Final Project Overview and Tasks

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Project Description / Business Task

Download the dataset provided and complete the tasks given below. You will then submit the completed worksheet and answer questions based on the tasks. When you submit your project, you will need to review the projects of three of your peers.

Data sources

You've been hired as a BI analyst by a supermarket chain. The management wants to analyze the probability distribution of revenue over the last three years, compare region-wise and product-wise revenue, and also find trends in the monthly revenue.

You've been provided with sales data for a store in the supermarket chain for the years 2021, 2022, and 2023, including information on sales transactions, product categories, and customer demographics.

In this assignment, you will:

```
Calculate the measures of central tendency: Mean, median, and mode.
Calculate the measures of dispersion: Standard deviation and variance.
Find the minimum, maximum, percentiles, and quartiles.
Create a histogram.
Create a pivot table.
Perform a multiple linear regression and interpret the outcome.
```

Data Tasks

For tasks 1 to 6, access the dataset in the sales_data worksheet. For task 7, use the dataset in the monthly_sales worksheet.

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Import Libraries

```
import numpy as np
#from numpy import count_nonzero, median, mean
import pandas as pd
from pandas.plotting import scatter_matrix
```

```
import matplotlib.pyplot as plt
import seaborn as sns
import random
#import squarify

import statistics
from collections import Counter
import statsmodels.api as sm
import statsmodels.formula.api as smf
from statsmodels.formula.api import ols
# Import variance_inflation_factor from statsmodels
#from statsmodels.stats.outliers_influence import
variance_inflation_factor
# Import Tukey's HSD function
#from statsmodels.stats.multicomp import pairwise_tukeyhsd

import datetime
from datetime import datetime, timedelta, date

import scipy
from scipy import stats
from scipy.stats.mstats import normaltest # D'Agostino K^2 Test
from scipy.stats import boxcox
from collections import Counter

%matplotlib inline
#sets the default autosave frequency in seconds
%autosave 60
sns.set_style('dark')
sns.set(font_scale=1.2)
#sns.set(rc={'figure.figsize':(14,10)})

plt.rc('axes', titlesize=9)
plt.rc('axes', labelsize=14)
plt.rc('xtick', labelsize=12)
plt.rc('ytick', labelsize=12)

import warnings
warnings.filterwarnings('ignore')

pd.set_option('display.max_columns',None)
#pd.set_option('display.max_rows',None)
pd.set_option('display.width', 1000)
pd.set_option('display.float_format','{:.2f}'.format)

random.seed(0)
np.random.seed(0)
np.set_printoptions(suppress=True)
```

```
Autosaving every 60 seconds
```

==========

Import Data

```
df = pd.read_csv("supermarketsales.csv")
```

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Data Quick Glance

```
df.head()
```

```
   Transaction  Purchase Date  Customer ID Gender Marital Status
Homeowner  Children  Annual Income           City State or Province
Country Product Family Product Department      Product Category  Units
Sold  Revenue
0            1           2021         7223      F               S
Y         2    $30K - $50K    Los Angeles                CA     USA
Food        Snack Foods           Snack Foods           5    27.38
1            2           2021         7841      M               M
Y         5    $70K - $90K    Los Angeles                CA     USA
Food            Produce            Vegetables           5    14.90
2            3           2021         8374      F               M
N         2    $50K - $70K      Bremerton                WA     USA
Food        Snack Foods           Snack Foods           3     5.52
3            4           2021         9619      M               M
Y         3    $30K - $50K       Portland                OR     USA
Food             Snacks                 Candy           4     4.44
4            5           2021         1900      F               S
Y         3  $130K - $150K  Beverly Hills                CA     USA
Drink          Beverages  Carbonated Beverages           4    14.00
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14059 entries, 0 to 14058
Data columns (total 16 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   Transaction         14059 non-null  int64
 1   Purchase Date       14059 non-null  int64
 2   Customer ID         14059 non-null  int64
 3   Gender              14059 non-null  object
 4   Marital Status      14059 non-null  object
 5   Homeowner           14059 non-null  object
 6   Children            14059 non-null  int64
 7   Annual Income       14059 non-null  object
 8   City                14059 non-null  object
```

```
 9   State or Province   14059 non-null  object
 10  Country             14059 non-null  object
 11  Product Family      14059 non-null  object
 12  Product Department  14059 non-null  object
 13  Product Category    14059 non-null  object
 14  Units Sold          14059 non-null  int64
 15  Revenue             14059 non-null  float64
dtypes: float64(1), int64(5), object(10)
memory usage: 1.7+ MB
```

```
df.dtypes.value_counts()
```

```
object     10
int64       5
float64     1
dtype: int64
```

```
#1 Measures of central tendency: Calculate the mean, median, and mode
of the revenue earned in each of the years 2021, 2022, and 2023.
```

```
df["Purchase Date"].unique()
```

```
array([2021, 2022, 2023], dtype=int64)
```

```
df2021 = df[df["Purchase Date"] == 2021]
df2021.head()
```

```
   Transaction  Purchase Date  Customer ID Gender Marital Status
Homeowner  Children  Annual Income           City State or Province
Country Product Family Product Department      Product Category  Units
Sold  Revenue
0            1           2021         7223      F               S
Y         2    $30K - $50K    Los Angeles               CA     USA
Food        Snack Foods           Snack Foods          5    27.38
1            2           2021         7841      M               M
Y         5    $70K - $90K    Los Angeles               CA     USA
Food            Produce            Vegetables          5    14.90
2            3           2021         8374      F               M
N         2    $50K - $70K      Bremerton               WA     USA
Food        Snack Foods           Snack Foods          3     5.52
3            4           2021         9619      M               M
Y         3    $30K - $50K       Portland               OR     USA
Food             Snacks                Candy          4     4.44
4            5           2021         1900      F               S
Y         3  $130K - $150K  Beverly Hills               CA     USA
Drink          Beverages  Carbonated Beverages           4    14.00
```

```
df2021.Revenue.describe()
```

```
count   35.00
mean    11.38
```

```
std      5.98
min      1.43
25%      7.00
50%     11.82
75%     14.63
max     27.38
Name: Revenue, dtype: float64
```

```
statistics.mode(df2021.Revenue)
```

```
8.74
```

```
df2022 = df[df["Purchase Date"] == 2022]
df2022.head()
```

```
    Transaction  Purchase Date  Customer ID Gender Marital Status
Homeowner  Children Annual Income         City State or Province
Country  Product Family  Product Department   Product Category  Units
Sold  Revenue
35           36           2022          240      M              M
N          2   $30K - $50K  Los Angeles               CA     USA
Food             Produce              Fruit           2     8.42
36           37           2022         6510      F              M
Y          0   $50K - $70K        Salem               OR     USA
Food             Produce         Vegetables           5     7.23
37           38           2022         7570      M              M
Y          4   $70K - $90K        Salem               OR     USA  Non-
Consumable  Health and Hygiene  Bathroom Products           3     6.07
38           39           2022         4686      F              S
N          2   $50K - $70K  Los Angeles               CA     USA  Non-
Consumable           Household         Electrical           5    11.90
39           40           2022         6207      M              M
N          1   $30K - $50K  Los Angeles               CA     USA
Drink               Dairy              Dairy            5    13.16
```

```
df2022.Revenue.describe()
```

```
count   4692.00
mean      12.90
std        8.09
min        0.62
25%        6.72
50%       11.16
75%       17.38
max       53.19
Name: Revenue, dtype: float64
```

```
statistics.mode(df2022.Revenue)
```

```
5.04
```

```
df2023 = df[df["Purchase Date"] == 2023]
df2023.head()
```

```
      Transaction  Purchase Date  Customer ID Gender Marital Status
Homeowner  Children  Annual Income         City State or Province
Country Product Family Product Department  Product Category  Units
Sold  Revenue
4727         4728           2023         4422      F               M
Y         3    $30K - $50K  Los Angeles               CA     USA
Food      Starchy Foods     Starchy Foods           2    11.68
4728         4729           2023         6712      M               M
Y         3  $110K - $130K      Spokane               WA     USA
Food       Baking Goods  Jams and Jellies           5     4.62
4729         4730           2023         2217      F               S
Y         4  $110K - $130K      Seattle               WA     USA
Food        Snack Foods       Snack Foods           4    12.77
4730         4731           2023         5295      M               S
Y         3    $30K - $50K      Spokane               WA     USA
Food            Produce        Vegetables           5     2.77
4731         4732           2023         3639      F               M
Y         2    $30K - $50K    San Diego               CA     USA
Food        Snack Foods       Snack Foods           5     7.13
```

```
df2023.Revenue.describe()
```

```
count   9332.00
mean      13.06
std        8.29
min        0.53
25%        6.91
50%       11.28
75%       17.37
max       56.70
Name: Revenue, dtype: float64
```

```
statistics.mode(df2023.Revenue)
```

```
7.56
```

```
#2 Measures of dispersion: Calculate the variance and standard
deviation for the revenue earned in 2021
```

```
df2021.Revenue.var(), df2021.Revenue.std()
```

```
(35.717896974789916, 5.976445178765544)
```

```
#3 Minimum and maximum: Calculate the minimum and maximum revenues
from 2021 to 2023.
```

```
df.Revenue.min(), df.Revenue.max()
```

```
(0.53, 56.7)
```

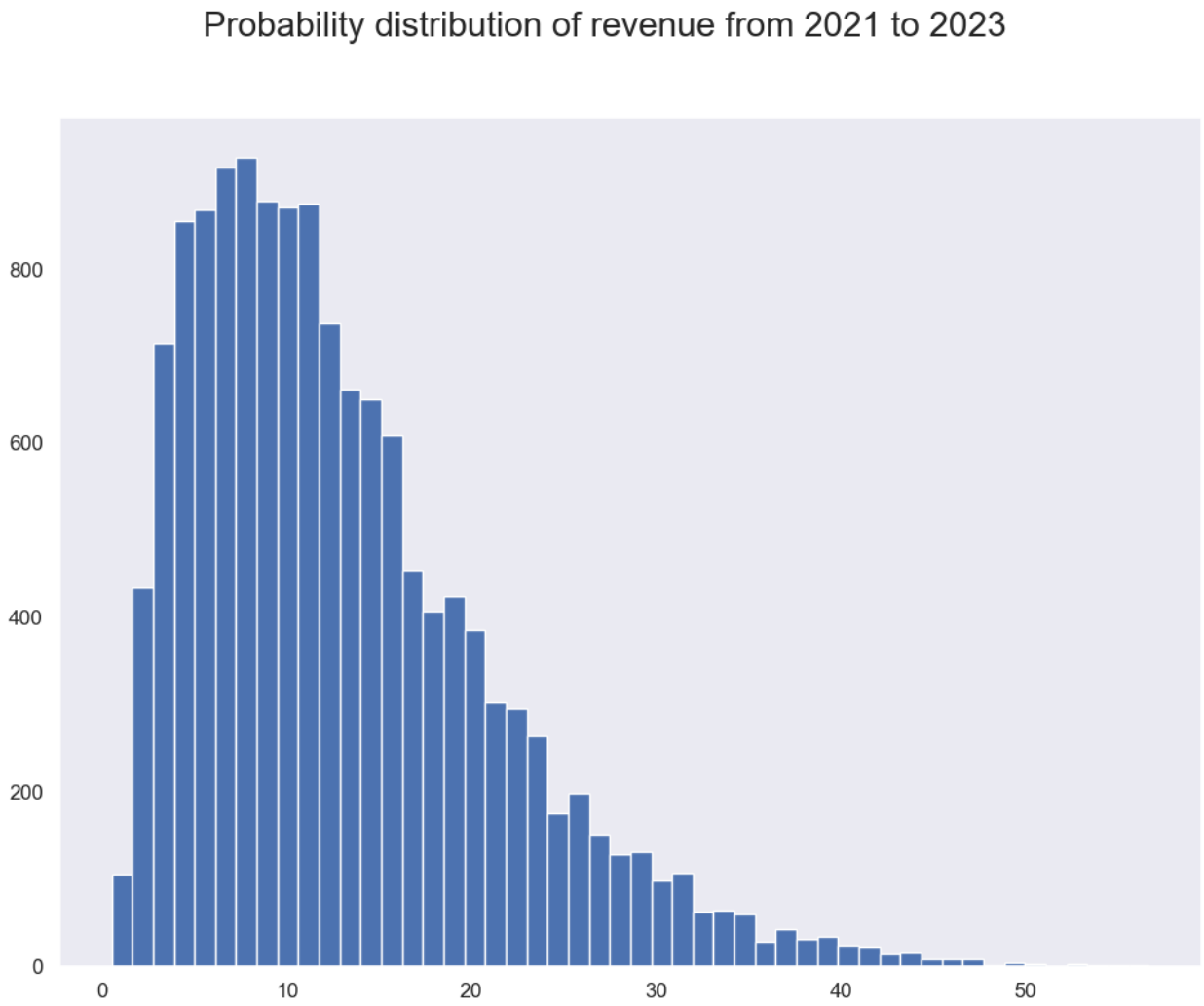
```
#4 Quartiles and percentiles: Calculate the following quartiles and percentiles:

# Calculate quartiles
first_quartile = np.percentile(df2021.Revenue, 25)
second_quartile = np.percentile(df2021.Revenue, 50)  # Median
third_quartile = np.percentile(df2021.Revenue, 75)

first_quartile, second_quartile, third_quartile
```

```
(7.0, 11.82, 14.629999999999999)
```

```
# Calculate percentiles
percentiles = [1, 5, 50, 75, 95, 99]
percentile_values = np.percentile(df2021.Revenue, percentiles)

print("\nPercentiles of the 2021 revenue:")
for p, value in zip(percentiles, percentile_values):
    print(f"{p} percentile:", value)
```

```
Percentiles of the 2021 revenue:
1 percentile: 1.7632
5 percentile: 3.117
50 percentile: 11.82
75 percentile: 14.629999999999999
95 percentile: 20.135999999999996
99 percentile: 25.42159999999998
```

```
#5 Histogram: Create a histogram showing the probability distribution of revenue from 2021 to 2023.

df.Revenue.hist(bins=50, figsize=(10, 8), grid=False)
plt.suptitle('Probability distribution of revenue from 2021 to 2023',
x=0.5, y=1.02, ha='center', fontsize=20)

plt.tight_layout()
plt.show()
```




```
#6 Pivot charts: Create two pivot charts in two separate worksheets to
demonstrate the following:
#  Show the revenue generated in each country and city during the
period from 2021 to 2023.
#  Name the Worksheet, Pivot_chart_a. Find out which country grosses
the least revenue? (Canada)

# Create a pivot table
pivot_table1 = df.pivot_table(index=['Country', 'City'],
columns='Purchase Date', values='Revenue', aggfunc='sum')

pivot_table1
```

Purchase Date		2021	2022	2023
Country	City			
Canada	Vancouver	NaN	112.42	8552.58
	Victoria	NaN	29.54	2372.49
Mexico	Acapulco	NaN	33.24	5128.07
	Camacho	NaN	75.06	5722.39

```
        Guadalajara     NaN     NaN   523.32
        Hidalgo         NaN   65.20 11247.57
        Merida          NaN   98.46  8641.99
        Mexico City     NaN     NaN  2488.31
        Orizaba         NaN  162.65  6082.57
        San Andres      NaN   41.89  8164.16
USA     Bellingham    21.59  509.20   461.84
        Beverly Hills 77.40 4927.42  5315.35
        Bremerton      5.52 5221.51  5747.86
        Los Angeles   51.02 6528.91  5716.24
        Portland      42.92 5659.90  6223.78
        Salem         49.85 9477.28  8684.71
        San Diego     76.82 5593.27  5699.68
        San Francisco  4.49  384.60   355.21
        Seattle         NaN 5667.92  6484.47
        Spokane         NaN 5115.39  6118.65
        Tacoma        34.16 7824.27  8972.72
        Walla Walla     NaN  502.66   661.94
        Yakima        34.59 2499.93  2535.45
```

Which country generates the least revenue? (Canada)

```
# Show the average revenue generated by each product family in each
country and city.
# Name the worksheet 'Pivot_chart_b.'

pivot_table2 = df.pivot_table(index=['Country', 'City'],
columns='Product Family', values='Revenue', aggfunc='mean')

pivot_table2
```

```
Product Family         Drink  Food  Non-Consumable
Country City
Canada  Vancouver      13.00 13.98           12.90
        Victoria       12.87 14.15           12.38
Mexico  Acapulco       14.89 13.49           12.59
        Camacho        11.67 13.24           11.79
        Guadalajara     6.90  6.68            8.30
        Hidalgo        11.83 13.51           13.68
        Merida         12.27 13.38           13.76
        Mexico City    17.51 12.62           11.78
        Orizaba        12.99 13.27           14.29
        San Andres     14.20 13.16           12.99
USA     Bellingham      6.53  7.21            6.31
        Beverly Hills  11.81 12.86           12.66
        Bremerton      12.81 13.37           12.39
        Los Angeles    12.50 13.13           14.21
        Portland       12.31 13.69           13.88
        Salem          12.13 13.41           12.62
        San Diego      14.93 12.89           13.01
```

```
        San Francisco   8.72  5.35            5.26
        Seattle        13.94 13.09           13.12
        Spokane        11.86 13.06           12.50
        Tacoma         12.83 13.48           13.28
        Walla Walla     7.22  7.35            7.03
        Yakima         14.32 13.38           13.52
```

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```
# Multiple linear regression:

#a. Use the dataset in the monthly_sales worksheet. The data sheet
shows the monthly sales in 2021, 2022, and 2023. Find how the 2023
sales revenue depends on the monthly sales in 2021 and 2022 using
multiple linear regression. Use the XLMiner Analysis Toolpak add-in to
perform the regression analysis. (If you are using the desktop version
of Excel, you may use the Data Analysis Toolpak available in the add-
in.) The regression summary must be displayed in the same worksheet.

#b. Interpret the output. During your submission, you will record the
R-squared value, Significance F of the models, and p-values for each
independent variable and explain what these values signify.

df2 = pd.read_csv("monthly_sales.csv")
df2
```

	Month	2021Sales	2022Sales	2023Sales
0	January	47.80	5110.92	9877.97
1	February	22.81	5056.59	10243.35
2	March	23.53	4888.17	10329.64
3	April	35.23	5024.49	10371.28
4	May	51.74	4792.85	10248.42
5	June	38.81	5198.42	10243.03
6	July	32.33	419.79	10198.81
7	August	31.33	5125.88	10367.29
8	September	32.68	5230.95	10140.83
9	October	127.94	5160.45	9876.70
10	November	46.87	5045.88	10002.39
11	December	12.37	4762.18	10001.64

```
df2.columns
```

```
Index(['Month', '2021Sales', '2022Sales', '2023Sales'],
dtype='object')
```

What are the dependent and independent variables?

'2021Sales', '2022Sales' are Independent variables

'2023Sales' is Dependent variable

```
# Prepare the data
X = df2[['2021Sales', '2022Sales']]  # Independent variables
y = df2['2023Sales']  # Dependent variable

# Add a constant term to the independent variables
X = sm.add_constant(X)

# Fit the multiple linear regression model
model = sm.OLS(y, X).fit()

# Print the model summary
print(model.summary())
```

```
                            OLS Regression Results

==============================================================================
========
Dep. Variable:               2023Sales   R-squared:
0.272
Model:                             OLS   Adj. R-squared:
0.111
Method:                  Least Squares   F-statistic:
1.685
Date:                 Tue, 20 Feb 2024   Prob (F-statistic):
0.239
Time:                         20:08:23   Log-Likelihood:
-76.797
No. Observations:                  12   AIC:
159.6
Df Residuals:                       9   BIC:
161.0
Df Model:                           2

Covariance Type:             nonrobust

==============================================================================
========
                 coef    std err          t      P>|t|      [0.025
0.975]
------------------------------------------------------------------------------
--------
const        1.03e+04    188.689     54.576      0.000    9870.946
1.07e+04
2021Sales     -3.1604      1.744     -1.812      0.103      -7.106
```

```
0.785
2022Sales     -0.0015      0.038     -0.038      0.970      -0.088
0.085
==============================================================================
Omnibus:                        1.150   Durbin-Watson:
0.856
Prob(Omnibus):                  0.563   Jarque-Bera (JB):
0.935
Skew:                          -0.543   Prob(JB):
0.627
Kurtosis:                       2.170   Cond. No.
1.88e+04
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is
correctly specified.
[2] The condition number is large, 1.88e+04. This might indicate that
there are
strong multicollinearity or other numerical problems.
```

What part of the variance in the 2023 Sales is explained by the model?

R-squared value

Is the model as a whole statistically significant?

No, as both p-values more than 0.05

Is each independent variable statistically independent?

The p-values associated with some coefficients are not significant, it suggests that those independent variables may not be making a unique or statistically significant contribution to explaining the variation in the dependent variable, given the other independent variables in the model.

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Python code done by Dennis Lam