In [155…
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.metrics import r2_score
%matplotlib inline
```

In [156…
```
# Read the data
df = pd.read_csv('Polynomial_regresion/position_salaries.csv.txt')
df.head()
```

Out[156…

	Position	Level	Salary
0	Business Analyst	1	45000
1	Junior Consultant	2	50000
2	Senior Consultant	3	60000
3	Manager	4	80000
4	Country Manager	5	110000

In [157…
```
# Prepare the data
df = pd.concat([pd.Series(1, index=df.index, name='00'), df], axis=1)
df = df.drop(columns='Position')
df.head()
```

Out[157…

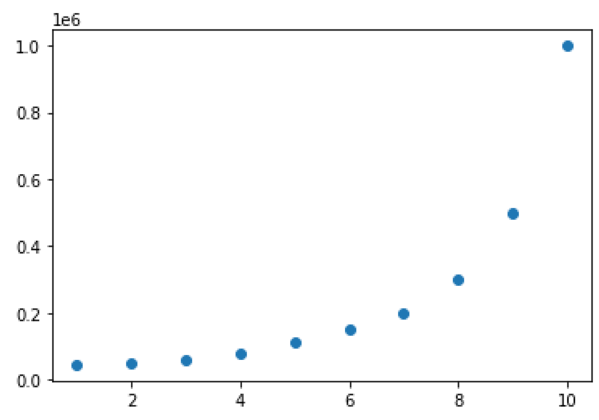
	00	Level	Salary
0	1	1	45000
1	1	2	50000
2	1	3	60000
3	1	4	80000
4	1	5	110000

In [158…
```
# Build the pices for gradient descent
Y = df['Salary']
X = df.drop(columns='Salary')
X.head()
```

Out[158…

	00	Level
0	1	1
1	1	2
2	1	3
3	1	4
4	1	5

In [159…
```
# As we can see a linear prediction won't fix very well so we have to try with a polynomial.
plt.figure()
plt.scatter(x=X['Level'],y=Y)
plt.show()
```



In [160…
```
# Add a two new features with exponential ^2 and ^3 to the data set.
X['Level2'] = X['Level']**2
X['Level3'] = X['Level']**3
X['Level4'] = X['Level']**4
X.head()
```

Out[160…

	00	Level	Level2	Level3	Level4
0	1	1	1	1	1
1	1	2	4	8	16
2	1	3	9	27	81
3	1	4	16	64	256
4	1	5	25	125	625

In [188…
```
# Normalize the data
m = len(X)
X = X / X.max()
alpha = 0.05 # Learning rate (gradient descent step)
m,n = X.shape
theta = np.ones(n) # Inital colomn vector of theta
num_of_iterations = 700
X
```

Out[188…

	00	Level	Level2	Level3	Level4
0	1.0	0.1	0.01	0.001	0.0001
1	1.0	0.2	0.04	0.008	0.0016
2	1.0	0.3	0.09	0.027	0.0081
3	1.0	0.4	0.16	0.064	0.0256
4	1.0	0.5	0.25	0.125	0.0625
5	1.0	0.6	0.36	0.216	0.1296
6	1.0	0.7	0.49	0.343	0.2401
7	1.0	0.8	0.64	0.512	0.4096
8	1.0	0.9	0.81	0.729	0.6561
9	1.0	1.0	1.00	1.000	1.0000

In [189…
```
def cost_function(X, Y, B):
    m = len(Y)
    J = np.sum((X.dot(B) - Y) ** 2)/(2 * m)
    return J
```

In [190…
```
# Gradient descent algorithm.
# 1) Calculate the hypothesis value for each row(B0x0 + B1x1 + B2X2 +,...+BnXn)
# 2) Calculate the loss (diference between hypothesis and y value of data set)
# 3) Gradient calculation
# 4) Add a new record of the cost
def batch_gradient_descent(x, y, theta, alpha, m, iterations_num):

    cost_history = [0] * iterations_num

    for i in range(0, iterations_num):
        # Hypothesis value
        hypotesis = np.dot(x, theta)
        #print("hypotesis: {}".format(hypotesis))

        # Loss
        loss = hypotesis - y
        #print("loss: {}".format(loss))

        # Gradient Calculation
        gradient = np.dot(np.transpose(x), loss) / m
        #print("gradient: {}".format(gradient))

        # Vectorization way to update theta values
        theta = theta - alpha * gradient
        #theta[0] = theta[0] - alpha * gradient[0] # Update theta0
        #theta[1] = theta[1] - alpha * gradient[1] # Update theta1

        # New Cost Value
        cost = cost_function(x, y, theta)
        cost_history[i] = cost

    return theta, cost_history
```

In [191…
```
theta.shape
X.shape
```

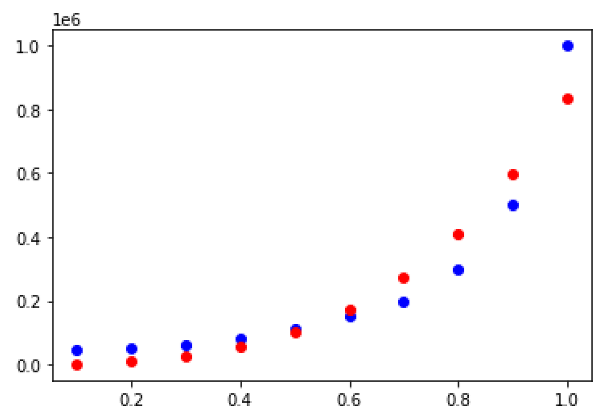
Out[191…
```
(10, 5)
```

In [192…
```
thetas_result, cost_history = batch_gradient_descent(X, Y, theta, alpha, m, num_of_iterations)
print(thetas_result)
```

```
[ -1610.20339038   9442.33676096 156430.55654818 285808.84182573
 386100.79260279]
```

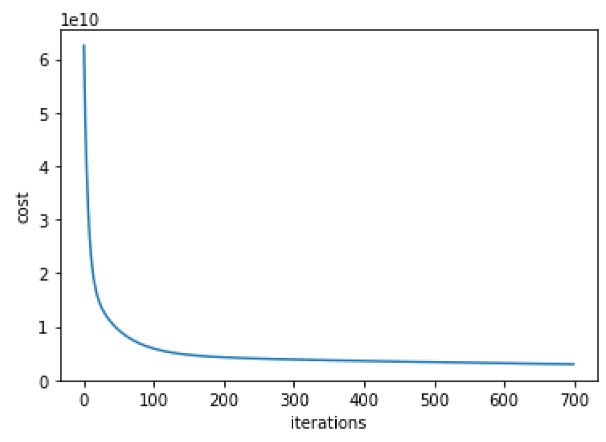
In [193…
```
# For plot purposes let's calculate all the "calculated" Y for given X
y_calculated = X.dot(thetas_result)
X_for_plot = X
Y_for_plot = y_calculated
```

In [194…
```
plt.figure()
plt.scatter(x=X['Level'],y=Y, c='b')
plt.scatter(x=X['Level'], y=y_calculated, c='r')
plt.show()
```



In [195…
```
# Visualice the cost fuction for each iteration in the batch gradient descend algorithm
iterations = list(range(0,num_of_iterations))
plt.plot(iterations, cost_history, label='linear')  # Plot some data on the (implicit) axes.
plt.xlabel('iterations')
plt.ylabel('cost')
```

Out[195…
```
Text(0, 0.5, 'cost')
```



In [196…
```
# Evaluate the accuracy level
r2 = r2_score(Y,y_calculated)
print(r2)
```

```
0.9265548779476576
```

In [ ]: