DS Automation Assignment

Using our prepared churn data from week 2:

- use pycaret to find an ML algorithm that performs best on the data
  - Choose a metric you think is best to use for finding the best model; by default, it is accuracy but it could be AUC, precision, recall, etc. The week 3 FTE has some information on these different metrics.
- save the model to disk
- create a Python script/file/module with a function that takes a pandas dataframe as an input and returns the probability of churn for each row in the dataframe
  - your Python file/function should print out the predictions for new data (new_churn_data.csv)
  - the true values for the new data are [1, 0, 0, 1, 0] if you're interested
- test your Python module and function with the new data, new_churn_data.csv
- write a short summary of the process and results at the end of this notebook
- upload this Jupyter Notebook and Python file to a Github repository, and turn in a link to the repository in the week 5 assignment dropbox

Optional challenges:

- return the probability of churn for each new prediction, and the percentile where that prediction is in the distribution of probability predictions from the training dataset (e.g. a high probability of churn like 0.78 might be at the 90th percentile)
- use other autoML packages, such as TPOT, H2O, MLBox, etc, and compare performance and features with pycaret
- create a class in your Python module to hold the functions that you created
- accept user input to specify a file using a tool such as Python's `input()` function, the `click` package for command-line arguments, or a GUI
- Use the unmodified churn data (new_unmodified_churn_data.csv) in your Python script. This will require adding the same preprocessing steps from week 2 since this data is like the original unmodified dataset from week 1.

1. DataPrep

Lets read the prepped Cleaveland heart diseases data

In [1]:
```
# import Pandas
import pandas as pd
```

In [2]:
```
# based on the col names in heart-disease.names, lets import processed.cleveland.data
names=[ 'age','sex','cp','trestbps','chol','fbs','restecg', 'thalach','exang','oldpeak','slope','ca','thal','num']
df = pd.read_csv('./data/heartdisease/cleveland.data',  names = names)
print('data frame rows,columns : ',df.shape)
df.head()
```

```
data frame rows,columns :  (290, 14)
```

Out[2]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	num
0	63.0	1.0	1.0	145.0	233.0	1.0	2.0	150.0	0.0	2.3	3.0	0.0	6.0	0
1	67.0	1.0	4.0	160.0	286.0	0.0	2.0	108.0	1.0	1.5	2.0	3.0	3.0	2
2	67.0	1.0	4.0	120.0	229.0	0.0	2.0	129.0	1.0	2.6	2.0	2.0	7.0	1
3	37.0	1.0	3.0	130.0	250.0	0.0	0.0	187.0	0.0	3.5	3.0	0.0	3.0	0
4	41.0	0.0	2.0	130.0	204.0	0.0	2.0	172.0	0.0	1.4	1.0	0.0	3.0	0

In [17]:
```
# creating target column indicating heart disease
df['heartdisease'] = df['num'].replace({0:0, 1:1, 2:1, 3:1, 4:1})
df = df.drop('num', axis=1)
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 290 entries, 0 to 289
Data columns (total 14 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   age           290 non-null    float64
 1   sex           290 non-null    float64
 2   cp            290 non-null    float64
 3   trestbps      290 non-null    float64
 4   chol          290 non-null    float64
 5   fbs           290 non-null    float64
 6   restecg       290 non-null    float64
 7   thalach       290 non-null    float64
 8   exang         290 non-null    float64
 9   oldpeak       290 non-null    float64
 10  slope         290 non-null    float64
 11  ca            290 non-null    float64
 12  thal          290 non-null    float64
 13  heartdisease  290 non-null    int64  
dtypes: float64(13), int64(1)
memory usage: 31.8 KB
```

Comments : *This Time, I created 2 data sets - cleaveland.data (290 records) and new_cleveland.data (6 records). My goal is to create the best model using the 1st data set and do the predictions on the 2nd data set.*

2. Auto ML using PyCaret , saving & using model to make predictions

In [10]:
```
# One time install of pycaret
# !pip install pycaret
```

In [12]:
```
 #import the needed functions
from pycaret.classification import ClassificationExperiment #setup, compare_models, predict_model, save_model, load_model
```

In [13]:
```
automl = ClassificationExperiment()
```

In [18]:
```
automl.setup(df, target='heartdisease')
```

	Description	Value
0	Session id	7153
1	Target	heartdisease
2	Target type	Binary
3	Original data shape	(290, 14)
4	Transformed data shape	(290, 14)
5	Transformed train set shape	(203, 14)
6	Transformed test set shape	(87, 14)
7	Numeric features	13
8	Preprocess	True
9	Imputation type	simple
10	Numeric imputation	mean
11	Categorical imputation	mode
12	Fold Generator	StratifiedKFold
13	Fold Number	10
14	CPU Jobs	-1
15	Use GPU	False
16	Log Experiment	False
17	Experiment Name	clf-default-name
18	USI	8caf

Out[18]:
```
<pycaret.classification.oop.ClassificationExperiment at 0x1ce2da8d3d0>
```

In [19]:
```
automl
```

Out[19]:
```
<pycaret.classification.oop.ClassificationExperiment at 0x1ce2da8d3d0>
```

In [20]:
```
best_model = automl.compare_models()
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC	TT (Sec)
lr	Logistic Regression	0.8281	0.8781	0.7956	0.8353	0.8078	0.6531	0.6619	0.0150
nb	Naive Bayes	0.8276	0.8826	0.7833	0.8447	0.8058	0.6514	0.6614	0.0050
et	Extra Trees Classifier	0.8231	0.8866	0.7844	0.8297	0.7995	0.6422	0.6519	0.0260
ridge	Ridge Classifier	0.8183	0.0000	0.7956	0.8150	0.7993	0.6338	0.6409	0.0050
lda	Linear Discriminant Analysis	0.8183	0.8796	0.7956	0.8150	0.7993	0.6338	0.6409	0.0050
qda	Quadratic Discriminant Analysis	0.7986	0.8311	0.7411	0.8234	0.7694	0.5931	0.6096	0.0050
rf	Random Forest Classifier	0.7979	0.8725	0.7611	0.7947	0.7735	0.5914	0.5967	0.0270
lightgbm	Light Gradient Boosting Machine	0.7883	0.8837	0.7200	0.8124	0.7518	0.5701	0.5854	0.0380
gbc	Gradient Boosting Classifier	0.7686	0.8543	0.7289	0.7699	0.7390	0.5329	0.5466	0.0140
ada	Ada Boost Classifier	0.7443	0.8156	0.6778	0.7626	0.7008	0.4818	0.5001	0.0120
dt	Decision Tree Classifier	0.6748	0.6726	0.6422	0.6668	0.6374	0.3457	0.3601	0.0050
svm	SVM - Linear Kernel	0.6543	0.0000	0.6267	0.7460	0.5970	0.3141	0.3655	0.0050
knn	K Neighbors Classifier	0.6455	0.7015	0.5667	0.6309	0.5817	0.2796	0.2918	0.0100
dummy	Dummy Classifier	0.5469	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0050

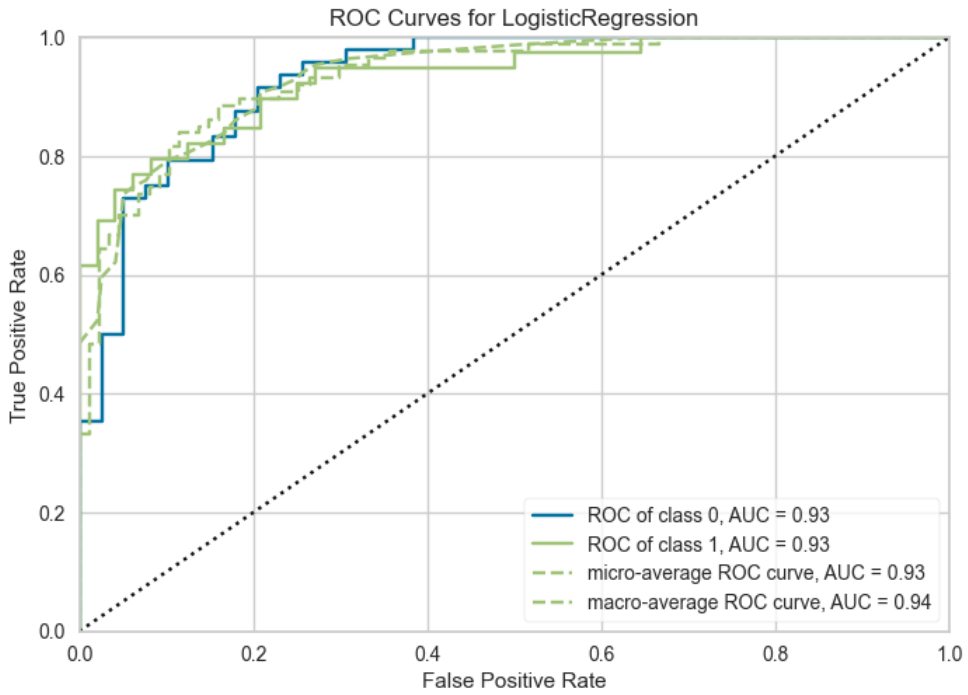
In [21]:
```
best_model
```

Out[21]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=1000,
                   multi_class='auto', n_jobs=None, penalty='l2',
                   random_state=7153, solver='lbfgs', tol=0.0001, verbose=0,
                   warm_start=False)
```

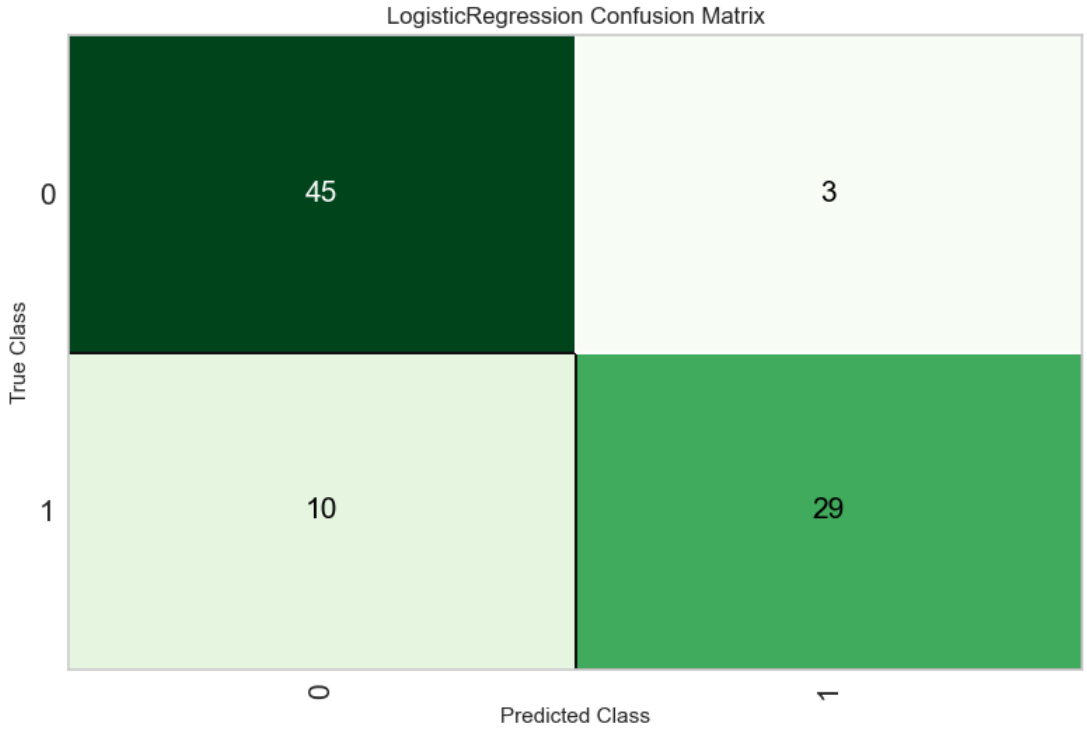
In [22]:
```
automl.evaluate_model(best_model)
```

```
interactive(children=(ToggleButtons(description='Plot Type:', icons=('',), options=(('Pipeline Plot', 'pipelin…
```

In [23]:
```
automl.plot_model(best_model)
```



In [24]:
```
automl.plot_model(best_model, plot = 'confusion_matrix')
```



In [25]:
```
automl.predict_model(best_model, df.iloc[-2:-1])
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	Logistic Regression	1.0000	0	1.0000	1.0000	1.0000	nan	0.0000

Out[25]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	heartdisease	prediction_label	prediction_sco
288	63.0	1.0	4.0	140.0	187.0	0.0	2.0	144.0	1.0	4.0	1.0	2.0	7.0	1	1	0.98

In [26]:
```
predictions = automl.predict_model(best_model, data=df)
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	Logistic Regression	0.8448	0.9214	0.7939	0.8525	0.8221	0.6848	0.6862

In [27]:
```
predictions.head()
```

Out[27]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	heartdisease	prediction_label	prediction_score
0	63.0	1.0	1.0	145.0	233.0	1.0	2.0	150.0	0.0	2.3	3.0	0.0	6.0	0	0	0.7011
1	67.0	1.0	4.0	160.0	286.0	0.0	2.0	108.0	1.0	1.5	2.0	3.0	3.0	1	1	0.9837
2	67.0	1.0	4.0	120.0	229.0	0.0	2.0	129.0	1.0	2.6	2.0	2.0	7.0	1	1	0.9865
3	37.0	1.0	3.0	130.0	250.0	0.0	0.0	187.0	0.0	3.5	3.0	0.0	3.0	0	0	0.7971
4	41.0	0.0	2.0	130.0	204.0	0.0	2.0	172.0	0.0	1.4	1.0	0.0	3.0	0	0	0.9606

In [28]:
```
automl.save_model(best_model, 'pycaret_model')
```

```
Transformation Pipeline and Model Successfully Saved
```

Out[28]:
```
(Pipeline(memory=Memory(location=None),
          steps=[('numerical_imputer',
                  TransformerWrapper(exclude=None,
                                     include=['age', 'sex', 'cp', 'trestbps',
                                              'chol', 'fbs', 'restecg',
                                              'thalach', 'exang', 'oldpeak',
                                              'slope', 'ca', 'thal'],
                                     transformer=SimpleImputer(add_indicator=False,
                                                               copy=True,
                                                               fill_value=None,
                                                               keep_empty_features=False,
                                                               missing_values=nan,
                                                               strategy='mean',
                                                               verbose='d...
                                                               keep_empty_features=False,
                                                               missing_values=nan,
                                                               strategy='most_frequent',
                                                               verbose='deprecated'))),
                 ('trained_model',
                  LogisticRegression(C=1.0, class_weight=None, dual=False,
                                     fit_intercept=True, intercept_scaling=1,
                                     l1_ratio=None, max_iter=1000,
                                     multi_class='auto', n_jobs=None,
                                     penalty='l2', random_state=7153,
                                     solver='lbfgs', tol=0.0001, verbose=0,
                                     warm_start=False))],
          verbose=False),
 'pycaret_model.pkl')
```

In [29]:
```
new_pycaret = ClassificationExperiment()
loaded_model = new_pycaret.load_model('pycaret_model')
```

```
Transformation Pipeline and Model Successfully Loaded
```

In [32]:
```
new_df = pd.read_csv('./data/heartdisease/new_cleveland.data',  names = names)
new_df['heartdisease'] = new_df['num'].replace({0:0, 1:1, 2:1, 3:1, 4:1})
new_df = new_df.drop('num', axis=1)
new_data = new_df
new_pycaret.predict_model(loaded_model, new_data)
```

Out[32]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	heartdisease	prediction_label	prediction_score
0	41.0	1.0	2.0	120.0	157.0	0.0	0.0	182.0	0.0	0.0	1.0	0.0	3.0	0	0	0.9806
1	59.0	1.0	4.0	164.0	176.0	1.0	2.0	90.0	0.0	1.0	2.0	2.0	6.0	1	1	0.9437
2	57.0	0.0	4.0	140.0	241.0	0.0	0.0	123.0	1.0	0.2	2.0	0.0	7.0	1	1	0.5816
3	45.0	1.0	1.0	110.0	264.0	0.0	0.0	132.0	0.0	1.2	2.0	0.0	7.0	1	0	0.8784
4	68.0	1.0	4.0	144.0	193.0	1.0	0.0	141.0	0.0	3.4	2.0	2.0	7.0	1	1	0.9332
5	57.0	1.0	4.0	130.0	131.0	0.0	0.0	115.0	1.0	1.2	2.0	1.0	7.0	1	1	0.8789
6	57.0	0.0	2.0	130.0	236.0	0.0	2.0	174.0	0.0	0.0	2.0	1.0	3.0	1	0	0.8911

Comments / learnings : *This Time, I created 2 data sets - cleaveland.data (290 records) and new_cleveland.data (6 records) . used the first dataset to get the best model using pycaret. the "automl.evaluate_model(best_model)" was interesting - it allowed to click on the different plots available. then i saved the best model to a pickle file. with this saved pycaret model, I used the 2nd dataset to make the predictions.*

3. Create a Python Script to Make Predictions

In [46]:
```
from IPython.display import Code
Code('predict_heartdisease.py')
```

Out[46]:
```
import pandas as pd
from pycaret.classification import ClassificationExperiment

def load_data(filepath):
    """
    Loads heartdisease data file into a DataFrame from a string filepath.
    """
    names=[ 'age','sex','cp','trestbps','chol','fbs','restecg', 'thalach','exang','oldpeak','slope','ca','thal','num']
    df = pd.read_csv(filepath,  names = names)
    df['heartdisease'] = df['num'].replace({0:0, 1:1, 2:1, 3:1, 4:1})
    df = df.drop('num', axis=1)
    return df


def make_predictions(df):
    """
    Uses the pycaret best model to make predictions on data in the df dataframe.
    """
    classifier = ClassificationExperiment()
    model = classifier.load_model('pycaret_model')
    predictions = classifier.predict_model(model, data=df)
    predictions.rename({'prediction_label': 'Heartdisease_prediction'}, axis=1, inplace=True)
    predictions['Heartdisease_prediction'].replace({1: 'Heart Disease', 0: 'No Heart Disease'},
                                    inplace=True)
    return predictions['Heartdisease_prediction']


if __name__ == "__main__":
    df = load_data('./data/heartdisease/new_cleveland.data')
    predictions = make_predictions(df)
    print('predictions:')
    print(predictions)
```

In [47]:
```
%run predict_heartdisease.py
```

```
Transformation Pipeline and Model Successfully Loaded
predictions:
0    No Heart Disease
1       Heart Disease
2       Heart Disease
3    No Heart Disease
4       Heart Disease
5       Heart Disease
6    No Heart Disease
Name: Heartdisease_prediction, dtype: object
<Figure size 800x550 with 0 Axes>
```

Comments / learnings : *to create the python file, I used the jupyter notbook itself. I have used pycharm before which provides coder friendly IDE. so wanted to try the jupyter notbook itself. I used the smaller dataset of 6 records to do the model and predictions.*

Summary

The automation ML was interesting. It allowed to choose the best model based on the accuracy score, save it and was able to use it on a different data set. Also learnt to create python scripts within the jyputer notebook environment. Finally setup a github account and published the code.