ML1000 - Project 1 - Heart Training

Environment Setup

```
!pip install pycaret -q
```

```
!pip install https://github.com/pandas-profiling/pandas-profiling/archive/master.zip -q
```

```
import numpy as np
import pandas as pd

from pycaret.classification import *
from pandas_profiling import ProfileReport
from pycaret.utils import enable_colab
enable_colab()
```

```
     Colab mode enabled.
```

```
# running this fixed the plots not displaying
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec
import seaborn as sns
%matplotlib inline
plt.close('all')
```

```
from google.colab import drive

drive.mount('/content/gdrive', force_remount=True)
```

```
     Mounted at /content/gdrive
```

```
#profile = ProfileReport(dataset, title="Heart Dataset", html={'style': {'full_width': True}})
#profile.to_notebook_iframe()
#profile.to_file(output_file="Heart_UCI_Profile.html")
```

Data Import/Setup

```
df_path = 'gdrive/My Drive/Colab Notebooks/heart_cleveland_upload.csv'  #change dir to your project folder
dataset = pd.read_csv(df_path)
dataset.shape
```

```
     (297, 14)
```

```
dataset.head(1)
```

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca
0	69	1	0	160	234	1	2	131	0	0.1	1	1

```
# Rename categorical modes for better graphs/understanding
dataset.sex = dataset.sex.map({0:'Female',1:'Male'})
dataset.cp = dataset.cp.map({3:'Asymptomatic', 1:'Atypical', 2:'Not Anginal', 0:'Typical'})
dataset.fbs = dataset.fbs.map({0:'<120mg',1:'120mg+'})
dataset.restecg= dataset.restecg.map({0:'Normal',1:'ST Abnormality',2:'LV Hypertrophy'})
dataset.exang = dataset.exang.map({0:'No',1:'Yes'})
dataset.slope = dataset.slope.map({0:'Upslope',1:'Flat',2:'Downslope'})
dataset.thal = dataset.thal.map({1:'Fixed Defect',0:'Normal',2:'Reversable Defect'})
#dataset.condition = dataset.condition.map({0:1, 1:0}) #Reverse order for better graph display?
dataset.condition = dataset.condition.map({0:'No', 1:'Yes'})

# bin oldpeak
bins= [-0.1,0.1,1.5,np.inf]
names=["None","Low","High"]
```

```
names = ['None', 'Low', 'High']
dataset.oldpeak=pd.cut(dataset.oldpeak, bins, labels=names)

# Renaming columns
dataset.columns = ['Age', 'Gender', 'Chest_Pain', 'Blood_Pressure', 'Cholesterol', 'Blood_Sugar', 'Rest_ECG', 'Max_Heart_Rat
       'Exercise_Angina', 'ST_Depression', 'ST_Slope', 'Marked_Vessels', 'Thalassemia', 'Heart_Disease']

dataset.head(4)
```

	Age	Gender	Chest_Pain	Blood_Pressure	Cholesterol	Blood_Sugar	Rest_ECG
0	69	Male	Typical	160	234	120mg+	LV Hypertrophy
1	69	Female	Typical	140	239	<120mg	Normal
2	66	Female	Typical	150	226	<120mg	Normal
3	65	Male	Typical	138	282	120mg+	LV

```
data = dataset.sample(frac=0.90, random_state=54321)
data_unseen = dataset.drop(data.index)

data.reset_index(inplace=True, drop=True)
data_unseen.reset_index(inplace=True, drop=True)

print('Data for Modeling: ' + str(data.shape))
print('Unseen Data For Predictions ' + str(data_unseen.shape))
```

```
Data for Modeling: (267, 14)
Unseen Data For Predictions (30, 14)
```

```
data.head(1)
```

	Age	Gender	Chest_Pain	Blood_Pressure	Cholesterol	Blood_Sugar	Rest_ECG	I
0	62	Female	Asymptomatic	150	244	<120mg	Normal	

```
#Decision:  We dropped the "fbs" column because in a small dataset there is are only two values and they are split into a 85

#data.drop('Blood_Sugar', axis=1, inplace=True)
#data.head(1)
```

```
#Set variable for name of target column
TARGET_COLUMN = 'Heart_Disease'

exp_clf102 = setup(
      data = data,
      target = TARGET_COLUMN,
#      feature_selection = True,
#      feature_selection_threshold = .5,
      pca = True,
#      pca_components = .999,
#      combine_rare_levels = True,
#      rare_level_threshold = 0.05,
#      ignore_features = ['oldpeak'],
      normalize = True,
#      transformation = True,
      remove_multicollinearity = True,
#      multicollinearity_threshold = 0.70,
#      numeric_features = ['Marked_Vessels'],
      bin_numeric_features = ['Age'],
      ordinal_features = {'ST_Depression': ['None','Low','High']},
#      feature_selection = True,
#      profile=True,
      silent=True,
      train_size = 0.9,
      remove_outliers = True,
      #log_experiment = True,
      #experiment_name = 'P1_Heart',
      session_id=123)
```

	Description	Value
0	session_id	123
1	Target	Heart_Disease
2	Target Type	Binary
3	Label Encoded	No: 0, Yes: 1
4	Original Data	(267, 14)
5	Missing Values	False
6	Numeric Features	4
7	Categorical Features	9
8	Ordinal Features	True
9	High Cardinality Features	False
10	High Cardinality Method	None
11	Transformed Train Set	(228, 23)
12	Transformed Test Set	(27, 23)
13	Shuffle Train-Test	True
14	Stratify Train-Test	False
15	Fold Generator	StratifiedKFold
16	Fold Number	10
17	CPU Jobs	-1
18	Use GPU	False
19	Log Experiment	False
20	Experiment Name	clf-default-name
21	USI	94e6
22	Imputation Type	simple
23	Iterative Imputation Iteration	None
24	Numeric Imputer	mean
25	Iterative Imputation Numeric Model	None
26	Categorical Imputer	constant
27	Iterative Imputation Categorical Model	None
28	Unknown Categoricals Handling	least_frequent
29	Normalize	True
30	Normalize Method	zscore
31	Transformation	False
32	Transformation Method	None
33	PCA	True
34	PCA Method	linear
35	PCA Components	0.99
36	Ignore Low Variance	False
37	Combine Rare Levels	False
38	Rare Level Threshold	None
39	Numeric Binning	True
40	Remove Outliers	True
41	Outliers Threshold	0.05
42	Remove Multicollinearity	True
43	Multicollinearity Threshold	0.9
44	Remove Perfect Collinearity	True
45	Clustering	False
46	Clustering Iteration	None
47	Polynomial Features	False
48	Polynomial Degree	None

49	Trignometry Features	False
50	Polynomial Threshold	None
51	Group Features	False
52	Feature Selection	False
53	Feature Selection Method	classic
54	Features Selection Threshold	None
55	Feature Interaction	False
56	Feature Ratio	False

Compare models

59	Fix Imbalance Method	SMOTE

```
#Compare models common parameters
#Decision:  Num folds = 10 because
#Decision: Optimize_for = Accuracy because
NUM_FOLDS = 10
OPTIMIZE_FOR = 'Recall'
```

```
top3 = compare_models(
      fold=NUM_FOLDS,
      n_select=3,
      sort=OPTIMIZE_FOR,
      turbo=False)
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC	T (Sec
mlp	MLP Classifier	0.7976	0.9052	0.7845	0.8042	0.7792	0.5944	0.6125	0.64
gbc	Gradient Boosting Classifier	0.8024	0.8819	0.7845	0.8079	0.7829	0.6037	0.6204	0.15
rbfsvm	SVM - Radial Kernel	0.8152	0.8979	0.7836	0.8261	0.7941	0.6282	0.6422	0.02
lightgbm	Light Gradient Boosting Machine	0.8148	0.8828	0.7818	0.8219	0.7938	0.6267	0.6367	0.07
lr	Logistic Regression	0.8067	0.9007	0.7655	0.8226	0.7809	0.6104	0.6251	0.02
et	Extra Trees Classifier	0.8026	0.8949	0.7645	0.8130	0.7731	0.6009	0.6160	0.46
qda	Quadratic Discriminant Analysis	0.7761	0.8443	0.7564	0.7761	0.7550	0.5509	0.5635	0.01
knn	K Neighbors Classifier	0.8283	0.8738	0.7555	0.8676	0.8015	0.6526	0.6638	0.11
ridge	Ridge	0.8111	0.9000	0.7970	0.8125	0.7970	0.6170	0.6220	0.01

Model 1 - Exploration

```
#comment out "create model" and switch to using top3[0] for automated model run/selection
#
#model1 = top3[0]
model1 = create_model('mlp')
display(model1)
```

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.7826	0.9615	0.9000	0.6923	0.7826	0.5725	0.5923
1	0.8261	0.8538	0.7000	0.8750	0.7778	0.6378	0.6485
2	0.9565	0.9462	1.0000	0.9091	0.9524	0.9125	0.9161
3	0.7826	0.8636	0.6364	0.8750	0.7368	0.5594	0.5800
4	0.7391	0.8485	0.6364	0.7778	0.7000	0.4733	0.4808
5	0.7826	0.9773	0.5455	1.0000	0.7059	0.5560	0.6205
6	0.6522	0.8258	0.7273	0.6154	0.6667	0.3083	0.3130
7	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8	0.6364	0.7917	0.7000	0.5833	0.6364	0.2787	0.2833
9	0.8182	0.9833	1.0000	0.7143	0.8333	0.6452	0.6901
Mean	0.7976	0.9052	0.7845	0.8042	0.7792	0.5944	0.6125

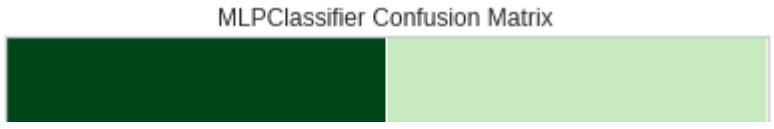
```
evaluate_model(model1)
```

Plot Type:

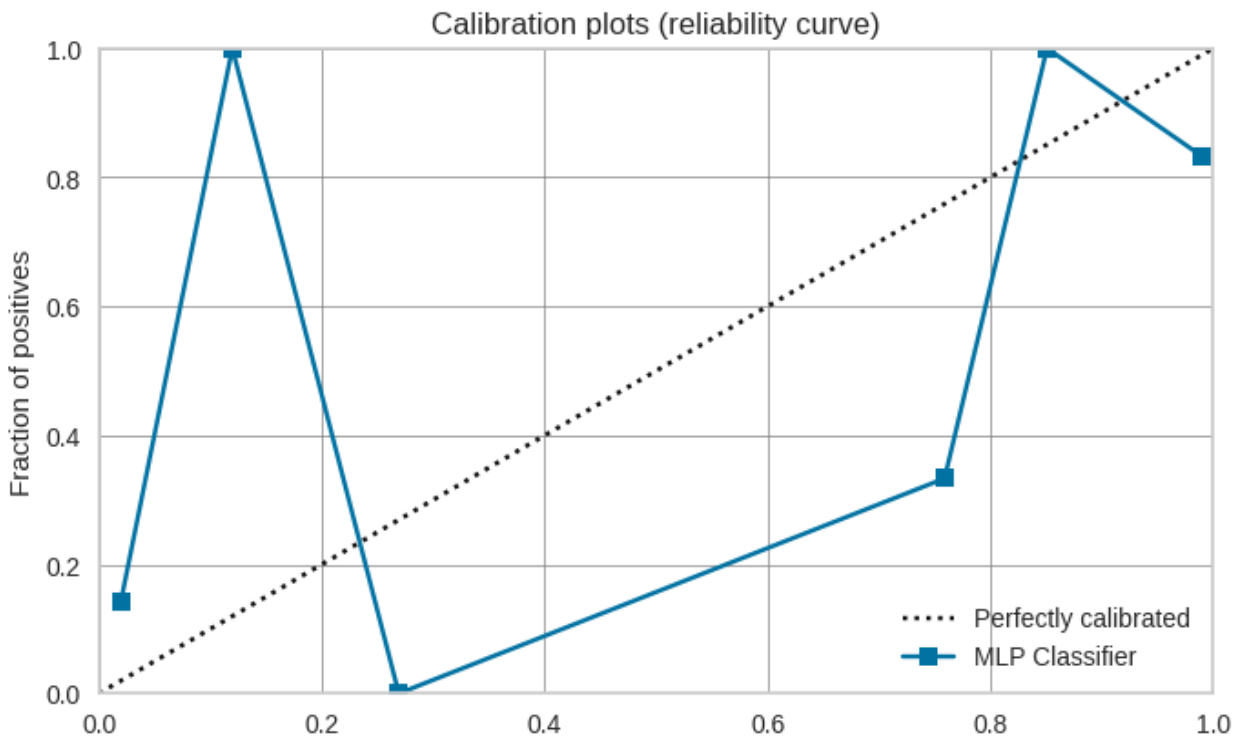
Hyperparameters	AUC	Confusion Matrix
Threshold	Precision Recall	Prediction Error
Class Report	Feature Selection	Learning Curve
Manifold Learning	Calibration Curve	Validation Curve
Dimensions	Feature Importance	Feature Importance…
Decision Boundary	Lift Chart	Gain Chart
Decision Tree	KS Statistic Plot	

	Parameters
activation	relu
alpha	0.0001
batch_size	auto
beta_1	0.9
beta_2	0.999
early_stopping	False
epsilon	1e-08
hidden_layer_sizes	(100,)
learning_rate	constant
learning_rate_init	0.001
max_fun	15000
max_iter	500
momentum	0.9
n_iter_no_change	10
nesterovs_momentum	True
power_t	0.5
random_state	123
shuffle	True
solver	adam
tol	0.0001

```
plot_model(model1, plot='confusion_matrix')
```




```
plot_model(model1, plot='calibration')
```




```
tuned_model1=tune_model(model1, optimize=OPTIMIZE_FOR,fold=NUM_FOLDS)
score_tuned_model1=pull()
display(tuned_model1)
```

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.8261	0.9385	0.9000	0.7500	0.8182	0.6541	0.6641
1	0.8261	0.9308	0.7000	0.8750	0.7778	0.6378	0.6485
2	0.8696	0.9692	0.9000	0.8182	0.8571	0.7376	0.7405
3	0.7826	0.8030	0.5455	1.0000	0.7059	0.5560	0.6205
4	0.7826	0.8636	0.6364	0.8750	0.7368	0.5594	0.5800
5	0.9130	0.9167	0.8182	1.0000	0.9000	0.8244	0.8374
6	0.8261	0.8712	0.8182	0.8182	0.8182	0.6515	0.6515
7	0.9565	0.9924	0.9091	1.0000	0.9524	0.9125	0.9161
8	0.6818	0.8333	0.7000	0.6364	0.6667	0.3636	0.3651
9	0.8636	0.9583	1.0000	0.7692	0.8696	0.7317	0.7596
Mean	0.8328	0.9077	0.7927	0.8542	0.8103	0.6629	0.6783
SD	0.0721	0.0590	0.1355	0.1152	0.0849	0.1454	0.1432

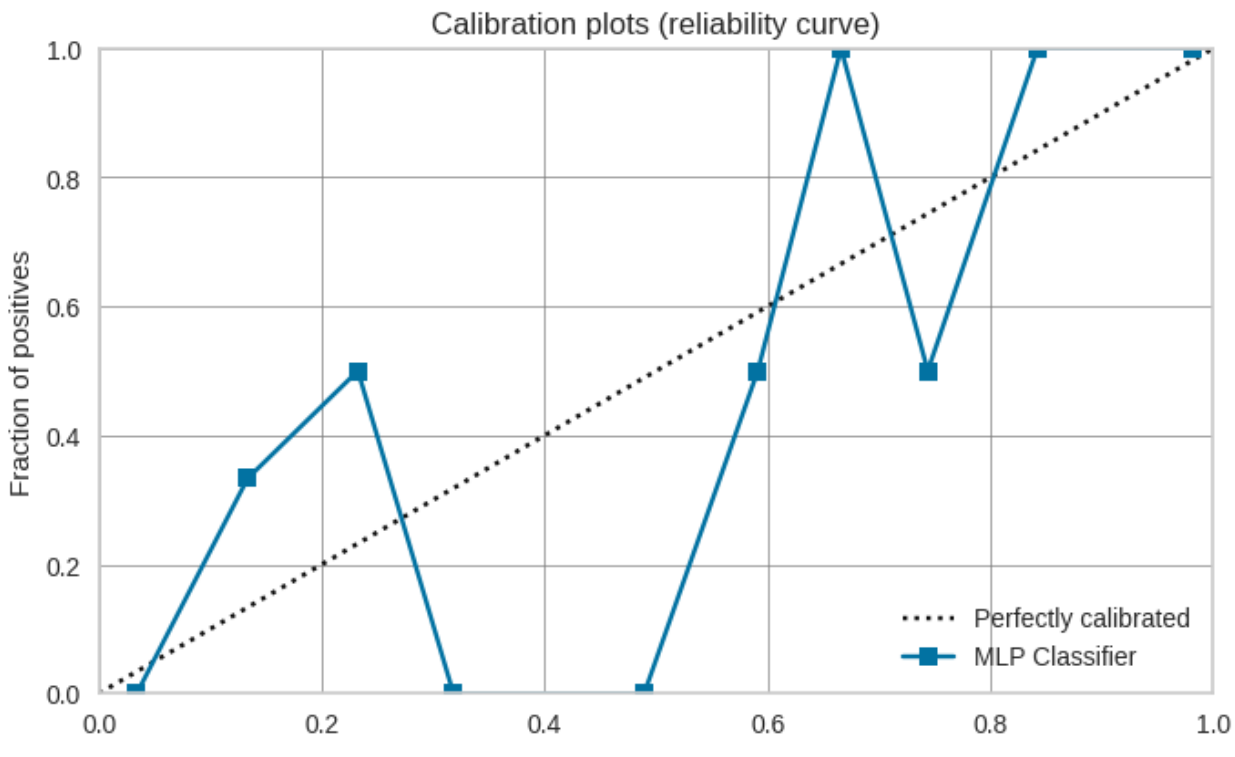
```
MLPClassifier(activation='identity', alpha=0.5, batch_size='auto', beta_1=0.9,
              beta_2=0.999, early_stopping=False, epsilon=1e-08,
              hidden_layer_sizes=[100], learning_rate='constant',
              learning_rate_init=0.001, max_fun=15000, max_iter=500,
              momentum=0.9, n_iter_no_change=10, nesterovs_momentum=True,
              power_t=0.5, random_state=123, shuffle=True, solver='adam',
              tol=0.0001, validation_fraction=0.1, verbose=False,
              warm_start=False)
```

```
evaluate_model(tuned_model1)
```

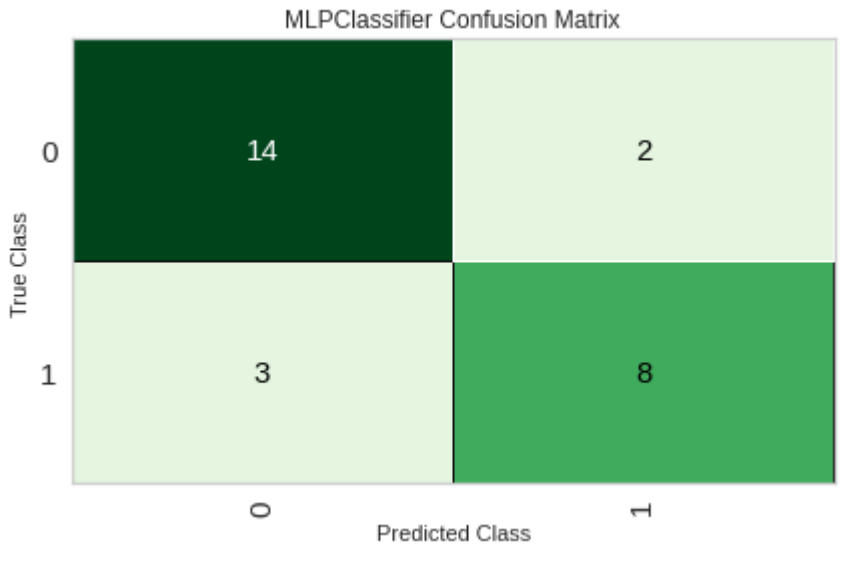
Plot Type:	Hyperparameters	AUC	Confusion Matrix
	Threshold	Precision Recall	Prediction Error
	Class Report	Feature Selection	Learning Curve
	Manifold Learning	Calibration Curve	Validation Curve
	Dimensions	Feature Importance	Feature Importance…
	Decision Boundary	Lift Chart	Gain Chart
	Decision Tree	KS Statistic Plot	

	Parameters
activation	identity
alpha	0.5
batch_size	auto
beta_1	0.9
beta_2	0.999
early_stopping	False
epsilon	1e-08
hidden_layer_sizes	[100]
learning_rate	constant
learning_rate_init	0.001

```
plot_model(tuned_model1, plot='calibration')
```




```
plot_model(tuned_model1, plot='confusion_matrix')
```




```
calibrated_model1 = calibrate_model(tuned_model1)
score_calibrated_model1=pull()
display(calibrated_model1)
```

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.8261	0.9385	0.9000	0.7500	0.8182	0.6541	0.6641
1	0.8261	0.9154	0.7000	0.8750	0.7778	0.6378	0.6485
2	0.9565	0.9769	1.0000	0.9091	0.9524	0.9125	0.9161
3	0.7391	0.7955	0.5455	0.8571	0.6667	0.4692	0.5017
4	0.7391	0.8182	0.5455	0.8571	0.6667	0.4692	0.5017
5	0.7826	0.9318	0.5455	1.0000	0.7059	0.5560	0.6205
6	0.6522	0.7727	0.7273	0.6154	0.6667	0.3083	0.3130
7	0.9130	0.9848	0.9091	0.9091	0.9091	0.8258	0.8258
8	0.7273	0.8000	0.7000	0.7000	0.7000	0.4500	0.4500
9	0.8182	0.9500	0.9000	0.7500	0.8182	0.6393	0.6500
Mean	0.7980	0.8884	0.7473	0.8223	0.7681	0.5922	0.6091
SD	0.0859	0.0780	0.1624	0.1096	0.0992	0.1725	0.1684

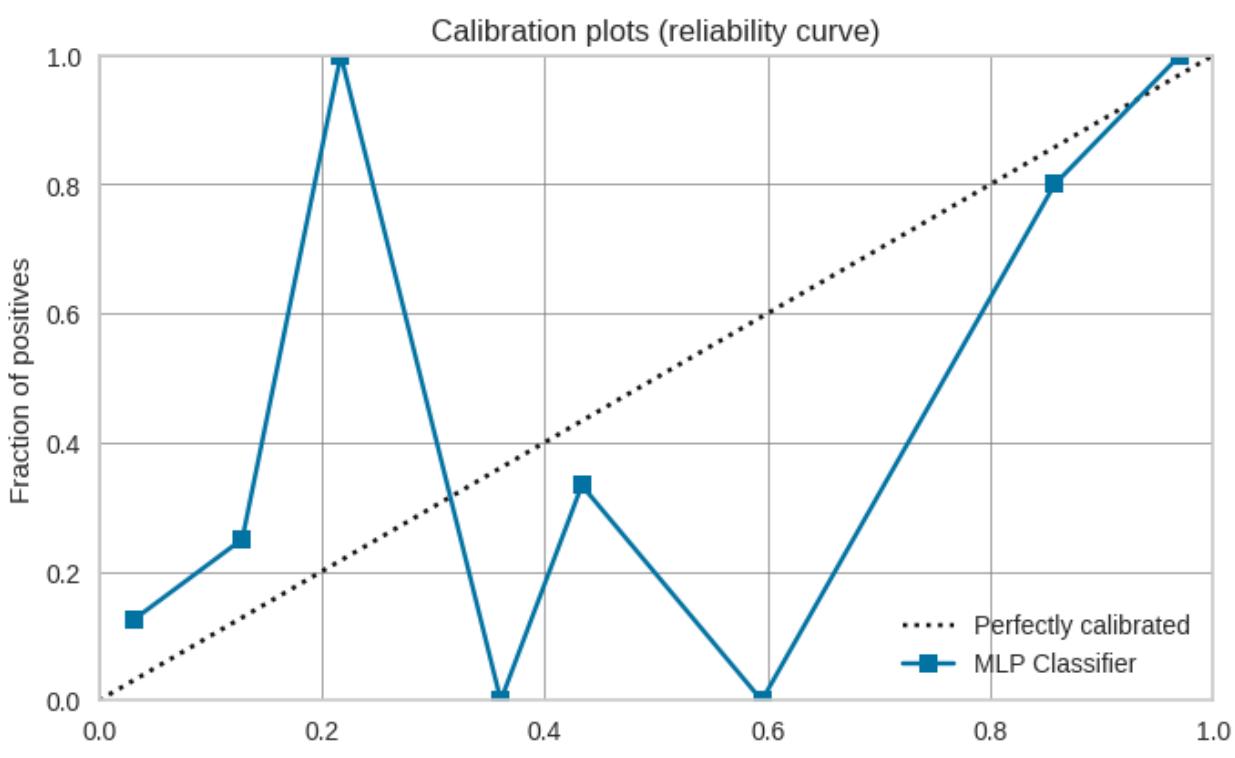
```
CalibratedClassifierCV(base_estimator=MLPClassifier(activation='identity',
                                                    alpha=0.5,
                                                    batch_size='auto',
                                                    beta_1=0.9, beta_2=0.999,
                                                    early_stopping=False,
                                                    epsilon=1e-08,
                                                    hidden_layer_sizes=[100],
                                                    learning_rate='constant',
                                                    learning_rate_init=0.001,
                                                    max_fun=15000, max_iter=500,
                                                    momentum=0.9,
                                                    n_iter_no_change=10,
                                                    nesterovs_momentum=True,
                                                    power_t=0.5,
                                                    random_state=123,
                                                    shuffle=True, solver='adam',
                                                    tol=0.0001,
                                                    validation_fraction=0.1,
```

```
evaluate_model(calibrated_model1)
```

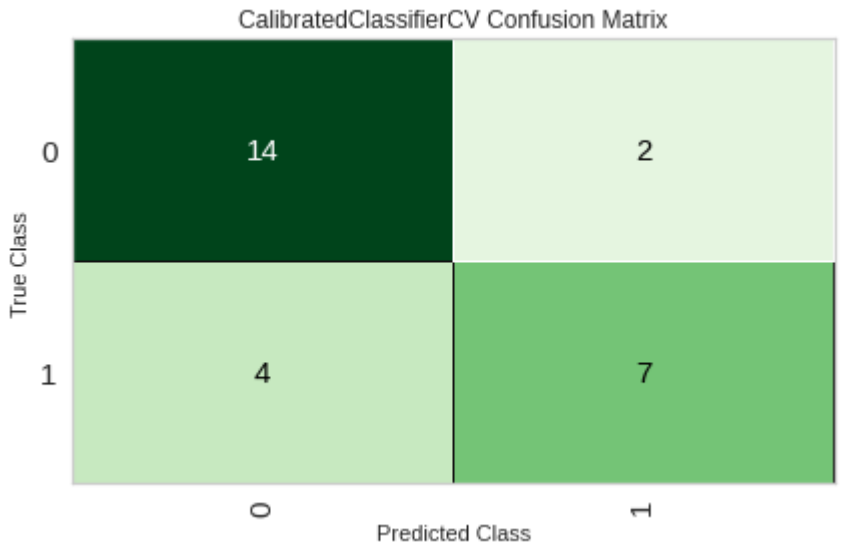
Plot Type:			
	Hyperparameters	AUC	Confusion Matrix
	Threshold	Precision Recall	Prediction Error
	Class Report	Feature Selection	Learning Curve
	Manifold Learning	Calibration Curve	Validation Curve
	Dimensions	Feature Importance	Feature Importance…
	Decision Boundary	Lift Chart	Gain Chart
	Decision Tree	KS Statistic Plot	

Parameters

```
plot_model(calibrated_model1,plot='calibration')
```



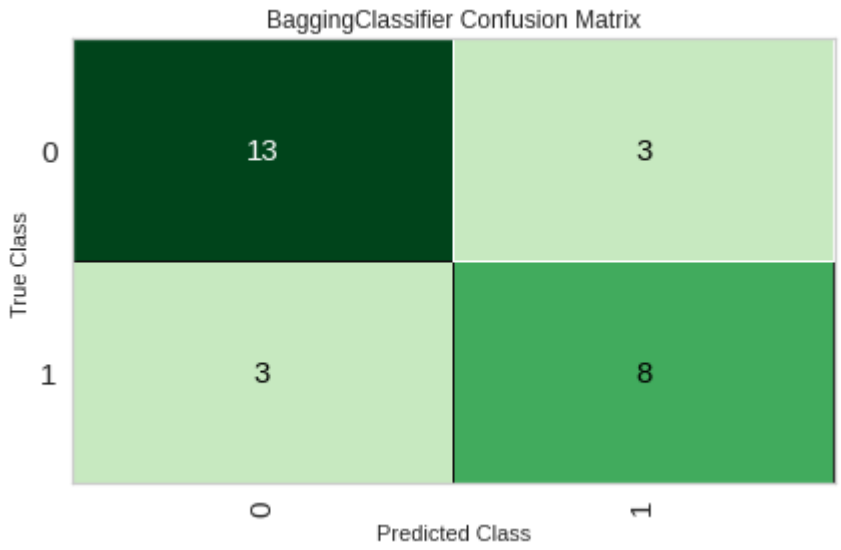

```
plot_model(calibrated_model1, plot='confusion_matrix')
```




```
#Decide between tuned model and calibrated model
#used as base for bag/boost

move_forward_model = tuned_model1
#move_forward_model = calibrated_model1



bagged_model1 = ensemble_model(move_forward_model)
score_bagged_model1=pull()
```

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.8261	0.9308	0.9000	0.7500	0.8182	0.6541	0.6641
1	0.8261	0.8923	0.7000	0.8750	0.7778	0.6378	0.6485
2	0.9130	0.9769	0.9000	0.9000	0.9000	0.8231	0.8231
3	0.7391	0.7955	0.5455	0.8571	0.6667	0.4692	0.5017
4	0.7391	0.8485	0.5455	0.8571	0.6667	0.4692	0.5017
5	0.8696	0.9015	0.7273	1.0000	0.8421	0.7356	0.7628
6	0.7391	0.8561	0.8182	0.6923	0.7500	0.4812	0.4886
7	0.9565	0.9924	0.9091	1.0000	0.9524	0.9125	0.9161
8	0.7273	0.8333	0.7000	0.7000	0.7000	0.4500	0.4500
9	0.8636	0.9667	1.0000	0.7692	0.8696	0.7317	0.7596
Mean	0.8200	0.8994	0.7745	0.8401	0.7943	0.6365	0.6516
SD	0.0774	0.0631	0.1485	0.1054	0.0940	0.1565	0.1535

```
plot_model(bagged_model1, plot='confusion_matrix')
```




```
#boosted_model1 = ensemble_model(move_forward_model,method = 'Boosting')
#score_boosted_model1=pull()



#plot_model(boosted_model1, plot='confusion_matrix')
```

Blend Models

[ ] ↳ *6 cells hidden*

Model Evaluation

```
#Compare Model Summaries

#Not including base model 1 as tuned model 1 should be no worse
#display('Summary: model1')
#results_model1 = predict_model(model1)

display('Summary: tuned_model1')
display(score_tuned_model1)

display('Prediction: calibrated_model1')
display(score_calibrated_model1)

display('Prediction: bagged_model1')
display(score_bagged_model1)

#display('Prediction: boosted_model1')
#display(score_boosted_model1)

display('Prediction: blend_soft')
display(score_blend_soft)
```

```
display('Prediction: blend_hard')
display(score_blend_hard)
```

'Summary: tuned_model1'

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.8261	0.9385	0.9000	0.7500	0.8182	0.6541	0.6641
1	0.8261	0.9308	0.7000	0.8750	0.7778	0.6378	0.6485
2	0.8696	0.9692	0.9000	0.8182	0.8571	0.7376	0.7405
3	0.7826	0.8030	0.5455	1.0000	0.7059	0.5560	0.6205
4	0.7826	0.8636	0.6364	0.8750	0.7368	0.5594	0.5800
5	0.9130	0.9167	0.8182	1.0000	0.9000	0.8244	0.8374
6	0.8261	0.8712	0.8182	0.8182	0.8182	0.6515	0.6515
7	0.9565	0.9924	0.9091	1.0000	0.9524	0.9125	0.9161
8	0.6818	0.8333	0.7000	0.6364	0.6667	0.3636	0.3651
9	0.8636	0.9583	1.0000	0.7692	0.8696	0.7317	0.7596
Mean	0.8328	0.9077	0.7927	0.8542	0.8103	0.6629	0.6783
SD	0.0721	0.0590	0.1355	0.1152	0.0849	0.1454	0.1432

'Prediction: calibrated_model1'

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.8261	0.9385	0.9000	0.7500	0.8182	0.6541	0.6641
1	0.8261	0.9154	0.7000	0.8750	0.7778	0.6378	0.6485
2	0.9565	0.9769	1.0000	0.9091	0.9524	0.9125	0.9161
3	0.7391	0.7955	0.5455	0.8571	0.6667	0.4692	0.5017
4	0.7391	0.8182	0.5455	0.8571	0.6667	0.4692	0.5017
5	0.7826	0.9318	0.5455	1.0000	0.7059	0.5560	0.6205
6	0.6522	0.7727	0.7273	0.6154	0.6667	0.3083	0.3130
7	0.9130	0.9848	0.9091	0.9091	0.9091	0.8258	0.8258
8	0.7273	0.8000	0.7000	0.7000	0.7000	0.4500	0.4500
9	0.8182	0.9500	0.9000	0.7500	0.8182	0.6393	0.6500
Mean	0.7980	0.8884	0.7473	0.8223	0.7681	0.5922	0.6091
SD	0.0859	0.0780	0.1624	0.1096	0.0992	0.1725	0.1684

'Prediction: bagged_model1'

	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.8261	0.9308	0.9000	0.7500	0.8182	0.6541	0.6641
1	0.8261	0.8923	0.7000	0.8750	0.7778	0.6378	0.6485
2	0.9130	0.9769	0.9000	0.9000	0.9000	0.8231	0.8231
3	0.7391	0.7955	0.5455	0.8571	0.6667	0.4692	0.5017
4	0.7391	0.8485	0.5455	0.8571	0.6667	0.4692	0.5017
5	0.8696	0.9015	0.7273	1.0000	0.8421	0.7356	0.7628
6	0.7391	0.8561	0.8182	0.6923	0.7500	0.4812	0.4886
7	0.9565	0.9924	0.9091	1.0000	0.9524	0.9125	0.9161
8	0.7273	0.8333	0.7000	0.7000	0.7000	0.4500	0.4500

```
#Compare Model Prediction Summaries
display('Prediction: model1')
results_model1 = predict_model(model1)
display('Prediction: tuned_model1')
results_tuned_model1 = predict_model(tuned_model1)
display('Prediction: calibrated_model1')
results_calibrated_model1 = predict_model(calibrated_model1)
display('Prediction: bagged_model1')
results_bagged_model1 = predict_model(bagged_model1)
#display('Prediction: boosted_model1')
#results_boosted_model1 = predict_model(boosted_model1)
display('Prediction: blend_soft')
results_boosted_model1 = predict_model(blend_soft)
display('Prediction: blend_hard')
results_boosted_model1 = predict_model(blend_hard)
```

```
'Prediction: model1'
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	MLP Classifier	0.7407	0.875	0.6364	0.7	0.6667	0.4553	0.4567

```
'Prediction: tuned_model1'
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	MLP Classifier	0.8148	0.875	0.7273	0.8	0.7619	0.611	0.6128

```
'Prediction: calibrated_model1'
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	MLP Classifier	0.7778	0.8239	0.6364	0.7778	0.7	0.5263	0.533

```
'Prediction: bagged_model1'
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	MLP Classifier	0.7778	0.8523	0.7273	0.7273	0.7273	0.5398	0.5398

```
'Prediction: blend_soft'
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	Voting Classifier	0.7778	0.858	0.6364	0.7778	0.7	0.5263	0.533

```
'Prediction: blend_hard'
```

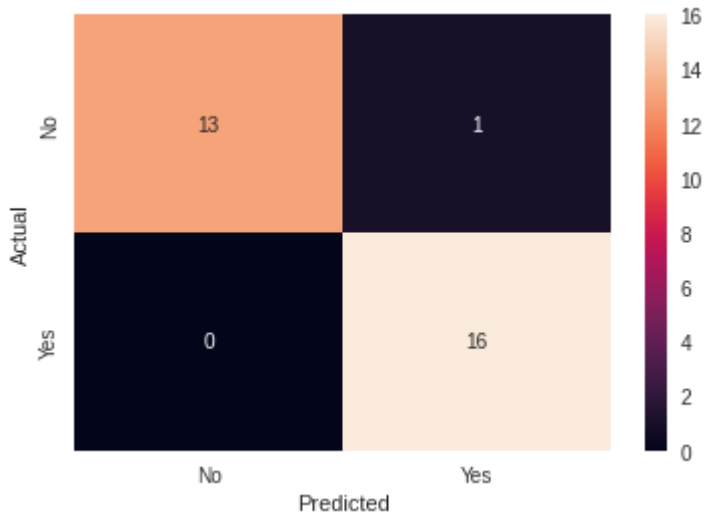
	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC

Model Finalization

```
#Choose winning model and set to "winning_model"
final_model = finalize_model(tuned_model1)
print (final_model)
```

```
    MLPClassifier(activation='identity', alpha=0.5, batch_size='auto', beta_1=0.9,
                  beta_2=0.999, early_stopping=False, epsilon=1e-08,
                  hidden_layer_sizes=[100], learning_rate='constant',
                  learning_rate_init=0.001, max_fun=15000, max_iter=500,
                  momentum=0.9, n_iter_no_change=10, nesterovs_momentum=True,
                  power_t=0.5, random_state=123, shuffle=True, solver='adam',
                  tol=0.0001, validation_fraction=0.1, verbose=False,
                  warm_start=False)
```

```
results_final_model = predict_model(final_model, data=data_unseen)
holdout_score=pull()
confusion_matrix_final = pd.crosstab(results_final_model[TARGET_COLUMN], results_final_model['Label'], rownames=['Actual'],c
sns.heatmap(confusion_matrix_final, annot=True)
plt.show()
display(results_final_model)
```



	Age	Gender	Chest_Pain	Blood_Pressure	Cholesterol	Blood_Sugar	Rest_EC
0	59	Male	Typical	170	288	<120mg	LV Hypertroph
1	66	Male	Atypical	160	246	<120mg	Norma
2	59	Male	Atypical	140	221	<120mg	Norma
3	56	Male	Atypical	120	236	<120mg	Norma
4	68	Male	Not Anginal	118	277	<120mg	Norma
5	67	Female	Not Anginal	152	277	<120mg	Norma
6	66	Female	Not Anginal	146	278	<120mg	LV Hypertroph
7	59	Male	Not Anginal	126	218	120mg+	Norma
8	58	Male	Not Anginal	112	230	<120mg	LV Hypertroph
9	50	Male	Not Anginal	129	196	<120mg	Norma
10	46	Female	Not Anginal	142	177	<120mg	LV Hypertroph
11	44	Female	Not Anginal	118	242	<120mg	Norma
12	44	Male	Not Anginal	130	233	<120mg	Norma
13	44	Male	Not Anginal	140	235	<120mg	LV Hypertroph
14	39	Female	Not Anginal	138	220	<120mg	Norma
15	70	Male	Asymptomatic	130	322	<120mg	LV Hypertroph
16	64	Female	Asymptomatic	130	303	<120mg	Norma

```
save_model(final_model, 'Final-ML1000-P1-Heart-20211015')

     Transformation Pipeline and Model Successfully Saved
     (Pipeline(memory=None,
               steps=[('dtypes',
                DataTypes_Auto_infer(categorical_features=[],
                                     display_types=False, features_todrop=[],
                                     id_columns=[],
                                     ml_usecase='classification',
                                     numerical_features=[],
                                     target='Heart_Disease',
                                     time_features=[])),
               ('imputer',
                Simple_Imputer(categorical_strategy='not_available',
                               fill_value_categorical=None,
                               fill_value_numerical=None,
                               numer...
                               batch_size='auto', beta_1=0.9, beta_2=0.999,
                               early_stopping=False, epsilon=1e-08,
                               hidden_layer_sizes=[100],
                               learning_rate='constant',
                               learning_rate_init=0.001, max_fun=15000,
                               max_iter=500, momentum=0.9, n_iter_no_change=10,
                               nesterovs_momentum=True, power_t=0.5,
                               random_state=123, shuffle=True, solver='adam',
                               tol=0.0001, validation_fraction=0.1,
                               verbose=False, warm_start=False)]],
     verbose=False), 'Final-ML1000-P1-Heart-20211015.pkl')
```

All Models - Conf. Matrix (unseen data)

[ ] ↳ *7 cells hidden*

Scratchpad

```
#note
```

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