PANDAS

AND

GRAPHICS

A Numerical Dataset

object x_i	Height (H)	Weight (W)	Foot (F)	Label (L)
x_1	5.00	100	6	green
x_2	5.50	150	8	green
x_3	5.33	130	7	green
x_4	5.75	150	9	green
x_5	6.00	180	13	red
x_6	5.92	190	11	red
x_7	5.58	170	12	red
x_8	5.92	165	10	red

- $N = 8$ items
- $M = 3$ (unscaled) attributes

Code for the Dataset

```
import pandas as pd
data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])
```

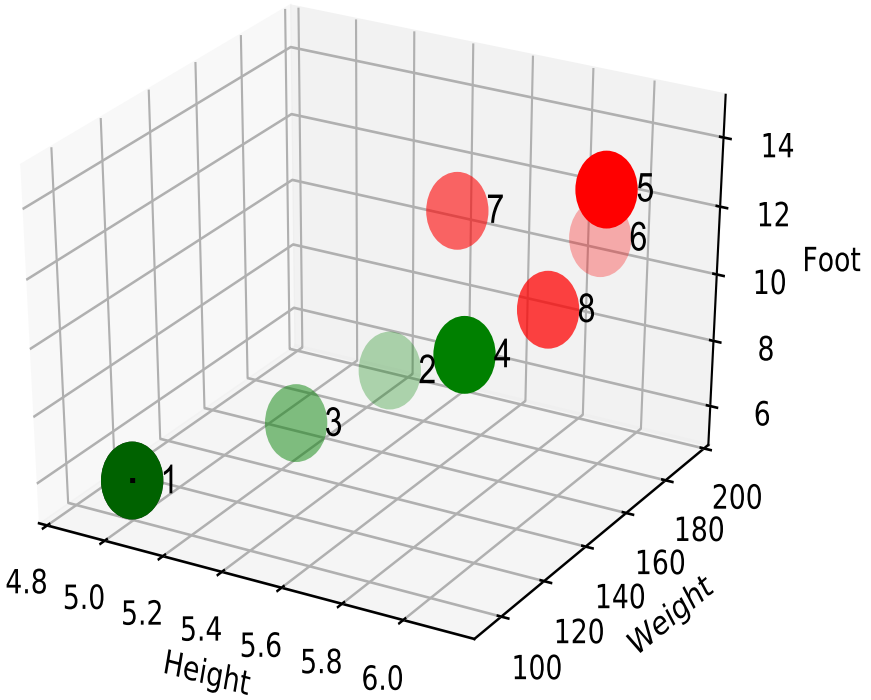
```
ipdb> data
  id Height Weight Foot Label
0  1   5.00    100    6  green
1  2   5.50    150    8  green
2  3   5.33    130    7  green
3  4   5.75    150    9  green
4  5   6.00    180   13    red
5  6   5.92    190   11    red
6  7   5.58    170   12    red
7  8   5.92    165   10    red
```

Desribing the Dataset

```
import pandas as pd
data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])
```

```
ipdb> data.describe()
             id    Height      Weight      Foot
count   8.00000  8.000000    8.000000   8.00000
mean    4.50000  5.625000  154.375000   9.50000
std     2.44949  0.343428   28.962722   2.44949
min     1.00000  5.000000  100.000000   6.00000
25%     2.75000  5.457500  145.000000   7.75000
50%     4.50000  5.665000  157.500000   9.50000
75%     6.25000  5.920000  172.500000  11.25000
max     8.00000  6.000000  190.000000  13.00000
```

A Dataset Illustration



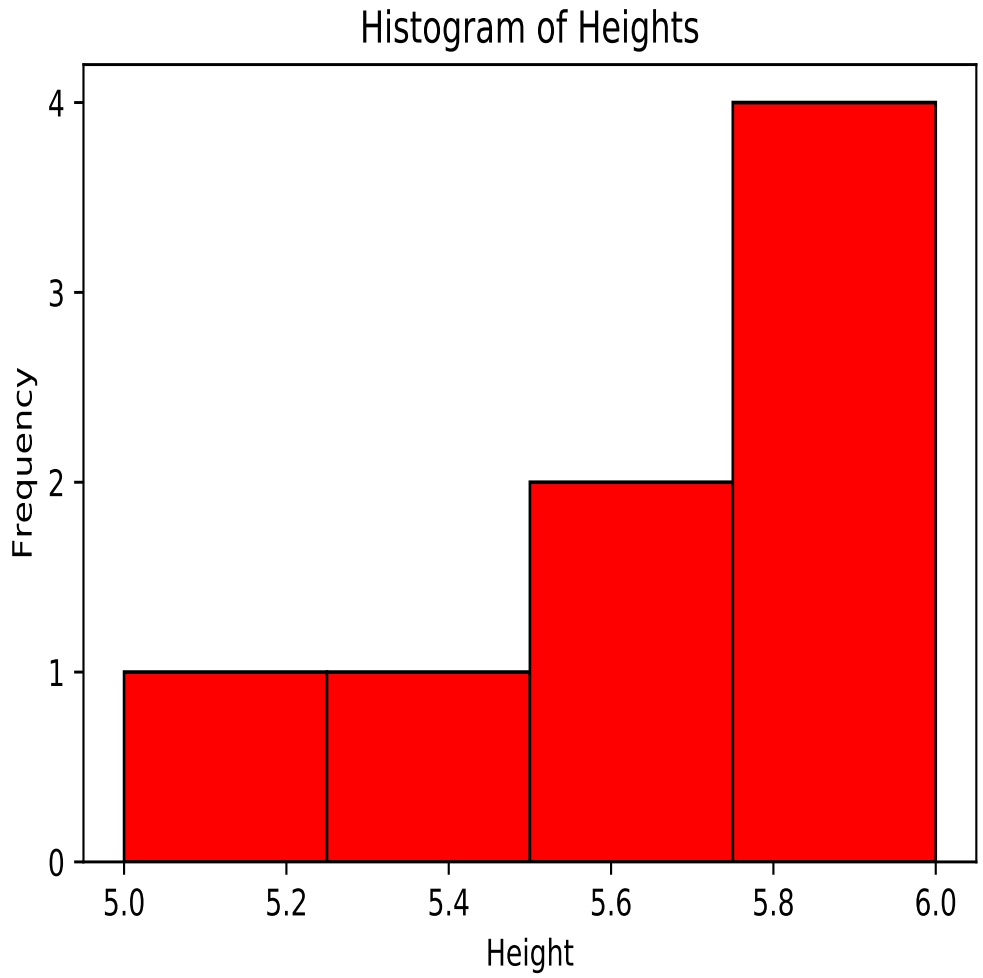
A Simple Histogram

```
import pandas as pd
import matplotlib.pyplot as plt
from matplotlib.ticker import MaxNLocator

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

fig = plt.figure()
axes1 = fig.add_subplot(1,1,1)
axes1.hist(data['Height'], bins = 4, histtype='bar',
           ec='black', color='red')
axes1.set_title('Histogram of Heights')
axes1.set_xlabel('Height')
axes1.set_ylabel('Frequency')
axes1.yaxis.set_major_locator(MaxNLocator(integer=True))
fig.show()
```

Histogram Illustration



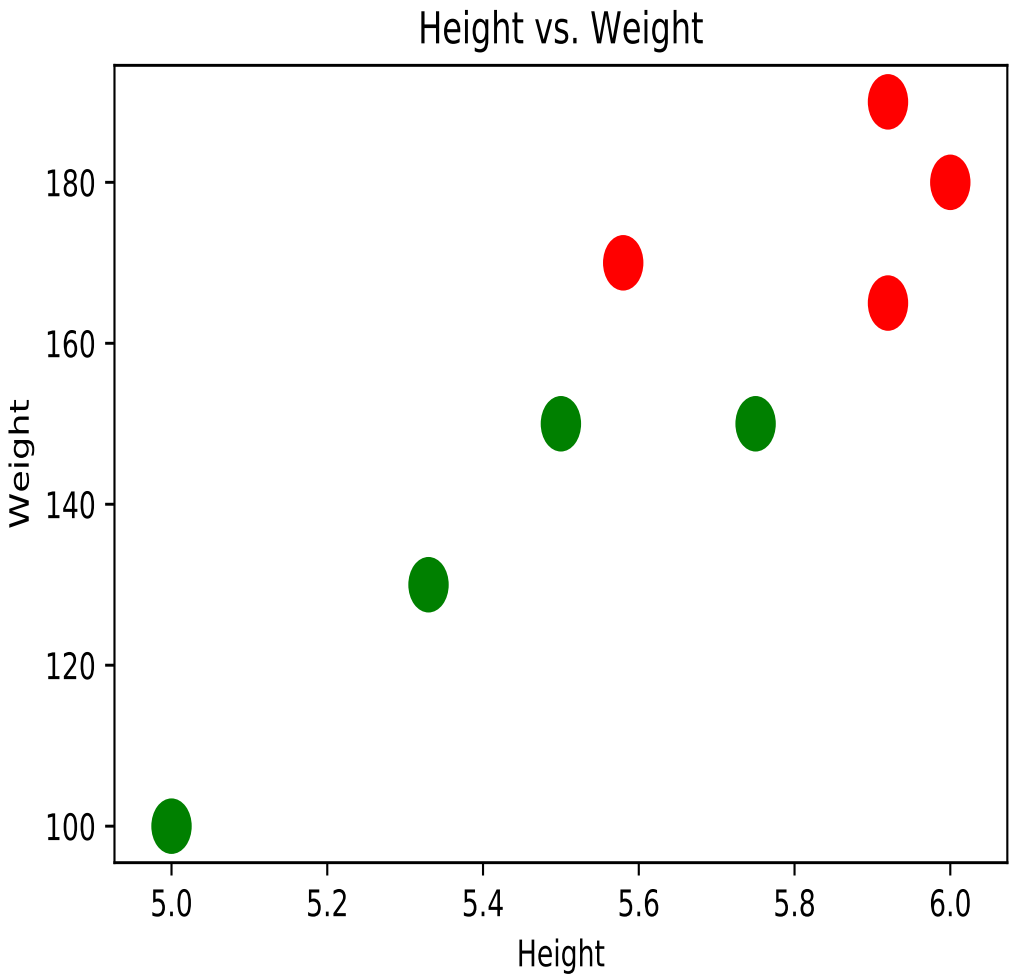
A Simple Scatter Plot

```
import pandas as pd
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

scatter_plot = plt.figure()
axes1 = scatter_plot.add_subplot(1,1,1)
axes1.scatter(data['Height'], data['Weight'],
                    color=data['Label'], s=200)
axes1.set_title('Height vs. Weight')
axes1.set_xlabel('Height')
axes1.set_ylabel('Weight')
scatter_plot.show()
```

A Scatterplot Illustration



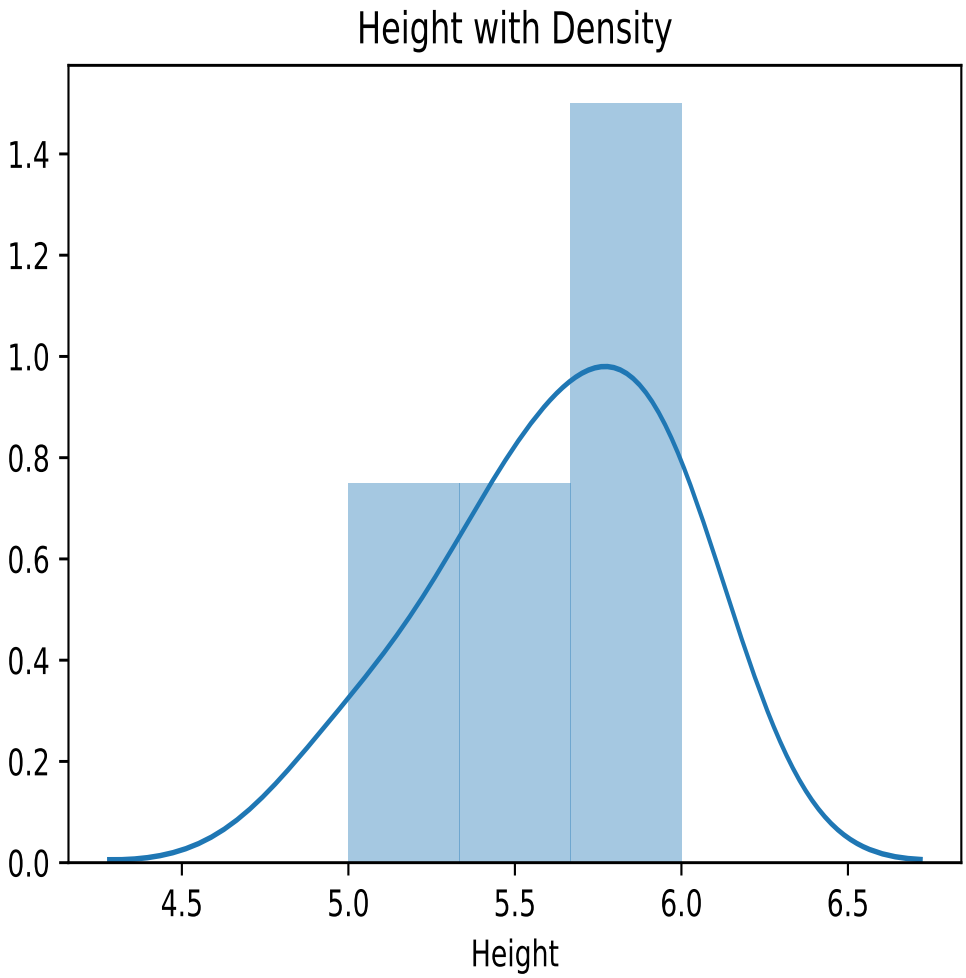
Histogram With Density

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

hist, ax = plt.subplots()
ax = sns.distplot(data['Height'])
ax.set_title('Height with Density')
plt.show()
```

Histogram with Density Illustration



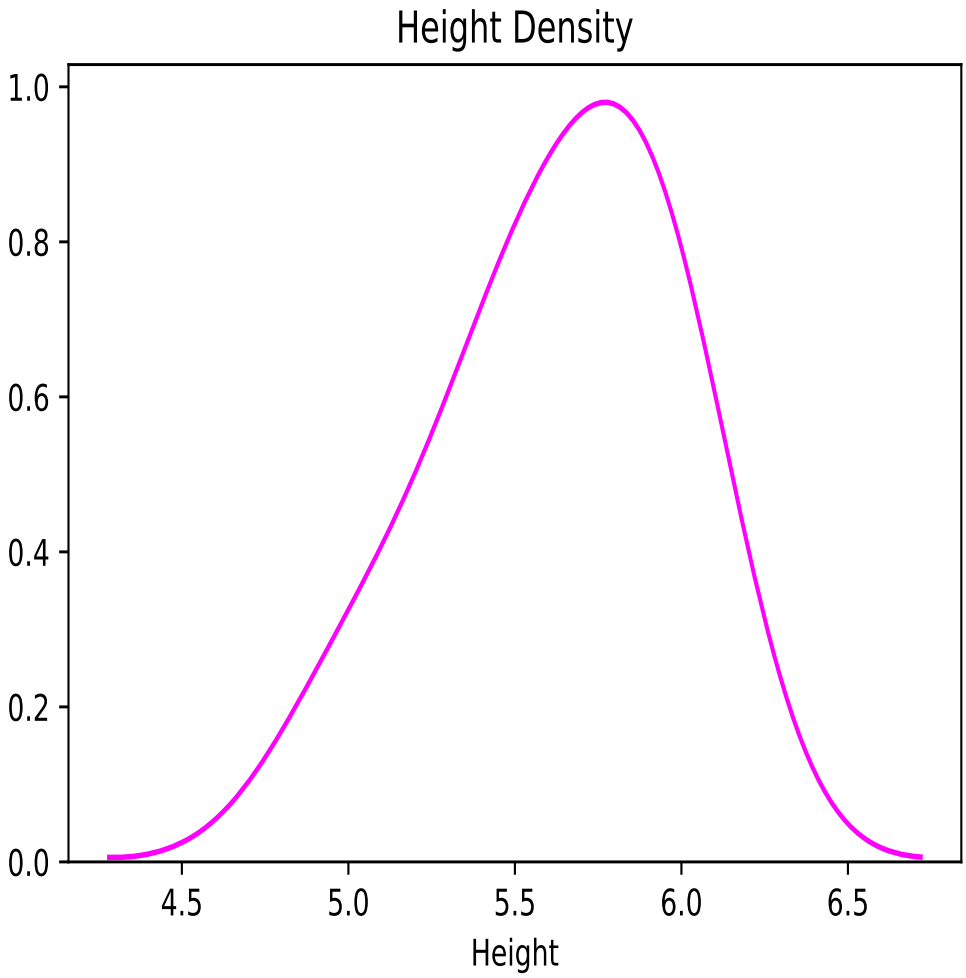
Density

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

hist, ax = plt.subplots()
ax=sns.distplot(data['Height'],hist=False, color='magenta')
ax.set_title('Height Density')
plt.show()
```

Density Illustration



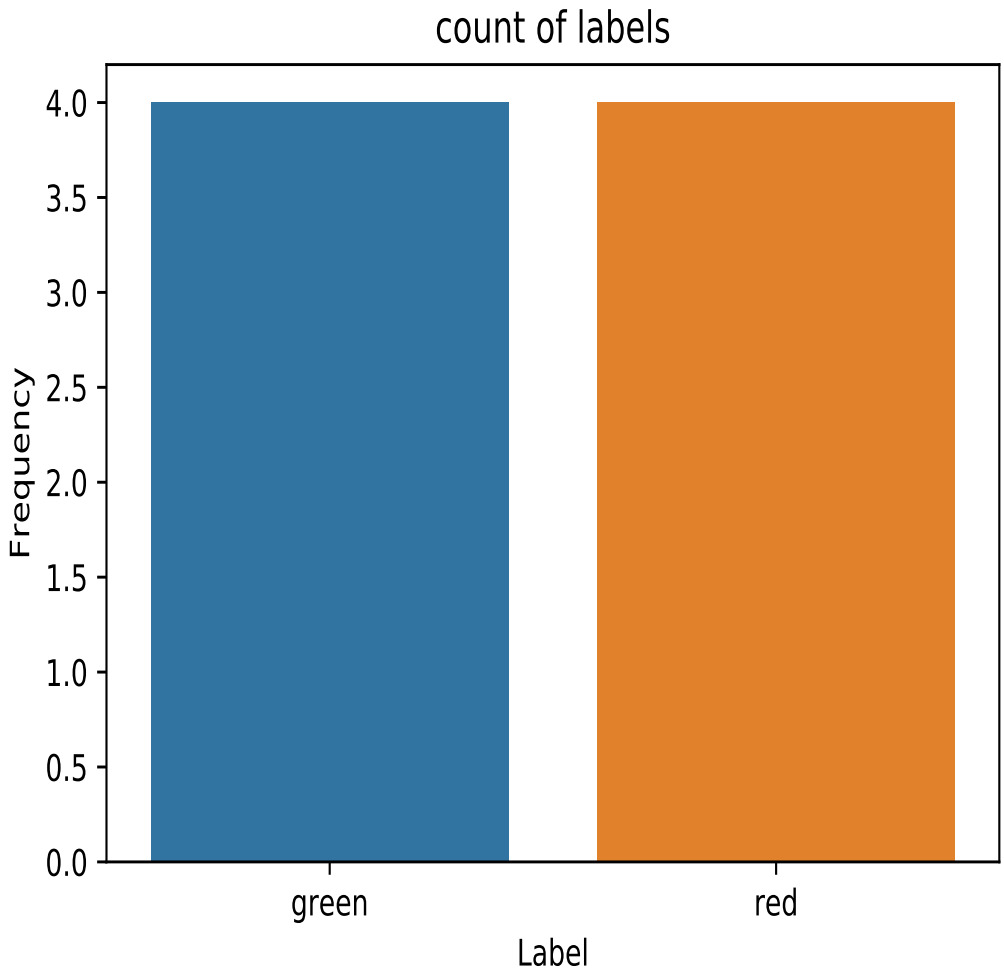
Counting

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

count, ax = plt.subplots()
ax = sns.countplot('Label', data=data)
ax.set_title('count of labels')
ax.set_xlabel('Label')
ax.set_ylabel('Frequency')
axes1.yaxis.set_major_locator(MaxNLocator(integer=True))
plt.show()
```

Counting Illustration



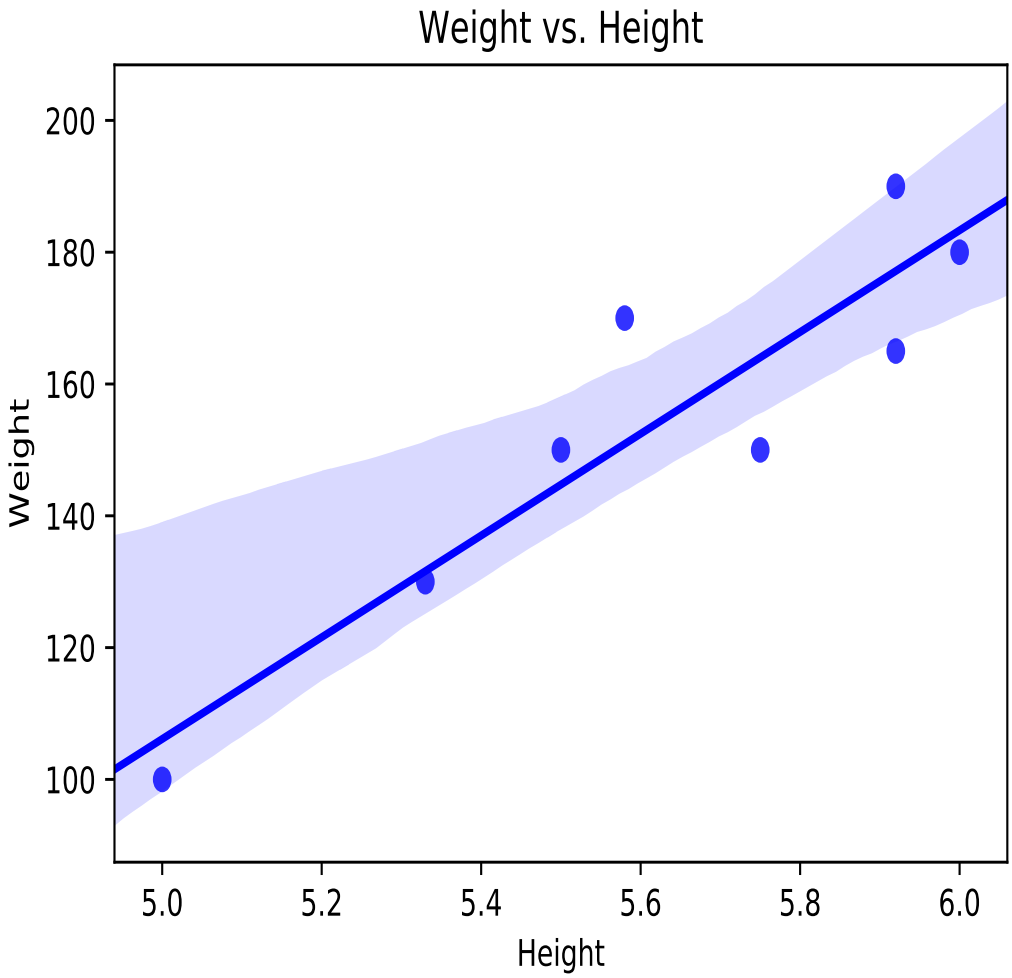
Scatterplot With Regression

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

scatter, ax = plt.subplots()
ax = sns.regplot(x='Height', y='Weight',
                 data=data, color='blue')
ax.set_title('Weight vs. Height')
ax.set_xlabel('Height')
ax.set_ylabel('Weight')
plt.show()
```

Scatterplot with Regression Illustration



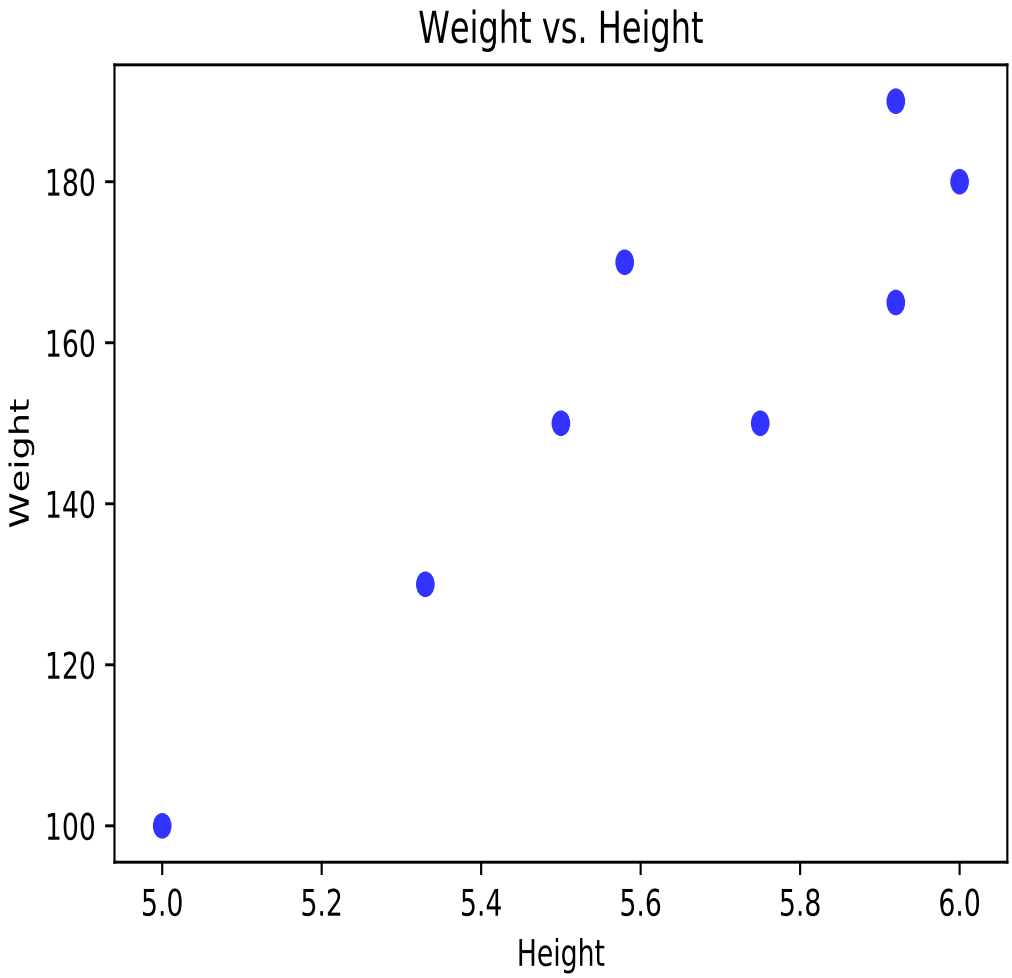
Scatterplot Without Regression

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

scatter, ax = plt.subplots()
ax = sns.regplot(x='Height', y='Weight',
                 data=data, color='blue', fit_reg=False)
ax.set_title('Weight vs. Height')
ax.set_xlabel('Height')
ax.set_ylabel('Weight')
plt.show()
```

Scatterplot Without Regression



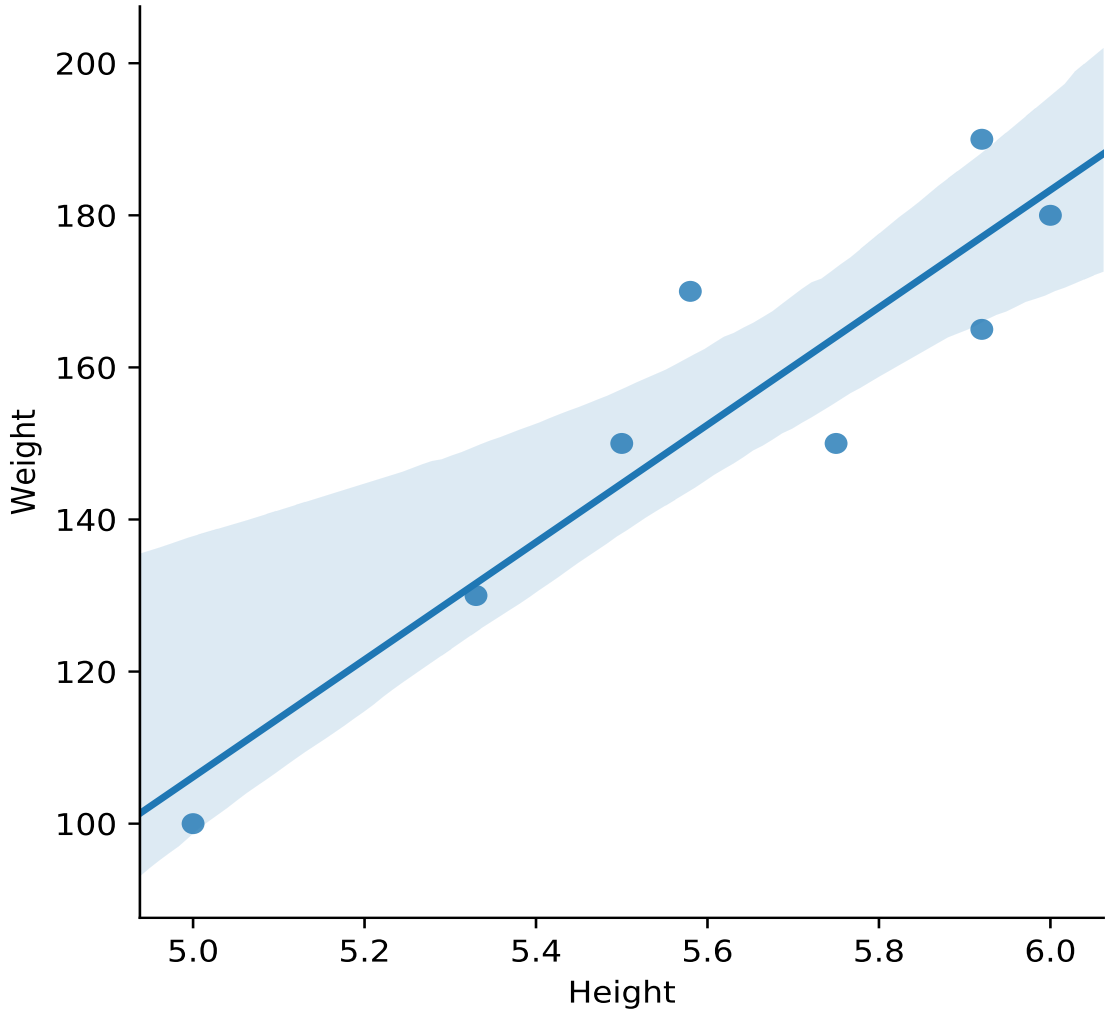
Creating a Figure

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

fig = sns.lmplot(x='Height', y='Weight',
                 data=data)
plt.show()
```

Illustration

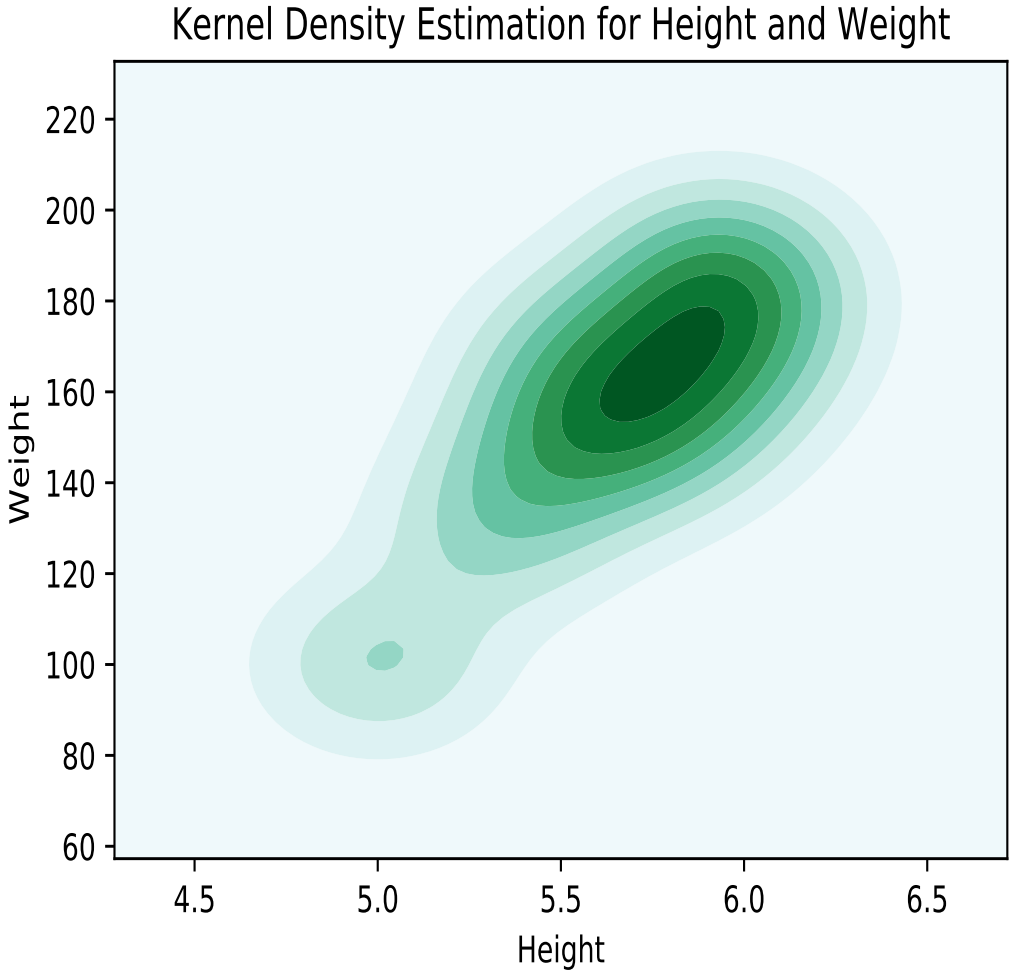


Density for Two Variables

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

kde, ax = plt.subplots()
ax = sns.kdeplot(data=data['Height'],
                 data2=data['Weight'], shade=True)
ax.set_title('Kernel Density Estimation for Height and Weight')
ax.set_xlabel('Height')
ax.set_ylabel('Weight')
plt.show()
```

Density for Two Variables



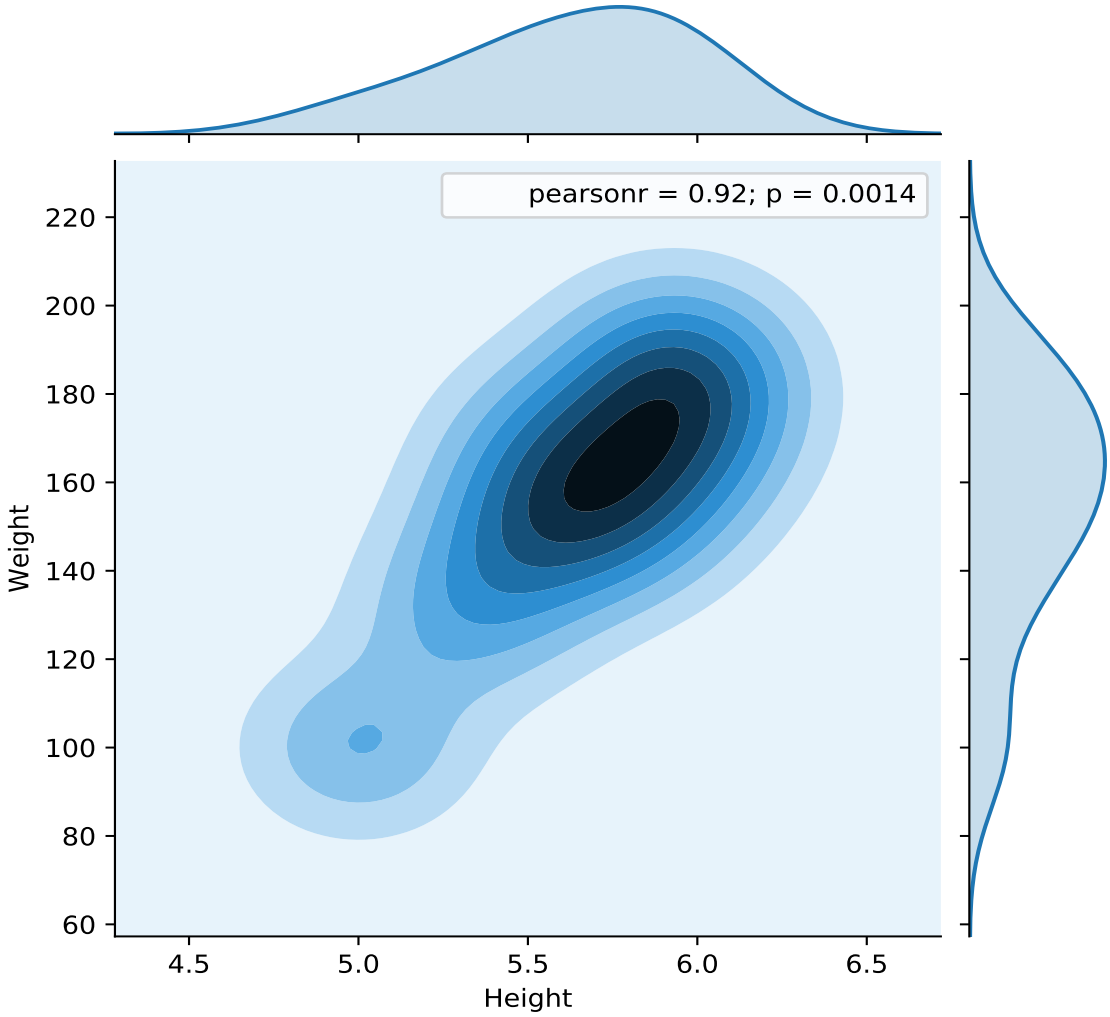
Joint Density

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

kde_joint = sns.jointplot(x='Height', y='Weight',
                          data=data, kind='kde')
```

Joint Density



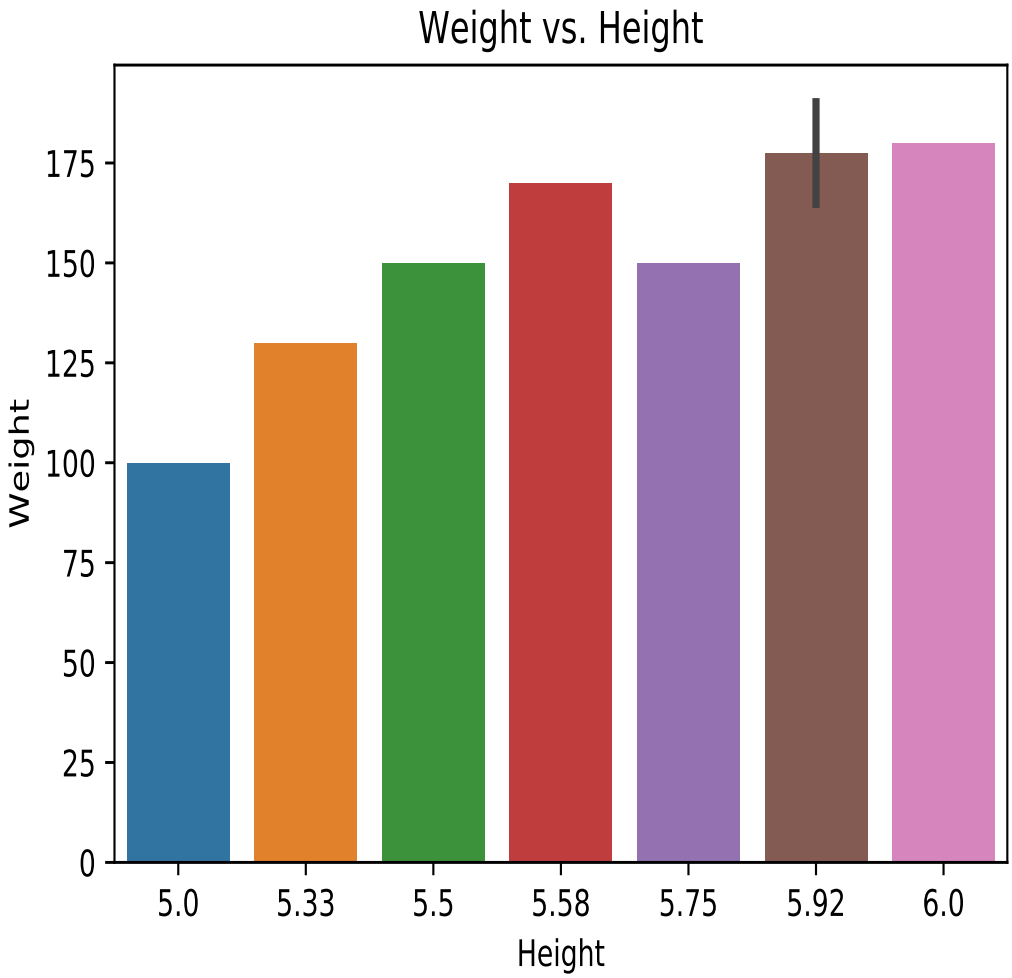
Bar Plots

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

bar, ax = plt.subplots()
ax = sns.barplot(x='Height',y='Weight', data=data)
ax.set_title('Weight vs. Height')
ax.set_xlabel('Height')
ax.set_ylabel('Weight')
plt.show()
```

Bar Plots


Weight vs. Height
Weight
0
25
50
75
100
125
150
175
5.0
5.33
5.5
5.58
5.75
5.92
6.0
Height

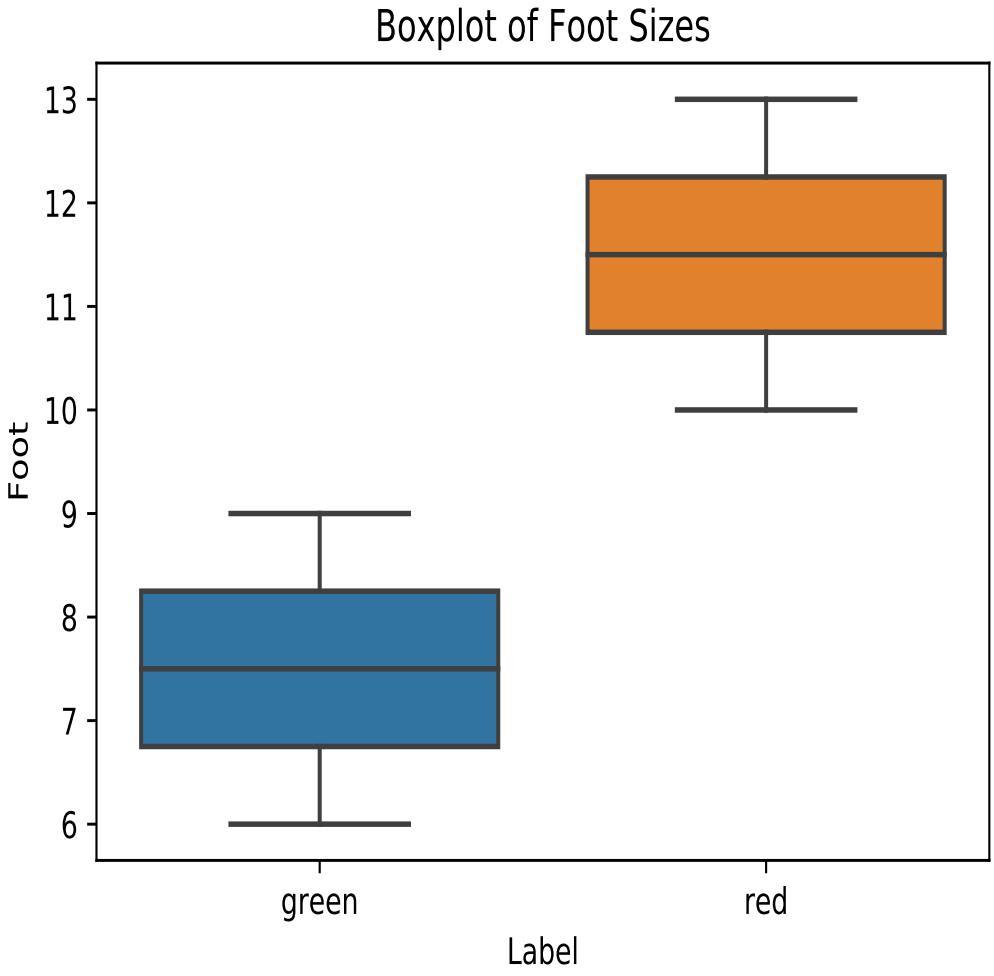
Box Plots

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

box, ax = plt.subplots()
ax = sns.boxplot(x='Label',y='Foot',data=data)
ax.set_title('Boxplot of Foot Sizes')
ax.set_xlabel('Label')
ax.set_ylabel('Foot')
plt.show()
```

Box Plots



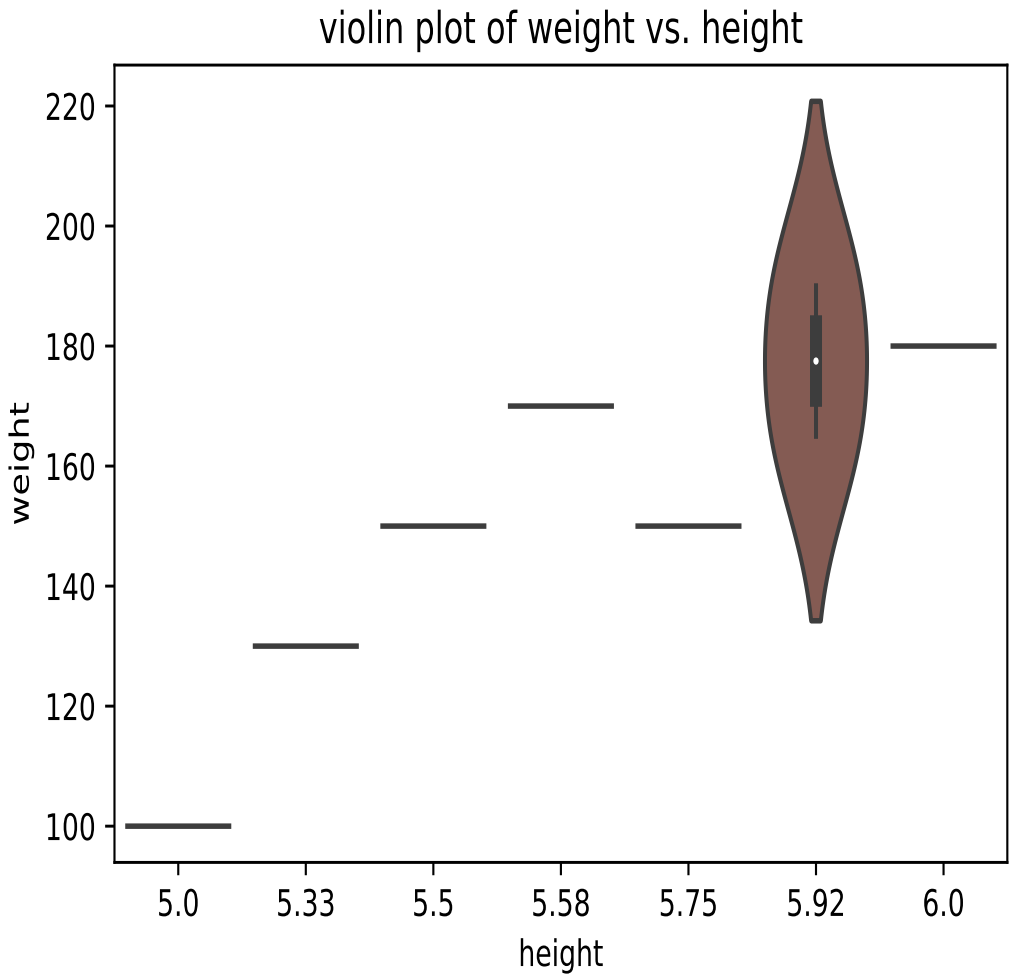
Violin Plots

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

violin, ax = plt.subplots()
ax = sns.violinplot(x='Height',y='Weight',data=data)
ax.set_title('violin plot of weight vs. height')
ax.set_xlabel('height')
ax.set_ylabel('weight')
plt.show()
```

Violin Plots



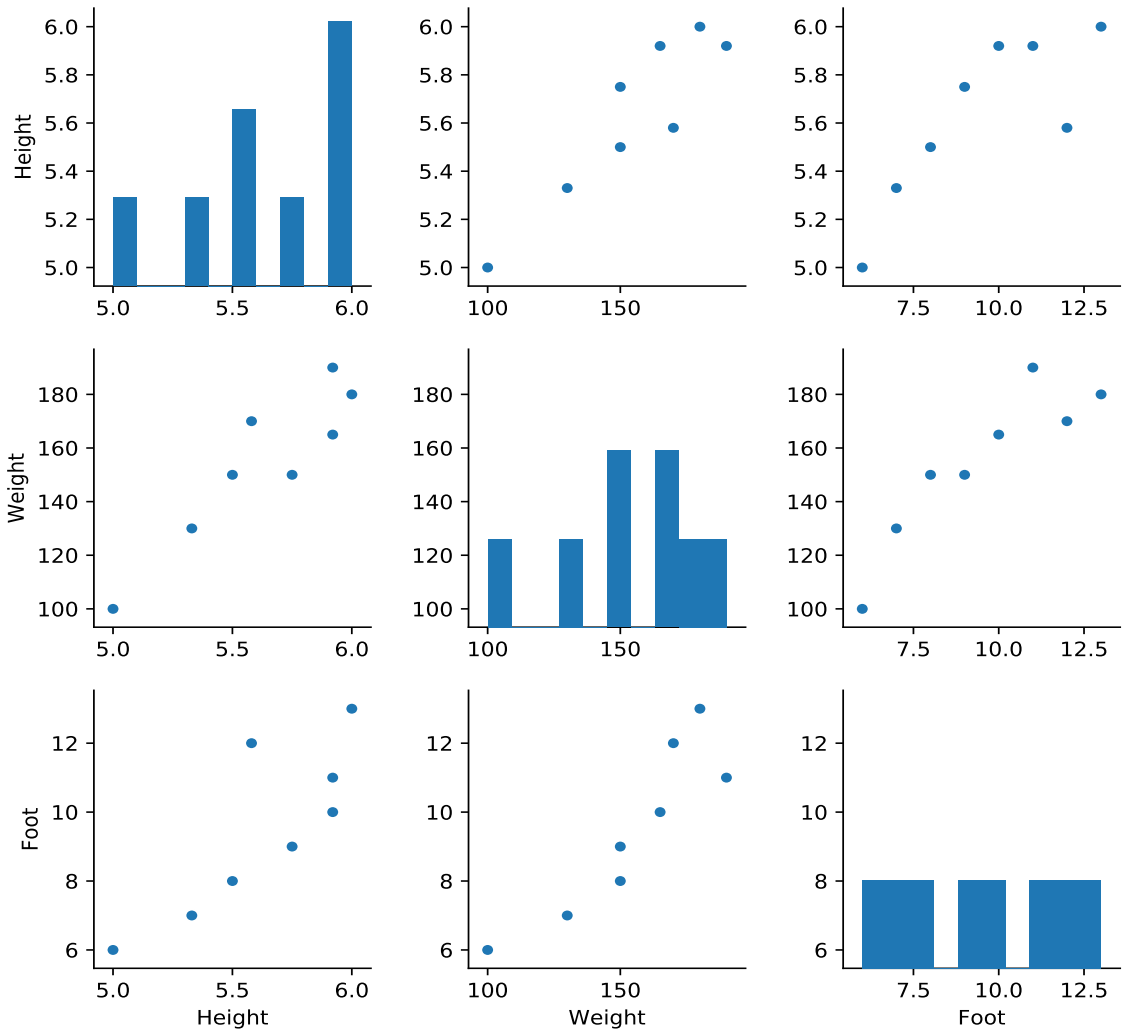
Pairwise Relationships

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

pair_plot = sns.pairplot(data[['Height','Weight',
                                        'Foot']])
plt.show()
```

Pairwise Relationships



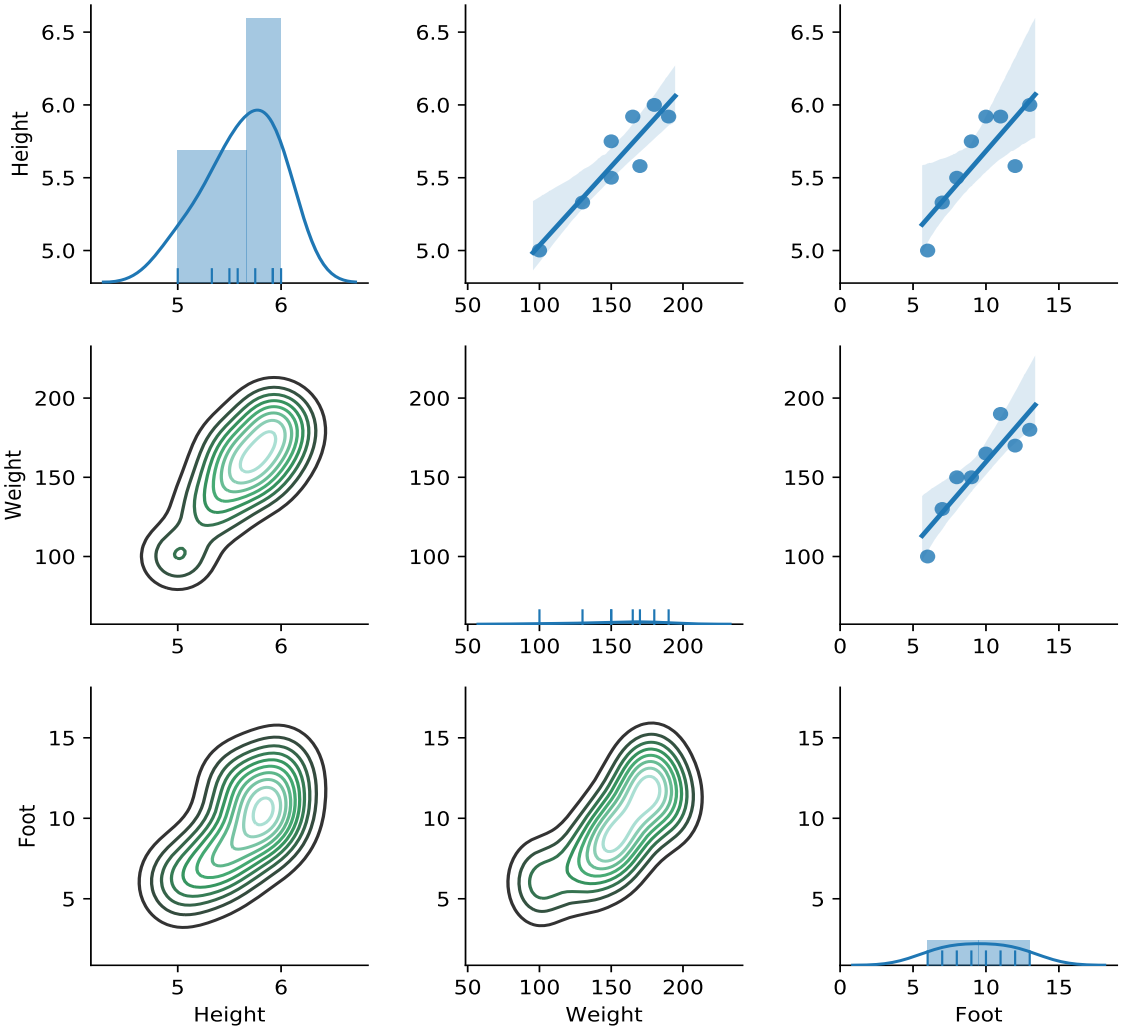
Specific Pairwise relationships

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

pair_grid = sns.PairGrid(data[['Height','Weight',
                                'Foot']])
pair_grid = pair_grid.map_upper(sns.regplot)
pair_grid = pair_grid.map_lower(sns.kdeplot)
pair_grid = pair_grid.map_diag(sns.distplot,rug=True)
plt.show()
```

Specific Relationships



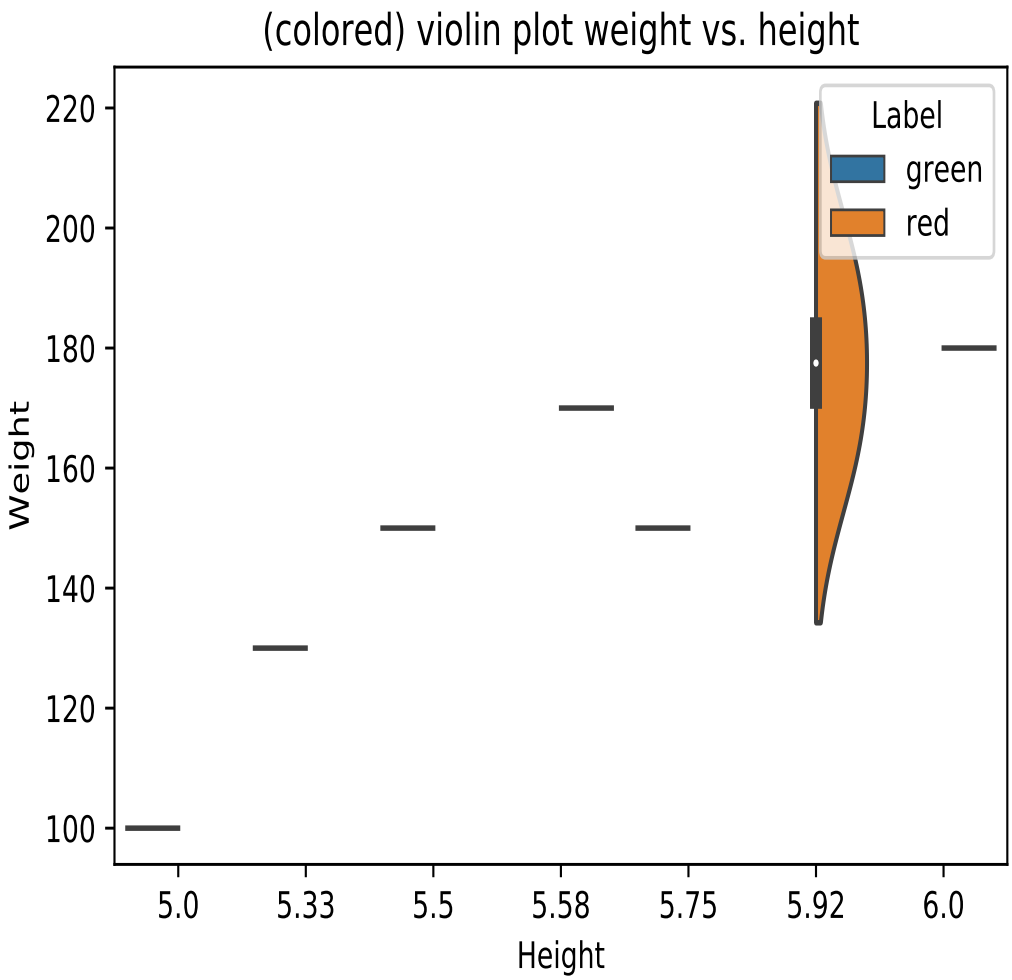
Colored Violin Plot

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                  'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

colored_violin, ax = plt.subplots()
ax = sns.violinplot(x='Height',y='Weight',
                 hue='Label', data=data, split=True)
ax.set_title('(colored) violin plot weight vs. height')
ax.set_xlabel('Height')
ax.set_ylabel('Weight')
plt.show()
```

Colored Violin Plot



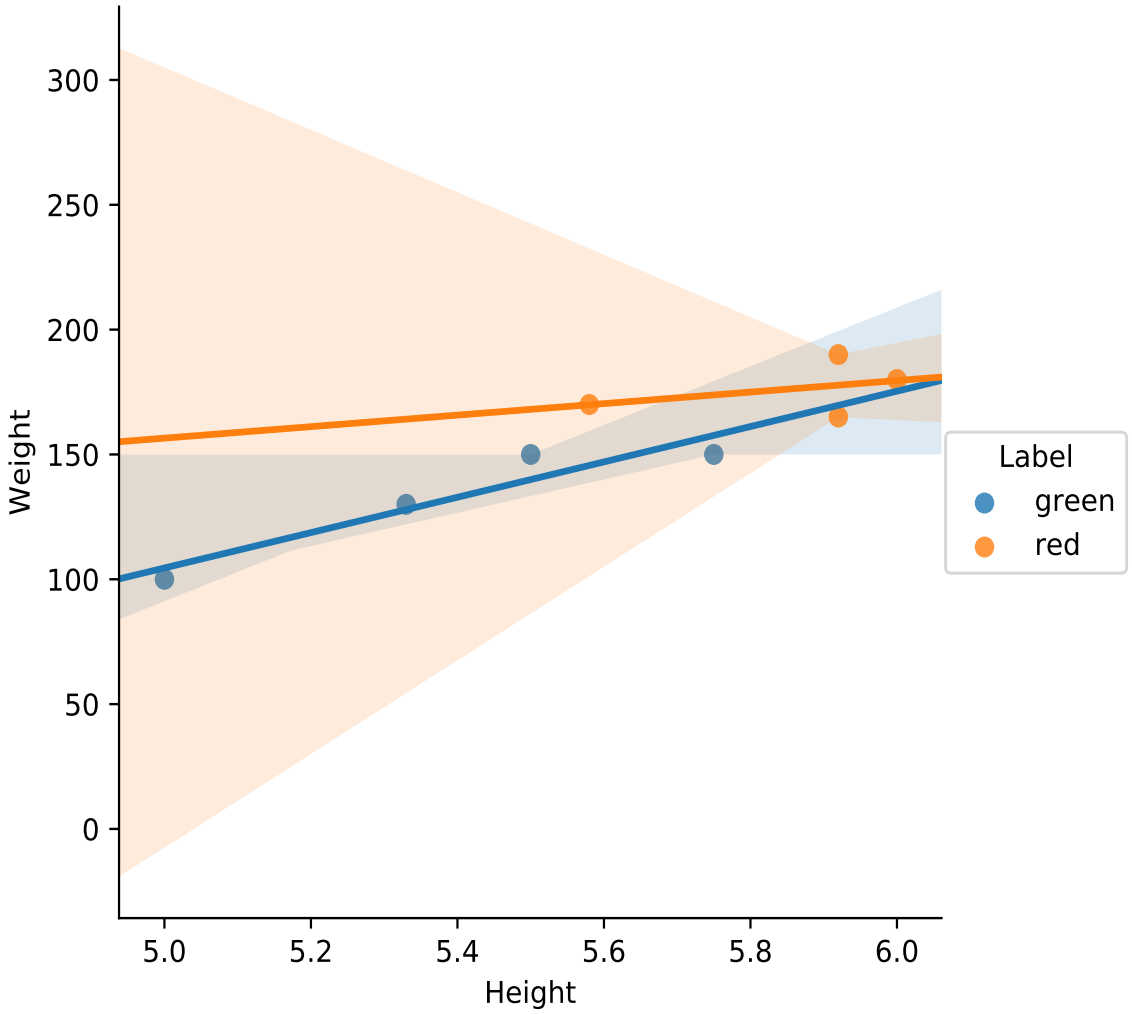
Regression Plot by Label

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

fig = sns.lmplot(x='Height',y='Weight',hue='Label',
                                data=data,fit_reg=True)
plt.show()
```

Regression Plot By Label



Colored Pair Plots

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

data = pd.DataFrame(
    {'id':[ 1,2,3,4,5,6,7,8],
    'Label':['green','green','green','green',
                    'red','red','red','red'],
    'Height':[5,5.5,5.33,5.75,6.00,5.92,5.58,5.92],
    'Weight':[100,150,130,150,180,190,170,165],
    'Foot':[6, 8, 7, 9, 13, 11, 12, 10]},
    columns=['id','Height','Weight','Foot','Label'])

fig=sns.pairplot(data[['Height','Weight',
                       'Foot','Label']], hue='Label')
plt.show()
```

Colored Pair Plot