Project 1 part 2

October 12, 2022

[2]:
```
import numpy as np
import pandas as pd
from numpy.random import default_rng

from sklearn.datasets import make_classification, load_digits
from sklearn.linear_model import LogisticRegression, Ridge, Lasso
from sklearn.metrics import roc_curve, roc_auc_score, log_loss,␣
↪confusion_matrix, accuracy_score, r2_score
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.preprocessing import StandardScaler
from sklearn import svm
from sklearn.model_selection import GridSearchCV
from sklearn.svm import SVC

import matplotlib
import matplotlib.pyplot as plt
import seaborn as sns

%matplotlib inline
np.set_printoptions(suppress=True, precision=3)

import warnings
warnings.filterwarnings('ignore')
```

[109]:
```
from numpy import mean
from numpy import std
from sklearn.datasets import make_classification
from sklearn.model_selection import KFold
from sklearn.model_selection import cross_val_score
from sklearn.linear_model import LogisticRegression, LogisticRegressionCV
```

[239]:
```
#importing files
x_trains = np.loadtxt('troudress_train_x.csv', delimiter=',', skiprows=1)
x_tests = np.loadtxt('troudress_test_x.csv', delimiter=',', skiprows=1)

y_trains = np.loadtxt('troudress_train_y.csv', delimiter=',', skiprows=1)
```

[65]:
```python
#importing files as df's
X_train = pd.read_csv('troudress_train_x.csv')
X_test = pd.read_csv('troudress_test_x.csv')

Y_train = pd.read_csv('troudress_train_y.csv')
```

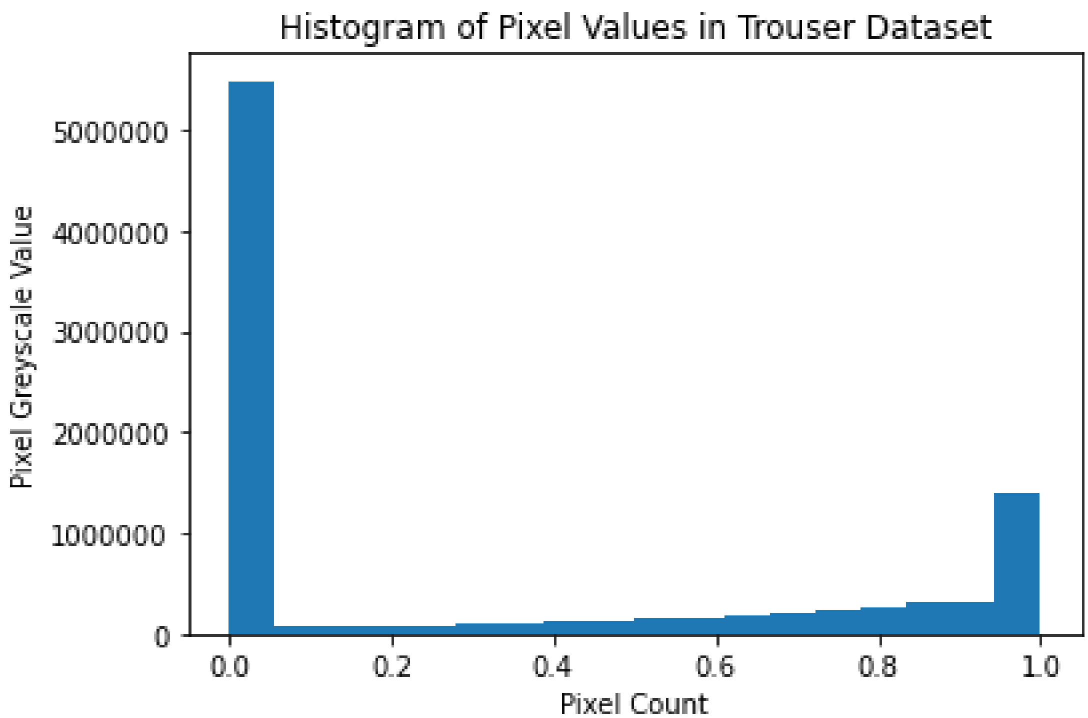
[66]:
```python
shirts_df = pd.concat([X_train, Y_train], axis=1)
shirts_df
```

[66]:
```
       pixel000  pixel001  pixel002  pixel003  pixel004  pixel005  pixel006  \
0           0.0       0.0       0.0       0.0       0.0       0.0       0.0
1           1.0       0.0       0.0       0.0       0.0       0.0       1.0
2           0.0       0.0       0.0       0.0       0.0       1.0       0.0
3           0.0       1.0       0.0       0.0       0.0       0.0       1.0
4           0.0       1.0       0.0       0.0       1.0       1.0       0.0
…          …        …        …        …        …        …        …
11995       0.0       0.0       0.0       0.0       0.0       0.0       0.0
11996       0.0       0.0       0.0       0.0       0.0       0.0       1.0
11997       1.0       0.0       0.0       0.0       0.0       1.0       0.0
11998       1.0       0.0       0.0       0.0       0.0       0.0       0.0
11999       0.0       0.0       0.0       0.0       0.0       0.0       0.0

       pixel007  pixel008  pixel009  …  pixel775  pixel776  pixel777  \
0           0.0    0.0000    0.0522  …       0.0    1.0000       0.0
1           0.0    1.0000    0.0000  …       0.0    1.0000       1.0
2           0.0    0.0000    1.0000  …       1.0    0.0000       1.0
3           0.0    1.0000    0.0080  …       0.0    0.0078       0.0
4           0.0    0.0000    1.0000  …       0.0    0.0000       0.0
…          …        …      …  …        …        …        …
11995       0.0    1.0000    0.1176  …       0.0    1.0000       0.0
11996       1.0    0.0129    0.1928  …       0.0    1.0000       1.0
11997       0.0    0.0000    0.0000  …       0.0    0.0000       0.0
11998       0.0    0.0000    0.0000  …       0.0    0.0000       0.0
11999       0.0    1.0000    0.0000  …       1.0    0.0000       0.0

       pixel778  pixel779  pixel780  pixel781  pixel782  pixel783  is_trousers
0           0.0       0.0       0.0       0.0       0.0       0.0            0
1           0.0       0.0       0.0       1.0       0.0       1.0            1
2           0.0       0.0       1.0       0.0       1.0       0.0            1
3           0.0       1.0       0.0       0.0       0.0       0.0            0
4           0.0       0.0       0.0       0.0       0.0       0.0            1
…          …        …        …        …        …        …        …
11995       0.0       0.0       0.0       0.0       0.0       0.0            1
11996       0.0       0.0       0.0       0.0       0.0       0.0            0
11997       0.0       0.0       0.0       0.0       1.0       1.0            1
11998       1.0       0.0       0.0       0.0       0.0       1.0            0
11999       0.0       0.0       0.0       0.0       0.0       0.0            0
```

[12000 rows x 785 columns]

[67]:
```
import numpy as np
import matplotlib.pyplot as plt
## MAKE A HIST OF DF TO SEE GRAYSCALE FREQUENCY
```

[68]:
```
# configure and draw the histogram figure
plt.hist(shirts_df.to_numpy().flatten(),  bins=18)
plt.title('Histogram of Pixel Values in Trouser Dataset')
plt.ticklabel_format(style='plain')
plt.xlabel('Pixel Count')
plt.ylabel('Pixel Greyscale Value')
plt.show()
```



[69]:
```
X = shirts_df.drop('is_trousers', axis=1)
y = shirts_df.is_trousers
```

[84]:
```
#due to comp power fold not optimised but split is
listsplit = [.1,.2,.3,.4,.5,.6,.7,.8,.9]
scores = list()
split = list()
loss = list()
```

```
#find best k fold slpit number
for s in listsplit:
    # prepare the cross-validation procedure
    Xtrain, Xtest, ytrain, ytest = train_test_split(X, y, test_size=s,␣
 ↪random_state=0)
    # create model
    model = LogisticRegression()
    #fit
    model.fit(Xtrain, ytrain)
    ypred = model.predict(Xtest)
    # evaluate model
    scores.append(accuracy_score(ytest, ypred))
    # report performance
    split.append(s)
    # log loss
    loss.append(log_loss(ytest ,model.predict_proba(Xtest)))

len(split), len(scores), len(loss)
```

[84]: (9, 9, 9)

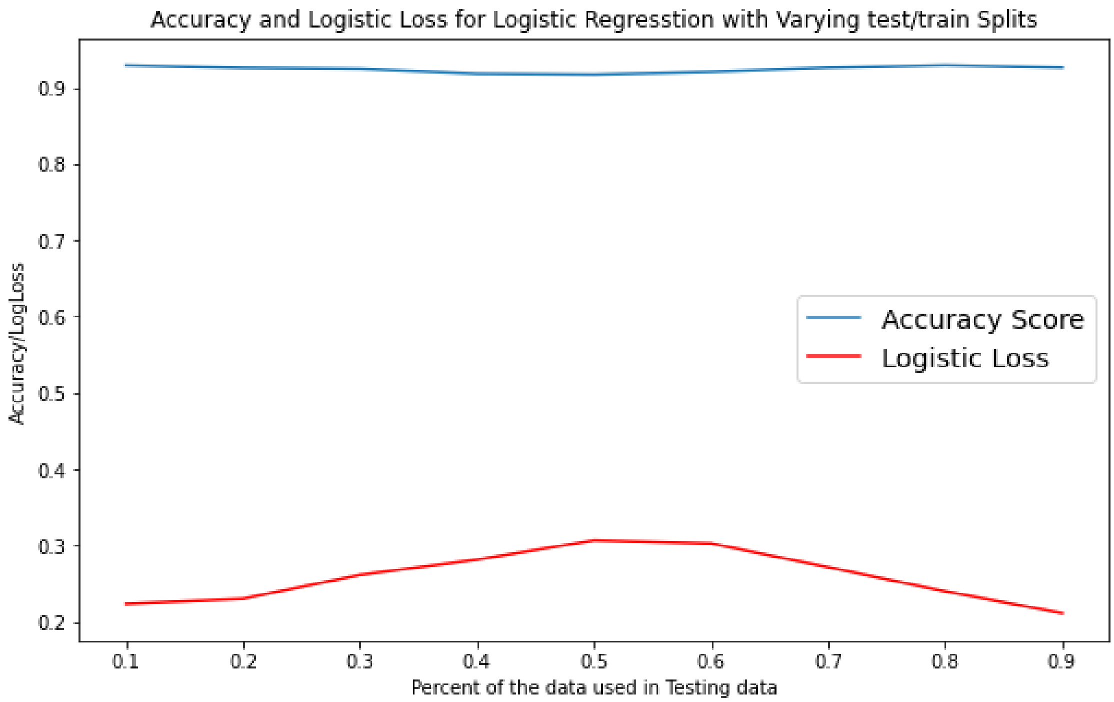
[88]:
```
d = {'Split':split , 'Accuracy':scores, 'LogLoss':loss}
df = pd.DataFrame(d)

df = df.sort_values(by=['Split'])
df
```

[88]:

	Split	Accuracy	LogLoss
0	0.1	0.929167	0.223804
1	0.2	0.925833	0.230370
2	0.3	0.924444	0.261559
3	0.4	0.918125	0.281587
4	0.5	0.917000	0.306782
5	0.6	0.920556	0.302784
6	0.7	0.926071	0.271704
7	0.8	0.929271	0.240096
8	0.9	0.926296	0.211566

[97]:
```
# TODO make plot
plt.figure(figsize=(10,6))
plt.plot(split, scores)
plt.plot(split, loss, color='red')
# TODO add legend, titles, etc.
####plt.xscale('plt.xscale('log')')
plt.title('Accuracy and Logistic Loss for Logistic Regresstion with Varying␣
 ↪test/train Splits')
plt.legend(['Accuracy Score', 'Logistic Loss'], fontsize='x-large')
```

```
plt.xlabel('Percent of the data used in Testing data');
plt.ylabel('Accuracy/LogLoss');
plt.show()
```



[90]:
```
df['Accuracy'].idxmax() #7 0.8        0.929271        0.240096
df['LogLoss'].idxmin() #8
```

[90]: 8

[242]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=0)
#Splitting the data into training and testing (70% Train and 30% Test)
```

[122]:
```
## k fold testing
k_fold = list()
scores = list()
loss = list()
stdd = list()

#find best k fold slpit number
    # prepare the cross-validation procedure
Xtrain, Xtest, ytrain, ytest = train_test_split(X, y, test_size=.2,␣
 ↪random_state=0)
    # create model
```

```
for k in list(range(2,12)):
    model = LogisticRegressionCV(cv=k, random_state=0)
    #fit
    model.fit(Xtrain, ytrain)
    # evaluate model
    scores.append(mean(accuracy_score(ytest, model.predict(Xtest))))
    stdd.append(std(accuracy_score(ytest, model.predict(Xtest))))
    # report performance
    k_fold.append(k)
    # log loss
    loss.append(log_loss(ytest ,model.predict_proba(Xtest)))

len(k_fold), len(scores), len(loss)
```

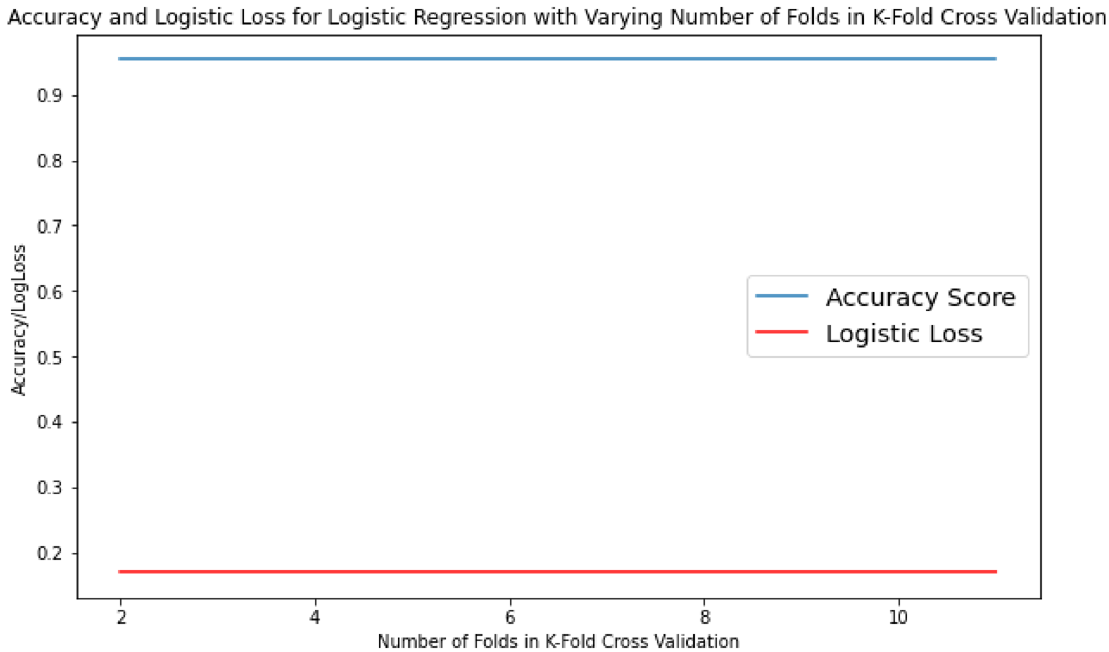
[122]: (10, 10, 10)

[123]:
```
d = {'K-fold':k_fold , 'Accuracy':scores, 'LogLoss':loss, 'STD':stdd}
df1 = pd.DataFrame(d)

df1 = df1.sort_values(by=['K-fold'])
df1
```

[123]:

	K-fold	Accuracy	LogLoss	STD
0	2	0.953333	0.170084	0.0
1	3	0.953333	0.170085	0.0
2	4	0.953333	0.170087	0.0
3	5	0.953333	0.170084	0.0
4	6	0.953333	0.170084	0.0
5	7	0.953333	0.170084	0.0
6	8	0.953333	0.170085	0.0
7	9	0.953333	0.170086	0.0
8	10	0.953333	0.170088	0.0
9	11	0.953333	0.170088	0.0

[126]:
```
# TODO make plot
plt.figure(figsize=(10,6))
plt.plot(k_fold, scores)
plt.plot(k_fold, loss, color='red')
# TODO add legend, titles, etc.
####plt.xscale('plt.xscale('log')')
plt.title('Accuracy and Logistic Loss for Logistic Regression with Varying␣
↪Number of Folds in K-Fold Cross Validation')
plt.legend(['Accuracy Score', 'Logistic Loss'], fontsize='x-large')
plt.xlabel('Number of Folds in K-Fold Cross Validation');
plt.ylabel('Accuracy/LogLoss');
plt.show()
```



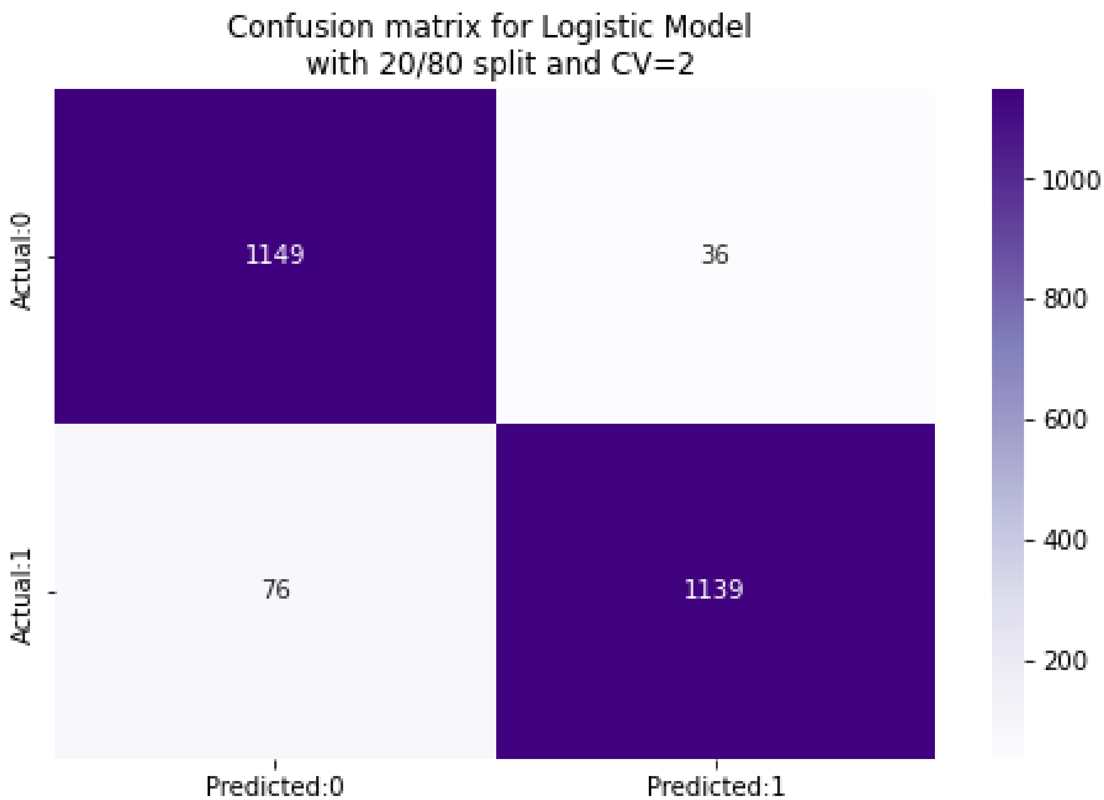
[ ]:

[135]:

```
logreg = LogisticRegressionCV(cv=2, max_iter=1000000) #Instantiating the␣
↪LogisticRegression Object
logreg.fit(X_train, y_train) #Fitting the model on our training data using fit␣
↪method
y_pred = logreg.predict(X_test) #Making predictions on Testing Model
```

[136]:

```
#Creating Confusion Matrix to evaluate the model
cm = confusion_matrix(y_test,y_pred)
conf_matrix=pd.DataFrame(data=cm,columns=['Predicted:0','Predicted:
↪1'],index=['Actual:0','Actual:1'])
plt.figure(figsize = (8,5))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap="Purples")
plt.title('Confusion matrix for Logistic Model \n with 20/80 split and CV=2')
plt.show()
```



[137]:

```
#True Negative, True Positive, False Negative, False Positive
TN=cm[0,0]
TP=cm[1,1]
FN=cm[1,0]
FP=cm[0,1]

#Accuracy
print('The acuracy of the model = TP+TN/(TP+TN+FP+FN) = ', round((TP+TN)/
 ↪float(TP+TN+FP+FN),3))
#Misclassification
print('The Missclassification = 1-Accuracy = ', round(1-((TP+TN)/
 ↪float(TP+TN+FP+FN)), 3))
#Sensitivity
print('Sensitivity or True Positive Rate = TP/(TP+FN) = ', round(TP/
 ↪float(TP+FN),3))
#Specificity
print('Specificity or True Negative Rate = TN/(TN+FP) = ', round(TN/
 ↪float(TN+FP),3))
#Error Rate
print('Error Rate = (FP+FN)/(TP+TN+FP+FN) = ', round((FP+FN)/
 ↪float(TP+TN+FP+FN),3))
```

```
#Classification Report
from sklearn.metrics import classification_report
print(classification_report(y_test, y_pred))
```

```
The acuracy of the model = TP+TN/(TP+TN+FP+FN) =  0.953
The Missclassification = 1-Accuracy =  0.047
Sensitivity or True Positive Rate = TP/(TP+FN) =  0.937
Specificity or True Negative Rate = TN/(TN+FP) =  0.97
Error Rate = (FP+FN)/(TP+TN+FP+FN) =  0.047
              precision    recall  f1-score   support

           0       0.94      0.97      0.95      1185
           1       0.97      0.94      0.95      1215

    accuracy                           0.95      2400
   macro avg       0.95      0.95      0.95      2400
weighted avg       0.95      0.95      0.95      2400
```

https://towardsdatascience.com/classifying-images-with-feature-transformations-1fcb69b44fce

FEATURE TRANSFORMATION

[145]:
```
X = shirts_df.drop('is_trousers', axis=1)
y = shirts_df.is_trousers
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
↪random_state=0)
#Splitting the data into training and testing (80% Train and 20% Test)
```

[175]:
```
################ robust scalar attempt #################
from sklearn.preprocessing import RobustScaler, QuantileTransformer,␣
↪PowerTransformer, MinMaxScaler, MaxAbsScaler, StandardScaler
sca = list()
acc = list()
logloss = list()
scaler = [RobustScaler(), QuantileTransformer(),␣
↪PowerTransformer(method='yeo-johnson'), MinMaxScaler(), MaxAbsScaler(),␣
↪StandardScaler()]
for scales in scaler:
    scale = scales
    xtrain = scale.fit_transform(X_train)
    xtest = scale.fit_transform(X_test)

    logreg = LogisticRegressionCV(cv=2) #Instantiating the LogisticRegression␣
↪Object
    logreg.fit(xtrain, y_train) #Fitting the model on our training data using␣
↪fit method
```

```
    y_pred = logreg.predict(xtest) #Making predictions on Testing Model
    y_prob = logreg.predict_proba(xtest)
    acc.append(accuracy_score(y_test, y_pred))
    logloss.append(log_loss(y_test, y_prob))
    sca.append(scales)
```

[176]:

```
d = {'Scaler':sca , 'Accuracy':acc, 'LogLoss':logloss}
dfs = pd.DataFrame(d)


dfs
```

[176]:

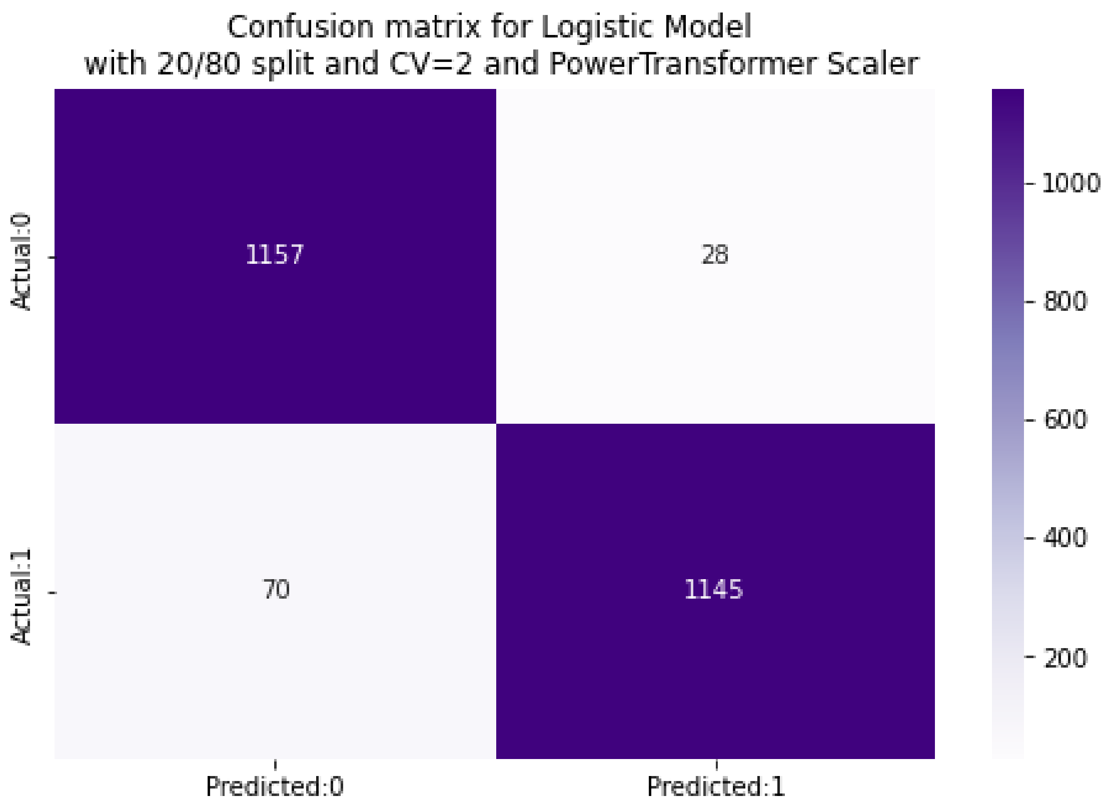
	Scaler	Accuracy	LogLoss
0	RobustScaler()	0.809167	2.137948
1	QuantileTransformer()	0.955417	0.167687
2	PowerTransformer()	0.959167	0.155131
3	MinMaxScaler()	0.953333	0.170084
4	MaxAbsScaler()	0.953333	0.170084
5	StandardScaler()	0.953750	0.173646

[188]:

```
scale = PowerTransformer()
Xtrain = scale.fit_transform(X_train)
Xtest = scale.fit_transform(X_test)

logreg = LogisticRegressionCV(cv=2, max_iter=1000000) #Instantiating the␣
↪LogisticRegression Object
logreg.fit(Xtrain, y_train) #Fitting the model on our training data using fit␣
↪method
y_pred = logreg.predict(Xtest) #Making predictions on Testing Model
```

[189]:

```
#Creating Confusion Matrix to evaluate the model
cm = confusion_matrix(y_test,y_pred)
conf_matrix=pd.DataFrame(data=cm,columns=['Predicted:0','Predicted:
↪1'],index=['Actual:0','Actual:1'])
plt.figure(figsize = (8,5))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap="Purples")
plt.title('Confusion matrix for Logistic Model \n with 20/80 split and CV=2 and␣
↪PowerTransformer Scaler')
plt.show()
```



[190]:
```
#True Negative, True Positive, False Negative, False Positive
TN=cm[0,0]
TP=cm[1,1]
FN=cm[1,0]
FP=cm[0,1]

#Accuracy
print('The acuracy of the model = TP+TN/(TP+TN+FP+FN) = ', round((TP+TN)/
 ↪float(TP+TN+FP+FN),3))
#Misclassification
print('The Missclassification = 1-Accuracy = ', round(1-((TP+TN)/
 ↪float(TP+TN+FP+FN)), 3))
#Sensitivity
print('Sensitivity or True Positive Rate = TP/(TP+FN) = ', round(TP/
 ↪float(TP+FN),3))
#Specificity
print('Specificity or True Negative Rate = TN/(TN+FP) = ', round(TN/
 ↪float(TN+FP),3))
#Error Rate
print('Error Rate = (FP+FN)/(TP+TN+FP+FN) = ', round((FP+FN)/
 ↪float(TP+TN+FP+FN),3))
```

```
#Classification Report
from sklearn.metrics import classification_report
print(classification_report(y_test, y_pred))
```

```
The acuracy of the model = TP+TN/(TP+TN+FP+FN) =  0.959
The Missclassification = 1-Accuracy =  0.041
Sensitivity or True Positive Rate = TP/(TP+FN) =  0.942
Specificity or True Negative Rate = TN/(TN+FP) =  0.976
Error Rate = (FP+FN)/(TP+TN+FP+FN) =  0.041
              precision    recall  f1-score   support

           0       0.94      0.98      0.96      1185
           1       0.98      0.94      0.96      1215

    accuracy                           0.96      2400
   macro avg       0.96      0.96      0.96      2400
weighted avg       0.96      0.96      0.96      2400
```

[ ]:

[191]:
```
scale = PowerTransformer()
Xtrain = scale.fit_transform(X_train)
Xtest = scale.fit_transform(X_test)
```

[194]:
```
# grid searching key hyperparametres for logistic regression
from sklearn.model_selection import RepeatedStratifiedKFold
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
# define models and parameters
model = LogisticRegression()
solvers = ['newton-cg', 'lbfgs', 'sag']
penalty = ['none','l2']
c_values = [100, 10, 1.0, 0.1, 0.01, 0.001, 0.0001, 0.00001]
max_iter = [1000, 10000, 100000, 1000000]
# define grid search
grid = dict(solver=solvers,penalty=penalty,C=c_values, max_iter=max_iter)
cv = RepeatedStratifiedKFold(n_splits=2, n_repeats=1, random_state=0)
grid_search = GridSearchCV(estimator=model, param_grid=grid, n_jobs=-1, cv=cv,␣
 ↪scoring='accuracy',error_score=0)
grid_result = grid_search.fit(Xtrain, y_train)
# summarize results
print("Best: %f using %s" % (grid_result.best_score_, grid_result.best_params_))
means = grid_result.cv_results_['mean_test_score']
stds = grid_result.cv_results_['std_test_score']
params = grid_result.cv_results_['params']
```

```
for mean, stdev, param in zip(means, stds, params):
    print("%f (%f) with: %r" % (mean, stdev, param))

    #Best: 0.959167 using {'C': 0.001, 'max_iter': 50, 'penalty': 'l2',␣
↪'solver': 'newton-cg'}
    #Best: 0.959167 using {'C': 0.001, 'max_iter': 30, 'penalty': 'l2',␣
↪'solver': 'newton-cg'}
```

```
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
penalty='none' will ignore the C and l1_ratio parameters
  warnings.warn(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
penalty='none' will ignore the C and l1_ratio parameters
  warnings.warn(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
penalty='none' will ignore the C and l1_ratio parameters
  warnings.warn(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
penalty='none' will ignore the C and l1_ratio parameters
  warnings.warn(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
penalty='none' will ignore the C and l1_ratio parameters
  warnings.warn(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
penalty='none' will ignore the C and l1_ratio parameters
  warnings.warn(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed
to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed
to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

```
Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed
to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed
to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
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STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
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```

```
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packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed
to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
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```
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```

```
Best: 0.959167 using {'C': 0.001, 'max_iter': 30, 'penalty': 'l2', 'solver':
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0.920417 (0.000208) with: {'C': 100, 'max_iter': 30, 'penalty': 'l2', 'solver':
```

```
'lbfgs'}
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0.914583 (0.001875) with: {'C': 100, 'max_iter': 40, 'penalty': 'none',
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0.919896 (0.000729) with: {'C': 100, 'max_iter': 40, 'penalty': 'l2', 'solver':
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0.932396 (0.001771) with: {'C': 100, 'max_iter': 40, 'penalty': 'l2', 'solver':
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0.919896 (0.000729) with: {'C': 100, 'max_iter': 10000, 'penalty': 'l2',
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0.922396 (0.001354) with: {'C': 100, 'max_iter': 10000, 'penalty': 'l2',
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0.918542 (0.000417) with: {'C': 100, 'max_iter': 100000, 'penalty': 'none',
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0.921875 (0.001250) with: {'C': 100, 'max_iter': 100000, 'penalty': 'none',
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0.914583 (0.002292) with: {'C': 10, 'max_iter': 30, 'penalty': 'none', 'solver':
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0.924271 (0.000104) with: {'C': 10, 'max_iter': 30, 'penalty': 'l2', 'solver':
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0.914583 (0.001875) with: {'C': 10, 'max_iter': 40, 'penalty': 'none', 'solver':
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0.924167 (0.001250) with: {'C': 10, 'max_iter': 40, 'penalty': 'l2', 'solver':
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0.931562 (0.002188) with: {'C': 1.0, 'max_iter': 40, 'penalty': 'l2', 'solver':
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0.914583 (0.001875) with: {'C': 1.0, 'max_iter': 100, 'penalty': 'none',
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0.921563 (0.001146) with: {'C': 1.0, 'max_iter': 100000, 'penalty': 'none',
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0.914583 (0.001875) with: {'C': 1.0, 'max_iter': 1000000, 'penalty': 'none',
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0.914583 (0.002292) with: {'C': 0.1, 'max_iter': 30, 'penalty': 'none',
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0.932917 (0.002917) with: {'C': 0.1, 'max_iter': 30, 'penalty': 'none',
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0.935729 (0.001979) with: {'C': 0.1, 'max_iter': 30, 'penalty': 'l2', 'solver':
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0.914583 (0.001875) with: {'C': 0.1, 'max_iter': 40, 'penalty': 'none',
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0.918542 (0.000417) with: {'C': 0.1, 'max_iter': 1000, 'penalty': 'none',
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0.922396 (0.000937) with: {'C': 0.1, 'max_iter': 1000, 'penalty': 'none',
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0.921875 (0.001250) with: {'C': 0.01, 'max_iter': 10000, 'penalty': 'none',
'solver': 'sag'}
0.952292 (0.001875) with: {'C': 0.01, 'max_iter': 10000, 'penalty': 'l2',
'solver': 'newton-cg'}
0.952292 (0.001875) with: {'C': 0.01, 'max_iter': 10000, 'penalty': 'l2',
'solver': 'lbfgs'}
0.952396 (0.001771) with: {'C': 0.01, 'max_iter': 10000, 'penalty': 'l2',
'solver': 'sag'}
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0.952292 (0.001875) with: {'C': 0.01, 'max_iter': 100000, 'penalty': 'l2',
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0.952396 (0.001771) with: {'C': 0.01, 'max_iter': 100000, 'penalty': 'l2',
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0.959167 (0.000417) with: {'C': 0.001, 'max_iter': 40, 'penalty': 'l2',
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0.959167 (0.000417) with: {'C': 0.001, 'max_iter': 1000, 'penalty': 'l2',
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'solver': 'lbfgs'}
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0.914583 (0.001875) with: {'C': 0.001, 'max_iter': 100000, 'penalty': 'none',
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0.933021 (0.002396) with: {'C': 0.0001, 'max_iter': 30, 'penalty': 'none',
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0.947396 (0.004062) with: {'C': 0.0001, 'max_iter': 30, 'penalty': 'l2',
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'solver': 'lbfgs'}
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0.914583 (0.001875) with: {'C': 0.0001, 'max_iter': 40, 'penalty': 'none',
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'solver': 'lbfgs'}
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0.914583 (0.001875) with: {'C': 0.0001, 'max_iter': 10000, 'penalty': 'none',
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0.921667 (0.001458) with: {'C': 0.0001, 'max_iter': 10000, 'penalty': 'none',
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0.947396 (0.004062) with: {'C': 0.0001, 'max_iter': 10000, 'penalty': 'l2',
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0.947396 (0.004062) with: {'C': 0.0001, 'max_iter': 10000, 'penalty': 'l2',
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0.921875 (0.001042) with: {'C': 0.0001, 'max_iter': 1000000, 'penalty': 'none',
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0.947396 (0.004062) with: {'C': 0.0001, 'max_iter': 1000000, 'penalty': 'l2',
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0.933125 (0.004792) with: {'C': 1e-05, 'max_iter': 30, 'penalty': 'l2',
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```
'solver': 'lbfgs'}
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'solver': 'newton-cg'}
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0.931875 (0.002292) with: {'C': 1e-05, 'max_iter': 40, 'penalty': 'none',
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0.931667 (0.001875) with: {'C': 1e-05, 'max_iter': 50, 'penalty': 'none',
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'solver': 'lbfgs'}
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'solver': 'sag'}
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0.914583 (0.001875) with: {'C': 1e-05, 'max_iter': 10000, 'penalty': 'none',
'solver': 'lbfgs'}
0.921667 (0.000833) with: {'C': 1e-05, 'max_iter': 10000, 'penalty': 'none',
'solver': 'sag'}
0.933125 (0.004792) with: {'C': 1e-05, 'max_iter': 10000, 'penalty': 'l2',
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0.933229 (0.004896) with: {'C': 1e-05, 'max_iter': 10000, 'penalty': 'l2',
'solver': 'sag'}
0.918542 (0.000417) with: {'C': 1e-05, 'max_iter': 100000, 'penalty': 'none',
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0.914583 (0.001875) with: {'C': 1e-05, 'max_iter': 100000, 'penalty': 'none',
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0.921667 (0.000833) with: {'C': 1e-05, 'max_iter': 100000, 'penalty': 'none',
'solver': 'sag'}
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'solver': 'newton-cg'}
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'solver': 'lbfgs'}
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'solver': 'sag'}
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'solver': 'lbfgs'}
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'solver': 'sag'}
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'solver': 'newton-cg'}
0.933125 (0.004792) with: {'C': 1e-05, 'max_iter': 1000000, 'penalty': 'l2',
'solver': 'lbfgs'}
0.933229 (0.004896) with: {'C': 1e-05, 'max_iter': 1000000, 'penalty': 'l2',
'solver': 'sag'}
```

[195]:
```
from sklearn.model_selection import RepeatedStratifiedKFold
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
# define models and parameters
model = LogisticRegression()
solvers = ['liblinear']
penalty = ['l1','l2']
```

```python
c_values = [100, 10, 1.0, 0.1, 0.01, 0.001, 0.0001, 0.00001]
max_iter = [1000, 10000, 100000, 1000000]
# define grid search
grid = dict(solver=solvers,penalty=penalty,C=c_values, max_iter=max_iter)
cv = RepeatedStratifiedKFold(n_splits=2, n_repeats=1, random_state=0)
grid_search = GridSearchCV(estimator=model, param_grid=grid, n_jobs=-1, cv=cv,␣
↪scoring='accuracy',error_score=0)
grid_result = grid_search.fit(Xtrain, y_train)
# summarize results
print("Best: %f using %s" % (grid_result.best_score_, grid_result.best_params_))
means = grid_result.cv_results_['mean_test_score']
stds = grid_result.cv_results_['std_test_score']
params = grid_result.cv_results_['params']
for mean, stdev, param in zip(means, stds, params):
    print("%f (%f) with: %r" % (mean, stdev, param))

#Best: 0.957812 using {'C': 0.001, 'max_iter': 1000, 'penalty': 'l2', 'solver':␣
↪'liblinear'}
```

```
Best: 0.957812 using {'C': 0.001, 'max_iter': 1000, 'penalty': 'l2', 'solver':
'liblinear'}
0.921146 (0.000313) with: {'C': 100, 'max_iter': 1000, 'penalty': 'l1',
'solver': 'liblinear'}
0.920521 (0.000521) with: {'C': 100, 'max_iter': 1000, 'penalty': 'l2',
'solver': 'liblinear'}
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```

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```

[196]:

```
from sklearn.model_selection import RepeatedStratifiedKFold
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
# define models and parameters
model = LogisticRegression()
solvers = ['saga']
penalty = ['elasticnet', 'l1','l2','none']
c_values = [100, 10, 1.0, 0.1, 0.01, 0.001, 0.0001, 0.00001]
max_iter = [30,40,50, 100, 1000, 10000, 100000, 1000000]
# define grid search
grid = dict(solver=solvers,penalty=penalty,C=c_values, max_iter=max_iter)
cv = RepeatedStratifiedKFold(n_splits=2, n_repeats=1, random_state=0)
grid_search = GridSearchCV(estimator=model, param_grid=grid, n_jobs=-1, cv=cv,␣
↪scoring='accuracy',error_score=0)
grid_result = grid_search.fit(Xtrain, y_train)
# summarize results
print("Best: %f using %s" % (grid_result.best_score_, grid_result.best_params_))
means = grid_result.cv_results_['mean_test_score']
stds = grid_result.cv_results_['std_test_score']
params = grid_result.cv_results_['params']
for mean, stdev, param in zip(means, stds, params):
    print("%f (%f) with: %r" % (mean, stdev, param))
```

```
/Users/dalithendel/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-
packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
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packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
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```
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```

```
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packages/sklearn/linear_model/_logistic.py:1483: UserWarning: Setting
penalty='none' will ignore the C and l1_ratio parameters
  warnings.warn(
```

```
---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
Input In [196], in <cell line: 14>()
     12 cv = RepeatedStratifiedKFold(n_splits=2, n_repeats=1, random_state=0)
     13 grid_search = GridSearchCV(estimator=model, param_grid=grid, n_jobs=-1,
 ↪cv=cv, scoring='accuracy',error_score=0)
---> 14 grid_result = grid_search.fit(Xtrain, y_train)
     15 # summarize results
     16 print("Best: %f using %s" % (grid_result.best_score_, grid_result.
 ↪best_params_))

File ~/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-packages/sklearn/
 ↪model_selection/_search.py:891, in BaseSearchCV.fit(self, X, y, groups,
 ↪**fit_params)
```

```
    885     results = self._format_results(
    886         all_candidate_params, n_splits, all_out, all_more_results
    887     )
    889     return results
--> 891 self._run_search(evaluate_candidates)
    893 # multimetric is determined here because in the case of a callable
    894 # self.scoring the return type is only known after calling
    895 first_test_score = all_out[0]["test_scores"]

File ~/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-packages/sklearn/
 ↪model_selection/_search.py:1392, in GridSearchCV._run_search(self,␣
 ↪evaluate_candidates)
   1390 def _run_search(self, evaluate_candidates):
   1391     """Search all candidates in param_grid"""
-> 1392     evaluate_candidates(ParameterGrid(self.param_grid))

File ~/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-packages/sklearn/
 ↪model_selection/_search.py:838, in BaseSearchCV.fit.<locals>.
 ↪evaluate_candidates(candidate_params, cv, more_results)
    830 if self.verbose > 0:
    831     print(
    832         "Fitting {0} folds for each of {1} candidates,"
    833         " totalling {2} fits".format(
    834             n_splits, n_candidates, n_candidates * n_splits
    835         )
    836     )
--> 838 out = parallel(
    839     delayed(_fit_and_score)(
    840         clone(base_estimator),
    841         X,
    842         y,
    843         train=train,
    844         test=test,
    845         parameters=parameters,
    846         split_progress=(split_idx, n_splits),
    847         candidate_progress=(cand_idx, n_candidates),
    848         **fit_and_score_kwargs,
    849     )
    850     for (cand_idx, parameters), (split_idx, (train, test)) in product(
    851         enumerate(candidate_params), enumerate(cv.split(X, y, groups))
    852     )
    853 )
    855 if len(out) < 1:
    856     raise ValueError(
    857         "No fits were performed. "
    858         "Was the CV iterator empty? "
    859         "Were there no candidates?"
    860     )
```

```
File ~/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-packages/joblib/
↪parallel.py:1056, in Parallel.__call__(self, iterable)
   1053     self._iterating = False
   1055 with self._backend.retrieval_context():
-> 1056     self.retrieve()
   1057 # Make sure that we get a last message telling us we are done
   1058 elapsed_time = time.time() - self._start_time

File ~/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-packages/joblib/
↪parallel.py:935, in Parallel.retrieve(self)
    933 try:
    934     if getattr(self._backend, 'supports_timeout', False):
--> 935         self._output.extend(job.get(timeout=self.timeout))
    936     else:
    937         self._output.extend(job.get())

File ~/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/site-packages/joblib/
↪_parallel_backends.py:542, in LokyBackend.wrap_future_result(future, timeout)
    539 """Wrapper for Future.result to implement the same behaviour as
    540 AsyncResults.get from multiprocessing."""
    541 try:
--> 542     return future.result(timeout=timeout)
    543 except CfTimeoutError as e:
    544     raise TimeoutError from e

File ~/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/concurrent/futures/_base
↪py:441, in Future.result(self, timeout)
    438 elif self._state == FINISHED:
    439     return self.__get_result()
--> 441 self._condition.wait(timeout)
    443 if self._state in [CANCELLED, CANCELLED_AND_NOTIFIED]:
    444     raise CancelledError()

File ~/opt/anaconda3/envs/ml135_env_su22/lib/python3.9/threading.py:312, in␣
↪Condition.wait(self, timeout)
    310 try:    # restore state no matter what (e.g., KeyboardInterrupt)
    311     if timeout is None:
--> 312         waiter.acquire()
    313         gotit = True
    314     else:

KeyboardInterrupt:
```

[ ]:

```
grid_predictions = grid_search.predict(Xtest)
# print classification report
```

```
print(classification_report(y_test, grid_predictions))
```

[208]:
```
from sklearn.linear_model import RidgeClassifier
# define models and parameters
model = RidgeClassifier()
alpha = [0.0001, 0.001, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]
# define grid search
grid = dict(alpha=alpha)
cv = RepeatedStratifiedKFold(n_splits=3, n_repeats=1, random_state=0)
grid_search = GridSearchCV(estimator=model, param_grid=grid, n_jobs=-1, cv=cv,␣
↪scoring='accuracy',error_score=0)
grid_result = grid_search.fit(Xtrain, y_train)
# summarize results
print("Best: %f using %s" % (grid_result.best_score_, grid_result.best_params_))
means = grid_result.cv_results_['mean_test_score']
stds = grid_result.cv_results_['std_test_score']
params = grid_result.cv_results_['params']
for mean, stdev, param in zip(means, stds, params):
    print("%f (%f) with: %r" % (mean, stdev, param))
```

```
Best: 0.956875 using {'alpha': 0.0001}
0.956875 (0.002434) with: {'alpha': 0.0001}
0.956875 (0.002434) with: {'alpha': 0.001}
0.956875 (0.002434) with: {'alpha': 0.05}
0.956875 (0.002434) with: {'alpha': 0.1}
0.956875 (0.002434) with: {'alpha': 0.2}
0.956875 (0.002434) with: {'alpha': 0.3}
0.956875 (0.002434) with: {'alpha': 0.4}
0.956875 (0.002434) with: {'alpha': 0.5}
0.956875 (0.002434) with: {'alpha': 0.6}
0.956875 (0.002434) with: {'alpha': 0.7}
0.956875 (0.002434) with: {'alpha': 0.8}
0.956875 (0.002434) with: {'alpha': 0.9}
0.956875 (0.002434) with: {'alpha': 1.0}
```

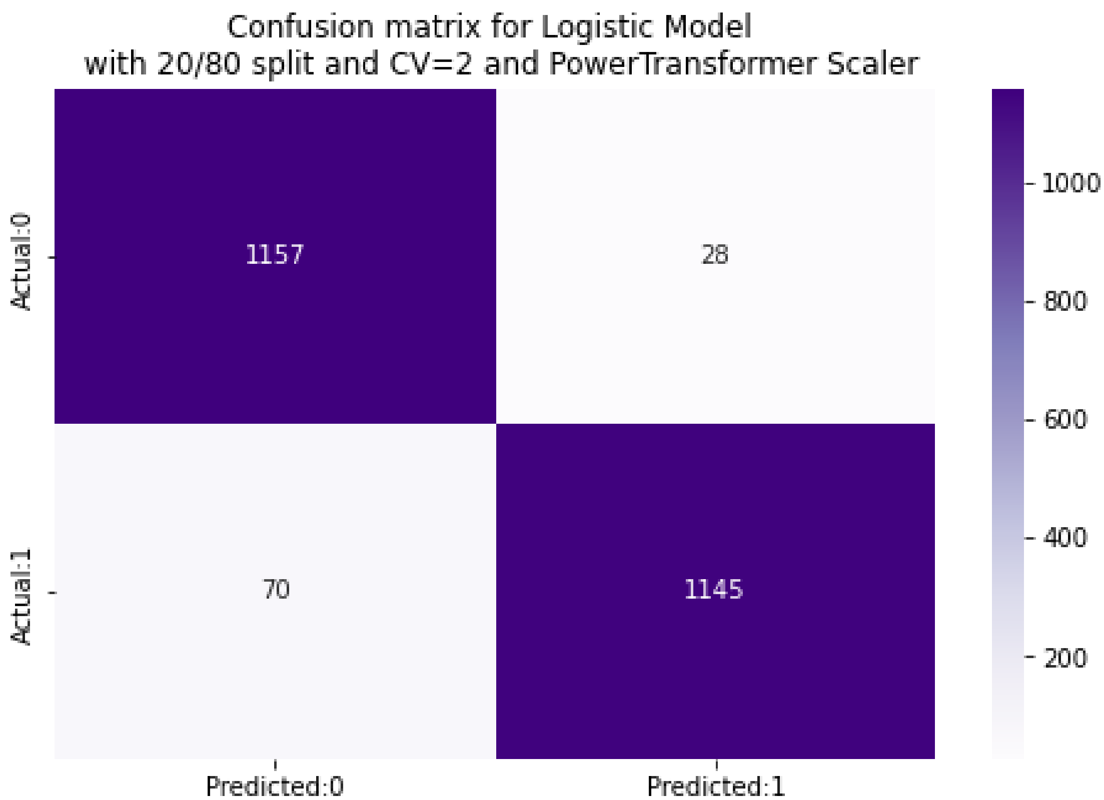
[209]:
```
grid_predictions = grid_search.predict(Xtest)

# print classification report
print(classification_report(y_test, grid_predictions))
```

```
              precision    recall  f1-score   support

           0       0.94      0.98      0.96      1185
           1       0.98      0.94      0.96      1215

    accuracy                           0.96      2400
   macro avg       0.96      0.96      0.96      2400
weighted avg       0.96      0.96      0.96      2400
```

FINAL MODEL

[243]:
```
#{'C': 0.001, 'max_iter': 30, 'penalty': 'l2', 'solver': 'newton-cg'}

scale = PowerTransformer()
Xtrain = scale.fit_transform(X_train)
Xtest = scale.fit_transform(X_test)

logreg = LogisticRegressionCV(cv=2, max_iter=1000000, penalty = 'l2', solver =␣
↪'newton-cg') #Instantiating the LogisticRegression Object
logreg.fit(Xtrain, y_train) #Fitting the model on our training data using fit␣
↪method
y_pred = logreg.predict(Xtest) #Making predictions on Testing Model
y_prob = logreg.predict_proba(Xtest)
```

[214]:
```
#Creating Confusion Matrix to evaluate the model
cm = confusion_matrix(y_test,y_pred)
conf_matrix=pd.DataFrame(data=cm,columns=['Predicted:0','Predicted:
↪1'],index=['Actual:0','Actual:1'])
plt.figure(figsize = (8,5))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap="Purples")
plt.title('Confusion matrix for Logistic Model \n with 20/80 split and CV=2 and␣
↪PowerTransformer Scaler')
plt.show()
```



[215]:
```
#True Negative, True Positive, False Negative, False Positive
TN=cm[0,0]
TP=cm[1,1]
FN=cm[1,0]
FP=cm[0,1]

#Accuracy
print('The acuracy of the model = TP+TN/(TP+TN+FP+FN) = ', round((TP+TN)/
↪float(TP+TN+FP+FN),3))
#Misclassification
print('The Missclassification = 1-Accuracy = ', round(1-((TP+TN)/
↪float(TP+TN+FP+FN)), 3))
#Sensitivity
print('Sensitivity or True Positive Rate = TP/(TP+FN) = ', round(TP/
↪float(TP+FN),3))
#Specificity
print('Specificity or True Negative Rate = TN/(TN+FP) = ', round(TN/
↪float(TN+FP),3))
#Error Rate
print('Error Rate = (FP+FN)/(TP+TN+FP+FN) = ', round((FP+FN)/
↪float(TP+TN+FP+FN),3))
```

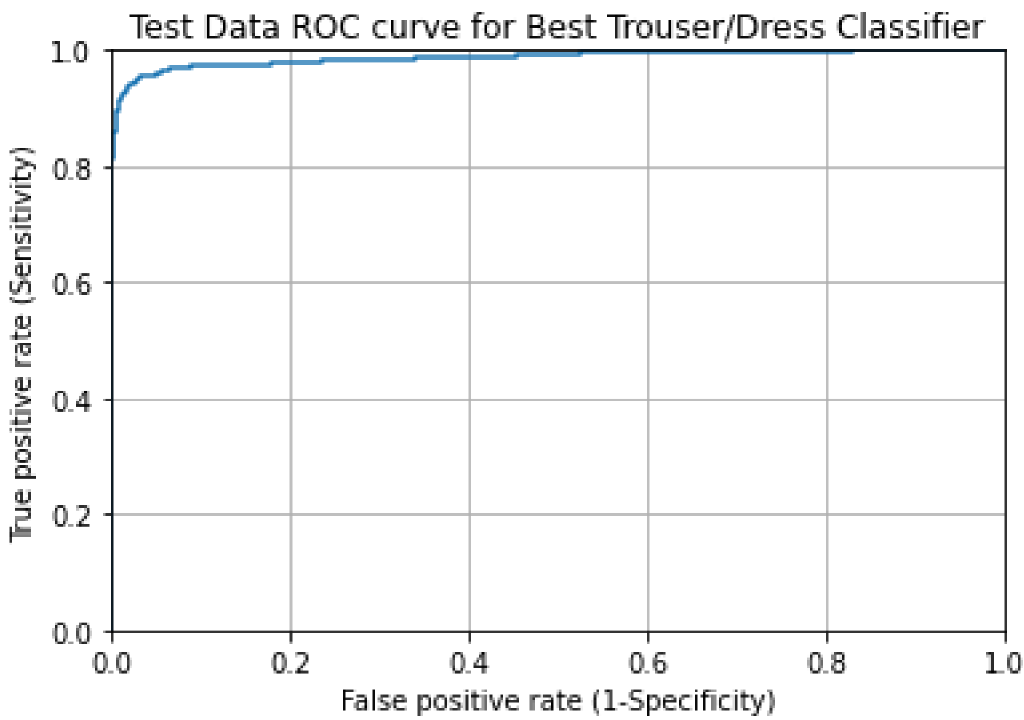
```
#Classification Report
from sklearn.metrics import classification_report
print(classification_report(y_test, y_pred))
```

```
The acuracy of the model = TP+TN/(TP+TN+FP+FN) =  0.959
The Missclassification = 1-Accuracy =  0.041
Sensitivity or True Positive Rate = TP/(TP+FN) =  0.942
Specificity or True Negative Rate = TN/(TN+FP) =  0.976
Error Rate = (FP+FN)/(TP+TN+FP+FN) =  0.041
              precision    recall  f1-score   support

           0       0.94      0.98      0.96      1185
           1       0.98      0.94      0.96      1215

    accuracy                           0.96      2400
   macro avg       0.96      0.96      0.96      2400
weighted avg       0.96      0.96      0.96      2400
```

ROC for training vs test on final model

[221]:
```
### ROC Curve
from sklearn.metrics import roc_curve

y_pred_prob_yes=logreg.predict_proba(Xtest)

fpr, tpr, thresholds = roc_curve(y_test, y_pred_prob_yes[:,1])
plt.plot(fpr,tpr)

plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.0])

plt.title('Test Data ROC curve for Best Trouser/Dress Classifier')
plt.xlabel('False positive rate (1-Specificity)')
plt.ylabel('True positive rate (Sensitivity)')

plt.grid(True)

from sklearn import metrics
print(round(metrics.roc_auc_score(y_test,y_pred_prob_yes[:,1]),3))
```

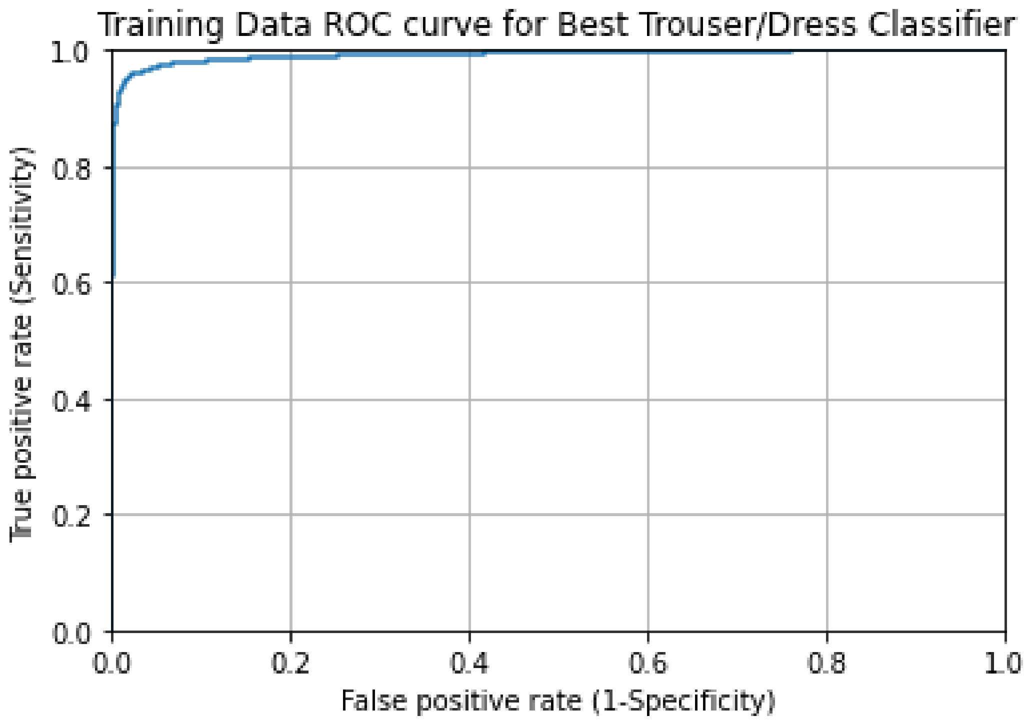
```
0.987
```



[223]:

```
### ROC Curve
from sklearn.metrics import roc_curve

y_pred_prob_yes=logreg.predict_proba(Xtrain)

fpr, tpr, thresholds = roc_curve(y_train, y_pred_prob_yes[:,1])
plt.plot(fpr,tpr)

plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.0])

plt.title('Training Data ROC curve for Best Trouser/Dress Classifier')
plt.xlabel('False positive rate (1-Specificity)')
plt.ylabel('True positive rate (Sensitivity)')

plt.grid(True)

from sklearn import metrics
print(round(metrics.roc_auc_score(y_train,y_pred_prob_yes[:,1]),3))
```

```
0.991
```



[206]:
```
x_test = np.loadtxt('troudress_test_x.csv', delimiter=',', skiprows=1)
yproba1_test = logreg.predict_proba(x_test)[:, 1]
#np.savetxt('yproba1_test.txt', yproba1_test)
```

[207]:
```
yproba1_test
```

[207]: array([0.262, 0.539, 0.335, …, 0.833, 0.823, 0.214])

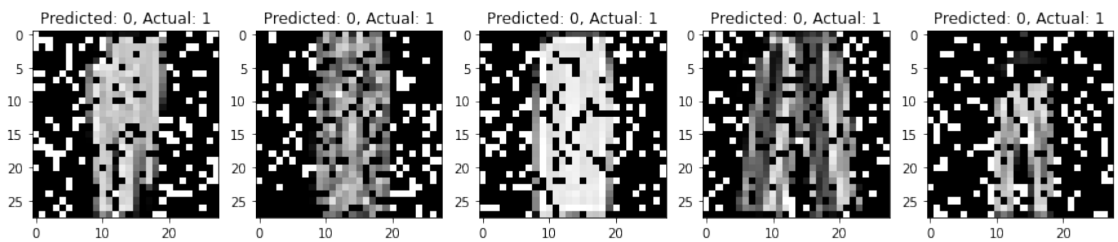
[ ]:
```

```

[247]:
```
scale = PowerTransformer()
Xtrain = scale.fit_transform(X_train)
Xtest = scale.fit_transform(X_test)

logreg = LogisticRegressionCV(cv=2, max_iter=1000000, penalty = 'l2', solver =␣
 ↪'newton-cg') #Instantiating the LogisticRegression Object
logreg.fit(Xtrain, y_train) #Fitting the model on our training data using fit␣
 ↪method
y_pred = logreg.predict(Xtest) #Making predictions on Testing Model
y_prob = logreg.predict_proba(Xtest)
```

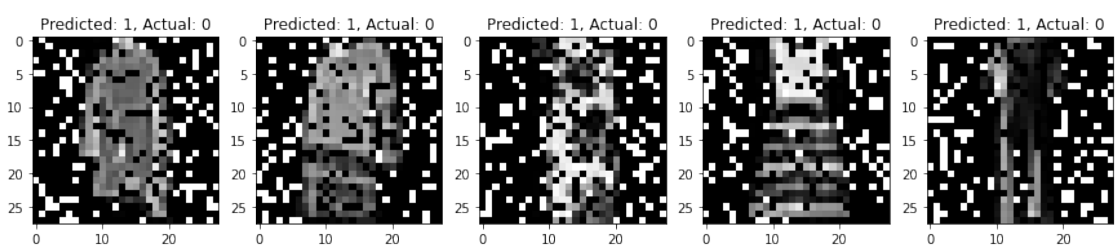
[245]:
```
X_train.shape, X_test.shape, y_train.shape, y_test.shape
```

[245]: ((9600, 784), (2400, 784), (9600,), (2400,))

[333]:
```
# False negatives visualized
wrong_fn = np.nonzero(y_pred < y_test)[0]
x_test = X_test.to_numpy()
#y_test = y_test.to_numpy()

plt.figure(figsize=(15, 6))
for plotIdx, wrongIdx in enumerate(wrong_fn[0:5]):
    plt.subplot(1, 5, plotIdx + 1)
    plt.imshow(np.reshape(x_test[wrongIdx], (28,28)), cmap=plt.cm.gray, vmin =␣
↪0.0, vmax = 1)
    plt.title('Predicted: {}, Actual: {}'.format(y_pred[wrongIdx],
             y_test[wrongIdx]))
```



[334]:
```
wrong_fp = np.nonzero(y_pred > y_test)[0]

plt.figure(figsize=(15, 6))
for plotIdx, wrongIdx in enumerate(wrong_fp[0:5]):
    plt.subplot(1, 5, plotIdx + 1)
    plt.imshow(np.reshape(x_test[wrongIdx], (28,28)), cmap=plt.cm.gray, vmin =␣
↪0.0, vmax = 1)
    plt.title('Predicted: {}, Actual: {}'.format(y_pred[wrongIdx],
             y_test[wrongIdx]))
```



[324]:
```
y_test
```

[324]:
```
4954     0
11999    0
11041    0
7532     0
11966    1
        ..
2954     0
5033     1
6606     1
2495     1
11341    0
Name: is_trousers, Length: 2400, dtype: int64
```

[ ]:
```
wrong_fp = np.nonzero(y_prob_ > y_test)[0]
```