In [ ]:

```python
# Tyler Boudreau

# Import Required packages as needed throughout
import pandas as pd
import numpy as np
import seaborn as sb
import matplotlib.pyplot as plt

# Location of Dataset must be set
df = pd.read_csv('C:\\Users\\Tyler\\Downloads\\Heart_disease_cleveland_new.csv')
print(df)
df.head(10)
```

```
     age  sex  cp  trestbps  chol  fbs  restecg  thalach  exang  oldpeak  \
0     63    1   0       145   233    1        2      150      0      2.3   
1     67    1   3       160   286    0        2      108      1      1.5   
2     67    1   3       120   229    0        2      129      1      2.6   
3     37    1   2       130   250    0        0      187      0      3.5   
4     41    0   1       130   204    0        2      172      0      1.4   
..   ...  ...  ..       ...   ...  ...      ...      ...    ...      ...   
298   45    1   0       110   264    0        0      132      0      1.2   
299   68    1   3       144   193    1        0      141      0      3.4   
300   57    1   3       130   131    0        0      115      1      1.2   
301   57    0   1       130   236    0        2      174      0      0.0   
302   38    1   2       138   175    0        0      173      0      0.0   

     slope  ca  thal  target  
0        2   0     2       0  
1        1   3     1       1  
2        1   2     3       1  
3        2   0     1       0  
4        0   0     1       0  
..     ...  ..   ...     ...  
298      1   0     3       1  
299      1   2     3       1  
300      1   1     3       1  
301      1   1     1       1  
302      0   0     1       0  

[303 rows x 14 columns]
```

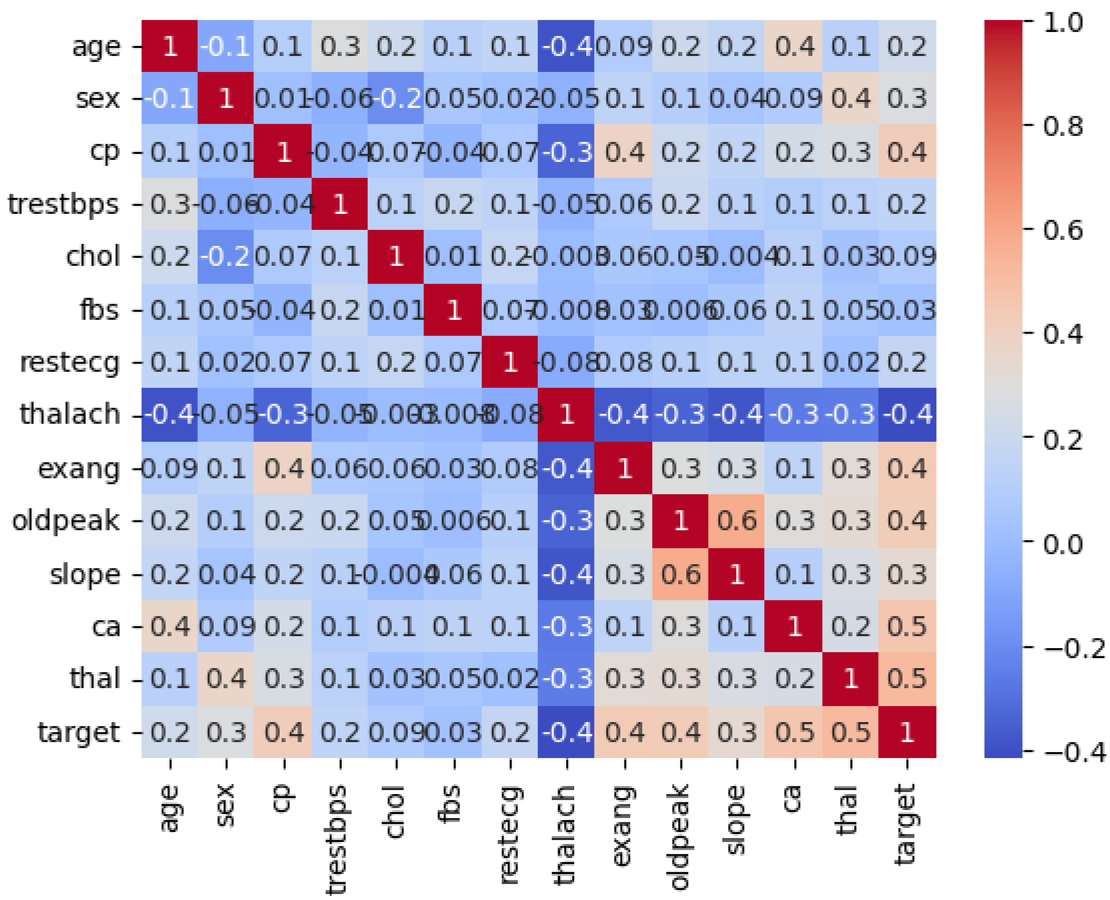
Out[ ]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	ta
0	63	1	0	145	233	1	2	150	0	2.3	2	0	2	
1	67	1	3	160	286	0	2	108	1	1.5	1	3	1	
2	67	1	3	120	229	0	2	129	1	2.6	1	2	3	
3	37	1	2	130	250	0	0	187	0	3.5	2	0	1	
4	41	0	1	130	204	0	2	172	0	1.4	0	0	1	
5	56	1	1	120	236	0	0	178	0	0.8	0	0	1	
6	62	0	3	140	268	0	2	160	0	3.6	2	2	1	
7	57	0	3	120	354	0	0	163	1	0.6	0	0	1	
8	63	1	3	130	254	0	2	147	0	1.4	1	1	3	
9	53	1	3	140	203	1	2	155	1	3.1	2	0	3	

In [ ]:

```python
# Create Correlation Matrix to check for Collinearity
CorrMatrix1 = df.corr()

sb.heatmap(CorrMatrix1, cmap="coolwarm", annot=True, fmt=".1g")
plt.show()
```



In [ ]:
```
X=df.iloc[:,0:13]
X
y=df['target']

# Create Supervised Train and Unsupervised Test Partitions
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=.33, random_state

# Count number 0 and 1 prediction values for Heart Disease, 0 being absent, 1 being
y.value_counts()
```

Out[ ]:
```
target
0    164
1    139
Name: count, dtype: int64
```

In [ ]:
```
# Logistic Regression Model
from sklearn.linear_model import LogisticRegression
logModel=LogisticRegression(max_iter=10000)
logModel.fit(X_train, y_train)
pred_y = logModel.predict(X_test)
from sklearn.metrics import accuracy_score
print('Logistic Regression Model Accuracy: {0:0.4f}'.format(accuracy_score(y_test,p
predresult1 = pd.DataFrame({"Actual" : y_test, "Predicted" : pred_y})
print(predresult1)
```

```
Logistic Regression Model Accuracy: 81.0000 %
     Actual  Predicted
166       0          0
182       0          1
292       1          1
22        1          0
179       0          1
..      ...        ...
41        0          0
282       1          1
200       0          0
174       1          1
18        0          0

[100 rows x 2 columns]
```

In [ ]:
```
# Testing Logistic Regression model on example data
XTestValues1 = pd.DataFrame(np.array([[63,1,0,145,233,1,2,150,0,2.3,2,0,2]]), colum
XTestValues2 = pd.DataFrame(np.array([[67,1,3,160,286,0,2,108,1,1.5,1,3,1]]), colum
Logmodelprediction1 = logModel.predict(XTestValues1)
Logmodelprediction2 = logModel.predict(XTestValues2)
print(Logmodelprediction1)
print(Logmodelprediction2)
```

```
[0]
[1]
```

In [ ]:
```
# LightGBM Model
import lightgbm as lgb
clf = lgb.LGBMClassifier()
```

```
clf.fit(X_train, y_train)
y_pred=clf.predict(X_test)
accuracy=accuracy_score(y_pred, y_test)
print('LightGBM Model Accuracy: {0:0.4f}'.format(accuracy_score(y_test, y_pred)*100
predresult2 = pd.DataFrame({"Actual" : y_test, "Predicted" : y_pred})
print(predresult2)

LightGBMPred1 = clf.predict(XTestValues1)
LightGBMPred2 = clf.predict(XTestValues2)

print(LightGBMPred1)
print(LightGBMPred2)
```

```
LightGBM Model Accuracy: 76.0000 %
     Actual  Predicted
166       0          0
182       0          1
292       1          1
22        1          0
179       0          1
..      ...        ...
41        0          0
282       1          1
200       0          0
174       1          1
18        0          0

[100 rows x 2 columns]
[0]
[1]
```

In [ ]:

```
# Random Forest Model
from sklearn.ensemble import RandomForestClassifier
clf = RandomForestClassifier(n_estimators = 100)

# Training the model on the training dataset
# fit function is used to train the model using the training sets as parameters
clf.fit(X_train, y_train)

# performing predictions on the test dataset
y_pred8 = clf.predict(X_test)
 # metrics are used to find accuracy or error
from sklearn import metrics
print()

# using metrics module for accuracy calculation
print("Random Forest Accuracy:",metrics.accuracy_score(y_test, y_pred8)*100,"%")

predresult3 = pd.DataFrame({"Actual" : y_test, "Predicted" : y_pred8})
print(predresult3)
RandomForestPred1 = clf.predict(XTestValues1)
RandomForestPred2 = clf.predict(XTestValues2)

print(RandomForestPred1)
print(RandomForestPred2)
```

```
Random Forest Accuracy: 83.0 %
     Actual  Predicted
166       0          0
182       0          0
292       1          1
22        1          0
179       0          1
..      ...        ...
41        0          0
282       1          1
200       0          0
174       1          1
18        0          0

[100 rows x 2 columns]
[0]
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```

In [ ]:

```
# ExtraTree Model
from sklearn.ensemble import ExtraTreesClassifier
clf = ExtraTreesClassifier(n_estimators=100,max_depth=6,min_samples_split=2,min_wei
clf.fit(X_train, y_train)
print("ExtraTree Classifier Accuracy:",clf.score(X_test, y_test)*100,"%")
y_pred9 = clf.predict(X_test)
predresult4 = pd.DataFrame({"Actual" : y_test, "Predicted" : y_pred9})
print(predresult4)
ExtraTreePred1 = clf.predict(XTestValues1)
ExtraTreePred2 = clf.predict(XTestValues2)

print(ExtraTreePred1)
print(ExtraTreePred2)
```

```
ExtraTree Classifier Accuracy: 83.0 %
     Actual  Predicted
166       0          0
182       0          1
292       1          1
22        1          0
179       0          1
..      ...        ...
41        0          1
282       1          1
200       0          0
174       1          1
18        0          0

[100 rows x 2 columns]
[0]
[1]
```

In [ ]:

```
# XGBoost Model
from xgboost import XGBClassifier
from sklearn.metrics import accuracy_score
model = XGBClassifier(eval_metric='mlogloss')
model.fit(X_train, y_train)
y_pred1 = model.predict(X_test)
```

```
accuracy = accuracy_score(y_test, y_pred1)
print("XGBoost Accuracy:",accuracy*100,"%")
predresult5 = pd.DataFrame({"Actual" : y_test, "Predicted" : y_pred1})
print(predresult5)
XGBoostPred1 = model.predict(XTestValues1)
XGBoostPred2 = model.predict(XTestValues2)

print(XGBoostPred1)
print(XGBoostPred2)
```

```
XGBoost Accuracy: 78.0 %
     Actual  Predicted
166       0          0
182       0          1
292       1          1
22        1          0
179       0          1
..      ...        ...
41        0          0
282       1          1
200       0          0
174       1          1
18        0          0

[100 rows x 2 columns]
[0]
[1]
```

In [ ]:
```
# Setup TensorFLow Model
from tensorflow.keras.models import Sequential #Helps to create Forward and backwar
from tensorflow.keras.layers import Dense #Helps to create neurons in ANN
```

In [ ]:
```
# Continue TensorFlow Setup
classifier=Sequential()
classifier.add(Dense(units=11,activation='relu'))
classifier.add(Dense(units=7,activation='relu'))
classifier.add(Dense(units=6,activation='relu'))
## Adding the output layer
classifier.add(Dense(units=1,activation='sigmoid'))
classifier.compile(optimizer='adam',loss="binary_crossentropy",metrics=["accuracy"]
#classifier.compile(optimizer=opt,loss="binary_crossentropy",metrics=["accuracy"])
```

In [ ]:
```
# TensorFlow continued setup
import tensorflow as tf
early_stopping=tf.keras.callbacks.EarlyStopping(
    monitor="val_loss",
    min_delta=0.0001,
    patience=20,
    verbose=1,
    mode="auto",
    baseline=None,
    restore_best_weights=False,
)
```

In [ ]:
```
# Runs TensorFlow model up to 1000 iterations or until optimal value is found
```

```
model_history=classifier.fit(X_train,y_train,validation_split=0.30,batch_size=10,ep
```

```
Epoch 1/1000
15/15 [==============================] - 2s 22ms/step - loss: 4.0854 - accuracy: 0.5
141 - val_loss: 2.8482 - val_accuracy: 0.5410
Epoch 2/1000
15/15 [==============================] - 0s 6ms/step - loss: 2.8483 - accuracy: 0.51
41 - val_loss: 1.8760 - val_accuracy: 0.5410
Epoch 3/1000
15/15 [==============================] - 0s 6ms/step - loss: 2.0220 - accuracy: 0.49
30 - val_loss: 1.1076 - val_accuracy: 0.5738
Epoch 4/1000
15/15 [==============================] - 0s 5ms/step - loss: 1.3995 - accuracy: 0.42
25 - val_loss: 0.9665 - val_accuracy: 0.4754
Epoch 5/1000
15/15 [==============================] - 0s 5ms/step - loss: 1.0792 - accuracy: 0.47
89 - val_loss: 1.0543 - val_accuracy: 0.5410
Epoch 6/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.9078 - accuracy: 0.57
04 - val_loss: 0.9074 - val_accuracy: 0.5082
Epoch 7/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.7892 - accuracy: 0.58
45 - val_loss: 0.8317 - val_accuracy: 0.5082
Epoch 8/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.7672 - accuracy: 0.57
75 - val_loss: 0.7986 - val_accuracy: 0.5082
Epoch 9/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.7191 - accuracy: 0.61
97 - val_loss: 0.7534 - val_accuracy: 0.5574
Epoch 10/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.7010 - accuracy: 0.62
68 - val_loss: 0.7228 - val_accuracy: 0.5738
Epoch 11/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.6943 - accuracy: 0.62
68 - val_loss: 0.7220 - val_accuracy: 0.5738
Epoch 12/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.6890 - accuracy: 0.64
79 - val_loss: 0.7189 - val_accuracy: 0.5574
Epoch 13/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6852 - accuracy: 0.64
08 - val_loss: 0.7097 - val_accuracy: 0.5902
Epoch 14/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.6823 - accuracy: 0.61
97 - val_loss: 0.6983 - val_accuracy: 0.5738
Epoch 15/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.6803 - accuracy: 0.62
68 - val_loss: 0.7021 - val_accuracy: 0.5738
Epoch 16/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6753 - accuracy: 0.64
08 - val_loss: 0.7075 - val_accuracy: 0.5738
Epoch 17/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.6726 - accuracy: 0.62
68 - val_loss: 0.7031 - val_accuracy: 0.5902
Epoch 18/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.6726 - accuracy: 0.63
38 - val_loss: 0.7048 - val_accuracy: 0.5738
Epoch 19/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.6673 - accuracy: 0.63
```

```
38 - val_loss: 0.6967 - val_accuracy: 0.5738
Epoch 20/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6697 - accuracy: 0.62
68 - val_loss: 0.7070 - val_accuracy: 0.5902
Epoch 21/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6643 - accuracy: 0.63
38 - val_loss: 0.6965 - val_accuracy: 0.5738
Epoch 22/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6628 - accuracy: 0.63
38 - val_loss: 0.7033 - val_accuracy: 0.5738
Epoch 23/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6650 - accuracy: 0.63
38 - val_loss: 0.7101 - val_accuracy: 0.5574
Epoch 24/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6586 - accuracy: 0.63
38 - val_loss: 0.7034 - val_accuracy: 0.5738
Epoch 25/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6557 - accuracy: 0.63
38 - val_loss: 0.7038 - val_accuracy: 0.5738
Epoch 26/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6539 - accuracy: 0.61
97 - val_loss: 0.6983 - val_accuracy: 0.5902
Epoch 27/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.6531 - accuracy: 0.64
08 - val_loss: 0.7142 - val_accuracy: 0.5246
Epoch 28/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.6481 - accuracy: 0.64
79 - val_loss: 0.6951 - val_accuracy: 0.5902
Epoch 29/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.6439 - accuracy: 0.61
97 - val_loss: 0.6927 - val_accuracy: 0.5738
Epoch 30/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.6421 - accuracy: 0.63
38 - val_loss: 0.6936 - val_accuracy: 0.5738
Epoch 31/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.6440 - accuracy: 0.64
08 - val_loss: 0.6952 - val_accuracy: 0.5738
Epoch 32/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.6384 - accuracy: 0.62
68 - val_loss: 0.7020 - val_accuracy: 0.5902
Epoch 33/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6394 - accuracy: 0.64
08 - val_loss: 0.6966 - val_accuracy: 0.5738
Epoch 34/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6456 - accuracy: 0.64
08 - val_loss: 0.7103 - val_accuracy: 0.5902
Epoch 35/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6343 - accuracy: 0.64
79 - val_loss: 0.6889 - val_accuracy: 0.5738
Epoch 36/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.6314 - accuracy: 0.64
08 - val_loss: 0.6984 - val_accuracy: 0.5902
Epoch 37/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.6312 - accuracy: 0.64
08 - val_loss: 0.6960 - val_accuracy: 0.5738
Epoch 38/1000
```

```
15/15 [==============================] - 0s 7ms/step - loss: 0.6258 - accuracy: 0.63
38 - val_loss: 0.6955 - val_accuracy: 0.5738
Epoch 39/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6278 - accuracy: 0.63
38 - val_loss: 0.6965 - val_accuracy: 0.5738
Epoch 40/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6221 - accuracy: 0.64
79 - val_loss: 0.6901 - val_accuracy: 0.5574
Epoch 41/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6196 - accuracy: 0.64
08 - val_loss: 0.6903 - val_accuracy: 0.5574
Epoch 42/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.6184 - accuracy: 0.63
38 - val_loss: 0.6942 - val_accuracy: 0.5574
Epoch 43/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6161 - accuracy: 0.66
20 - val_loss: 0.6905 - val_accuracy: 0.5738
Epoch 44/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.6209 - accuracy: 0.64
79 - val_loss: 0.6869 - val_accuracy: 0.5246
Epoch 45/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.6127 - accuracy: 0.64
08 - val_loss: 0.6858 - val_accuracy: 0.5410
Epoch 46/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.6157 - accuracy: 0.64
79 - val_loss: 0.6867 - val_accuracy: 0.5410
Epoch 47/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.6083 - accuracy: 0.64
79 - val_loss: 0.6868 - val_accuracy: 0.5574
Epoch 48/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6076 - accuracy: 0.66
20 - val_loss: 0.6874 - val_accuracy: 0.5246
Epoch 49/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6160 - accuracy: 0.66
20 - val_loss: 0.6906 - val_accuracy: 0.5902
Epoch 50/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5980 - accuracy: 0.65
49 - val_loss: 0.6938 - val_accuracy: 0.5902
Epoch 51/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6120 - accuracy: 0.65
49 - val_loss: 0.6825 - val_accuracy: 0.5902
Epoch 52/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6245 - accuracy: 0.67
61 - val_loss: 0.6918 - val_accuracy: 0.5574
Epoch 53/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.6118 - accuracy: 0.66
20 - val_loss: 0.6798 - val_accuracy: 0.6066
Epoch 54/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5983 - accuracy: 0.67
61 - val_loss: 0.6799 - val_accuracy: 0.5574
Epoch 55/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5937 - accuracy: 0.65
49 - val_loss: 0.6763 - val_accuracy: 0.5738
Epoch 56/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5989 - accuracy: 0.66
20 - val_loss: 0.6818 - val_accuracy: 0.6066
```

```
Epoch 57/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5851 - accuracy: 0.67
61 - val_loss: 0.6804 - val_accuracy: 0.5738
Epoch 58/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5923 - accuracy: 0.66
20 - val_loss: 0.6804 - val_accuracy: 0.5738
Epoch 59/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5840 - accuracy: 0.66
20 - val_loss: 0.6792 - val_accuracy: 0.5246
Epoch 60/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5852 - accuracy: 0.68
31 - val_loss: 0.6823 - val_accuracy: 0.5738
Epoch 61/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5946 - accuracy: 0.68
31 - val_loss: 0.6796 - val_accuracy: 0.5738
Epoch 62/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5734 - accuracy: 0.69
01 - val_loss: 0.6725 - val_accuracy: 0.6230
Epoch 63/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5790 - accuracy: 0.67
61 - val_loss: 0.6758 - val_accuracy: 0.5738
Epoch 64/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5767 - accuracy: 0.66
20 - val_loss: 0.6725 - val_accuracy: 0.5738
Epoch 65/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5770 - accuracy: 0.66
90 - val_loss: 0.6712 - val_accuracy: 0.5902
Epoch 66/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5688 - accuracy: 0.67
61 - val_loss: 0.6686 - val_accuracy: 0.5902
Epoch 67/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5671 - accuracy: 0.68
31 - val_loss: 0.6643 - val_accuracy: 0.5902
Epoch 68/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5699 - accuracy: 0.68
31 - val_loss: 0.6610 - val_accuracy: 0.6230
Epoch 69/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5698 - accuracy: 0.72
54 - val_loss: 0.6769 - val_accuracy: 0.6066
Epoch 70/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5738 - accuracy: 0.67
61 - val_loss: 0.6655 - val_accuracy: 0.6066
Epoch 71/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5630 - accuracy: 0.68
31 - val_loss: 0.6574 - val_accuracy: 0.6066
Epoch 72/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.5741 - accuracy: 0.67
61 - val_loss: 0.6561 - val_accuracy: 0.6066
Epoch 73/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5859 - accuracy: 0.67
61 - val_loss: 0.6619 - val_accuracy: 0.6230
Epoch 74/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5558 - accuracy: 0.69
01 - val_loss: 0.6482 - val_accuracy: 0.6230
Epoch 75/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5588 - accuracy: 0.69
```

```
72 - val_loss: 0.6452 - val_accuracy: 0.5902
Epoch 76/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5595 - accuracy: 0.71
13 - val_loss: 0.6454 - val_accuracy: 0.6557
Epoch 77/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5523 - accuracy: 0.70
42 - val_loss: 0.6465 - val_accuracy: 0.6393
Epoch 78/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.5561 - accuracy: 0.71
13 - val_loss: 0.6440 - val_accuracy: 0.6393
Epoch 79/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5603 - accuracy: 0.71
13 - val_loss: 0.6434 - val_accuracy: 0.6557
Epoch 80/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5583 - accuracy: 0.69
72 - val_loss: 0.6429 - val_accuracy: 0.6393
Epoch 81/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.5541 - accuracy: 0.71
83 - val_loss: 0.6427 - val_accuracy: 0.6230
Epoch 82/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5490 - accuracy: 0.71
13 - val_loss: 0.6376 - val_accuracy: 0.6393
Epoch 83/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5502 - accuracy: 0.71
83 - val_loss: 0.6436 - val_accuracy: 0.6393
Epoch 84/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5429 - accuracy: 0.70
42 - val_loss: 0.6350 - val_accuracy: 0.6557
Epoch 85/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5409 - accuracy: 0.70
42 - val_loss: 0.6361 - val_accuracy: 0.6557
Epoch 86/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5443 - accuracy: 0.69
01 - val_loss: 0.6264 - val_accuracy: 0.6230
Epoch 87/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5497 - accuracy: 0.72
54 - val_loss: 0.6299 - val_accuracy: 0.6885
Epoch 88/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5543 - accuracy: 0.73
94 - val_loss: 0.6306 - val_accuracy: 0.6557
Epoch 89/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5356 - accuracy: 0.70
42 - val_loss: 0.6336 - val_accuracy: 0.6557
Epoch 90/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5447 - accuracy: 0.71
83 - val_loss: 0.6238 - val_accuracy: 0.6885
Epoch 91/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5325 - accuracy: 0.73
24 - val_loss: 0.6255 - val_accuracy: 0.6721
Epoch 92/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5335 - accuracy: 0.71
83 - val_loss: 0.6208 - val_accuracy: 0.6885
Epoch 93/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5304 - accuracy: 0.71
83 - val_loss: 0.6167 - val_accuracy: 0.6230
Epoch 94/1000
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15/15 [==============================] - 0s 7ms/step - loss: 0.5311 - accuracy: 0.73
24 - val_loss: 0.6175 - val_accuracy: 0.6885
Epoch 95/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5427 - accuracy: 0.73
24 - val_loss: 0.6179 - val_accuracy: 0.6885
Epoch 96/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5650 - accuracy: 0.71
83 - val_loss: 0.6174 - val_accuracy: 0.6885
Epoch 97/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5669 - accuracy: 0.69
72 - val_loss: 0.6190 - val_accuracy: 0.6885
Epoch 98/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5359 - accuracy: 0.72
54 - val_loss: 0.6075 - val_accuracy: 0.6393
Epoch 99/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5213 - accuracy: 0.74
65 - val_loss: 0.6153 - val_accuracy: 0.6885
Epoch 100/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5220 - accuracy: 0.73
94 - val_loss: 0.6077 - val_accuracy: 0.6885
Epoch 101/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5192 - accuracy: 0.73
94 - val_loss: 0.6048 - val_accuracy: 0.7213
Epoch 102/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5178 - accuracy: 0.71
13 - val_loss: 0.6094 - val_accuracy: 0.6885
Epoch 103/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5233 - accuracy: 0.74
65 - val_loss: 0.6049 - val_accuracy: 0.6885
Epoch 104/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5491 - accuracy: 0.72
54 - val_loss: 0.6025 - val_accuracy: 0.6885
Epoch 105/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5732 - accuracy: 0.70
42 - val_loss: 0.6065 - val_accuracy: 0.6885
Epoch 106/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5328 - accuracy: 0.75
35 - val_loss: 0.5962 - val_accuracy: 0.7213
Epoch 107/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5122 - accuracy: 0.75
35 - val_loss: 0.6118 - val_accuracy: 0.7049
Epoch 108/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5168 - accuracy: 0.72
54 - val_loss: 0.5977 - val_accuracy: 0.7049
Epoch 109/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5106 - accuracy: 0.72
54 - val_loss: 0.5955 - val_accuracy: 0.7049
Epoch 110/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5185 - accuracy: 0.72
54 - val_loss: 0.5965 - val_accuracy: 0.6885
Epoch 111/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5173 - accuracy: 0.72
54 - val_loss: 0.5886 - val_accuracy: 0.7213
Epoch 112/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5114 - accuracy: 0.74
65 - val_loss: 0.6007 - val_accuracy: 0.7213
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Epoch 113/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5142 - accuracy: 0.70
42 - val_loss: 0.5859 - val_accuracy: 0.7049
Epoch 114/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5094 - accuracy: 0.75
35 - val_loss: 0.5889 - val_accuracy: 0.7049
Epoch 115/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5182 - accuracy: 0.73
24 - val_loss: 0.5829 - val_accuracy: 0.7213
Epoch 116/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5108 - accuracy: 0.77
46 - val_loss: 0.5919 - val_accuracy: 0.7213
Epoch 117/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5040 - accuracy: 0.74
65 - val_loss: 0.5794 - val_accuracy: 0.7377
Epoch 118/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5054 - accuracy: 0.73
24 - val_loss: 0.5875 - val_accuracy: 0.7377
Epoch 119/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5144 - accuracy: 0.74
65 - val_loss: 0.5794 - val_accuracy: 0.7049
Epoch 120/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5322 - accuracy: 0.70
42 - val_loss: 0.5759 - val_accuracy: 0.7377
Epoch 121/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4970 - accuracy: 0.75
35 - val_loss: 0.5781 - val_accuracy: 0.7049
Epoch 122/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5006 - accuracy: 0.76
06 - val_loss: 0.5710 - val_accuracy: 0.7377
Epoch 123/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5000 - accuracy: 0.76
06 - val_loss: 0.5785 - val_accuracy: 0.7213
Epoch 124/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4988 - accuracy: 0.75
35 - val_loss: 0.5700 - val_accuracy: 0.7377
Epoch 125/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.5103 - accuracy: 0.74
65 - val_loss: 0.5737 - val_accuracy: 0.7213
Epoch 126/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4923 - accuracy: 0.75
35 - val_loss: 0.5636 - val_accuracy: 0.7213
Epoch 127/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5049 - accuracy: 0.76
06 - val_loss: 0.5702 - val_accuracy: 0.7213
Epoch 128/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4899 - accuracy: 0.75
35 - val_loss: 0.5730 - val_accuracy: 0.7541
Epoch 129/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4992 - accuracy: 0.77
46 - val_loss: 0.5594 - val_accuracy: 0.7377
Epoch 130/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.5129 - accuracy: 0.74
65 - val_loss: 0.5632 - val_accuracy: 0.7377
Epoch 131/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.4887 - accuracy: 0.78
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17 - val_loss: 0.5623 - val_accuracy: 0.7377
Epoch 132/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4831 - accuracy: 0.76
06 - val_loss: 0.5597 - val_accuracy: 0.7377
Epoch 133/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4888 - accuracy: 0.77
46 - val_loss: 0.5585 - val_accuracy: 0.7377
Epoch 134/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4833 - accuracy: 0.77
46 - val_loss: 0.5566 - val_accuracy: 0.7377
Epoch 135/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4837 - accuracy: 0.76
06 - val_loss: 0.5635 - val_accuracy: 0.7541
Epoch 136/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4893 - accuracy: 0.76
06 - val_loss: 0.5503 - val_accuracy: 0.7377
Epoch 137/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4867 - accuracy: 0.78
17 - val_loss: 0.5473 - val_accuracy: 0.7377
Epoch 138/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4750 - accuracy: 0.76
76 - val_loss: 0.5665 - val_accuracy: 0.7705
Epoch 139/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4831 - accuracy: 0.76
06 - val_loss: 0.5424 - val_accuracy: 0.7541
Epoch 140/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4746 - accuracy: 0.76
76 - val_loss: 0.5452 - val_accuracy: 0.7541
Epoch 141/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.4722 - accuracy: 0.78
87 - val_loss: 0.5527 - val_accuracy: 0.7869
Epoch 142/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4758 - accuracy: 0.76
76 - val_loss: 0.5450 - val_accuracy: 0.7541
Epoch 143/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.4706 - accuracy: 0.78
17 - val_loss: 0.5382 - val_accuracy: 0.7705
Epoch 144/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4811 - accuracy: 0.76
76 - val_loss: 0.5341 - val_accuracy: 0.7541
Epoch 145/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4728 - accuracy: 0.79
58 - val_loss: 0.5318 - val_accuracy: 0.7541
Epoch 146/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4780 - accuracy: 0.75
35 - val_loss: 0.5423 - val_accuracy: 0.7869
Epoch 147/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4661 - accuracy: 0.78
17 - val_loss: 0.5304 - val_accuracy: 0.8033
Epoch 148/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4703 - accuracy: 0.78
87 - val_loss: 0.5314 - val_accuracy: 0.7705
Epoch 149/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4676 - accuracy: 0.77
46 - val_loss: 0.5304 - val_accuracy: 0.7541
Epoch 150/1000
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15/15 [==============================] - 0s 6ms/step - loss: 0.4624 - accuracy: 0.78
87 - val_loss: 0.5237 - val_accuracy: 0.8033
Epoch 151/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4595 - accuracy: 0.78
17 - val_loss: 0.5207 - val_accuracy: 0.7705
Epoch 152/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4608 - accuracy: 0.78
87 - val_loss: 0.5264 - val_accuracy: 0.7541
Epoch 153/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4650 - accuracy: 0.77
46 - val_loss: 0.5175 - val_accuracy: 0.7541
Epoch 154/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4578 - accuracy: 0.76
76 - val_loss: 0.5221 - val_accuracy: 0.7541
Epoch 155/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4578 - accuracy: 0.80
28 - val_loss: 0.5169 - val_accuracy: 0.8033
Epoch 156/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4517 - accuracy: 0.78
17 - val_loss: 0.5144 - val_accuracy: 0.8033
Epoch 157/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4561 - accuracy: 0.79
58 - val_loss: 0.5193 - val_accuracy: 0.7705
Epoch 158/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4501 - accuracy: 0.78
17 - val_loss: 0.5087 - val_accuracy: 0.7705
Epoch 159/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4611 - accuracy: 0.81
69 - val_loss: 0.5090 - val_accuracy: 0.8033
Epoch 160/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4581 - accuracy: 0.78
17 - val_loss: 0.5158 - val_accuracy: 0.7869
Epoch 161/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4529 - accuracy: 0.78
17 - val_loss: 0.5057 - val_accuracy: 0.8033
Epoch 162/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4660 - accuracy: 0.77
46 - val_loss: 0.5105 - val_accuracy: 0.7869
Epoch 163/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.4621 - accuracy: 0.76
76 - val_loss: 0.5006 - val_accuracy: 0.7869
Epoch 164/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4498 - accuracy: 0.78
87 - val_loss: 0.5192 - val_accuracy: 0.7869
Epoch 165/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4463 - accuracy: 0.77
46 - val_loss: 0.4964 - val_accuracy: 0.7869
Epoch 166/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4404 - accuracy: 0.78
87 - val_loss: 0.5011 - val_accuracy: 0.8033
Epoch 167/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4416 - accuracy: 0.80
28 - val_loss: 0.4932 - val_accuracy: 0.8033
Epoch 168/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.4479 - accuracy: 0.80
99 - val_loss: 0.4916 - val_accuracy: 0.7869
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Epoch 169/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4398 - accuracy: 0.80
28 - val_loss: 0.4928 - val_accuracy: 0.8033
Epoch 170/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4377 - accuracy: 0.80
28 - val_loss: 0.4873 - val_accuracy: 0.8033
Epoch 171/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4474 - accuracy: 0.78
17 - val_loss: 0.5459 - val_accuracy: 0.7377
Epoch 172/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4950 - accuracy: 0.76
76 - val_loss: 0.4941 - val_accuracy: 0.7213
Epoch 173/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4359 - accuracy: 0.80
28 - val_loss: 0.5021 - val_accuracy: 0.8033
Epoch 174/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4408 - accuracy: 0.78
87 - val_loss: 0.4833 - val_accuracy: 0.7705
Epoch 175/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4551 - accuracy: 0.78
17 - val_loss: 0.4871 - val_accuracy: 0.8361
Epoch 176/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4304 - accuracy: 0.83
10 - val_loss: 0.4769 - val_accuracy: 0.8033
Epoch 177/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4318 - accuracy: 0.80
28 - val_loss: 0.4826 - val_accuracy: 0.8361
Epoch 178/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4347 - accuracy: 0.79
58 - val_loss: 0.4754 - val_accuracy: 0.7869
Epoch 179/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4510 - accuracy: 0.76
76 - val_loss: 0.5030 - val_accuracy: 0.7705
Epoch 180/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4304 - accuracy: 0.78
17 - val_loss: 0.4718 - val_accuracy: 0.8033
Epoch 181/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.4340 - accuracy: 0.79
58 - val_loss: 0.4711 - val_accuracy: 0.8361
Epoch 182/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4320 - accuracy: 0.80
28 - val_loss: 0.4675 - val_accuracy: 0.8197
Epoch 183/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4333 - accuracy: 0.78
87 - val_loss: 0.4674 - val_accuracy: 0.8361
Epoch 184/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4238 - accuracy: 0.81
69 - val_loss: 0.4653 - val_accuracy: 0.8197
Epoch 185/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4224 - accuracy: 0.82
39 - val_loss: 0.4791 - val_accuracy: 0.7869
Epoch 186/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4364 - accuracy: 0.78
87 - val_loss: 0.4673 - val_accuracy: 0.7541
Epoch 187/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4351 - accuracy: 0.81
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69 - val_loss: 0.4620 - val_accuracy: 0.8525
Epoch 188/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4158 - accuracy: 0.82
39 - val_loss: 0.4563 - val_accuracy: 0.8197
Epoch 189/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4175 - accuracy: 0.78
87 - val_loss: 0.4824 - val_accuracy: 0.7705
Epoch 190/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4267 - accuracy: 0.82
39 - val_loss: 0.4586 - val_accuracy: 0.8525
Epoch 191/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.4298 - accuracy: 0.80
28 - val_loss: 0.4570 - val_accuracy: 0.8525
Epoch 192/1000
15/15 [==============================] - 0s 8ms/step - loss: 0.4334 - accuracy: 0.80
28 - val_loss: 0.4496 - val_accuracy: 0.8525
Epoch 193/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4117 - accuracy: 0.82
39 - val_loss: 0.4490 - val_accuracy: 0.8689
Epoch 194/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4123 - accuracy: 0.81
69 - val_loss: 0.4514 - val_accuracy: 0.8525
Epoch 195/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4114 - accuracy: 0.80
28 - val_loss: 0.4446 - val_accuracy: 0.8852
Epoch 196/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4114 - accuracy: 0.84
51 - val_loss: 0.4415 - val_accuracy: 0.8852
Epoch 197/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4116 - accuracy: 0.83
80 - val_loss: 0.4406 - val_accuracy: 0.8361
Epoch 198/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4236 - accuracy: 0.79
58 - val_loss: 0.4904 - val_accuracy: 0.7705
Epoch 199/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.4596 - accuracy: 0.76
76 - val_loss: 0.4487 - val_accuracy: 0.7377
Epoch 200/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4141 - accuracy: 0.77
46 - val_loss: 0.4681 - val_accuracy: 0.7869
Epoch 201/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4210 - accuracy: 0.79
58 - val_loss: 0.4409 - val_accuracy: 0.7869
Epoch 202/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4040 - accuracy: 0.83
80 - val_loss: 0.4444 - val_accuracy: 0.8361
Epoch 203/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4090 - accuracy: 0.83
80 - val_loss: 0.4382 - val_accuracy: 0.8689
Epoch 204/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3967 - accuracy: 0.83
80 - val_loss: 0.4307 - val_accuracy: 0.8361
Epoch 205/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4260 - accuracy: 0.82
39 - val_loss: 0.4362 - val_accuracy: 0.8525
Epoch 206/1000
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15/15 [==============================] - 0s 6ms/step - loss: 0.3973 - accuracy: 0.84
51 - val_loss: 0.4276 - val_accuracy: 0.8852
Epoch 207/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3982 - accuracy: 0.83
10 - val_loss: 0.4323 - val_accuracy: 0.8525
Epoch 208/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3980 - accuracy: 0.83
10 - val_loss: 0.4247 - val_accuracy: 0.8689
Epoch 209/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4178 - accuracy: 0.83
10 - val_loss: 0.4251 - val_accuracy: 0.8525
Epoch 210/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4271 - accuracy: 0.81
69 - val_loss: 0.4540 - val_accuracy: 0.8033
Epoch 211/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4006 - accuracy: 0.81
69 - val_loss: 0.4257 - val_accuracy: 0.8689
Epoch 212/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.3960 - accuracy: 0.83
80 - val_loss: 0.4298 - val_accuracy: 0.8525
Epoch 213/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3950 - accuracy: 0.83
10 - val_loss: 0.4206 - val_accuracy: 0.8525
Epoch 214/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4153 - accuracy: 0.80
99 - val_loss: 0.4548 - val_accuracy: 0.8197
Epoch 215/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4059 - accuracy: 0.80
28 - val_loss: 0.4257 - val_accuracy: 0.7705
Epoch 216/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3990 - accuracy: 0.83
80 - val_loss: 0.4319 - val_accuracy: 0.8525
Epoch 217/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3937 - accuracy: 0.84
51 - val_loss: 0.4156 - val_accuracy: 0.8689
Epoch 218/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3934 - accuracy: 0.83
80 - val_loss: 0.4199 - val_accuracy: 0.8525
Epoch 219/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3959 - accuracy: 0.82
39 - val_loss: 0.4120 - val_accuracy: 0.8525
Epoch 220/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3880 - accuracy: 0.82
39 - val_loss: 0.4096 - val_accuracy: 0.8525
Epoch 221/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3917 - accuracy: 0.83
10 - val_loss: 0.4155 - val_accuracy: 0.8525
Epoch 222/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3964 - accuracy: 0.83
80 - val_loss: 0.4165 - val_accuracy: 0.8525
Epoch 223/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3883 - accuracy: 0.83
10 - val_loss: 0.4095 - val_accuracy: 0.8525
Epoch 224/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4117 - accuracy: 0.80
28 - val_loss: 0.4303 - val_accuracy: 0.8525
```

```
Epoch 225/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3826 - accuracy: 0.85
21 - val_loss: 0.4074 - val_accuracy: 0.8525
Epoch 226/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3866 - accuracy: 0.83
10 - val_loss: 0.4072 - val_accuracy: 0.8525
Epoch 227/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3866 - accuracy: 0.85
21 - val_loss: 0.4064 - val_accuracy: 0.7869
Epoch 228/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3803 - accuracy: 0.85
21 - val_loss: 0.4039 - val_accuracy: 0.8525
Epoch 229/1000
15/15 [==============================] - 0s 5ms/step - loss: 0.3814 - accuracy: 0.83
10 - val_loss: 0.4033 - val_accuracy: 0.8525
Epoch 230/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3804 - accuracy: 0.85
92 - val_loss: 0.4278 - val_accuracy: 0.8525
Epoch 231/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4208 - accuracy: 0.82
39 - val_loss: 0.4082 - val_accuracy: 0.8197
Epoch 232/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3804 - accuracy: 0.83
10 - val_loss: 0.4038 - val_accuracy: 0.8525
Epoch 233/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3778 - accuracy: 0.84
51 - val_loss: 0.4000 - val_accuracy: 0.8525
Epoch 234/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.3862 - accuracy: 0.83
10 - val_loss: 0.4058 - val_accuracy: 0.8033
Epoch 235/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3853 - accuracy: 0.84
51 - val_loss: 0.3981 - val_accuracy: 0.8525
Epoch 236/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3847 - accuracy: 0.83
10 - val_loss: 0.4021 - val_accuracy: 0.8033
Epoch 237/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3815 - accuracy: 0.84
51 - val_loss: 0.4124 - val_accuracy: 0.8689
Epoch 238/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3836 - accuracy: 0.83
10 - val_loss: 0.4046 - val_accuracy: 0.8033
Epoch 239/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3712 - accuracy: 0.83
80 - val_loss: 0.4240 - val_accuracy: 0.8525
Epoch 240/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4058 - accuracy: 0.83
10 - val_loss: 0.4075 - val_accuracy: 0.8033
Epoch 241/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4066 - accuracy: 0.83
80 - val_loss: 0.4006 - val_accuracy: 0.8033
Epoch 242/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3829 - accuracy: 0.85
92 - val_loss: 0.3960 - val_accuracy: 0.8197
Epoch 243/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3729 - accuracy: 0.84
```

```
51 - val_loss: 0.3966 - val_accuracy: 0.8689
Epoch 244/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3742 - accuracy: 0.84
51 - val_loss: 0.3936 - val_accuracy: 0.8361
Epoch 245/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3692 - accuracy: 0.85
92 - val_loss: 0.3954 - val_accuracy: 0.8689
Epoch 246/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3712 - accuracy: 0.84
51 - val_loss: 0.4023 - val_accuracy: 0.8689
Epoch 247/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3874 - accuracy: 0.84
51 - val_loss: 0.3934 - val_accuracy: 0.8361
Epoch 248/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3658 - accuracy: 0.85
21 - val_loss: 0.4004 - val_accuracy: 0.8689
Epoch 249/1000
15/15 [==============================] - 0s 7ms/step - loss: 0.3755 - accuracy: 0.84
51 - val_loss: 0.3920 - val_accuracy: 0.8525
Epoch 250/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3668 - accuracy: 0.85
21 - val_loss: 0.3915 - val_accuracy: 0.8689
Epoch 251/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3747 - accuracy: 0.85
21 - val_loss: 0.3856 - val_accuracy: 0.8525
Epoch 252/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3702 - accuracy: 0.83
80 - val_loss: 0.3875 - val_accuracy: 0.8361
Epoch 253/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3851 - accuracy: 0.84
51 - val_loss: 0.4091 - val_accuracy: 0.8689
Epoch 254/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3787 - accuracy: 0.84
51 - val_loss: 0.3848 - val_accuracy: 0.8361
Epoch 255/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3699 - accuracy: 0.86
62 - val_loss: 0.3827 - val_accuracy: 0.8361
Epoch 256/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3671 - accuracy: 0.84
51 - val_loss: 0.4037 - val_accuracy: 0.8689
Epoch 257/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3730 - accuracy: 0.85
21 - val_loss: 0.3909 - val_accuracy: 0.8852
Epoch 258/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3949 - accuracy: 0.81
69 - val_loss: 0.3866 - val_accuracy: 0.8361
Epoch 259/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3687 - accuracy: 0.85
92 - val_loss: 0.3854 - val_accuracy: 0.8525
Epoch 260/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3772 - accuracy: 0.85
21 - val_loss: 0.4030 - val_accuracy: 0.8689
Epoch 261/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3964 - accuracy: 0.83
10 - val_loss: 0.3976 - val_accuracy: 0.7869
Epoch 262/1000
```

```
15/15 [==============================] - 0s 6ms/step - loss: 0.3772 - accuracy: 0.84
51 - val_loss: 0.3884 - val_accuracy: 0.8852
Epoch 263/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3986 - accuracy: 0.84
51 - val_loss: 0.4005 - val_accuracy: 0.8689
Epoch 264/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4111 - accuracy: 0.82
39 - val_loss: 0.3866 - val_accuracy: 0.8361
Epoch 265/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3626 - accuracy: 0.85
92 - val_loss: 0.3855 - val_accuracy: 0.8689
Epoch 266/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3655 - accuracy: 0.85
92 - val_loss: 0.3862 - val_accuracy: 0.8525
Epoch 267/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3749 - accuracy: 0.85
21 - val_loss: 0.3870 - val_accuracy: 0.8852
Epoch 268/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3623 - accuracy: 0.85
92 - val_loss: 0.3841 - val_accuracy: 0.8525
Epoch 269/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3777 - accuracy: 0.87
32 - val_loss: 0.4099 - val_accuracy: 0.8525
Epoch 270/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3815 - accuracy: 0.81
69 - val_loss: 0.3960 - val_accuracy: 0.7869
Epoch 271/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3644 - accuracy: 0.84
51 - val_loss: 0.3943 - val_accuracy: 0.8852
Epoch 272/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3659 - accuracy: 0.85
21 - val_loss: 0.3886 - val_accuracy: 0.8852
Epoch 273/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3895 - accuracy: 0.81
69 - val_loss: 0.4359 - val_accuracy: 0.7377
Epoch 274/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.4158 - accuracy: 0.82
39 - val_loss: 0.4184 - val_accuracy: 0.8525
Epoch 275/1000
15/15 [==============================] - 0s 6ms/step - loss: 0.3773 - accuracy: 0.83
80 - val_loss: 0.3888 - val_accuracy: 0.8033
Epoch 275: early stopping
```

In [ ]:

```python
# Make predictions with model on test set
y_pred = classifier.predict(X_test)
y_pred = (y_pred > 0.5) # If greater than .5 then model returns True or present for
```

```
4/4 [==============================] - 0s 2ms/step
4/4 [==============================] - 0s 2ms/step
```

In [ ]:

```python
# Calculate the Accuracy
from sklearn.metrics import accuracy_score
score=accuracy_score(y_pred,y_test)
print("TensorFLow Accuracy:",score*100,"%")
```

```
TensorFlowPred1 = classifier.predict(XTestValues1)
TensorFlowPred2 = classifier.predict(XTestValues2)
```

```
TensorFLow Accuracy: 83.0 %
1/1 [==============================] - 0s 28ms/step
1/1 [==============================] - 0s 28ms/step
1/1 [==============================] - 0s 30ms/step
```

In [ ]:
```
# Make predictions with example test values
print(TensorFlowPred1)
print(TensorFlowPred2)
```

```
[[0.18484353]]
[[0.9896394]]
```

In [ ]:
```
from sklearn.model_selection import RepeatedKFold
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import Ridge

# Define K-Fold Cross Validation
#cv = RepeatedKFold(n_splits=203,n_repeats=3,random_state=1)

# Define predictor and target variables
X = df[["age",'sex','cp','trestbps','chol','fbs','restecg','thalach','exang','oldpe
y = df["target"]

# Linear Regression
LinearModel1 = LinearRegression().fit(X_train, y_train)

LinearModel1.predict(X_test)
accuracy = LinearModel1.score(X_test,y_test)

print('The predicted accuracy for Linear Regression is: {0:0.4f}'.format((accuracy*

# Ridge Model
RidgeModel1 = Ridge(alpha=10)

RidgeModel1.fit(X_train,y_train)

accuracy = RidgeModel1.score(X_test,y_test)

print('The Predicted accuracy for the Ridge Model is: {0:0.4f}'.format((accuracy*10
```

```
The predicted accuracy for Linear Regression is: 44.6637 %

The Predicted accuracy for the Ridge Model is: 45.1017 %
```