Exploring relationships

EXPLORATORY DATA ANALYSIS IN PYTHON

Allen Downey
Professor, Olin College

DataCamp

Height and weight

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

SEARCH

CDC A-Z INDEX

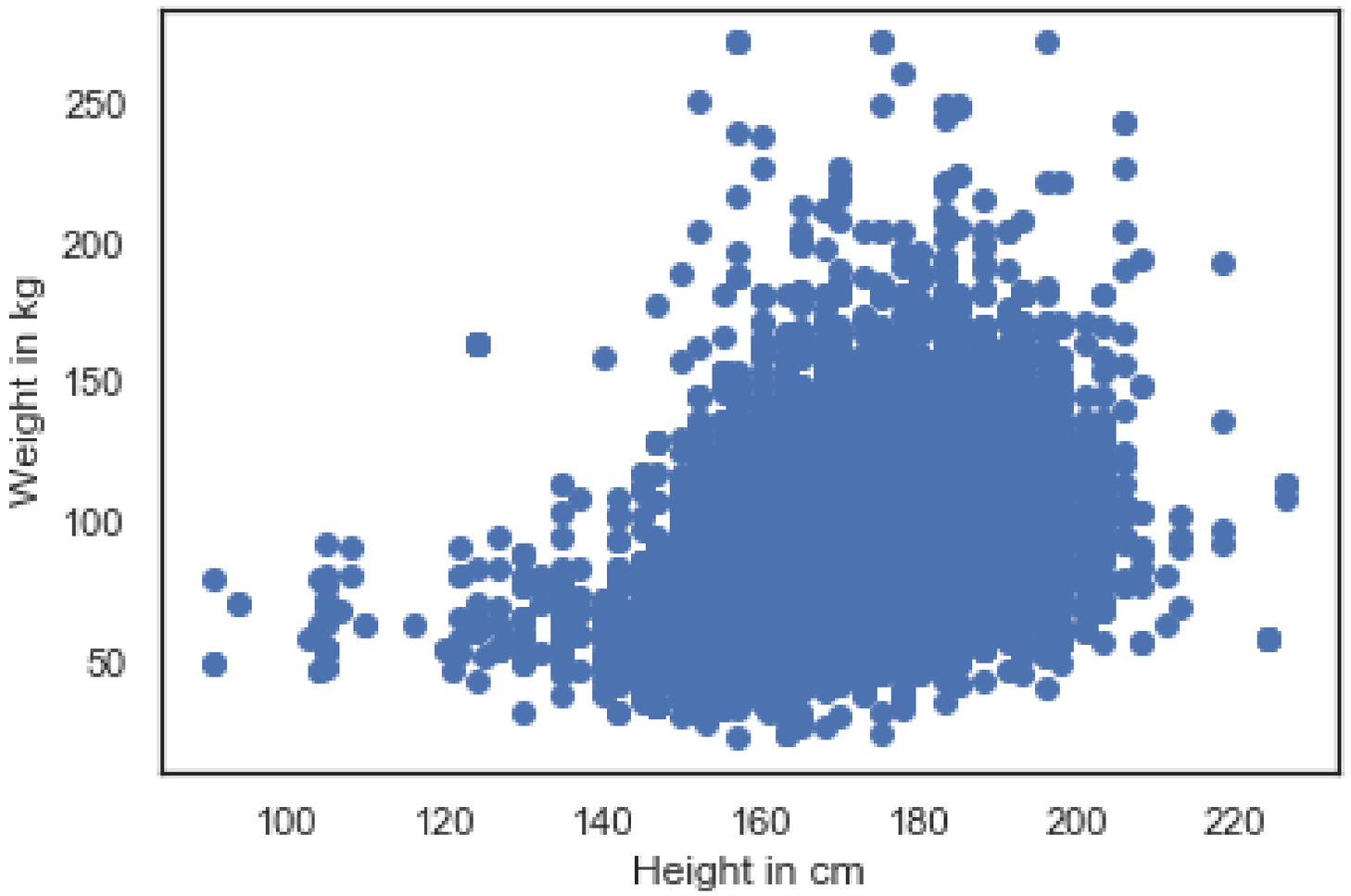
Behavioral Risk Factor Surveillance System

BRFSS™

The Behavioral Risk Factor Surveillance System (BRFSS) is the nation's premier system of health-related telephone surveys that collect state data about U.S. residents regarding their health-related risk behaviors, chronic health conditions, and use of preventive services. Established in 1984 with 15 states, BRFSS now collects data in all 50 states as well as the District of Columbia and three U.S. territories. BRFSS completes more than 400,000 adult interviews each year, making it the largest continuously conducted health survey system in the world. See More.

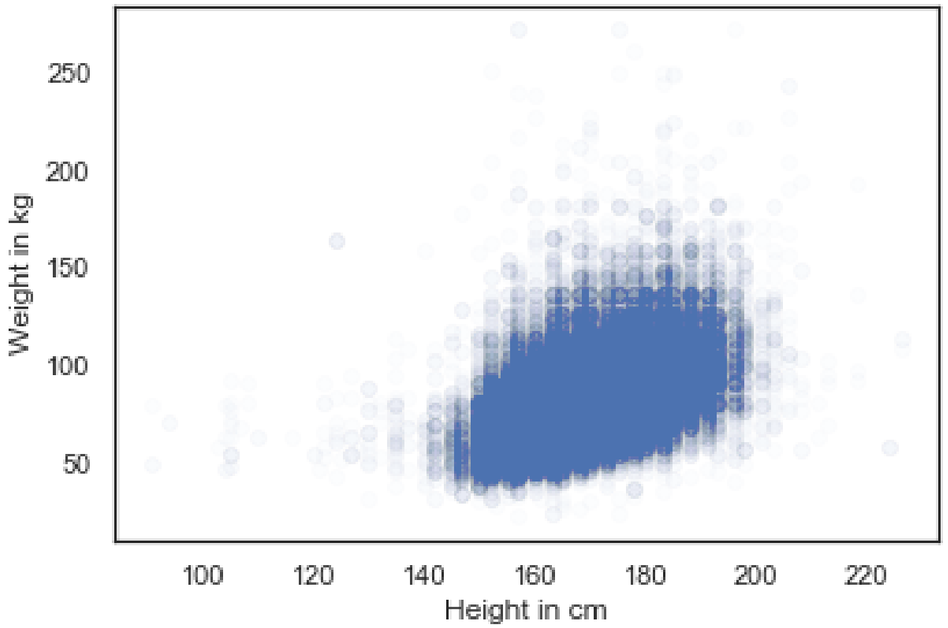
Scatter plot

```
brfss = pd.read_hdf('brfss.hdf5', 'brfss')
height = brfss['HTM4']
weight = brfss['WTKG3']

plt.plot(height, weight, 'o')

plt.xlabel('Height in cm')
plt.ylabel('Weight in kg')
plt.show()
```


250
200
150
100
50
Weight in kg
100
120
140
160
180
200
220
Height in cm

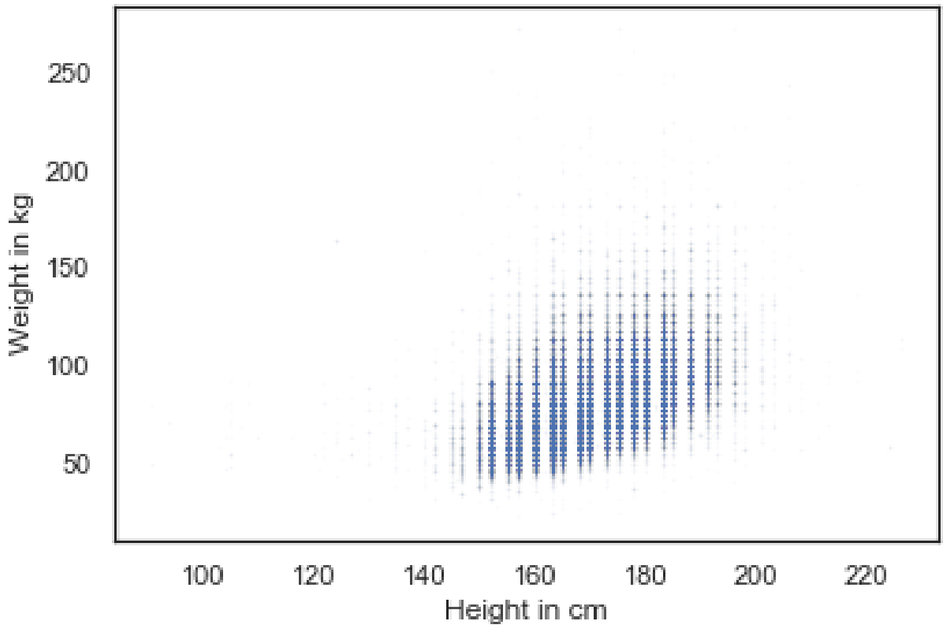
Transparency

```
plt.plot(height, weight, 'o', alpha=0.02)
plt.show()
```



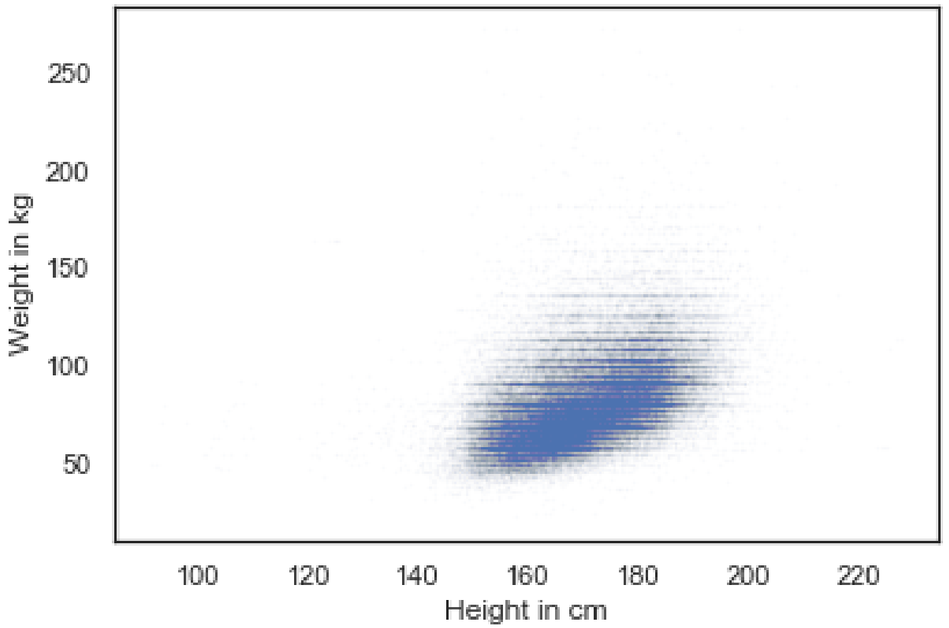
Marker size

```
plt.plot(height, weight, 'o', markersize=1, alpha=0.02)
plt.show()
```



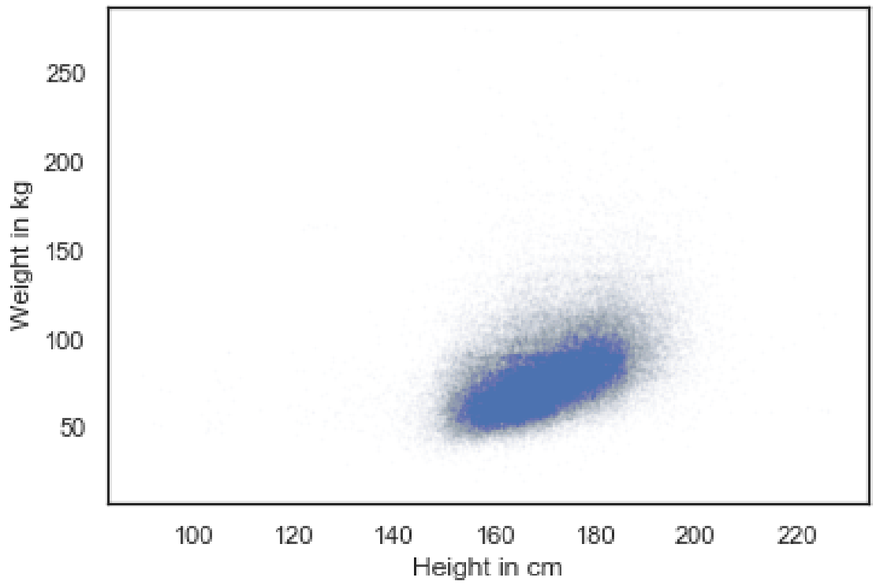
Jittering

```
height_jitter = height + np.random.normal(0, 2, size=len(brfss))
plt.plot(height_jitter, weight, 'o', markersize=1, alpha=0.02)
plt.show()
```



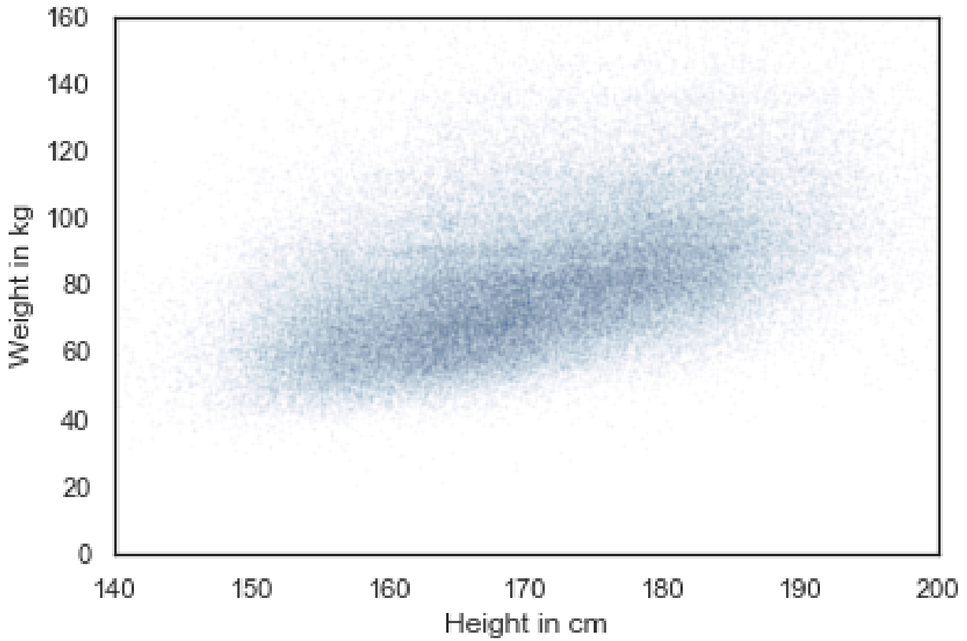
More jittering

```
height_jitter = height + np.random.normal(0, 2, size=len(brfss))
weight_jitter = weight + np.random.normal(0, 2, size=len(brfss))
plt.plot(height_jitter, weight_jitter, 'o', markersize=1, alpha=0.01
plt.show()
```

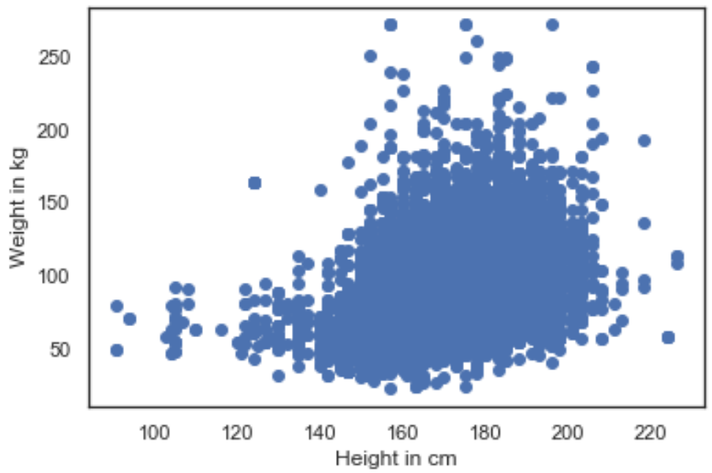


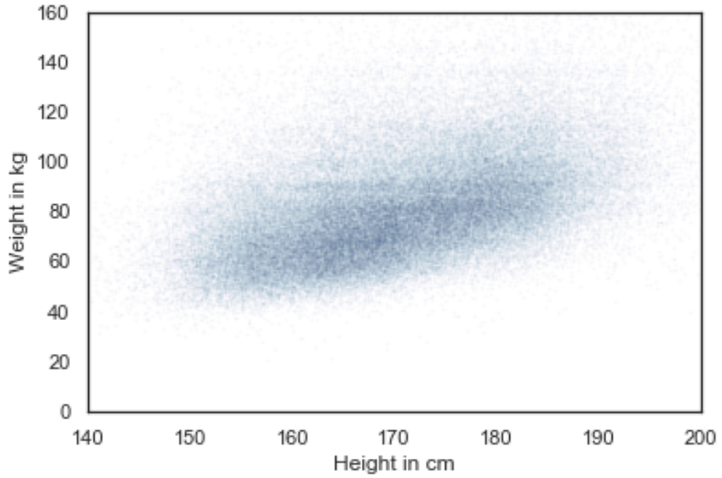
Zoom

```
plt.plot(height_jitter, weight_jitter, 'o', markersize=1, alpha=0.02
plt.axis([140, 200, 0, 160])
plt.show()
```



Before and after





Let's explore!

EXPLORATORY DATA ANALYSIS IN PYTHON

DataCamp

Visualizing relationships

EXPLORATORY DATA ANALYSIS IN PYTHON

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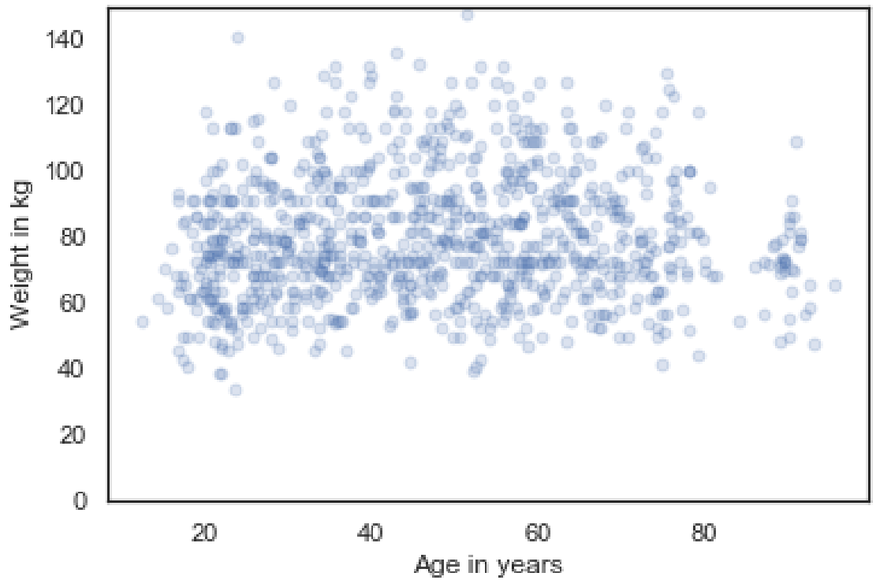
DataCamp

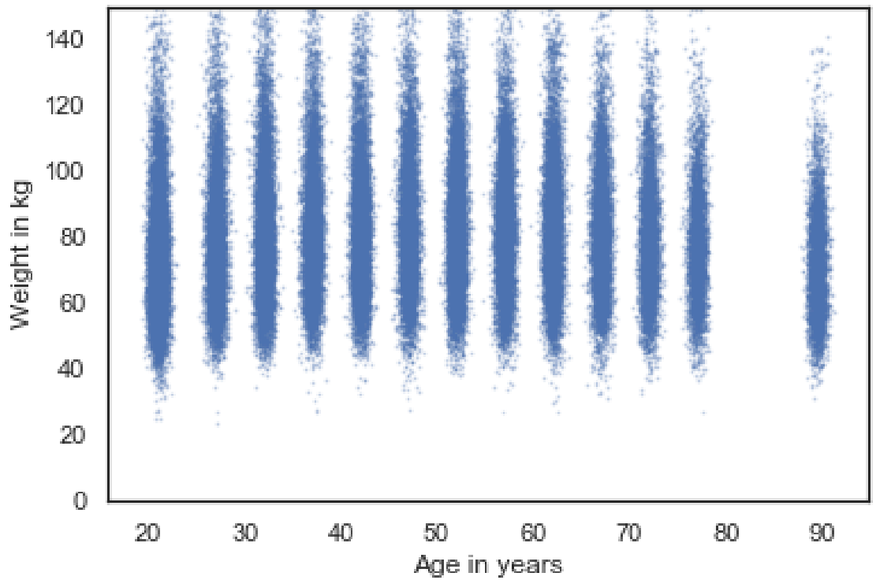
Weight and age

```
age = brfss['AGE'] + np.random.normal(0, 2.5, size=len(brfss))
weight = brfss['WTKG3']
plt.plot(age, weight, 'o', markersize=5, alpha=0.2)
plt.show()
```



More data

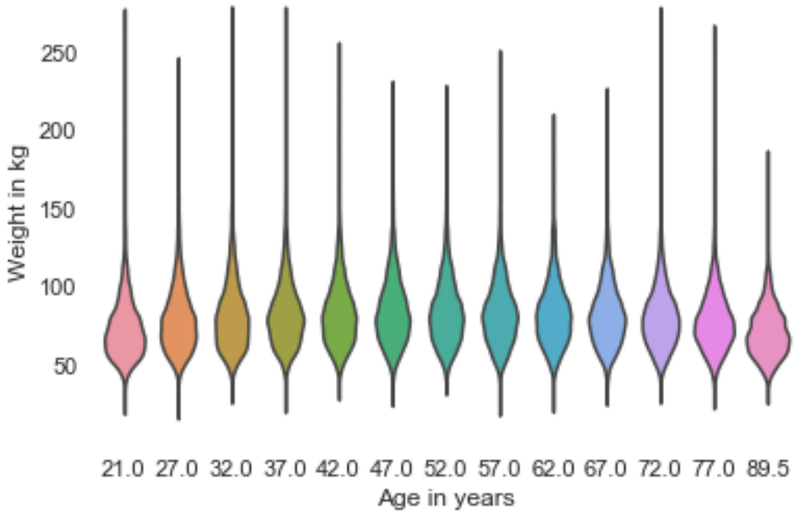
```
age = brfss['AGE'] + np.random.normal(0, 0.5, size=len(brfss))
weight = brfss['WTKG3'] + np.random.normal(0, 2, size=len(brfss))
plt.plot(age, weight, 'o', markersize=1, alpha=0.2)
plt.show()
```



Violin plot

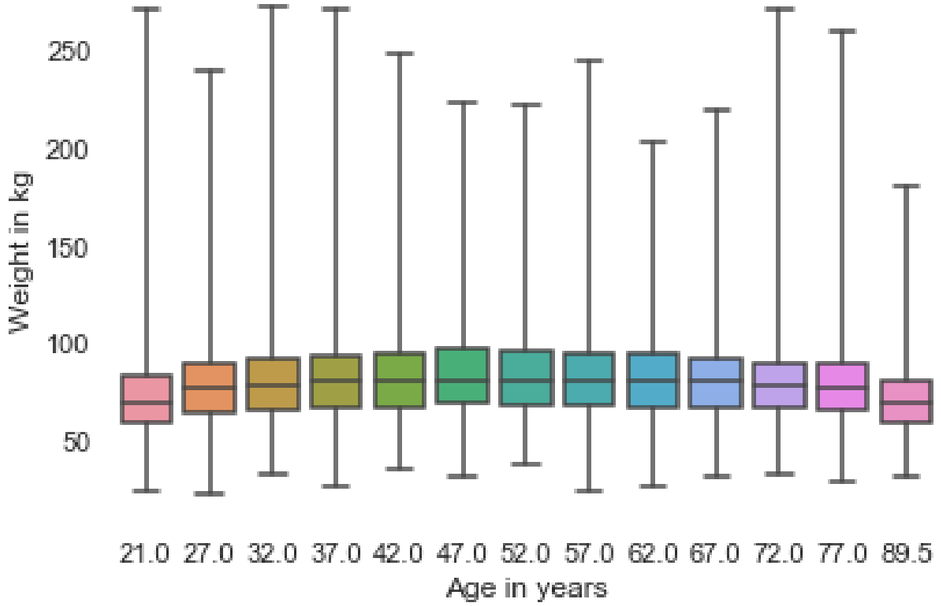
```
data = brfss.dropna(subset=['AGE', 'WTKG3'])

sns.violinplot(x='AGE', y='WTKG3', data=data, inner=None)
plt.show()
```



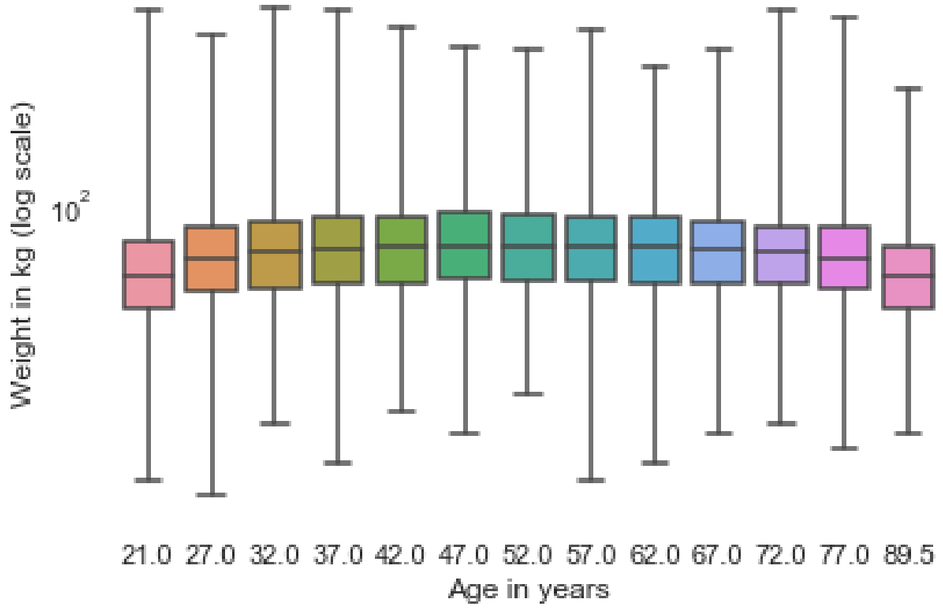
Box plot

```
sns.boxplot(x='AGE', y='WTKG3', data=data, whis=10)
plt.show()
```



Log scale

```
sns.boxplot(x='AGE', y='WTKG3', data=data, whis=10)
plt.yscale('log')
plt.show()
```



Let's practice!

EXPLORATORY DATA ANALYSIS IN PYTHON

DataCamp

Correlation

EXPLORATORY DATA ANALYSIS IN PYTHON

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Professor, Olin College

DataCamp

Correlation coefficient

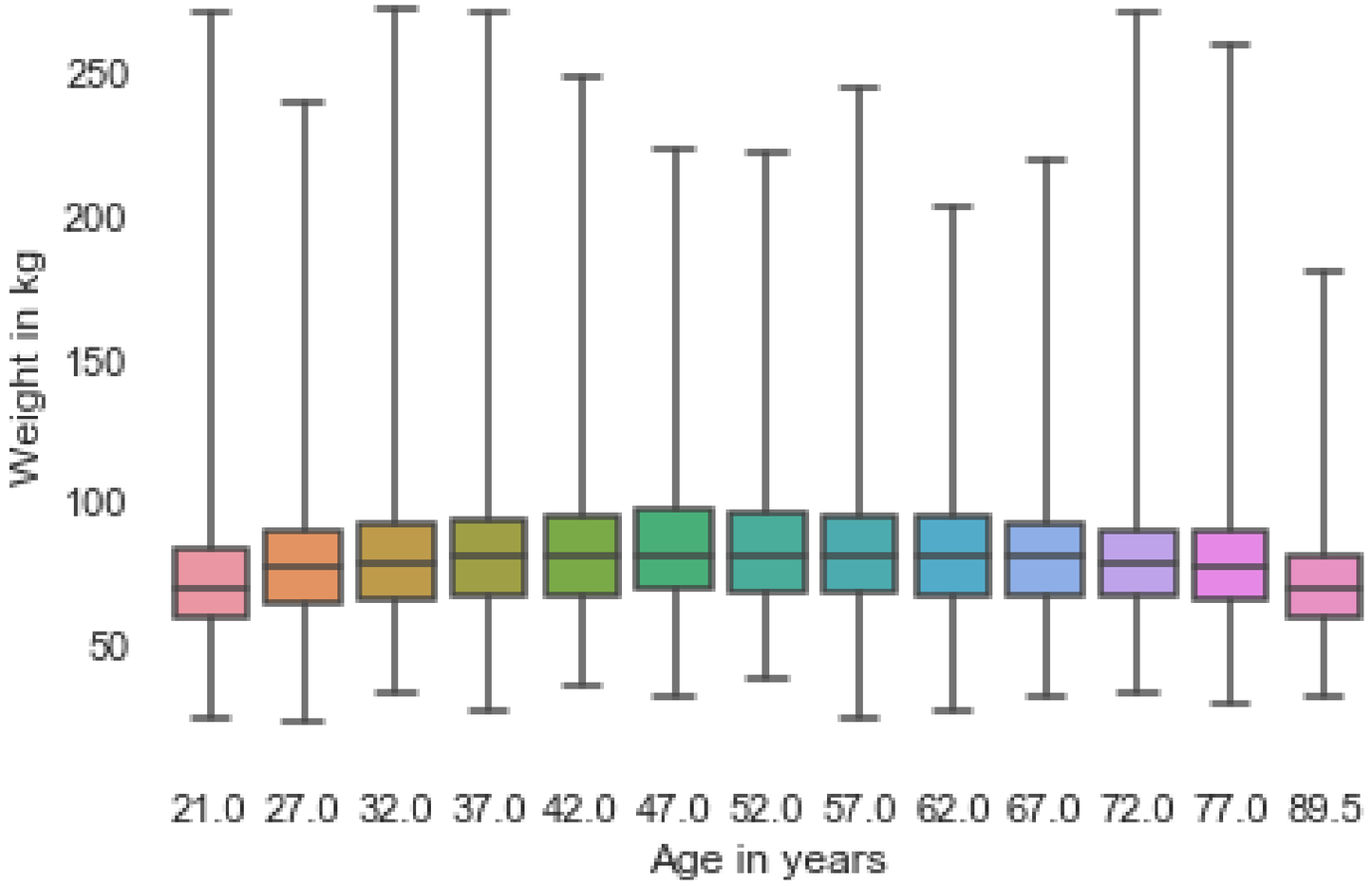
```
columns = ['HTM4', 'WTKG3', 'AGE']
subset = brfss[columns]
```

```
subset.corr()
```

Correlation matrix

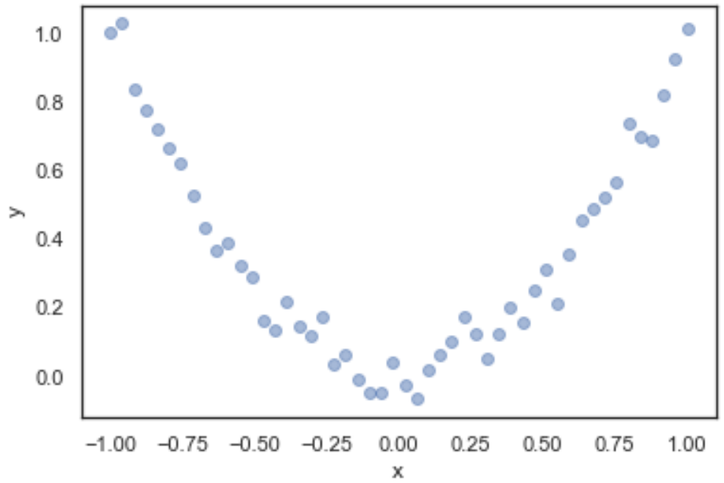
```
          HTM4          WTKG3          AGE
HTM4      1.000000      0.474203     -0.093684
WTKG3     0.474203      1.000000      0.021641
AGE      -0.093684      0.021641      1.000000
```

- Height with itself: 1
- Height and weight: 0.47
- Height and age: -0.09
- Weight and age: 0.02


Weight in kg
250
200
150
100
50
21.0
27.0
32.0
37.0
42.0
47.0
52.0
57.0
62.0
67.0
72.0
77.0
89.5
Age in years

```
xs = np.linspace(-1, 1)
ys = xs**2
ys += normal(0, 0.05, len(xs))
np.corrcoef(xs, ys)
```

```
array([[ 1.        , -0.01111647],
       [-0.01111647,  1.        ]])
```

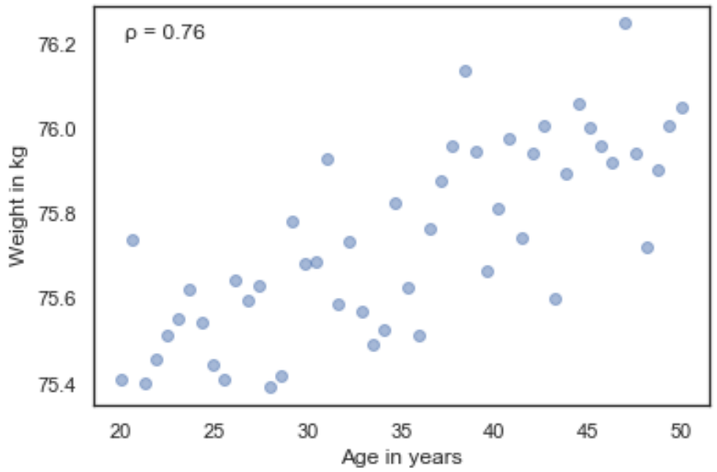


You keep using that word

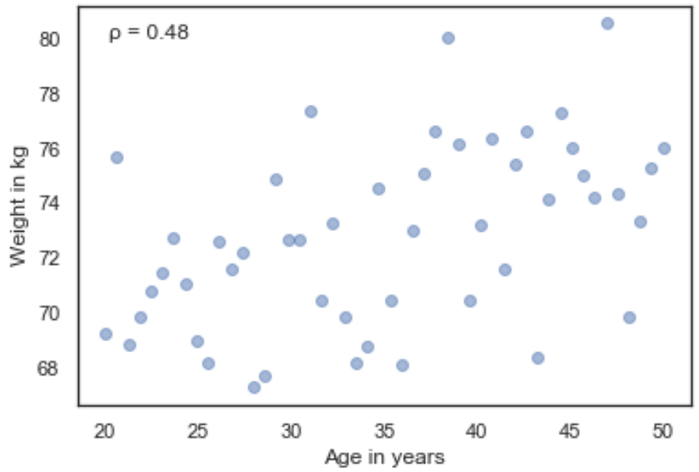
I do not think it means what you think it means

Strength of relationship

Hypothetical #1



Hypothetical #2



Let's practice!

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DataCamp

Simple regression

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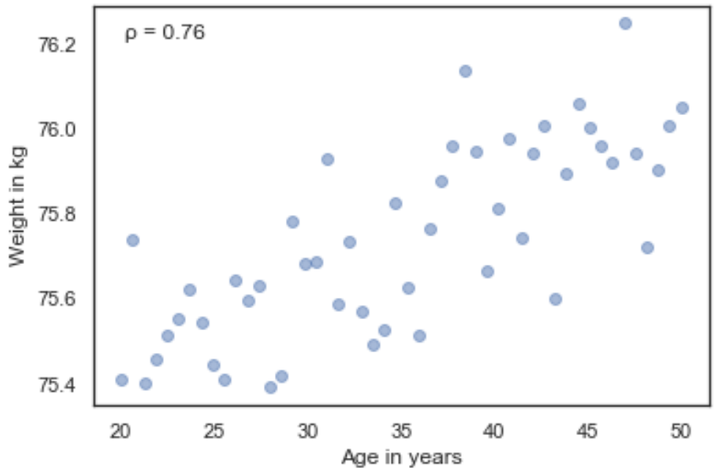
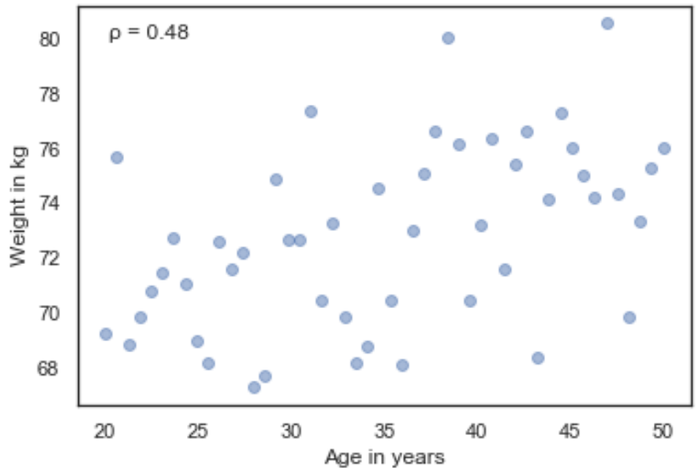
DataCamp

Strength of relationship

Hypothetical #1



Hypothetical #2



Strength of effect

```
from scipy.stats import linregress


# Hypothetical 1
res = linregress(xs, ys)
```

```
LinregressResult(slope=0.01882103490324438 6,
            intercept=75.08049023710964,
                rvalue=0.7579660563439402,
                pvalue=1.8470158725246148e-10,
                stderr=0.00233784926056081 8)
```

Strength of effect

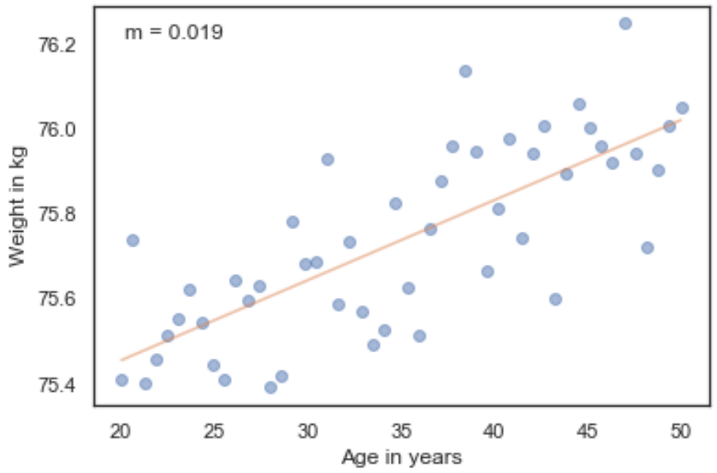
```
# Hypothetical 2
res = linregress(xs, ys)
```

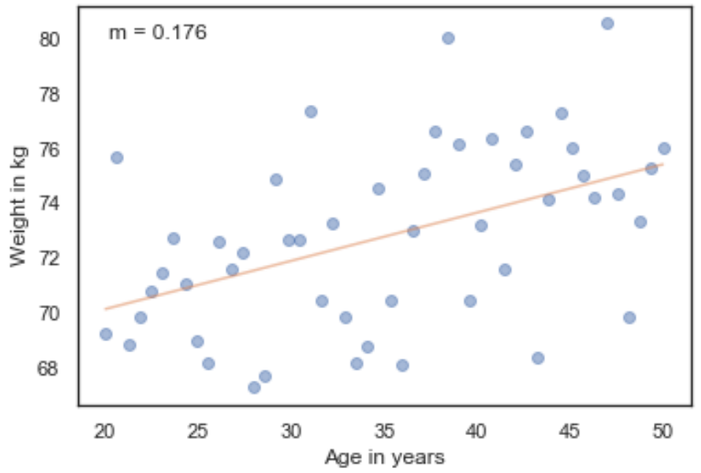
```
LinregressResult(slope=0.1764206980648885,
                 intercept=66.60980474219305,
                     rvalue=0.4782776976576317,
                     pvalue=0.0004430600283776241,
                     stderr=0.04675698521121631)
```

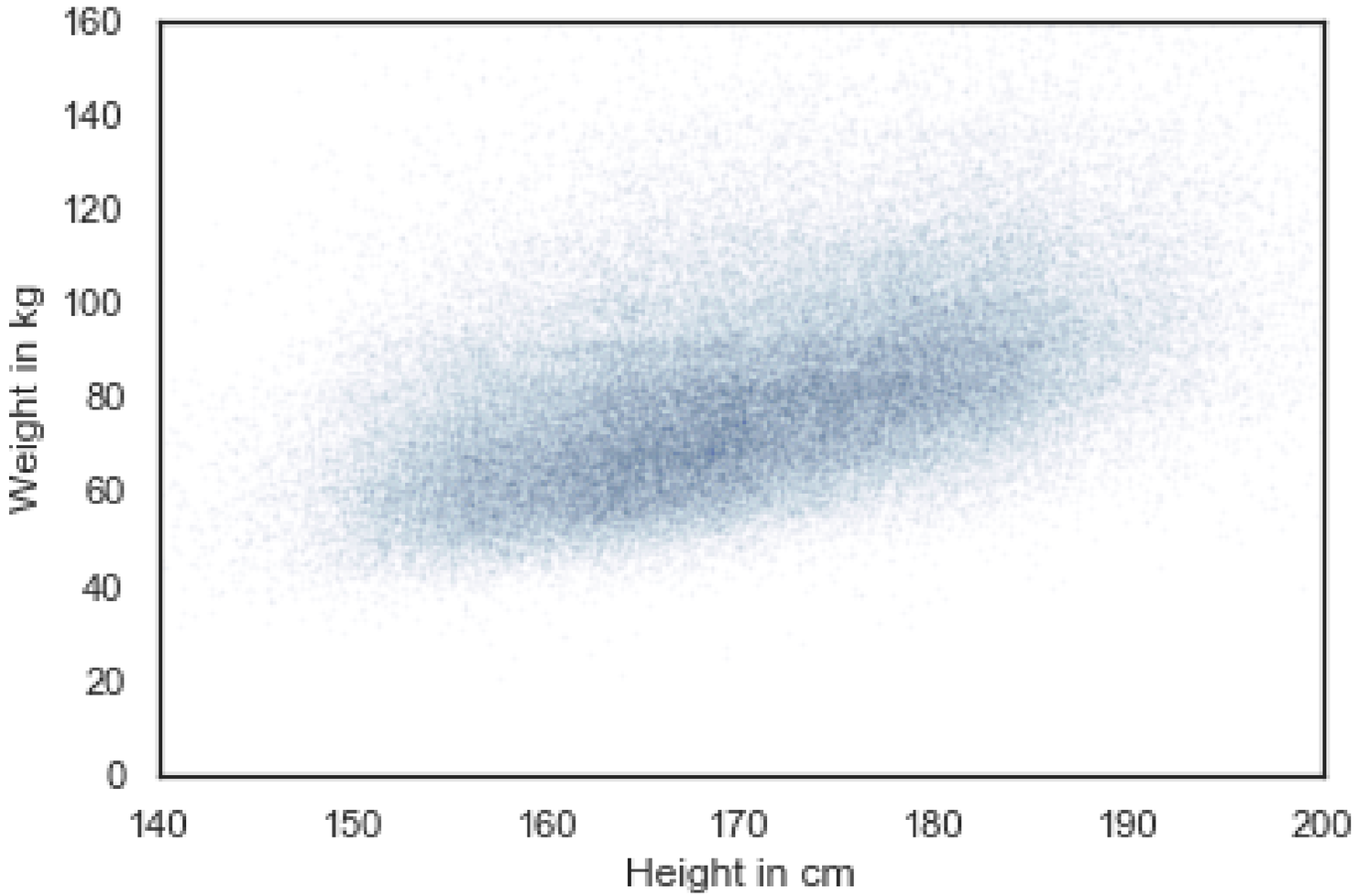
Regression lines

```
fx = np.array([xs.min(), xs.max()])
fy = res.intercept + res.slope * fx
plt.plot(fx, fy, '-')
```

```
fx = ...
fy = ...
plt.plot(fx, fy, '-')
```






160
140
120
100
80
60
40
20
0
Weight in kg
140
150
160
170
180
190
200
Height in cm

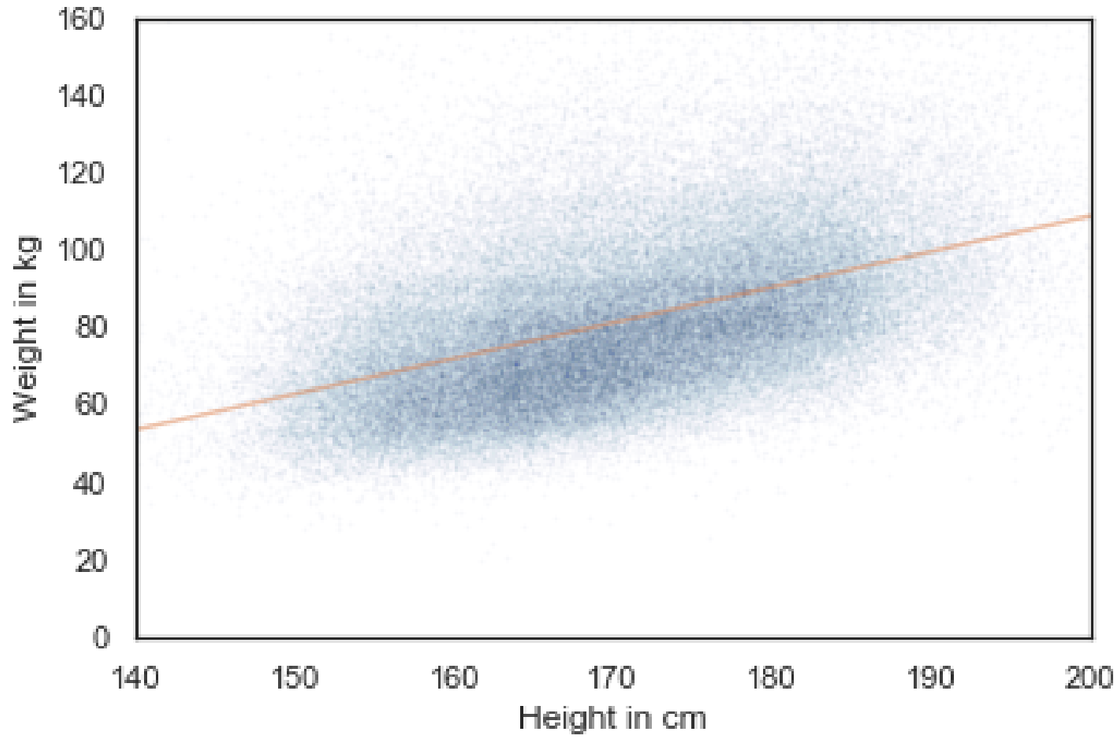
Regression line

```
subset = brfss.dropna(subset=['WTKG3', 'HTM4'])
```

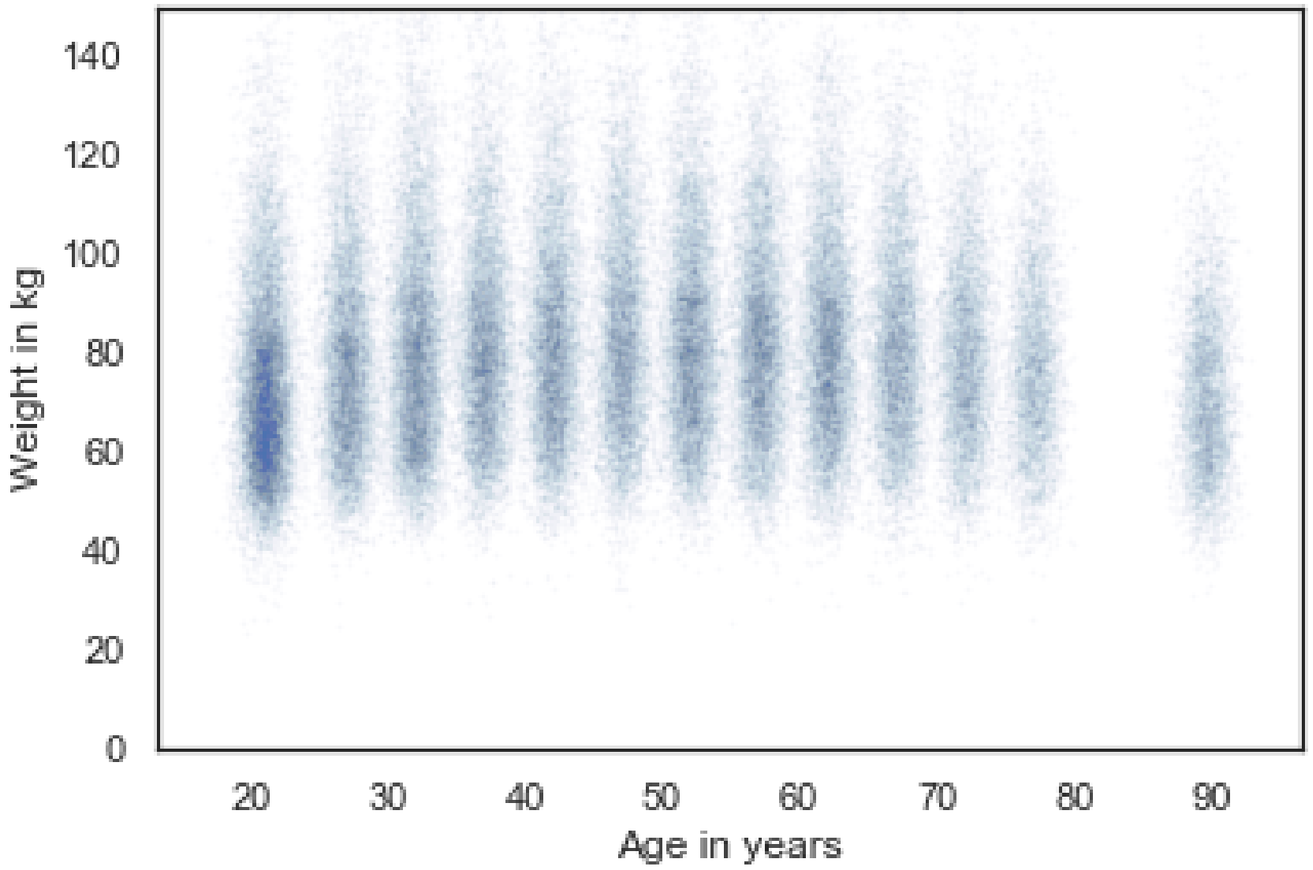
```
xs = subset['HTM4']
ys = subset['WTKG3']
res = linregress(xs, ys)
```

```
LinregressResult(slope=0.9192115381848297,
           intercept=-75.12704250330233,
                rvalue=0.4742030879024584,
                pvalue=0.0,
                stderr=0.005632863769802998)
```

```
fx = np.array([xs.min(), xs.max()])
fy = res.intercept + res.slope * fx
plt.plot(fx, fy, '-')
```



Linear relationships



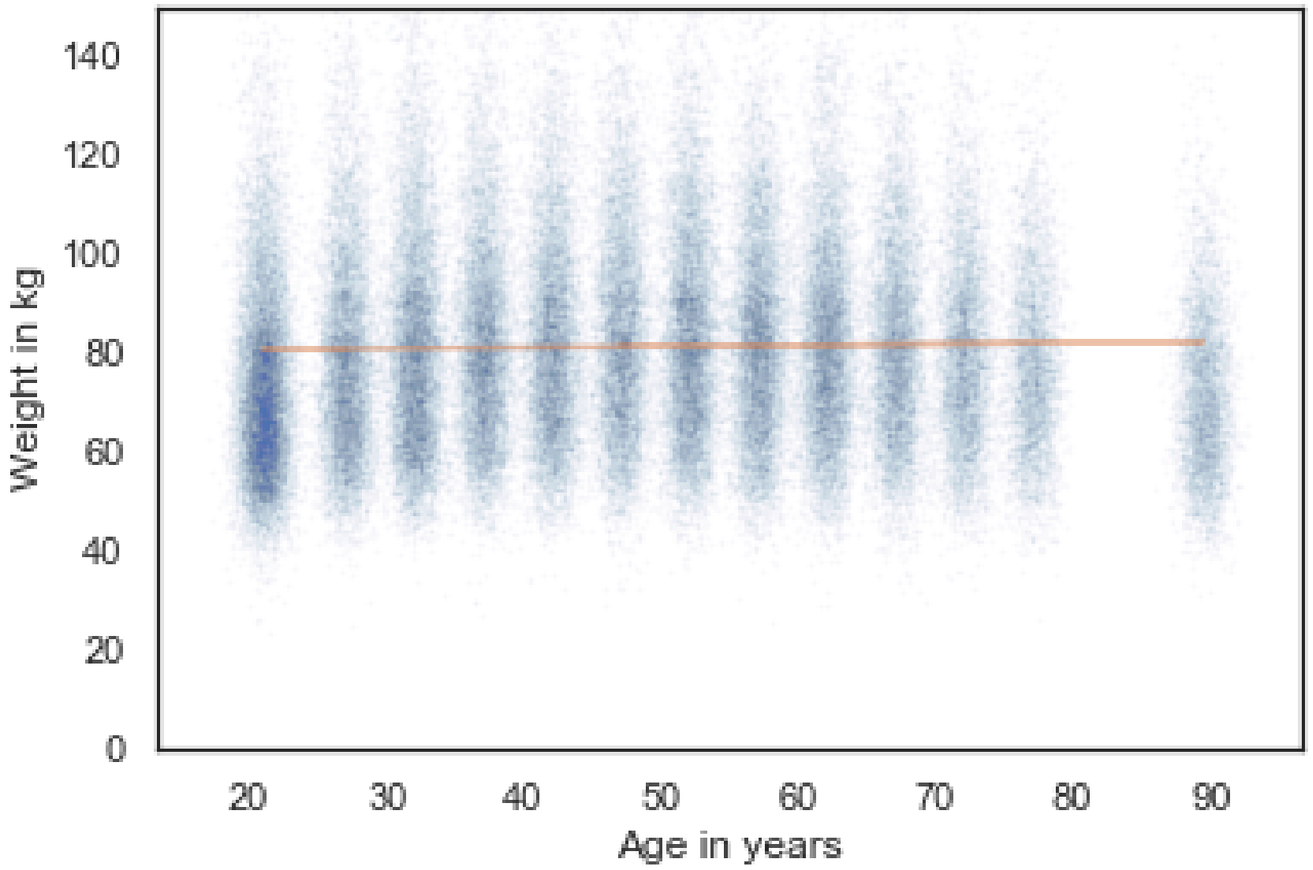
Nonlinear relationships

```
subset = brfss.dropna(subset=['WTKG3', 'AGE'])
xs = subset['AGE']
ys = subset['WTKG3']

res = linregress(xs, ys)
```

```
LinregressResult(slope=0.02398115956696872 4,
           intercept=80.07977583683224,
               rvalue=0.021641432889064068,
               pvalue=4.374327493007566e-11,
               stderr=0.003638139410742186)
```

Not a good fit



Let's practice!

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