```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
```

```
url = "https://www.statlearning.com/s/Advertising.csv"
advertising = pd.read_csv(url, index_col=0)
advertising.head()
```

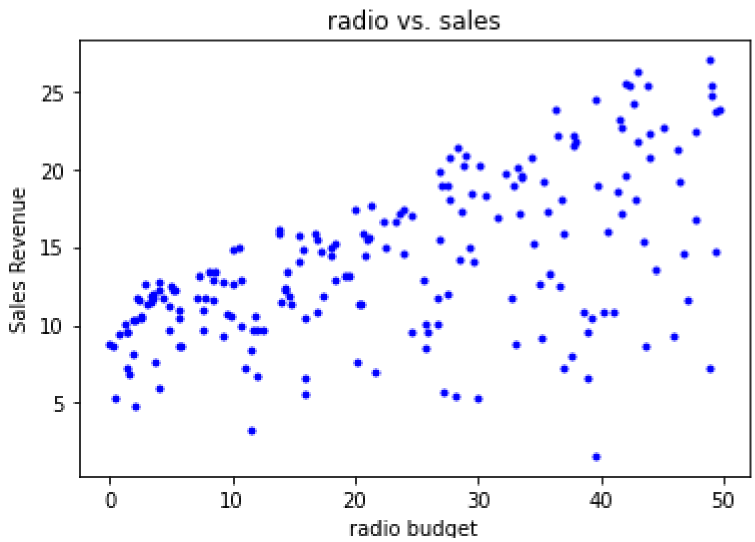
	TV	radio	newspaper	sales
1	230.1	37.8	69.2	22.1
2	44.5	39.3	45.1	10.4
3	17.2	45.9	69.3	9.3
4	151.5	41.3	58.5	18.5
5	180.8	10.8	58.4	12.9

1. Apply the normal equation to calculate parameter values for the best fit.

```
# Let extract the data of radio and sales from advertising data
data = advertising.loc[:, ['radio', 'sales']]
data.head()
```

	radio	sales
1	37.8	22.1
2	39.3	10.4
3	45.9	9.3
4	41.3	18.5
5	10.8	12.9

```
# Let visualize the aspect training data points on plot
# plot radio vs. sales
plt.plot(advertising['radio'], advertising['sales'], 'b.')
plt.title("radio vs. sales")
plt.xlabel("radio budget")
plt.ylabel("Sales Revenue")
plt.savefig("radiovsSales.png")
plt.show()
```




```
# The relation between X and Y in linear regression is: Y≈f(X)=β0+β1X. where β0 and β1 are pa
# Let train a linear regression model using sklearn between radio and sales
from sklearn.linear_model import LinearRegression
model_lr = LinearRegression()
model_lr.fit(data[['radio']], data[['sales']])
```

```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

```
# Let calculate those parameters' values
print(model_lr.coef_)
print(model_lr.intercept_)
```

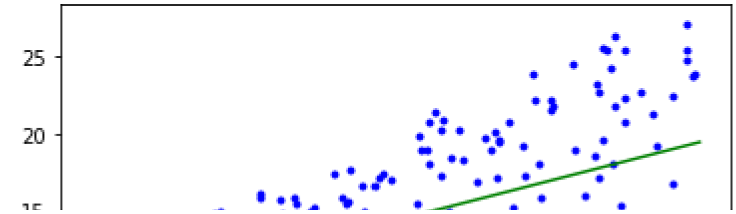
```
[[0.20249578]]
[9.3116381]
```

2. Display the regression line with the training data points.

```
# Regression line and training data point
m = model_lr.coef_[0, 0]   # slope
b = model_lr.intercept_[0] # y-intercept

plt.plot(data['radio'], data['sales'], 'b.')
x_coordinates = np.array([0,50])
y_coordinates = x_coordinates * m + b
plt.plot(x_coordinates, y_coordinates, 'g-')
```

```
[<matplotlib.lines.Line2D at 0x7f05eee53110>]
```



3. Use `sklearn` to build the same model. Verify that the parameters values are the same as those from the normal equation.

```
# Let calculate the squared error of those parameters
beta0 = 9.31
beta1 = 0.20
#i = 1
x1 = data.loc[1, 'radio'] # 37.8
y1 = data.loc[1, 'sales'] #22.1
print("x1, y1:", x1, y1)

# Calculate f(x1) = beta0 + beta1 * x1
prediction1 = beta0 + beta1 * x1
print("Prediction on Record 1:", prediction1)

# Calculate the squared error (y1 - f(x1)) ** 2
error1 = (y1 - prediction1) ** 2
print("Squared error on Record 1:", error1)
```

```
x1, y1: 37.8 22.1
Prediction on Record 1: 16.87
Squared error on Record 1: 27.352900000000005
```

```
# Let create a function that calculate the squared error of all index
def get_squared_error (beta0, beta1, data, i):

  x = data.loc[i, 'radio']
  y = data.loc[i, 'sales']
  prediction = beta0 + beta1 * x
  squared_error = (y - prediction)**2

  return squared_error


# Let calculate the list of all errors
list_errors = [get_squared_error(beta0, beta1, data, i) for i in data.index]
print(list_errors)
```

```
[27.352900000000005, 45.832900000000016, 84.45610000000002, 0.8648999999999994, 2.04489
```

```
# Calculate the MSE
```

```
MSE = np.mean(list_errors)
print("MSE:", MSE)
```

```
MSE: 18.097328
```

```
# Construct X and Y as numpy arrays
X = np.hstack([np.ones([len(data), 1]), data[['radio']].values])
# print(X)
y = data[['sales']].values
# print(y)

beta = np.linalg.inv(X.T.dot(X)).dot(X.T).dot(y)
print(beta)
```

```
[[9.3116381 ]
 [0.20249578]]
```

```
# In conclusion we can see the the parameters are the same
beta0 = 9.31
beta1 = 0.20
```