gradedtest1

August 5, 2023

[29]:

```
import pandas as pd
import numpy as np
import math
import matplotlib.pyplot as plt
```

[3]:

```
data = pd.read_excel('DataSet.xls')
```

0.0.1 Simple Regression

[67]:

```
X = data.Age
Y = data.Expenditures
```

0.1 Question 1

0.1.1 Coefficients

[19]:

```
b = (X*Y - X*Y.mean()).sum()/(X*X - X*X.mean()).sum()
a = Y.mean() - b*X.mean()
a, b
```

[19]:

```
(114.24110795493151, -0.3335960966062749)
```

0.1.2 Standard Error

[34]:

```
error            = Y - (a + b*X)
Sum_Square_Error = ( error**2).sum()
n = data.shape[0]
stdev = math.sqrt(1/(n-2)*Sum_Square_Error)
# logging.info(f'standard error is {round(standard_error, 3)}')
print(f'standard error is {round(standard_error, 3)}')
```

```
standard error is 5.073
```

[41]:

```
C = (X-X.mean())/((X-X.mean())**2).sum()
beta = b - (C*error).sum()

print(f'beta is {beta}')
```

```
beta is -0.333596096660627315
```

[42]:
```
s_b = stdev ** 2 / ((X-X.mean())**2).sum()
print(f's_b is {s_b}')
```

```
s_b is 0.00909528102577286
```

[43]:
```
t_beta = (b-beta)/s_b
print(f't distribution of beta is {t_beta}')
```

```
t distribution of beta is -1.892020360110606e-13
```

0.1.3 Answer 1

[58]:
```
print('Answer of question 1:')
print( f'Value of intercept a is {round(a, 4)}')
print( f'Value of coefficient b is {round(b, 4)}')
print( f'Standard Error is {round(stdev, 4)}')
print( f't distribution of beta is {t_beta}')
```

```
Answer of question 1:
Value of intercept a is 114.2411
Value of coefficient b is -0.3336
Standard Error is 5.0733
t distribution of beta is -1.892020360110606e-13
```

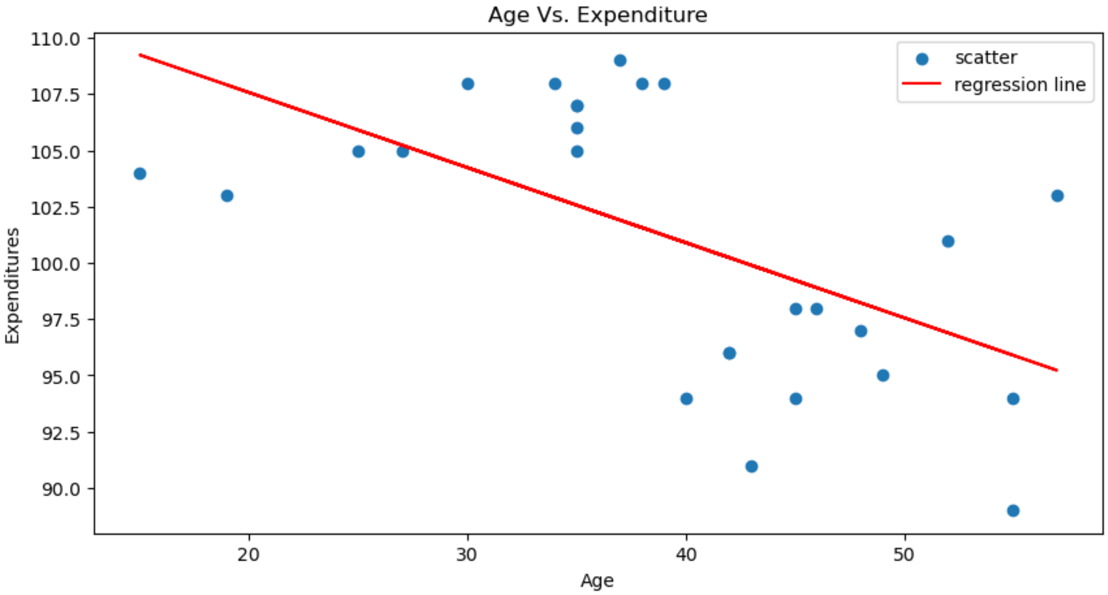
0.1.4 Summarize solution 1 into function for following questions

[71]:
```
def calc_q1(df_data, group):
    X = df_data.Age
    Y = df_data.Expenditures

    b = (X*Y - X*Y.mean()).sum()/(X*X - X*X.mean()).sum()
    a = Y.mean() - b*X.mean()

    error            = Y - (a + b*X)
    Sum_Square_Error = ( error**2).sum()
    n = data.shape[0]
    stdev = math.sqrt(1/(n-2)*Sum_Square_Error)

    C = (X-X.mean())/((X-X.mean())**2).sum()
    beta = b - (C*error).sum()

    s_b = stdev ** 2 / ((X-X.mean())**2).sum()

    t_beta = (b-beta)/s_b

    print( f'Present result for Age {group}')
    print( f'Value of intercept a is {round(a, 4)}')
    print( f'Value of coefficient b is {round(b, 4)}')
    print( f'Standard Error is {round(stdev, 4)}')
    print( f't distribution of beta is {t_beta}')

    return a, b, stdev, t_beta
```

0.2 Question 2

[65]:

```
plt.figure(figsize=(10, 5))
plt.scatter(X, Y, label='raw data')
plt.plot(X, a+b*X, color='r', linestyle='solid', label='regression line')
plt.xlabel('Age')
plt.ylabel('Expenditures')
plt.title('Age Vs. Expenditure')
plt.legend()
plt.show()
```



0.2.1 Answer 2

- 1. Based on regresion line, expense decreases as age increases
- 2. Based on raw data points, these data can be separated into two groups and each group can be modeled separately.

0.2.2 Question 3

[76]:

```python
# Split group based on Age
df_g1 = data[data.Age >= 40]
df_g2 = data[data.Age < 40]
```

0.2.3 Answer 3

[77]:

```python
a1, b1, stdev1, t_beta1 = calc_q1(df_g1, group='>= 40')
```

```
Present result for Age >= 40
Value of intercept a is 88.8719
Value of coefficient b is 0.1465
Standard Error is 2.5949
t distribution of beta is -5.782105357881236e-13
```

[78]:

```python
a2, b2, stdev2, t_beta2 = calc_q1(df_g2, group='< 40')
```

```
Present result for Age < 40
Value of intercept a is 100.2323
Value of coefficient b is 0.198
Standard Error is 0.7806
t distribution of beta is 1.998185385211897e-12
```

0.2.4 Question 4 and Answer 4

- 1. in a) we can see the Age and Expenditure are negative related. However, in c), for each group, Age and Expenditure are possitive related.
- 2. Based on standard error, models in c) have smaller standard error and can model the dataset better than a)