Bryan Jamieson

BAMTESTING - https://www.bamtesting.com/bamscore (https://www.bamtesting.com/bamscore)

Data From Martin (Head Data Scientist) @ Bamtesting

Business Case:

- Can I predict BAMscore using NBA Combine Test Results and use it as a predictor to understand which of the 12 athletic tests actually can improve bamscore?

- How can it give insight to athletes + coaches?

Hypothesis

- Protocols (specifically 2 agility tests) are more important for predicting and or improving bamscore, athletes need to focus on improving those

Target Audience

= High School Basketball Athletes that are trying to plan and play at next level

DATA Explained

bamid

- Number randomly assigned to each athlete without knowing full name

bamscore

- Single Numerical Value that measures and benchmarks athletic performence
- "Athletic SAT Score"
- Standardized athletic assessment that gives coaches insight into where players need improvement

Protocols (Athletic Tests)

approach_vertical

- running start, jump as high as you can

vertical_jump

- stationary start, jump as high as you can

three_quarter_court_sprint

- 75 ft straight sprint

four_way_agility

- run arouund 4 points in box, run back through

reaction_shuttle

- agility test - start in middle of box, run left, right, run back and finish through left line

Anthros (Body Measurements)

wingspan

- horizontal distance from arms extended side to side

reach

- standing vertical reach

height

- how tall you are in inches

weight

- how much you weigh in pounds

body_comp

- body fat (varies in measurement methods)

hand_length

- vertical length of hand

hand_width

- horizontal length of hand

Flow

Notebook (1) Explore and Clean BAM Data

- Visualize the data to see trends, relationships, outliers

- Clean Outliers

- Make Observation/Hypothesis

- Save as "clean data"

Notebook (2) Modeling

- Model data in modeling notebook (2)

- Try different regressions and models

- Iterate to improve r2 score without over fitting

1) Import Libraries + Data

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import scipy.stats as scs
import seaborn as sns
import os
import plotly.express as px
from sklearn.ensemble import RandomForestRegressor
from sklearn.preprocessing import maxabs_scale
from sklearn.pipeline import Pipeline
```

In [2]:
```
df = pd.read_excel('bam_testing_data.xlsx')
## Name the dataset "df"
```

In [3]:
```
df.info()
# See if anything is funky with the data using .info() and the eye test
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1059 entries, 0 to 1058
Data columns (total 16 columns):
BAMid                  1057 non-null object
Approach Vertical      986 non-null float64
Vertical Jump          1019 non-null float64
3/4 Court sprint       1026 non-null object
4-Way agility          1020 non-null object
Reaction Shuttle       1024 non-null float64
BAMScore               1056 non-null float64
Wingspan               1012 non-null float64
Reach                  1012 non-null float64
Height                 1012 non-null float64
Weight                 1012 non-null float64
Body Comp              1012 non-null float64
Hand Length            1010 non-null float64
Hand Width             1009 non-null float64
Unnamed: 14            0 non-null float64
Unnamed: 15            1 non-null object
dtypes: float64(12), object(4)
memory usage: 132.5+ KB
```

In [4]:
```
df
```

Out[4]:

	BAMid	Approach Vertical	Vertical Jump	3/4 Court sprint	4-Way agility	Reaction Shuttle	BAMScore	Wingspan	Reach	Height
0	1037	33.5	28.5	3.376	11.471	3.669	2003.0	72.75	94.0	70.00
1	656	30.5	21.5	3.486	12.114	3.355	1865.0	82.00	104.5	79.50
2	477	37.0	31.0	3.23	12.036	3.562	2005.0	81.50	99.0	74.00
3	1200	29.0	23.0	3.37	12.509	3.173	1902.0	79.50	101.0	77.50
4	1501	31.0	26.0	3.389	12.724	3.316	1903.0	77.00	101.5	78.00
...	...	...	...	...	...	...	...	...	...	...
1054	574	36.0	31.0	3.424	12.654	3.635	1917.0	72.00	88.0	68.25
1055	651	31.5	26.5	3.256	11.136	3.343	2029.0	74.00	91.5	68.00
1056	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1057		NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1058	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

1059 rows × 16 columns

Observation - This shows we have 1059 rows and 16 columns

I dont like the looks of Unnamed 14 + 15. Replace spaces with _ for punctuation purposes

In [5]:
```
df.columns = [column.strip().lower().replace(" ", "_") for column in df.
columns]
df.head()
```

Out[5]:

	bamid	approach_vertical	vertical_jump	3/4_court_sprint	4-way_agility	reaction_shuttle	bamsco
0	1037	33.5	28.5	3.376	11.471	3.669	2003
1	656	30.5	21.5	3.486	12.114	3.355	1865
2	477	37.0	31.0	3.23	12.036	3.562	2005
3	1200	29.0	23.0	3.37	12.509	3.173	1902
4	1501	31.0	26.0	3.389	12.724	3.316	1903

Have to change spaces (strings) to numberic values to we can work with it

Fill spaces/na with 0 so we can fill with mean later

In [6]:

```
column_names = ['bamid', '3/4_court_sprint', '4-way_agility', 'unnamed:_
14', 'unnamed:_15']

for column in df.columns:
    if column in column_names:
        df[column].replace('', 0)
        df[column] = pd.to_numeric(df[column], errors='coerce')
    df[column].fillna(df[column].mean(), inplace=True)
    print(f'{column}: fixed!')
# Have to change spaces (strings) to numberic values to we can work with
it
```

```
bamid: fixed!
approach_vertical: fixed!
vertical_jump: fixed!
3/4_court_sprint: fixed!
4-way_agility: fixed!
reaction_shuttle: fixed!
bamscore: fixed!
wingspan: fixed!
reach: fixed!
height: fixed!
weight: fixed!
body_comp: fixed!
hand_length: fixed!
hand_width: fixed!
unnamed:_14: fixed!
unnamed:_15: fixed!
```

In [7]:

```
df.columns
```

Out[7]:

```
Index(['bamid', 'approach_vertical', 'vertical_jump', '3/4_court_sprin
t',
       '4-way_agility', 'reaction_shuttle', 'bamscore', 'wingspan', 're
ach',
       'height', 'weight', 'body_comp', 'hand_length', 'hand_width',
       'unnamed:_14', 'unnamed:_15'],
      dtype='object')
```

In [8]:

```
df.rename(columns = {'3/4_court_sprint':'three_quarter_court_sprint', '4
-way_agility':'four_way_agility'}
          , inplace = True)
# rename columns so they all work later on in notebook
```

In [9]:

```
df.drop(columns=['unnamed:_14','unnamed:_15','bamid'],inplace=True)
# Remove because only 1 value from our df.info check above
# Check df.info() again to make sure it worked
```

In [10]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1059 entries, 0 to 1058
Data columns (total 13 columns):
approach_vertical             1059 non-null float64
vertical_jump                 1059 non-null float64
three_quarter_court_sprint    1059 non-null float64
four_way_agility              1059 non-null float64
reaction_shuttle              1059 non-null float64
bamscore                      1059 non-null float64
wingspan                      1059 non-null float64
reach                         1059 non-null float64
height                        1059 non-null float64
weight                        1059 non-null float64
body_comp                     1059 non-null float64
hand_length                   1059 non-null float64
hand_width                    1059 non-null float64
dtypes: float64(13)
memory usage: 107.7 KB
```

In [11]:
```
df.columns.isna()
# Check and make sure nulls are gone - looking for all false.
```

Out[11]:
```
array([False, False, False, False, False, False, False, False, False,
       False, False, False, False])
```

Data Visualization + EDA

What does our data even look like?

First lets create a simple pairplot to:

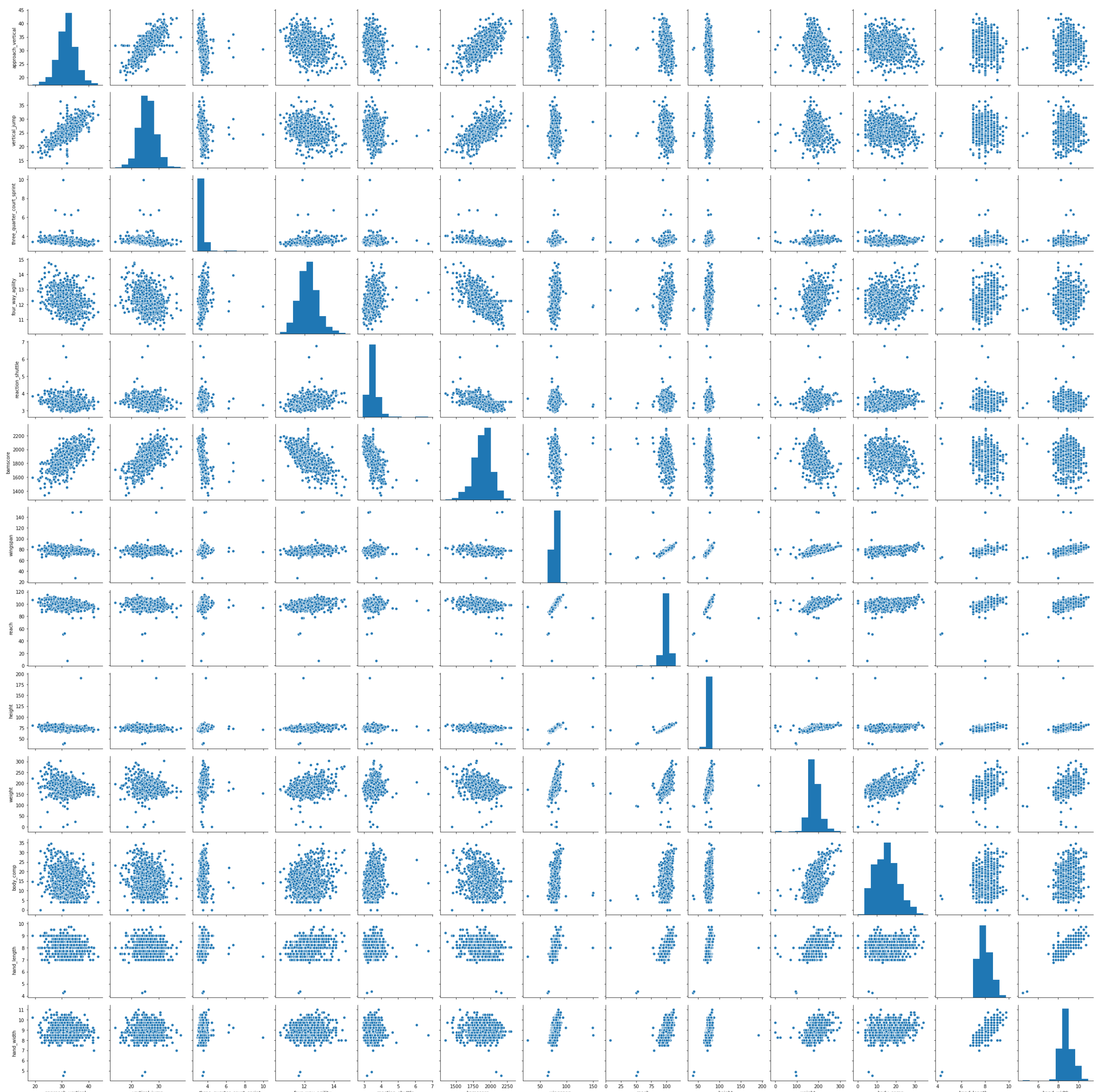
- Use the eye test to look at relationships in our data

- Identify multicollinearity

In [12]:

```
# First lets use the eye test and look at relationships in our data + identify multicollinearity.
# Multicollinearity is bad - because you can use one column to essentially predict another column
# Multicollinearity can overfit sometimes and gives you a lot of same info as similar column - ex appr jump x vert jump
sns.pairplot(df)
```

Out[12]: <seaborn.axisgrid.PairGrid at 0x7f9bf0667630>



Observations:

Top right column where points look like they are lining up

Diags shows us baseline normal distribution

Can see on reaction shuttle and 3/4 court sprint outlier because it's skewed to left

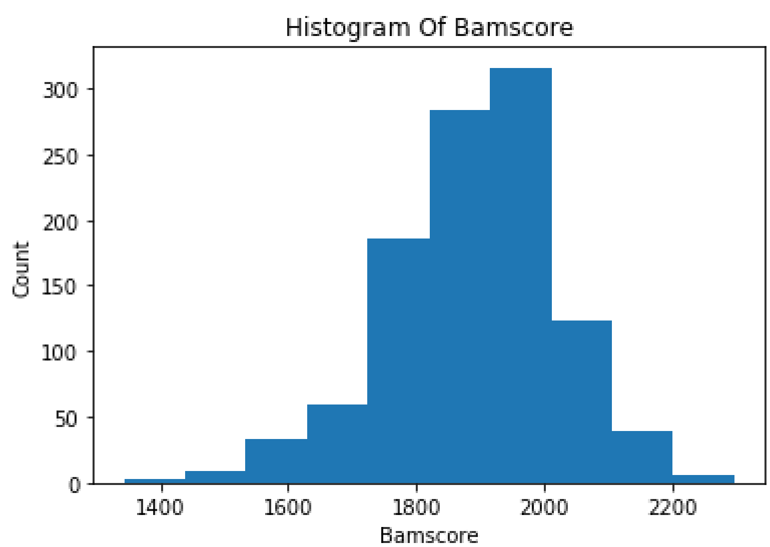
What does bamscore look like? What is it?

In [13]:
```
df['bamscore'].describe(),
```

Out[13]:
```
(count     1059.000000
 mean      1890.976326
 std        134.866028
 min       1343.000000
 25%       1811.000000
 50%       1899.000000
 75%       1981.000000
 max       2298.000000
 Name: bamscore, dtype: float64,)
```

In [14]:
```
fig,ax = plt.subplots(1,1)
df['bamscore'].plot.hist(bins=10)
ax.set_title("Histogram Of Bamscore")
ax.set_xlabel('Bamscore')
ax.set_ylabel('Count')
```

Out[14]:
```
Text(0, 0.5, 'Count')
```



Observations:

BAMscore Range: [1343-2298]

BAMscore Min: [1343]

BAMscore Max: [2298]

- More above avg/good bamscores than poor

Create BAM_score_rank

Split bamscore into 5 ranks (1-5) and add it as a new column

- For visualization purposes + EDA only

- !! Don't forget to drop before saving notebook because bam_score_rank is a classifier and we are doing a regression !!

- In the future, if we decide to change this to a classification, then we can keep bam_score_rank and ranks for other factors

In [15]:

```
bam_mu = df['bamscore'].mean()
bam_std = df['bamscore'].std()

min95 = bam_mu-2*bam_std
max95 = bam_mu+2*bam_std


def get_rank_bam_score(bam):
    if bam > bam_mu+1*bam_std:
        return 5
    if bam > bam_mu:
        return 4
    if bam > bam_mu - bam_std:
        return 3
    if bam > bam_mu - 2*bam_std:
        return 2
    return 1
```

```
In [16]: df['bam_score_rank'] = df['bamscore'].apply(get_rank_bam_score)
         df.head()
         # I ended up dropping this, but if I want to do a classification instead
         of regression, use bam_score_rank
         # Instead of splitting data into 5 collections and then referencing a li
         st, I will use bamscorerank
```

Out[16]:

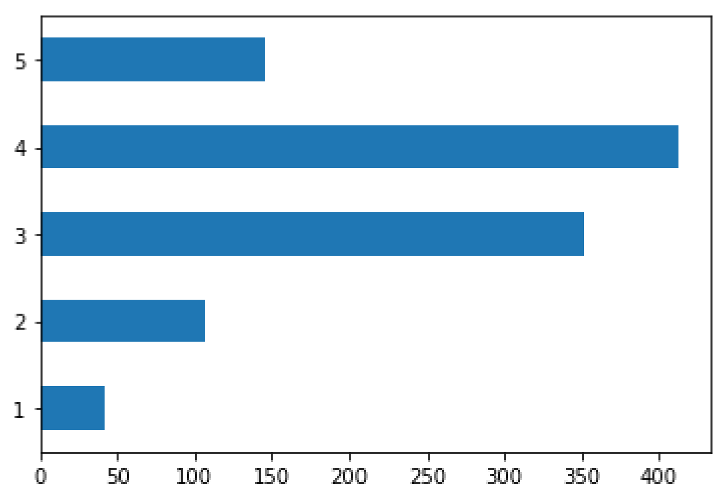
	approach_vertical	vertical_jump	three_quarter_court_sprint	four_way_agility	reaction_shuttle	b
0	33.5	28.5	3.376	11.471	3.669	
1	30.5	21.5	3.486	12.114	3.355	
2	37.0	31.0	3.230	12.036	3.562	
3	29.0	23.0	3.370	12.509	3.173	
4	31.0	26.0	3.389	12.724	3.316	

BAM_SCORE_RANK

1 = Worst Bam Scores | 5 = Best Bam Scores

```
In [17]: av_rank_bam_score = pd.value_counts(df['bam_score_rank'].values, sort=Fa
         lse)
         av_rank_bam_score.plot.barh()
```

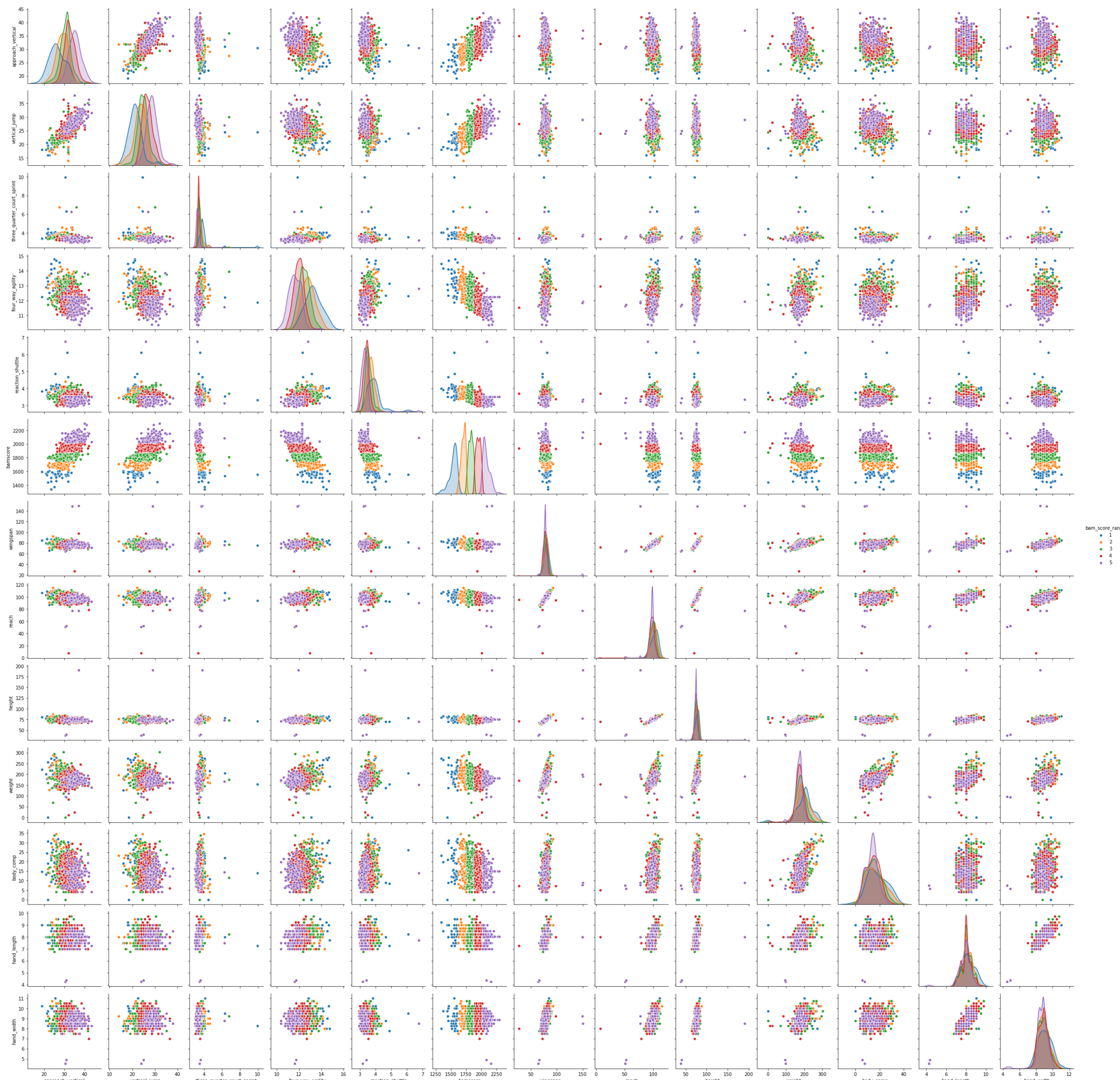
```
Out[17]: <matplotlib.axes._subplots.AxesSubplot at 0x7f9c319f1240>
```



I wonder what the pairplot looks like if I split bamscore into 5 groups

In [18]:
```python
sns.pairplot(df, hue='bam_score_rank')
# hard to see but just gives us more insight + verifies that data makes
 generally makes sense
# https://seaborn.pydata.org/generated/seaborn.pairplot.html
```

Out[18]: <seaborn.axisgrid.PairGrid at 0x7f9bf0e0e3c8>



Next let's look at the relationship of each factor with respect to bam score

I picked histograms + violin plots because:

- Gives us quick information to help us understand the data

- Outliers tend to stick out like a sore thumb

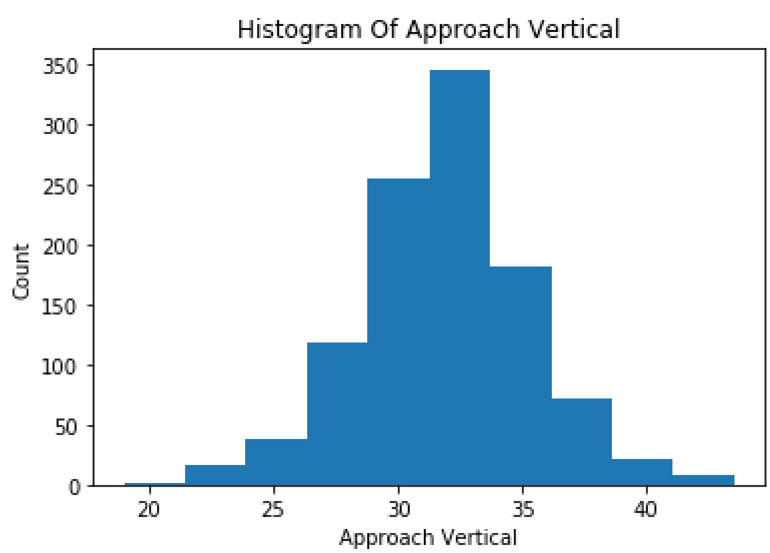
- Easy to look at and visualize

Note my observations in comments

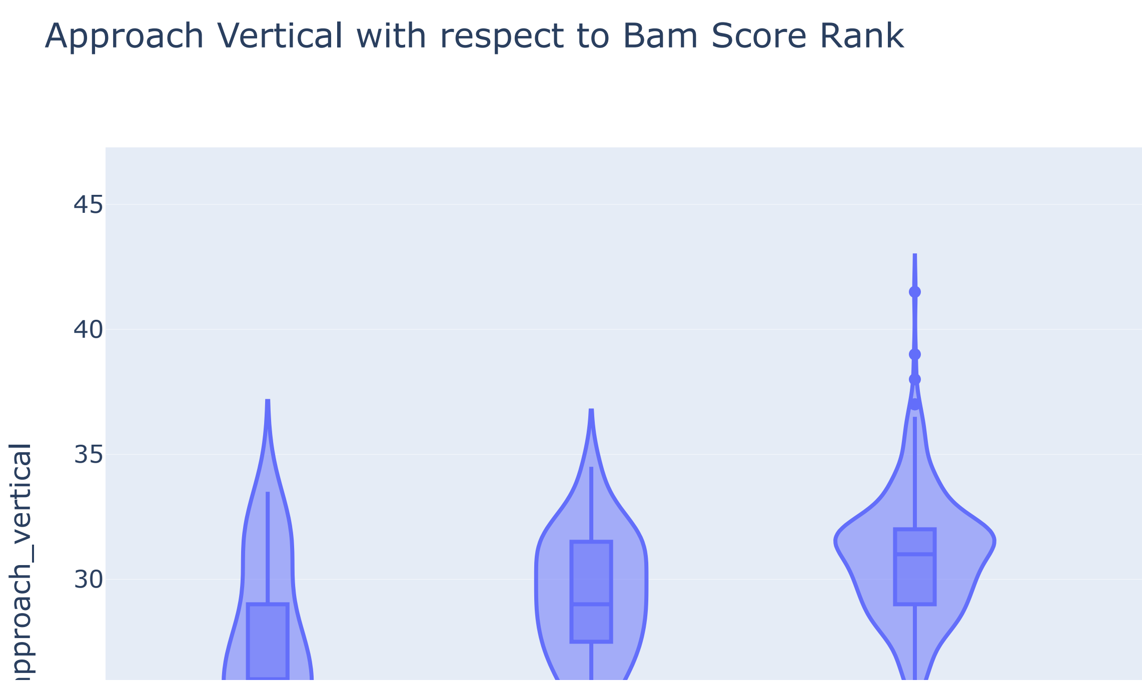
Approach Vertical

In [19]:
```
fig,ax = plt.subplots(1,1)
df['approach_vertical'].plot.hist(bins=10)
ax.set_title("Histogram Of Approach Vertical")
ax.set_xlabel('Approach Vertical')
ax.set_ylabel('Count')
```

Out[19]: Text(0, 0.5, 'Count')



In [20]:
```
fig = px.violin(df, y='approach_vertical', x='bam_score_rank',
                box=True, hover_data=df.columns, title='Approach Vertica
l with respect to Bam Score Rank')
fig.show()
```

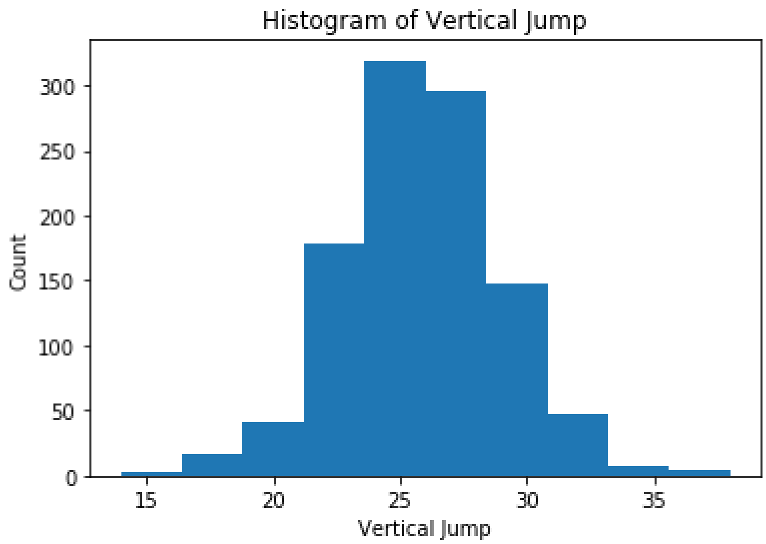


In [ ]:

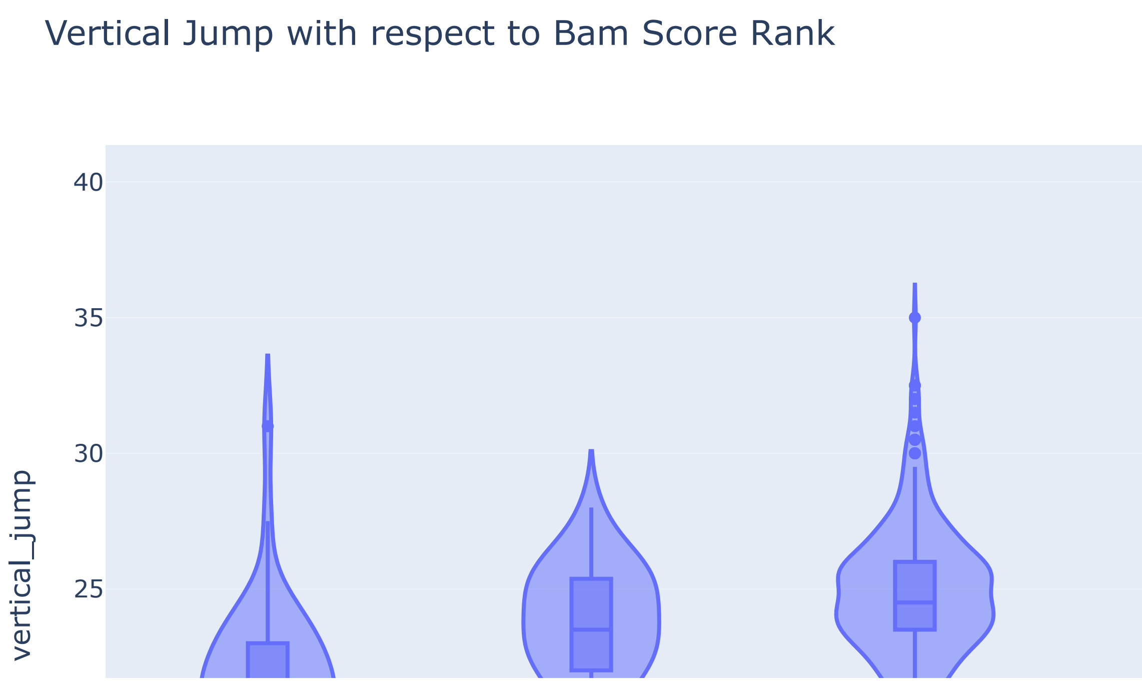
Vertical Jump

In [21]:
```
fig,ax = plt.subplots(1,1)
df['vertical_jump'].plot.hist(bins=10)
ax.set_title("Histogram of Vertical Jump")
ax.set_xlabel('Vertical Jump')
ax.set_ylabel('Count')
```

Out[21]: Text(0, 0.5, 'Count')



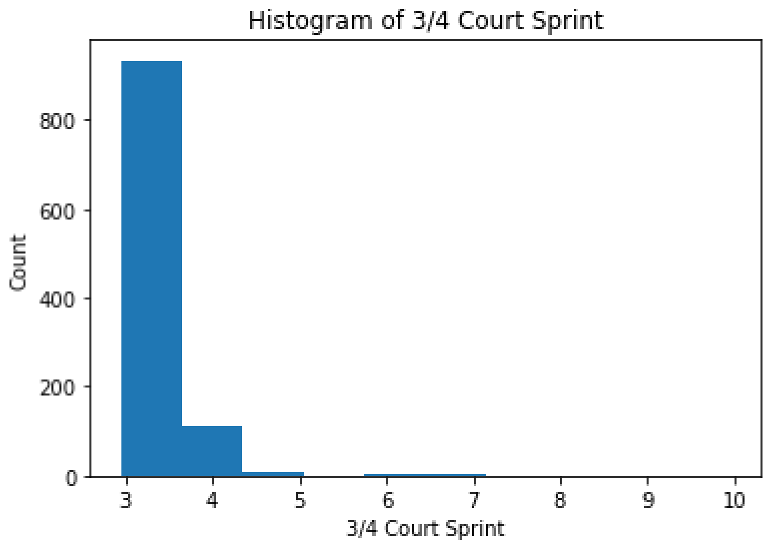
In [22]:
```
fig = px.violin(df, y='vertical_jump', x='bam_score_rank',
                box=True, hover_data=df.columns, title='Vertical Jump wi
th respect to Bam Score Rank')
fig.show()
```



3/4 Court Sprint

In [23]:
```
fig,ax = plt.subplots(1,1)
df['three_quarter_court_sprint'].plot.hist(bins=10)
ax.set_title("Histogram of 3/4 Court Sprint")
ax.set_xlabel('3/4 Court Sprint')
ax.set_ylabel('Count')
```

Out[23]:
```
Text(0, 0.5, 'Count')
```



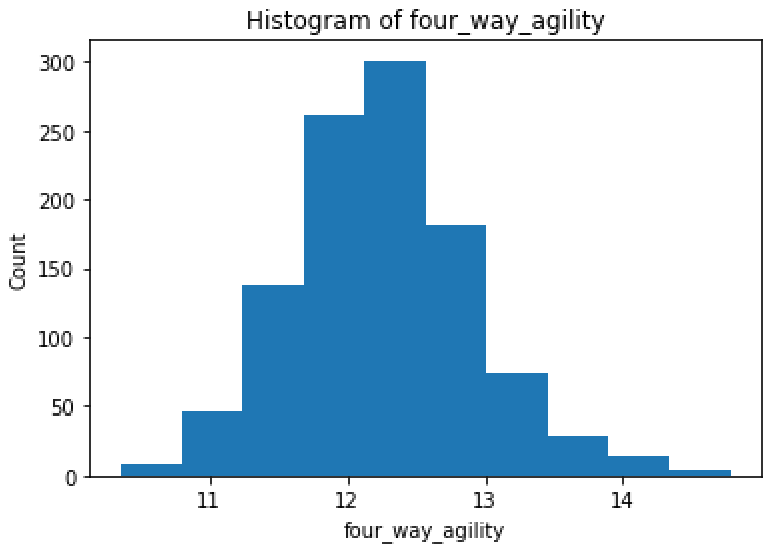
In [24]:
```
fig = px.violin(df, y='three_quarter_court_sprint', x='bam_score_rank',
                box=True, hover_data=df.columns, title='3/4 Court Sprint
with respect to Bam Score Rank')
fig.show()
```

In [25]:
```
# Outliers Present
```

4 Way Agility

In [26]:
```
fig,ax = plt.subplots(1,1)
df['four_way_agility'].plot.hist(bins=10)
ax.set_title("Histogram of four_way_agility")
ax.set_xlabel('four_way_agility')
ax.set_ylabel('Count')
```

Out[26]: Text(0, 0.5, 'Count')



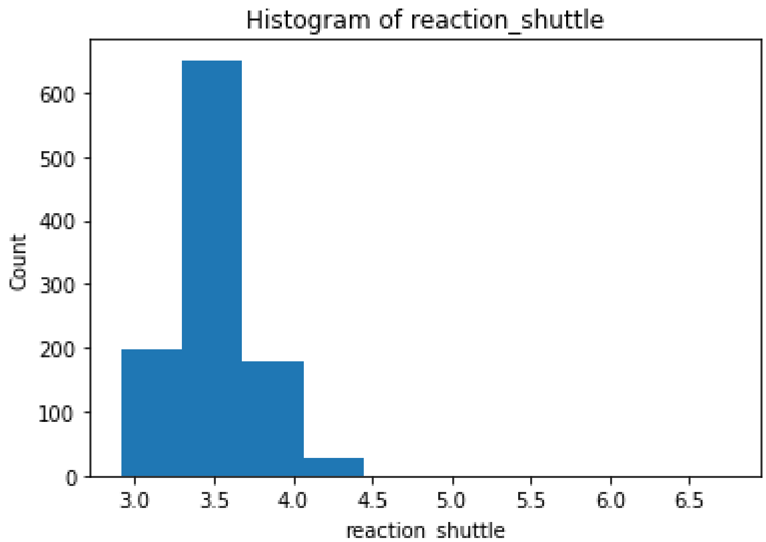
In [27]:
```
fig = px.violin(df, y='four_way_agility', x='bam_score_rank',
                box=True, hover_data=df.columns, title='four_way_agility
with respect to Bam Score Rank')
fig.show()
```

In [28]:
```
# Outliers Present
```

Reaction Shuttle

In [29]:
```
fig,ax = plt.subplots(1,1)
df['reaction_shuttle'].plot.hist(bins=10)
ax.set_title("Histogram of reaction_shuttle")
ax.set_xlabel('reaction_shuttle')
ax.set_ylabel('Count')
```

Out[29]:
```
Text(0, 0.5, 'Count')
```

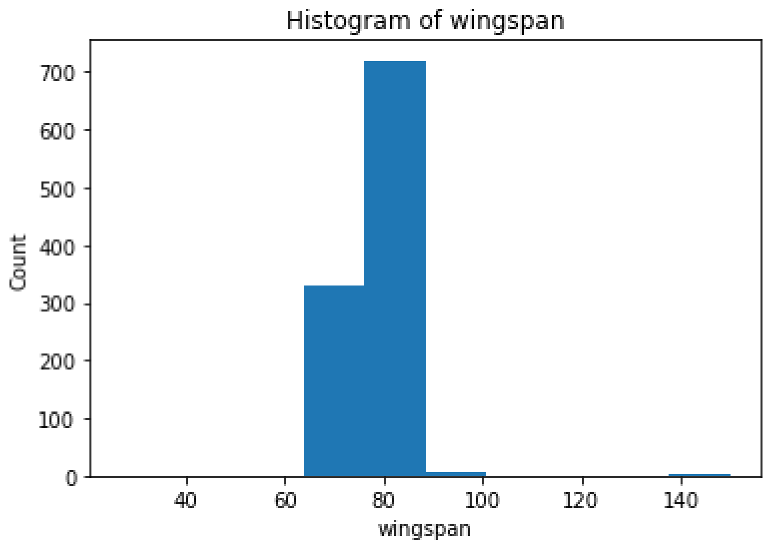


In [30]:
```
fig = px.violin(df, y='reaction_shuttle', x='bam_score_rank',
                box=True, hover_data=df.columns, title='Reaction Shuttle
with respect to Bam Score Rank')
fig.show()
```

Wingspan

In [31]:
```
fig,ax = plt.subplots(1,1)
df['wingspan'].plot.hist(bins=10)
ax.set_title("Histogram of wingspan")
ax.set_xlabel('wingspan')
ax.set_ylabel('Count')
```

Out[31]: Text(0, 0.5, 'Count')

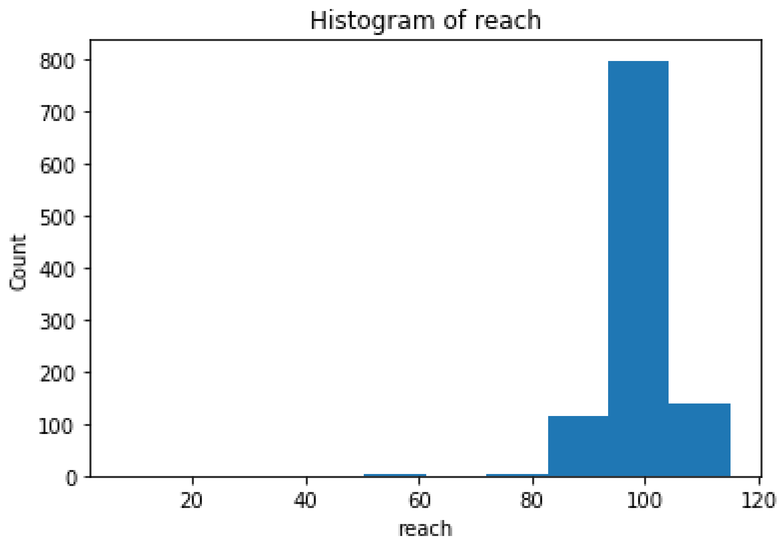


```
In [32]: fig = px.violin(df, y='wingspan', x='bam_score_rank',
                         box=True, hover_data=df.columns, title='wingspan with re
         spect to Bam Score Rank')
         fig.show()
```

Reach

In [33]:
```
fig,ax = plt.subplots(1,1)
df['reach'].plot.hist(bins=10)
ax.set_title("Histogram of reach")
ax.set_xlabel('reach')
ax.set_ylabel('Count')
```

Out[33]: Text(0, 0.5, 'Count')

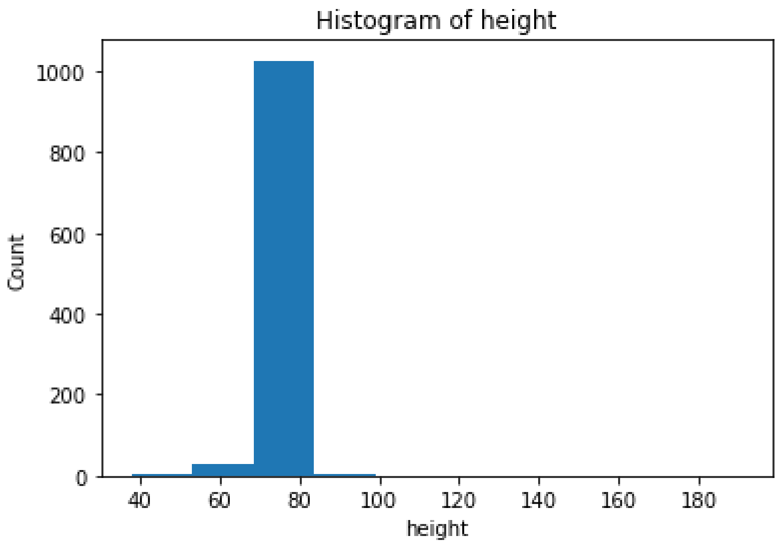


In [34]:
```
fig = px.violin(df, y='reach', x='bam_score_rank',
                box=True, hover_data=df.columns, title='reach with respe
ct to Bam Score Rank')
fig.show()
```

Height

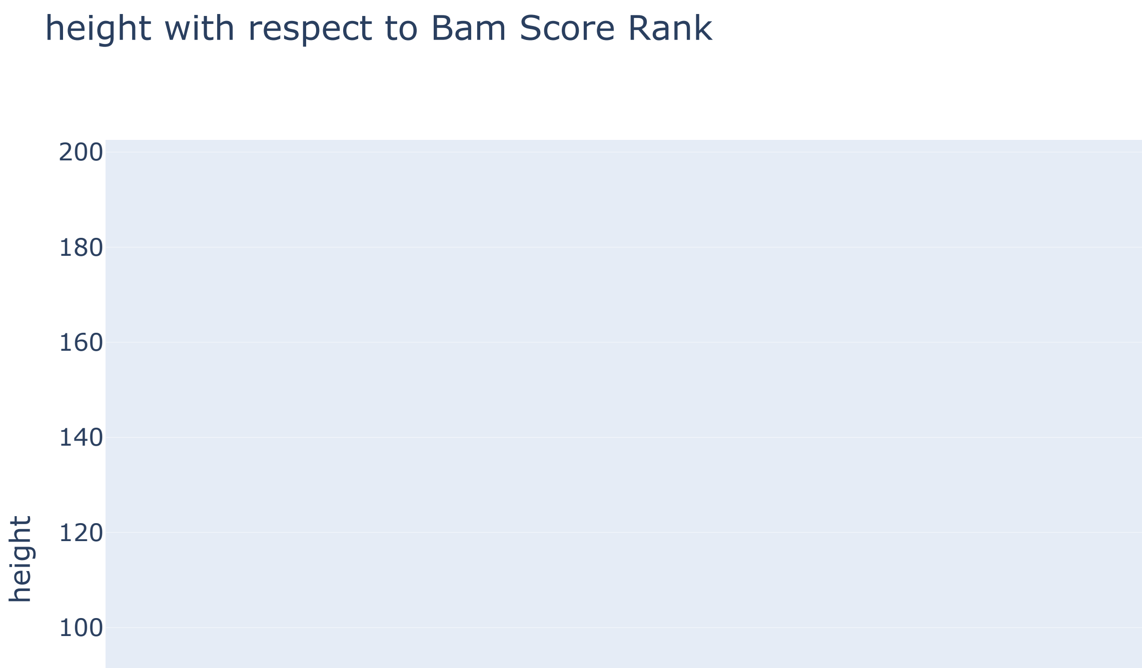
In [35]:
```
fig,ax = plt.subplots(1,1)
df['height'].plot.hist(bins=10)
ax.set_title("Histogram of height")
ax.set_xlabel('height')
ax.set_ylabel('Count')
```

Out[35]: Text(0, 0.5, 'Count')



In [36]:

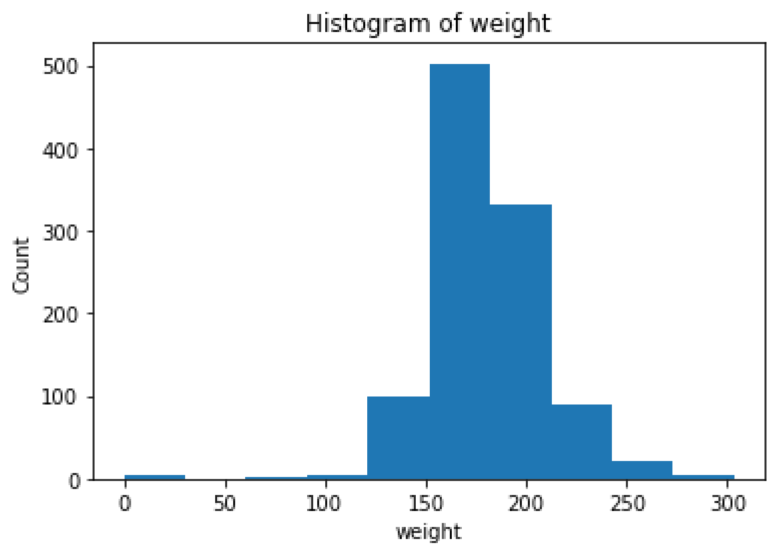
```python
fig = px.violin(df, y='height', x='bam_score_rank',
                box=True, hover_data=df.columns, title='height with respect to Bam Score Rank')
fig.show()
```



Weight

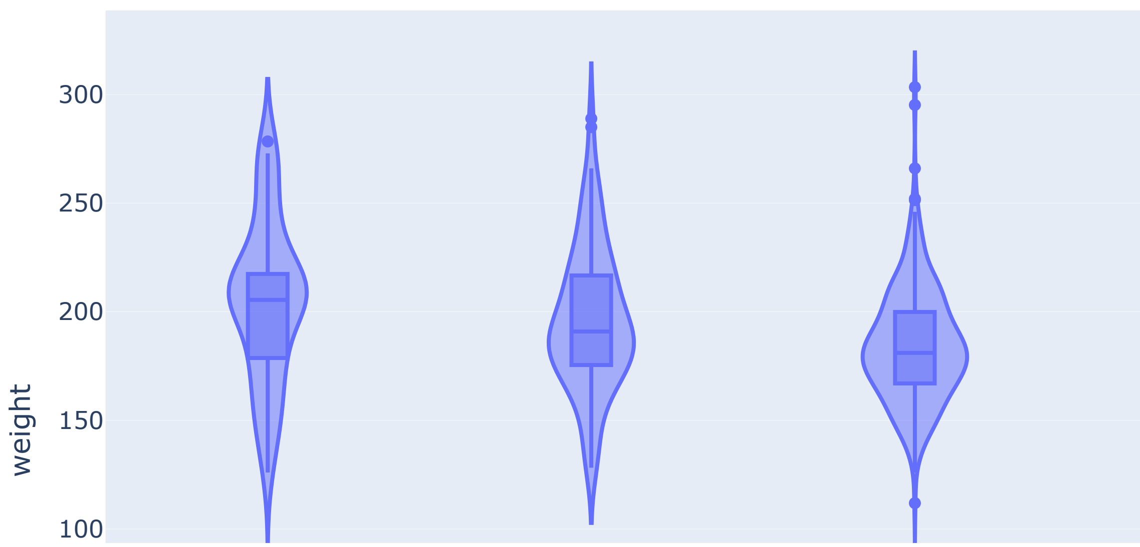
In [37]:
```
fig,ax = plt.subplots(1,1)
df['weight'].plot.hist(bins=10)
ax.set_title("Histogram of weight")
ax.set_xlabel('weight')
ax.set_ylabel('Count')
```

Out[37]: Text(0, 0.5, 'Count')



In [38]:
```
fig = px.violin(df, y='weight', x='bam_score_rank',
                box=True, hover_data=df.columns, title='weight with resp
ect to Bam Score Rank')
fig.show()
```

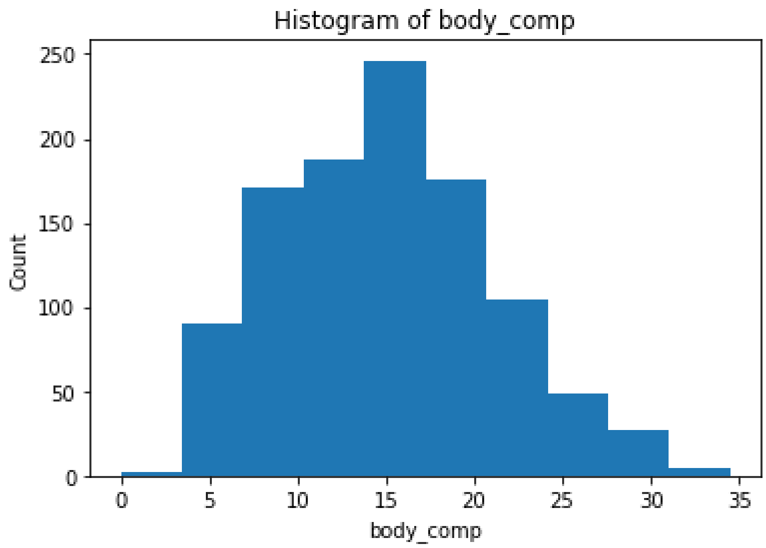
weight with respect to Bam Score Rank



Body Comp

In [39]:
```
fig,ax = plt.subplots(1,1)
df['body_comp'].plot.hist(bins=10)
ax.set_title("Histogram of body_comp")
ax.set_xlabel('body_comp')
ax.set_ylabel('Count')
```

Out[39]: Text(0, 0.5, 'Count')



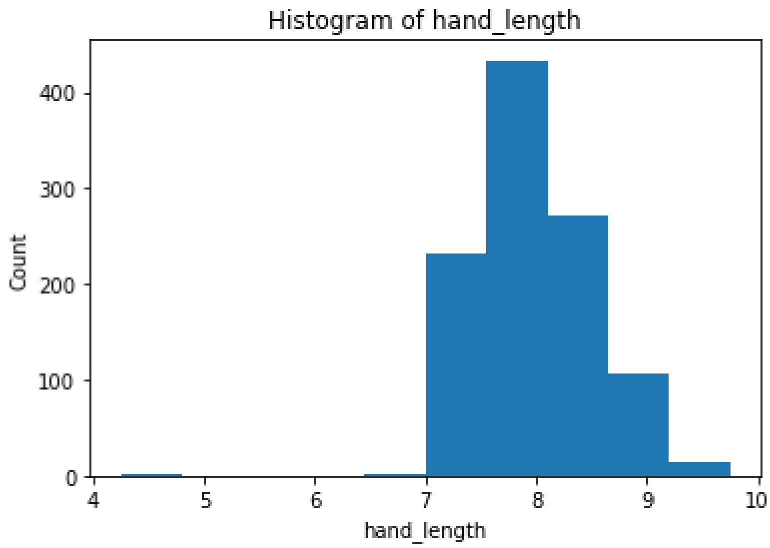
In [40]:
```
fig = px.violin(df, y='body_comp', x='bam_score_rank',
                box=True, hover_data=df.columns, title='body_comp with r
espect to Bam Score Rank')
fig.show()
```

In [41]:
```
# Outliers Present, has 0 values. Replace with mean after EDA
```

Hand Length

In [42]:
```
fig,ax = plt.subplots(1,1)
df['hand_length'].plot.hist(bins=10)
ax.set_title("Histogram of hand_length")
ax.set_xlabel('hand_length')
ax.set_ylabel('Count')
```

Out[42]:
```
Text(0, 0.5, 'Count')
```

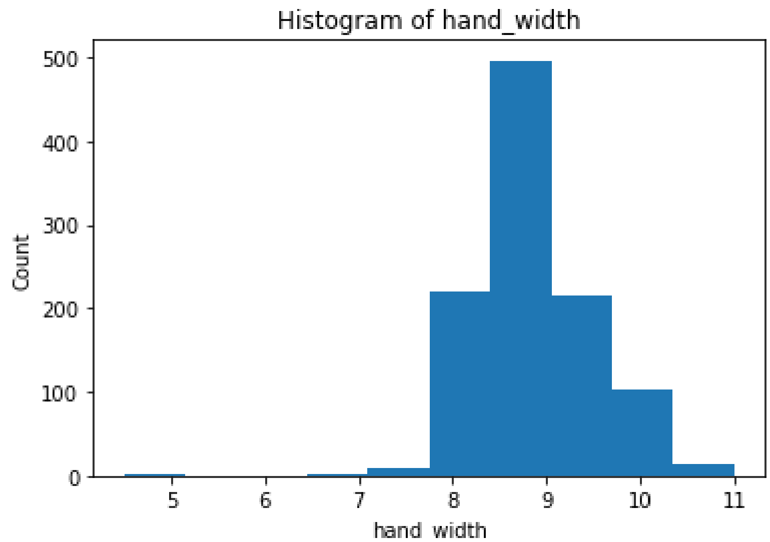


In [43]:
```
fig = px.violin(df, y='hand_length', x='bam_score_rank',
                box=True, hover_data=df.columns, title='hand_length with
respect to Bam Score Rank')
fig.show()
```

Hand Width

In [44]:
```
fig,ax = plt.subplots(1,1)
df['hand_width'].plot.hist(bins=10)
ax.set_title("Histogram of hand_width")
ax.set_xlabel('hand_width')
ax.set_ylabel('Count')
```

Out[44]:
```
Text(0, 0.5, 'Count')
```



In [45]:
```
fig = px.violin(df, y='hand_width', x='bam_score_rank',
                box=True, hover_data=df.columns, title='hand_width with
 respect to Bam Score Rank')
fig.show()
```

3) Find + Fix Outliers

In [46]:
```
# I noticed weight and body comp had at least 1 value of 0. So I want to
locate these and fix them (replace mean)
```

In [47]:
```
df.describe()
```

Out[47]:

	approach_vertical	vertical_jump	three_quarter_court_sprint	four_way_agility	reaction_shuttl
count	1059.000000	1059.000000	1059.000000	1059.000000	1059.00000
mean	31.829615	25.860157	3.467047	12.247189	3.50524
std	3.423395	3.065653	0.335502	0.652726	0.2737
min	19.000000	14.000000	2.950000	10.359000	2.9140
25%	30.000000	24.000000	3.339500	11.806000	3.3480
50%	31.829615	25.860157	3.424000	12.244000	3.4920
75%	34.000000	28.000000	3.537500	12.658000	3.6340
max	43.500000	38.000000	9.954000	14.775000	6.7590

In [48]:
```
# df.loc[(df.weight == 0)]
# df.loc[(df.body_comp == 0)]
# to use in modeling notebook incase I need to prove why we need to repl
ace 0 in weight and body comp
```

In [49]:
```
df['body_comp'].replace(to_replace=0, value = df['body_comp'].mean(), in
place = True)
```

In [50]:
```
df['weight'].replace(to_replace=0, value = df['weight'].mean(), inplace
= True)
```

In [51]:
```
df.describe()
```

Out[51]:

	approach_vertical	vertical_jump	three_quarter_court_sprint	four_way_agility	reaction_shuttl
count	1059.000000	1059.000000	1059.000000	1059.000000	1059.00000
mean	31.829615	25.860157	3.467047	12.247189	3.50524
std	3.423395	3.065653	0.335502	0.652726	0.2737
min	19.000000	14.000000	2.950000	10.359000	2.9140
25%	30.000000	24.000000	3.339500	11.806000	3.3480
50%	31.829615	25.860157	3.424000	12.244000	3.4920
75%	34.000000	28.000000	3.537500	12.658000	3.6340
max	43.500000	38.000000	9.954000	14.775000	6.7590

```
In [52]: for col in df.columns:
             Q1 = df[col].quantile(0.25)
             Q3 = df[col].quantile(0.75)
             IQR = Q3 - Q1
             whisker_width = 1.5
             df.loc[(df[col] < Q1 - whisker_width*IQR) | (df[col] > Q3 + whisker_
         width*IQR),col] = df[col].mean()
             #df[col][(df[col] < Q1 - whisker_width*IQR) | (df[col] > Q3 + whiske
         r_width*IQR)] = df[col].mean()
             # absolute dist between q3 and q1 is your iqr. 1.5xiqr + q3 is an ac
         ceptable range to determine outlier range
```

```
In [53]: df.drop(columns=['bam_score_rank'],inplace=True)
```

```
In [54]: df.describe()
```

Out[54]:

	approach_vertical	vertical_jump	three_quarter_court_sprint	four_way_agility	reaction_shutt
count	1059.000000	1059.000000	1059.000000	1059.000000	1059.00000
mean	31.889632	25.864994	3.431342	12.222711	3.48093
std	3.027257	2.806422	0.143779	0.601871	0.20879
min	24.000000	18.000000	3.053000	10.598000	2.95700
25%	30.000000	24.000000	3.344000	11.813000	3.34850
50%	31.829615	25.860157	3.424000	12.247000	3.49300
75%	34.000000	27.500000	3.511500	12.634000	3.60200
max	40.000000	34.000000	3.831000	13.904000	4.05100

4) Save Cleaned Data as csv

```
In [55]: df.to_csv('bam_data.csv',index = None)
```

```
In [56]: # Index = None - do this to not have blank index/unamed column
```