4-FINAL

October 9, 2018

1 Instructions

The following Cells need to be executed.

They are used to download and generate a dataset that has an aggregated count of bike trips per hundredth of an hour through the 24 hours in a day.

I put all this here instead of providing you the dataset directly, so that you could learn something along the way :)

The assignment is in the last cell.

```
In [25]: !pip3 install seaborn
```

```
Collecting seaborn
  Downloading seaborn-0.7.1.tar.gz (158kB)
    100% || 163kB 1.8MB/s ta 0:00:01
Building wheels for collected packages: seaborn
  Running setup.py bdist_wheel for seaborn ... done
  Stored in directory: /Users/mahmoud/Library/Caches/pip/wheels/cb/c8/67/83d615c0ef9b529558525a
Successfully built seaborn
Installing collected packages: seaborn
Successfully installed seaborn-0.7.1
```

1.1 This cell automatically downloads Capital Bikeshare data

```
In [9]: import sys
        sys.path.append('..')
        from utils.bikeshare import download_bikeshare_data

        download_bikeshare_data(2016, 1, '../data/')
```

```
Downloading: 2016 Q1 | Extracting... | Created: ../data/2016-Q1-cabi-trip-history-data.csv
```

1.1.1 And here we read in the data

```
In [4]: import seaborn as sns
        import matplotlib.pyplot as plt
        %matplotlib inline
```

```
import pandas as pd
bikes = pd.read_csv('../data/2016Q1-capitalbikeshare-tripdata.csv')
bikes.head()
bikes['start'] = pd.to_datetime(bikes['Start date'], infer_datetime_format=True)
bikes['end'] = pd.to_datetime(bikes['End date'], infer_datetime_format=True)

bikes.head()
```

```
Out[4]:    Duration           Start date             End date  Start station number  \
        0       166  2016-01-01 00:06:58  2016-01-01 00:09:44                 31102
        1       448  2016-01-01 00:10:20  2016-01-01 00:17:48                 32039
        2       715  2016-01-01 00:13:52  2016-01-01 00:25:48                 31222
        3       213  2016-01-01 00:15:29  2016-01-01 00:19:03                 31506
        4       872  2016-01-01 00:16:16  2016-01-01 00:30:49                 31041

                           Start station  End station number  \
        0            11th & Kenyon St NW               31105
        1  Old Georgetown Rd & Southwick St            32002
        2         New York Ave & 15th St NW            31214
        3         1st & Rhode Island Ave NW            31509
        4              Prince St & Union St            31048

                        End station Bike number Member type                start  \
        0         14th & Harvard St NW      W01346      Member 2016-01-01 00:06:58
        1  Bethesda Ave & Arlington Rd      W22202      Member 2016-01-01 00:10:20
        2        17th & Corcoran St NW      W21427      Member 2016-01-01 00:13:52
        3      New Jersey Ave & R St NW      W01294      Member 2016-01-01 00:15:29
        4          King St Metro South      W22058      Member 2016-01-01 00:16:16

                          end
        0 2016-01-01 00:09:44
        1 2016-01-01 00:17:48
        2 2016-01-01 00:25:48
        3 2016-01-01 00:19:03
        4 2016-01-01 00:30:49
```

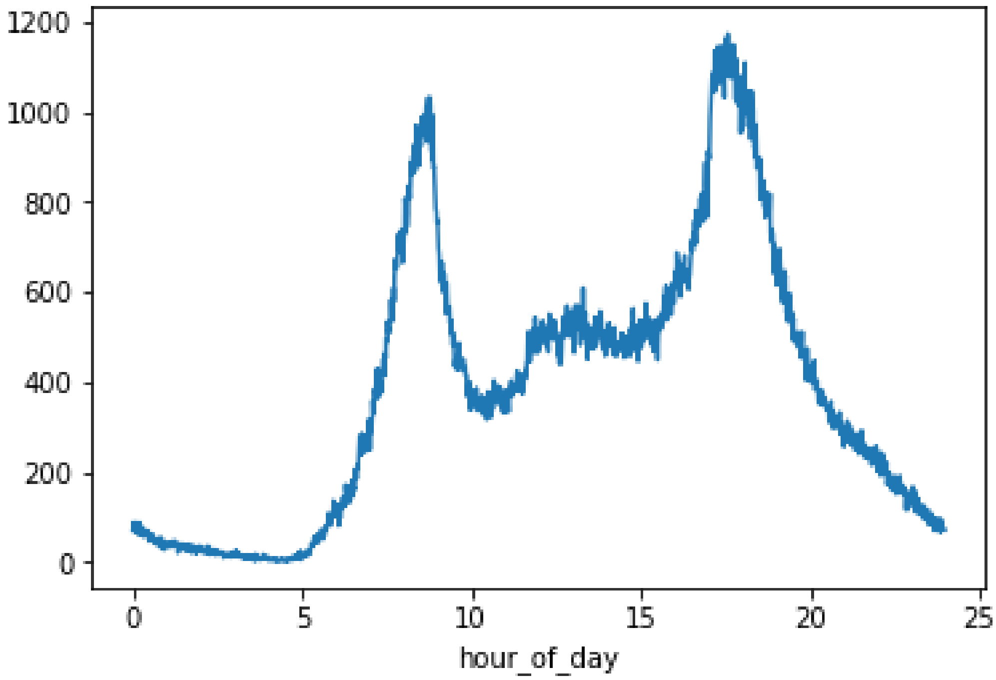
1.1.2 Create a new column that represents the hour of the day

```
In [5]: bikes['hour_of_day'] = (bikes.start.dt.hour + (bikes.start.dt.minute/60).round(2))
```

1.1.3 Aggregate to get a count per hour/minute of the day across all trips

```
In [6]: hours = bikes.groupby('hour_of_day').agg('count')
        hours['hour'] = hours.index

        hours.start.plot()
        # import seaborn as sns

        # sns.lmplot(x='hour', y='start', data=hours, aspect=1.5, scatter_kws={'alpha':0.2})
```

Out[6]: <matplotlib.axes._subplots.AxesSubplot at 0x27b0f91c208>



2 Assignment 4

Using the **hours** dataframe and the hour_of_day column, perform the following cells.
Explain the results in a **paragraph + charts** of to describe which model you'd recommend

2.1 1. Create 3 models fit to hour_of_day with varying polynomial degrees

In [7]:
```
import numpy as np
import matplotlib.pylab as plt
%matplotlib inline
from sklearn import linear_model
```

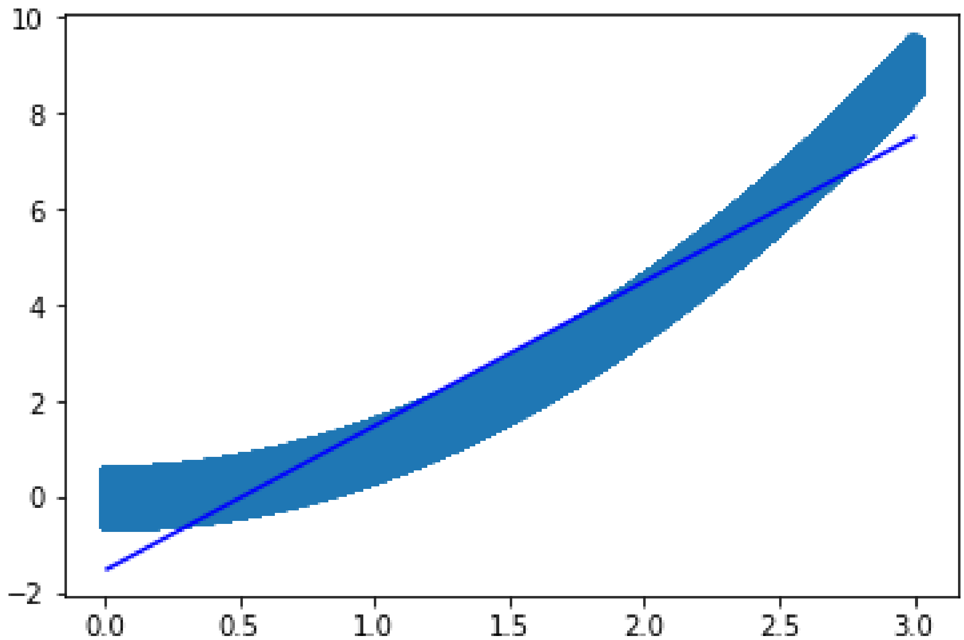
In [15]:
```
hours
hours.head()
```

Out[15]:
```
             Duration  Start date  End date  Start station number  \
hour_of_day
0.00               71          71        71                    71
0.02               88          88        88                    88
0.03               74          74        74                    74
0.05               77          77        77                    77
0.07               66          66        66                    66
```

```
             Start station  End station number  End station  Bike number  \
hour_of_day
0.00                    71                  71           71           71
0.02                    88                  88           88           88
0.03                    74                  74           74           74
0.05                    77                  77           77           77
0.07                    66                  66           66           66

             Member type  start  end  hour
hour_of_day
0.00                  71     71   71  0.00
0.02                  88     88   88  0.02
0.03                  74     74   74  0.03
0.05                  77     77   77  0.05
0.07                  66     66   66  0.07
```

In [19]:
```
n = 552400
x = np.linspace(0.01, 3, n).reshape(-1, 1)
y = np.linspace(0.01, 3, n) * np.linspace(0.01, 3, n) + np.random.rand(n) - .5


plt.scatter(x,y)
plt.plot(x, x*linear.coef_ + linear.intercept_, c='b')
```

Out[19]: [<matplotlib.lines.Line2D at 0x27b0fafe9b0>]

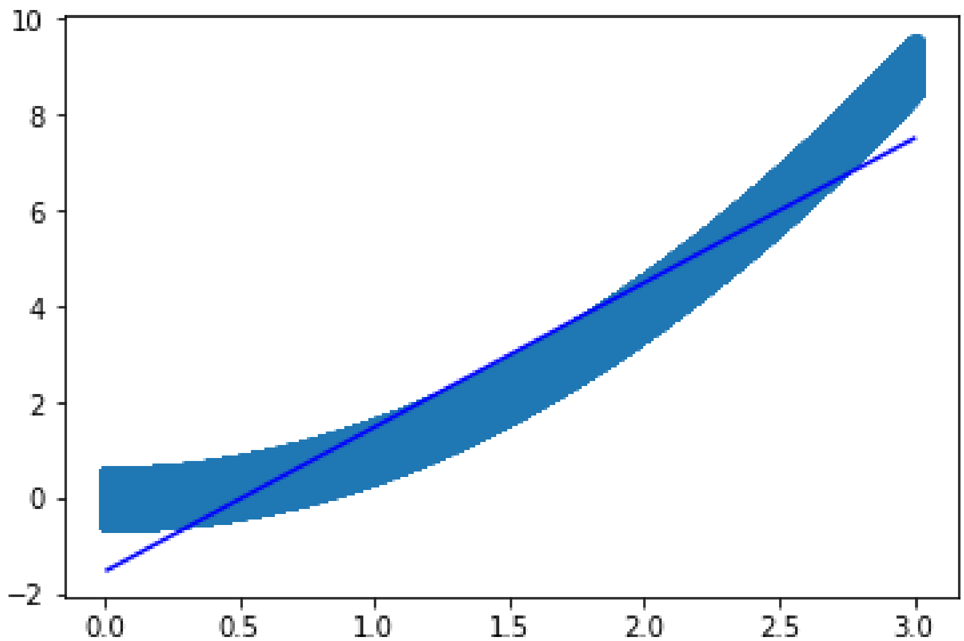


```
In [17]: linear = linear_model.LinearRegression()

         linear.fit(x, y)

         linear.coef_, linear.intercept_
```

```
Out[17]: (array([3.00979324]), -1.5202046888365257)
```

```
In [18]: plt.scatter(x,y)
         plt.plot(x, x*linear.coef_ + linear.intercept_, c='b')
```

```
Out[18]: [<matplotlib.lines.Line2D at 0x27b0fb5d3c8>]
```




```
In [21]: from sklearn.preprocessing import PolynomialFeatures

         poly = PolynomialFeatures(degree=15)

         x_15= poly.fit_transform(x.reshape(-1, 1))
```

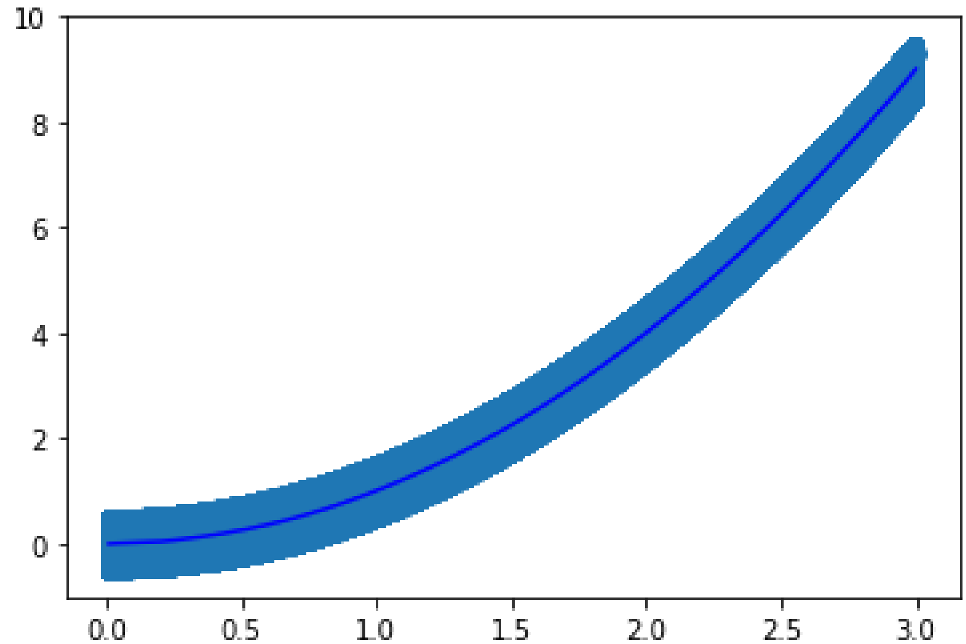
```
In [22]: linear = linear_model.LinearRegression()

         linear.fit(x_15, y)

         (linear.coef_, linear.intercept_)
```

```
Out[22]: (array([ 0.00000000e+00,  6.65557172e-01, -9.74062628e+00,  7.81070563e+01,
                 -3.18460897e+02,  8.23299881e+02, -1.45031105e+03,  1.81566889e+03,
```

```
         -1.65301894e+03,  1.10494527e+03, -5.41441591e+02,  1.91966499e+02,
         -4.78655265e+01,  7.95204148e+00, -7.89550837e-01,  3.54187776e-02]),
 -0.012000741002065940)
```

```
In [23]: plt.scatter(x,y)
         plt.plot(x, np.dot(x_15, linear.coef_) + linear.intercept_, c='b')
```

```
Out[23]: [<matplotlib.lines.Line2D at 0x27b10a8a6d8>]
```



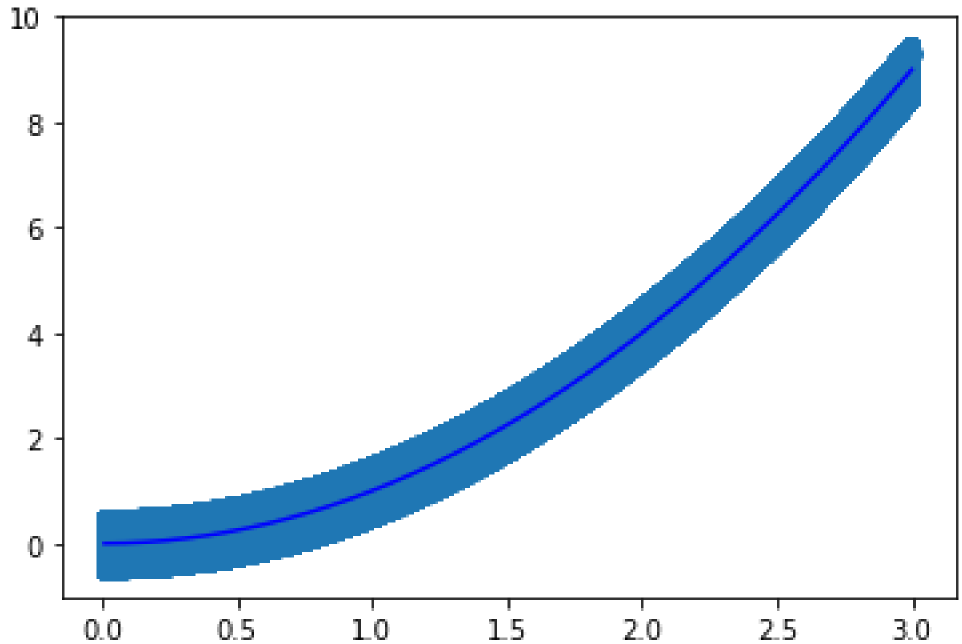

```
In [24]: from sklearn.preprocessing import PolynomialFeatures

         poly = PolynomialFeatures(degree=2)

         x_2= poly.fit_transform(x.reshape(-1, 1))
```

```
In [25]: linear = linear_model.LinearRegression()

         linear.fit(x_2, y)

         (linear.coef_, linear.intercept_)
```

```
Out[25]: (array([ 0.00000000e+00, -2.80547562e-04,  1.00001556e+00]),
          0.0002031101826003301)
```

```
In [26]: plt.scatter(x,y)
         plt.plot(x, np.dot(x_2, linear.coef_) + linear.intercept_, c='b')
```

Out[26]: [<matplotlib.lines.Line2D at 0x27b10a73f28>]



2.2 2. Choose one of the polynomial models and create 3 new models fit to `hour_of_day` with different Ridge Regression α (alpha) Ridge Coefficient values

In [28]:
```
from sklearn.preprocessing import PolynomialFeatures

poly = PolynomialFeatures(degree=2)

x_2= poly.fit_transform(x.reshape(-1, 1))
```

In [29]:
```
linear = linear_model.LinearRegression()

linear.fit(x_2, y)

(linear.coef_, linear.intercept_)
```

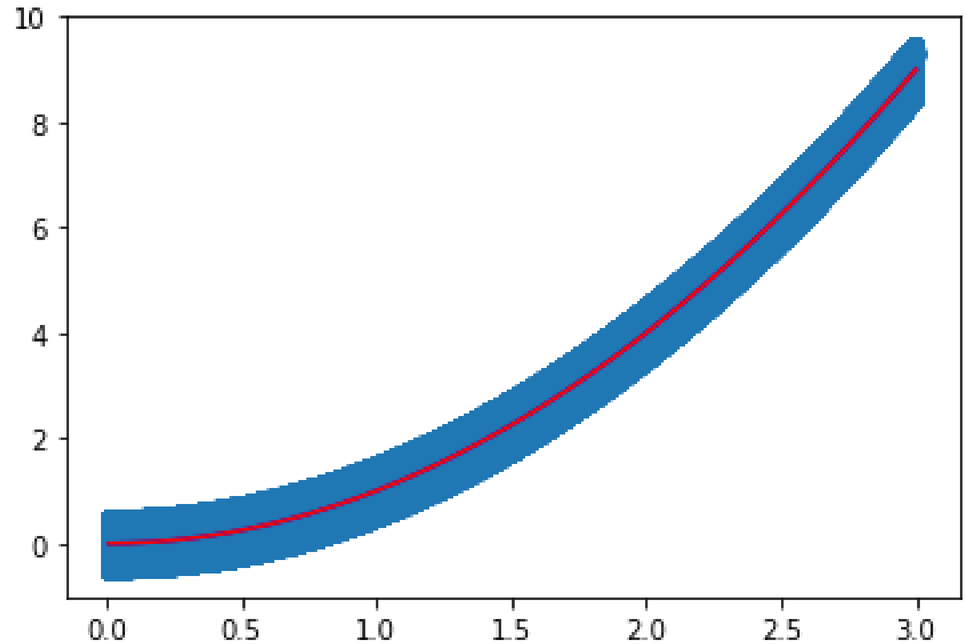
Out[29]:
```
(array([ 0.00000000e+00, -2.80547562e-04,  1.00001556e+00]),
 0.0002031101826003301)
```

In [30]:
```
ridge = linear_model.Ridge()

ridge.fit(x_2, y)

(ridge.coef_, ridge.intercept_)
```

```
Out[30]: (array([ 0.00000000e+00, -2.68265367e-04,  1.00001148e+00]),
          0.00019690716894382732)
```

```
In [31]: plt.scatter(x,y)
         plt.plot(x, np.dot(x_2, linear.coef_) + linear.intercept_, c='b')
         plt.plot(x, np.dot(x_2, ridge.coef_) + ridge.intercept_, c='r')
```

```
Out[31]: [<matplotlib.lines.Line2D at 0x27b21c3de48>]
```




```
In [33]: from sklearn.preprocessing import PolynomialFeatures

         poly = PolynomialFeatures(degree=10)

         x_10= poly.fit_transform(x.reshape(-1, 1))
```

```
In [34]: linear = linear_model.LinearRegression()

         linear.fit(x_10, y)

         (linear.coef_, linear.intercept_)
```

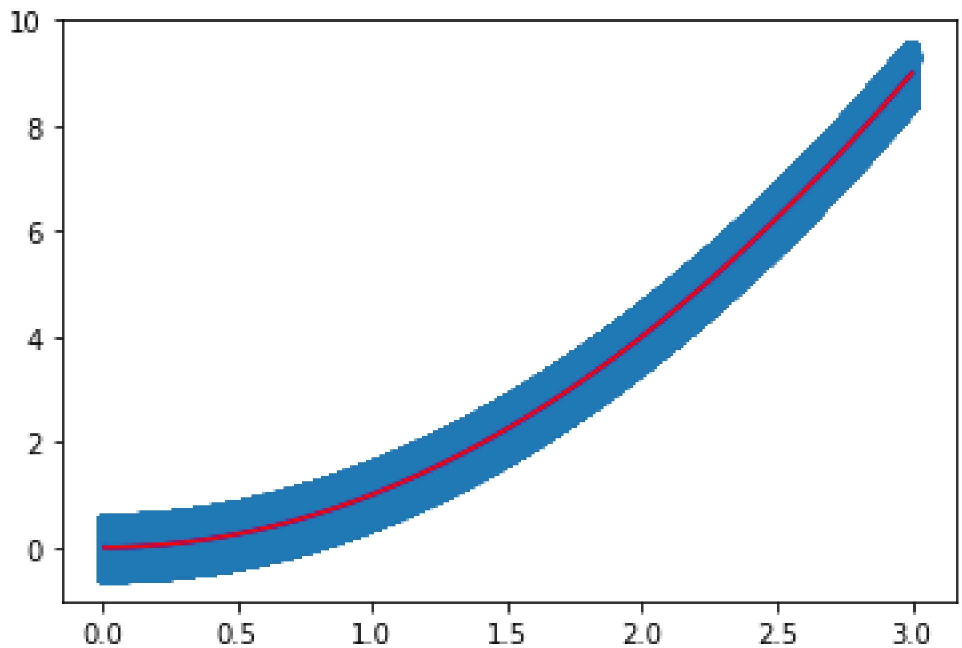
```
Out[34]: (array([ 0.00000000e+00, -2.69350137e-01,  3.23020591e+00, -7.93397599e+00,
                  1.50586040e+01, -1.69134968e+01,  1.17999450e+01, -5.16990652e+00,
                  1.38409188e+00, -2.06961823e-01,  1.32467576e-02]),
          0.00821148524487425)
```

```
In [35]: ridge = linear_model.Ridge()

         ridge.fit(x_10, y)

         (ridge.coef_, ridge.intercept_)
```

```
Out[35]: (array([ 0.00000000e+00,  5.75627166e-02,  8.15267892e-01,  2.14350609e-01,
                 -5.16450114e-02, -6.66603686e-02,  2.71026942e-02,  2.37241422e-02,
                 -2.01040579e-02,  5.41370221e-03, -5.11622599e-04]),
          -0.00444042052149074)
```

```
In [36]: plt.scatter(x,y)
         plt.plot(x, np.dot(x_10, linear.coef_) + linear.intercept_, c='b')
         plt.plot(x, np.dot(x_10, ridge.coef_) + ridge.intercept_, c='r')
```

```
Out[36]: [<matplotlib.lines.Line2D at 0x27b21cc32e8>]
```




```
In [41]: from sklearn.preprocessing import PolynomialFeatures

         poly = PolynomialFeatures(degree=50)

         x_50= poly.fit_transform(x.reshape(-1, 1))
```

```
In [43]: linear = linear_model.LinearRegression()

         linear.fit(x_50, y)

         (linear.coef_, linear.intercept_)
```

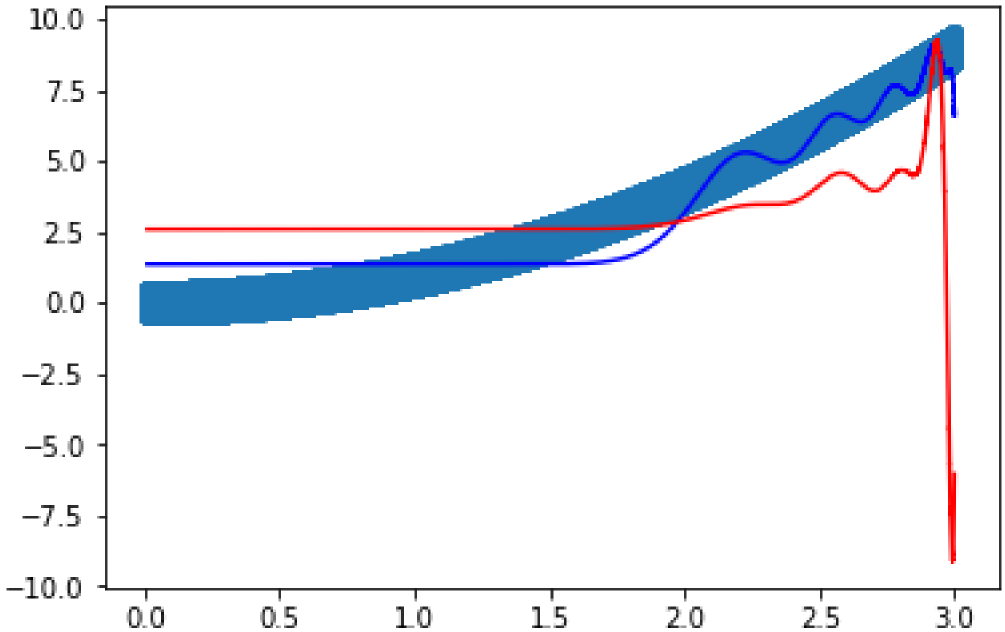
```
Out[43]: (array([-7.84092274e-15, -6.28289279e-09,  3.25145576e-10, -1.57611314e-11,
                 -1.00807983e-10,  4.96783680e-11, -5.49029186e-11,  2.50288708e-11,
                 -1.35409544e-11, -8.94452050e-11, -3.41023130e-10, -2.63362808e-10,
                  2.49462510e-13,  4.93069187e-13,  9.62038249e-13,  1.85377499e-12,
                  3.52796551e-12,  6.62948500e-12,  1.22939988e-11,  2.24816467e-11,
                  4.04989290e-11,  7.17774222e-11,  1.24964481e-10,  2.13315392e-10,
                  3.56208461e-10,  5.80264770e-10,  9.18973083e-10,  1.40888850e-09,
                  2.07957683e-09,  2.93412479e-09,  3.91854130e-09,  4.88384816e-09,
                  5.55633790e-09,  5.54926479e-09,  4.46543565e-09,  2.13238582e-09,
                 -1.05868097e-09, -3.90481767e-09, -4.64164904e-09, -2.10766202e-09,
                  2.43784701e-09,  4.71228663e-09,  1.01570546e-09, -4.68704963e-09,
                 -1.71789488e-09,  5.96949340e-09, -4.25118396e-09,  1.54375889e-09,
                 -3.18034208e-10,  3.55562964e-11, -1.68615021e-12]),
          1.3545903246543278)
```

```
In [44]: ridge = linear_model.Ridge()

         ridge.fit(x_50, y)

         (ridge.coef_, ridge.intercept_)
```

```
Out[44]: (array([-4.54651451e-10, -5.45183013e-08,  1.45916922e-08,  3.79095648e-08,
                 -1.03128319e-08,  4.94298116e-09, -6.07296967e-10, -1.24841405e-09,
                  1.72398705e-09, -4.95932816e-10,  4.62597221e-08, -4.86216542e-08,
                  2.95555274e-09, -3.39590468e-09, -5.39262619e-09,  9.22836668e-10,
                  5.96188294e-09,  9.43570327e-11,  1.57776112e-10,  2.84270233e-10,
                  4.27793062e-10,  4.93504949e-10,  8.14715766e-10,  1.16570418e-09,
                  1.57830235e-09,  2.14680423e-09,  2.94137260e-09,  3.61328913e-09,
                  4.28970383e-09,  4.76800546e-09,  4.55545859e-09,  3.77685886e-09,
                  2.31607521e-09, -2.75192354e-12, -2.26865886e-09, -3.63123481e-09,
                 -3.05716080e-09, -4.37109221e-10,  2.76484288e-09,  3.50522401e-09,
                  2.77570365e-10, -3.32272907e-09, -2.30737298e-09,  3.82373934e-09,
                  5.26011859e-10, -2.92605503e-09,  2.04301439e-09, -7.22374677e-10,
                  1.45758086e-10, -1.60650606e-11,  7.55336314e-13]), 2.583655266060578)
```

```
In [45]: plt.scatter(x,y)
         plt.plot(x, np.dot(x_50, linear.coef_) + linear.intercept_, c='b')
         plt.plot(x, np.dot(x_50, ridge.coef_) + ridge.intercept_, c='r')
```

```
Out[45]: [<matplotlib.lines.Line2D at 0x27b21d24cf8>]
```


10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0