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_scatter(r):
    plots.figure(figsize=(5,5))
    "Generate a scatter plot with a correlation approximately r"
    x = np.random.normal(0, 1, 1000)
    z = np.random.normal(0, 1, 1000)
    y = r*x + (np.sqrt(1-r**2))*z
    plots.scatter(x, y)
    plots.xlim(-4, 4)
    plots.ylim(-4, 4)
```

In [4]:

```
def standard_units(arr):
    "Convert any array of numbers to standard units."
    return (arr - np.mean(arr))/np.std(arr)
```

In [5]:

```
def correlation(t, label_x, label_y):
    x_standard = standard_units(t.column(label_x))
    y_standard = standard_units(t.column(label_y))
    return np.mean(x_standard * y_standard)
```

In [6]:

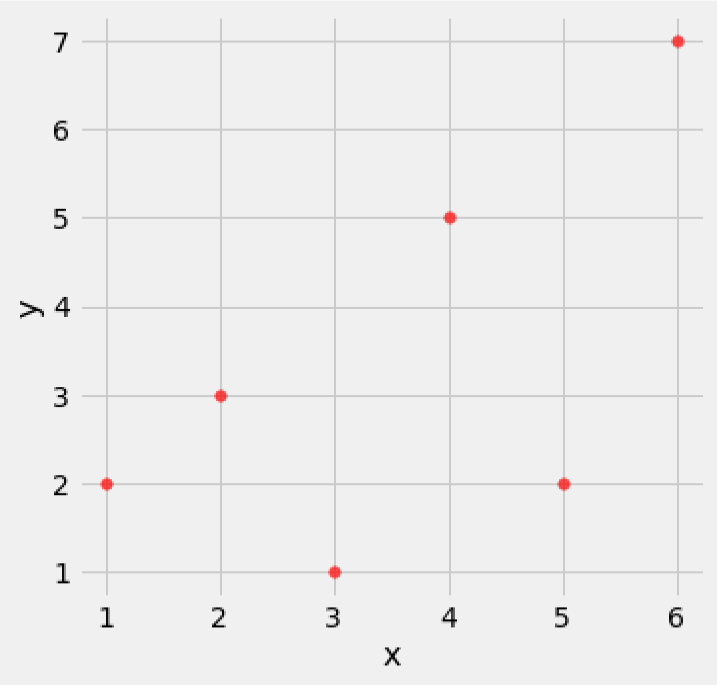
```
x = np.arange(1, 7, 1)
y = make_array(2, 3, 1, 5, 2, 7)
t = Table().with_columns(
        'x', x,
        'y', y
    )
t
```

Out[6]:

x	y
1	2
2	3
3	1
4	5
5	2
6	7

In [7]:

```
t.scatter('x', 'y', s=30, color='red')
```



In [8]:

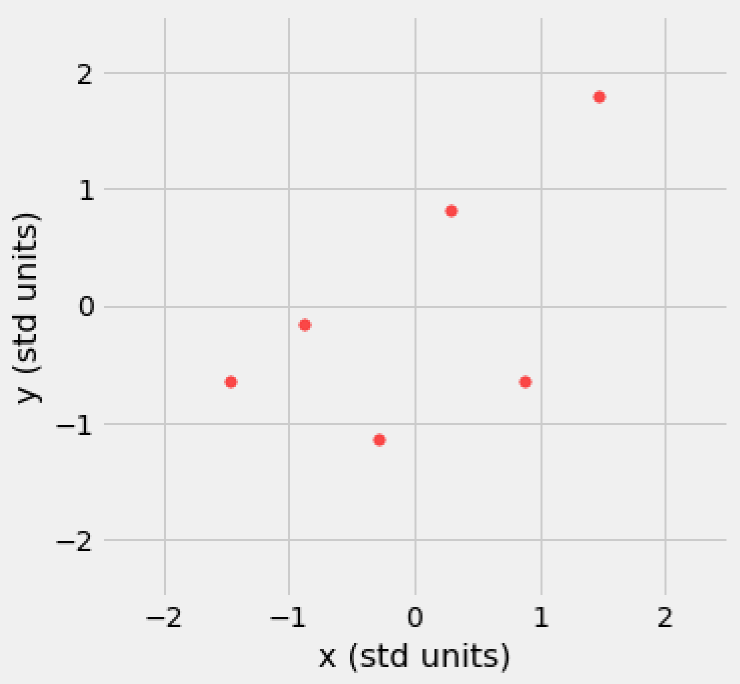
```
t = t.with_columns(
    'x (std units)', standard_units(x),
    'y (std units)', standard_units(y))
t
```

Out[8]:

x	y	x (std units)	y (std units)
1	2	-1.46385	-0.648886
2	3	-0.87831	-0.162221
3	1	-0.29277	-1.13555
4	5	0.29277	0.811107
5	2	0.87831	-0.648886
6	7	1.46385	1.78444

In [9]:

```
t.scatter('x (std units)', 'y (std units)', s=30, color='red')
plots.xlim(-2.5, 2.5)
plots.ylim(-2.5, 2.5);
```



In [10]:

```
x_standard = t.column('x (std units)')
y_standard = t.column('y (std units)')
t = t.with_column(
    'product in standard units', x_standard * y_standard)
t
```

Out[10]:

x	y	x (std units)	y (std units)	product in standard units
1	2	-1.46385	-0.648886	0.949871
2	3	-0.87831	-0.162221	0.142481
3	1	-0.29277	-1.13555	0.332455
4	5	0.29277	0.811107	0.237468
5	2	0.87831	-0.648886	-0.569923
6	7	1.46385	1.78444	2.61215

In [11]:

```
r = np.mean(t.column('product in standard units'))
r
```

Out[11]:

```
0.6174163971897709
```

In [12]:

```
correlation(t, 'x', 'y')
```

Out[12]:

```
0.6174163971897709
```

In [13]:

```
hybrid = Table.read_table('hybrid.csv').drop('year')
hybrid
```

Out[13]:

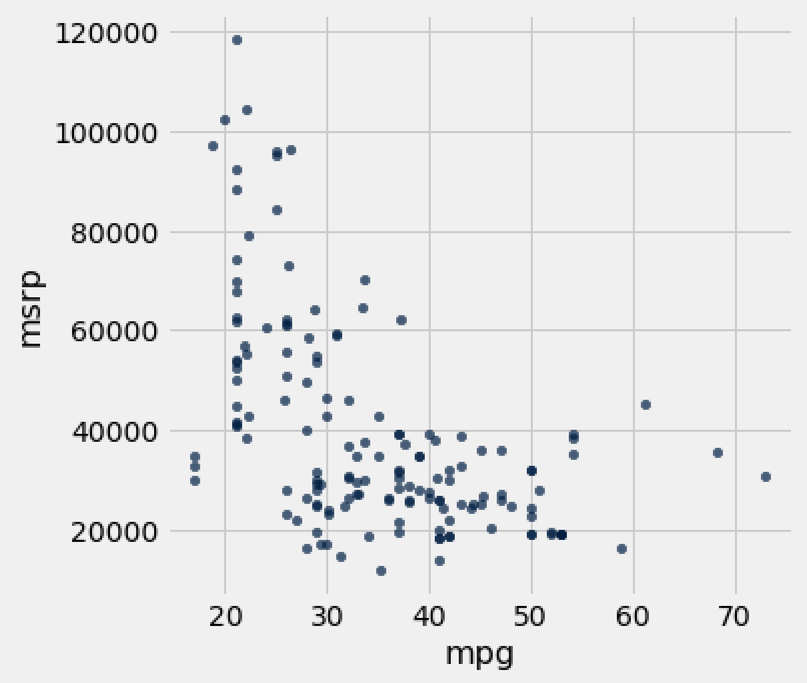
vehicle	msrp	acceleration	mpg	class
Prius (1st Gen)	24509.7	7.46	41.26	Compact
Tino	35355	8.2	54.1	Compact
Prius (2nd Gen)	26832.2	7.97	45.23	Compact
Insight	18936.4	9.52	53	Two Seater
Civic (1st Gen)	25833.4	7.04	47.04	Compact
Insight	19036.7	9.52	53	Two Seater

vehicle	msrp	acceleration	mpg	class
Insight	19137	9.71	53	Two Seater
Alphard	38084.8	8.33	40.46	Minivan
Insight	19137	9.52	53	Two Seater
Civic	14071.9	8.62	41	Compact

... (143 rows omitted)

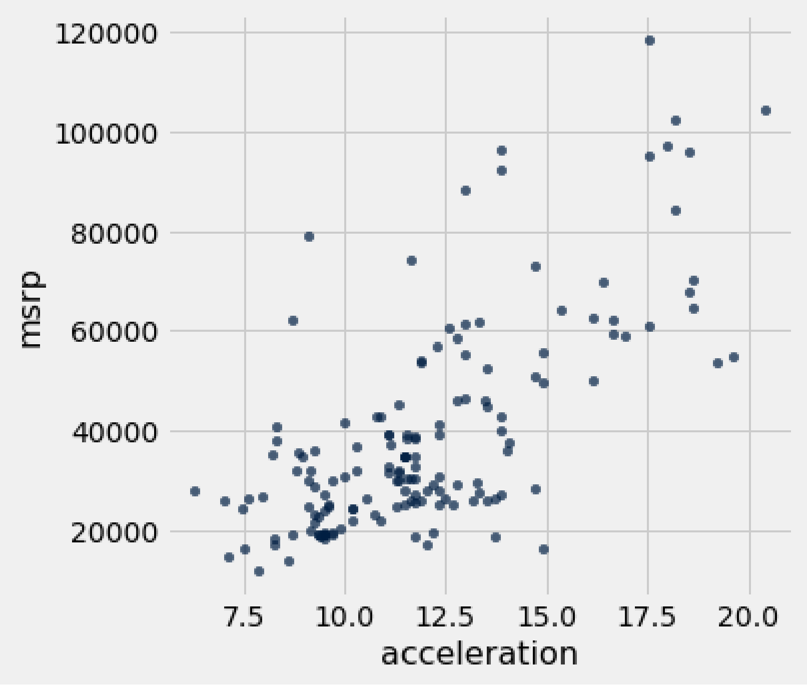
In [14]:

```
hybrid.scatter('mpg', 'msrp')
```



In [15]:

```
hybrid.scatter('acceleration', 'msrp')
```



In [16]:

```
suv = hybrid.where('class','SUV')
```

In [17]:

```
suv = suv.with_columns(
    'mpg (standard units)',  standard_units(suv.column('mpg')),
    'msrp (standard units)', standard_units(suv.column('msrp')),
    'acceleration (standard units)', standard_units(suv.column('acceleration')),
)
suv
```

Out[17]:

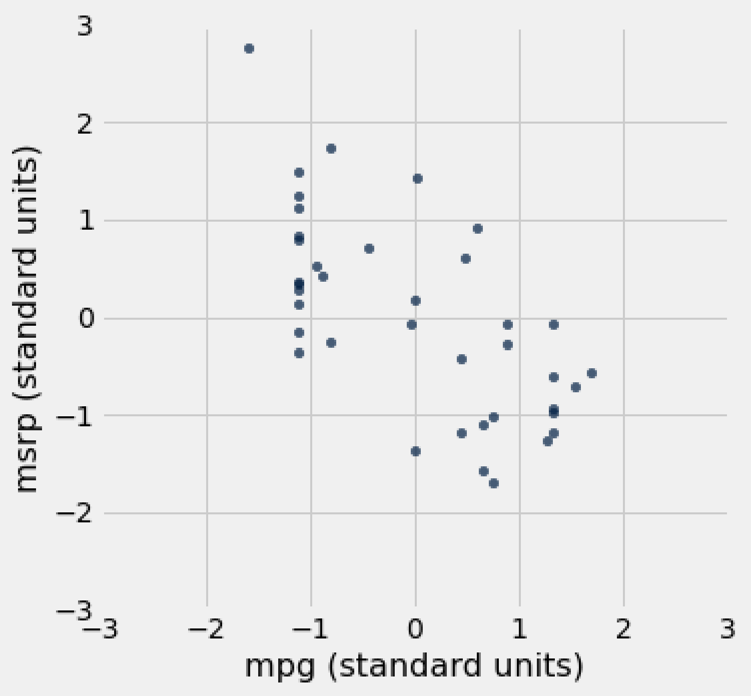
vehicle	msrp	acceleration	mpg	class	mpg (standard units)	msrp (standard units)	acceleration (standard units)
Escape	36676.1	10.32	31.99	SUV	1.31784	-0.60884	-1.16157
Lexus RX400h	58521.1	12.76	28.23	SUV	0.48955	0.605991	-0.0718039
Highlander	29186.2	12.76	29.4	SUV	0.747288	-1.02536	-0.0718039
Escape 2WD	19322.6	9.52	29	SUV	0.659172	-1.57389	-1.51888
Mercury Mariner	34772.4	8.98	32.93	SUV	1.52491	-0.714707	-1.76005
Chevrolet Tahoe	42924.3	10.91	22.35	SUV	-0.805749	-0.261367	-0.898064

vehicle	msrp	acceleration	mpg	class	mpg (standard units)	msrp (standard units)	acceleration (standard units)
Kluger	46229.5	12.76	25.87	SUV	-0.0303321	-0.0775641	-0.0718039
Tribute	24823.8	11.28	31.75	SUV	1.26497	-1.26796	-0.732812
GMC Yukon	57094.8	12.28	21.78	SUV	-0.931314	0.526671	-0.286185
Vue	22938.3	10.75	26	SUV	-0.00169453	-1.37281	-0.969524

... (29 rows omitted)

In [18]:

```
suv.scatter('mpg (standard units)', 'msrp (standard units)')
plots.xlim(-3, 3)
plots.ylim(-3, 3);
```



In [19]:

```
correlation(suv, 'mpg','msrp')
```

Out[19]:

```
-0.6667143635709919
```

In [20]:

```
correlation(suv, 'msrp','mpg')
```

Out[20]:

```
-0.6667143635709919
```

In [21]:

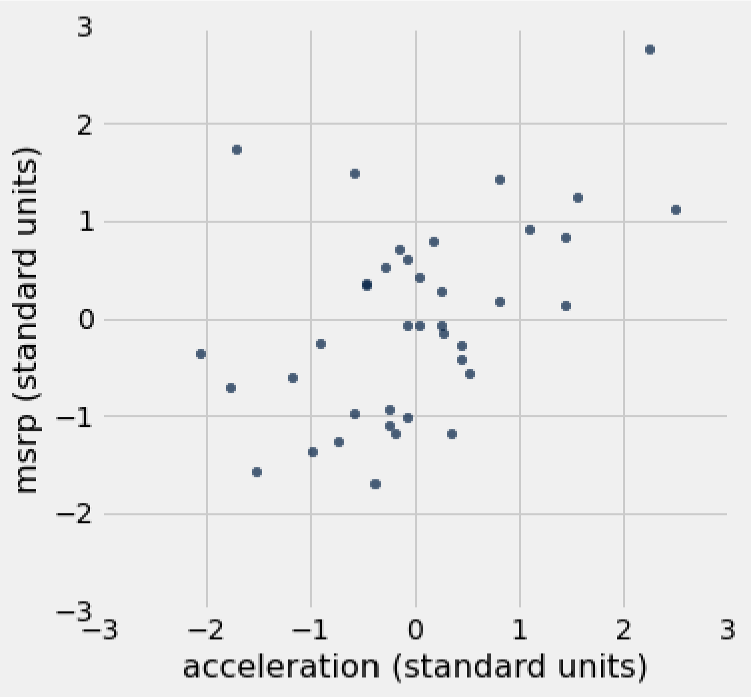
```
correlation(suv, 'mpg (standard units)', 'msrp (standard units)')
```

Out[21]:

```
-0.6667143635709918
```

In [22]:

```
suv.scatter('acceleration (standard units)', 'msrp (standard units)')
plots.xlim(-3, 3)
plots.ylim(-3, 3);
```



In [23]:

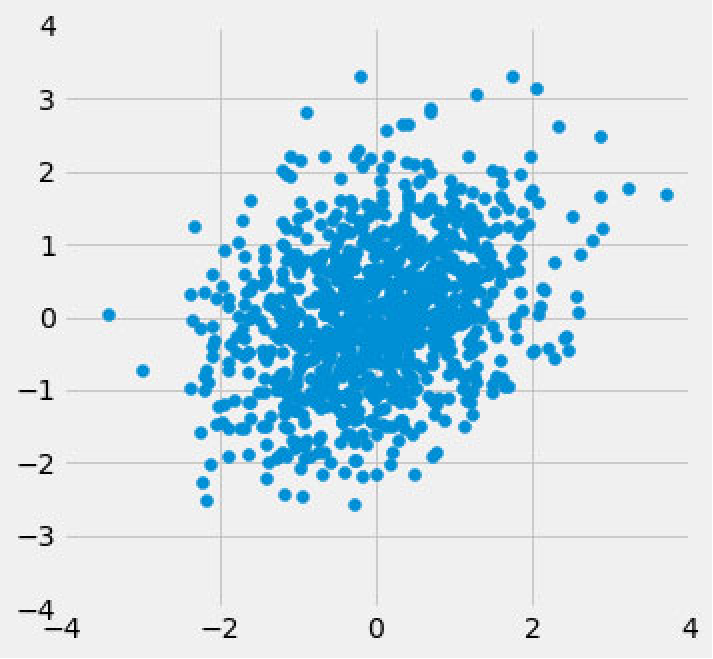
```
correlation(suv, 'acceleration','msrp')
```

Out[23]:

```
0.48699799279959155
```

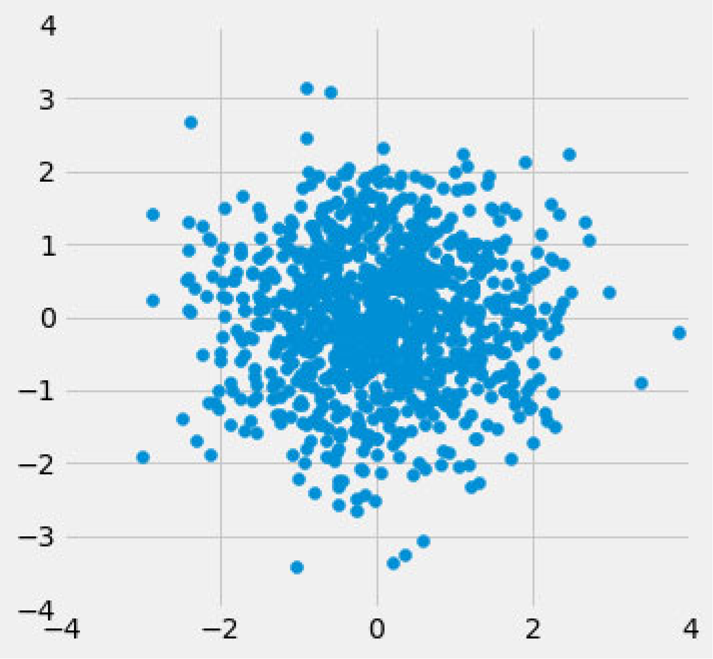
In [24]:

```
r_scatter(0.3)
```



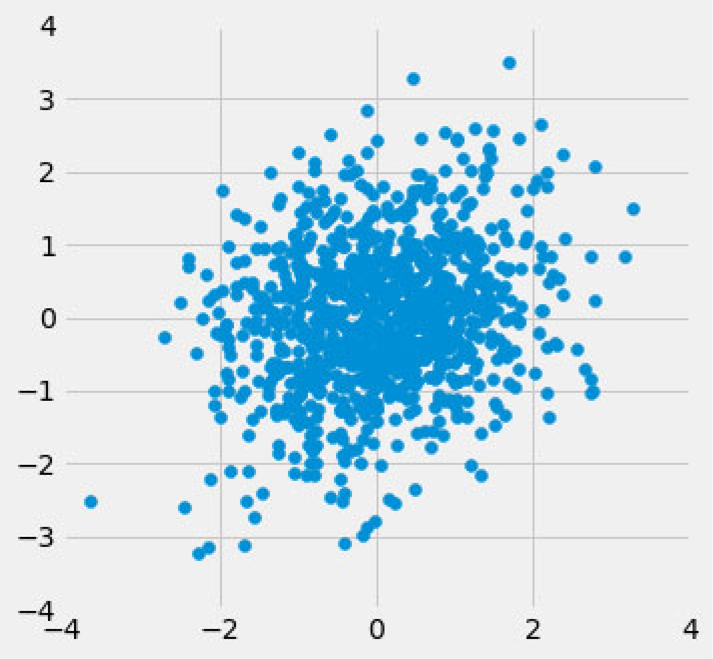
In [25]:

```
r_scatter(0)
```



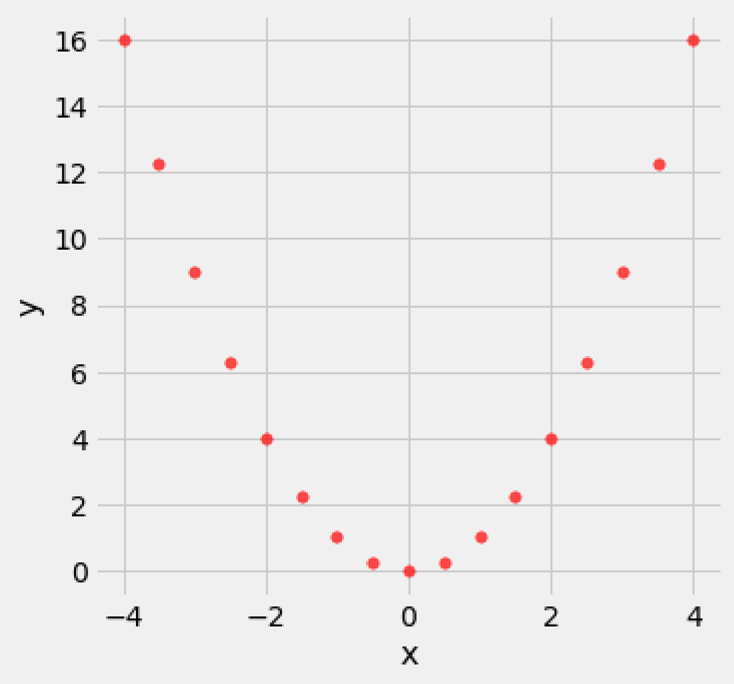
In [26]:

```
r_scatter(0.2)
```



In [27]:

```
new_x = np.arange(-4, 4.1, 0.5)
nonlinear = Table().with_columns(
        'x', new_x,
        'y', new_x**2
    )
nonlinear.scatter('x', 'y', s=30, color='r')
```



In [28]:

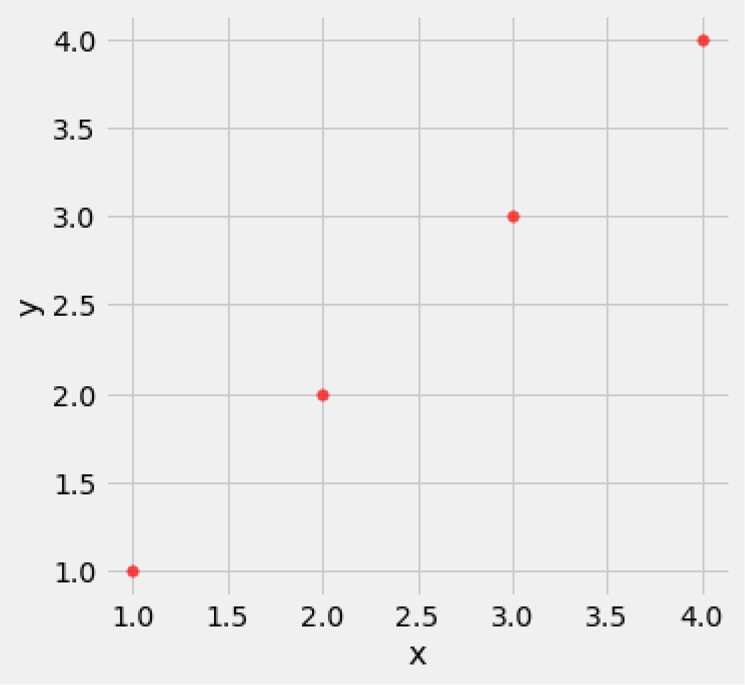
```
correlation(nonlinear, 'x', 'y')
```

Out[28]:

```
0.0
```

In [29]:

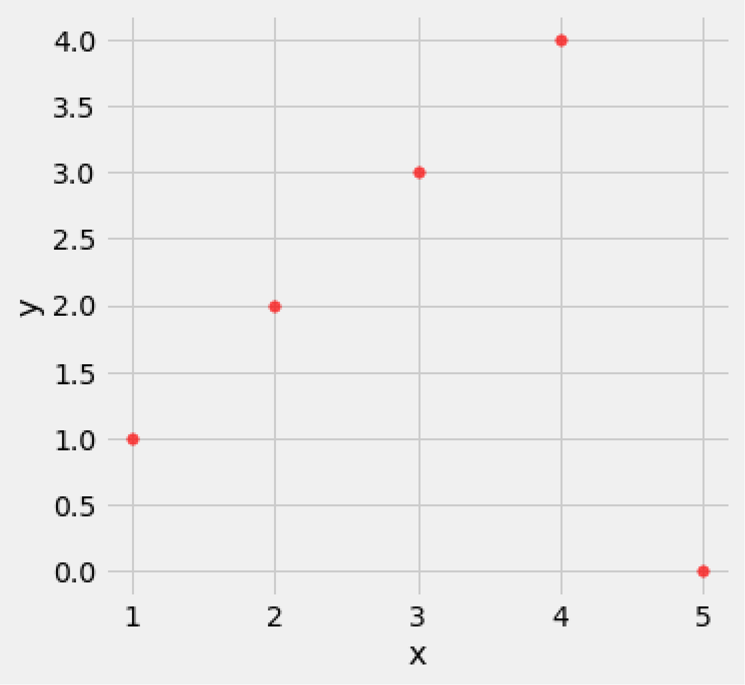
```
line = Table().with_columns(
        'x', make_array(1, 2, 3, 4),
        'y', make_array(1, 2, 3, 4)
    )
line.scatter('x', 'y', s=30, color='r')
```



In [30]:
```
correlation(line, 'x', 'y')
```

Out[30]:
```
1.0
```

In [31]:
```
outlier = Table().with_columns(
        'x', make_array(1, 2, 3, 4, 5),
        'y', make_array(1, 2, 3, 4, 0)
    )
outlier.scatter('x', 'y', s=30, color='r')
```



In [32]:

```
correlation(outlier, 'x', 'y')
```

Out[32]:

```
0.0
```

In [33]:

```
sat2014 = Table.read_table('sat2014.csv').sort('State').drop('Participation Rate', 'Writing','Combined')
sat2014
```

Out[33]:

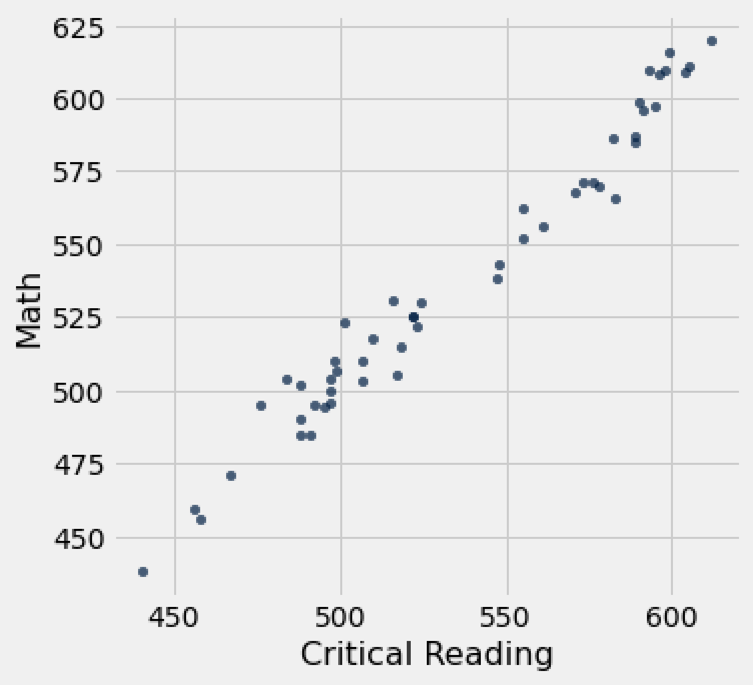
State	Critical Reading	Math
Alabama	547	538
Alaska	507	503
Arizona	522	525
Arkansas	573	571
California	498	510
Colorado	582	586
Connecticut	507	510

State	Critical Reading	Math
Delaware	456	459
District of Columbia	440	438
Florida	491	485

... (41 rows omitted)

In [34]:

```
sat2014.scatter('Critical Reading', 'Math')
```



In [35]:

```
correlation(sat2014, 'Critical Reading', 'Math')
```

Out[35]:

```
0.9847558411067434
```

In [ ]: