mileage

May 16, 2016

```
In [29]: data = graphlab.SFrame('auto-mpg.csv')
         data
```

```
Finished parsing file /Users/adityajp/Desktop/ML course/Mileage project/auto-mpg.csv


Parsing completed. Parsed 100 lines in 0.01403 secs.


Finished parsing file /Users/adityajp/Desktop/ML course/Mileage project/auto-mpg.csv


Parsing completed. Parsed 392 lines in 0.014766 secs.


------------------------------------------------------
Inferred types from first 100 line(s) of file as
column_type_hints=[int,int,float,int,int,float,int,int,str]
If parsing fails due to incorrect types, you can correct
the inferred type list above and pass it to read_csv in
the column_type_hints argument
------------------------------------------------------
```

```
Out[29]: Columns:
                 mpg        int
                 cylinders        int
                 displacement        float
                 hp        int
                 weight        int
                 acceleration        float
                 model year        int
                 origin        int
                 name        str

         Rows: 392

         Data:
         +-----+-----------+--------------+-----+--------+--------------+------------+--------+
         | mpg | cylinders | displacement |  hp | weight | acceleration | model year | origin |
         +-----+-----------+--------------+-----+--------+--------------+------------+--------+
         |  18 |     8     |    307.0     | 130 |  3504  |     12.0     |     70     |   1    |
         |  15 |     8     |    350.0     | 165 |  3693  |     11.5     |     70     |   1    |
         |  18 |     8     |    318.0     | 150 |  3436  |     11.0     |     70     |   1    |
         |  16 |     8     |    304.0     | 150 |  3433  |     12.0     |     70     |   1    |
         |  17 |     8     |    302.0     | 140 |  3449  |     10.5     |     70     |   1    |
```

```
|  15 |     8     |     429.0     | 198 |  4341  |     10.0     |     70     |   1    |
|  14 |     8     |     454.0     | 220 |  4354  |     9.0      |     70     |   1    |
|  14 |     8     |     440.0     | 215 |  4312  |     8.5      |     70     |   1    |
|  14 |     8     |     455.0     | 225 |  4425  |     10.0     |     70     |   1    |
|  15 |     8     |     390.0     | 190 |  3850  |     8.5      |     70     |   1    |
+-----+-----------+---------------+-----+--------+--------------+------------+--------+
+-----------------------------+
|             name            |
+-----------------------------+
| "chevrolet chevelle malibu" |
|     "buick skylark 320"     |
|     "plymouth satellite"    |
|       "amc rebel sst"       |
|        "ford torino"        |
|      "ford galaxie 500"     |
|      "chevrolet impala"     |
|     "plymouth fury iii"     |
|      "pontiac catalina"     |
|     "amc ambassador dpl"    |
+-----------------------------+
[392 rows x 9 columns]
Note: Only the head of the SFrame is printed.
You can use print_rows(num_rows=m, num_columns=n) to print more rows and columns.
```

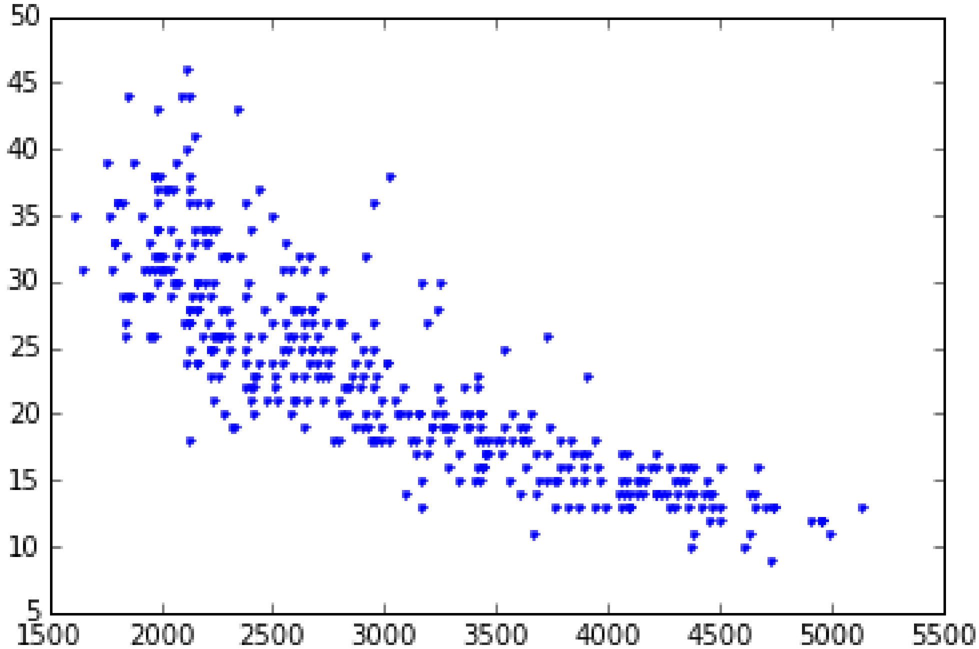
In [2]:
```python
import graphlab
```

In [128]:
```python
def polynomial_sframe(feature, degree, quantity):
    # assume that degree >= 1
    # initialize the SFrame:
    poly_sframe = graphlab.SFrame()
    # and set poly_sframe['power_1'] equal to the passed feature
    poly_sframe[quantity+'power_1'] = feature
    # first check if degree > 1
    if degree > 1:
        # then loop over the remaining degrees:
        # range usually starts at 0 and stops at the endpoint-1. We want it to start at 2 and
        for power in range(2, degree+1):
            # first we'll give the column a name:
            name = quantity +'power_' + str(power)
            # then assign poly_sframe[name] to the appropriate power of feature
            poly_sframe[name] = feature**power

    return poly_sframe
```

In [31]:
```python
import matplotlib.pyplot as plt
%matplotlib inline
```

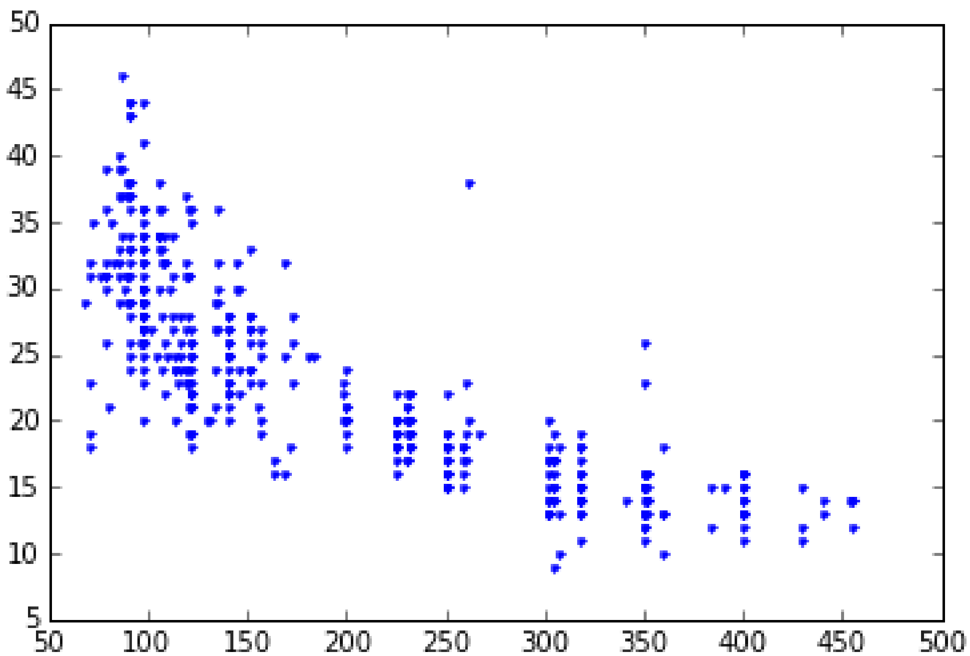
In [32]:
```python
plt.plot(data['weight'],data['mpg'],'.')
#Relation between weight and mpg - Strong correlation
```

Out[32]:
```
[<matplotlib.lines.Line2D at 0x117723690>]
```



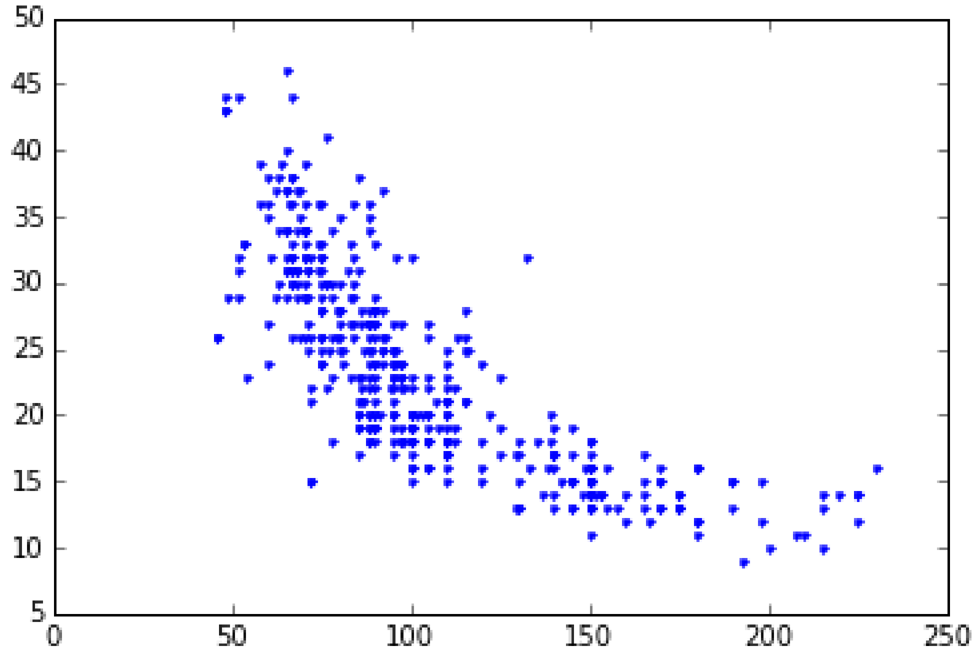

```
In [33]: plt.plot(data['displacement'],data['mpg'],'.')
         #Relation between displacement and mpg - Time series like correlation
```

```
Out[33]: [<matplotlib.lines.Line2D at 0x118681910>]
```



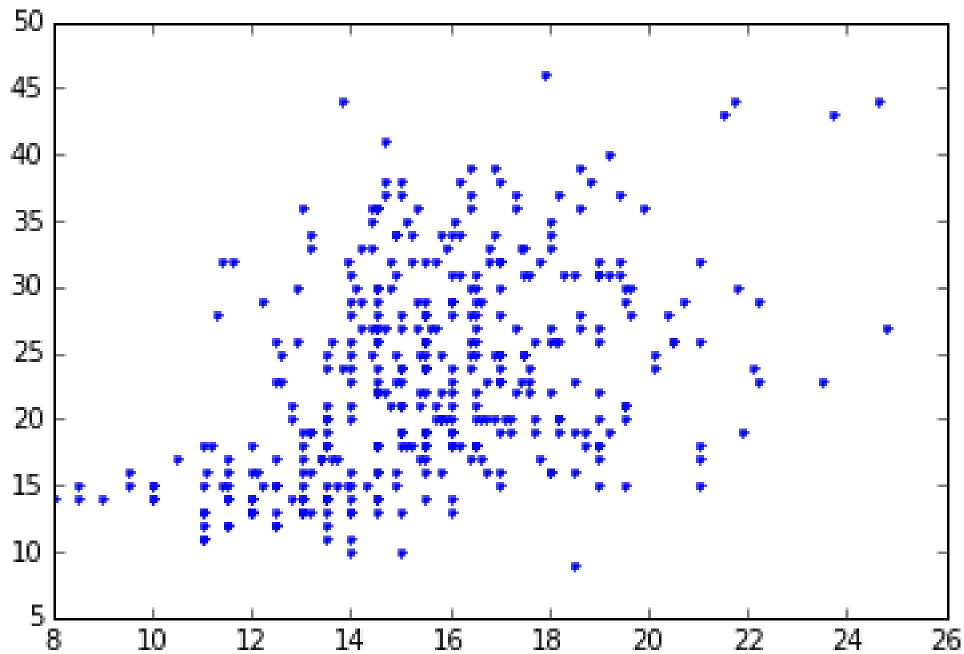
```
In [34]: plt.plot(data['hp'],data['mpg'],'.')
         #Relation between hp and mpg - Somewhat of a correlation
```

```
Out[34]: [<matplotlib.lines.Line2D at 0x118953650>]
```



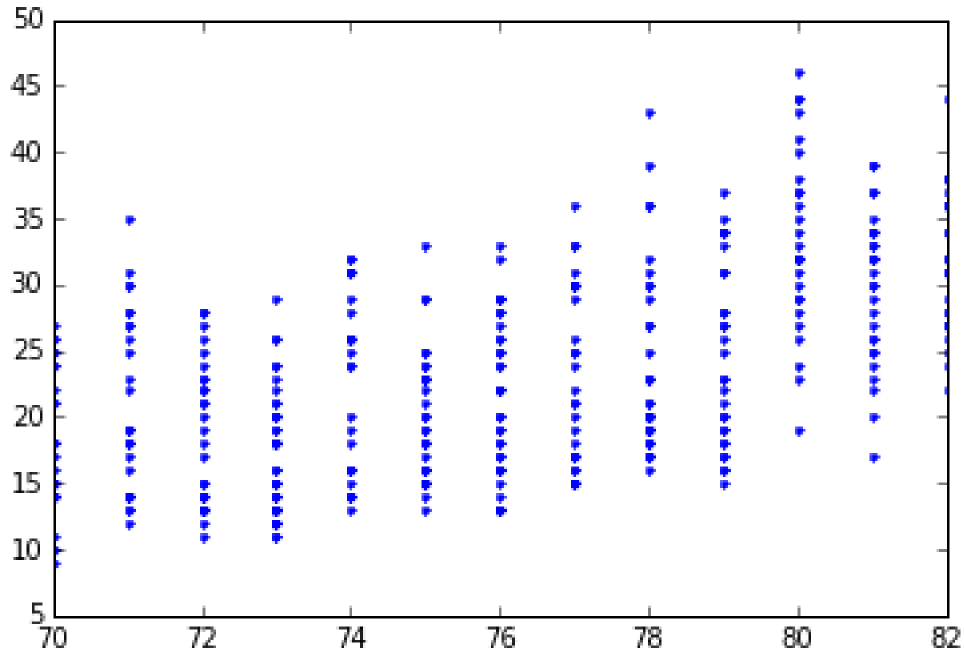

```
In [38]: plt.plot(data['acceleration'],data['mpg'],'.')
         #Relation between acceleration and mpg - weak correlation
```

```
Out[38]: [<matplotlib.lines.Line2D at 0x118f04b90>]
```



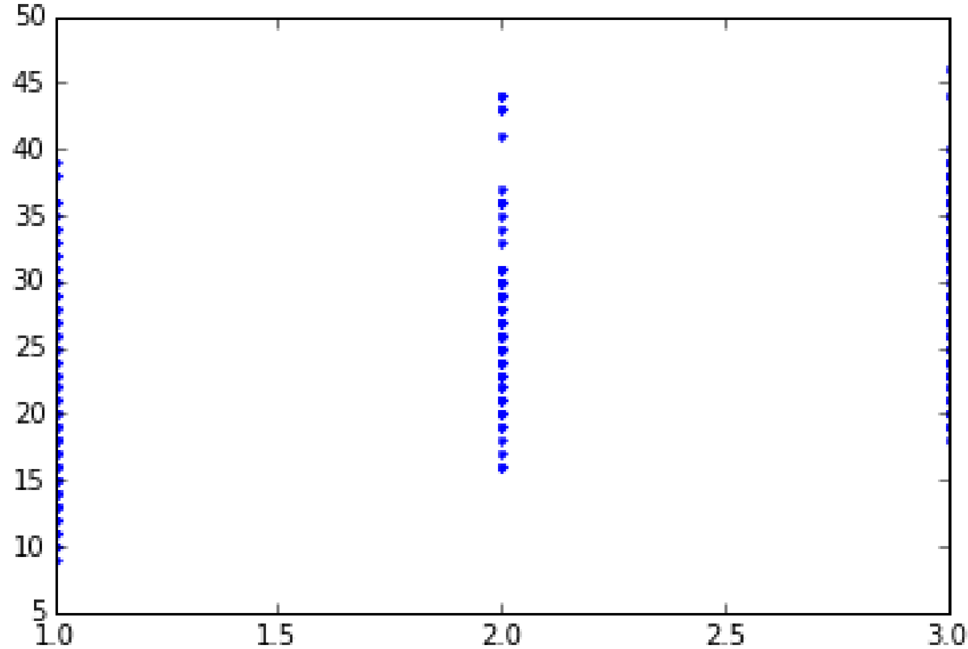
In [40]:
```
plt.plot(data['model year'],data['mpg'],'.')
#Relation between model year and mpg - Weak correlation
```

Out[40]: [<matplotlib.lines.Line2D at 0x11914ce90>]

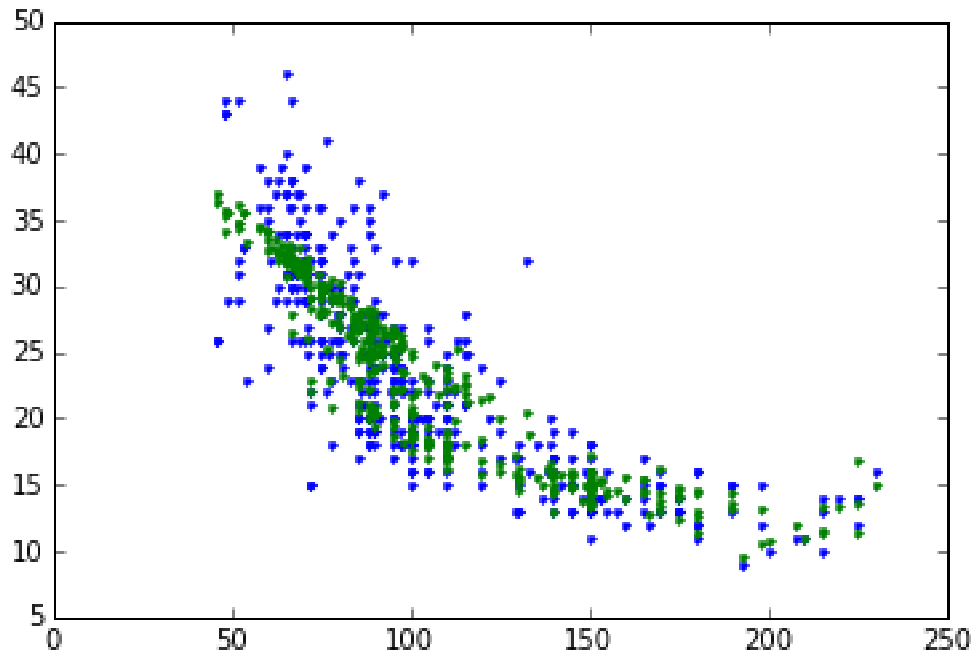


In [43]:
```
plt.plot(data['origin'],data['mpg'],'.')
#Relation between origin and mpg - No correlation. Discard this information.
```

Out[43]: [<matplotlib.lines.Line2D at 0x1199d6a10>]

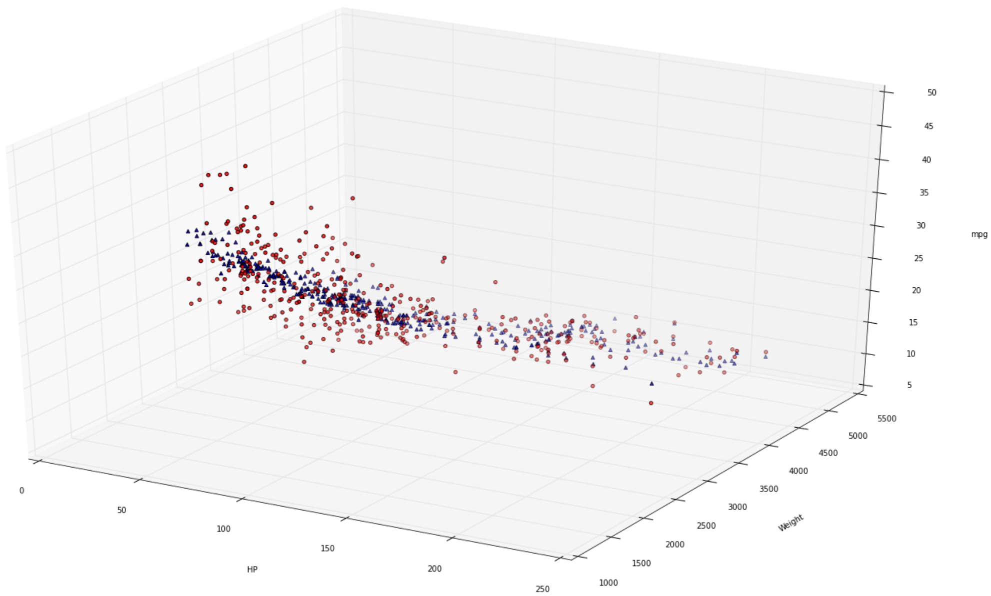


```
In [105]: (training_and_validation, testing) = data.random_split(0.9,seed=0)
          (training, validation) = data.random_split(0.5,seed=0)

In [180]: #Data to use weight, displacement, hp, acceleration.
          poly_data = polynomial_sframe(data['hp'],15,"hp")
          poly_data_weight = polynomial_sframe(data['weight'],15,"weight")
          poly_data_disp = polynomial_sframe(data['displacement'],15,"displacement")
          poly_data.add_columns(poly_data_weight)
          poly_data.add_columns(poly_data_disp)
          my_features = poly_data.column_names()
          poly_data['mpg'] = data['mpg']
          model = graphlab.linear_regression.create(poly_data, target = 'mpg', features = my_features, v

In [181]: plt.plot(poly_data['hppower_1'],poly_data['mpg'],'.',
                  poly_data['hppower_1'], model.predict(poly_data),'.')

Out[181]: [<matplotlib.lines.Line2D at 0x1206fdf90>,
           <matplotlib.lines.Line2D at 0x120738250>]
```



In [177]:
```
from matplotlib import pyplot
import pylab
from mpl_toolkits.mplot3d import Axes3D
import random
import numpy as np

fig = pylab.figure()
fig.set_size_inches(25.5, 14.5)

ax = fig.add_subplot(110, projection='3d')


hp = np.array(poly_data['hppower_1'])
weight = np.array(poly_data['weightpower_1'])
mpg = np.array(poly_data['mpg'])
x_vals = hp
y_vals = weight
z_vals = mpg

pred_x_vals = hp
pred_y_vals = weight
pred_z_vals = model.predict(poly_data)
#random.shuffle(sequence_containing_x_vals)
#random.shuffle(sequence_containing_y_vals)
#random.shuffle(sequence_containing_z_vals)

ax.scatter(x_vals, y_vals,z_vals,c='r', marker='o')
ax.scatter(pred_x_vals, pred_y_vals, pred_z_vals,c='b', marker='^')
ax.set_xlabel('HP')
```

```
ax.set_ylabel('Weight')
ax.set_zlabel('mpg')
pyplot.show()
fig.savefig('test2png.png', dpi=100)
```




```
In [287]: rss_list = []

          #going to consider polynomial upto the power of 15
          for i in range(1,16):

              #Gathering necessary data from the training set
              poly_data = polynomial_sframe(training['hp'],i,"hp")
              poly_data.add_columns(polynomial_sframe(training['weight'],i,"weight"))
              poly_data.add_columns(polynomial_sframe(training['displacement'],i,"displacement"))
              poly_data.add_columns(polynomial_sframe(training['acceleration'],i,"acceleration"))
              #column_names
              my_features = poly_data.column_names()

              poly_data['mpg'] = training['mpg']

              #Creating a regression model
              model = graphlab.linear_regression.create(poly_data, target = 'mpg', features = my_featur

              #Getting necessary data from the validation set
              validation_data = polynomial_sframe(validation['hp'],i,"hp")
              validation_data.add_columns(polynomial_sframe(validation['weight'],i,"weight"))
              validation_data.add_columns(polynomial_sframe(validation['displacement'],i,"displacement"
              validation_data.add_columns(polynomial_sframe(validation['acceleration'],i,"acceleration"

              #Predicted mpg
```

```
        prediction = model.predict(validation_data)

        #Computing the RSS (Residual sum of squares)
        difference = validation['mpg'] - prediction
        difference = difference ** 2 #Squaring all elements in the SFrame

        difference = np.array(difference)
        rss = np.sum(difference)

        rss_list.append((rss,i)) #Append degree of the polynomial and RSS (Used for sorting later

    sorted_rss = sorted(rss_list, key=lambda tup: tup[0])
    degree = sorted_rss[0][1]

    for i in sorted_rss:
        print i
    #RSS is least for polynomial of degree 7 and highest for polynomial of degree 1 and RSS of de
```

```
(3221.5765214009725, 3)
(3226.0471238434775, 2)
(3306.1360244889956, 4)
(3345.6813203488928, 5)
(3403.116566599871, 6)
(3627.8744744869477, 7)
(3822.5616595836882, 1)
(4025.5880719590386, 8)
(4540.5537163976205, 9)
(5148.9033698786106, 10)
(5842.5112581298999, 11)
(6601.1162841234327, 12)
(7389.8261699294908, 13)
(8172.6708302590287, 14)
(8922.7567327277957, 15)
```

In [288]:
```
#Gathering testing data into an SFrame
def prediction(testing, model):
    testing_data = polynomial_sframe(testing['hp'],degree,"hp")
    testing_data.add_columns(polynomial_sframe(testing['weight'],degree,"weight"))
    testing_data.add_columns(polynomial_sframe(testing['displacement'],degree,"displacement")
    testing_data.add_columns(polynomial_sframe(testing['acceleration'],degree,"acceleration")
    #Prediction step
    testing_prediction = model.predict(testing_data)

    return (testing_prediction)


#Computing the RSS (Residual sum of squares)
predicted['mpg'] = testing['mpg']
predicted['predicted_results'] = prediction(testing,model)

difference = testing['mpg'] - predicted['predicted_results']
predicted['difference'] = difference
difference = difference ** 2 #Squaring all elements in the SFrame

difference = np.array(difference)
```

```
rss = np.sum(difference)

print rss
```

```
5631.4898989
```

```
In [285]: #predicted['mpg','predicted','difference'].print_rows(100,100)
          print predicted
```

```
+-----+----------------+-------------------+----------------+----------------+
| mpg |   predicted    | predicted_results |   differnce    |   difference   |
+-----+----------------+-------------------+----------------+----------------+
|  15 | -24.5863221627 |    41.936200147   | -26.936200147  | -26.936200147  |
|  22 | 27.7579668808  |   17.6166743233   | 4.38332567671  | 4.38332567671  |
|  28 | 35.9924972688  |   21.9232293157   | 6.07677068425  | 6.07677068425  |
|  24 | 35.6695108685  |   21.5328612405   | 2.46713875948  | 2.46713875948  |
|  13 | -6.2817479709  |   26.3984305342   | -13.3984305342 | -13.3984305342 |
|  13 | 0.156837826423 |   22.8234156944   | -9.82341569445 | -9.82341569445 |
|  14 | 0.121701026037 |   21.5109049503   | -7.51090495033 | -7.51090495033 |
|  22 | 35.6418542922  |    21.117153017   | 0.882846982955 | 0.882846982955 |
|  20 | 26.4984432094  |   17.5812026779   | 2.41879732208  | 2.41879732208  |
|  29 | 38.8228638577  |    23.155953446   | 5.84404655405  | 5.84404655405  |
+-----+----------------+-------------------+----------------+----------------+
[37 rows x 5 columns]
Note: Only the head of the SFrame is printed.
You can use print_rows(num_rows=m, num_columns=n) to print more rows and columns.
```

```
In [ ]:
```