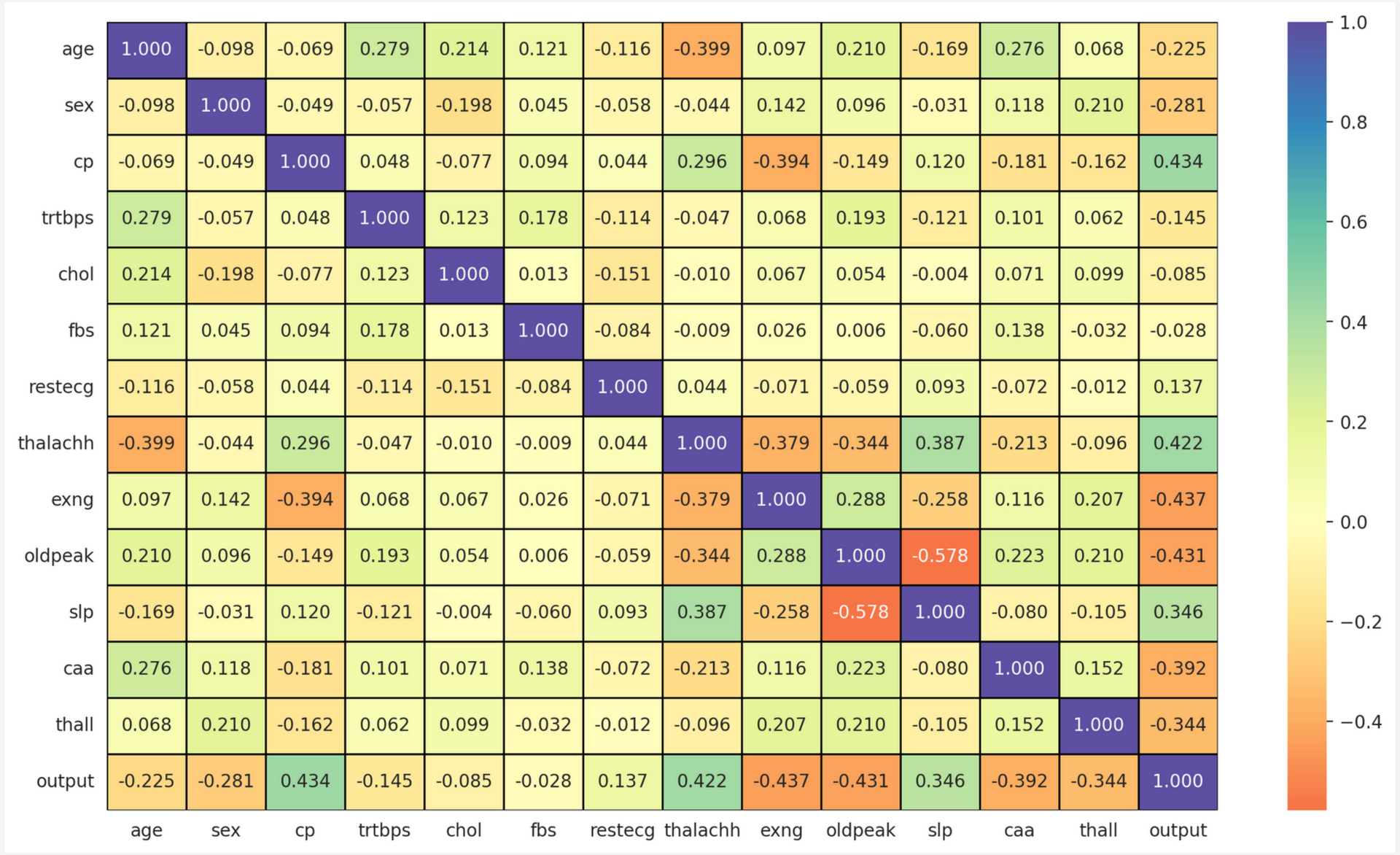




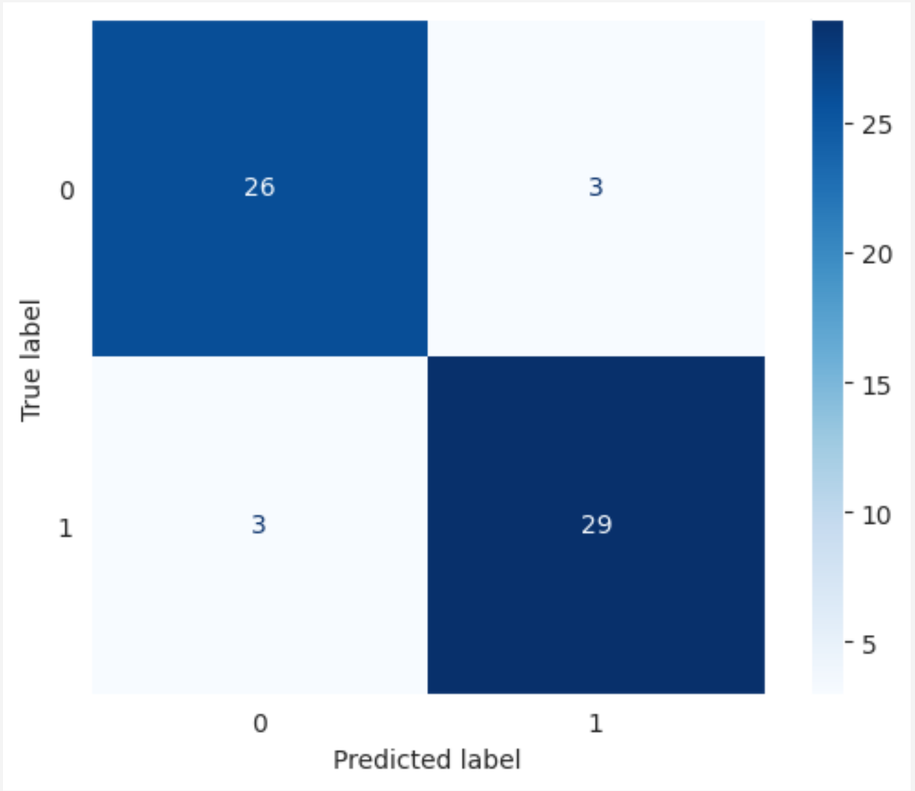




- Trtbps and Chol are not likely to have correlation.
- Age and Thalachh might have weak correlation.
- Oldpeak is likely to be correlated.

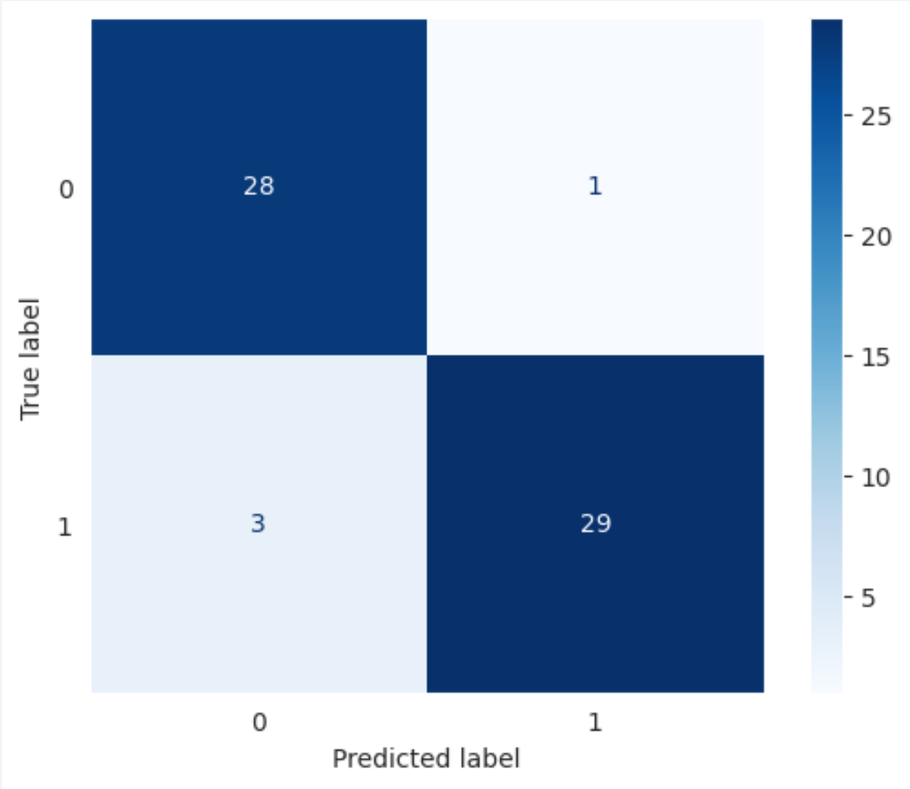

age 1.000 -0.098 -0.069 0.279 0.214 0.121 -0.116 -0.399 0.097 0.210 -0.169 0.276 0.068 -0.225
sex -0.098 1.000 -0.049 -0.057 -0.198 0.045 -0.058 -0.044 0.142 0.096 -0.031 0.118 0.210 -0.281
cp -0.069 -0.049 1.000 0.048 -0.077 0.094 0.044 0.296 -0.394 -0.149 0.120 -0.181 -0.162 0.434
trtbps 0.279 -0.057 0.048 1.000 0.123 0.178 -0.114 -0.047 0.068 0.193 -0.121 0.101 0.062 -0.145
chol 0.214 -0.198 -0.077 0.123 1.000 0.013 -0.151 -0.010 0.067 0.054 -0.004 0.071 0.099 -0.085
fbs 0.121 0.045 0.094 0.178 0.013 1.000 -0.084 -0.009 0.026 0.006 -0.060 0.138 -0.032 -0.028
restecg -0.116 -0.058 0.044 -0.114 -0.151 -0.084 1.000 0.044 -0.071 -0.059 0.093 -0.072 -0.012 0.137
thalachh -0.399 -0.044 0.296 -0.047 -0.010 -0.009 0.044 1.000 -0.379 -0.344 0.387 -0.213 -0.096 0.422
exng 0.097 0.142 -0.394 0.068 0.067 0.026 -0.071 -0.379 1.000 0.288 -0.258 0.116 0.207 -0.437
oldpeak 0.210 0.096 -0.149 0.193 0.054 0.006 -0.059 -0.344 0.288 1.000 -0.578 0.223 0.210 -0.431
slp -0.169 -0.031 0.120 -0.121 -0.004 -0.060 0.093 0.387 -0.258 -0.578 1.000 -0.080 -0.105 0.346
caa 0.276 0.118 -0.181 0.101 0.071 0.138 -0.072 -0.213 0.116 0.223 -0.080 1.000 0.152 -0.392
thall 0.068 0.210 -0.162 0.062 0.099 -0.032 -0.012 -0.096 0.207 0.210 -0.105 0.152 1.000 -0.344
output -0.225 -0.281 0.434 -0.145 -0.085 -0.028 0.137 0.422 -0.437 -0.431 0.346 -0.392 -0.344 1.000
age sex cp trtbps chol fbs restecg thalachh exng oldpeak slp caa thall output
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4

SVM



	precision	recall	f1-score	support
0	0.90	0.90	0.90	29
1	0.91	0.91	0.91	32
accuracy			0.90	61
macro avg	0.90	0.90	0.90	61
weighted avg	0.90	0.90	0.90	61

finding the optimal parameter values
by GridSearchCV



The best params are :
'C'(Regularization): 3
'gamma': 0.1

The test accuracy score of SVM after hyper-parameter tuning is 0.9344262295081968

	precision	recall	f1-score	support
0	0.90	0.97	0.93	29
1	0.97	0.91	0.94	32
accuracy			0.93	61
macro avg	0.93	0.94	0.93	61
weighted avg	0.94	0.93	0.93	61

Logistic Regression

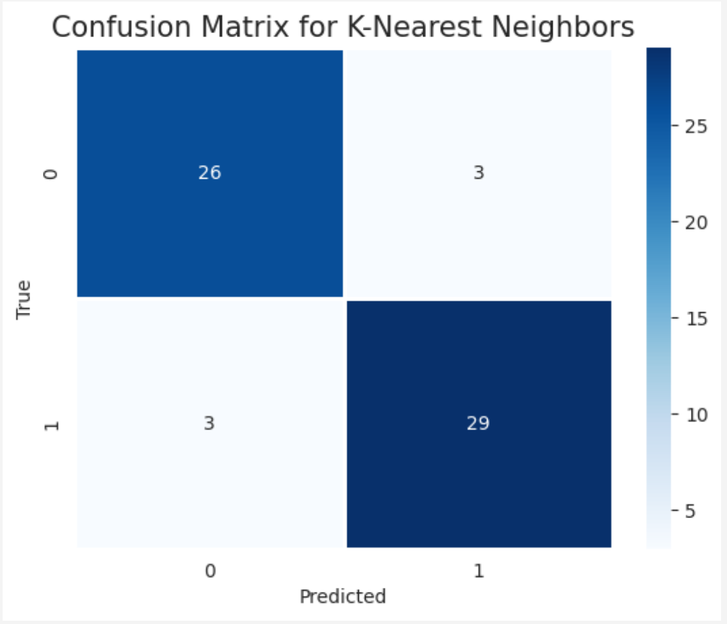
Accuracy: 0.96721
Precision: 1.0
Recall: 0.9375
F1: 0.96774

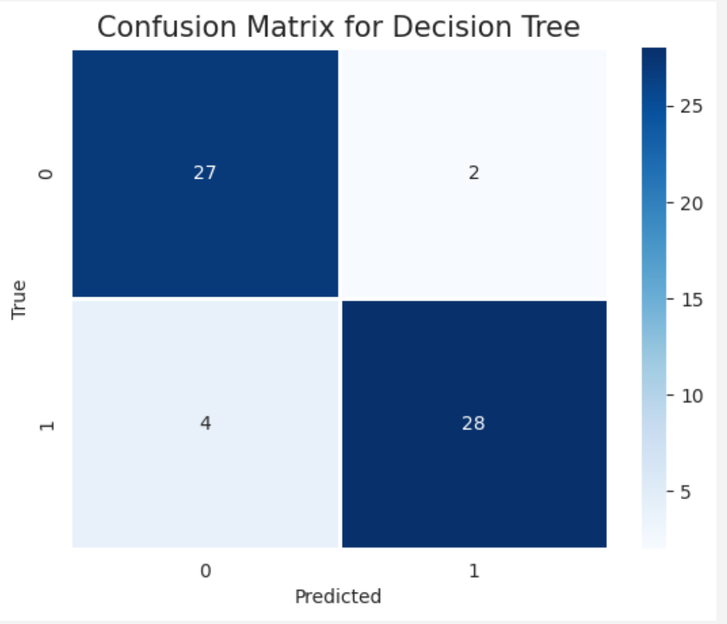
K-Nearest Neighbors

Accuracy: 0.90164
Precision: 0.90625
Recall: 0.90625
F1: 0.90625

Decision Tree

Accuracy: 0.90164
Precision: 0.93333
Recall: 0.875
F1: 0.90323

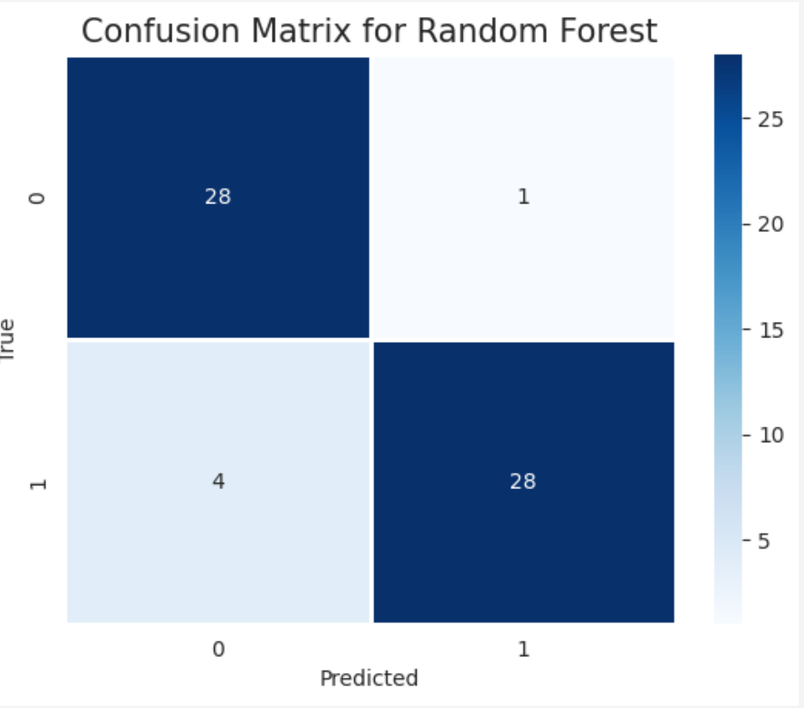


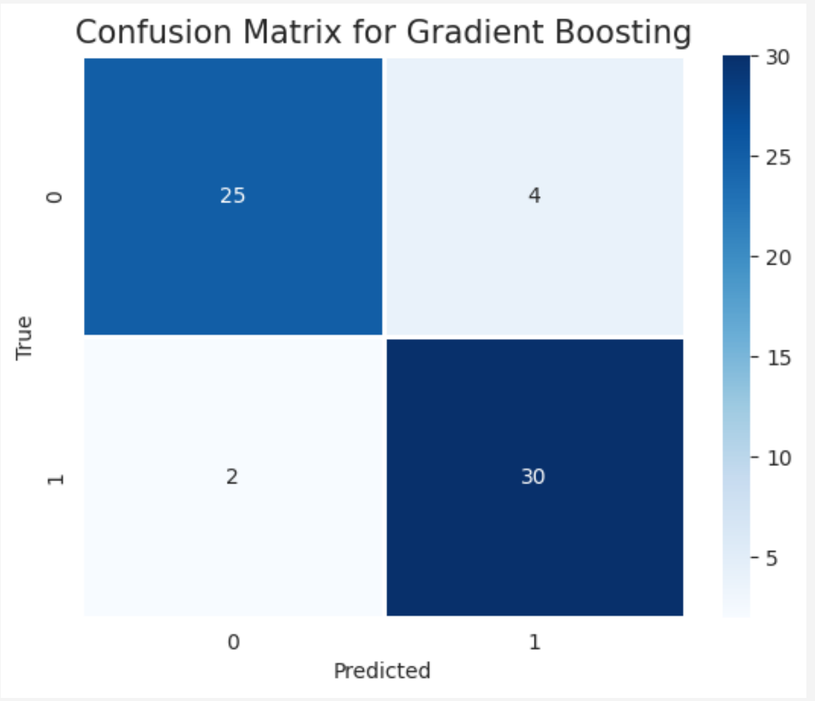


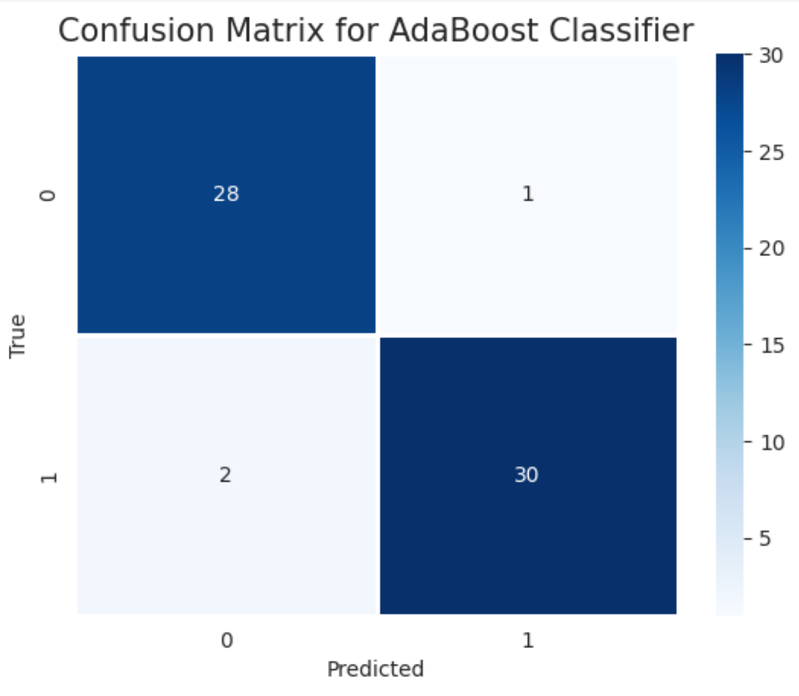
```
----------------------
 Random Forest
----------------------
Accuracy: 0.91803
Precision: 0.96552
Recall: 0.875
F1: 0.91803
```

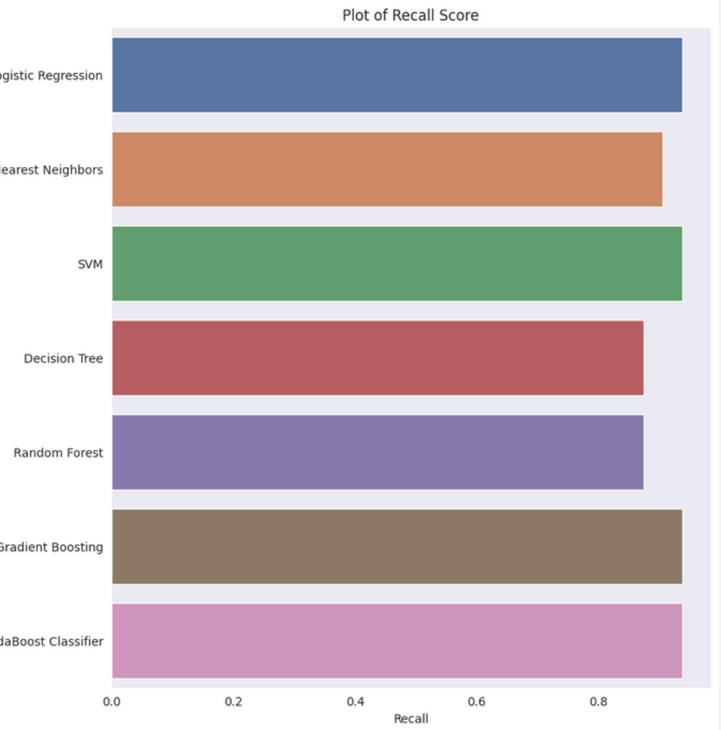
```
----------------------
 Gradient Boosting
----------------------
Accuracy: 0.90164
Precision: 0.88235
Recall: 0.9375
F1: 0.90909
```

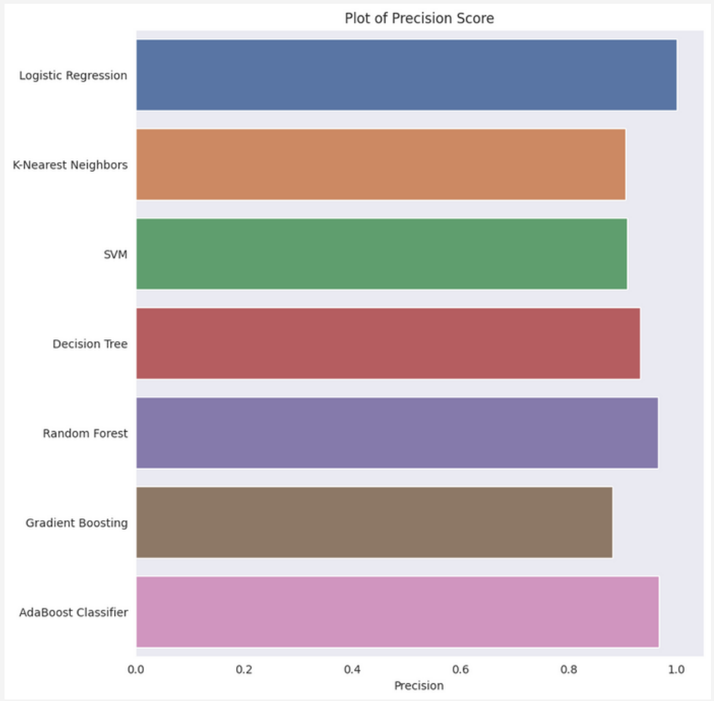
```
----------------------
 AdaBoost Classifier
----------------------
Accuracy: 0.95082
Precision: 0.96774
Recall: 0.9375
F1: 0.95238
```

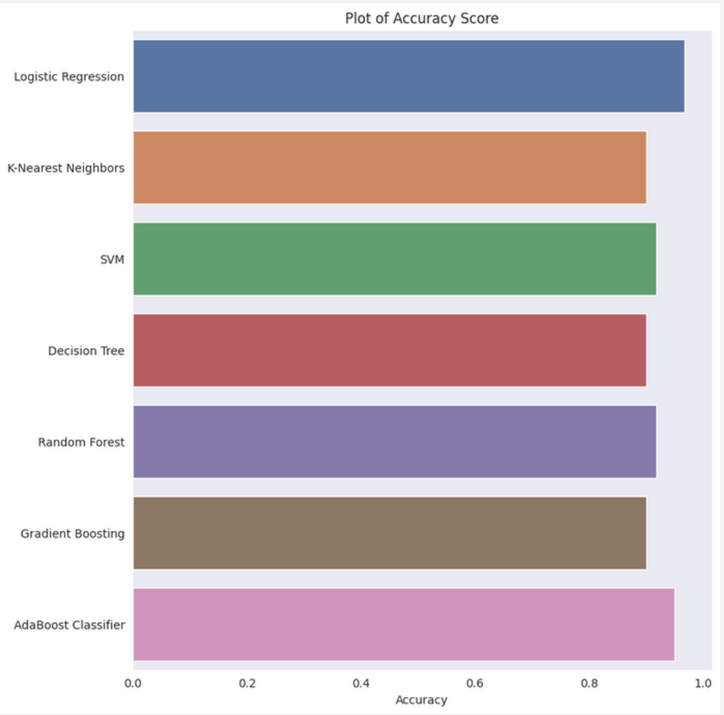


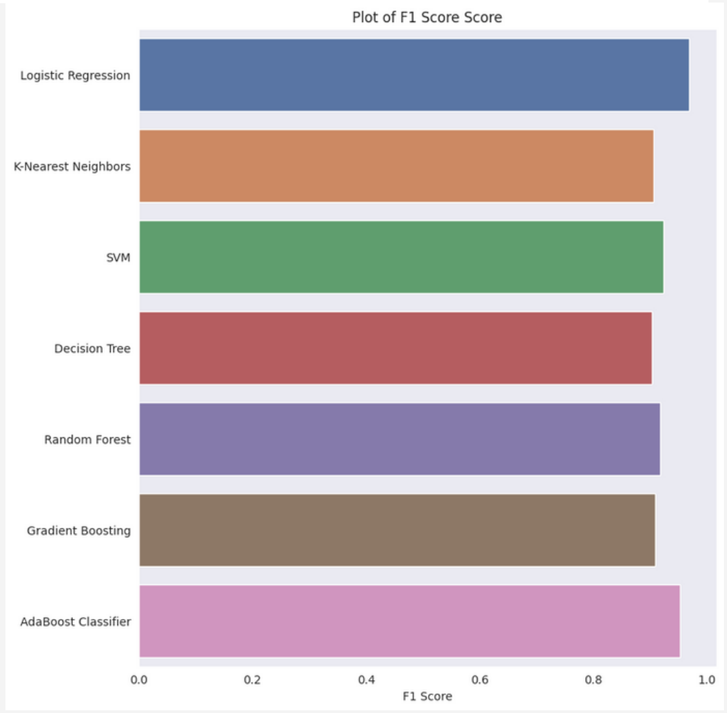








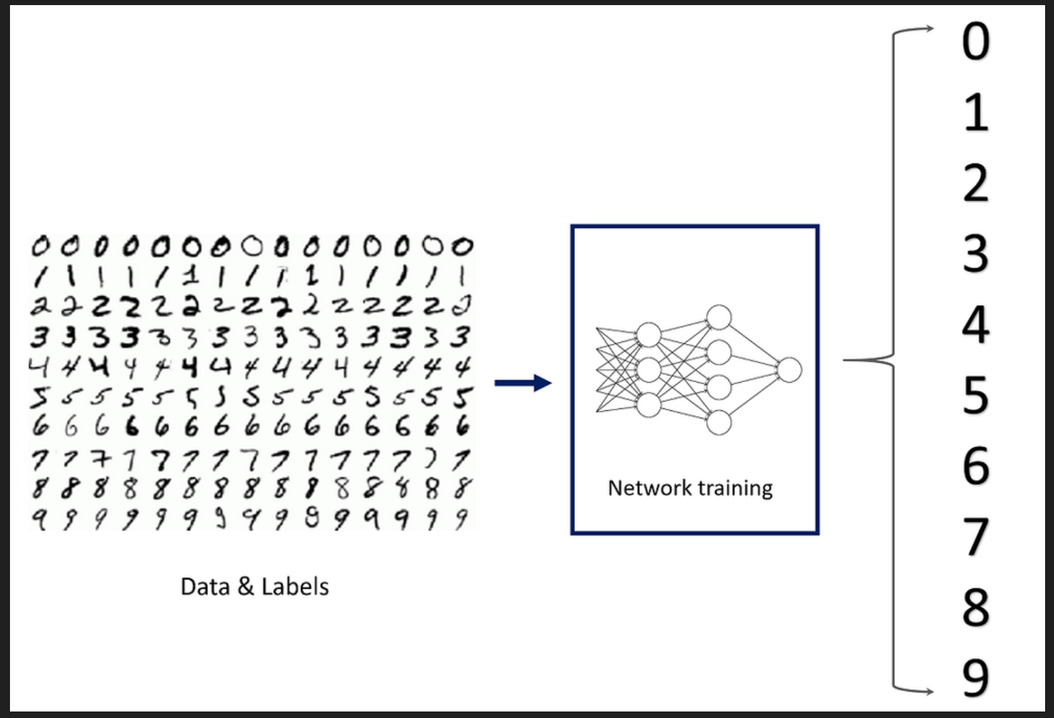


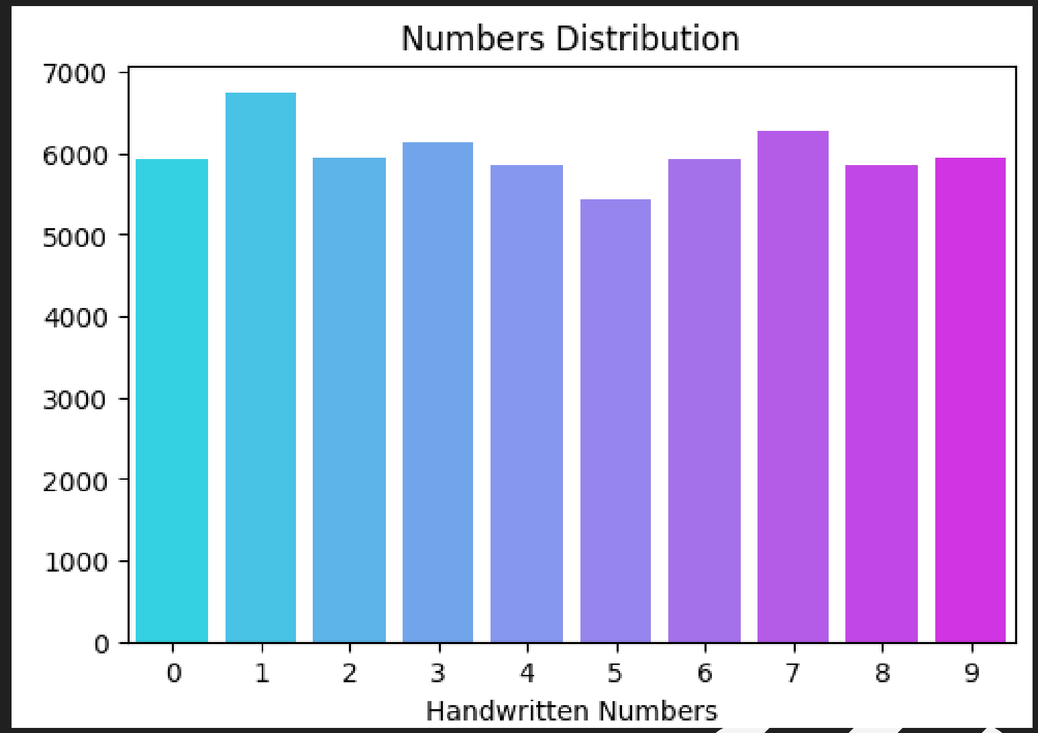


The best ones were (AdaBoost, SVM and Logistic Regression)

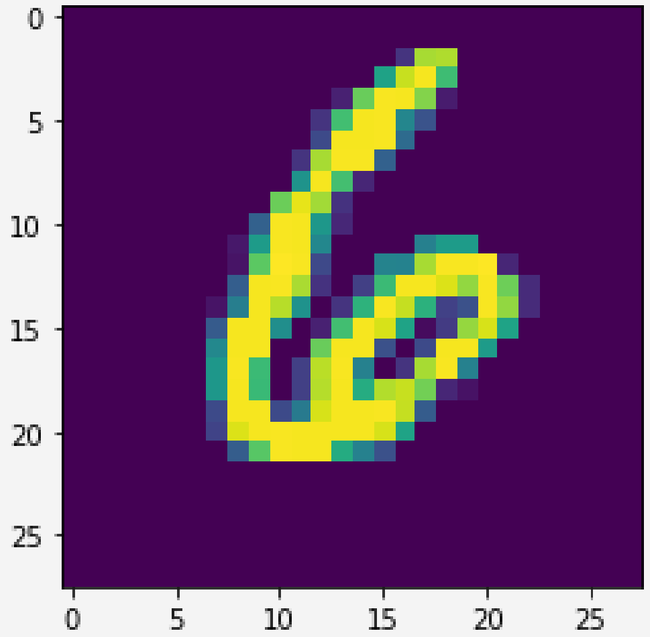
Image classification - MNIST dataset

60000 observations
10 labels





EDA



visualization of the sample image at index 7777

- Reshaping and normalizing the image
- Using scaler transform for SVM

```
X_train = X_train/255
X_test = X_test/255
```

```
test.shape
```

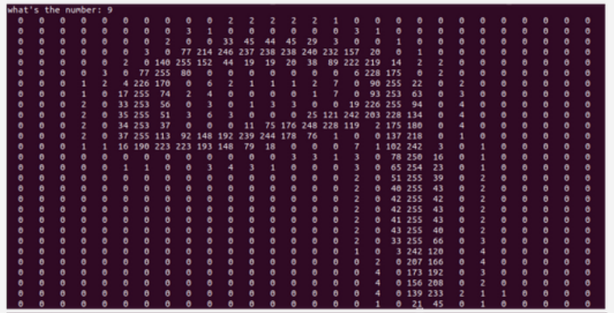
```
(1155, 785)
```

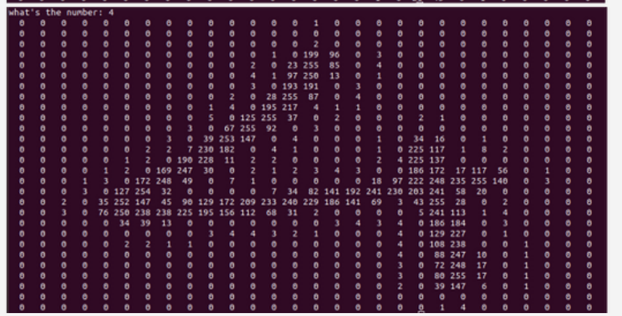
```
training_dataset_x.shape
```

```
(60000, 784)
```

```
test_dataset_x.shape
```

```
(10000, 784)
```



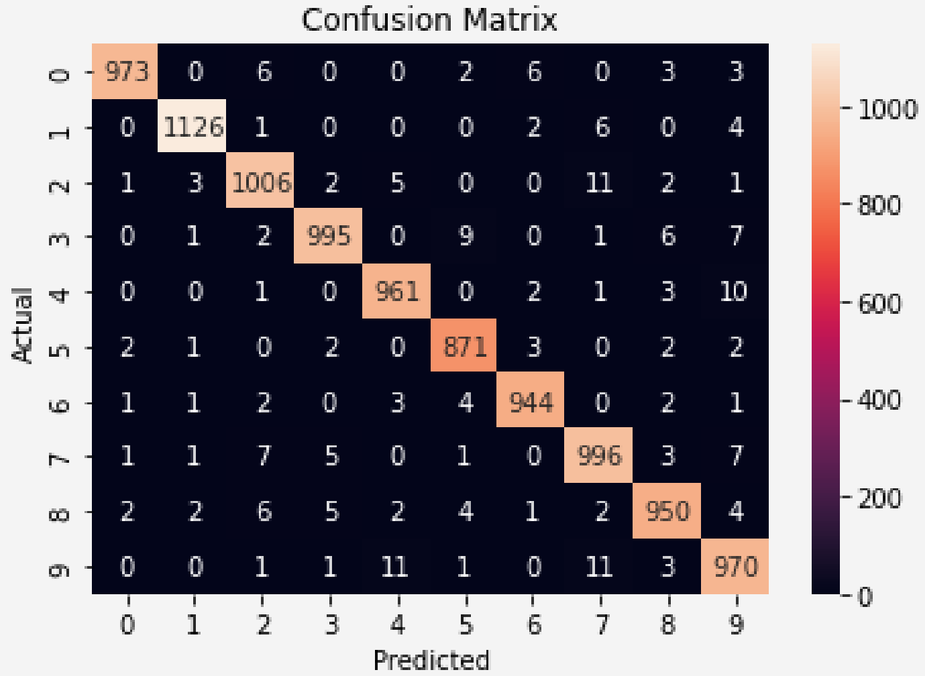


SVM

RBF kernel

```
#svm w RBF kernel
rbf_svm = svm.SVC(kernel='rbf')
rbf_svm.fit(training_dataset_x, y_train)
```

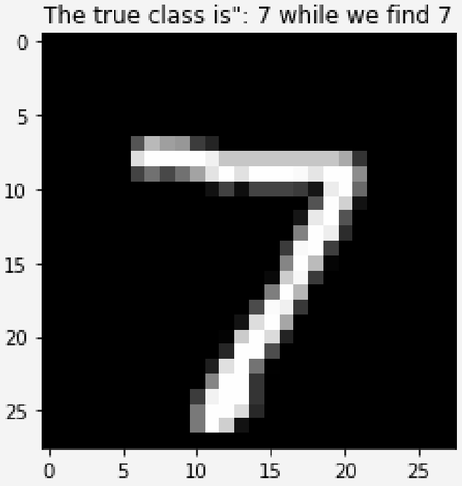
```
SVC()
```



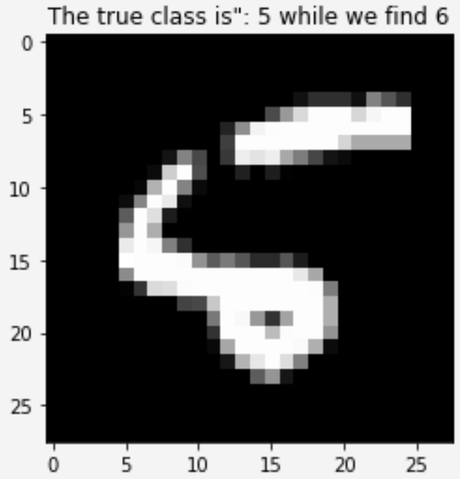

```
#the accuracy score of the model

accuracy_score(y_pred, y_test)
```

```
0.9792
```

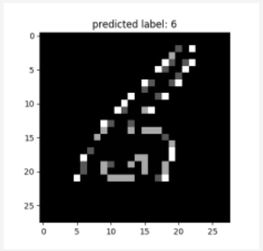
SVM

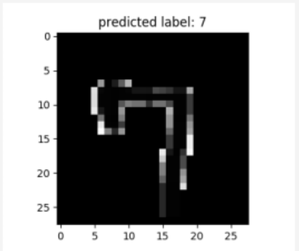


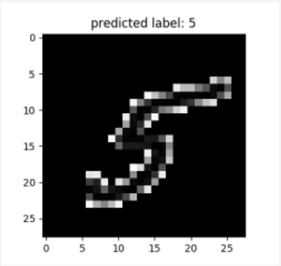
a case that the model correctly classified

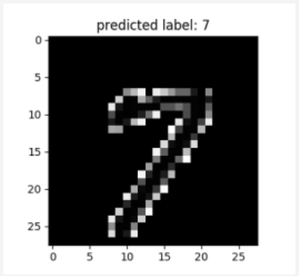


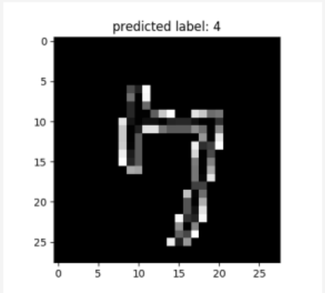
a case that the model misclassified

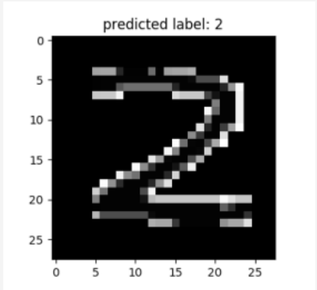












Random Forest

Metrics

Accuracy score -90.6

```
#training random Forest
rf=RandomForestClassifier(n_estimators=100)
rf.fit(training_dataset_x,training_dataset_y)
```

```
RandomForestClassifier()
```

```
Classification Report
              precision    recall  f1-score   support

           0       0.99      0.97      0.98       980
           1       1.00      0.98      0.99      1135
           2       0.99      0.89      0.94      1032
           3       1.00      0.87      0.93      1010
           4       0.99      0.89      0.94       982
           5       1.00      0.86      0.92       892
           6       1.00      0.93      0.96       958
           7       0.99      0.91      0.95      1028
           8       0.99      0.83      0.90       974
           9       0.99      0.89      0.93      1009

   micro avg       0.99      0.90      0.95     10000
   macro avg       0.99      0.90      0.94     10000
weighted avg       0.99      0.90      0.95     10000
 samples avg       0.90      0.90      0.90     10000
```

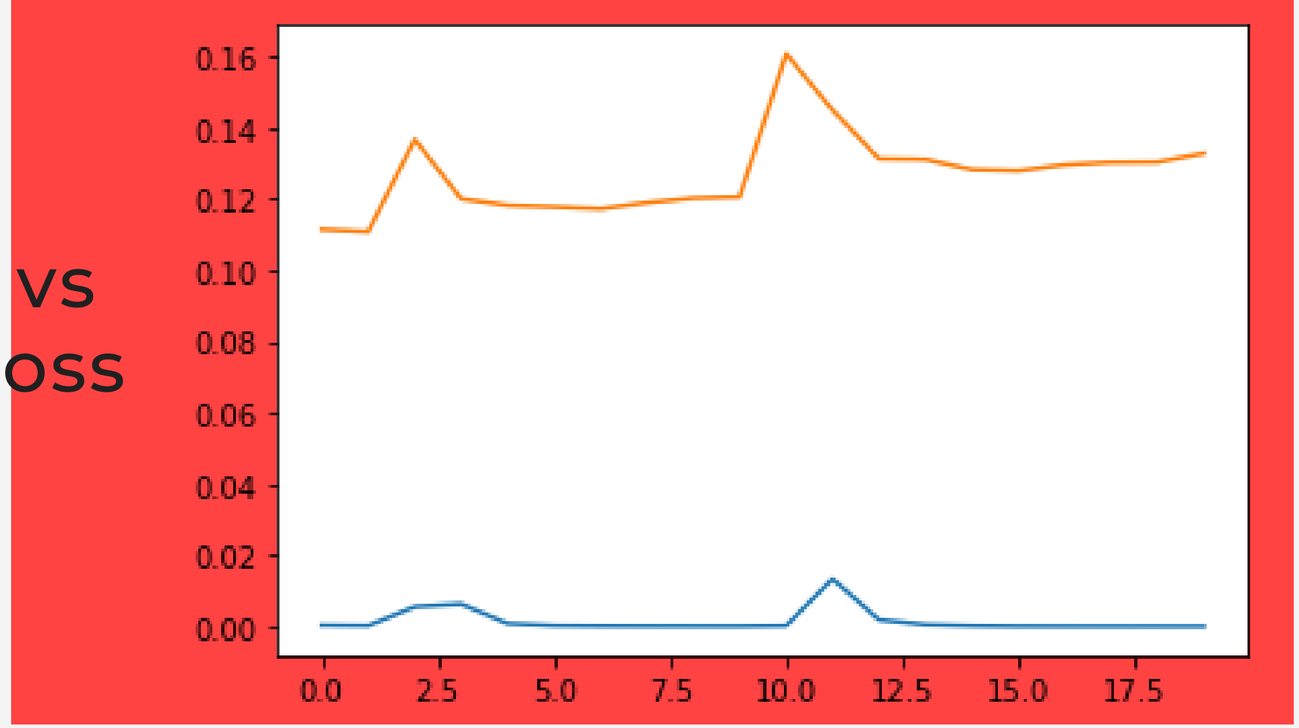
Sequential

Accuracy scores for train

```
history = model.fit(X_train, y_train, batch_size = 64, epochs = 20, verbose = 1, validation_split = 0.2)
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 flatten_1 (Flatten)         (None, 784)               0

 dense (Dense)               (None, 128)               100480

 dense_1 (Dense)             (None, 10)                1290

=================================================================
Total params: 101,770
Trainable params: 101,770
Non-trainable params: 0
_________________________________________________________________
```

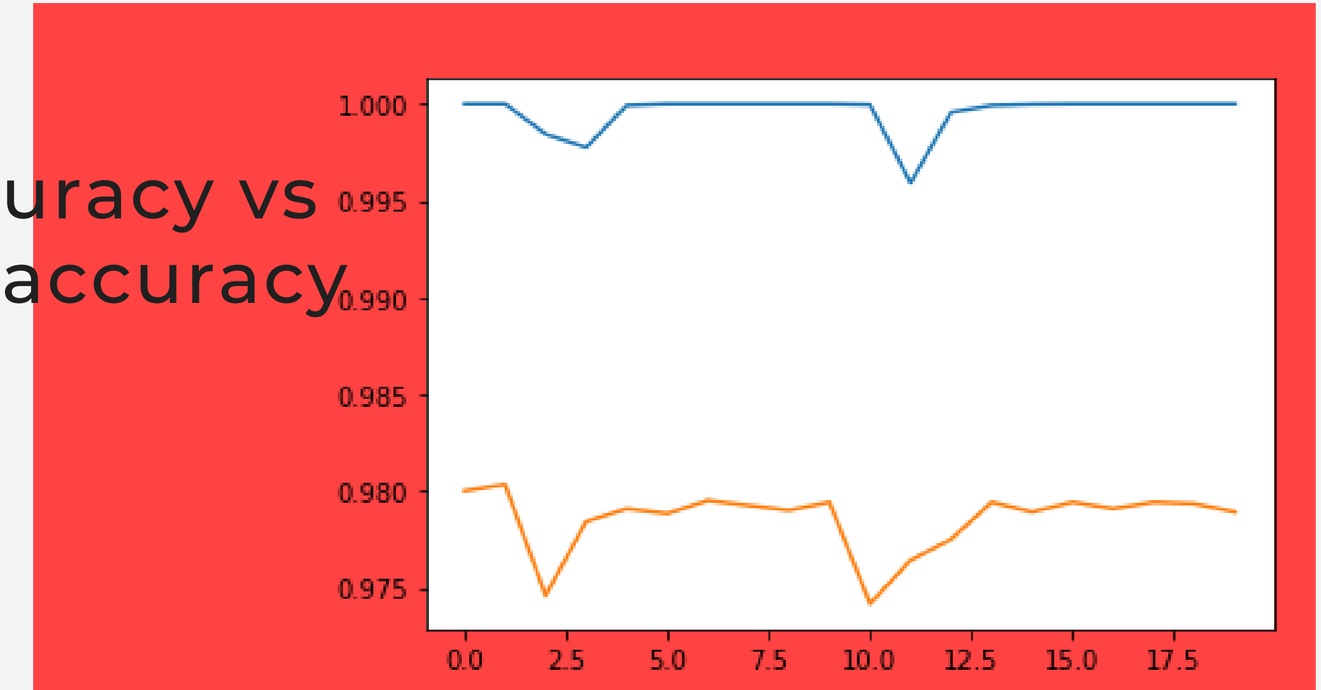
loss vs
val loss




```
predictions
```

```
array([[0, 0, 0, ..., 1, 0, 0],
       [0, 0, 1, ..., 0, 0, 0],
       [0, 1, 0, ..., 0, 0, 0],
       ...,
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0]], dtype=int32)
```

accuracy vs
val accuracy




```
- 2s 2ms/step - loss: 0.0056 - accuracy: 0.9984 - val_loss: 0.1368 - val_accuracy: 0.9746
- 2s 2ms/step - loss: 0.0064 - accuracy: 0.9977 - val_loss: 0.1201 - val_accuracy: 0.9784
```

example metric


Thank you for
your
attention!