In [5]:
```
%config IPCompleter.greedy=True
```

In a retail experiment, we want to understand how advertising expenditure, store location, and competition affect sales revenue. Using synthetic data, implement multiple linear regression in Python to analyse these factors. Interpret the coefficients, perform an F-test to assess overall model significance, and conduct t-tests to evaluate the significance of individual coefficients.

In [6]:
```
import pandas as pd
import matplotlib.pyplot as plt
import statsmodels.api as sm
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import r2_score, mean_squared_error
```

In [7]:
```
df = pd.read_csv("datasets/sales.csv")
df.head()
```

Out[7]:

	AdvertisingExpenditure	StoreLocation	Competition	SalesRevenue
0	4269	1	1.509	16259
1	4441	1	1.285	18432
2	1866	0	1.018	9630
3	3871	0	1.116	14029
4	4760	1	1.015	18392

In [8]:
```
X = df[["AdvertisingExpenditure", "StoreLocation", "Competition"]]
Y = df["SalesRevenue"]
```

In [10]:
```
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.25,
random_state=42, shuffle=True)
```

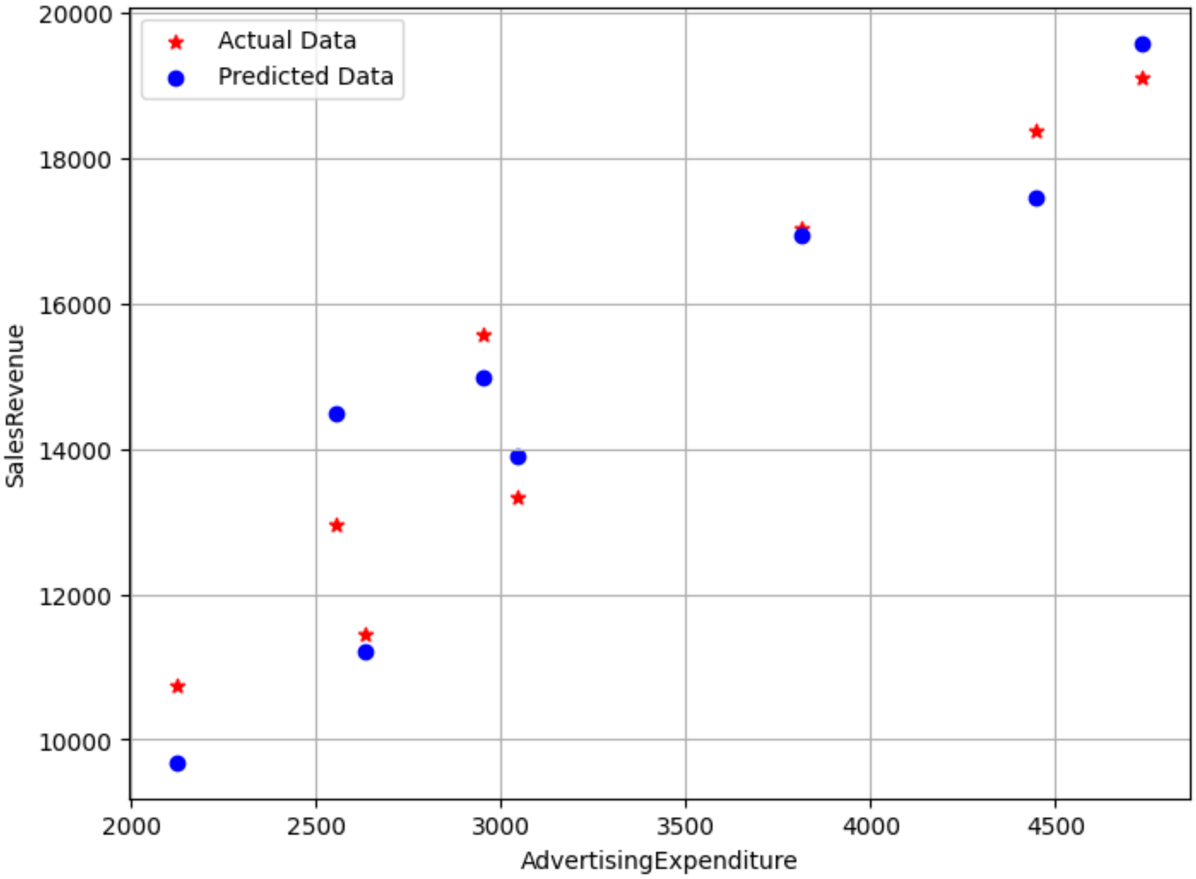
In [11]:
```
model = LinearRegression()
model.fit(X_train, Y_train)
```

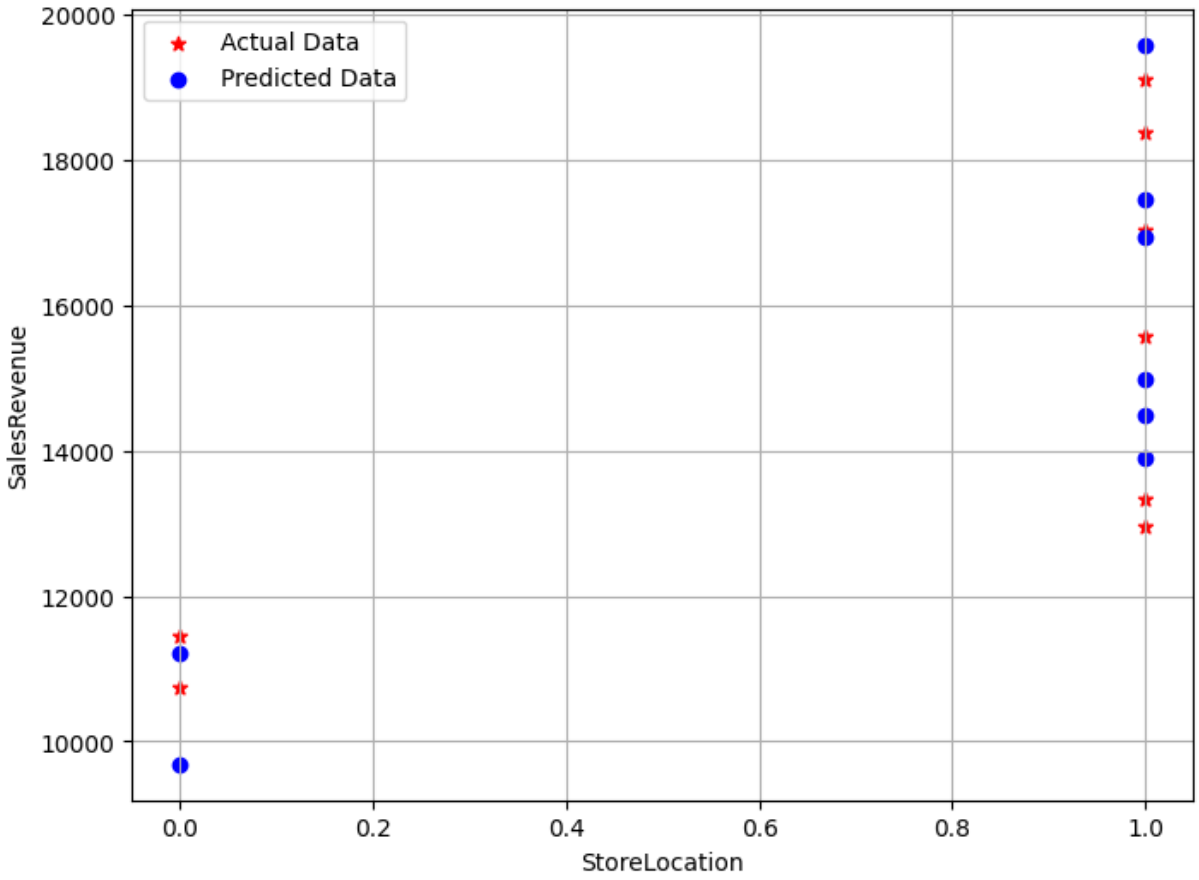
Out[11]:

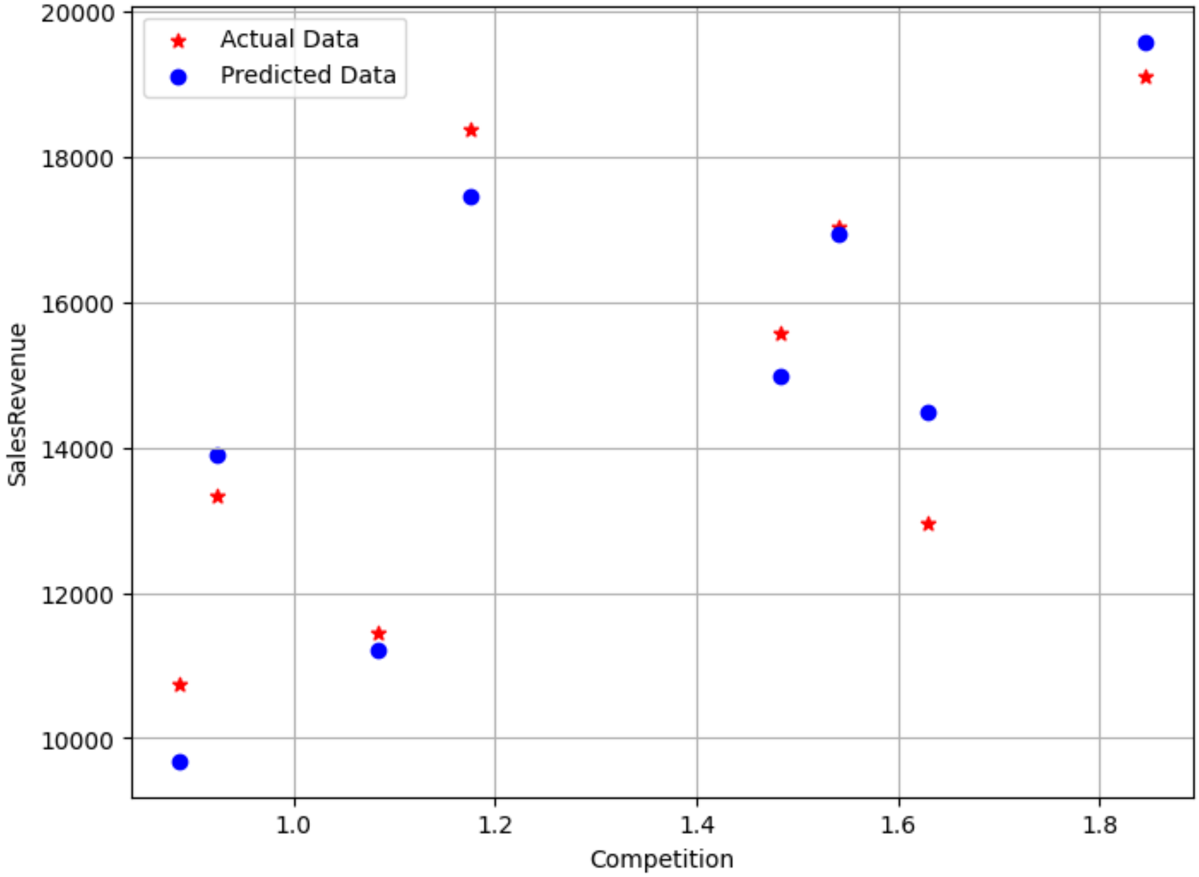
```
▾ LinearRegression  i ?

LinearRegression()
```

In [13]:
```
Y_pred = model.predict(X_test)
```

In [31]:
```
predictors = ["AdvertisingExpenditure", "StoreLocation", "Competition"]

for predictor in predictors:
    plt.figure(figsize=(8, 6))
    plt.scatter(X_test[predictor], Y_test, color="red", marker="*",
label="Actual Data")
    plt.scatter(X_test[predictor], Y_pred, color="blue", marker="o",
label="Predicted Data")

    plt.xlabel(predictor)
    plt.ylabel("SalesRevenue")
    plt.grid()
    plt.legend()
```




Actual Data
Predicted Data
20000
18000
16000
14000
12000
10000
SalesRevenue
0.0
0.2
0.4
0.6
0.8
1.0
StoreLocation


Actual Data
Predicted Data
20000
18000
16000
14000
12000
10000
SalesRevenue
1.0
1.2
1.4
1.6
1.8
Competition

In [22]:

```
mse = mean_squared_error(Y_pred, Y_test)
r2 = r2_score(Y_pred, Y_test)
```

In [23]:

```
print(f"Mean Squared Error = {mse}\nr^2 = {r2}")
```

```
Mean Squared Error = 657202.55549179
r^2 = 0.9293489215262755
```

In [24]:

```
coefs = model.coef_
intercept = model.intercept_
```

In [30]:

```
for coef, predictor in zip(coefs, predictors):
    print(f"The coefficient is {coef} for the predictor {predictor}. ")
```

```
The coefficient is 2.114936909246981 for the predictor AdvertisingExpenditur
e.
The coefficient is 2193.9622818087573 for the predictor StoreLocation.
The coefficient is 2272.7433334485504 for the predictor Competition.
```

In [38]:

```
X = sm.add_constant(X)
model = sm.OLS(Y, X).fit()

for predictor in predictors:
    print(f"t-test for predictor {predictor}")
    t_statistic = model.tvalues[predictor]
    p_value_t = model.pvalues[predictor]

    if p_value_t < 0.000001:
        print(f"{predictor} is a statistically significant predictor of
SalesRevenue")
    else:
        print(f"{predictor} is NOT a statistically significant predictor of
SalesRevenue")
```

```
t-test for predictor AdvertisingExpenditure
AdvertisingExpenditure is a statistically significant predictor of SalesReve
nue
t-test for predictor StoreLocation
StoreLocation is NOT a statistically significant predictor of SalesRevenue
t-test for predictor Competition
Competition is NOT a statistically significant predictor of SalesRevenue
```

In [43]:

```
f_statistic = model.fvalue
p_value_f = model.f_pvalue

if p_value_f < 0.02:
    print(f"The overall model and the regression coefficients are
statistically significant.")
else:
    print(f"The overall model and the regression coefficients are
statistically significant.")
```

```
The overall model and the regression coefficients are statistically signific
ant.
```