In-Class Assignment 2

- Answer the questions in this notebook and turn it in by the end of class.
- Note, the code is provided for you. If you cannot run the code, you can still type your answers next to the "Answer:" prompts and turn in the notebook.

In [33]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

# !pip install -q ISLP
import ISLP
from ISLP.models import summarize
import statsmodels.api as sm

from sklearn.model_selection import train_test_split
```

In [34]:
```
advertising_df = pd.read_csv("../../data/Advertising.csv", index_col=0)
advertising_df
```

Out[34]:

	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
...	...	...	...	...
196	38.2	3.7	13.8	7.6
197	94.2	4.9	8.1	9.7
198	177.0	9.3	6.4	12.8
199	283.6	42.0	66.2	25.5
200	232.1	8.6	8.7	13.4

200 rows × 4 columns

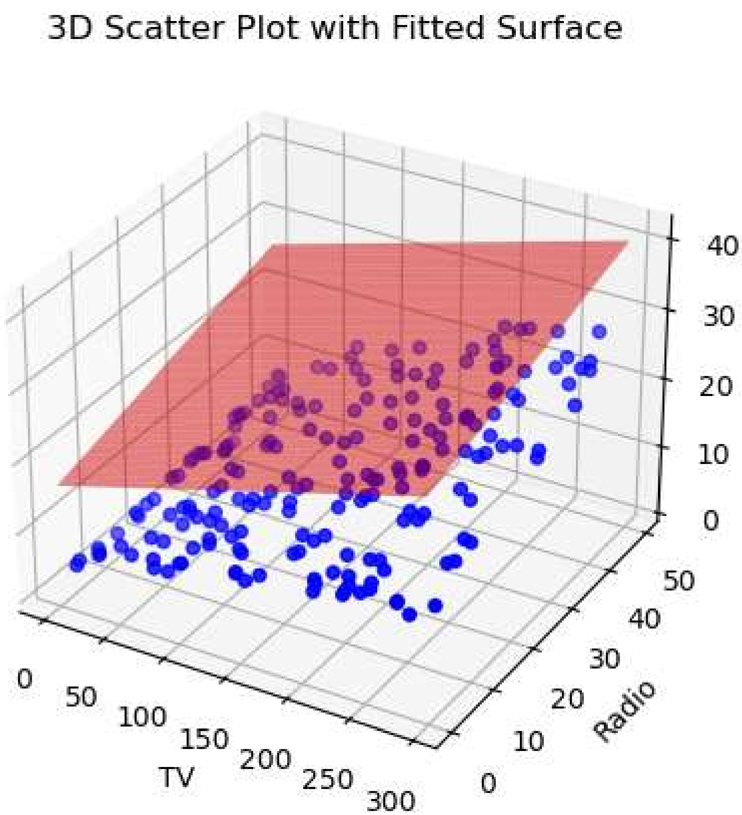
First, a small note from last week's class

In [35]:
```
fig, ax = plt.subplots(1, 3, figsize=(15, 5))
for (i, col) in enumerate(['TV', 'radio', 'newspaper']):
```

```
    advertising_df.plot.scatter(x=col, y='sales', ax=ax[i])
fig.suptitle('Advertising Expenditure to Predict Sales')
plt.tight_layout()
```

In [36]:

```
# Extracting the data
x = advertising_df['TV']
y = advertising_df['radio']
z = advertising_df['sales']

# Creating the 3D scatter plot
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.scatter(x, y, z, c='blue', marker='o')

# Fitting a surface
# Create a meshgrid for the surface plot
x_surf, y_surf = np.meshgrid(np.linspace(x.min(), x.max(), 100), np.linspace(y.min(
# Fit a polynomial surface
z_surf = np.polyval(np.polyfit(x, z, 1), x_surf) + np.polyval(np.polyfit(y, z, 1),

# Plot the surface
ax.plot_surface(x_surf, y_surf, z_surf, color='red', alpha=0.5)

# Labels
ax.set_xlabel('TV')
ax.set_ylabel('Radio')
ax.set_zlabel('Sales')
ax.set_title('3D Scatter Plot with Fitted Surface')

# Show the plot
plt.show()
```



In [37]:
```
advertising_df['intercept'] = 1
model = sm.OLS(advertising_df['sales'], advertising_df[['intercept', 'TV', 'radio',
results = model.fit()
summarize(results)
```

Out[37]:

	coef	std err	t	P>|t|
intercept	2.9389	0.312	9.422	0.00
TV	0.0458	0.001	32.809	0.00
radio	0.1885	0.009	21.893	0.00
newspaper	-0.0010	0.006	-0.177	0.86

In [40]:
```
advertising_df['TV*radio'] = advertising_df['TV'] * advertising_df['radio']
model = sm.OLS(advertising_df['sales'], advertising_df[['intercept', 'TV', 'radio',
results = model.fit()
summarize(results)
```

Out[40]:

	coef	std err	t	P>|t|
intercept	6.7284	0.253000	26.561	0.000
TV	0.0191	0.002000	12.633	0.000
radio	0.0280	0.009000	3.062	0.003
newspaper	0.0014	0.003000	0.438	0.662
TV*radio	0.0011	0.000053	20.686	0.000

Let's create a test set

In [41]:

```
# Define the test size
test_size = 0.1

# Perform the train-test split
train_df, test_df = train_test_split(advertising_df, test_size=test_size, random_st

# Display the test DataFrame
test_df
```

Out[41]:

	TV	radio	newspaper	sales	intercept	TV*Radio	TV*radio
96	163.3	31.6	52.9	16.9	1	5160.28	5160.28
16	195.4	47.7	52.9	22.4	1	9320.58	9320.58
31	292.9	28.3	43.2	21.4	1	8289.07	8289.07
159	11.7	36.9	45.2	7.3	1	431.73	431.73
129	220.3	49.0	3.2	24.7	1	10794.70	10794.70
116	75.1	35.0	52.7	12.6	1	2628.50	2628.50
70	216.8	43.9	27.2	22.3	1	9517.52	9517.52
171	50.0	11.6	18.4	8.4	1	580.00	580.00
175	222.4	3.4	13.1	11.5	1	756.16	756.16
46	175.1	22.5	31.5	14.9	1	3939.75	3939.75
67	31.5	24.6	2.2	9.5	1	774.90	774.90
183	56.2	5.7	29.7	8.7	1	320.34	320.34
166	234.5	3.4	84.8	11.9	1	797.30	797.30
79	5.4	29.9	9.4	5.3	1	161.46	161.46
187	139.5	2.1	26.6	10.3	1	292.95	292.95
178	170.2	7.8	35.2	11.7	1	1327.56	1327.56
57	7.3	28.1	41.4	5.5	1	205.13	205.13
153	197.6	23.3	14.2	16.6	1	4604.08	4604.08
83	75.3	20.3	32.5	11.3	1	1528.59	1528.59
69	237.4	27.5	11.0	18.9	1	6528.50	6528.50

Calculate MSE with different models

In [43]:

```
def get_train_test_mse_predictions(y_var, xvars, train_df, test_df):
    model = sm.OLS(train_df[y_var], train_df[xvars])
    model_fit = model.fit()
    train_y_hat = model_fit.predict(train_df[xvars])
    test_y_hat = model_fit.predict(test_df[xvars])
    train_mse = ((train_df[y_var] - train_y_hat)**2).mean()
    test_mse = ((test_df[y_var] - test_y_hat)**2).mean()

    print(xvars)
    print("Train MSE:", train_mse)
    print("Test MSE:", test_mse)
    print()
    return test_y_hat
```

```
y_var = 'sales'
x_vars_1 = ['intercept', 'TV', 'radio', 'newspaper']
x_vars_2 = ['intercept', 'TV', 'radio', 'newspaper', 'TV*radio']

test_y_hat_1 = get_train_test_mse_predictions(y_var, x_vars_1, train_df, test_df)
test_y_hat_2 = get_train_test_mse_predictions(y_var, x_vars_2, train_df, test_df)
```

```
['intercept', 'TV', 'radio', 'newspaper']
Train MSE: 2.7543155639500685
Test MSE: 3.1308020912380448

['intercept', 'TV', 'radio', 'newspaper', 'TV*radio']
Train MSE: 0.8661112504818059
Test MSE: 0.951547109426838
```

Question 1

Which model (1 or 2) has a lower Test MSE?

Answer: Model 2 has the lower test MSE as compared to Module 1

Question 2

Which model (1 or 2) performs better on the Training set and the Test set?

Answer: Model 2 performs better.