In [1]:
```
%autosave 7200
```

```
Autosaving every 7200 seconds
```

In [2]:
```
from datascience import *
import numpy as np
%matplotlib inline
import matplotlib.pyplot as plots
plots.style.use('fivethirtyeight')
```

In [3]:
```
def r_table(r, num_points=1000):
    """
    Generate a table of N data points with a correlation approximately r
    """
    np.random.seed(8)
    x = np.random.normal(0, 1, num_points)
    z = np.random.normal(0, 1, num_points)
    y = r*x + (np.sqrt(1-r**2))*z
    return Table().with_columns('x', x, 'y', y)
```

In [4]:
```
def draw_line(slope=0, intercept=0, x=make_array(-4, 4), color='r'):
    y = x*slope + intercept
    plots.plot(x, y, color=color)
```

In [5]:
```
def draw_vertical_line(x_position, color='black'):
    x = make_array(x_position, x_position)
    y = make_array(-4, 4)
    plots.plot(x, y, color=color)
```

In [6]:
```
def resize_window(lim=3.5):
    plots.xlim(-lim, lim)
    plots.ylim(-lim, lim)
```

In [7]:
```
def predict_y(x_val):       #Nearest Neighbor
    """
    Predicts y-values for the example table using points within an x-value of 0.25
```

```
    """
    nearby_points = example.where('x', are.between(x_val - 0.25, x_val + 0.25))
    return np.mean(nearby_points.column('y'))
```

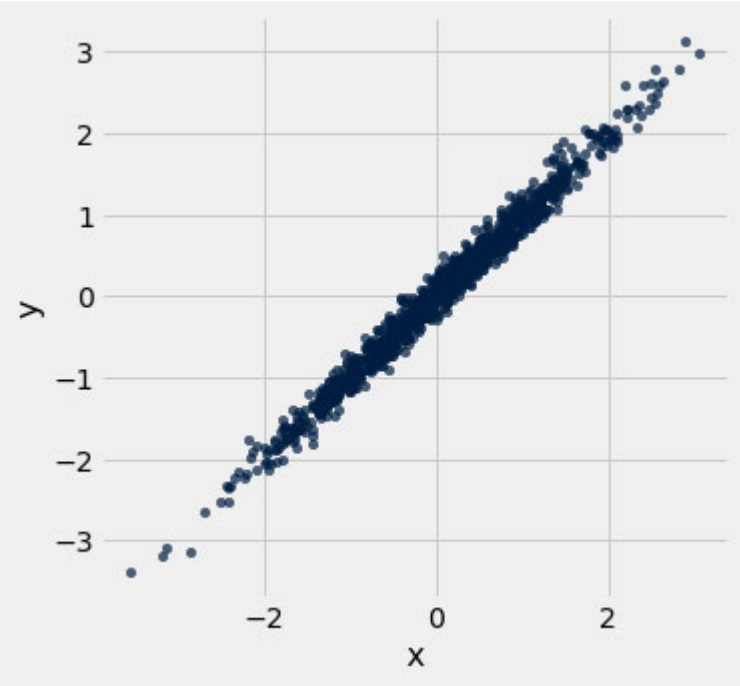
In [8]:
```
example = r_table(0.99)
example
```

Out[8]:

x	y
0.0912047	-0.0680119
1.09128	1.04391
-1.94697	-1.88316
-1.38635	-1.34674
-2.29649	-2.14933
2.40983	2.59627
1.72784	1.76089
2.20456	2.5933
0.794828	0.778249
0.976421	1.18139

... (990 rows omitted)

In [9]:
```
example.scatter('x', 'y')
```



In [10]:
```
example = example.with_column(
    'NN Predicted y',
    example.apply(predict_y, 'x'))
example
```

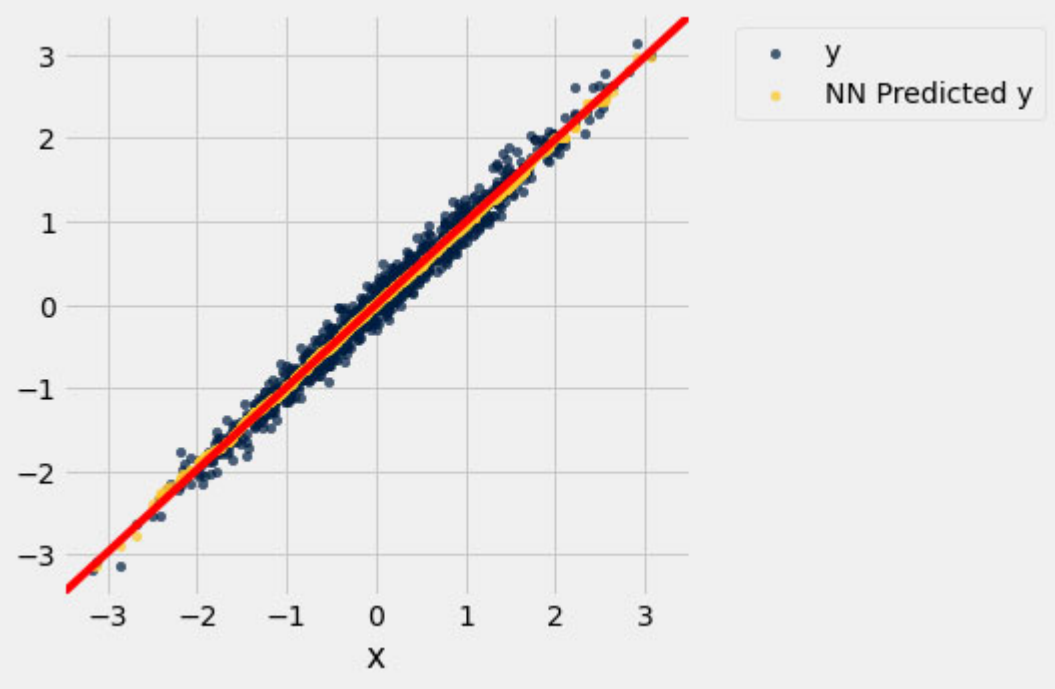
Out[10]:

x	y	NN Predicted y
0.0912047	-0.0680119	0.104202
1.09128	1.04391	1.05235
-1.94697	-1.88316	-1.85456
-1.38635	-1.34674	-1.32041
-2.29649	-2.14933	-2.17514
2.40983	2.59627	2.41498
1.72784	1.76089	1.70671
2.20456	2.5933	2.12065
0.794828	0.778249	0.791607

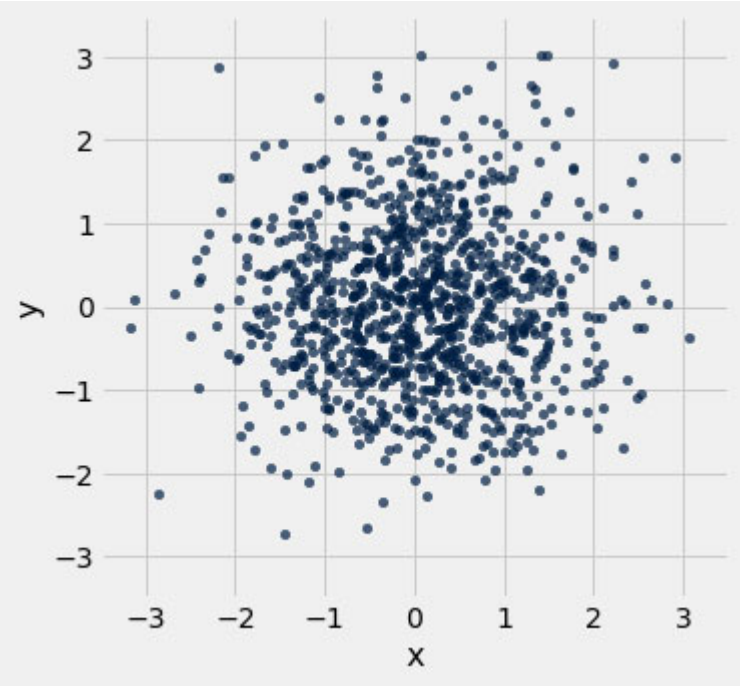
x	y	NN Predicted y
0.976421	1.18139	0.947165

... (990 rows omitted)

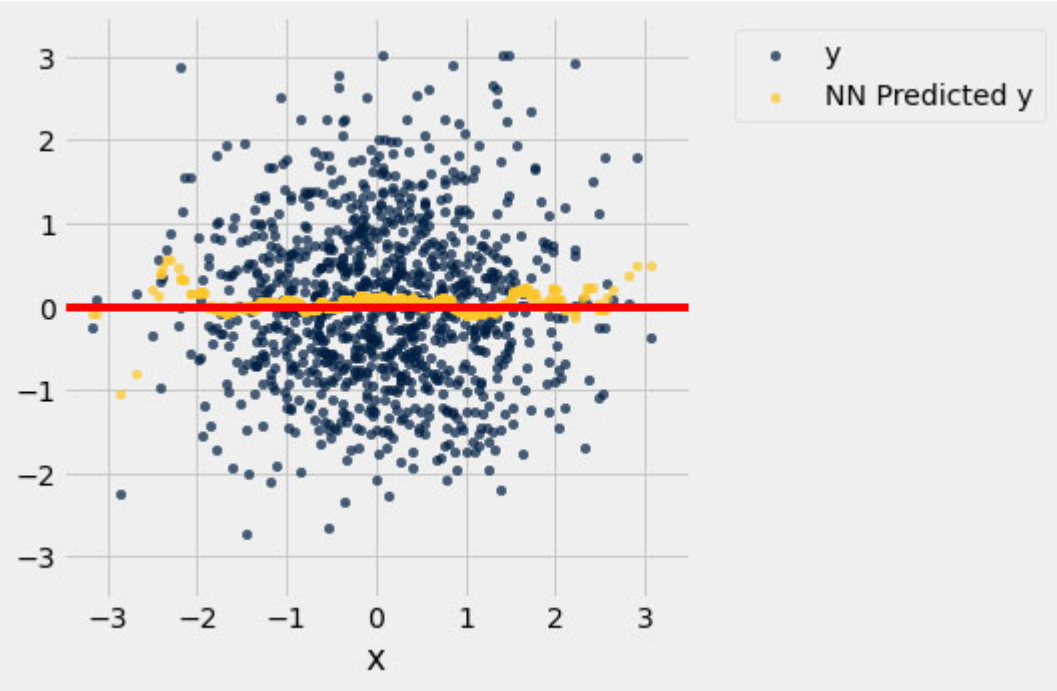
In [11]:
```
example = example.with_column('NN Predicted y', example.apply(predict_y, 'x'))
example.scatter('x')
draw_line(slope=0.99)
resize_window()
```



In [12]:
```
example = r_table(0)
example.scatter('x', 'y')
resize_window()
```

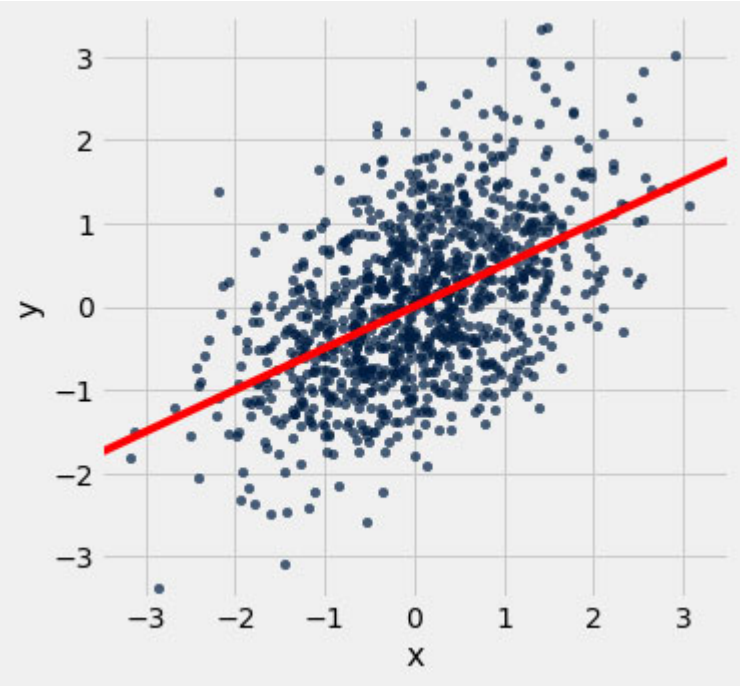


In [13]:
```
example = example.with_column('NN Predicted y', example.apply(predict_y, 'x'))
example.scatter('x')
draw_line(slope=0)
resize_window()
```

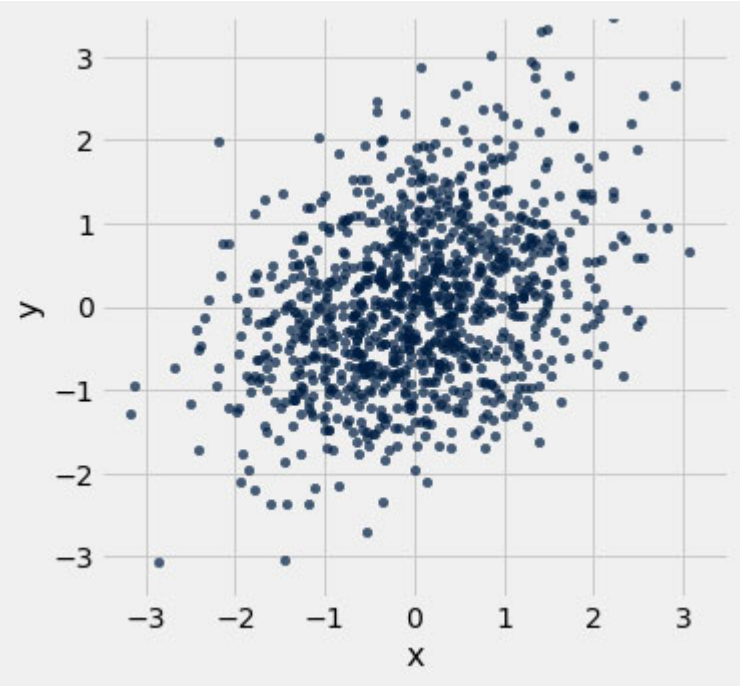


In [14]:
```
example = r_table(0.5)
```

In [15]:
```
example = example.with_column('NN Predicted y', example.apply(predict_y, 'x'))
example.scatter('x', 'y')
draw_line(slope=.5)
resize_window()
```

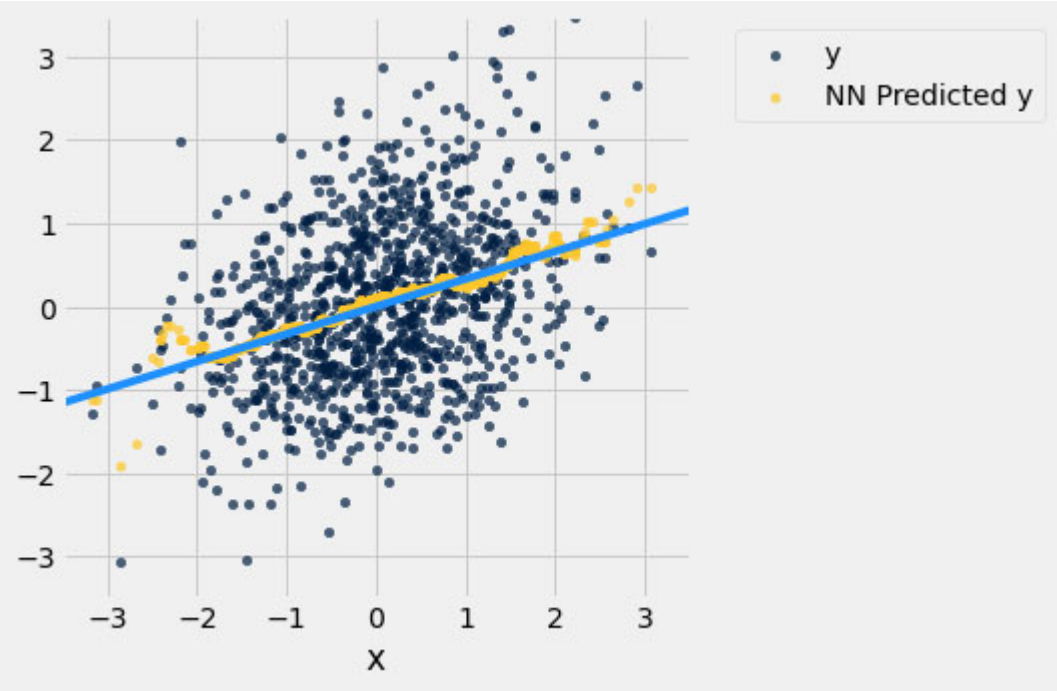


In [16]:
```
example = r_table(0.33)
example.scatter('x', 'y')
resize_window()
```



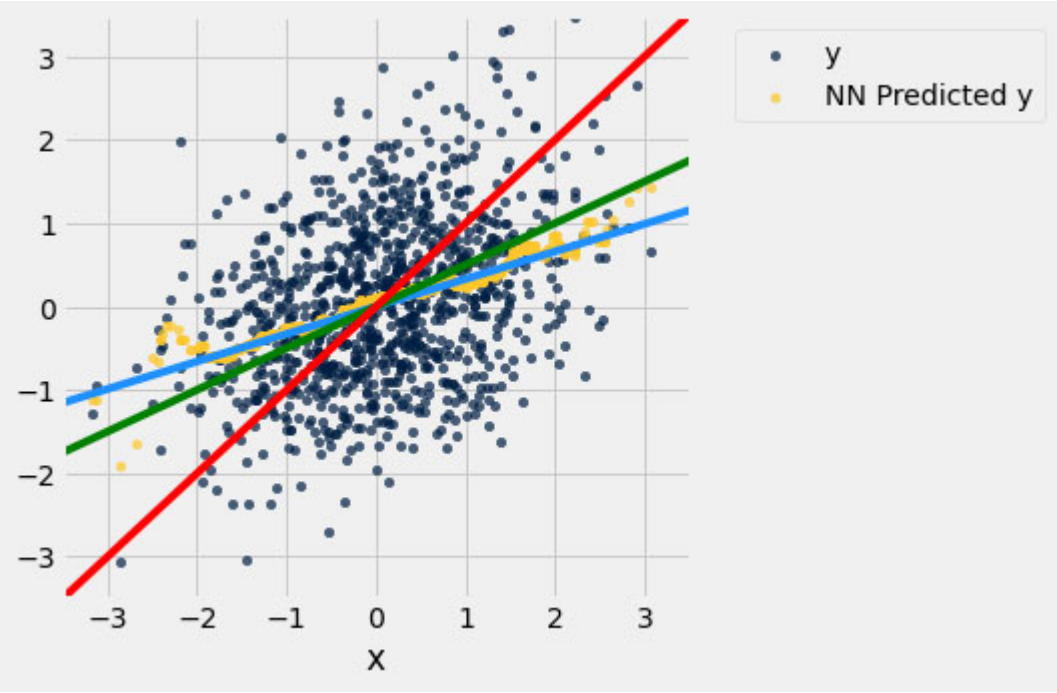
In [17]:

```
example = example.with_column('NN Predicted y', example.apply(predict_y, 'x'))
example.scatter('x')
draw_line(slope=0.33, color='dodgerblue')
resize_window()
```



In [18]:

```
example = example.with_column('NN Predicted y', example.apply(predict_y, 'x'))
example.scatter('x')
draw_line(slope=0.33, color='dodgerblue')
draw_line(slope=0.5, color='green')
draw_line(slope=1, color='red')
resize_window()
```



In [19]:
```
def standard_units(arr):
    return (arr - np.mean(arr)) / np.std(arr)

def correlation(tbl, x, y):
    x_standard = standard_units(tbl.column(x))
    y_standard = standard_units(tbl.column(y))
    return np.mean(x_standard * y_standard)

def slope(tbl, x, y):
    r = correlation(tbl, x, y)
    sd_x = np.std(tbl.column(x))
    sd_y = np.std(tbl.column(y))
    return r * sd_y / sd_x

def intercept(tbl, x, y):
    avg_x = np.mean(tbl.column(x))
    avg_y = np.mean(tbl.column(y))
    data_slope = slope(tbl, x, y)
    return avg_y - data_slope * avg_x
```

In [20]:
```
galton = Table.read_table('galton.csv')
```

```
heights = Table().with_columns(
    'MidParent', galton.column('midparentHeight'),
    'Child', galton.column('childHeight'))
heights
```

Out[20]:

MidParent	Child
75.43	73.2
75.43	69.2
75.43	69
75.43	69
73.66	73.5
73.66	72.5
73.66	65.5
73.66	65.5
72.06	71
72.06	68

... (924 rows omitted)

In [21]:

```
def predict_child(h):
    """Return a prediction of the height of a child
    whose parents have a midparent height of h.

    The prediction is the average height of the children
    whose midparent height is in the range h plus or minus 0.25 inches.
    """

    close_points = heights.where('MidParent', are.between(h-0.5, h + 0.5))
    return close_points.column('Child').mean()
```

In [22]:

```
heights_with_predictions = heights.with_column(
    'NN prediction', heights.apply(predict_child, 'MidParent'))
```

In [23]:
```
galton_slope = slope(heights, 'MidParent', 'Child')
galton_intercept = intercept(heights, 'MidParent', 'Child')
galton_slope, galton_intercept
```

Out[23]:
```
(0.637360896969479, 22.63624054958975)
```

In [24]:
```
#midparent height is 69.48 and child height is 71.5
#for the 123rd record in dataset.
heights.take(123)
```

Out[24]:

MidParent	Child
69.48	71.5

In [25]:
```
#regression line estimate for average height of child
#when parent height is 69.48 is 66.92...
galton_slope*69.48 + galton_intercept
```

Out[25]:
```
66.92007567102915
```

In [26]:
```
heights_with_predictions.with_column(
    'Regression Prediction',
    galton_slope*heights.column('MidParent') + galton_intercept)
```

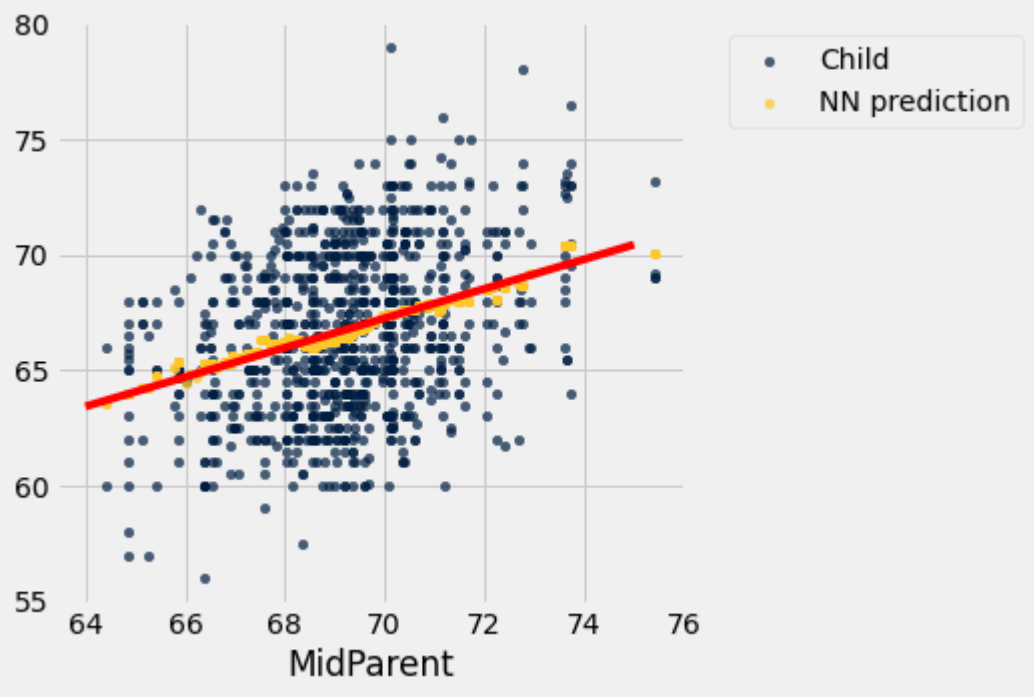
Out[26]:

MidParent	Child	NN prediction	Regression Prediction
75.43	73.2	70.1	70.7124
75.43	69.2	70.1	70.7124
75.43	69	70.1	70.7124
75.43	69	70.1	70.7124
73.66	73.5	70.4158	69.5842
73.66	72.5	70.4158	69.5842
73.66	65.5	70.4158	69.5842
73.66	65.5	70.4158	69.5842

MidParent	Child	NN prediction	Regression Prediction
72.06	71	68.5025	68.5645
72.06	68	68.5025	68.5645

... (924 rows omitted)

In [27]:
```
heights_with_predictions.scatter('MidParent')
draw_line(slope=galton_slope, intercept=galton_intercept, x=make_array(64, 75))
```



In [28]:
```
demographics = Table.read_table('district_demographics2016.csv').drop('District','Percent voting for Clinton')
demographics
```

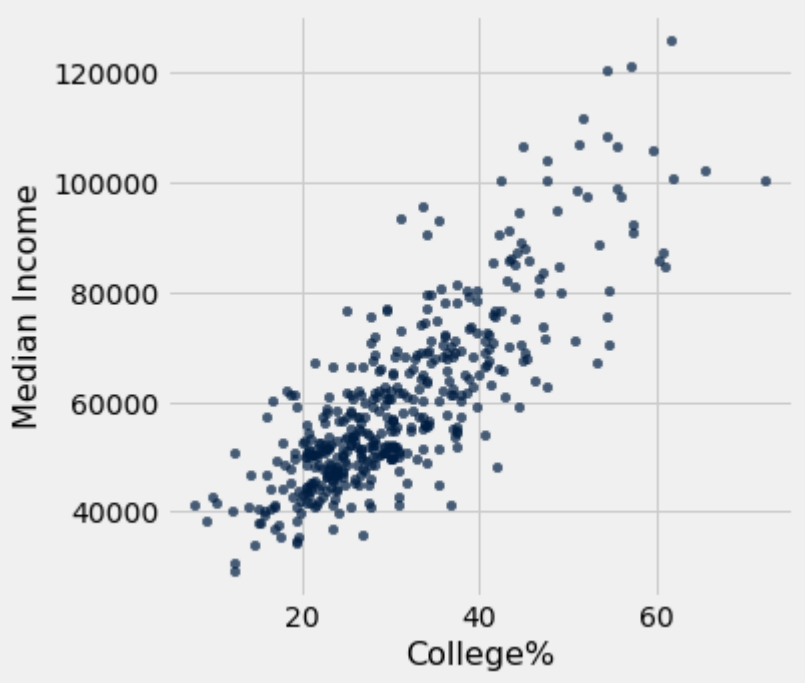
Out[28]:

State	Median Income	College%
Alabama	47083	24
Alabama	42035	21.8

State	Median Income	College%
Alabama	46544	22.8
Alabama	41110	17
Alabama	51690	30.3
Alabama	61413	36.7
Alabama	34664	19.4
Alaska	76440	29.6
Arizona	50537	24.5
Arizona	49072	34

... (425 rows omitted)

In [29]:
```
demographics.scatter('College%', 'Median Income')
```



In [30]:
```
correlation(demographics, 'College%', 'Median Income')
```

Out[30]: 0.8184648517141335

In [31]:
```
demographics_slope = slope(demographics, 'College%', 'Median Income')
demographics_intercept = intercept(demographics, 'College%', 'Median Income')
(demographics_slope, demographics_intercept)
```

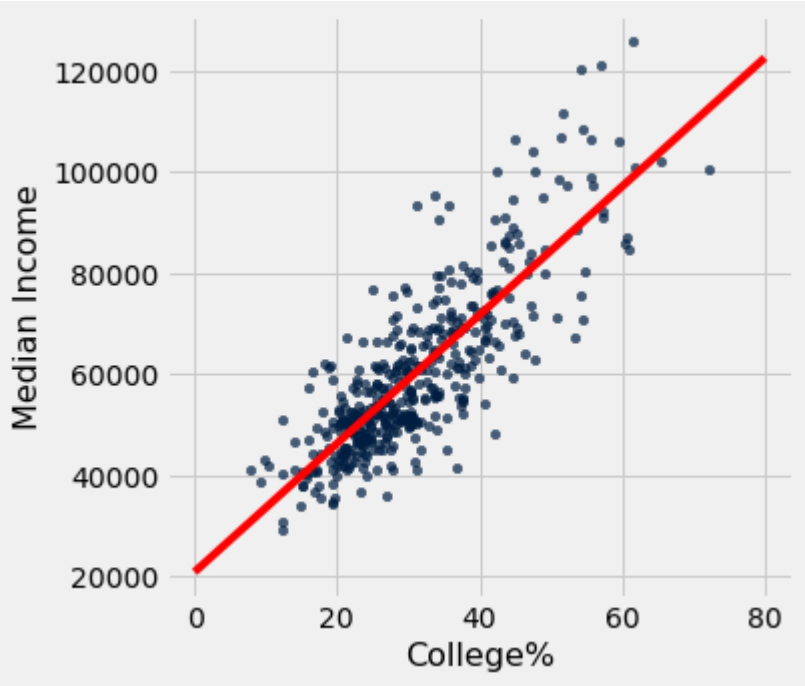
Out[31]: (1270.70168946388, 20802.577766677925)

In [32]:
```
demographics.where('College%', are.between(58, 60)).where('Median Income', are.between(100000, 120000))
```

Out[32]:

State	Median Income	College%
California	105918	59.5

In [33]:
```
demographics.scatter('College%', 'Median Income')
draw_line(slope=demographics_slope, intercept=demographics_intercept, x=make_array(0, 80))
```



In [ ]:

In [ ]: