```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
plt.tight_layout()
import os
import statsmodels.formula.api as sm
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV
import warnings
```

```
<Figure size 640x480 with 0 Axes>
```

```
warnings.simplefilter(action='ignore', category=FutureWarning)
```

```
data_path = "/content/Advertising.csv"
df = pd.read_csv(data_path)
```

+ Code + Text

```
df.head()
```

	Unnamed: 0	TV	Radio	Newspaper	Sales
0	1	230.1	37.8	69.2	22.1
1	2	44.5	39.3	45.1	10.4
2	3	17.2	45.9	69.3	9.3
3	4	151.5	41.3	58.5	18.5
4	5	180.8	10.8	58.4	12.9

```
df.columns
```

```
Index(['Unnamed: 0', 'TV', 'Radio', 'Newspaper', 'Sales'], dtype='object')
```

```
df.rename(columns={'Unnamed: 0': 'Index'}, inplace=True)
```

```
df.shape
```

```
(200, 5)
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 5 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Index      200 non-null    int64
 1   TV         200 non-null    float64
 2   Radio      200 non-null    float64
 3   Newspaper  200 non-null    float64
 4   Sales      200 non-null    float64
dtypes: float64(4), int64(1)
memory usage: 7.9 KB
```

```
df
```

	Index	TV	Radio	Newspaper	Sales
0	1	230.1	37.8	69.2	22.1
1	2	44.5	39.3	45.1	10.4
2	3	17.2	45.9	69.3	9.3

```
df.describe()
```

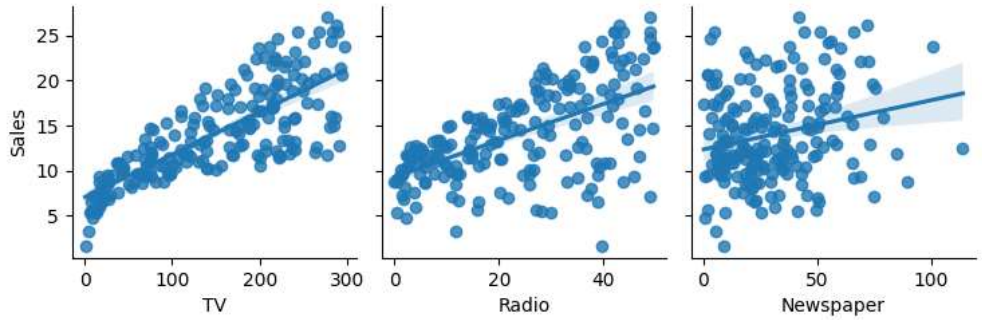
	Index	TV	Radio	Newspaper	Sales
count	200.000000	200.000000	200.000000	200.000000	200.000000
mean	100.500000	147.042500	23.264000	30.554000	14.022500
std	57.879185	85.854236	14.846809	21.778621	5.217457
min	1.000000	0.700000	0.000000	0.300000	1.600000
25%	50.750000	74.375000	9.975000	12.750000	10.375000
50%	100.500000	149.750000	22.900000	25.750000	12.900000
75%	150.250000	218.825000	36.525000	45.100000	17.400000
max	200.000000	296.400000	49.600000	114.000000	27.000000

```
df.isnull().values.any()
df.isnull().sum()
```

```
Index        0
TV           0
Radio        0
Newspaper    0
Sales        0
dtype: int64
```

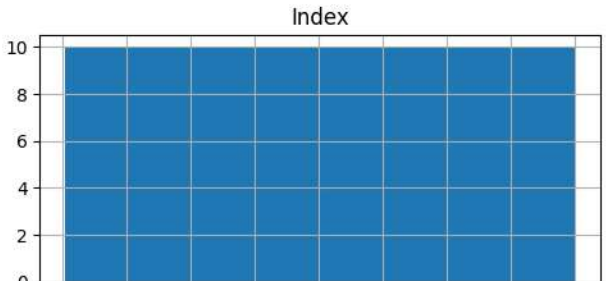
```
sns.pairplot(df, x_vars=["TV", "Radio", "Newspaper"], y_vars="Sales", kind="reg")
```

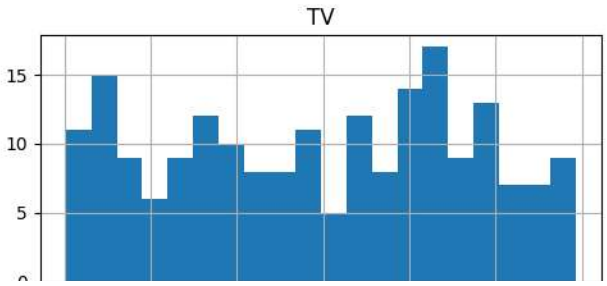
```
<seaborn.axisgrid.PairGrid at 0x7aa35d302920>
```




```
df.hist(bins=20, figsize=(13, 9))
```

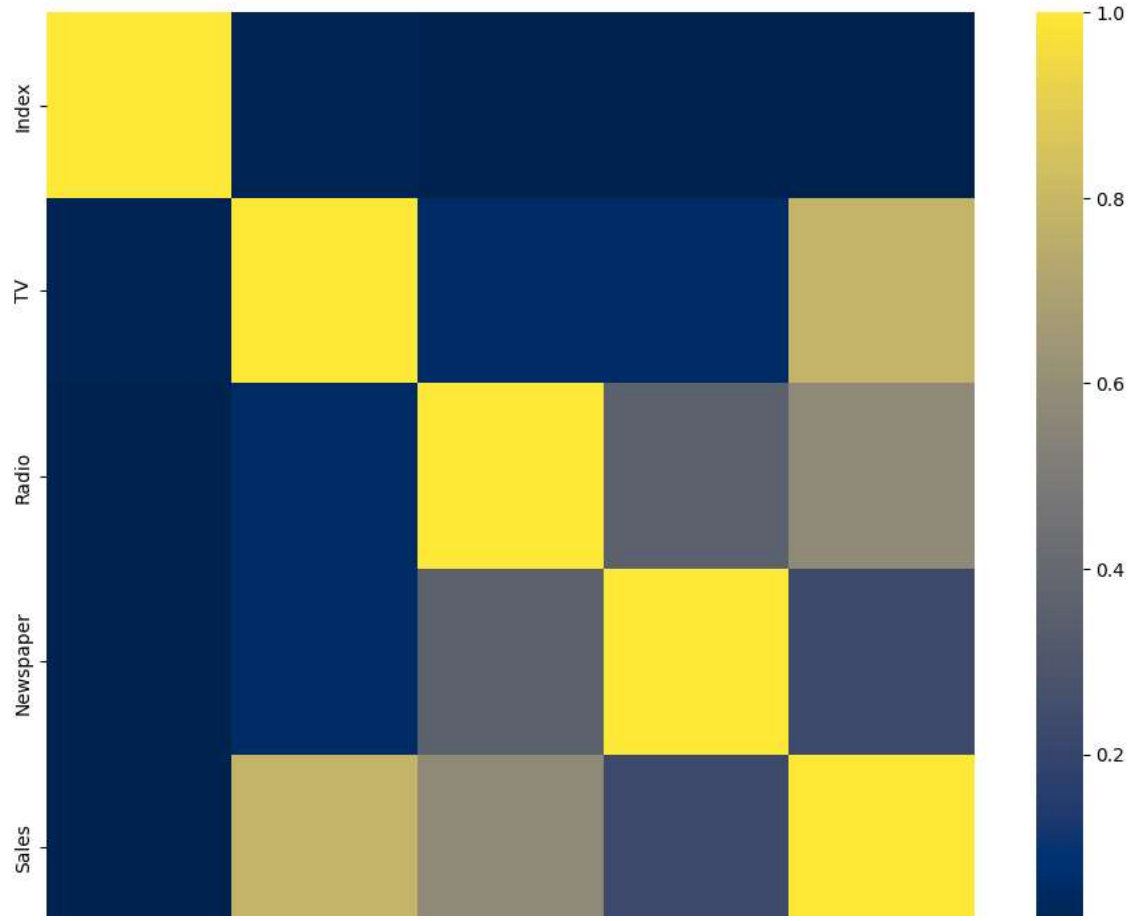
```
array([[<Axes: title={'center': 'Index'}>,
        <Axes: title={'center': 'TV'}>],
       [<Axes: title={'center': 'Radio'}>,
        <Axes: title={'center': 'Newspaper'}>],
       [<Axes: title={'center': 'Sales'}>, <Axes: >]], dtype=object)
```






```
sns.lmplot(x='TV', y='Sales', data=df)
sns.lmplot(x='Radio', y='Sales', data=df)
sns.lmplot(x='Newspaper', y='Sales', data=df)
```

```
corrmat = df.corr()
f, ax = plt.subplots(figsize=(12, 9))
sns.heatmap(corrmat, vmin=0, vmax=1, square=True, cmap="cividis", ax=ax)
plt.show()
```




```
X = df.drop('Sales', axis=1)
y = df[["Sales"]]
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.20, random_state=40)
```

```
lin_model = sm.ols(formula="Sales ~ TV + Radio + Newspaper", data=df).fit()
```

```
print(lin_model.params, "\n")
```

```
Intercept    2.938889
TV           0.045765
Radio        0.188530
Newspaper   -0.001037
dtype: float64
```

```
print(lin_model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                  Sales   R-squared:                       0.897
Model:                            OLS   Adj. R-squared:                  0.896
Method:                 Least Squares   F-statistic:                     570.3
Date:                Fri, 15 Sep 2023   Prob (F-statistic):          1.58e-96
Time:                        05:47:22   Log-Likelihood:                -386.18
No. Observations:                 200   AIC:                             780.4
Df Residuals:                     196   BIC:                             793.6
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept      2.9389      0.312      9.422      0.000       2.324       3.554
TV             0.0458      0.001     32.809      0.000       0.043       0.049
Radio          0.1885      0.009     21.893      0.000       0.172       0.206
Newspaper     -0.0010      0.006     -0.177      0.860      -0.013       0.011
==============================================================================
Omnibus:                       60.414   Durbin-Watson:                   2.084
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              151.241
Skew:                          -1.327   Prob(JB):                     1.44e-33
Kurtosis:                       6.332   Cond. No.                         454.
==============================================================================
```

```
Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

```
models = [('LinearRegression', LinearRegression())]
```

```
for name, model in models:
    model.fit(X_train, y_train)
    y_pred = model.predict(X_test)
    rmse = np.sqrt(mean_squared_error(y_test, y_pred))
    print(f"{name}: RMSE = {rmse:.2f}")
```

```
LinearRegression: RMSE = 2.36
```

```
new_data_1 = pd.DataFrame({'TV': [100], 'Radio': [50], 'Newspaper': [25]})
predicted_sales_1 = lin_model.predict(new_data_1)
print("Predicted Sales (Data 1):", predicted_sales_1)
```

```
Predicted Sales (Data 1): 0    16.915917
dtype: float64
```

```
new_data_2 = pd.DataFrame({'TV': [25], 'Radio': [63], 'Newspaper': [80]})
predicted_sales_2 = lin_model.predict(new_data_2)
print("Predicted Sales (Data 2):", predicted_sales_2)
```

```
Predicted Sales (Data 2): 0    15.877397
dtype: float64
```