Programming Exercise 1 - Linear Regression

Xinyu_Chen

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0.1 Programming Exercise 1 - Linear Regression

- warmUpExercise
- Linear regression with one variable
- Gradient Descent

```
In [1]: # %load ../../standard_import.txt
        import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt

        from sklearn.linear_model import LinearRegression
        from mpl_toolkits.mplot3d import axes3d

        pd.set_option('display.notebook_repr_html', False)
        pd.set_option('display.max_columns', None)
        pd.set_option('display.max_rows', 150)
        pd.set_option('display.max_seq_items', None)

        #%config InlineBackend.figure_formats = {'pdf',}
        %matplotlib inline

        import seaborn as sns
        sns.set_context('notebook')
        sns.set_style('white')
```

warmUpExercise

```
In [2]: def warmUpExercise():
            return(np.identity(5))
```

```
In [3]: warmUpExercise()
```

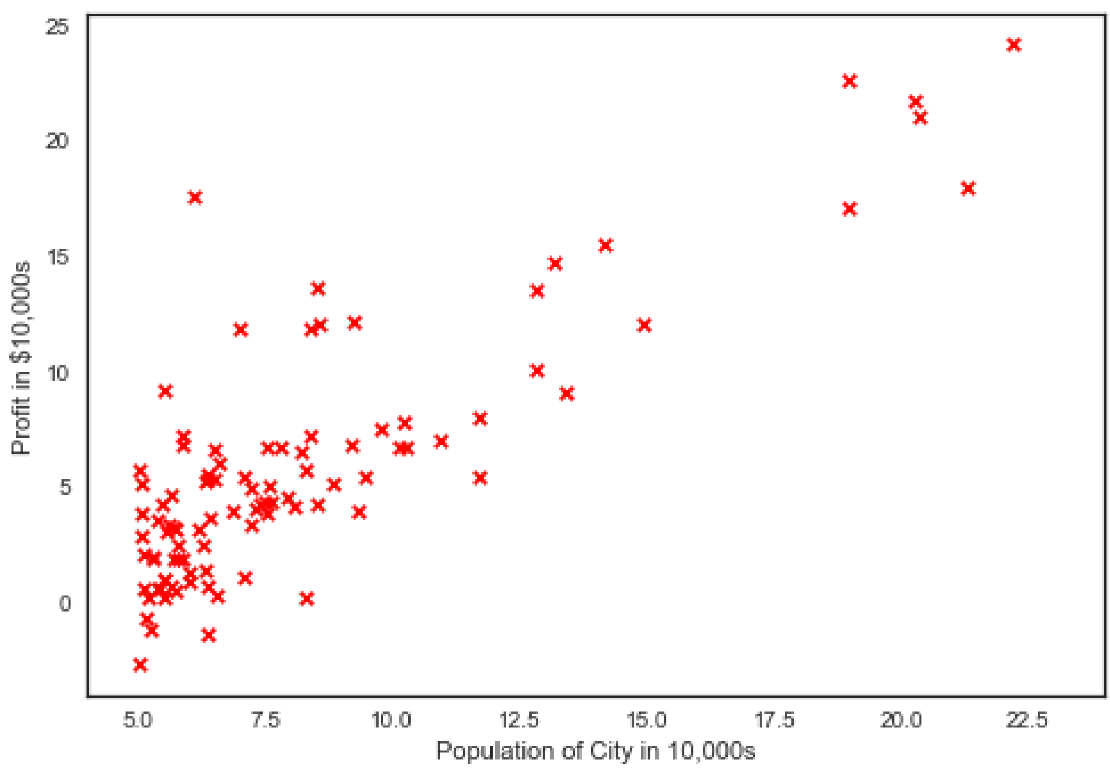
```
Out[3]: array([[ 1.,  0.,  0.,  0.,  0.],
               [ 0.,  1.,  0.,  0.,  0.],
               [ 0.,  0.,  1.,  0.,  0.],
               [ 0.,  0.,  0.,  1.,  0.],
               [ 0.,  0.,  0.,  0.,  1.]])
```

0.1.1 Linear regression with one variable

```
In [4]: data = np.loadtxt('data/ex1data1.txt', delimiter=',')

        X = np.c_[np.ones(data.shape[0]),data[:,0]]
        y = np.c_[data[:,1]]
```

```
In [5]: plt.scatter(X[:,1], y, s=30, c='r', marker='x', linewidths=1)
        plt.xlim(4,24)
        plt.xlabel('Population of City in 10,000s')
        plt.ylabel('Profit in $10,000s');
```



Gradient Descent

```
In [6]: def computeCost(X, y, theta=[[0],[0]]):
            m = y.size
            J = 0

            h = X.dot(theta)

            J = 1/(2*m)*np.sum(np.square(h-y))

            return(J)
```

In [7]:
```
computeCost(X,y)
```

Out[7]:
```
32.072733877455676
```

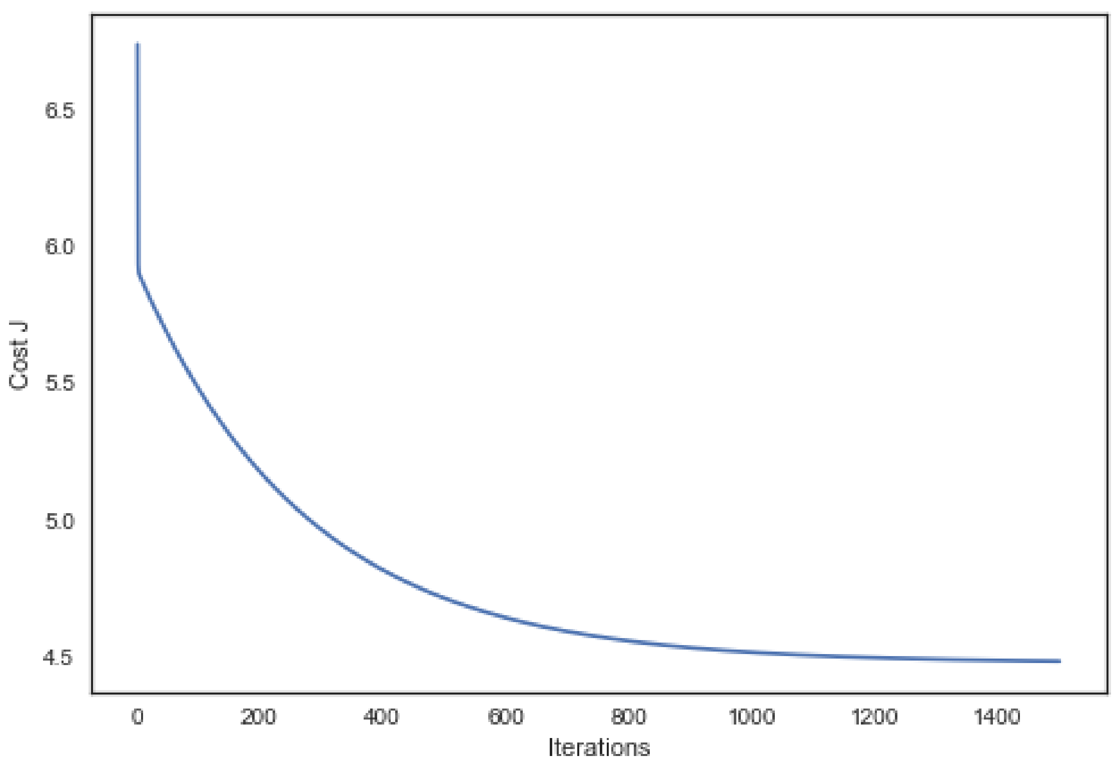
In [8]:
```
def gradientDescent(X, y, theta=[[0],[0]], alpha=0.01, num_iters=1500):
    m = y.size
    J_history = np.zeros(num_iters)

    for iter in np.arange(num_iters):
        h = X.dot(theta)
        theta = theta - alpha*(1/m)*(X.T.dot(h-y))
        J_history[iter] = computeCost(X, y, theta)
    return(theta, J_history)
```

In [9]:
```
# theta for minimized cost J
theta , Cost_J = gradientDescent(X, y)
print('theta: ',theta.ravel())

plt.plot(Cost_J)
plt.ylabel('Cost J')
plt.xlabel('Iterations');
```

```
theta:  [-3.63029144  1.16636235]
```

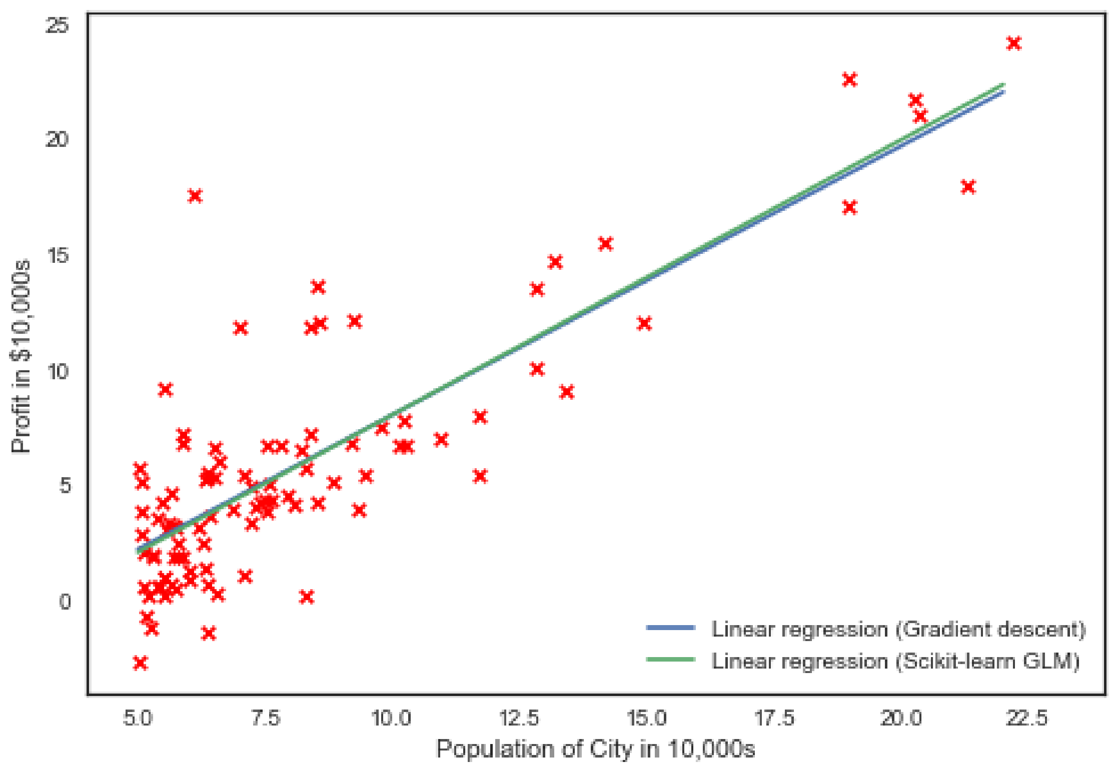


```
In [10]: xx = np.arange(5,23)
         yy = theta[0]+theta[1]*xx

         # Plot gradient descent
         plt.scatter(X[:,1], y, s=30, c='r', marker='x', linewidths=1)
         plt.plot(xx,yy, label='Linear regression (Gradient descent)')

         # Compare with Scikit-learn Linear regression
         regr = LinearRegression()
         regr.fit(X[:,1].reshape(-1,1), y.ravel())
         plt.plot(xx, regr.intercept_+regr.coef_*xx, label='Linear regression (Scik

         plt.xlim(4,24)
         plt.xlabel('Population of City in 10,000s')
         plt.ylabel('Profit in $10,000s')
         plt.legend(loc=4);
```




```
In [11]: # Predict profit for a city with population of 35000 and 70000
         print(theta.T.dot([1, 3.5])*10000)
         print(theta.T.dot([1, 7])*10000)

[ 4519.7678677]
[ 45342.45012945]
```

In [12]:
```python
# Create grid coordinates for plotting
B0 = np.linspace(-10, 10, 50)
B1 = np.linspace(-1, 4, 50)
xx, yy = np.meshgrid(B0, B1, indexing='xy')
Z = np.zeros((B0.size,B1.size))

# Calculate Z-values (Cost) based on grid of coefficients
for (i,j),v in np.ndenumerate(Z):
    Z[i,j] = computeCost(X,y, theta=[[xx[i,j]], [yy[i,j]]])

fig = plt.figure(figsize=(15,6))
ax1 = fig.add_subplot(121)
ax2 = fig.add_subplot(122, projection='3d')

# Left plot
CS = ax1.contour(xx, yy, Z, np.logspace(-2, 3, 20), cmap=plt.cm.jet)
ax1.scatter(theta[0],theta[1], c='r')

# Right plot
ax2.plot_surface(xx, yy, Z, rstride=1, cstride=1, alpha=0.6, cmap=plt.cm.j
ax2.set_zlabel('Cost')
ax2.set_zlim(Z.min(),Z.max())
ax2.view_init(elev=15, azim=230)

# settings common to both plots
for ax in fig.axes:
    ax.set_xlabel(r'$\theta_0$', fontsize=17)
    ax.set_ylabel(r'$\theta_1$', fontsize=17)
```