## **ASSIGNMENT 2**

Name: Pola Gnana Shekar

## Roll No: 21CS10052

```
import pandas as pd
#import the data
train data = pd.read csv('./data train.csv')
test data = pd.read csv('./data test.csv')
output data = pd.read csv('./Copy of actual.csv')
#manipulating the data
train_data.drop(train_data.columns[0], axis=1, inplace=True)
test data.drop(test data.columns[0],axis=1,inplace=True)
num columns train = len(train data.columns)
num columns test = len(test data.columns)
for i in range(1, num columns train-1,2):
train data[train data.columns[i]]=train data[train data.columns[i+1]]
for i in range(1, num columns test-1,2):
    test data[test data.columns[i]]=test data[test data.columns[i+1]]
train data.drop(train data.columns[2::2], axis=1, inplace=True)
test data.drop(test data.columns[2::2], axis=1, inplace=True)
train data=train data.T
test data=test data.T
train_data.reset_index(inplace=True)
train data.columns=train data.iloc[0]
train data=train data[1:]
train data = train data.rename(columns={'Gene Accession Number':
'patient'})
test data.reset index(inplace=True)
test data.columns=test_data.iloc[0]
test_data=test data[1:]
test data = test data.rename(columns={'Gene Accession Number':
'patient'})
```

```
train_data['patient'] = train_data['patient'].astype('int64')
test data['patient'] = test data['patient'].astype('int64')
trainD=pd.merge(train data,output data,on='patient',how='inner')
testD=pd.merge(test data,output data,on='patient',how='inner')
# The final data set has each patient as a sample data(rows) and each
gene as on of it's feature(columns) and the last
# column represent the target value (cancer)
print("Train data: \n")
print(trainD)
print("Test data: \n")
print(testD)
Train data:
    patient AFFX-BioB-5 at AFFX-BioB-M at AFFX-BioB-3 at AFFX-BioC-
5_at \
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5	A	A	A	A	ALL	
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11	A	Α	Α	A	ALL	
12	Α	Α		A	ALL	
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14	A	A	A	A	ALL	
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18	A	A		A		
19	Ā	A		Ä		
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21	A	A		A		
22	Α	Α		Α		
23	Α	А	Α	Α	ALL	
24	Α	Α	Р	Α	ALL	
25	Р	Α		Α	ALL	
26	Α	Α		A		
27	A	A		A		
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36	A	A	A	A	AML
37	A	A	P	A	AML

[38 rows x 7131 columns] Test data:

p	atient /	AFFX-BioB-5 at	AFFX-BioB-M at	AFFX-BioB-3_at	AFFX-BioC-
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6	41	А	А	А	
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7	43	А	А	А	
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8	44	Α	Α	А	
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21	53	Α	Α	Α
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23	50	Α	Α	Α
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25	57	Α	Α	Α
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26	58	Α	Α	Α
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7	А	Α	А	Α
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26 27	Ä	Ä		A	
28					
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29	A	A		A	
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#encoding the data values to make it processable to train the models
import pandas as pd
from sklearn.preprocessing import LabelEncoder
# Split the data into features (X) and target labels (y)
X train = trainD.drop(['patient', 'cancer'], axis=1)
y_train = trainD['cancer']
X test = testD.drop(['patient', 'cancer'], axis=1)
y test = testD['cancer']
# Initialize the LabelEncoder
encoder = LabelEncoder()
# Concatenate X train and X test to ensure all categories are seen
combined data = pd.concat([X train, X test], axis=0)
# Apply label encoding to combined data
```

```
for column in combined data.columns:
    combined data[column] =
encoder.fit transform(combined data[column])
# Split the encoded data back into X train encoded and X test encoded
X_train_encoded = combined_data.iloc[:len(X_train)]
X_test_encoded = combined_data.iloc[len(X_train):]
# Print X train encoded
print("X train encoded:\n")
print(X train encoded)
# Print X test encoded
print("\nX test encoded:\n")
print(X test encoded)
X_train_encoded:
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## [38 rows x 7129 columns]

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29
              0
30
              0
31
              0
32
              0
33
              0
[34 rows x 7129 columns]
#SVM model
from sklearn.preprocessing import StandardScaler
from sklearn.svm import SVC
from sklearn.metrics import accuracy score, precision score,
recall score, fl score, confusion matrix
# Define a list of kernel names
kernels = ['linear', 'rbf', 'poly', 'sigmoid']
for kernel in kernels:
    # Create an SVM model with the specified kernel
    model = SVC(kernel=kernel)
    # Scale the features
    scaler = StandardScaler()
    X_train_scaled = scaler.fit_transform(X_train_encoded)
    X_test_scaled = scaler.transform(X_test_encoded)
    # Train the model
    model.fit(X train scaled, y train)
    # Make predictions on the test data
```

```
y pred = model.predict(X test scaled)
    # Evaluate the model
    accuracy = accuracy_score(y_test, y_pred)
    precision = precision_score(y_test, y_pred, pos_label='ALL')
    recall = recall_score(y_test, y_pred, pos_label='ALL')
    f1 = f1_score(y_test, y_pred, pos_label='ALL')
    confusion = confusion matrix(y test, y pred)
    # Print the evaluation metrics
    print(f"SVM Model with {kernel} kernel")
    print(f"Accuracy: {accuracy}")
    print(f"Precision: {precision}")
    print(f"Recall: {recall}")
    print(f"F1 Score: {f1}")
    print(f"Confusion Matrix:\n{confusion}\n")
SVM Model with linear kernel
Accuracy: 0.9117647058823529
Precision: 0.8695652173913043
Recall: 1.0
F1 Score: 0.9302325581395349
Confusion Matrix:
[[20 0]
[ 3 11]]
SVM Model with rbf kernel
Accuracy: 0.5882352941176471
Precision: 0.5882352941176471
Recall: 1.0
F1 Score: 0.7407407407407407
Confusion Matrix:
[[20 0]
[14 0]]
SVM Model with poly kernel
Accuracy: 0.5882352941176471
Precision: 0.5882352941176471
Recall: 1.0
F1 Score: 0.7407407407407407
Confusion Matrix:
[[20 0]
[14 0]]
SVM Model with sigmoid kernel
Accuracy: 0.8529411764705882
Precision: 0.8
Recall: 1.0
F1 Score: 0.88888888888888
Confusion Matrix:
```

```
[[20 0]
[ 5 911
#Random Forest
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy score, precision score,
recall score, f1 score, confusion matrix
# Create a Random Forest model
rf model = RandomForestClassifier(n estimators=100, random state=42)
# Train the model
rf model.fit(X train encoded, y train)
# Make predictions on the test data
y pred rf = rf model.predict(X test encoded)
# Evaluate the model
accuracy_rf = accuracy_score(y_test, y_pred_rf)
precision_rf = precision_score(y_test, y_pred_rf, pos_label='ALL')
recall_rf = recall_score(y_test, y_pred_rf, pos_label='ALL')
f1_rf = f1_score(y_test, y_pred_rf, pos_label='ALL')
confusion rf = confusion matrix(y test, y pred rf)
# Print the evaluation metrics
print("Random Forest Model")
print(f"Accuracy: {accuracy rf}")
print(f"Precision: {precision rf}")
print(f"Recall: {recall rf}")
print(f"F1 Score: {f1 rf}")
print(f"Confusion Matrix:\n{confusion rf}\n")
Random Forest Model
Accuracy: 0.8823529411764706
Precision: 0.833333333333334
Recall: 1.0
F1 Score: 0.9090909090909091
Confusion Matrix:
[[20 0]
[ 4 10]]
from itertools import product
from sklearn.neural network import MLPClassifier
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy score, precision score,
recall score, f1 score, confusion matrix
# Define the hyperparameter grid to search through
param grid = {
```

```
'hidden layer sizes': [(100, 50), (50, 75), (200, 100)],
    'alpha': [0.001, 0.01],
    'max iter': [500, 1000],
    'solver': ['adam', 'lbfgs'],
    'learning rate init': [0.001, 0.01]
}
# Create a list of all parameter combinations
param combinations = list(product(param grid['hidden layer sizes'],
param_grid['alpha'], param_grid['max_iter'],
                                    param grid['solver'],
param grid['learning rate init']))
# Create a Neural Network model
nn model = MLPClassifier()
# Scale the features
scaler = StandardScaler()
X train scaled = scaler.fit transform(X train encoded)
X test scaled = scaler.transform(X test encoded)
best accuracy = 0
best params = None
best precision = 0
best recall = 0
best f1 score = 0
best confusion matrix = None
# Iterate through each parameter combination
for params in param combinations:
    hidden layer sizes, alpha, max iter, solver, learning rate init =
params
    # Print the current parameter combination being processed
    print(f"Working on {params}...")
    # Set the hyperparameters for the current combination
    nn model.set params(hidden layer sizes=hidden layer sizes,
alpha=alpha, max_iter=max_iter, solver=solver,
                       learning rate init=learning rate init)
    # Train the model
    nn model.fit(X train scaled, y train)
    # Make predictions on the test data
    y pred nn = nn model.predict(X test scaled)
    # Evaluate the model
    accuracy_nn = accuracy_score(y_test, y_pred_nn)
```

```
# Check if this combination has the best accuracy so far
    if accuracy nn > best accuracy:
        best accuracy = accuracy nn
        best params = params
        # Calculate precision, recall, and F1-score
        precision nn = precision score(y test, y pred nn,
pos label='ALL')
         recall nn = recall score(y test, y pred nn, pos label='ALL')
        f1 nn = f1 score(y test, y pred nn, pos label='ALL')
        # Calculate confusion matrix
        confusion nn = confusion matrix(y test, y pred nn)
        # Update best metrics
        best precision = precision nn
        best recall = recall nn
        best f1 score = f1 nn
        best confusion matrix = confusion nn
# Print the best result and its hyperparameters
print("\n\nBest Neural Network Model")
print(f"Best Hyperparameters: {best params}")
print(f"Best Accuracy: {best accuracy}")
print(f"Best Precision: {best precision}")
print(f"Best Recall: {best recall}")
print(f"Best F1 Score: {best f1 score}")
print("Best Confusion Matrix:")
print(best confusion matrix)
Working on ((100, 50), 0.001, 500, 'adam', 0.001)...
Working on ((100, 50), 0.001, 500, 'adam', 0.01)...
Working on ((100, 50), 0.001, 500, 'lbfgs', 0.001)...
Working on ((100, 50), 0.001, 500, 'lbfgs', 0.01)...
Working on ((100, 50), 0.001, 1000, 'adam', 0.001)...
Working on ((100, 50), 0.001, 1000, 'adam', 0.01)...
Working on ((100, 50), 0.001, 1000, 'lbfgs', 0.001)...
Working on ((100, 50), 0.001, 1000, 'lbfgs', 0.01)...
Working on ((100, 50), 0.01, 500, 'adam', 0.001)...
Working on ((100, 50), 0.01, 500, 'adam', 0.01)...
Working on ((100, 50), 0.01, 500, 'lbfgs', 0.001)...
Working on ((100, 50), 0.01, 500, 'lbfgs', 0.01)...
Working on ((100, 50), 0.01, 1000, 'adam', 0.001)...
Working on ((100, 50), 0.01, 1000, 'adam', 0.01)...
Working on ((100, 50), 0.01, 1000, 'lbfgs', 0.001)...
Working on ((100, 50), 0.01, 1000, 'lbfgs', 0.01)...
Working on ((50, 75), 0.001, 500, 'adam', 0.001)...
Working on ((50, 75), 0.001, 500, 'adam', 0.01)...
Working on ((50, 75), 0.001, 500, 'lbfgs', 0.001)...
Working on ((50, 75), 0.001, 500, 'lbfgs', 0.01)...
```

```
Working on ((50, 75), 0.001, 1000, 'adam', 0.001)...
Working on ((50, 75), 0.001, 1000, 'adam', 0.01)...
Working on ((50, 75), 0.001, 1000, 'lbfgs', 0.001)...
Working on ((50, 75), 0.001, 1000, 'lbfgs', 0.01)...
Working on ((50, 75), 0.01, 500, 'adam', 0.001)...
Working on ((50, 75), 0.01, 500, 'adam', 0.01)...
Working on ((50, 75), 0.01, 500,
                                   'lbfgs', 0.001)...
                                    'lbfgs', 0.01)...
Working on ((50, 75), 0.01, 500,
Working on ((50, 75), 0.01, 1000, 'adam', 0.001)...
Working on ((50, 75), 0.01, 1000, 'adam', 0.01)...
Working on ((50, 75), 0.01, 1000, 'lbfgs', 0.001)...
Working on ((50, 75), 0.01, 1000, 'lbfgs', 0.01)...
Working on ((200, 100), 0.001, 500, 'adam', 0.001)...
Working on ((200, 100), 0.001, 500, 'adam', 0.01)...
Working on ((200, 100), 0.001, 500, 'lbfgs', 0.001)...
Working on ((200, 100), 0.001, 500, 'lbfgs', 0.01)...
Working on ((200, 100), 0.001, 1000, 'adam', 0.001)...
Working on ((200, 100), 0.001, 1000, 'adam', 0.01)...
Working on ((200, 100), 0.001, 1000, 'lbfgs', 0.001)...
Working on ((200, 100), 0.001, 1000, 'lbfgs', 0.01)...
Working on ((200, 100), 0.01, 500, 'adam', 0.001)...
                                     'adam', 0.01)...
Working on ((200, 100), 0.01, 500,
Working on ((200, 100), 0.01, 500,
                                      'lbfgs', 0.001)...
Working on ((200, 100), 0.01, 500, 'lbfgs', 0.01)...
Working on ((200, 100), 0.01, 1000, 'adam', 0.001)...
Working on ((200, 100), 0.01, 1000, 'adam', 0.01)...
Working on ((200, 100), 0.01, 1000, 'lbfgs', 0.001)...
Working on ((200, 100), 0.01, 1000, 'lbfgs', 0.01)...
Best Neural Network Model
Best Hyperparameters: ((200, 100), 0.001, 1000, 'adam', 0.001)
Best Accuracy: 1.0
Best Precision: 1.0
Best Recall: 1.0
Best F1 Score: 1.0
Best Confusion Matrix:
[[20 0]
 [ 0 14]]
```