modeling_class

March 16, 2023

[2]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import statsmodels.api as sm
import warnings
import xgboost as xgb
from statsmodels.stats.anova import anova_lm
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import KFold
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import cross_val_score
import os as os
import math

warnings.filterwarnings('ignore')
```

[4]:
```
import statsmodels
import statsmodels.formula.api as smf
import pandas as pd
import numpy as np
import seaborn as sns
from statsmodels.tools.tools import maybe_unwrap_results
from statsmodels.graphics.gofplots import ProbPlot
from statsmodels.stats.outliers_influence import variance_inflation_factor
import matplotlib.pyplot as plt
from typing import Type

style_talk = 'seaborn-talk'    #refer to plt.style.available
```

[5]:
```
# load data
path = '/Users/dylanjorling/UCLA/412proj/data/'
name = 'full_combine_data'
```

```
data = pd.read_csv(path + name, index_col=0)
data.head()
```

[5]:

	year	name	college	pos	height	weight	hand_size	arm_length	forty	bench	vert	broad_jump	shuttle	3cone	pick
0	1987	Mike Adams	Arizona St.	DB	69.8	198	8.50	30.50	4.42	13.0	32.0	118.0	4.60	NaN	undrafted
1	1987	John Adickes	Baylor	OL	74.8	266	10.25	30.00	4.97	25.0	26.5	103.0	4.60	NaN	154
2	1987	Tommy Agee	Auburn	RB	71.8	217	9.00	30.75	NaN	15.0	NaN	NaN	NaN	NaN	119
3	1987	David Alexander	Tulsa	OL	75.0	279	10.50	32.75	5.13	22.0	27.5	105.0	4.33	NaN	121
4	1987	Lyneal Alston	Southern Miss	WR	72.1	202	10.00	33.00	4.64	7.0	32.0	114.0	4.52	NaN	undrafted

[4]:
```
data.columns = [x.lower() for x in data.columns]
data.head()
```

[4]:

	year	name	college	pos	height (in)	weight (lbs)	hand size (in)	arm length (in)	40 yard	bench press	vert leap (in)	broad jump (in)	shuttle	3cone	pick
0	1987	Mike Adams	Arizona St.	DB	69.8	198	8.50	30.50	4.42	13.0	32.0	118.0	4.60	NaN	undrafted
1	1987	John Adickes	Baylor	OL	74.8	266	10.25	30.00	4.97	25.0	26.5	103.0	4.60	NaN	154
2	1987	Tommy Agee	Auburn	RB	71.8	217	9.00	30.75	NaN	15.0	NaN	NaN	NaN	NaN	119
3	1987	David Alexander	Tulsa	OL	75.0	279	10.50	32.75	5.13	22.0	27.5	105.0	4.33	NaN	121
4	1987	Lyneal Alston	Southern Miss	WR	72.1	202	10.00	33.00	4.64	7.0	32.0	114.0	4.52	NaN	undrafted

[5]:
```
data.head()
```

[5]:

	year	name	college	pos	height (in)	weight (lbs)	hand size (in)	arm length (in)	40 yard	bench press	vert leap (in)	broad jump (in)	shuttle	3cone	pick
0	1987	Mike Adams	Arizona St.	DB	69.8	198	8.50	30.50	4.42	13.0	32.0	118.0	4.60	NaN	undrafted
1	1987	John Adickes	Baylor	OL	74.8	266	10.25	30.00	4.97	25.0	26.5	103.0	4.60	NaN	154
2	1987	Tommy Agee	Auburn	RB	71.8	217	9.00	30.75	NaN	15.0	NaN	NaN	NaN	NaN	119

```
3  1987  David Alexander          Tulsa  OL         75.0           279
4  1987    Lyneal Alston  Southern Miss  WR         72.1           202

   hand size (in)  arm length (in)  40 yard  bench press  vert leap (in)  \
0            8.50            30.50     4.42         13.0            32.0
1           10.25            30.00     4.97         25.0            26.5
2            9.00            30.75      NaN         15.0             NaN
3           10.50            32.75     5.13         22.0            27.5
4           10.00            33.00     4.64          7.0            32.0

   broad jump (in)  shuttle  3cone       pick
0            118.0     4.60    NaN  undrafted
1            103.0     4.60    NaN        154
2              NaN      NaN    NaN        119
3            105.0     4.33    NaN        121
4            114.0     4.52    NaN  undrafted
```

[6]:
```
data.columns = [x.lower() for x in data.columns]
data.head()
```

[6]:
```
   year             name        college pos  height (in)  weight (lbs)  \
0  1987       Mike Adams    Arizona St.  DB         69.8           198
1  1987     John Adickes          Baylor  OL         74.8           266
2  1987       Tommy Agee          Auburn  RB         71.8           217
3  1987  David Alexander           Tulsa  OL         75.0           279
4  1987    Lyneal Alston  Southern Miss  WR         72.1           202

   hand size (in)  arm length (in)  40 yard  bench press  vert leap (in)  \
0            8.50            30.50     4.42         13.0            32.0
1           10.25            30.00     4.97         25.0            26.5
2            9.00            30.75      NaN         15.0             NaN
3           10.50            32.75     5.13         22.0            27.5
4           10.00            33.00     4.64          7.0            32.0

   broad jump (in)  shuttle  3cone       pick
0            118.0     4.60    NaN  undrafted
1            103.0     4.60    NaN        154
2              NaN      NaN    NaN        119
3            105.0     4.33    NaN        121
4            114.0     4.52    NaN  undrafted
```

[7]:
```
data = data.dropna()
data["pick"][data["pick"] == "undrafted"] = 0
data["pick"] = pd.to_numeric(data["pick"])
data["pick"][data["pick"] > 0] = 1
#drafted = 1
#undrafted = 0
```

```
y = data['pick']
X = data.iloc[:, 4:-1]
#X = data.iloc[:, 3:-1]
#X = pd.get_dummies(X)
print(X)
y
```

```
       height (in)  weight (lbs)  hand size (in)  arm length (in)  40 yard  \
3350         76.40           244           10.00            32.50     5.01
3351         74.60           239            9.00            32.75     4.92
3355         75.50           274            9.50            35.63     5.03
3357         70.60           190           10.25            32.00     4.80
3360         70.00           203            9.50            32.00     4.66
...            ...           ...             ...              ...      ...
13495        76.88           308           10.25            33.88     4.96
13496        71.50           194            9.00            31.13     4.40
13502        78.50           249            9.75            33.00     4.76
13507        78.13           315           10.50            33.88     5.27
13542        78.13           316            9.88            32.88     5.13

       bench press  vert leap (in)  broad jump (in)  shuttle  3cone
3350          15.0            32.0            112.0     4.32   7.45
3351          18.0            33.5            115.0     4.28   7.48
3355          19.0            32.5            110.0     4.83   8.80
3357          12.0            32.5            111.0     4.05   7.14
3360          18.0            36.0            117.0     4.41   7.85
...            ...             ...              ...      ...    ...
13495         21.0            22.5            107.0     4.65   7.40
13496         15.0            37.5            127.0     4.13   6.84
13502         17.0            27.0            120.0     4.41   7.06
13507         25.0            25.0            104.0     4.93   8.31
13542         27.0            28.5            110.0     4.71   7.75

[5843 rows x 10 columns]
```

[7]:
```
3350     1
3351     0
3355     1
3357     1
3360     1
        ..
13495    1
13496    0
13502    1
13507    1
13542    1
Name: pick, Length: 5843, dtype: int64
```

[11]:
```
data.columns = ["year", "name", "college", "pos", "height", "weight",␣
↪"hand_size", "arm_length", "forty", "bench_press", "vert", "broad_jump",␣
↪"shuttle", "cone", "pick"]
```

[13]:
```
data.head()
X.head()
```

[13]:

	height (in)	weight (lbs)	hand size (in)	arm length (in)	40 yard	\
3350	76.40	244	10.00	32.50	5.01	
3351	74.60	239	9.00	32.75	4.92	
3355	75.50	274	9.50	35.63	5.03	
3357	70.60	190	10.25	32.00	4.80	
3360	70.00	203	9.50	32.00	4.66	
...	...	...	...	...	...	
13495	76.88	308	10.25	33.88	4.96	
13496	71.50	194	9.00	31.13	4.40	
13502	78.50	249	9.75	33.00	4.76	
13507	78.13	315	10.50	33.88	5.27	
13542	78.13	316	9.88	32.88	5.13	

	bench press	vert leap (in)	broad jump (in)	shuttle	3cone
3350	15.0	32.0	112.0	4.32	7.45
3351	18.0	33.5	115.0	4.28	7.48
3355	19.0	32.5	110.0	4.83	8.80
3357	12.0	32.5	111.0	4.05	7.14
3360	18.0	36.0	117.0	4.41	7.85
...	...	...	...	...	...
13495	21.0	22.5	107.0	4.65	7.40
13496	15.0	37.5	127.0	4.13	6.84
13502	17.0	27.0	120.0	4.41	7.06
13507	25.0	25.0	104.0	4.93	8.31
13542	27.0	28.5	110.0	4.71	7.75

[5843 rows x 10 columns]

[14]:
```
X.columns = ["height", "weight", "hand_size", "arm_length", "forty",␣
↪"bench_press", "vert", "broad_jump", "shuttle", "cone"]
```

[15]:
```
X.corr()
```

[15]:

	height	weight	hand_size	arm_length	forty	bench_press	\
height	1.000000	0.749966	0.494092	0.723978	0.626795	0.357892	
weight	0.749966	1.000000	0.496161	0.602941	0.883426	0.626132	
hand_size	0.494092	0.496161	1.000000	0.504237	0.411424	0.294874	
arm_length	0.723978	0.602941	0.504237	1.000000	0.468437	0.259697	
forty	0.626795	0.883426	0.411424	0.468437	1.000000	0.459114	
bench_press	0.357892	0.626132	0.294874	0.259697	0.459114	1.000000	

```
vert         -0.438507 -0.673852  -0.275543   -0.316546 -0.754774    -0.314744
broad_jump   -0.424118 -0.717905  -0.274962   -0.279479 -0.795473    -0.368405
shuttle       0.528578  0.748888   0.340291    0.461745  0.772295     0.374785
cone          0.508327  0.771973   0.346123    0.438580  0.809775     0.403321

                  vert  broad_jump   shuttle      cone
height       -0.438507   -0.424118  0.528578  0.508327
weight       -0.673852   -0.717905  0.748888  0.771973
hand_size    -0.275543   -0.274962  0.340291  0.346123
arm_length   -0.316546   -0.279479  0.461745  0.438580
forty        -0.754774   -0.795473  0.772295  0.809775
bench_press  -0.314744   -0.368405  0.374785  0.403321
vert          1.000000    0.786275 -0.691112 -0.668508
broad_jump    0.786275    1.000000 -0.670406 -0.702932
shuttle      -0.691112   -0.670406  1.000000  0.801462
cone         -0.668508   -0.702932  0.801462  1.000000
```

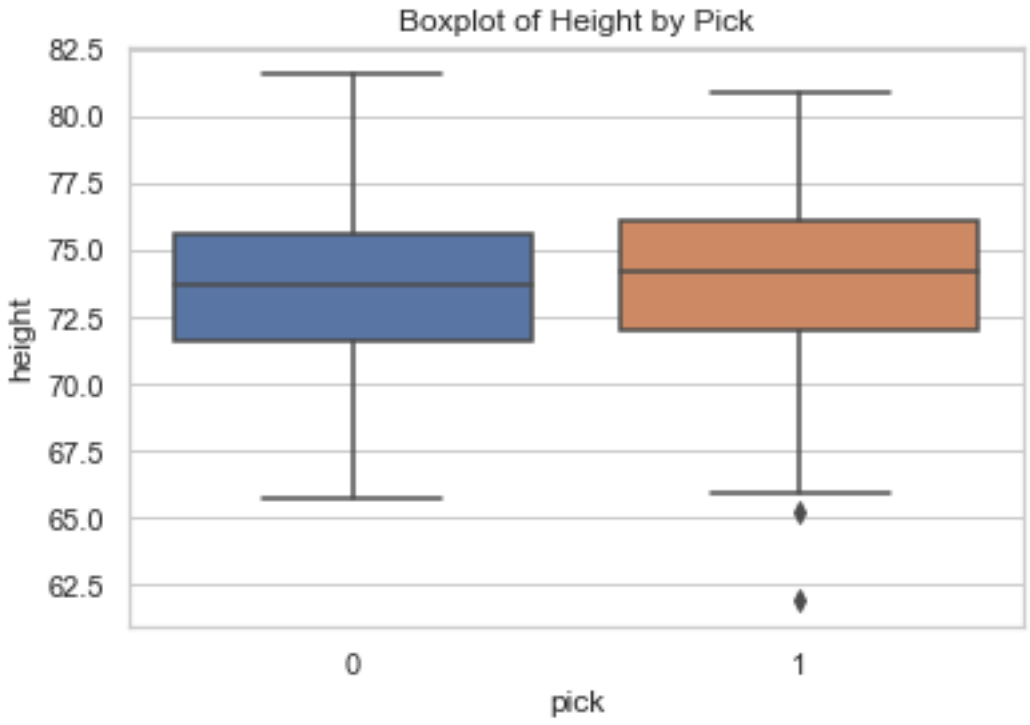
[16]:
```
np.mean(y)
```

[16]:
```
0.5856580523703577
```

[135]:
```
from sklearn.linear_model import LogisticRegression, LogisticRegressionCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, confusion_matrix, precision_score,␣
 ↪recall_score, ConfusionMatrixDisplay
from sklearn.model_selection import RandomizedSearchCV, train_test_split
from scipy.stats import randint
from sklearn.metrics import classification_report
```

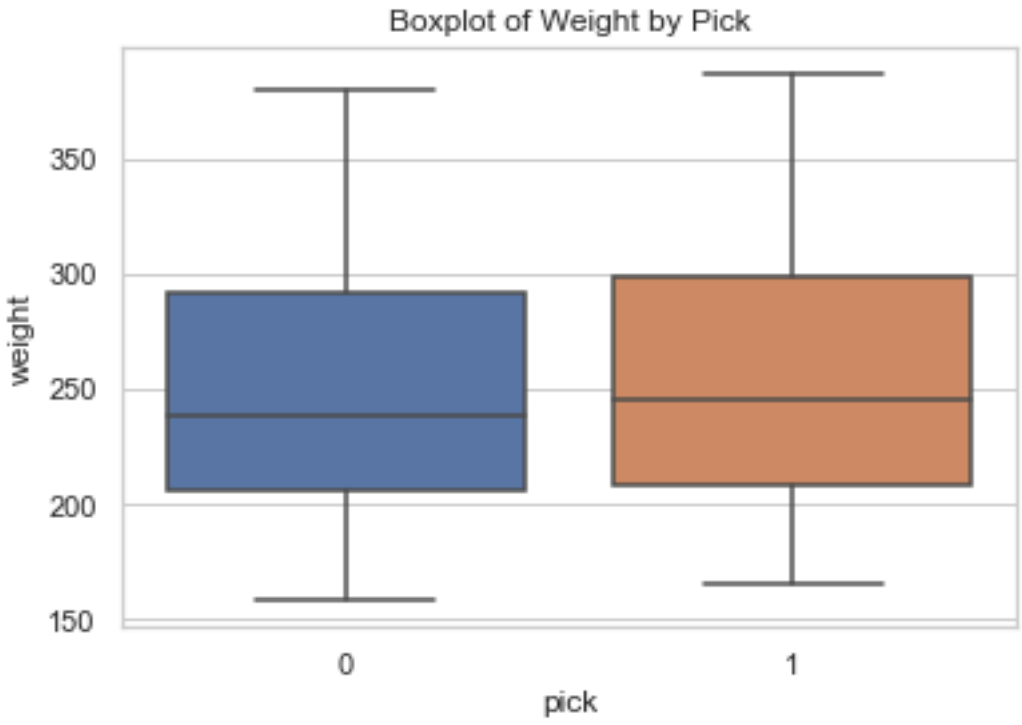
[70]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='height', data=data).set(title = "Boxplot of Height by␣
 ↪Pick")
```

[70]:
```
[Text(0.5, 1.0, 'Boxplot of Height by Pick')]
```



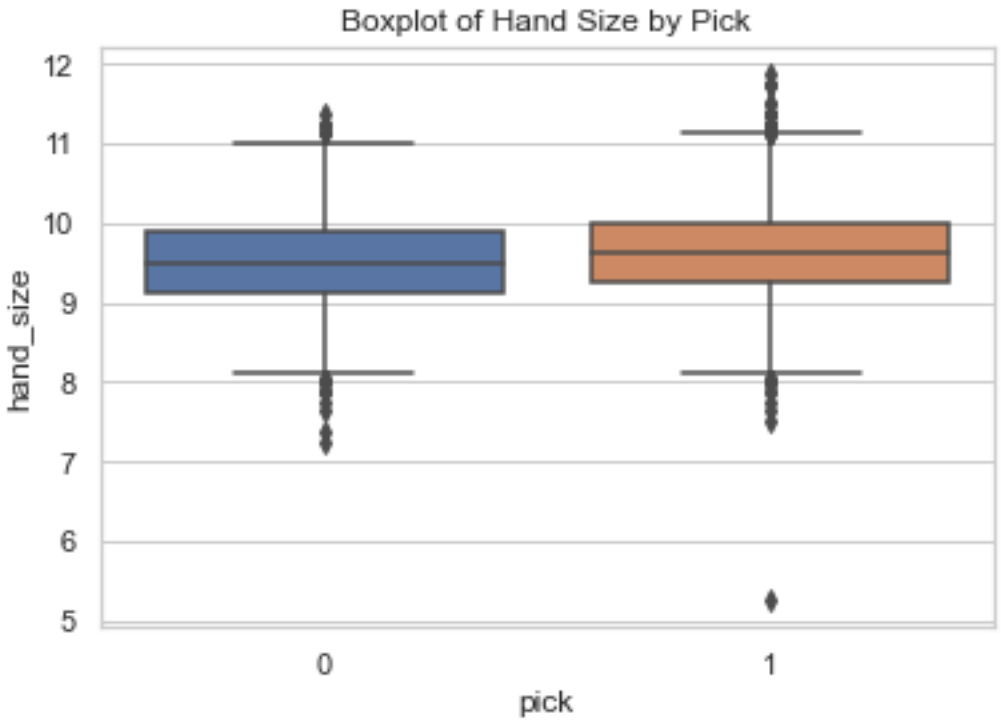
[18]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='weight', data=data).set(title = "Boxplot of Weight by␣
↪Pick")
```

[18]:
```
[Text(0.5, 1.0, 'Boxplot of Weight by Pick')]
```



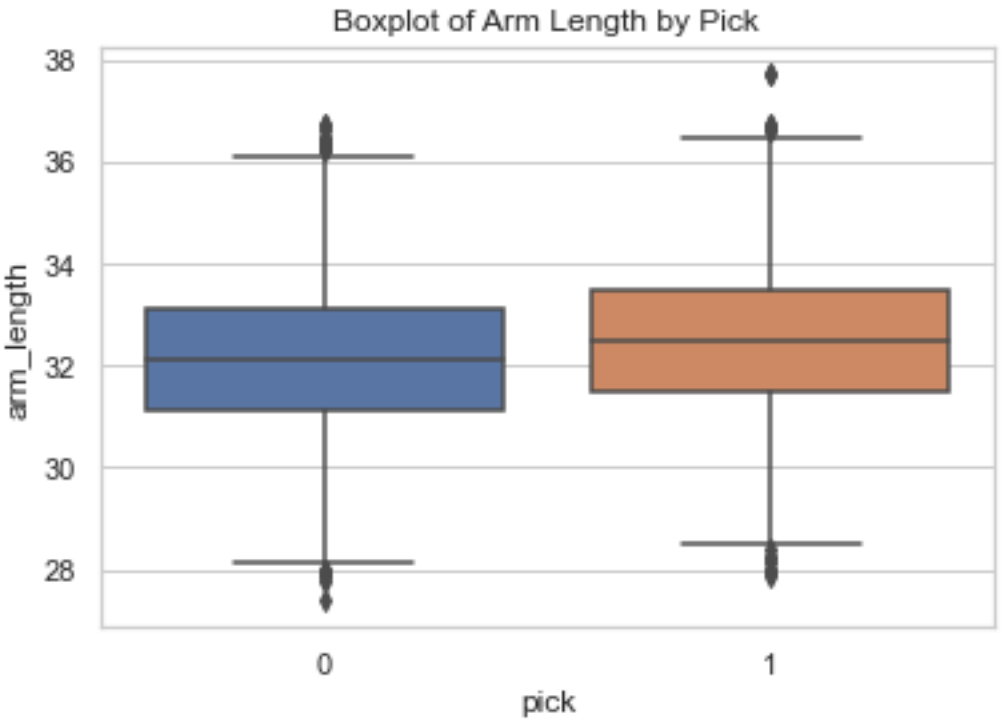
[37]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='hand_size', data=data).set(title = "Boxplot of Hand␣
↪Size by Pick")
```

[37]:
```
[Text(0.5, 1.0, 'Boxplot of Hand Size by Pick')]
```



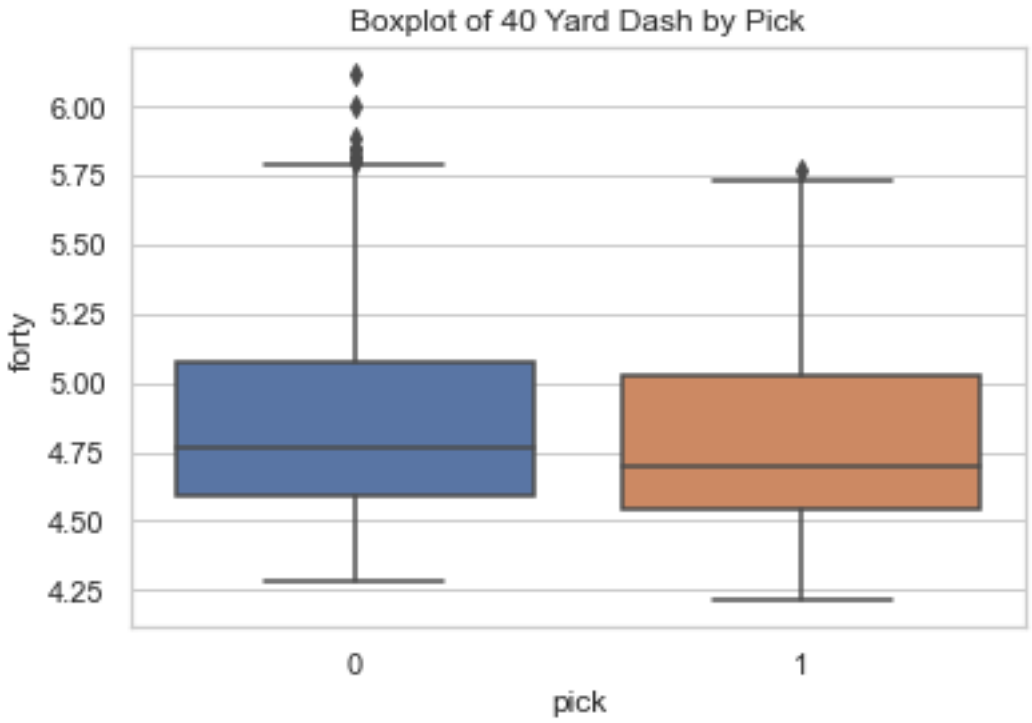
[38]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='arm_length', data=data).set(title = "Boxplot of Arm␣
↪Length by Pick")
```

[38]:
```
[Text(0.5, 1.0, 'Boxplot of Arm Length by Pick')]
```



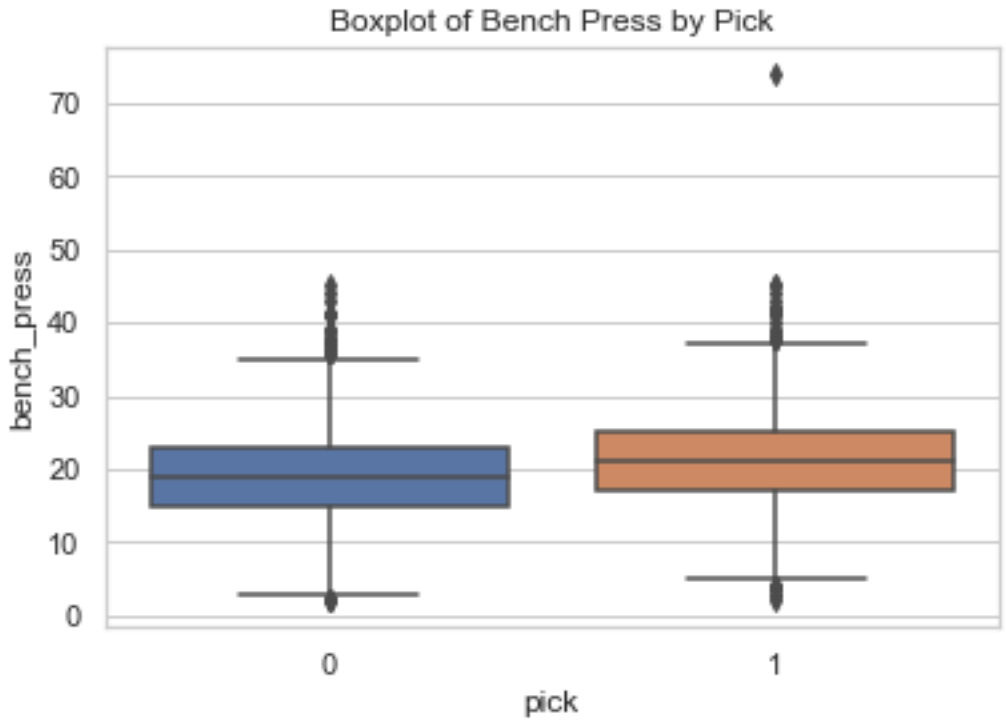
[39]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='forty', data=data).set(title = "Boxplot of 40 Yard Dash␣
↪by Pick")
```

[39]:
```
[Text(0.5, 1.0, 'Boxplot of 40 Yard Dash by Pick')]
```



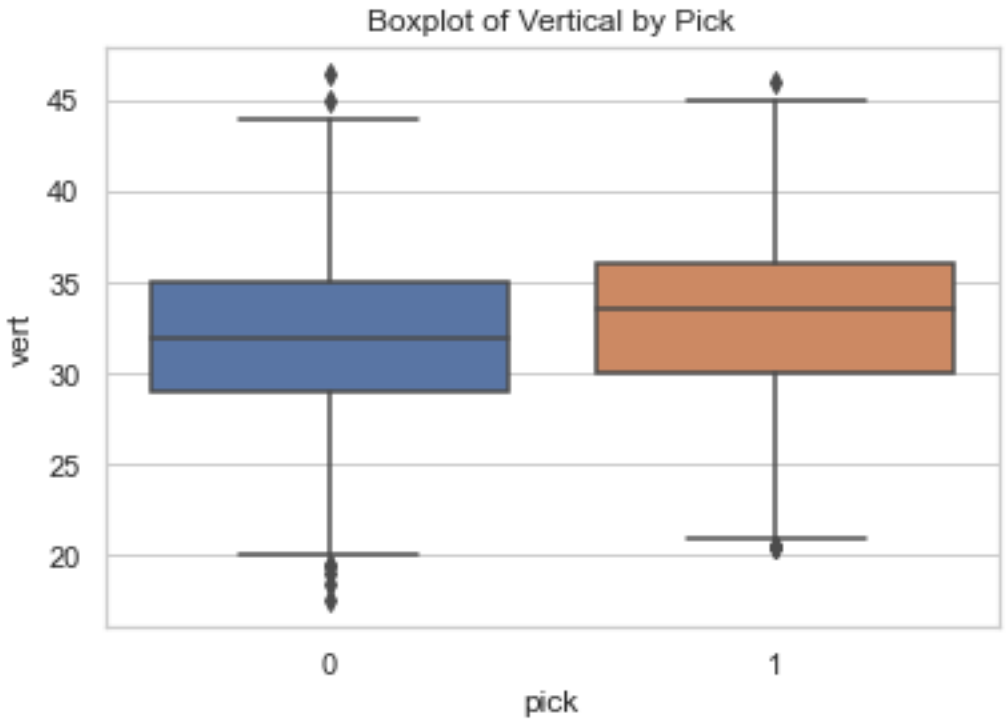
[55]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='bench_press', data=data).set(title = "Boxplot of Bench␣
↪Press by Pick")
```

[55]:
```
[Text(0.5, 1.0, 'Boxplot of Bench Press by Pick')]
```



[40]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='vert', data=data).set(title = "Boxplot of Vertical by␣
↪Pick")
```

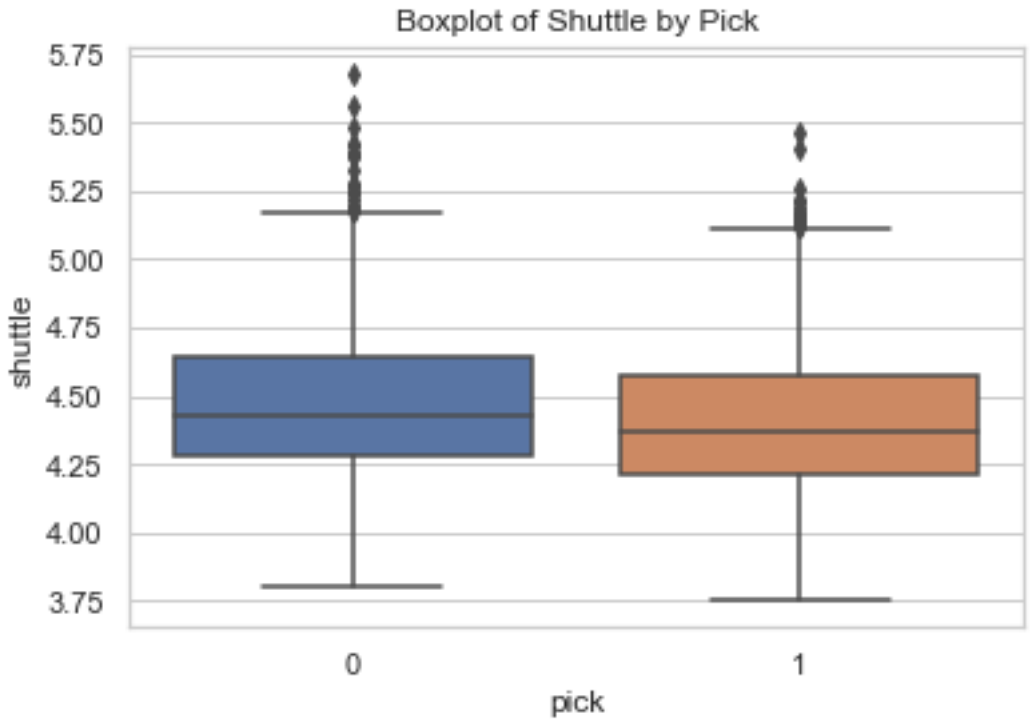
[40]:
```
[Text(0.5, 1.0, 'Boxplot of Vertical by Pick')]
```



[ ]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='broad_jump', data=data).set(title = "Boxplot of Broad␣
↪Jump by Pick")
```

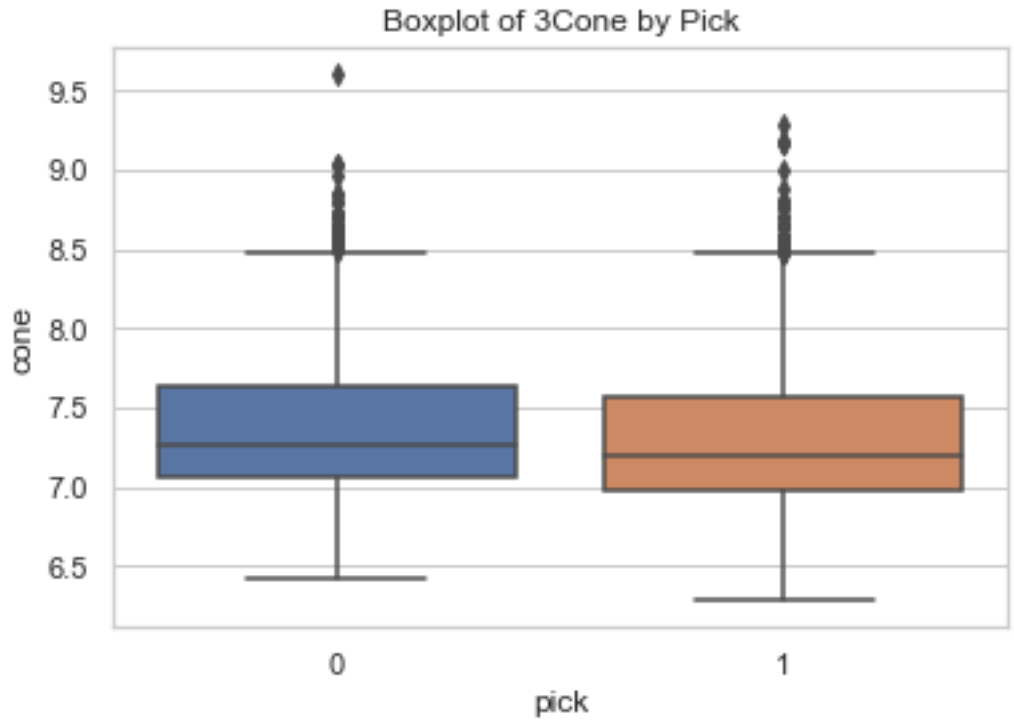
[42]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='shuttle', data=data).set(title = "Boxplot of Shuttle by␣
↪Pick")
```

[42]:
```
[Text(0.5, 1.0, 'Boxplot of Shuttle by Pick')]
```



[43]:
```
sns.set(style='whitegrid')
sns.boxplot(x='pick', y='cone', data=data).set(title = "Boxplot of 3Cone by␣
↪Pick")
```

[43]:
```
[Text(0.5, 1.0, 'Boxplot of 3Cone by Pick')]
```



1 Condense Logistic Model

[205]:
```
new = X.loc[:, X.columns.isin(["forty", #56.8
                               "weight",#, 62.9
                               "shuttle"#,65.9
                               #"cone"#,66.05
                              #"height", #65.9
                              #"arm_length"#, 66.05
                              #"vert"#, 65.7
                              #"bench_press"#,65.2
                              #"broad_jump"#, 65.0
                              #"hand_size" 64.3
                              ])]


new_train, new_test, y_train, y_test = train_test_split(new, y, test_size=0.3,␣
↪random_state=42)
```

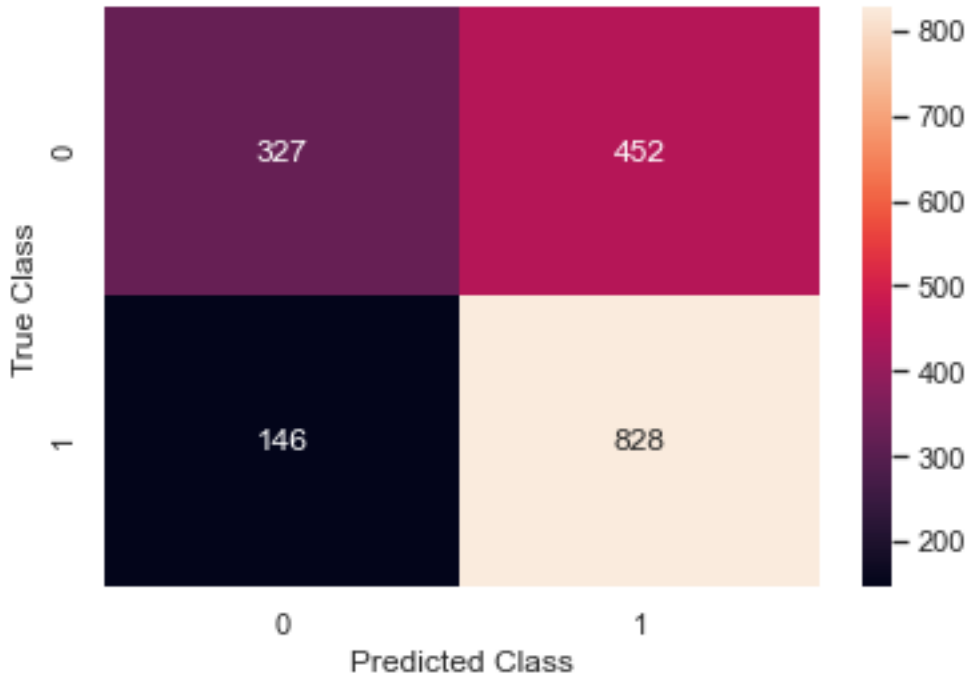
[206]:
```
# Logistic Regression with CV
new_model_cv = LogisticRegressionCV(cv=10, random_state=42)
new_model_cv.fit(new_train, y_train)
new_model_cv.score(new_test, y_test)
```

[206]: 0.6588705077010839

[207]:
```
y_pred = new_model_cv.predict(new_test)
cf_matrix = confusion_matrix(y_test, y_pred)
print(cf_matrix)
import seaborn as sns
conf = sns.heatmap(cf_matrix, annot=True, fmt=".0f")
conf.set(xlabel='Predicted Class', ylabel='True Class')
```

```
[[327 452]
 [146 828]]
```

[207]: [Text(0.5, 12.5, 'Predicted Class'), Text(30.5, 0.5, 'True Class')]



[208]:
```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.69      0.42      0.52       779
           1       0.65      0.85      0.73       974

    accuracy                           0.66      1753
   macro avg       0.67      0.63      0.63      1753
weighted avg       0.67      0.66      0.64      1753
```

1.1 Odds

[162]:
```
odds = [math.exp(x) for x in new_model_cv.coef_[0]]
print(new_train.columns)
print(odds)
```

```
Index(['weight', 'forty', 'shuttle'], dtype='object')
[1.0374082566598295, 0.017438080181058697, 0.10777813172346859]
```

[163]:
```
new_model.coef_[0]
```

[163]:
```
array([ 0.03634102, -3.98757502, -2.24177384])
```

[164]:
```
new_train.columns
```

[164]:
```
Index(['weight', 'forty', 'shuttle'], dtype='object')
```

From our reduced model we get coefficients of 0.0363 for weight, -3.9875 for forty yard dash, and -2.2418 in shuttle. After converting these coefficients to odds we get that for every 1 pound increase in weight, the odds of being drafted to the NFL increase by 3.74%, for every 1 unit increase in Forty Yard Dash Time the odds of being drafted to the NFL decrease by 97.1%, and for every 1 unit increase in Shuttle Time the odds of being drafted to the NFL decrease by 89.6%

2 Full Logistic

[194]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,␣
↪random_state=42)
```

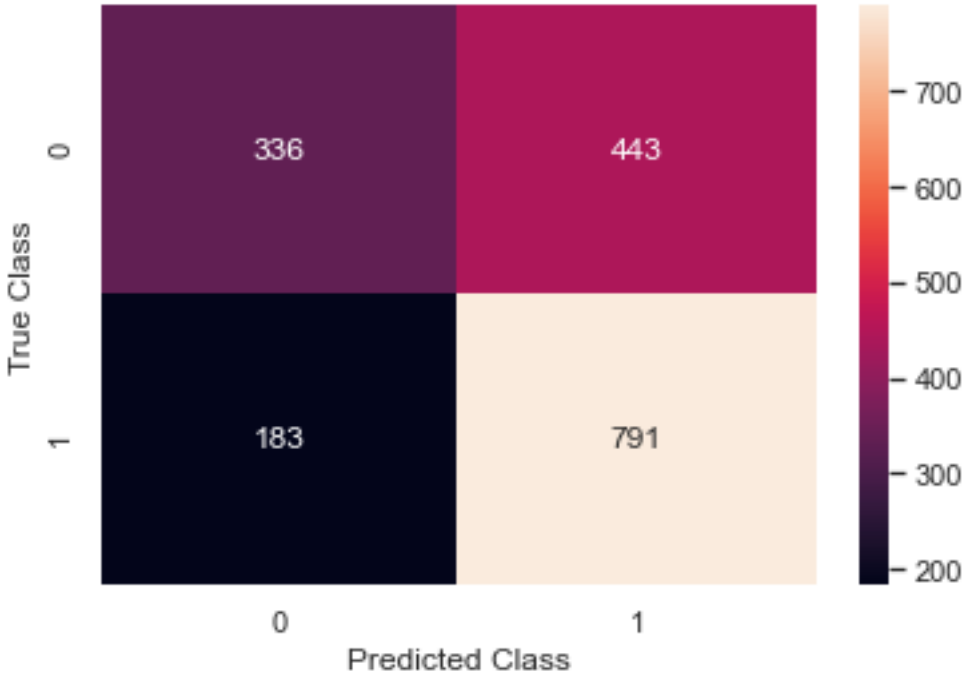
[195]:
```
# Logistic Regression with CV
model_cv = LogisticRegressionCV(cv=10, random_state=42)
model_cv.fit(X_train, y_train)
print(model_cv.score(X_test, y_test))
y_pred = model_cv.predict(X_test)
```

```
0.6428978893325727
```

[201]:
```
cf_matrix = confusion_matrix(y_test, y_pred)
print(cf_matrix)
import seaborn as sns
conf = sns.heatmap(cf_matrix, annot=True, fmt=".0f")
conf.set(xlabel='Predicted Class', ylabel='True Class')

print(classification_report(y_test, y_pred))
```

```
[[336 443]
 [183 791]]
              precision    recall  f1-score   support
```

```
              0       0.65      0.43      0.52       779
              1       0.64      0.81      0.72       974

       accuracy                           0.64      1753
      macro avg       0.64      0.62      0.62      1753
   weighted avg       0.64      0.64      0.63      1753
```



[204]:
```
791/(791+443) #of the predicted positive values it only identifies 64% correctly
791/(791+183) # of the drafted players it identifies 81% of them
```

[204]: 0.6410048622366289

2.1 RF

[209]:
```
rf = RandomForestClassifier()
rf.fit(X_train, y_train)
```

[209]: RandomForestClassifier()

[210]:
```
y_pred = rf.predict(X_test)
```

[211]:
```
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)
```

```
Accuracy: 0.6423274386765545
```

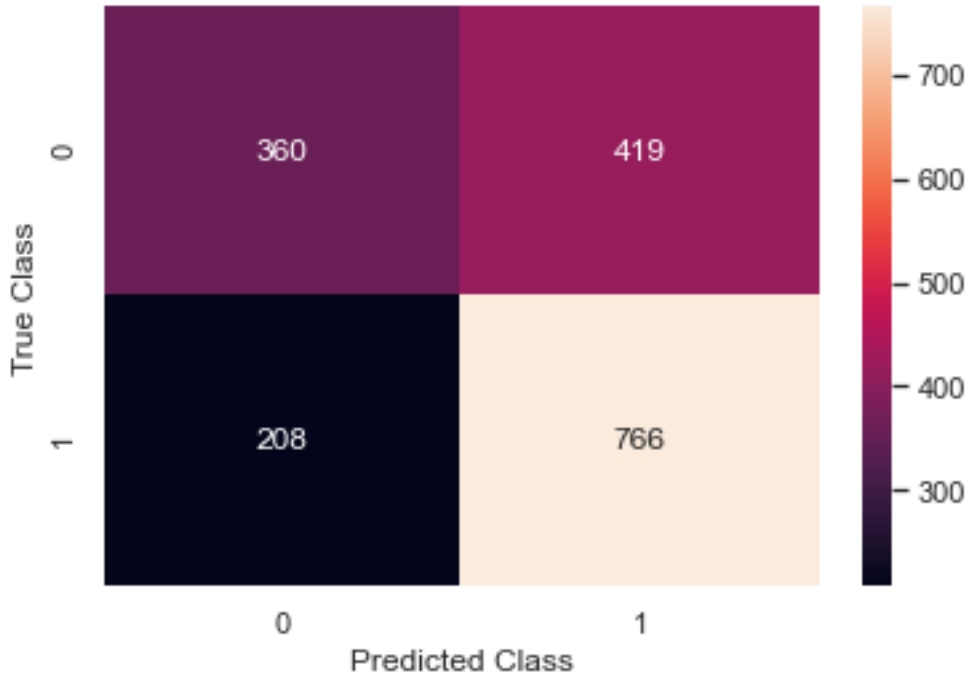
[212]:
```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.63      0.46      0.53       779
           1       0.65      0.79      0.71       974

    accuracy                           0.64      1753
   macro avg       0.64      0.62      0.62      1753
weighted avg       0.64      0.64      0.63      1753
```

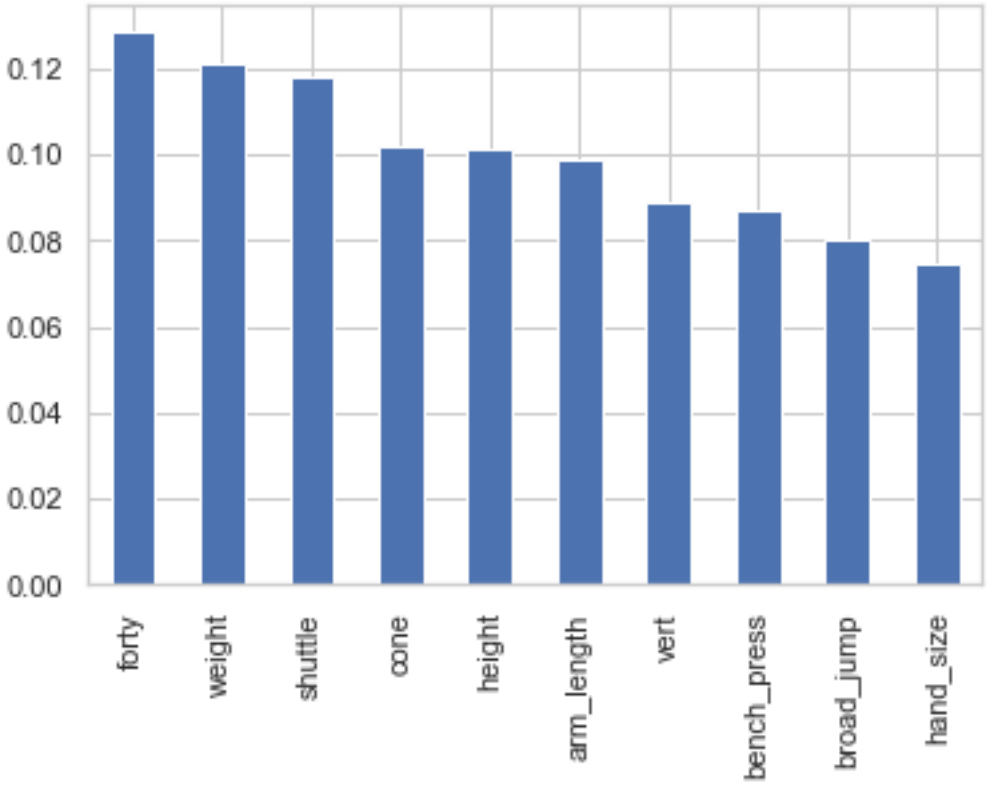
[213]:
```
cf_matrix1 = confusion_matrix(y_test, y_pred)
print(cf_matrix1)
import seaborn as sns
conf1 = sns.heatmap(cf_matrix1, annot=True, fmt=".0f")
conf1.set(xlabel='Predicted Class', ylabel='True Class')
```

```
[[360 419]
 [208 766]]
```

[213]: [Text(0.5, 12.5, 'Predicted Class'), Text(30.5, 0.5, 'True Class')]



[182]:
```
feature_importances = pd.Series(rf.feature_importances_, index=X_train.columns).
↪sort_values(ascending=False)

# Plot a simple bar chart
feature_importances.plot.bar();
```



[214]:
```
fws = X[["forty", "weight", "shuttle"]]
new_train2, new_test2, y_train2, y_test2 = train_test_split(fws, y, test_size=0.
↪3, random_state=42)
```

[215]:
```
rf2 = RandomForestClassifier()
rf2.fit(new_train2, y_train2)
y_pred2 = rf2.predict(new_test2)
accuracy = accuracy_score(y_test2, y_pred2)
print("Accuracy:", accuracy)
```

```
Accuracy: 0.6383342840844267
```

[216]:
```
print(classification_report(y_test2,y_pred2))
```

```
              precision    recall  f1-score   support
```

```
              0       0.62      0.49      0.55       779
              1       0.65      0.76      0.70       974

    accuracy                            0.64      1753
   macro avg       0.63      0.62      0.62      1753
weighted avg       0.64      0.64      0.63      1753
```

[217]:
```
cf_matrix2 = confusion_matrix(y_test2, y_pred2)
print(cf_matrix2)
import seaborn as sns
conf2 = sns.heatmap(cf_matrix2, annot=True, fmt=".0f")
conf2.set(xlabel='Predicted Class', ylabel='True Class')
```

```
[[382 397]
 [237 737]]
```

[217]: `[Text(0.5, 12.5, 'Predicted Class'), Text(30.5, 0.5, 'True Class')]`