```
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
import warnings
warnings.simplefilter('ignore')
from sklearn.cluster import KMeans
import numpy as np
import seaborn as sns
from google.colab import files
from sklearn.ensemble import GradientBoostingClassifier
from xgboost import XGBClassifier
from sklearn.metrics import classification_report, confusion_matrix


df = pd.read_csv('https://raw.githubusercontent.com/grantwestfall/stat_482_project/main/Rookie_And_Career_Data.csv', encoding = 'unicode_esca
dfRookie = pd.read_csv('https://raw.githubusercontent.com/justiincho/STAT482Dataset/main/data.csv', encoding = 'unicode_escape')


df.head()
df.shape
```

```
(829, 62)
```

```
df.columns
print(dfRookie.columns)
```

```
Index(['Player', 'Rook_Year', 'Rook_Age', 'Rook_FG_Percent', 'Rook_3P_Percent',
       'Rook_FT_Percent', 'Rook_MPG', 'Rook_PPG', 'Rook_RPG', 'Rook_APG'],
      dtype='object')
```

```
#print(df.isna().sum().to_string())
print(dfRookie.isna().sum().to_string())
```

```
Player             0
Rook_Year          0
Rook_Age           0
Rook_FG_Percent    2
Rook_3P_Percent    6
Rook_FT_Percent    7
Rook_MPG           0
Rook_PPG           0
Rook_RPG           0
Rook_APG           0
```

```
df[["3P_Percent", "FT_Percent", "FG_Percent", "2P_Percent", "eFG_Percent", "TS_Percent"]] = \
df[["3P_Percent", "FT_Percent", "FG_Percent", "2P_Percent", "eFG_Percent", "TS_Percent"]].fillna(0)

dfRookie[["Rook_3P_Percent", "Rook_FT_Percent", "Rook_FG_Percent"]] = \
dfRookie[["Rook_3P_Percent", "Rook_FT_Percent", "Rook_FG_Percent"]].fillna(0)


df = df.dropna()


career_stats = df[['WS', 'G', 'GS',
       'MP', 'FG', 'FGA', '2P', '2PA', '3P', '3PA', 'FT', 'FTA', 'ORB', 'DRB',
       'TRB', 'AST', 'STL', 'BLK', 'TOV', 'PF', 'PTS', 'FG_Percent',
       '2P_Percent', '3P_Percent', 'FT_Percent', 'TS_Percent', 'eFG_Percent', 'ORtg', 'DRtg', 'OWS', 'DWS', 'WS_Per_48', 'OBPM',
       'DBPM', 'BPM', 'VORP', 'PER', 'ORB_Percent', 'DRB_Percent',
       'TRB_Percent', 'AST_Percent', 'STL_Percent', 'BLK_Percent',
       'TOV_Percent', 'USG_Percent']]


from sklearn.cluster import KMeans
kmeans_kwargs = {
       "init": "random",
       "n_init": 10,
       "max_iter": 300,
       "random_state": 42,
   }

kmc = KMeans(n_clusters=3, init='random', n_init=10, max_iter=300,tol=1e-04, random_state=0)
y_kmc = kmc.fit_predict(career_stats)
ssd = []
for k in range(1, 11):
```

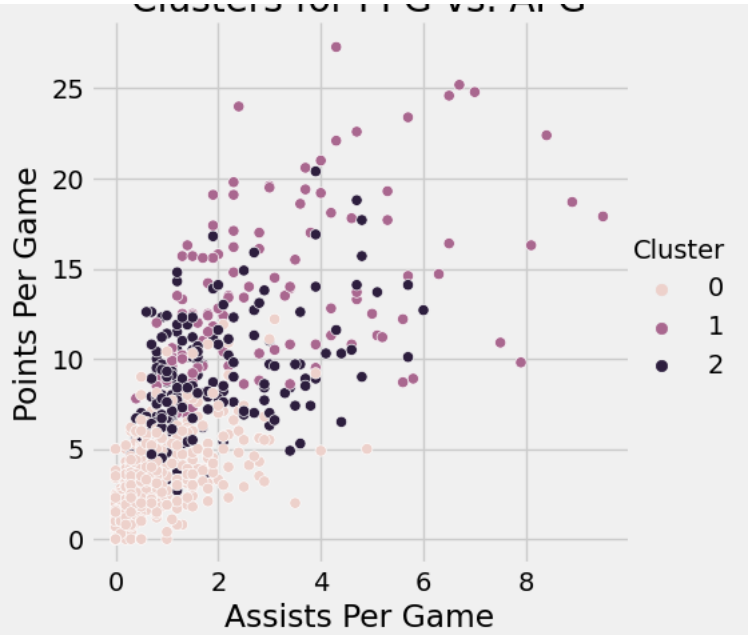
```
        kmeans = KMeans(n_clusters=k, **kmeans_kwargs)
        kmeans.fit(career_stats)
        ssd.append(kmeans.inertia_)

plt.style.use("fivethirtyeight")
plt.plot(range(1, 11), ssd)
plt.xticks(range(1, 11))
plt.xlabel("Number of Clusters")
plt.ylabel("SSD")
plt.show()
```

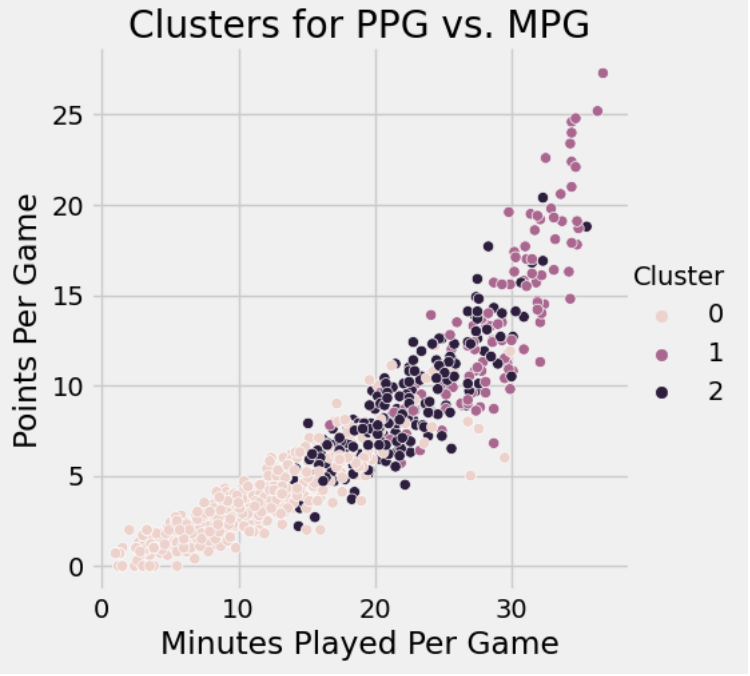

```
kmeans = KMeans(n_clusters=3, random_state=0, n_init="auto").fit(career_stats)


df["Cluster"] = kmeans.labels_


cluster_summary = df.groupby(by = "Cluster").mean()[['WS', 'G','PTS', 'FG_Percent',
       '2P_Percent', '3P_Percent', 'FT_Percent', 'TS_Percent', 'eFG_Percent',
       'ORtg', 'DRtg', 'OWS', 'DWS', 'WS_Per_48', 'OBPM',
       'DBPM', 'BPM', 'VORP', 'PER']]


cluster_summary
```

Cluster	WS	G	PTS	FG_Percent	2P_Percent	3P_Percent	FT_P
0	1.324600	86.442000	3.460000	0.405696	0.435858	0.200184	0.(
1	62.697391	836.521739	13.767826	0.469435	0.502696	0.322061	0.7
2	21.380383	529.191388	8.546890	0.457722	0.490029	0.290646	0.7

```
print(f'{df.loc[df["Cluster"] == 0].sum()["G"]},\n{df.loc[df["Cluster"] == 1].sum()["G"]},\n{df.loc[df["Cluster"] == 2].sum()["G"]}')

    43221,
    96200,
    110601


df.value_counts("Cluster")

    Cluster
    0    500
    2    209
    1    115
    dtype: int64
```

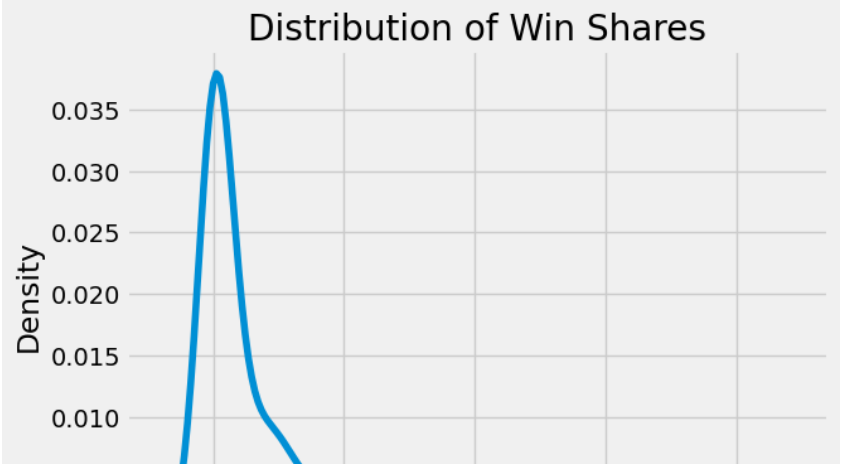
```
sns.relplot(data = df, x = "OWS", y = "DWS", hue = "Cluster").set(xlabel = "Offensive Win Shares", ylabel = "Defensive Win Shares",
                                                                  title = "Clusters for Offensive/Defensive Win Shares")
sns.relplot(data = df, x = "G", y = "VORP", hue = "Cluster").set(xlabel = "Games Played",ylabel = "Value Over Replacement Player",
                                                                 title = "Clusters for VORP vs. Games Played")
sns.relplot(data = df, x = "OBPM", y = "DBPM", hue = "Cluster").set(xlabel = "Offensive Box Plus Minus", ylabel = "Defensive Box Plus Minus",
                                                                    title = "Clusters for Offensive/Defensive Box Plus Minus")
sns.relplot(data = df, x = "AST", y = "PTS", hue = "Cluster").set(xlabel = "Assists Per Game", ylabel = "Points Per Game", title = "Clusters
sns.relplot(data = df, x = "MP", y = "PTS", hue = "Cluster").set(xlabel = "Minutes Played Per Game", ylabel = "Points Per Game", title = "Clu
```





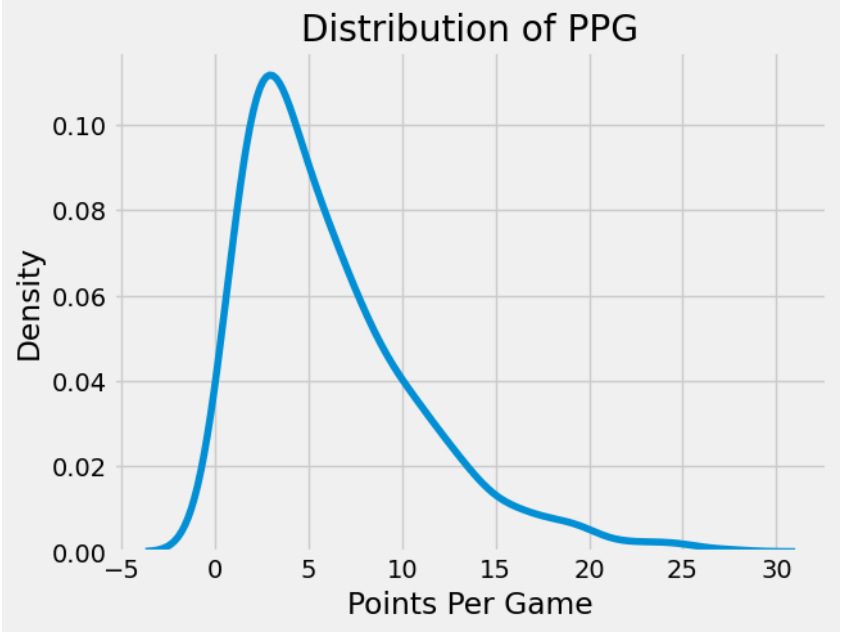

```
sns.kdeplot(data = df, x = "WS").set(xlabel = "Win Shares", title = "Distribution of Win Shares")
```

```
[Text(0.5, 0, 'Win Shares'), Text(0.5, 1.0, 'Distribution of Win Shares')]
```




```
sns.kdeplot(data = df, x = "PTS").set(xlabel = "Points Per Game", title = "Distribution of PPG")
```

```
[Text(0.5, 0, 'Points Per Game'), Text(0.5, 1.0, 'Distribution of PPG')]
```




```
df.loc[df["Cluster"] == 2, "Player"].to_string()
```

```
'5              Andris Biedri?\x9a\n7                 Matt Bonner\n12
Josh Childress\n13               Nick Collison\n15              Carlos Delfino\n1
7                Chris Duhon\n23                  Ben Gordon\n27              Kr
is Humphries\n30                  Royal Ivey\n38                Nenad Krsti?\n40
Shaun Livingston\n43              Andrés Nocioni\n50                Quinton Ross
\n60           Sebastian Telfair\n63                  Beno Udrih\n64            A
nderson Varejão\n66               Sasha Vuja?i?\n67                Delonte West\n
```

```
import numpy as np
from tensorflow import keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dense, Flatten
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.layers import Dropout


X = df[['Rook_Age', 'Rook_FG_Percent', 'Rook_3P_Percent',
       'Rook_FT_Percent', 'Rook_MPG', 'Rook_PPG', 'Rook_RPG', 'Rook_APG', 'Rook_Year']]
Y = df['Cluster']

X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size = 0.3, random_state = 123)


X_train_2, X_val, Y_train_2, Y_val = train_test_split(X_train, Y_train, test_size = 0.3, random_state = 123)

lr_list = [0.05, 0.075, 0.1, 0.25, 0.5, 0.75, 1]
```

```
for learning_rate in lr_list:
    gb_clf = GradientBoostingClassifier(n_estimators=20, learning_rate=learning_rate, max_features=2, max_depth=2, random_state=123)
    gb_clf.fit(X_train_2, Y_train_2)

    print("Learning rate: ", learning_rate)
    print("Accuracy score (training): {0:.3f}".format(gb_clf.score(X_train_2, Y_train_2)))
    print("Accuracy score (validation): {0:.3f}".format(gb_clf.score(X_val, Y_val)))

xgb_clf = XGBClassifier()
xgb_clf.fit(X_train_2, Y_train_2)
print(f"XGBoost score (validation): {xgb_clf.score(X_val, Y_val)}")

gb_clf_opt = GradientBoostingClassifier(n_estimators = 20, learning_rate = 0.25, max_features = 2, max_depth = 2, random_state = 123)
gb_clf_opt.fit(X_train_2, Y_train_2)
print(f"Optimized model accuracy score (testing): {gb_clf_opt.score(X_test, Y_test)}")

predictions = gb_clf_opt.predict(X_test)
print("Confusion Matrix:")
print(confusion_matrix(Y_test, predictions))

print("Classification Report")
print(classification_report(Y_test, predictions))
```

```
Learning rate:  0.05
Accuracy score (training): 0.670
Accuracy score (validation): 0.642
Learning rate:  0.075
Accuracy score (training): 0.715
Accuracy score (validation): 0.636
Learning rate:  0.1
Accuracy score (training): 0.732
Accuracy score (validation): 0.613
Learning rate:  0.25
Accuracy score (training): 0.794
Accuracy score (validation): 0.682
Learning rate:  0.5
Accuracy score (training): 0.844
Accuracy score (validation): 0.659
Learning rate:  0.75
Accuracy score (training): 0.893
Accuracy score (validation): 0.653
Learning rate:  1
Accuracy score (training): 0.921
Accuracy score (validation): 0.624
XGBoost score (validation): 0.6416184971098265
Optimized model accuracy score (testing): 0.7016129032258065
Confusion Matrix:
[[142   2   9]
 [  9  11  16]
 [ 28  10  21]]
Classification Report
              precision    recall  f1-score   support

           0       0.79      0.93      0.86       153
           1       0.48      0.31      0.37        36
           2       0.46      0.36      0.40        59

    accuracy                           0.70       248
   macro avg       0.58      0.53      0.54       248
weighted avg       0.67      0.70      0.68       248
```

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score, mean_squared_error, r2_score, confusion_matrix, classifi

X1 = df[['Rook_Age', 'Rook_FG_Percent', 'Rook_3P_Percent',
       'Rook_FT_Percent', 'Rook_MPG', 'Rook_PPG', 'Rook_RPG', 'Rook_APG', 'Rook_Year']]
Y1 = df['Cluster']

X_train, X_test, y_train, y_test = train_test_split(X1, Y1, test_size=0.2, random_state=42)


rfc = RandomForestClassifier(n_estimators=100, random_state=42)

rfc.fit(X_train, y_train)


y_pred = rfc.predict(X_test)
```

```
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred, average='weighted')
recall = recall_score(y_test, y_pred, average='weighted')
f1 = f1_score(y_test, y_pred, average='weighted')
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)
cm = confusion_matrix(y_test, y_pred)
classification = classification_report(y_test, y_pred)


print("Random Forest Accuracy:", accuracy)
print("Random Forest Precision:", precision)
print("Random Forest Recall:", recall)
print("Random Forest F1 Score:", f1)
print("Random Forest Mean Squared Error:", mse)
print("Random Forest R-squared Score:", r2)
print("Random Forest Confusion Matrix:")
print(cm)
print("Random Forest Classification Report:")
print(classification)
```

```
Random Forest Accuracy: 0.6787878787878788
Random Forest Precision: 0.6571813807107925
Random Forest Recall: 0.6787878787878788
Random Forest F1 Score: 0.6562287896187642
Random Forest Mean Squared Error: 0.9030303030303031
Random Forest R-squared Score: -0.21804399524375762
Random Forest Confusion Matrix:
[[87  0 10]
 [ 8  9  8]
 [22  5 16]]
Random Forest Classification Report:
              precision    recall  f1-score   support

           0       0.74      0.90      0.81        97
           1       0.64      0.36      0.46        25
           2       0.47      0.37      0.42        43

    accuracy                           0.68       165
   macro avg       0.62      0.54      0.56       165
weighted avg       0.66      0.68      0.66       165
```

```
rookieXPred = dfRookie[['Rook_Age', 'Rook_FG_Percent', 'Rook_3P_Percent',
       'Rook_FT_Percent', 'Rook_MPG', 'Rook_PPG', 'Rook_RPG', 'Rook_APG', 'Rook_Year']]
rookieCluster = rfc.predict(rookieXPred)

dfRookie['Predicted_Cluster'] = rookieCluster
dfRookie
```

	Player	Rook_Year	Rook_Age	Rook_FG_Percent	Rook_3P_Percent	Rook_FT_Per
0	Ochai Agbaji	2023	22	0.427	0.355	0
1	Patrick Baldwin Jr.	2023	20	0.394	0.381	0
2	Paolo Banchero	2023	20	0.427	0.298	0
3	Dominick Barlow	2023	19	0.535	0.000	0
4	MarJon Beauchamp	2023	22	0.395	0.331	0
...	...	...	...	...	...	
80	Jalen Williams	2023	21	0.521	0.356	0
81	Jaylin Williams	2023	20	0.436	0.407	0

```
dfRookie[dfRookie["Predicted_Cluster"] == 1]
```

	Player	Rook_Year	Rook_Age	Rook_FG_Percent	Rook_3P_Percent	Rook_FT_Perce
2	Paolo Banchero	2023	20	0.427	0.298	0.7
7	Malaki Branham	2023	19	0.440	0.302	0.8
29	RaiQuan Gray	2023	23	0.500	0.400	1.0
31	AJ Griffin	2023	19	0.465	0.390	0.8
33	Jaden Hardy	2023	20	0.438	0.404	0.8
43	Walker Kessler	2023	21	0.720	0.333	0.9

```
import numpy as np
from tensorflow import keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dense, Flatten
from tensorflow.keras.layers import Dropout

X1 = df[['Rook_Age', 'Rook_FG_Percent', 'Rook_3P_Percent',
       'Rook_FT_Percent', 'Rook_MPG', 'Rook_PPG', 'Rook_RPG', 'Rook_APG', 'Rook_Year']]
Y1 = df['Cluster'].astype(int)



x_train, x_test, y_train, y_test = train_test_split(X1, Y1, test_size=0.2, random_state = 123)

neuralNetwork = Sequential()
neuralNetwork.add(Dense(256, input_shape = (9,), activation = 'relu'))
neuralNetwork.add(Dense(128, activation = 'relu'))
neuralNetwork.add(Dense(64, activation = 'relu'))
neuralNetwork.add(Dense(32, activation = 'relu'))
neuralNetwork.add(Dense(3, activation = 'sigmoid'))

neuralNetwork.compile(loss = 'sparse_categorical_crossentropy', optimizer = 'adam', metrics = ['accuracy'])
neuralNetwork.fit(x_train, y_train, epochs = 150, batch_size = 32)

print()
neuralNetwork.evaluate(x_test, y_test)
```

```
Epoch 1/150
21/21 [==============================] - 2s 3ms/step - loss: 22.9545 - accuracy: 0.4704
Epoch 2/150
21/21 [==============================] - 0s 3ms/step - loss: 6.3985 - accuracy: 0.4598
Epoch 3/150
21/21 [==============================] - 0s 3ms/step - loss: 4.5756 - accuracy: 0.4901
Epoch 4/150
21/21 [==============================] - 0s 4ms/step - loss: 3.5844 - accuracy: 0.4082
Epoch 5/150
21/21 [==============================] - 0s 3ms/step - loss: 3.9068 - accuracy: 0.4659
Epoch 6/150
21/21 [==============================] - 0s 3ms/step - loss: 3.3799 - accuracy: 0.4704
Epoch 7/150
21/21 [==============================] - 0s 4ms/step - loss: 2.1161 - accuracy: 0.4492
Epoch 8/150
21/21 [==============================] - 0s 4ms/step - loss: 1.6309 - accuracy: 0.4932
Epoch 9/150
21/21 [==============================] - 0s 3ms/step - loss: 1.9858 - accuracy: 0.5448
Epoch 10/150
21/21 [==============================] - 0s 3ms/step - loss: 1.7208 - accuracy: 0.5235
Epoch 11/150
21/21 [==============================] - 0s 3ms/step - loss: 1.5050 - accuracy: 0.4613
Epoch 12/150
21/21 [==============================] - 0s 3ms/step - loss: 2.1330 - accuracy: 0.4932
Epoch 13/150
21/21 [==============================] - 0s 3ms/step - loss: 2.1613 - accuracy: 0.4825
Epoch 14/150
21/21 [==============================] - 0s 4ms/step - loss: 1.5331 - accuracy: 0.5266
Epoch 15/150
21/21 [==============================] - 0s 3ms/step - loss: 1.3359 - accuracy: 0.5068
Epoch 16/150
21/21 [==============================] - 0s 3ms/step - loss: 1.1502 - accuracy: 0.5827
Epoch 17/150
21/21 [==============================] - 0s 3ms/step - loss: 1.2588 - accuracy: 0.5645
Epoch 18/150
21/21 [==============================] - 0s 4ms/step - loss: 1.8746 - accuracy: 0.5266
```

```
Epoch 19/150
21/21 [==============================] - 0s 3ms/step - loss: 1.1031 - accuracy: 0.5630
Epoch 20/150
21/21 [==============================] - 0s 3ms/step - loss: 1.3230 - accuracy: 0.5266
Epoch 21/150
21/21 [==============================] - 0s 3ms/step - loss: 2.5729 - accuracy: 0.4841
Epoch 22/150
21/21 [==============================] - 0s 3ms/step - loss: 2.3582 - accuracy: 0.4750
Epoch 23/150
21/21 [==============================] - 0s 4ms/step - loss: 1.5236 - accuracy: 0.5341
Epoch 24/150
21/21 [==============================] - 0s 3ms/step - loss: 0.9033 - accuracy: 0.6009
Epoch 25/150
21/21 [==============================] - 0s 3ms/step - loss: 1.4466 - accuracy: 0.5493
Epoch 26/150
21/21 [==============================] - 0s 3ms/step - loss: 1.1349 - accuracy: 0.5766
Epoch 27/150
21/21 [==============================] - 0s 3ms/step - loss: 0.9046 - accuracy: 0.6176
Epoch 28/150
21/21 [==============================] - 0s 3ms/step - loss: 1.0478 - accuracy: 0.5615
Epoch 29/150
```

```
x_test_prediction = neuralNetwork.predict(x_test)
x_test_pred = np.argmax(x_test_prediction, axis = 1)
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred, average='weighted')
recall = recall_score(y_test, y_pred, average='weighted')

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

print("Classification Report")
print(classification_report(y_test, y_pred))

print(f'The accuracy is: {accuracy}.')
print(f'The precision is: {precision}.')
print(f'The recall is: {recall}.')
```

```
6/6 [==============================] - 0s 4ms/step
Confusion Matrix:
[[93  0 11]
 [ 9  2 15]
 [13  0 22]]
Classification Report
              precision    recall  f1-score   support

           0       0.81      0.89      0.85       104
           1       1.00      0.08      0.14        26
           2       0.46      0.63      0.53        35

    accuracy                           0.71       165
   macro avg       0.76      0.53      0.51       165
weighted avg       0.76      0.71      0.67       165

The accuracy is: 0.7090909090909091.
The precision is: 0.7645212999560824.
The recall is: 0.7090909090909091.
```

```
from sklearn.datasets import make_classification
from sklearn.preprocessing import LabelEncoder
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score, mean_squared_error, r2_score, confusion_matrix, classifi

X = df[['Rook_Age', 'Rook_FG_Percent', 'Rook_3P_Percent',
       'Rook_FT_Percent', 'Rook_MPG', 'Rook_PPG', 'Rook_RPG', 'Rook_APG', 'Rook_Year']]
y = df['Cluster']

encoder = LabelEncoder()
y_enc = encoder.fit_transform(y)

model = LogisticRegression(multi_class='ovr')
model.fit(X, y_enc)

y_pred = model.predict(X)

y_pred_dec = encoder.inverse_transform(y_pred)

accuracy = accuracy_score(y, y_pred_dec)
precision = precision_score(y, y_pred_dec, average='weighted')
```