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```
This notebook explains how cost function is used to find best value of parameters using LINEAR REGRESSION
```

Cost Function ¶

In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.metrics import mean_squared_error as mse
```

```
C:\Users\rkt7k\anaconda3\lib\site-packages\scipy\__init__.py:146: UserWarning: A NumPy version >=1.16.5 and <1.23.0 is requ
ired for this version of SciPy (detected version 1.24.1
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

In [2]:

```
# creating the sample dataset
experience = [1.2,1.5,1.9,2.2,2.4,2.5,2.8,3.1,3.3,3.7,4.2,4.4]
salary     = [1.7,2.4,2.3,3.1,3.7,4.2,4.4,6.1,5.4,5.7,6.4,6.2]

df = pd.DataFrame({
    'experience' : experience,
    'salary' : salary
})
df.head()
```

Out[2]:

	experience	salary
0	1.2	1.7
1	1.5	2.4
2	1.9	2.3
3	2.2	3.1
4	2.4	3.7

Defining a Linear Regression Equation to Predict Salary

(Variables taken as constant for demonstration)

In [3]:

```
pred_salary = np.array(experience)*1.7 - 0.7
df['pred_salary'] = pred_salary
```

In [4]:

```
df.head()
```

Out[4]:

	experience	salary	pred_salary
0	1.2	1.7	1.34
1	1.5	2.4	1.85
2	1.9	2.3	2.53
3	2.2	3.1	3.04
4	2.4	3.7	3.38

Calculating error

In [5]:

```
df['error'] = df['salary'] - df['pred_salary']
error = salary - pred_salary # storing in array
```

Calculating MSE

In [6]:

```
# method 1
np.square(error).sum()/len(error)
```

Out[6]:

```
0.3383500000000003
```

In [7]:

```
# method 2
mse(df.salary, df.pred_salary)
```

Out[7]:

```
0.3383500000000003
```

Visualizing Data

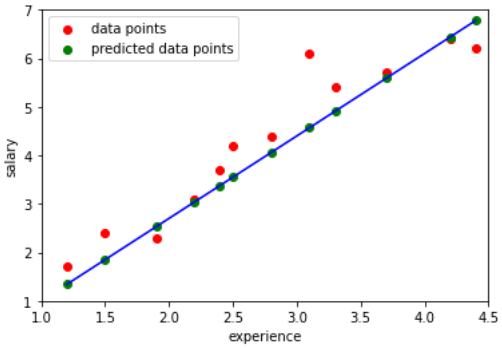
In [8]:

```
plt.scatter(df.experience, df.salary, color = 'red', label = 'data points')
plt.scatter(df.experience, df.pred_salary, color = 'green', label = 'predicted data points')
plt.plot(df.experience, df.pred_salary, '-b')
plt.xlim(1,4.5)
plt.ylim(1,7)
plt.xlabel('experience')
plt.ylabel('salary')
plt.legend()

# data follows linear curve
# blue line demonstrates the best fit line
```

Out[8]:

```
<matplotlib.legend.Legend at 0x15daa054970>
```



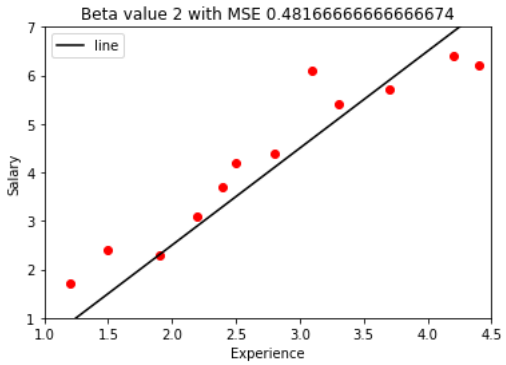
Try playing around with the values of beta and b here to observe the change in fitting line

In [9]:

```
beta = 2
b = 1.5

#predicted points
line1 = np.array(experience)*beta - b

# Plotting the line
plt.scatter(df.experience, df.salary, color = 'red')
plt.plot(df.experience, line1, color = 'black', label = 'line')
plt.xlim(1,4.5)
plt.ylim(1,7)
plt.xlabel('Experience')
plt.ylabel('Salary')
plt.legend()
MSE = mse(df.salary, line1)
plt.title("Beta value "+str(beta)+" with MSE "+ str(MSE))
MSE = mse(df.salary, line1)
```



Calculating error for a range of values of Beta

In [15]:

```
def calc_error(beta, df):

    b = 1.1 # considering b as constant

    pred_salary = df.experience*beta + b  # predictions for each data point

    MSE = mse(df.salary, pred_salary) # calculating MSE for current Beta value predicitons

    return MSE
```

In [19]:

```
# Calculating Cost (Errors) for raneg of Beta (slope) values
slope = [i/100 for i in range(0,300)]
costs = []

for i in slope:
    cost = calc_error(beta= i, df= df)
    costs.append(cost)

# Arranging in a DataFrame
cost_df = pd.DataFrame({
    'Beta' : slope,
    'Cost' : costs
})
cost_df.head()
```

Out[19]:

	Beta	Cost
0	0.00	12.791667
1	0.01	12.585876
2	0.02	12.381806
3	0.03	12.179455
4	0.04	11.978824

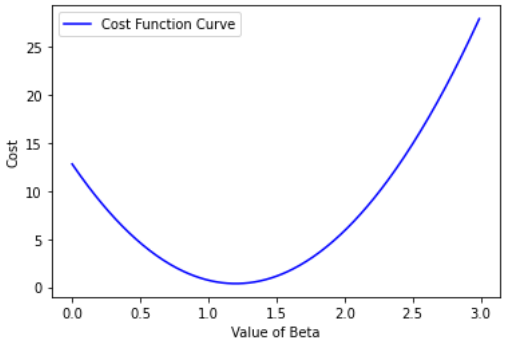
Visualising Cost v/s Beta

In [20]:

```
# plotting the cost values corresponding to every value of Beta
plt.plot(cost_df.Beta, cost_df.Cost, color = 'blue', label = 'Cost Function Curve')
plt.xlabel('Value of Beta')
plt.ylabel('Cost')
plt.legend()
```

Out[20]:

```
<matplotlib.legend.Legend at 0x15dac390eb0>
```



In [35]:

```
# Method 1 => Calc. lowest cost and then locate respective Beta with index location of cost
min_cost= cost_df[cost_df['Cost'] == cost_df['Cost'].min()].index
best_beta = cost_df.iloc[min_cost]['Beta']
best_beta
```

Out[35]:

```
120    1.2
Name: Beta, dtype: float64
```

In [40]:

```
# Method 2 => Sort Dataframe w.r.t Cost and get the beta value of 0th row
cost_df.sort_values(by='Cost')['Beta'].iloc[0]
```

Out[40]:

```
1.2
```