

# TASK 1

## Description of the Dataset (100 words)

This dataset is a collection of global retail company in United States, shows the transaction details from a retail operation, linking customers, orders, and products through sales records. It includes:

Customer information ('Customer ID', 'Customer Name', 'Segment', 'Country', 'City', 'State', 'Postal Code', 'Region'),

Order specifics ('Order ID', 'Order Date', 'Ship Date', 'Ship Mode'), where 'Order Date' and 'Ship Date' are incorrectly categorized and should be in Datetime format.

Product attributes ('Product ID', 'Category', 'Sub-Category', 'Product Name'),

Sales transactions ('Sales', 'Quantity', 'Discount', 'Profit'), which should be in Numeric format.

There are some challenges which need to be addressed before analysis can be conducted. Among these challenges are missing values, typos, also errors that are scattered around the datas. Missing values can impact the accuracy of any analysis, leading to incorrect conclusions.

Typos, particularly in text-based fields such as 'Product Name' or 'Customer Name', create inconsistencies which complicate categorization and analysis.

Errors, which manifest as incorrect entries in numerical fields like 'Sales', 'Quantity', 'Discount', 'Profit', or inaccuracies in 'Order Date' and 'Ship Date' fields, can mislead analysis then affect the reliability of any insights from the dataset.

Addressing these issues is very important to ensure the integrity of the analysis, requiring a data cleaning process to identify these imperfections, to enhance the dataset's quality and reliability for analytical tasks.

```
In [1]: import numpy as np
import pandas as pd
from sklearn import tree
import matplotlib.pyplot as plt
from scipy.stats import zscore
from sklearn.preprocessing import MinMaxScaler
import seaborn as sns
pd.set_option('display.max_colwidth', 160)
import warnings
warnings.filterwarnings('ignore')
```

```
In [2]: input_file = "sample-superstore_2023_T3.csv"
df = pd.read_csv(input_file, header = 0)
df.head(10)
```

Out[2]:

	Row ID	Order ID	Order Date	Ship Date	Ship Mode	Customer ID	Customer Name	Segment	Country	City	...	Postal Code
0	7773	CA-2016-108196	25/11/2016	12/02/2016	Standard Class	CS-12505	Cindy Stewart	Consumer	United States	Lancaster	...	43130
1	684	US-2017-168116	11/04/2017	11/04/2017	Same Day	GT-14635	Grant Thornton	Corporate	United States	Burlington	...	"27217"
2	9775	CA-2014-169019	26/07/2014	30/07/2014	Standard Class	LF-17185	Luke Foster	Consumer	United States	San Antonio	...	78207
3	3012	CA-2017-134845	17/04/2017	24/04/2017	Standard Class	SR-20425	Sharelle Roach	Home Office	United States	Louisville	...	80027
4	4992	US-2017-122714	12/07/2017	13/12/2017	Standard Class	HG-14965	Henry Goldwyn	Corporate	United States	Chicago	...	60653
5	3152	CA-2015-147830	15/12/2015	18/12/2015	First Class	NF-18385	Natalie Fritzler	Consumer	United States	Newark	...	43055
6	5311	CA-2017-131254	19/11/2017	21/11/2017	First Class	NC-18415	Nathan Cano	Consumer	United States	Houston	...	77095
7	9640	CA-2015-116638	28/01/2015	NaN	Second Class	JH-15985	Joseph Holt	Consumer	United States	Concord	...	28027
8	1200	CA-2016-130946	04/08/2016	04/12/2016	Standard Class	Zuschuss Carroll	Zuschuss Carroll	Consumer	United States	Houston	...	77041
9	2698	CA-2014-145317	18/03/2014	23/03/2014	Standard Class	SM-20320	Sean Miller	Home Office	NaN	Jacksonville	...	32216

10 rows × 21 columns

In [3]: `len(df)`

Out[3]: 9994

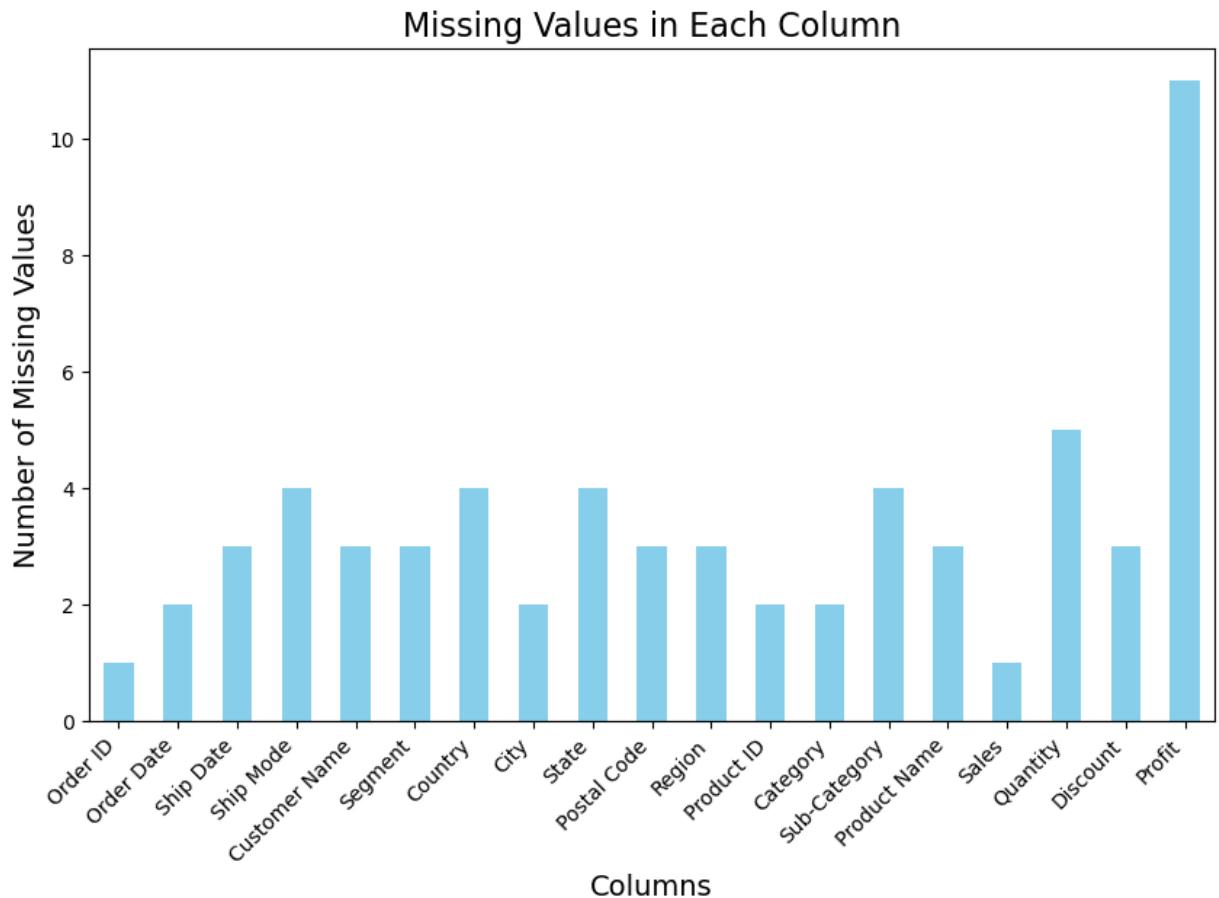
In [4]: `print(df.columns)`

```
Index(['Row ID', 'Order ID', 'Order Date', 'Ship Date', 'Ship Mode',
       'Customer ID', 'Customer Name', 'Segment', 'Country', 'City', 'State',
       'Postal Code', 'Region', 'Product ID', 'Category', 'Sub-Category',
       'Product Name', 'Sales', 'Quantity', 'Discount', 'Profit'],
      dtype='object')
```

In [5]: `#Check all missing value in dataset`  
`df_missing_values = df.isnull().sum()`  
`df_missing_values`

```
Out[5]: Row ID      0  
Order ID     1  
Order Date   2  
Ship Date    3  
Ship Mode    4  
Customer ID  0  
Customer Name 3  
Segment      3  
Country      4  
City          2  
State         4  
Postal Code   3  
Region        3  
Product ID   2  
Category      2  
Sub-Category  4  
Product Name  3  
Sales          1  
Quantity      5  
Discount      3  
Profit         11  
dtype: int64
```

```
In [6]: df_missing_values = df_missing_values[df_missing_values > 0]  
  
plt.figure(figsize=(10, 6))  
df_missing_values.plot(kind='bar', color='skyblue')  
plt.title('Missing Values in Each Column', fontsize=16)  
plt.xlabel('Columns', fontsize=14)  
plt.ylabel('Number of Missing Values', fontsize=14)  
plt.xticks(rotation=45, ha='right')  
plt.show()
```



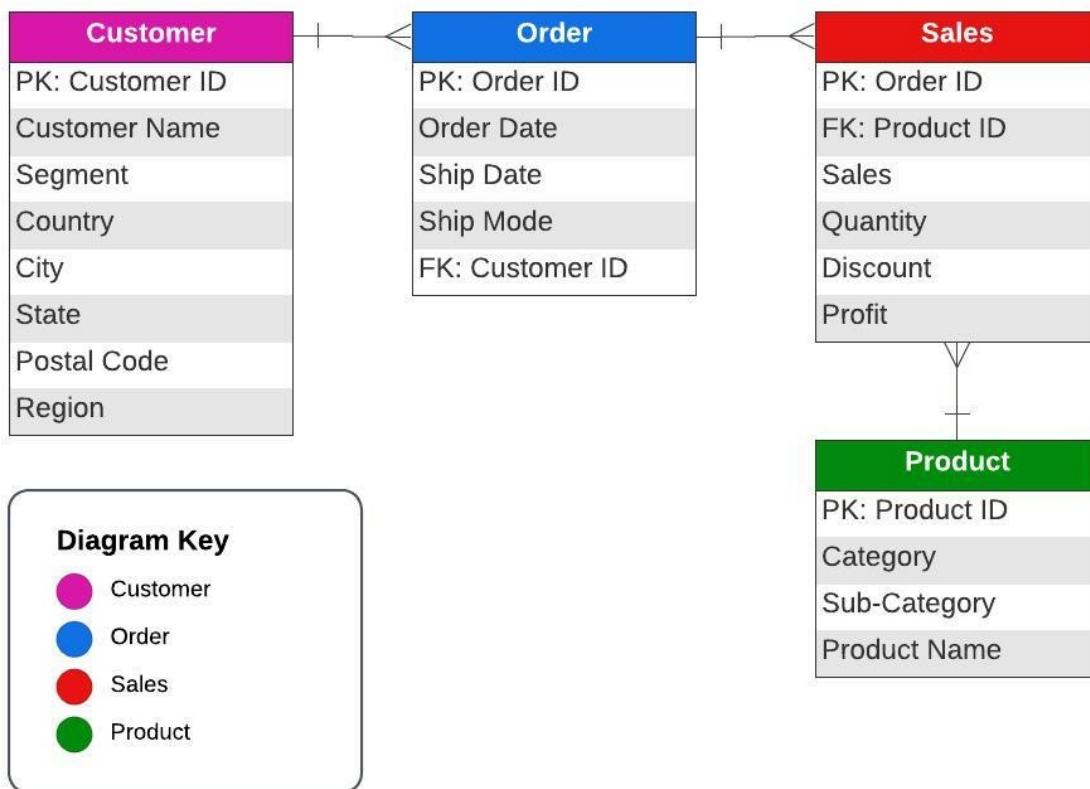
## ER Diagram

Relationships:

Customer to Order: One-to-Many. A customer can place multiple orders, but each order is placed by a single customer. "Customer ID" should be a foreign key (FK) in the "Order" entity.

Order to Sales: One-to-Many. An order can include multiple products (sales), but each sale row is associated with one order.

Product to Sales: One-to-Many. A product can be part of multiple sales (orders), but each sale row references one specific product.



## TASK 2

### Summarization of How to Apply Various Techniques to the Dataset (300 words)

#### Data Cleaning and Preparation:

Before analysis can commence, need to clean the dataset to be prepared due to several issues. Begins with importing necessary libraries such as pandas, NumPy, matplotlib, and seaborn. The initial step involves loading a dataset, followed by preliminary cleaning. This includes handling missing values, correcting data types like converting 'Order Date' and 'Ship Date' to datetime format, and addressing inconsistencies/ errors in the data, such as typos in several columns.

Inconsistencies are everywhere, with notable typos in 'Order Date' and 'Ship Date' columns leading to unrealistic delivery periods, such as 91 days. Furthermore, the date fields are not formatted as datetime, and the 'Quantity' and 'Profit' columns, which should be numerical, are erroneously listed as object data types. This situation complicates any attempts to correct data types without first addressing the missing values.

The initial phase involves segregating dataset (df) into 4 groups: df\_Product, df\_Sales, df\_Customer, and df\_Order, and then cleaning each group individually. This stage covers rectifying missing information, adjusting data types, and later merging these cleaned segments into a unified dataset (df1).

#### Tackle missing values:

Apply imputation techniques, filling in gaps with correspondence values from similar data. This step is necessary for the integrity of our dataset.

Correcting date entries is another critical task. Incorrect placements of day and month values can lead to skewed delivery times; therefore, adjustments—such as swapping the day and month—are made to ensure that delivery schedules accurately mirror reality.

After rectifying these preliminary issues, we compile the cleansed data into a comprehensive dataset ready for further analysis.

#### Outlier Detection and Removal:

Using statistical methods like the calculation of z-scores, identifies outliers within the dataset is necessary, especially in numerical columns such as 'Sales', 'Quantity', 'Discount', 'Profit'. These outliers are removed to normalize the data distribution and improve the accuracy.

#### Normalization or Scaling:

To ensure uniformity in the dataset, especially before conducting any form of multivariate analysis, apply scaling techniques to numerical variables. This process ensures that variables are on a similar scale, preventing any one variable from disproportionately influencing the analysis.

#### Descriptive Statistical Analysis:

After cleaning, performs a descriptive statistical analysis to summarize the central tendencies, dispersion, and shape of the dataset's distributions. This include calculating means, medians, modes, variances, and standard deviations for numerical data, providing a solid understanding of dataset's characteristics.

#### Univariate Analysis:

The univariate analysis focusing on single variables to understand the individual properties.

#### Visualization:

Various data visualizations are to convey findings effectively. This could range from simple line plots and bar charts to more complex visualizations like heatmaps for correlation matrices, or pie charts to illustrate proportional relationships.

## Grouping of Data

```
In [7]: df_Product = df[['Row ID','Product ID', 'Category', 'Sub-Category', 'Product Name']]  
df_Sales = df[['Row ID', 'Order ID', 'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]  
df_Customer = df[['Row ID','Customer ID', 'Customer Name', 'Segment','Country', 'City', 'State', 'Po  
df_Order = df[['Row ID','Order ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Customer ID']]
```

### 1. df\_Product group

```
In [8]: df_Product.head(10)
```

Out[8]:

	Row ID	Product ID	Category	Sub-Category	Product Name
0	7773	TEC-MA-10000418	Technology	Machines	Cubify CubeX 3D Printer Double Head Print
1	684	TEC-MA-10004125	Technology	Machines	Cubify CubeX 3D Printer Triple Head Print
2	9775	OFF-BI-10004995	Office Supplies	Binders	GBC DocuBind P400 Electric Binding System
3	3012	TEC-MA-10000822	Technology	Machines	Lexmark MX611dhe Monochrome Laser Printer
4	4992	OFF-BI-10001120	Office Supplies	Binders	Ibico EPK-21 Electric Binding System
5	3152	TEC-MA-10000418	Technology	Machines	Cubify CubeX 3D Printer Double Head Print
6	5311	OFF-BI-10003527	Office Supplies	Binders	Fellowes PB500 Electric Punch Plastic Comb Binding Machine with Manual Bind
7	9640	FUR-TA-10000198	Frnture	Tables	Chromcraft Bull-Nose Wood Oval Conference Tables & Bases
8	1200	OFF-BI-10004995	Office Supplies	Binders	GBC DocuBind P400 Electric Binding System
9	2698	TEC-MA-10002412	Technology	Machines	Cisco TelePresence System EX90 Videoconferencing Unit

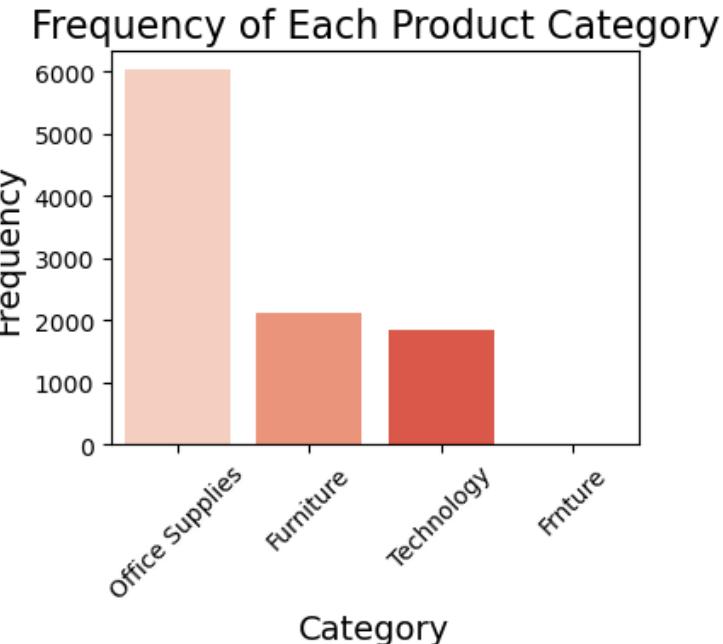
## df\_Product - Handling outliers and missing values

### df\_Product Finding Outliers

```
In [9]: #Find unique values in df_Product['Category']
unique_cat = df_Product['Category'].unique()
print(unique_cat)
```

```
['Technology' 'Office Supplies' 'Frnture' 'Furniture' 'nan']
```

```
In [10]: df_Product_category_counts = df_Product['Category'].value_counts()
plt.figure(figsize=(4, 3))
sns.barplot(x=df_Product_category_counts.index, y=df_Product_category_counts.values, palette='Reds')
plt.title('Frequency of Each Product Category', fontsize=16)
plt.xlabel('Category', fontsize=14)
plt.ylabel('Frequency', fontsize=14)
plt.xticks(rotation=45)
plt.show()
```

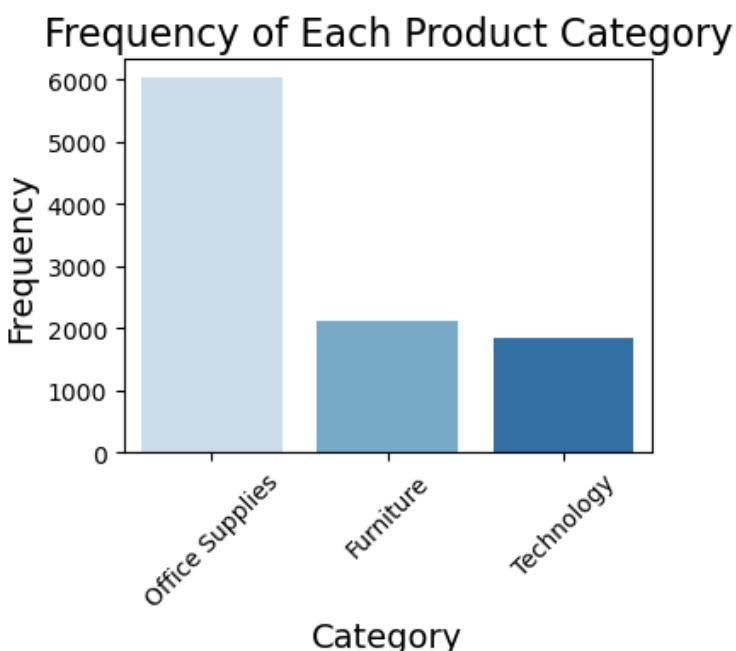


'Frnture' value is a typo.

```
In [11]: # Replace typos
df_Product['Category'] = df_Product['Category'].replace({'Frnture': 'Furniture'})
unique_cat = df_Product['Category'].unique()
print(unique_cat)
```

['Technology' 'Office Supplies' 'Furniture' 'nan']

```
In [12]: df_Product_category_counts = df_Product['Category'].value_counts()
plt.figure(figsize=(4, 3))
sns.barplot(x=df_Product_category_counts.index, y=df_Product_category_counts.values, palette='Blues')
plt.title('Frequency of Each Product Category', fontsize=16)
plt.xlabel('Category', fontsize=14)
plt.ylabel('Frequency', fontsize=14)
plt.xticks(rotation=45)
plt.show()
```



```
In [13]: #Find unique values in df_Product['Sub-Category']
unique_subcat = df_Product['Sub-Category'].unique()
unique_subcat
```

```
Out[13]: array(['Machines', 'Binders', 'Tables', 'Bookcases', nan, 'Appliances',
   'Supplies', 'Chairs', 'Furnishings', 'Phones', 'Storage',
   'Accessories', 'Fasteners', 'Art', 'Envelopes', 'Labels', 'Paper',
   'Copiers'], dtype=object)
```

No strange values.

```
In [14]: #Find unique values in df_Product['Product Name']
unique_prodname = df_Product['Product Name'].unique()
len(unique_prodname)
```

```
Out[14]: 1851
```

```
In [15]: # Show data types of each column in df_Product
print(df_Product.dtypes)
```

```
Row ID      int64
Product ID    object
Category     object
Sub-Category  object
Product Name  object
dtype: object
```

```
In [16]: #Check updated missing value in df_Product
df_Product_missing_values = df_Product.isnull().sum()
print(df_Product_missing_values)
```

```
Row ID      0
Product ID  2
Category     2
Sub-Category 4
Product Name 3
dtype: int64
```

## df\_Product['Product ID'] missing values

To fill in missing 'Product ID' values with correspond 'Product Name' values in the dataset

```
In [17]: #Compare with specified 'Product ID' and 'Product Name' in other rows
Product_missing_id = df_Product.loc[df_Product['Product ID'].isnull(), 'Product Name'].unique()
print(Product_missing_id)

['Laminate Occasional Tables' 'GBC ProClick Punch Binding System']
```

```
In [18]: df_Product.sort_values(by=['Product Name'], inplace=True, ascending=False)
product_laminate = df_Product[df_Product['Product Name'] == 'Laminate Occasional Tables'][[
    'Product ID', 'Category', 'Sub-Category', 'Product Name']]
print(product_laminate)
```

```
Product ID  Category Sub-Category          Product Name
206         NaN     Furniture      Tables  Laminate Occasional Tables
675  FUR-TA-10002774  Furniture      Tables  Laminate Occasional Tables
1063  FUR-TA-10002774  Furniture      Tables  Laminate Occasional Tables
```

```
In [19]: #Fill in missing value in 'Product ID' with correspondence 'value with the same 'Product Name'
df_Product.loc[206, 'Product ID'] = 'FUR-TA-10002774'
```

```
In [20]: df_Product.sort_values(by=['Product Name'], inplace=True, ascending=False)
product_laminate = df_Product[df_Product['Product Name'] == 'Laminate Occasional Tables'][[
    'Product ID', 'Category', 'Sub-Category', 'Product Name']]
print(product_laminate)
```

```
Product ID  Category Sub-Category          Product Name
206  FUR-TA-10002774  Furniture      Tables  Laminate Occasional Tables
675  FUR-TA-10002774  Furniture      Tables  Laminate Occasional Tables
1063  FUR-TA-10002774  Furniture      Tables  Laminate Occasional Tables
```

```
In [21]: df_Product.sort_values(by=['Product Name'], inplace=True, ascending=False)
product_gbc = df_Product[df_Product['Product Name'] == 'GBC ProClick Punch Binding System'][[
    'Product ID', 'Category', 'Product Name']]
print(product_gbc)
```

	Product ID	Category	Product Name
9445	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
9621	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
9622	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
8570	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
377	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
494	NaN	Office Supplies	GBC ProClick Punch Binding System
7854	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System

```
In [22]: #Fill in missing value in 'Product ID' with correspondence 'value with the same 'Product Name'
df_Product.loc[494, 'Product ID'] = 'OFF-BI-10001071'
```

```
In [23]: df_Product.sort_values(by=['Product Name'], inplace=True, ascending=False)
product_gbc = df_Product[df_Product['Product Name'] == 'GBC ProClick Punch Binding System'][[
    'Product ID', 'Category', 'Product Name']]
print(product_gbc)
```

	Product ID	Category	Product Name
9445	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
9621	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
9622	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
8570	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
377	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
494	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System
7854	OFF-BI-10001071	Office Supplies	GBC ProClick Punch Binding System

## df\_Product['Category', 'Sub-Category', 'Product Name'] outliers and missing values

To fill in missing 'Category', 'Sub-Category', 'Product Name' values with correspond 'Product ID' values in the dataset

```
In [24]: Product_columns_to_update = ['Category', 'Sub-Category', 'Product Name']

for column in Product_columns_to_update:
    Product_ids_missing_values = df_Product.loc[df_Product[column].isnull(), 'Product ID'].unique()
    for Product_id in Product_ids_missing_values:

        # Check if there's at least one not-null value for this Product ID in the current column
        if not df_Product[df_Product['Product ID'] == Product_id][column].dropna().empty:

            # Get the first not-null value
            value_to_fill = df_Product.loc[df_Product['Product ID'] == Product_id, column].dropna().values[0]

            # Fill in missing values for Product ID in the current column
            df_Product.loc[df_Product['Product ID'] == Product_id, column] = value_to_fill
```

```
In [25]: #Check updated missing value in df_Product
df_Product_missing_values = df_Product.isnull().sum()
print(df_Product_missing_values)
```

Row ID	0
Product ID	0
Category	0
Sub-Category	1
Product Name	0
dtype:	int64

Will investigate why it didn't work for one of 'Sub-Category' column.

## df\_Product['Sub-Category'] handling missing values

To fill in missing 'Category', 'Sub-Category', 'Product Name' values with correspond values in the dataset

```
In [26]: #Compare with specified 'Product ID' and 'Sub-Category' in other rows
Product_missing_sub= df_Product.loc[df_Product['Sub-Category'].isnull(), 'Product ID'].unique()
print(Product_missing_sub)

['TEC-MA-10003337']
```

```
In [27]: df_Product.sort_values(by=['Product ID'], inplace=True, ascending=False)
product_10003337 = df_Product[df_Product['Product ID'] == 'TEC-MA-10003337'][[
    'Product ID', 'Category', 'Sub-Category', 'Product Name']]
print(product_10003337)
```

	Product ID	Category	Sub-Category	Product Name
124	TEC-MA-10003337	Technology	NaN	Okidata B401 Printer

It appears that there is only one data entry for the 'Product ID' TEC-MA-10003337.

As a result, there are no additional records for this 'Product ID' to compare with.

```
In [28]: # Fill in the 'Sub-Category' manually
df_Product.loc[124, 'Sub-Category'] = 'Printers'
```

```
In [29]: df_Product.sort_values(by=['Product ID'], inplace=True, ascending=False)
product_10003337 = df_Product[df_Product['Product ID'] == 'TEC-MA-10003337'][[
    'Product ID', 'Category', 'Sub-Category', 'Product Name']]
print(product_10003337)
```

	Product ID	Category	Sub-Category	Product Name
124	TEC-MA-10003337	Technology	Printers	Okidata B401 Printer

```
In [30]: #Check updated missing value in df_Product
df_Product_missing_values = df_Product.isnull().sum()
print(df_Product_missing_values)
```

Row ID	0
Product ID	0
Category	0
Sub-Category	0
Product Name	0
dtype: int64	

All columns within the 'df\_Product' group dataset now have no missing values.

## 2. df\_Sales group - contains various numerical datas.

To calculate the profit we need to use the following formula: Profit = (Sales - (Cost Price \* Quantity)) \* (1 - Discount)

The provided data includes 'Sales,' 'Quantity,' 'Discount,' and 'Profit,' but it doesn't contain information about the cost price.

```
In [31]: df_Sales.sort_values(by=['Profit'], inplace=True, ascending=False)
df_Sales.head(10)
```

```
Out[31]:
```

Row ID	Order ID	Product ID	Sales	Quantity	Discount	Profit
<b>9103</b>	7100 CA-2015-124933	OFF-PA-10003302	212.64	6	0.0	99.9408
<b>9102</b>	4731 US-2015-103996	OFF-PA-10001736	212.64	6	0.0	99.9408
<b>9101</b>	6921 CA-2017-121706	OFF-AP-10003287	356.79	7	0.0	99.9012
<b>9100</b>	803 CA-2016-136133	OFF-AP-10000576	355.32	9	0.0	99.4896
<b>9099</b>	6709 CA-2015-123141	FUR-CH-10004287	883.84	4	0.2	99.432
<b>9098</b>	2660 CA-2015-135538	FUR-CH-10004287	883.84	4	0.2	99.432
<b>9097</b>	6711 CA-2016-149503	OFF-BI-10002133	273.92	8	0.2	99.296
<b>9095</b>	1621 CA-2017-108560	FUR-FU-10002937	198.46	2	0.0	99.23
<b>9096</b>	3748 CA-2017-161956	FUR-FU-10002937	198.46	2	0.0	99.23
<b>9094</b>	7705 CA-2016-114601	FUR-TA-10004147	447.84	4	0.0	98.5248

```
In [32]: # Show data types of each column in df_Sales
print(df_Sales.dtypes)
```

```
Row ID      int64
Order ID    object
Product ID  object
Sales       float64
Quantity    object
Discount    float64
Profit      object
dtype: object
```

The columns 'Quantity' and 'Profit' in 'df\_Sales' should be of numerical data types, rather than string.

After addressing outliers and missing values, we will convert their types appropriately.

## df\_Sales - Handling Missing values

```
In [33]: #Check updated missing value in df_Sales
df_Sales_missing_values = df_Sales.isnull().sum()
print(df_Sales_missing_values)
```

```
Row ID      0
Order ID    1
Product ID  2
Sales       1
Quantity    5
Discount    3
Profit      11
dtype: int64
```

```
In [34]: '''#For numrical data, Fill NaN values with mean

mean_sales = df['Sales'].mean()
mean_quantity = df['Quantity'].mean()
mean_discount = df['Discount'].mean()
mean_profit = df['Profit'].mean()

df['Sales'].fillna(mean_sales, inplace=True)
df['Quantity'].fillna(mean_quantity, inplace=True)
df['Discount'].fillna(mean_discount, inplace=True)
df['Profit'].fillna(mean_profit, inplace=True)'''
```

```
Out[34]: "#For numrical data, Fill NaN values with mean\nmean_sales = df['Sales'].mean()\nmean_quantity = df['Quantity'].mean()\nmean_discount = df['Discount'].mean()\nmean_profit = df['Profit'].mean()\ndf['Sales'].fillna(mean_sales, inplace=True)\nndf['Quantity'].fillna(mean_quantity, inplace=True)\nndf['Discount'].fillna(mean_discount, inplace=True)\nndf['Profit'].fillna(mean_profit, inplace=True)"
```

Because there are only small number of missing values, I will do imputation by comparing them with corresponding values, rather than using methods like filling with the mean or mode.

```
In [35]: #Compare with specified 'Product ID' and 'Sales' in other rows
Sales_missing_Sales= df_Sales.loc[df_Sales['Sales'].isnull(), 'Product ID'].unique()
print(Sales_missing_Sales)

['FUR-TA-10004442']
```

```
In [36]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10004442 = df_Sales[df_Sales['Product ID'] == 'FUR-TA-10004442'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10004442)
```

	Product ID	Sales	Quantity	Discount	Profit
239	FUR-TA-10004442	401.59	2	0.3	-131.951
166	FUR-TA-10004442	344.22	2	0.4	-189.321
330	FUR-TA-10004442	NaN	1	0.4	-94.6605

By dividing each value in row 166 by 2, we can fill in 172.11 value for 'Sales' in row 330

```
In [37]: df_Sales.loc[330, 'Sales'] = 172.11
df_Sales.loc[[239,166,330], ['Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
```

Out[37]:

	Product ID	Sales	Quantity	Discount	Profit
239	FUR-TA-10004442	401.59	2	0.3	-131.951
166	FUR-TA-10004442	344.22	2	0.4	-189.321
330	FUR-TA-10004442	172.11	1	0.4	-94.6605

## df\_Sales['Quantity'] errors and missing values

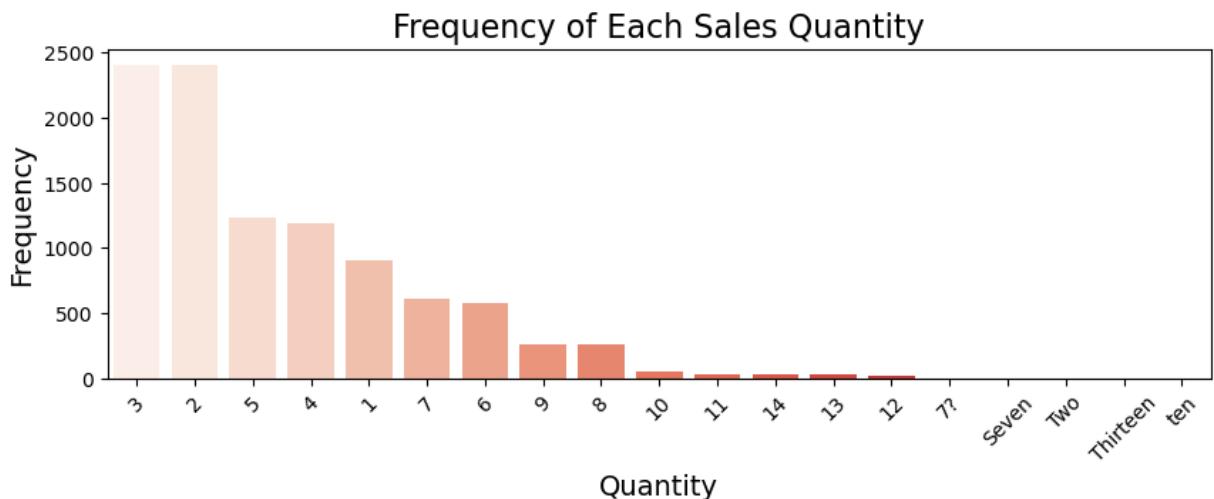
In [38]:

```
#Find unique values in df_Sales['Quantity']
unique_quantity = df_Sales['Quantity'].unique()
print("\nUnique Quantity:", unique_quantity)
```

Unique Quantity: ['6' '5' '4' '3' '13' '7' '8' '9' '2' 'Seven' 'Thirteen' '10' '12' '11' '14' 'Two' nan '1' '7?' 'ten']

In [39]:

```
df_Sales_quantity_counts = df_Sales['Quantity'].value_counts()
plt.figure(figsize=(10, 3))
sns.barplot(x=df_Sales_quantity_counts.index, y=df_Sales_quantity_counts.values, palette='Reds')
plt.title('Frequency of Each Sales Quantity', fontsize=16)
plt.xlabel('Quantity', fontsize=14)
plt.ylabel('Frequency', fontsize=14)
plt.xticks(rotation=45)
plt.show()
```



There are several inaccuracies in its values, such as '7?', 'Seven' instead of '7', 'Two' instead of '2', 'Thirteen' instead of '13', and 'ten' instead of '10'.

In [40]:

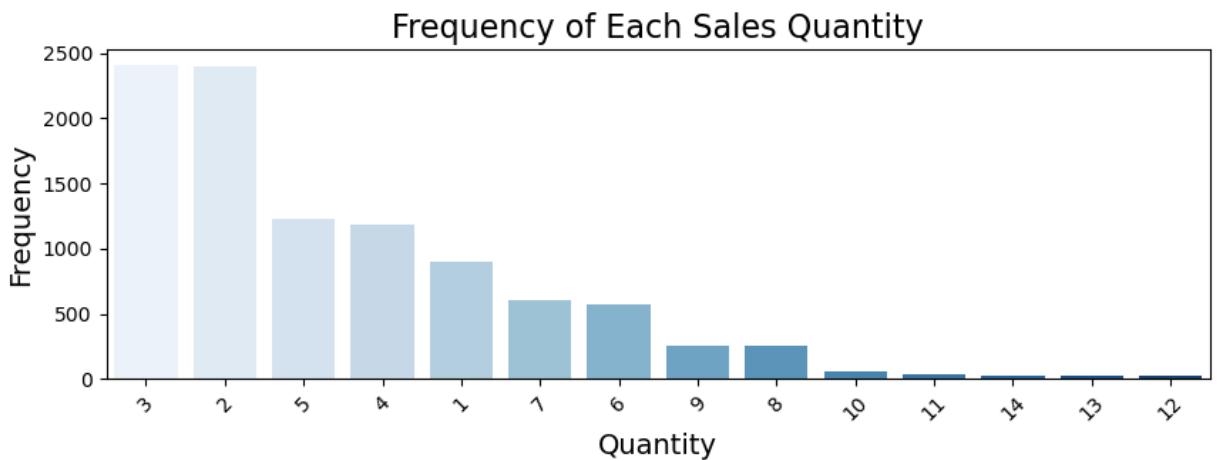
```
df_Sales['Quantity'] = df_Sales['Quantity'].replace({'7?': '7', 'Seven': '7', 'Two': '2', 'Thirteen': '13'});

# Check the unique values again to verify the changes
unique_quantity_corrected = df_Sales['Quantity'].unique()
print("\nCorrected Unique Quantity:", unique_quantity_corrected)
```

Corrected Unique Quantity: ['6' '5' '4' '3' '13' '7' '8' '9' '2' '10' '12' '11' '14' nan '1']

In [41]:

```
df_Sales_quantity_counts = df_Sales['Quantity'].value_counts()
plt.figure(figsize=(10, 3))
sns.barplot(x=df_Sales_quantity_counts.index, y=df_Sales_quantity_counts.values, palette='Blues')
plt.title('Frequency of Each Sales Quantity', fontsize=16)
plt.xlabel('Quantity', fontsize=14)
plt.ylabel('Frequency', fontsize=14)
plt.xticks(rotation=45)
plt.show()
```



```
In [42]: # Filter rows with NaN in the 'Quantity' column and display relevant columns
rows_with_nan_quantity = df_Sales[df_Sales['Quantity'].isna()][['Product ID', 'Sales', 'Quantity', '|'
print(rows_with_nan_quantity)
```

	Product ID	Sales	Quantity	Discount	Profit
28	OFF-BI-10000545	1369.764	NaN	0.70	-913.176
365	OFF-ST-10002574	331.536	NaN	0.20	-82.884
930	FUR-BO-10001337	308.499	NaN	0.15	-18.147
787	TEC-PH-10002890	108.576	NaN	0.40	-25.3344
712	FUR-FU-10001756	38.080	NaN	0.60	-29.512

```
In [43]: #Compare with specified 'Product ID' and 'Quantity' in other rows
product_missing_qty = df_Sales.loc[df_Sales['Quantity'].isnull(), 'Product ID'].unique()
print(product_missing_qty)

['OFF-BI-10000545' 'OFF-ST-10002574' 'FUR-BO-10001337' 'TEC-PH-10002890'
 'FUR-FU-10001756']
```

```
In [44]: #Comparing with correspondence Product ID with similar Sales

unique_qty_info = df_Sales[df_Sales['Product ID'].isin(product_missing_qty)][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']].drop_duplicates()
print(unique_qty_info)
```

	Product ID	Sales	Quantity	Discount	Profit
9990	OFF-BI-10000545	9892.740	13	0.00	4946.37
18	OFF-BI-10000545	1598.058	7	0.70	-1065.372
27	OFF-BI-10000545	1369.764	6	0.70	-913.176
28	OFF-BI-10000545	1369.764	NaN	0.70	-913.176
9864	OFF-BI-10000545	1217.568	2	0.20	456.588
33	OFF-BI-10000545	1141.470	5	0.70	-760.98
1896	OFF-ST-10002574	828.840	6	0.00	0
17	OFF-BI-10000545	760.980	5	0.80	-1141.47
197	OFF-ST-10002574	663.072	6	0.20	-165.768
622	FUR-BO-10001337	616.998	6	0.15	-36.294
1875	OFF-ST-10002574	552.560	4	0.00	0
232	OFF-ST-10002574	552.560	5	0.20	-138.14
702	FUR-BO-10001337	514.165	5	0.15	-30.245
104	OFF-BI-10000545	456.588	2	0.70	-304.392
7823	FUR-BO-10001337	362.940	3	0.00	36.294
366	OFF-ST-10002574	331.536	3	0.20	-82.884
365	OFF-ST-10002574	331.536	NaN	0.20	-82.884
930	FUR-BO-10001337	308.499	NaN	0.15	-18.147
623	FUR-BO-10001337	290.352	3	0.20	-36.294
1895	OFF-ST-10002574	276.280	2	0.00	0
7174	FUR-BO-10001337	241.960	2	0.00	24.196
8506	TEC-PH-10002890	226.200	5	0.00	58.812
487	OFF-ST-10002574	221.024	2	0.20	-55.256
1142	FUR-BO-10001337	205.666	2	0.15	-12.098
6002	TEC-PH-10002890	180.960	5	0.20	13.572
7777	TEC-PH-10002890	135.720	3	0.00	35.2872
5775	FUR-BO-10001337	120.980	1	0.00	12.098
787	TEC-PH-10002890	108.576	NaN	0.40	-25.3344
4882	TEC-PH-10002890	108.576	3	0.20	8.1432
1420	FUR-BO-10001337	102.833	1	0.15	-6.049
7380	FUR-FU-10001756	95.200	5	0.00	27.608
7126	TEC-PH-10002890	90.480	2	0.00	23.5248
3884	FUR-FU-10001756	45.696	3	0.20	5.1408
712	FUR-FU-10001756	38.080	NaN	0.60	-29.512
2894	TEC-PH-10002890	36.192	1	0.20	2.7144
947	FUR-FU-10001756	22.848	3	0.60	-17.7072
2490	FUR-FU-10001756	15.232	1	0.20	1.7136

## Imputation with Corresponding Values

To fill in missing 'Quantity' values with correspond values in the dataset

```
In [45]: df_Sales.loc[[27, 28, 366, 365, 787, 4882, 930, 712], ['Row ID', 'Product ID', 'Sales', 'Quantity', 'Dis
```

	Row ID	Product ID	Sales	Quantity	Discount	Profit
27	8209	OFF-BI-10000545	1369.764	6	0.70	-913.176
28	8633	OFF-BI-10000545	1369.764	NaN	0.70	-913.176
366	7727	OFF-ST-10002574	331.536	3	0.20	-82.884
365	5725	OFF-ST-10002574	331.536	NaN	0.20	-82.884
787	6417	TEC-PH-10002890	108.576	NaN	0.40	-25.3344
4882	2693	TEC-PH-10002890	108.576	3	0.20	8.1432
930	2797	FUR-BO-10001337	308.499	NaN	0.15	-18.147
712	6370	FUR-FU-10001756	38.080	NaN	0.60	-29.512

```
In [46]: #Replace value in 'Quantity'with correspondence 'Product ID' with similar 'Sales'
```

```
df_Sales.loc[28, 'Quantity'] = '6'
df_Sales.loc[365, 'Quantity'] = '3'
df_Sales.loc[787, 'Quantity'] = '3'
df_Sales.loc[930, 'Quantity'] = '3'
df_Sales.loc[712, 'Quantity'] = '4'
df_Sales.loc[[27, 28, 366, 365, 787, 4882, 930, 712], ['Product ID', 'Sales', 'Quantity', 'Discount', '
```

Out[46]:

	Product ID	Sales	Quantity	Discount	Profit
27	OFF-BI-10000545	1369.764	6	0.70	-913.176
28	OFF-BI-10000545	1369.764	6	0.70	-913.176
366	OFF-ST-10002574	331.536	3	0.20	-82.884
365	OFF-ST-10002574	331.536	3	0.20	-82.884
787	TEC-PH-10002890	108.576	3	0.40	-25.3344
4882	TEC-PH-10002890	108.576	3	0.20	8.1432
930	FUR-BO-10001337	308.499	3	0.15	-18.147
712	FUR-FU-10001756	38.080	4	0.60	-29.512

## df\_Sales['Discount'] outliers and missing values

In [47]: `#Finding Outliers in df_Sales['Discount']`

```
unique_discount = df_Sales['Discount'].unique()
print("\nUnique Discount:", unique_discount)
```

Unique Discount: [0.5 0. 0.2 0.4 0.7 0.3 0.1 0.15 0.32 0.8 0.45 0.6 nan]

There is no outlier in df\_Sales['Discount']. except nan

In [48]: `#Compare with specified 'Product ID' and 'Discount' in other rows`

```
product_missing_discount = df_Sales.loc[df_Sales['Discount'].isnull(), 'Product ID'].unique()
print(product_missing_discount)
```

['OFF-ST-10000604' 'OFF-BI-10002026' 'OFF-LA-10002762']

In [49]: `#Comparing missing values in 'Discount' with other values in correspondence`

```
unique_discount_info = df_Sales[df_Sales['Product ID'].isin(product_missing_discount)][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']].drop_duplicates()

print(unique_discount_info)
```

	Product ID	Sales	Quantity	Discount	Profit
9437	OFF-BI-10002026	437.472	14	0.2	153.1152
6312	OFF-ST-10000604	250.272	9	0.2	15.642
9203	OFF-BI-10002026	234.360	6	0.0	112.4928
8835	OFF-BI-10002026	232.400	5	0.2	78.435
8331	OFF-ST-10000604	208.560	6	NaN	52.14
8573	OFF-BI-10002026	185.920	4	0.2	62.748
8897	OFF-BI-10002026	174.300	3	0.0	81.921
8088	OFF-ST-10000604	173.800	5	0.0	43.45
8807	OFF-LA-10002762	162.890	13	0.0	76.5583
8185	OFF-BI-10002026	139.440	3	0.2	47.061
184	OFF-BI-10002026	104.580	9	0.8	-172.557
375	OFF-BI-10002026	104.580	6	NaN	-80.178
7286	OFF-ST-10000604	104.280	3	0.0	26.07
7602	OFF-BI-10002026	92.960	2	0.2	31.374
8004	OFF-LA-10002762	87.710	7	0.0	41.2237
7781	OFF-LA-10002762	75.180	6	0.0	35.3346
7779	OFF-LA-10002762	75.180	6	NaN	35.3346
6525	OFF-ST-10000604	69.520	2	0.0	17.38
6971	OFF-BI-10002026	62.496	2	0.2	21.8736
7128	OFF-LA-10002762	50.120	4	0.0	23.5564
766	OFF-BI-10002026	34.860	2	0.7	-26.726
5724	OFF-LA-10002762	25.060	2	0.0	11.7782
1091	OFF-BI-10002026	17.430	1	0.7	-13.363
795	OFF-BI-10002026	15.624	2	0.8	-24.9984

In [50]: `df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)`

```
product_10000604 = df_Sales[df_Sales['Product ID'] == 'OFF-ST-10000604'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000604)
```

	Product ID	Sales	Quantity	Discount	Profit
6312	OFF-ST-10000604	250.272	9	0.2	15.642
8331	OFF-ST-10000604	208.560	6	NaN	52.14
8088	OFF-ST-10000604	173.800	5	0.0	43.45
7286	OFF-ST-10000604	104.280	3	0.0	26.07
7285	OFF-ST-10000604	104.280	3	0.0	26.07
6525	OFF-ST-10000604	69.520	2	0.0	17.38
6526	OFF-ST-10000604	69.520	2	0.0	17.38

```
In [51]: '''By multiplying each column by 3 in row 6526, I identified that there is a 0.0 Discount in row 833:
df_Sales.loc[8331, 'Discount'] = '0.0''
```

## Imputation with Corresponding Values

To fill in missing 'Discount' values using discount correspond to the unique 'Product ID' values in the dataset.

```
In [52]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10002026 = df_Sales[df_Sales['Product ID'] == 'OFF-BI-10002026'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10002026)
```

	Product ID	Sales	Quantity	Discount	Profit
9437	OFF-BI-10002026	437.472	14	0.2	153.1152
9203	OFF-BI-10002026	234.360	6	0.0	112.4928
8834	OFF-BI-10002026	232.400	5	0.2	78.435
8835	OFF-BI-10002026	232.400	5	0.2	78.435
8573	OFF-BI-10002026	185.920	4	0.2	62.748
8897	OFF-BI-10002026	174.300	3	0.0	81.921
8185	OFF-BI-10002026	139.440	3	0.2	47.061
184	OFF-BI-10002026	104.580	9	0.8	-172.557
375	OFF-BI-10002026	104.580	6	NaN	-80.178
7602	OFF-BI-10002026	92.960	2	0.2	31.374
6971	OFF-BI-10002026	62.496	2	0.2	21.8736
766	OFF-BI-10002026	34.860	2	0.7	-26.726
1091	OFF-BI-10002026	17.430	1	0.7	-13.363
795	OFF-BI-10002026	15.624	2	0.8	-24.9984

```
In [53]: '''By multiplying each column by 6 in row 1091, I identified that there is a 0.7 Discount in row 375
df_Sales.loc[375, 'Discount'] = '0.7''
```

```
In [54]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10002762 = df_Sales[df_Sales['Product ID'] == 'OFF-LA-10002762'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10002762)
```

	Product ID	Sales	Quantity	Discount	Profit
8807	OFF-LA-10002762	162.89	13	0.0	76.5583
8004	OFF-LA-10002762	87.71	7	0.0	41.2237
8006	OFF-LA-10002762	87.71	7	0.0	41.2237
7780	OFF-LA-10002762	75.18	6	0.0	35.3346
7779	OFF-LA-10002762	75.18	6	NaN	35.3346
7781	OFF-LA-10002762	75.18	6	0.0	35.3346
7128	OFF-LA-10002762	50.12	4	0.0	23.5564
5724	OFF-LA-10002762	25.06	2	0.0	11.7782

```
In [55]: #Replace value in 'Discount'with correspondence 'Product ID' with similar 'Sales' and 'Profit'
df_Sales.loc[7779, 'Discount'] = '0.0'
```

```
In [56]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10002762 = df_Sales[df_Sales['Product ID'] == 'OFF-LA-10002762'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10002762)
```

	Product ID	Sales	Quantity	Discount	Profit
8807	OFF-LA-10002762	162.89	13	0.0	76.5583
8004	OFF-LA-10002762	87.71	7	0.0	41.2237
8006	OFF-LA-10002762	87.71	7	0.0	41.2237
7780	OFF-LA-10002762	75.18	6	0.0	35.3346
7779	OFF-LA-10002762	75.18	6	0.0	35.3346
7781	OFF-LA-10002762	75.18	6	0.0	35.3346
7128	OFF-LA-10002762	50.12	4	0.0	23.5564
5724	OFF-LA-10002762	25.06	2	0.0	11.7782

## df\_Sales['Profit'] outliers and missing values

```
In [57]: unique_discount = df_Sales['Profit'].unique()
unique_discount_list = unique_discount.tolist()
len(unique_discount_list)
```

Out[57]: 7282

```
In [58]: #Compare with specified 'Product ID' and 'Profit' in other rows
product_missing_profit = df_Sales.loc[df_Sales['Profit'].isnull(), 'Product ID'].unique()
print(product_missing_profit)

['FUR-TA-10000198' 'OFF-BI-10001359' 'FUR-BO-10003272' 'FUR-CH-10000309'
 'OFF-ST-10003716' 'FUR-BO-10002545' 'OFF-SU-10003505' 'TEC-PH-10000141'
 'FUR-FU-10000723' 'OFF-AP-10000358' 'OFF-BI-10003291']
```

```
In [59]: #Comparing missing values in 'Profit' with other values in correspondence
```

```
unique_profit_info = df_Sales[df_Sales['Product ID'].isin(product_missing_profit)][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']].drop_duplicates()

#unique_profit_info.head(60)
len(unique_profit_info)
```

Out[59]: 76

```
In [60]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000198 = df_Sales[df_Sales['Product ID'] == 'FUR-TA-10000198'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000198)
```

	Product ID	Sales	Quantity	Discount	Profit
7	FUR-TA-10000198	4297.644	13	0.4	NaN
21	FUR-TA-10000198	2314.116	7	0.4	-1002.7836
9650	FUR-TA-10000198	1652.940	3	0.0	231.4116
315	FUR-TA-10000198	1322.352	3	0.2	-99.1764
228	FUR-TA-10000198	330.588	1	0.4	-143.2548

```
In [61]: # Values in row #7 is 13 times of row #228
```

```
df_Sales.loc[7, 'Profit'] = '-1862.3124'
```

```
In [62]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000198 = df_Sales[df_Sales['Product ID'] == 'FUR-TA-10000198'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000198)
```

	Product ID	Sales	Quantity	Discount	Profit
7	FUR-TA-10000198	4297.644	13	0.4	-1862.3124
21	FUR-TA-10000198	2314.116	7	0.4	-1002.7836
9650	FUR-TA-10000198	1652.940	3	0.0	231.4116
315	FUR-TA-10000198	1322.352	3	0.2	-99.1764
228	FUR-TA-10000198	330.588	1	0.4	-143.2548

```
In [63]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10001359 = df_Sales[df_Sales['Product ID'] == 'OFF-BI-10001359'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10001359)
```

	Product ID	Sales	Quantity	Discount	Profit
9971	OFF-BI-10001359	4305.552	6	0.2	1453.1238
9962	OFF-BI-10001359	2690.970	3	0.0	1264.7559
9923	OFF-BI-10001359	2152.776	3	0.2	726.5619
9943	OFF-BI-10001359	1793.980	2	0.0	843.1706
9942	OFF-BI-10001359	1793.980	2	0.0	843.1706
9944	OFF-BI-10001359	1793.980	2	0.0	843.1706
14	OFF-BI-10001359	1614.582	6	0.7	NaN
20	OFF-BI-10001359	1345.485	5	0.7	-1031.5385
11	OFF-BI-10001359	896.990	5	0.8	-1480.0335
9852	OFF-BI-10001359	896.990	1	0.0	421.5853
68	OFF-BI-10001359	538.194	2	0.7	-412.6154

```
In [64]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10001359 = df_Sales[df_Sales['Product ID'] == 'OFF-BI-10001359'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10001359)
```

	Product ID	Sales	Quantity	Discount	Profit
9971	OFF-BI-10001359	4305.552	6	0.2	1453.1238
9962	OFF-BI-10001359	2690.970	3	0.0	1264.7559
9923	OFF-BI-10001359	2152.776	3	0.2	726.5619
9943	OFF-BI-10001359	1793.980	2	0.0	843.1706
9942	OFF-BI-10001359	1793.980	2	0.0	843.1706
9944	OFF-BI-10001359	1793.980	2	0.0	843.1706
14	OFF-BI-10001359	1614.582	6	0.7	NaN
20	OFF-BI-10001359	1345.485	5	0.7	-1031.5385
9852	OFF-BI-10001359	896.990	1	0.0	421.5853
11	OFF-BI-10001359	896.990	5	0.8	-1480.0335
68	OFF-BI-10001359	538.194	2	0.7	-412.6154

```
In [65]: # Values in row #14 is 6/5 times of row #20

df_Sales.loc[14, 'Profit'] = '-1237.8462'
```

```
In [66]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10001359 = df_Sales[df_Sales['Product ID'] == 'OFF-BI-10001359'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10001359)
```

	Product ID	Sales	Quantity	Discount	Profit
9971	OFF-BI-10001359	4305.552	6	0.2	1453.1238
9962	OFF-BI-10001359	2690.970	3	0.0	1264.7559
9923	OFF-BI-10001359	2152.776	3	0.2	726.5619
9943	OFF-BI-10001359	1793.980	2	0.0	843.1706
9942	OFF-BI-10001359	1793.980	2	0.0	843.1706
9944	OFF-BI-10001359	1793.980	2	0.0	843.1706
14	OFF-BI-10001359	1614.582	6	0.7	-1237.8462
20	OFF-BI-10001359	1345.485	5	0.7	-1031.5385
11	OFF-BI-10001359	896.990	5	0.8	-1480.0335
9852	OFF-BI-10001359	896.990	1	0.0	421.5853
68	OFF-BI-10001359	538.194	2	0.7	-412.6154

```
In [67]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10003272 = df_Sales[df_Sales['Product ID'] == 'FUR-BO-10003272'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10003272)
```

	Product ID	Sales	Quantity	Discount	Profit
62	FUR-BO-10003272	1352.3976	9	0.32	NaN
289	FUR-BO-10003272	883.9200	5	0.2	-110.49
572	FUR-BO-10003272	353.5680	2	0.2	-44.196
571	FUR-BO-10003272	353.5680	2	0.2	-44.196
322	FUR-BO-10003272	300.5328	2	0.32	-97.2312
846	FUR-BO-10003272	176.7840	1	0.2	-22.098

```
In [68]: # Values in row #62 is 9/2 times of row #322

df_Sales.loc[62, 'Profit'] = '-437.5404'
```

```
In [69]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10003272 = df_Sales[df_Sales['Product ID'] == 'FUR-BO-10003272'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10003272)
```

	Product ID	Sales	Quantity	Discount	Profit
62	FUR-BO-10003272	1352.3976	9	0.32	-437.5404
289	FUR-BO-10003272	883.9200	5	0.2	-110.49
572	FUR-BO-10003272	353.5680	2	0.2	-44.196
571	FUR-BO-10003272	353.5680	2	0.2	-44.196
322	FUR-BO-10003272	300.5328	2	0.32	-97.2312
846	FUR-BO-10003272	176.7840	1	0.2	-22.098

```
In [70]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000309 = df_Sales[df_Sales['Product ID'] == 'FUR-CH-10000309'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000309)
```

	Product ID	Sales	Quantity	Discount	Profit
9853	FUR-CH-10000309	1690.040	4	0.0	422.51
8932	FUR-CH-10000309	1352.032	4	0.2	84.502
9768	FUR-CH-10000309	1267.530	3	0.0	316.8825
447	FUR-CH-10000309	887.271	3	0.3	NaN
448	FUR-CH-10000309	887.271	3	0.3	-63.3765

```
In [71]: # Values in row #447 and row #448 are identical
df_Sales.loc[447, 'Profit'] = '-63.3765'
```

```
In [72]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000309 = df_Sales[df_Sales['Product ID'] == 'FUR-CH-10000309'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000309)
```

	Product ID	Sales	Quantity	Discount	Profit
9853	FUR-CH-10000309	1690.040	4	0.0	422.51
8932	FUR-CH-10000309	1352.032	4	0.2	84.502
9768	FUR-CH-10000309	1267.530	3	0.0	316.8825
447	FUR-CH-10000309	887.271	3	0.3	-63.3765
448	FUR-CH-10000309	887.271	3	0.3	-63.3765

```
In [73]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10003716 = df_Sales[df_Sales['Product ID'] == 'OFF-ST-10003716'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10003716)
```

	Product ID	Sales	Quantity	Discount	Profit
9579	OFF-ST-10003716	1575.140	7	0.0	204.7682
9512	OFF-ST-10003716	1350.120	6	0.0	175.5156
331	OFF-ST-10003716	1080.096	6	0.2	-94.5084
9232	OFF-ST-10003716	900.080	4	0.0	117.0104
9233	OFF-ST-10003716	900.080	4	0.0	117.0104
451	OFF-ST-10003716	720.064	4	0.2	-63.0056
450	OFF-ST-10003716	720.064	4	0.2	-63.0056
8973	OFF-ST-10003716	675.060	3	0.0	87.7578
540	OFF-ST-10003716	540.048	3	0.2	-47.2542
539	OFF-ST-10003716	540.048	3	0.2	NaN
8500	OFF-ST-10003716	450.040	2	0.0	58.5052
991	OFF-ST-10003716	180.016	1	0.2	-15.7514

```
In [74]: # Values in row #540 and row #539 are identical
df_Sales.loc[539, 'Profit'] = '-47.2542'
```

```
In [75]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10003716 = df_Sales[df_Sales['Product ID'] == 'OFF-ST-10003716'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10003716)
```

	Product ID	Sales	Quantity	Discount	Profit
9579	OFF-ST-10003716	1575.140	7	0.0	204.7682
9512	OFF-ST-10003716	1350.120	6	0.0	175.5156
331	OFF-ST-10003716	1080.096	6	0.2	-94.5084
9232	OFF-ST-10003716	900.080	4	0.0	117.0104
9233	OFF-ST-10003716	900.080	4	0.0	117.0104
451	OFF-ST-10003716	720.064	4	0.2	-63.0056
450	OFF-ST-10003716	720.064	4	0.2	-63.0056
8973	OFF-ST-10003716	675.060	3	0.0	87.7578
540	OFF-ST-10003716	540.048	3	0.2	-47.2542
539	OFF-ST-10003716	540.048	3	0.2	-47.2542
8500	OFF-ST-10003716	450.040	2	0.0	58.5052
991	OFF-ST-10003716	180.016	1	0.2	-15.7514

```
In [76]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10002545 = df_Sales[df_Sales['Product ID'] == 'FUR-BO-10002545'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10002545)
```

	Product ID	Sales	Quantity	Discount	Profit
9844	FUR-BO-10002545	1565.8800	6	0.0	407.1288
9573	FUR-BO-10002545	1552.8310	7	0.15	200.9546
9702	FUR-BO-10002545	1043.9200	4	0.0	271.4192
511	FUR-BO-10002545	913.4300	5	0.3	-52.196
9576	FUR-BO-10002545	782.9400	3	0.0	203.5644
8180	FUR-BO-10002545	626.3520	3	0.2	46.9764
546	FUR-BO-10002545	532.3992	3	0.32	NaN
126	FUR-BO-10002545	521.9600	4	0.5	-250.5408

```
In [77]: # Values in row #511 is approximately 5/3 of row #546
df_Sales.loc[546, 'Profit'] = '30.42'
```

```
In [78]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10002545 = df_Sales[df_Sales['Product ID'] == 'FUR-BO-10002545'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10002545)
```

	Product ID	Sales	Quantity	Discount	Profit
9844	FUR-BO-10002545	1565.8800	6	0.0	407.1288
9573	FUR-BO-10002545	1552.8310	7	0.15	200.9546
9702	FUR-BO-10002545	1043.9200	4	0.0	271.4192
511	FUR-BO-10002545	913.4300	5	0.3	-52.196
9576	FUR-BO-10002545	782.9400	3	0.0	203.5644
8180	FUR-BO-10002545	626.3520	3	0.2	46.9764
546	FUR-BO-10002545	532.3992	3	0.32	30.42
126	FUR-BO-10002545	521.9600	4	0.5	-250.5408

```
In [79]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10003505 = df_Sales[df_Sales['Product ID'] == 'OFF-SU-10003505'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10003505)
```

	Product ID	Sales	Quantity	Discount	Profit
7749	OFF-SU-10003505	695.160	6	0.0	34.758
7473	OFF-SU-10003505	579.300	5	0.0	28.965
6524	OFF-SU-10003505	347.580	3	0.0	17.379
5681	OFF-SU-10003505	231.720	2	0.0	11.586
5682	OFF-SU-10003505	231.720	2	0.0	11.586
647	OFF-SU-10003505	185.376	2	0.2	-34.758
648	OFF-SU-10003505	185.376	2	0.2	-34.758
649	OFF-SU-10003505	185.376	2	0.2	NaN

```
In [80]: # Values in row #648 and row #649 are identical
df_Sales.loc[649, 'Profit'] = '-34.758'
```

```
In [81]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10003505 = df_Sales[df_Sales['Product ID'] == 'OFF-SU-10003505'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10003505)
```

	Product ID	Sales	Quantity	Discount	Profit
7749	OFF-SU-10003505	695.160	6	0.0	34.758
7473	OFF-SU-10003505	579.300	5	0.0	28.965
6524	OFF-SU-10003505	347.580	3	0.0	17.379
5681	OFF-SU-10003505	231.720	2	0.0	11.586
5682	OFF-SU-10003505	231.720	2	0.0	11.586
647	OFF-SU-10003505	185.376	2	0.2	-34.758
648	OFF-SU-10003505	185.376	2	0.2	-34.758
649	OFF-SU-10003505	185.376	2	0.2	-34.758

```
In [82]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000141 = df_Sales[df_Sales['Product ID'] == 'TEC-PH-10000141'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000141)
```

	Product ID	Sales	Quantity	Discount	Profit
6342	TEC-PH-10000141	211.168	4	0.2	15.8376
618	TEC-PH-10000141	158.376	4	0.4	-36.9544
753	TEC-PH-10000141	118.782	3	0.4	NaN

```
In [83]: # Values in row #753 is 4/3 of row #753

df_Sales.loc[753, 'Profit'] = '-27.716'
```

```
In [84]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000141 = df_Sales[df_Sales['Product ID'] == 'TEC-PH-10000141'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000141)
```

	Product ID	Sales	Quantity	Discount	Profit
6342	TEC-PH-10000141	211.168	4	0.2	15.8376
618	TEC-PH-10000141	158.376	4	0.4	-36.9544
753	TEC-PH-10000141	118.782	3	0.4	-27.716

```
In [85]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000723 = df_Sales[df_Sales['Product ID'] == 'FUR-FU-10000723'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000723)
```

	Product ID	Sales	Quantity	Discount	Profit
7283	FUR-FU-10000723	289.240	7	0.0	26.0316
6165	FUR-FU-10000723	165.280	4	0.0	14.8752
929	FUR-FU-10000723	132.224	4	0.2	-18.1808
5601	FUR-FU-10000723	123.960	3	0.0	11.1564
5602	FUR-FU-10000723	123.960	3	0.0	11.1564
4701	FUR-FU-10000723	82.640	2	0.0	7.4376
1254	FUR-FU-10000723	66.112	2	0.2	-9.0904
360	FUR-FU-10000723	66.112	4	0.6	NaN
361	FUR-FU-10000723	66.112	4	0.6	-84.2928

```
In [86]: # Values in row #360 and row #361 are identical

df_Sales.loc[360, 'Profit'] = '-84.2928'
```

```
In [87]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000723 = df_Sales[df_Sales['Product ID'] == 'FUR-FU-10000723'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000723)
```

	Product ID	Sales	Quantity	Discount	Profit
7283	FUR-FU-10000723	289.240	7	0.0	26.0316
6165	FUR-FU-10000723	165.280	4	0.0	14.8752
929	FUR-FU-10000723	132.224	4	0.2	-18.1808
5601	FUR-FU-10000723	123.960	3	0.0	11.1564
5602	FUR-FU-10000723	123.960	3	0.0	11.1564
4701	FUR-FU-10000723	82.640	2	0.0	7.4376
360	FUR-FU-10000723	66.112	4	0.6	-84.2928
361	FUR-FU-10000723	66.112	4	0.6	-84.2928
1254	FUR-FU-10000723	66.112	2	0.2	-9.0904

```
In [88]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000358 = df_Sales[df_Sales['Product ID'] == 'OFF-AP-10000358'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000358)
```

	Product ID	Sales	Quantity	Discount	Profit
7295	OFF-AP-10000358	90.860	7	0.0	26.3494
7294	OFF-AP-10000358	90.860	7	0.0	26.3494
7040	OFF-AP-10000358	77.880	6	0.0	22.5852
6671	OFF-AP-10000358	64.900	5	0.0	18.821
3245	OFF-AP-10000358	31.152	3	0.2	3.5046
4726	OFF-AP-10000358	25.960	2	0.0	7.5284
2744	OFF-AP-10000358	20.768	2	0.2	2.3364
501	OFF-AP-10000358	20.768	8	0.8	NaN
3381	OFF-AP-10000358	12.980	1	0.0	3.7642

```
In [89]: # No correspondence values to be compared.
```

```
df_Sales.loc[501, 'Profit'] = '0'
```

```
In [90]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10003291 = df_Sales[df_Sales['Product ID'] == 'OFF-BI-10003291'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10003291)
```

	Product ID	Sales	Quantity	Discount	Profit
6067	OFF-BI-10003291	41.904	6	0.2	14.1426
6068	OFF-BI-10003291	41.904	6	0.2	14.1426
5235	OFF-BI-10003291	27.936	4	0.2	9.4284
5234	OFF-BI-10003291	27.936	4	0.2	9.4284
4608	OFF-BI-10003291	20.952	3	0.2	7.0713
4889	OFF-BI-10003291	17.460	2	0.0	8.2062
4888	OFF-BI-10003291	17.460	2	0.0	8.2062
884	OFF-BI-10003291	12.222	7	0.8	NaN
957	OFF-BI-10003291	10.476	6	0.8	-17.2854
1424	OFF-BI-10003291	7.857	3	0.7	-6.0237
2755	OFF-BI-10003291	6.984	1	0.2	2.3571
1557	OFF-BI-10003291	5.238	2	0.7	-4.0158

```
In [91]: # Values in row #884 is 7/6 of row #957
```

```
df_Sales.loc[884, 'Profit'] = '-20.1663'
```

```
In [92]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10003291 = df_Sales[df_Sales['Product ID'] == 'OFF-BI-10003291'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10003291)
```

	Product ID	Sales	Quantity	Discount	Profit
6067	OFF-BI-10003291	41.904	6	0.2	14.1426
6068	OFF-BI-10003291	41.904	6	0.2	14.1426
5235	OFF-BI-10003291	27.936	4	0.2	9.4284
5234	OFF-BI-10003291	27.936	4	0.2	9.4284
4608	OFF-BI-10003291	20.952	3	0.2	7.0713
4889	OFF-BI-10003291	17.460	2	0.0	8.2062
4888	OFF-BI-10003291	17.460	2	0.0	8.2062
884	OFF-BI-10003291	12.222	7	0.8	-20.1663
957	OFF-BI-10003291	10.476	6	0.8	-17.2854
1424	OFF-BI-10003291	7.857	3	0.7	-6.0237
2755	OFF-BI-10003291	6.984	1	0.2	2.3571
1557	OFF-BI-10003291	5.238	2	0.7	-4.0158

```
In [93]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000418 = df_Sales[df_Sales['Product ID'] == 'TEC-MA-10000418'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000418)
```

	Product ID	Sales	Quantity	Discount	Profit
9807	TEC-MA-10000418	4799.984	2	0.2	359.9988
0	TEC-MA-10000418	4499.985	5	0.7	-6599.978
5	TEC-MA-10000418	1799.994	2	0.7	"-2639.9912"

```
In [94]: # Unify the value with remove the "
```

```
df_Sales.loc[5, 'Profit'] = '-2639.9912'
```

```
In [95]: df_Sales.sort_values(by=['Sales'], inplace=True, ascending=False)
product_10000418 = df_Sales[df_Sales['Product ID'] == 'TEC-MA-10000418'][[
    'Product ID', 'Sales', 'Quantity', 'Discount', 'Profit']]
print(product_10000418)
```

```

      Product ID    Sales Quantity Discount      Profit
9807   TEC-MA-10000418  4799.984        2     0.2    359.9988
0       TEC-MA-10000418  4499.985        5     0.7   -6599.978
5       TEC-MA-10000418  1799.994        2     0.7   -2639.9912

```

In [96]: `print(df_Sales.dtypes)`

```

Row ID      int64
Order ID    object
Product ID  object
Sales       float64
Quantity    object
Discount    object
Profit      object
dtype: object

```

**Change data types of 'Quantity' and 'Profit' become NUMERICAL**

**df\_Sales - Change data types**

In [97]: `df_Sales['Quantity'] = pd.to_numeric(df_Sales['Quantity'], errors='coerce').fillna(0).astype(int)
df_Sales['Discount'] = pd.to_numeric(df_Sales['Discount'], errors='coerce')
df_Sales['Profit'] = pd.to_numeric(df_Sales['Profit'], errors='coerce')
print(df_Sales.dtypes)`

```

Row ID      int64
Order ID    object
Product ID  object
Sales       float64
Quantity    int32
Discount    float64
Profit      float64
dtype: object

```

In [98]: `#Check updated missing value in df_Sales
df_Sales_missing_values = df_Sales.isnull().sum()
print(df_Sales_missing_values)`

```

Row ID      0
Order ID    1
Product ID  2
Sales       0
Quantity    0
Discount    0
Profit      0
dtype: int64

```

Every column in the df\_Sales dataset is now complete with no missing values, except for 'Order ID', which will be addressed during the processing of df\_Order, and 'Product ID', which will be obtained from df\_Product.

In [ ]:

## To Merge df\_Product and df\_Sales into df\_Product\_Sales

In [99]: `df_Product_Sales = pd.merge(df_Product[['Row ID', 'Product ID', 'Category', 'Sub-Category', 'Product Name'],
df_Sales[['Row ID', 'Order ID', 'Sales', 'Quantity', 'Discount', 'Profit']], on='Row ID')`

In [100...]: `#Check updated missing value in df_Sales
df_Product_Sales_missing_values = df_Product_Sales.isnull().sum()
print(df_Product_Sales_missing_values)`

```

Row ID      0
Product ID  0
Category    0
Sub-Category 0
Product Name 0
Order ID    1
Sales       0
Quantity    0
Discount    0
Profit      0
dtype: int64

```

### 3. df\_Customer group

```
In [101... df_Customer.head(10)
```

```
Out[101]:
```

	Row ID	Customer ID	Customer Name	Segment	Country	City	State	Postal Code	Region
0	7773	CS-12505	Cindy Stewart	Consumer	United States	Lancaster	Ohio	43130	Est
1	684	GT-14635	Grant Thornton	Corporate	United States	Burlington	North Carolina	"27217"	South
2	9775	LF-17185	Luke Foster	Consumer	United States	San Antonio	Texas	78207	Central
3	3012	SR-20425	Sharelle Roach	Home Office	United States	Louisville	Colorado	80027	West
4	4992	HG-14965	Henry Goldwyn	Corporate	United States	Chicago	Illinois	60653	Central
5	3152	NF-18385	Natalie Fritzler	Consumer	United States	Newark	Ohio	43055	East
6	5311	NC-18415	Nathan Cano	Consumer	United States	Houston	Texas	77095	Central
7	9640	JH-15985	Joseph Holt	Consumer	United States	Concord	North Carolina	28027	South
8	1200	ZC-21910	Zuschuss Carroll	Consumer	United States	Houston	Texas	77041	Central
9	2698	SM-20320	Sean Miller	Home Office	NaN	Jacksonville	Florida	32216	Southh

```
In [102... # Show data types of each column in df_Customer  
print(df_Customer.dtypes)
```

```
Row ID           int64  
Customer ID    object  
Customer Name   object  
Segment          object  
Country          object  
City              object  
State              object  
Postal Code     object  
Region            object  
dtype: object
```

### df\_Customer Handling Outliers

```
In [103... #Finding Outliers in df_Customer['Country']
```

```
unique_country = df_Customer['Country'].unique()  
print(unique_country)
```

```
['United States' 'nan' '56']
```

```
In [104... #Finding Outliers in df_Customer['Region']
```

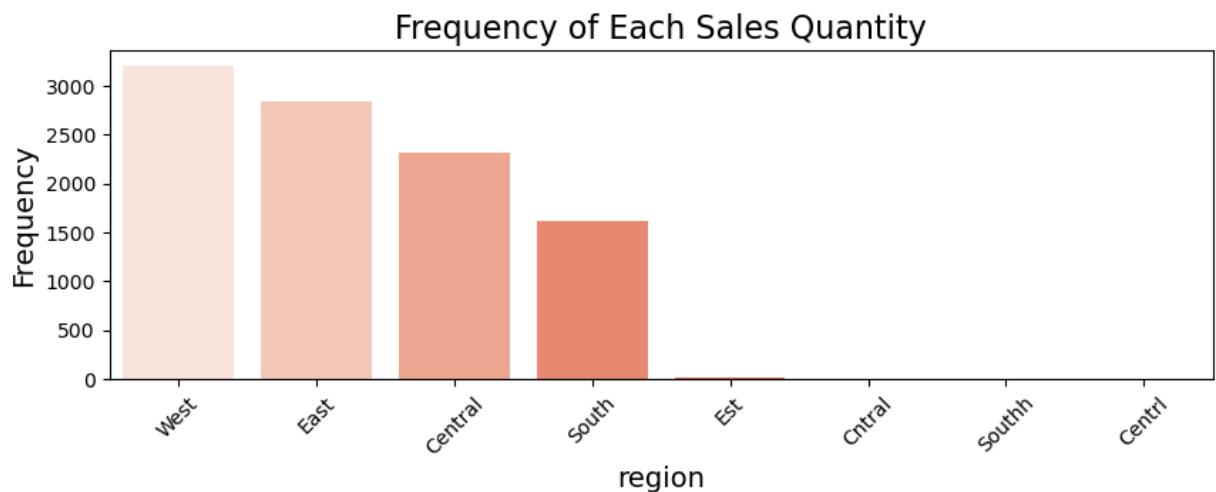
```
unique_region = df_Customer['Region'].unique()  
print(unique_region)
```

```
['Est' 'South' 'Central' 'West' 'East' 'Southh' 'Centrl' 'nan' 'Cntral']
```

```
In [105... df_Customer_region_counts = df_Customer['Region'].value_counts()
```

```
plt.figure(figsize=(10, 3))  
sns.barplot(x=df_Customer_region_counts.index, y=df_Customer_region_counts.values, palette='Reds')  
plt.title('Frequency of Each Sales Quantity', fontsize=16)  
plt.xlabel('region', fontsize=14)  
plt.ylabel('Frequency', fontsize=14)
```

```
plt.xticks(rotation=45)  
plt.show()
```

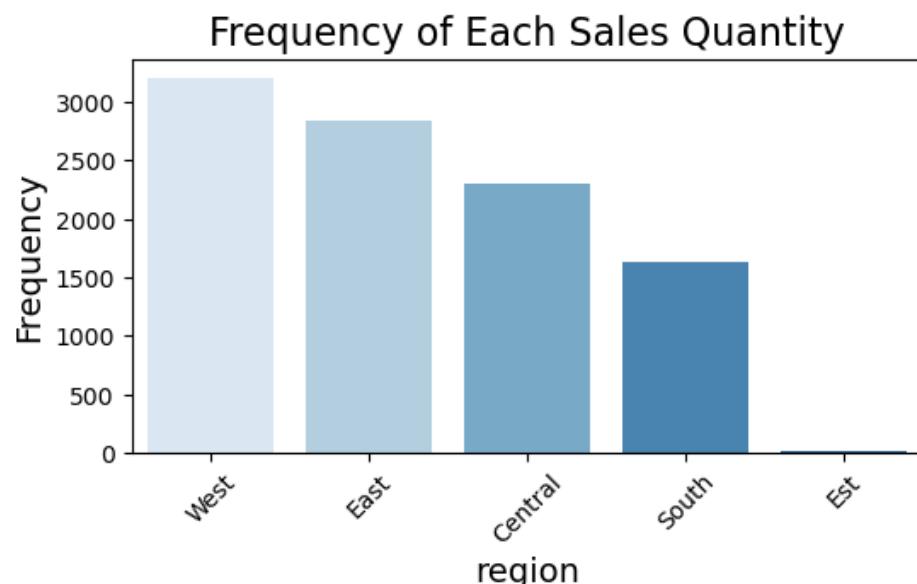


There are several typos to be fixed, such as 'Centrl','Cntral' instead of 'Central', 'Southh' instead of 'South' .

```
In [106...]  
# Replace 'Centrl' and 'Cntral' with 'Central' in the 'Region' column  
df_Customer['Region'] = df_Customer['Region'].replace({'Centrl': 'Central', 'Cntral': 'Central', 'So  
unique_region = df_Customer['Region'].unique()  
print(unique_region)
```

```
['Est' 'South' 'Central' 'West' 'East' nan]
```

```
In [231...]  
df_Customer_region_counts = df_Customer['Region'].value_counts()  
plt.figure(figsize=(6, 3))  
sns.barplot(x=df_Customer_region_counts.index, y=df_Customer_region_counts.values, palette='Blues')  
plt.title('Frequency of Each Sales Quantity', fontsize=16)  
plt.xlabel('region', fontsize=14)  
plt.ylabel('Frequency', fontsize=14)  
plt.xticks(rotation=45)  
plt.show()
```



```
In [107...]  
#Finding Outliers in df_Customer['Customer Name']  
  
unique_custname = df_Customer['Customer Name'].unique()  
len(unique_custname)
```

```
Out[107]: 795
```

```
In [108...]  
#Finding Outliers in df_Customer['Segment']  
  
unique_segment = df_Customer['Segment'].unique()  
print(unique_segment)
```

```

['Consumer' 'Corporate' 'Home Office' '%' nan]

In [109... df_Customer.sort_values(by=['Segment'], inplace=True, ascending=False)
segment1 = df_Customer[df_Customer['Segment'] == '%'][[
    'Customer ID', 'Customer Name', 'Segment', 'Country', 'City']]
print(segment1)

Customer ID Customer Name Segment      Country      City
43     SB-20290 Sean Braxton      % United States Philadelphia

Will compare the Segment value of the same Customer ID in other orders

In [110... df_Customer.sort_values(by=['Customer ID'], inplace=True, ascending=False)
cust_20290 = df_Customer[df_Customer['Customer ID'] == 'SB-20290'][[
    'Customer ID', 'Customer Name', 'Segment', 'Country', 'City']]
print(cust_20290)

Customer ID Customer Name Segment      Country      City
123     SB-20290 Sean Braxton Corporate United States Houston
3596    SB-20290 Sean Braxton Corporate United States Philadelphia
4952    SB-20290 Sean Braxton Corporate United States Philadelphia
3686    SB-20290 Sean Braxton Corporate United States Henderson
43      SB-20290 Sean Braxton      % United States Philadelphia
8852    SB-20290 Sean Braxton Corporate United States San Diego
5246    SB-20290 Sean Braxton Corporate United States Henderson
6482    SB-20290 Sean Braxton Corporate United States Kent
49      SB-20290 Sean Braxton Corporate United States Houston
1333    SB-20290 Sean Braxton Corporate United States Springfield
26      SB-20290 Sean Braxton Corporate United States Springfield
1030    SB-20290 Sean Braxton Corporate United States Philadelphia
6957    SB-20290 Sean Braxton Corporate United States Henderson
5851    SB-20290 Sean Braxton Corporate United States Florence
5128    SB-20290 Sean Braxton Corporate United States Springfield
6142    SB-20290 Sean Braxton Corporate United States Florence
6178    SB-20290 Sean Braxton Corporate United States Henderson

In [111... df_Customer.loc[43, 'Segment'] = 'Corporate'

In [112... #Finding Outliers in df_Customer['Country']

unique_country = df_Customer['Country'].unique()
print(unique_country)

['United States' 'US' nan '56']

In [113... df_Customer.sort_values(by=['Country'], inplace=True, ascending=False)
country56 = df_Customer[df_Customer['Country'] == '56'][[
    'Customer ID', 'Customer Name', 'Segment', 'Country', 'City', 'State']]
print(country56)

Customer ID Customer Name Segment Country      City      State
27     BG-11035 Barry Gonzalez Consumer      56 Nashville Tennessee

In [114... df_Customer.loc[27, 'Country'] = 'United States'

In [115... # Replace 'US' with 'United States' in the 'Country' column
df_Customer['Country'] = df_Customer['Country'].replace({'US': 'United States'})
unique_country = df_Customer['Country'].unique()
print(unique_country)

['United States' nan]

In [116... #Finding Outliers in df_Customer['City']

unique_city = df_Customer['City'].unique()
len(unique_city)

Out[116]: 532

In [117... #Finding Outliers in df_Customer['State']

unique_state = df_Customer['State'].unique()
print(unique_state)

```

```
['Florida' 'Delaware' 'Wisconsin' 'Arizona' 'Montana' 'Utah' 'New York'
 'California' 'Michigan' 'New Hampshire' 'Texas' 'Virginia' 'South Dakota'
 'Oregon' 'Georgia' 'New Jersey' 'Maryland' 'Illinois' 'Pennsylvania'
 'North Carolina' 'Rhode Island' 'Ohio' 'Colorado' 'Arkansas' 'Tennessee'
 'Minnesota' 'Massachusetts' 'Washington' 'Oklahoma' 'Alabama'
 'West Virginia' 'Missouri' 'Mississippi' 'Connecticut' 'South Carolina'
 'Kansas' 'Indiana' 'New Mexico' 'Kentucky' 'Iowa' 'Nebraska' 'Louisiana'
 'Idaho' 'Nevada' 'District of Columbia' nan 'North Dakota' 'Vermont'
 'Maine' 'Wyoming']
```

```
In [118...]: #Finding Outliers in df_Customer['Postal Code']

unique_postcode = df_Customer['Postal Code'].unique()
len(unique_postcode)
```

```
Out[118]: 634
```

## df\_Customer Handling Missing Values

```
In [119...]: df_Customer_missing_values = df_Customer.isnull().sum()
print(df_Customer_missing_values)
```

```
Row ID      0
Customer ID 0
Customer Name 3
Segment      3
Country      4
City          2
State         4
Postal Code   3
Region        3
dtype: int64
```

"Imputation with Corresponding Values" for missing values in "Customer Name" column.

To fill in missing 'Customer Name' values using names linked to the unique 'Customer ID' values in the dataset.

```
In [120...]: #Compare with specified 'Customer ID' and 'Customer Name' in other rows
customer_ids_missing_name = df_Customer.loc[df_Customer['Customer Name'].isnull(), 'Customer ID'].unique()
print(customer_ids_missing_name)
```

```
['DH-13075' 'BP-11095' 'SO-20335']
```

```
In [121...]: unique_customer_info = df_Customer[df_Customer['Customer ID'].isin(customer_ids_missing_name)][[
    'Customer ID', 'Customer Name']].drop_duplicates()
print(unique_customer_info)
```

```
Customer ID Customer Name
869      DH-13075      NaN
9184     BP-11095  Bart Pistole
877      BP-11095      NaN
6281      DH-13075  Dave Hallsten
5648      SO-20335  Sean O'Donnell
76       SO-20335      NaN
```

```
In [122...]: # Replace NaN values in 'Customer Name' with "Customer Name" values in corresponding Customer ID

for index, row in unique_customer_info.iterrows():
    customer_id = row['Customer ID']
    customer_name = df_Customer.loc[df_Customer['Customer ID'] == customer_id, 'Customer Name'].drop_duplicates()
    df_Customer.loc[df_Customer['Customer ID'] == customer_id, 'Customer Name'] = customer_name

specific_customer_name_info = df_Customer[df_Customer['Customer ID'].isin(['SO-20335', 'DH-13075',
    'Customer ID', 'Customer Name'])].drop_duplicates()
print(specific_customer_name_info)
```

```
Customer ID Customer Name
869      DH-13075  Dave Hallsten
9184     BP-11095  Bart Pistole
5648      SO-20335  Sean O'Donnell
```

To fill in missing 'Segment' values linked to the unique 'Customer ID' values in the dataset.

```
In [123...]  
#Compare with specified 'Customer ID' and 'Segment' in other rows  
customer_ids_missing_segment = df_Customer.loc[df_Customer['Segment'].isnull(), 'Customer ID'].unique()  
print(customer_ids_missing_segment)  
['EP-13915' 'TC-21475' 'TG-21310']  
  
In [124...]  
unique_segment_info = df_Customer[df_Customer['Customer ID'].isin(customer_ids_missing_segment)][['Customer ID', 'Segment']].drop_duplicates()  
print(unique_segment_info)  
  
Customer ID      Segment  
7501    EP-13915    Consumer  
206     EP-13915        NaN  
9862    TG-21310    Consumer  
414     TC-21475   Home Office  
494     TC-21475        NaN  
443     TG-21310        NaN  
  
In [125...]  
# Replace NaN values in 'Segment' with "Segment" values in corresponding Customer ID"  
  
for index, row in unique_segment_info.iterrows():  
    customer_id = row['Customer ID']  
    segment = df_Customer.loc[df_Customer['Customer ID'] == customer_id, 'Segment'].dropna().iloc[0]  
    df_Customer.loc[df_Customer['Customer ID'] == customer_id, 'Segment'] = segment  
  
specific_segment_info = df_Customer[df_Customer['Customer ID'].isin(['EP-13915', 'TG-21310', 'TC-21475'])][['Customer ID', 'Segment']]  
specific_segment_info = df_Customer.loc[[142, 163, 206, 414, 443, 494], ['Customer ID', 'Segment']]  
print(specific_segment_info)  
  
Customer ID      Segment  
142    EP-13915    Consumer  
163    TG-21310    Consumer  
206    EP-13915    Consumer  
414    TC-21475   Home Office  
443    TG-21310    Consumer  
494    TC-21475   Home Office
```

Imputation with Corresponding Values in 'Customer ID' for other missing values in Customer Group

```
In [126...]  
Customer_columns_to_update = ['Country', 'City', 'State', 'Postal Code', 'Region']  
  
for column in Customer_columns_to_update:  
    customer_ids_missing_values = df_Customer.loc[df_Customer[column].isnull(), 'Customer ID'].unique()  
    for customer_id in customer_ids_missing_values:  
  
        # Check if there's at least one not-null value for this Customer ID in the current column  
        if not df_Customer[df_Customer['Customer ID'] == customer_id][column].empty:  
  
            # Get the first not-null value  
            value_to_fill = df_Customer.loc[df_Customer['Customer ID'] == customer_id, column].dropna().values[0]  
  
            # Fill in missing values for Customer ID in the current column  
            df_Customer.loc[df_Customer['Customer ID'] == customer_id, column] = value_to_fill  
  
In [127...]  
#Check updated missing value in df_Customer  
df_Customer_missing_values = df_Customer.isnull().sum()  
print(df_Customer_missing_values)
```

```
Row ID      0
Customer ID 0
Customer Name 0
Segment      0
Country      0
City          0
State         0
Postal Code  0
Region        0
dtype: int64
```

## 4. df\_Order group

```
In [128... df_Order.head(10)
```

```
Out[128]:
```

	Row ID	Order ID	Order Date	Ship Date	Ship Mode	Customer ID
0	7773	CA-2016-108196	25/11/2016	12/02/2016	Standard Class	CS-12505
1	684	US-2017-168116	11/04/2017	11/04/2017	Same Day	GT-14635
2	9775	CA-2014-169019	26/07/2014	30/07/2014	Standard Class	LF-17185
3	3012	CA-2017-134845	17/04/2017	24/04/2017	Standard Class	SR-20425
4	4992	US-2017-122714	12/07/2017	13/12/2017	Standard Class	HG-14965
5	3152	CA-2015-147830	15/12/2015	18/12/2015	First Class	NF-18385
6	5311	CA-2017-131254	19/11/2017	21/11/2017	First Class	NC-18415
7	9640	CA-2015-116638	28/01/2015	NaN	Second Class	JH-15985
8	1200	CA-2016-130946	04/08/2016	04/12/2016	Standard Class	ZC-21910
9	2698	CA-2014-145317	18/03/2014	23/03/2014	Standard Class	SM-20320

```
In [129... # Show data types of each column in df_Order
print(df_Order.dtypes)
```

```
Row ID      int64
Order ID    object
Order Date  object
Ship Date   object
Ship Mode   object
Customer ID object
dtype: object
```

## df\_Order group Handling Outliers

```
In [130... #Finding Outliers in df_Order['Ship Mode']
unique_shipmode = df_Order['Ship Mode'].unique()
print(unique_shipmode)

['Standard Class' 'Same Day' 'First Class' 'Second Class' 'nan']
```

## df\_Order handling missing value

```
In [131... #Check updated missing value in df_Order
df_Order_missing_values = df_Order.isnull().sum()
print(df_Order_missing_values)
```

```
Row ID      0
Order ID    1
Order Date  2
Ship Date   3
Ship Mode   4
Customer ID 0
dtype: int64
```

```
# Show all rows where any specified columns have missing values
missing_values_filter = df_Order['Order ID'].isnull() | \
                        df_Order['Order Date'].isnull() | \
                        df_Order['Ship Date'].isnull() | \
                        df_Order['Ship Mode'].isnull()

# get rows with missing values in the columns
df_Order_with_missing_values = df_Order[missing_values_filter]
print(df_Order_with_missing_values[['Order ID','Order Date','Ship Date','Ship Mode']])
```

	Order ID	Order Date	Ship Date	Ship Mode
7	CA-2015-116638	28/01/2015	NaN	Second Class
13	US-2017-120390	19/10/2017	NaN	Standard Class
150	CA-2014-106229	06/07/2014	06/11/2014	NaN
197	US-2015-130512	NaN	25/08/2015	Standard Class
202		NaN	27/11/2015	Standard Class
211	US-2016-141264	13/08/2016	NaN	Standard Class
244	CA-2014-155887	NaN	17/05/2014	NaN
870	CA-2016-159009	23/09/2016	27/09/2016	NaN
1030	CA-2014-122882	09/07/2014	13/09/2014	NaN

## df\_Order['Ship Mode] - Handling missing values

To find the most frequently used Ship Mode by the customer with ID KT-16480

```
#Show all columns in df_Order for each unique Ship Mode, drop duplicates
columns2_to_check = ['Ship Mode']

for column in columns2_to_check:
    unique_values = df_Order[column].unique().tolist()
    print(f"\nUnique {column}:", unique_values)
```

Unique Ship Mode: ['Standard Class', 'Same Day', 'First Class', 'Second Class', nan]

```
In [134...]: df_Order.loc[244, 'Ship Mode'] = 'Second Class'
```

```
In [135...]: df_Order.loc[150, 'Ship Mode'] = 'Second Class'
df_Order.loc[870, 'Ship Mode'] = 'Second Class'
df_Order.loc[1030, 'Ship Mode'] = 'Standard Class'
```

## df\_Order['Ship Date] - Handling missing values

```
In [136...]: df_Order.loc[7, 'Ship Date'] = '01/02/2015'
df_Order.loc[13, 'Ship Date'] = '25/10/2017'
df_Order.loc[211, 'Ship Date'] = '19/08/2016'
```

## df\_Order['Order ID] - Handling missing values

Seems values in 'Order ID' is related to Country and year of order date

```
In [137...]: df.loc[202, 'Country']
```

```
Out[137]: 'United States'
```

```
In [138...]: #filtered_rows = df_Order[df_Order['Order Date'].str.contains('27/11/2015', na=False)]
filtered_rows = df[df['Order Date'].str.contains('27/11/2015', na=False)]
print(filtered_rows[['Order ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Customer ID']])
```

```

      Order ID Order Date   Ship Date     Ship Mode Customer ID
202           NaN 27/11/2015 12/03/2015 Standard Class EH-14125
209  US-2015-168935 27/11/2015 12/02/2015 Standard Class DO-13435
1831 US-2015-168935 27/11/2015 12/02/2015 Standard Class DO-13435
1931 CA-2015-130974 27/11/2015 29/11/2015 Second Class MA-17560
3038 CA-2015-160059 27/11/2015 12/01/2015 Standard Class TB-21190
3734 CA-2015-130974 27/11/2015 29/11/2015 Second Class MA-17560
4686 CA-2015-145184 27/11/2015 29/11/2015 First Class JD-16150
5846 CA-2015-163762 27/11/2015 12/01/2015 Standard Class JE-15475
6557 CA-2015-101910 27/11/2015 12/03/2015 Standard Class CD-11920
6711 CA-2015-130974 27/11/2015 29/11/2015 Second Class MA-17560
7047 CA-2015-125234 27/11/2015 12/01/2015 Standard Class SN-20710
7124 CA-2015-145184 27/11/2015 29/11/2015 First Class JD-16150
7418 CA-2015-130974 27/11/2015 29/11/2015 Second Class MA-17560
7654 CA-2015-130974 27/11/2015 29/11/2015 Second Class MA-17560
8376 CA-2015-125234 27/11/2015 12/01/2015 Standard Class SN-20710
8685 CA-2015-130974 27/11/2015 29/11/2015 Second Class MA-17560
8984 CA-2015-130974 27/11/2015 29/11/2015 Second Class MA-17560

```

In [139...]

```
#Check if 'US-2015-168934' Order ID is exist

filtered_rows2 = df[df['Order ID'].str.contains('US-2015-168934', na=False)]
print(filtered_rows2[['Order ID', 'Order Date', 'Ship Mode', 'Customer ID']])
```

Empty DataFrame

Columns: [Order ID, Order Date, Ship Mode, Customer ID]

Index: []

In [140...]

```
#Since 'US-2015-168934' Order ID doesn't exist, we can fill in the missing value in Order ID with the

df_Order.loc[202, 'Order ID'] = 'US-2015-168934'
```

## df\_Order['Order Date'] - Handling outliers and missing values

In [141...]

```
df_Order.sort_values(by=['Ship Mode'], inplace=True, ascending=False)
order_130512 = df_Order[df_Order['Order ID'] == 'US-2015-130512'][['Order ID', 'Order Date', 'Ship D
print(order_130512)

      Order ID Order Date   Ship Date     Ship Mode Customer ID
6254 US-2015-130512 21/08/2015 25/08/2015 Standard Class
1856 US-2015-130512 21/08/2015 25/08/2015 Standard Class
364  US-2015-130512 21/08/2015 25/08/2015 Standard Class
197   US-2015-130512     NaN 25/08/2015 Standard Class
3399 US-2015-130512 21/08/2015 25/08/2015 Standard Class
```

In [142...]

```
df_Order.sort_values(by=['Ship Mode'], inplace=True, ascending=False)
order_155887 = df_Order[df_Order['Order ID'] == 'CA-2014-155887'][['Order ID', 'Order Date', 'Ship D
print(order_155887)
```

Order ID	Order Date	Ship Date	Ship Mode	Customer ID	
244	CA-2014-155887	NaN	17/05/2014	Second Class	KT-16480

will look into the shipping mode preferences of this particular customer.

In [143...]

```
df_Order.sort_values(by=['Order ID'], inplace=True, ascending=False)
order_KT16480 = df_Order[df_Order['Customer ID'] == 'KT-16480'][['Order ID', 'Order Date', 'Ship Dat
print(order_KT16480)

      Order ID Order Date   Ship Date     Ship Mode Customer ID
5225 US-2014-140116 03/10/2014 17/03/2014 Standard Class KT-16480
989  US-2014-140116 03/10/2014 17/03/2014 Standard Class KT-16480
2331 CA-2017-159107 24/06/2017 26/06/2017 Second Class KT-16480
1426 CA-2017-142461 30/05/2017 06/03/2017 Second Class KT-16480
2784 CA-2017-126718 29/04/2017 05/04/2017 Standard Class KT-16480
7171 CA-2017-123351 21/09/2017 25/09/2017 Standard Class KT-16480
5834 CA-2017-105326 20/08/2017 27/08/2017 Standard Class KT-16480
652   CA-2016-146206 09/10/2016 14/09/2016 Second Class KT-16480
8390 CA-2016-146206 09/10/2016 14/09/2016 Second Class KT-16480
2108 CA-2015-132570 31/10/2015 11/02/2015 Second Class KT-16480
7805 CA-2015-132570 31/10/2015 11/02/2015 Second Class KT-16480
244   CA-2014-155887     NaN 17/05/2014 Second Class KT-16480
9661 CA-2014-116666 05/08/2014 05/10/2014 First Class KT-16480
```

In [144...]

```
order_KT16480['Ship Mode'].value_counts().idxmax()
```

```
Out[144]: 'Second Class'
```

```
In [145... df_Order.loc[197, 'Order Date'] = '18/08/2015'  
df_Order.loc[244, 'Order Date'] = '13/05/2014'
```

```
In [146... #Check updated missing value in df_Order  
df_Order_missing_values = df_Order.isnull().sum()  
print(df_Order_missing_values)
```

```
Row ID      0  
Order ID     0  
Order Date   0  
Ship Date    0  
Ship Mode    0  
Customer ID  0  
dtype: int64
```

## Convert df\_Order[['Order Date','Ship Date']] to datetime dtype

```
In [147... df_Order['Order Date'] = pd.to_datetime(df_Order['Order Date'], format='%d/%m/%Y', errors='coerce')  
df_Order['Ship Date'] = pd.to_datetime(df_Order['Ship Date'], format='%d/%m/%Y', errors='coerce')  
df_Order.head()
```

```
Out[147]:
```

	Row ID	Order ID	Order Date	Ship Date	Ship Mode	Customer ID
562	5930	US-2017-169551	2017-07-07	2017-09-07	First Class	RL-19615
282	5932	US-2017-169551	2017-07-07	2017-09-07	First Class	RL-19615
4013	5931	US-2017-169551	2017-07-07	2017-09-07	First Class	RL-19615
3783	5934	US-2017-169551	2017-07-07	2017-09-07	First Class	RL-19615
8949	5935	US-2017-169551	2017-07-07	2017-09-07	First Class	RL-19615

```
In [148... print(df_Order.dtypes)
```

```
Row ID          int64  
Order ID        object  
Order Date     datetime64[ns]  
Ship Date      datetime64[ns]  
Ship Mode       object  
Customer ID    object  
dtype: object
```

## To filter the data where the day and month might have mistakenly swapped or incorrectly entered:

```
In [149... order_month = df_Order['Order Date'].dt.month  
filtered_order_mm = df_Order[order_month > 12]  
print(filtered_order_mm)
```

Empty DataFrame  
Columns: [Row ID, Order ID, Order Date, Ship Date, Ship Mode, Customer ID]  
Index: []

```
In [150... ship_month = df_Order['Ship Date'].dt.month  
filtered_ship_mm = df_Order[order_month > 12]  
print(filtered_ship_mm)
```

Empty DataFrame  
Columns: [Row ID, Order ID, Order Date, Ship Date, Ship Mode, Customer ID]  
Index: []

It appears there are no months exceeding 12.

## To find the mode of the 'Delivery Duration' between 'Ship Date' and 'Order Date' for each 'Ship Mode'

```
In [151... # Calculate the difference between 'Ship Date' and 'Order Date'  
df_Order['Delivery Duration'] = (df_Order['Ship Date'] - df_Order['Order Date']).dt.days
```

```

# Filter the DataFrame for shipments
Same_Day_orders = df_Order[df_Order['Ship Mode'] == 'Same Day']
First_Class_orders = df_Order[df_Order['Ship Mode'] == 'First Class']
Second_Class_orders = df_Order[df_Order['Ship Mode'] == 'Second Class']
Standard_Class_orders = df_Order[df_Order['Ship Mode'] == 'Standard Class']

# Calculate max, mode, and min of
Same_Day_max_duration = Same_Day_orders['Delivery Duration'].max()
Same_Day_mode_duration = Same_Day_orders['Delivery Duration'].mode()[0]
Same_Day_mean_duration = Same_Day_orders['Delivery Duration'].mean()
Same_Day_min_duration = Same_Day_orders['Delivery Duration'].min()
print(f"Maximum delivery duration for Same Day : {Same_Day_max_duration} days")
print(f"Mode of delivery duration for Same Day : {Same_Day_mode_duration} days")
print(f"Mean of delivery duration for Same Day: {round(Same_Day_mean_duration, 1)} days")
print(f"Minimum delivery duration for Same Day : {Same_Day_min_duration} days")
print('-----')

# Calculate max, mode, and min of
First_Class_max_duration = First_Class_orders['Delivery Duration'].max()
First_Class_mode_duration = First_Class_orders['Delivery Duration'].mode()[0]
First_Class_mean_duration = First_Class_orders['Delivery Duration'].mean()
First_Class_min_duration = First_Class_orders['Delivery Duration'].min()
print(f"Maximum delivery duration for First Class : {First_Class_max_duration} days")
print(f"Mode of delivery duration for First Class : {First_Class_mode_duration} days")
print(f"Mean of delivery duration for First Class : {round(First_Class_mean_duration, 1)} days")
print(f"Minimum delivery duration for First Class : {First_Class_min_duration} days")
print('-----')

Second_Class_max_duration = Second_Class_orders['Delivery Duration'].max()
Second_Class_mode_duration = Second_Class_orders['Delivery Duration'].mode()[0]
Second_Class_mean_duration = Second_Class_orders['Delivery Duration'].mean()
Second_Class_min_duration = Second_Class_orders['Delivery Duration'].min()
print(f"Maximum delivery duration for second Class : {Second_Class_max_duration} days")
print(f"Mode of delivery duration for second Class : {Second_Class_mode_duration} days")
print(f"Mean of delivery duration for second Class : {round(Second_Class_mean_duration, 1)} days")
print(f"Minimum delivery duration for second Class : {Second_Class_min_duration} days")
print('-----')

Standard_Class_max_duration = Standard_Class_orders['Delivery Duration'].max()
Standard_Class_mode_duration = Standard_Class_orders['Delivery Duration'].mode()[0]
Standard_Class_mean_duration = Standard_Class_orders['Delivery Duration'].mean()
Standard_Class_min_duration = Standard_Class_orders['Delivery Duration'].min()
print(f"Maximum delivery duration for standard Class : {Standard_Class_max_duration} days")
print(f"Mode of delivery duration for standard Class : {Standard_Class_mode_duration} days")
print(f"Mean of delivery duration for standard Class : {round(Standard_Class_mean_duration, 1)} days")
print(f"Minimum delivery duration for standard Class : {Standard_Class_min_duration} days")
print('-----')

```

Maximum delivery duration for Same Day : 31.0 days

Mode of delivery duration for Same Day : 0.0 days

Mean of delivery duration for Same Day: 0.6 days

Minimum delivery duration for Same Day : -87.0 days

-----

Maximum delivery duration for First Class : 92.0 days

Mode of delivery duration for First Class : 3.0 days

Mean of delivery duration for First Class : 6.7 days

Minimum delivery duration for First Class : -320.0 days

-----

Maximum delivery duration for second Class : 153.0 days

Mode of delivery duration for second Class : 2.0 days

Mean of delivery duration for second Class : 5.2 days

Minimum delivery duration for second Class : -322.0 days

-----

Maximum delivery duration for standard Class : 214.0 days

Mode of delivery duration for standard Class : 4.0 days

Mean of delivery duration for standard Class : 12.2 days

Minimum delivery duration for standard Class : -320.0 days

-----

**The dataset appears to be inconsistent, potentially due to a mix-up between the day (DD) and month (MM) fields.**

In [152...]

```

# Set up
fig, axes = plt.subplots(2, 2, figsize=(14, 10))
axes = axes.flatten() # Flatten the axes array for easy iteration
ship_modes = ['Same Day', 'First Class', 'Second Class', 'Standard Class']

```

```

orders_by_ship_mode = [Same_Day_orders, First_Class_orders, Second_Class_orders, Standard_Class_orders]

# Titles
titles = ['Same Day', 'First Class', 'Second Class', 'Standard Class']

# Iterate each Ship Mode
for i, orders in enumerate(orders_by_ship_mode):
    max_duration = orders['Delivery Duration'].max()
    mode_duration = orders['Delivery Duration'].mode()[0]
    mean_duration = orders['Delivery Duration'].mean()
    min_duration = orders['Delivery Duration'].min()

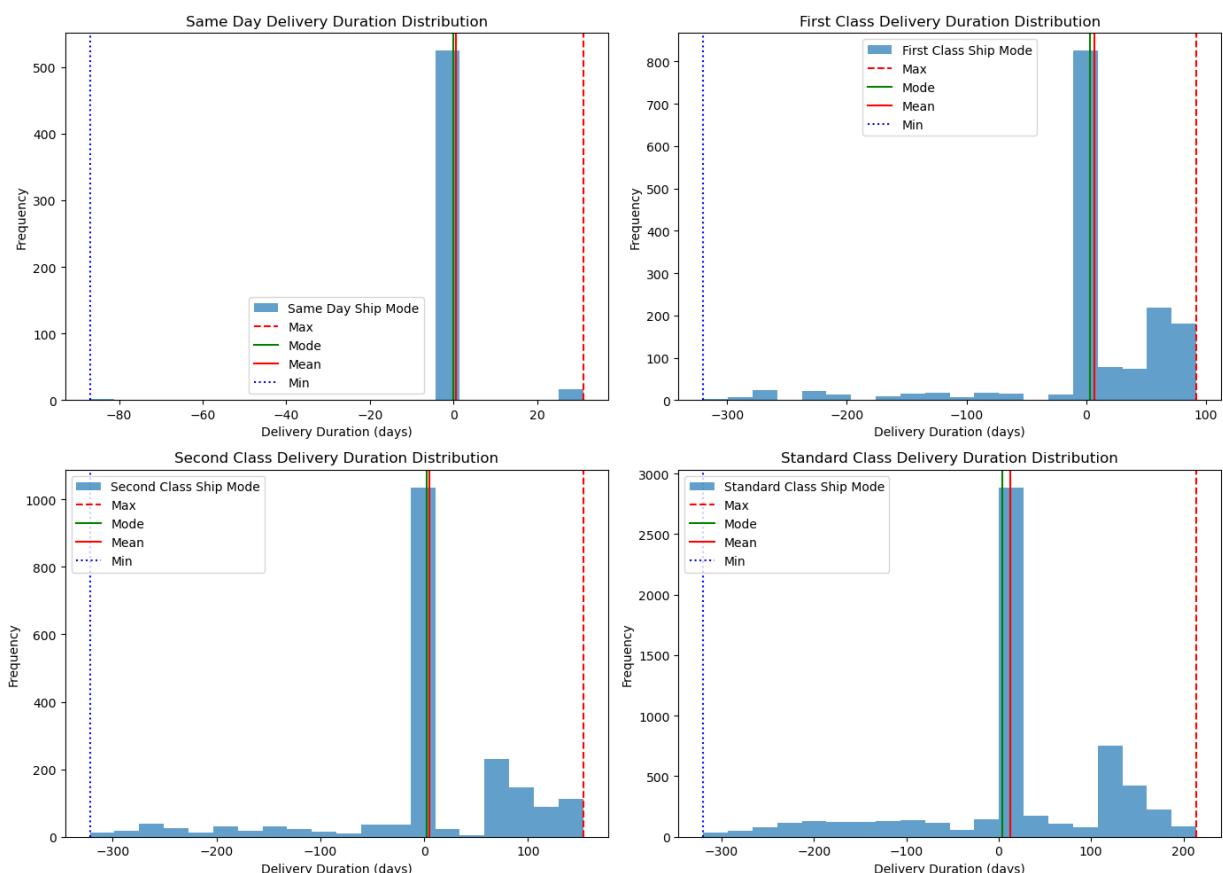
    # Plot for delivery durations
    axes[i].hist(orders['Delivery Duration'].dropna(), bins=20, alpha=0.7, label=f'{titles[i]} Ship Mode')

    # Add Lines for max, mode, and min
    axes[i].axvline(x=max_duration, color='r', linestyle='--', label='Max')
    axes[i].axvline(x=mode_duration, color='g', linestyle='-', label='Mode')
    axes[i].axvline(x=mean_duration, color='r', linestyle='-', label='Mean')
    axes[i].axvline(x=min_duration, color='b', linestyle=':', label='Min')

    # Titles & Labels
    axes[i].set_title(f'{titles[i]} Delivery Duration Distribution')
    axes[i].set_xlabel('Delivery Duration (days)')
    axes[i].set_ylabel('Frequency')
    axes[i].legend()

plt.tight_layout()
plt.show()

```



`df_Order['Ship Mode'] == 'Same Day'`

Identify df\_Order where 'Delivery Duration' is greater than 2 days or less than 0 for 'Same Day' shipments

```

In [153...]: # Identifying rows where 'Delivery Duration' is greater than 2 days or less than 0 for 'Same Day' shipments
criteria_sd = (df_Order['Ship Mode'] == 'Same Day') & ((df_Order['Delivery Duration'] > 2) | (df_Order['Delivery Duration'] < 0))

# Using the criteria to filter df_Order and then selecting specific columns
filtered_rows = df_Order.loc[criteria_sd, ['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']]

```

```
# Printing the filtered rows with specified columns
print(filtered_rows)
```

	Row ID	Order Date	Ship Date	Ship Mode	Delivery Duration
1558	1474	2015-01-12	2015-02-12	Same Day	31.0
5143	4769	2017-02-06	2017-03-06	Same Day	28.0
4295	3042	2017-11-09	2017-12-09	Same Day	30.0
5537	3043	2017-11-09	2017-12-09	Same Day	30.0
9687	3044	2017-11-09	2017-12-09	Same Day	30.0
5236	4124	2017-11-05	2017-12-05	Same Day	30.0
6551	4123	2017-11-05	2017-12-05	Same Day	30.0
6478	4122	2017-11-05	2017-12-05	Same Day	30.0
7037	2350	2017-02-12	2017-03-12	Same Day	28.0
7008	2352	2017-02-12	2017-03-12	Same Day	28.0
3851	2353	2017-02-12	2017-03-12	Same Day	28.0
3949	2351	2017-02-12	2017-03-12	Same Day	28.0
3084	2349	2017-02-12	2017-03-12	Same Day	28.0
5142	8770	2016-12-09	2016-09-13	Same Day	-87.0
3905	8771	2016-12-09	2016-09-13	Same Day	-87.0
635	4823	2016-10-07	2016-11-07	Same Day	31.0
4394	9005	2015-05-04	2015-06-04	Same Day	31.0
7302	9004	2015-05-04	2015-06-04	Same Day	31.0

```
In [154...]: df_Order.loc[5142, 'Order Date'] = '2016-09-12'
df_Order.loc[3905, 'Order Date'] = '2016-09-12'
```

```
In [155...]: df_Order.loc[[5142, 3905]]
```

```
Out[155]:
```

	Row ID	Order ID	Order Date	Ship Date	Ship Mode	Customer ID	Delivery Duration	
	5142	8770	CA-2016-151148	2016-09-12	2016-09-13	Same Day	PO-19180	-87.0
	3905	8771	CA-2016-151148	2016-09-12	2016-09-13	Same Day	PO-19180	-87.0

```
In [156...]: # Identifying rows where 'Delivery Duration' is greater than 2 days or less than 0 for 'Same Day' ship mode
criteria_sd = (df_Order['Ship Mode'] == 'Same Day') & (df_Order['Delivery Duration'] > 2)

# Correct the application of the Lambda function to swap day and month for rows matching the criteria
df_Order.loc[criteria_sd, 'Order Date'] = pd.to_datetime(df_Order.loc[criteria_sd, 'Order Date'].apply(lambda x: x.strftime('%Y-%m-%d') if pd.isnull(x) else x.strftime('%Y-%d-%m')))

df_Order.loc[criteria_sd, 'Ship Date'] = pd.to_datetime(df_Order.loc[criteria_sd, 'Ship Date'].apply(lambda x: x.strftime('%Y-%m-%d') if pd.isnull(x) else x.strftime('%Y-%d-%m')))

# Recalculate 'Delivery Duration' after correcting the dates
df_Order['Delivery Duration'] = (df_Order['Ship Date'] - df_Order['Order Date']).dt.days

# Filter & display the corrected rows
same_day_orders_over_2_days_corrected = df_Order[criteria_sd]
print(same_day_orders_over_2_days_corrected[['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']])
```

	Row ID	Order Date	Ship Date	Ship Mode	Delivery Duration
1558	1474	2015-12-01	2015-12-02	Same Day	1.0
5143	4769	2017-06-02	2017-06-03	Same Day	1.0
4295	3042	2017-09-11	2017-09-12	Same Day	1.0
5537	3043	2017-09-11	2017-09-12	Same Day	1.0
9687	3044	2017-09-11	2017-09-12	Same Day	1.0
5236	4124	2017-05-11	2017-05-12	Same Day	1.0
6551	4123	2017-05-11	2017-05-12	Same Day	1.0
6478	4122	2017-05-11	2017-05-12	Same Day	1.0
7037	2350	2017-12-02	2017-12-03	Same Day	1.0
7008	2352	2017-12-02	2017-12-03	Same Day	1.0
3851	2353	2017-12-02	2017-12-03	Same Day	1.0
3949	2351	2017-12-02	2017-12-03	Same Day	1.0
3084	2349	2017-12-02	2017-12-03	Same Day	1.0
635	4823	2016-07-10	2016-07-11	Same Day	1.0
4394	9005	2015-04-05	2015-04-06	Same Day	1.0
7302	9004	2015-04-05	2015-04-06	Same Day	1.0

After swapping the day (DD) with the month (MM) in 'Order Date' and 'Ship Date' for entries in df\_Order where the 'Delivery Duration' is more than 2 days or less than 0 days for the 'Same Day' ship mode, the delivery times for each ship mode now appear accurate.

## Identify df\_Order where 'Delivery Duration' is less than 0 for 'First Class' shipments

```
In [157]:  
criteria_1st = (df_Order['Ship Mode'] == 'First Class') & ((df_Order['Delivery Duration'] < 0) | (df_Order['Delivery Duration'] > 4))  
  
filtered_rows_1st = df_Order.loc[criteria_1st, ['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']]  
filtered_rows_1st.head(10)
```

Out[157]:

	Row ID	Order Date	Ship Date	Ship Mode	Delivery Duration
562	5930	2017-07-07	2017-09-07	First Class	62.0
282	5932	2017-07-07	2017-09-07	First Class	62.0
4013	5931	2017-07-07	2017-09-07	First Class	62.0
3783	5934	2017-07-07	2017-09-07	First Class	62.0
8949	5935	2017-07-07	2017-09-07	First Class	62.0
2208	5933	2017-07-07	2017-09-07	First Class	62.0
6670	9540	2017-07-09	2017-09-09	First Class	62.0
4786	9539	2017-07-09	2017-09-09	First Class	62.0
1003	9289	2017-11-30	2017-03-12	First Class	-263.0
7494	132	2017-02-02	2017-05-02	First Class	89.0

## df\_Order['Ship Mode'] == 'First Class'

Identify df\_Order where 'Delivery Duration' is greater than 4 days or less than 0 for 'First Class' shipments

```
In [158]:  
  
def swap_day_month_if_valid(date):  
    if pd.isnull(date):  
        return date # Return the original date if it's NaT  
    # Ensure the swap only happens if the day is within the 1-12 range, making it a valid month  
    if 1 <= date.day <= 12:  
        try:  
            # Attempt to create a new date with the swapped values  
            new_date = pd.Timestamp(year=date.year, month=date.day, day=date.month)  
            return new_date  
        except ValueError:  
            # If the swap results in an invalid date, return the original date  
            return date  
    else:  
        # If the day is not a valid month, return the original date without swapping  
        return date  
  
# Apply the function to swap day and month in 'Order Date' and 'Ship Date' for rows matching the criteria  
df_Order.loc[criteria_1st, 'Order Date'] = df_Order.loc[criteria_1st, 'Order Date'].apply(swap_day_month_if_valid)  
df_Order.loc[criteria_1st, 'Ship Date'] = df_Order.loc[criteria_1st, 'Ship Date'].apply(swap_day_month_if_valid)  
  
# Recalculate 'Delivery Duration' after potentially correcting the 'Ship Date'  
df_Order['Delivery Duration'] = (df_Order['Ship Date'] - df_Order['Order Date']).dt.days  
  
first_class_corrected = df_Order[criteria_1st]  
print(first_class_corrected[['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']])
```

```

      Row ID Order Date  Ship Date  Ship Mode Delivery Duration
562      5930 2017-07-07 2017-07-09 First Class           2.0
282      5932 2017-07-07 2017-07-09 First Class           2.0
4013     5931 2017-07-07 2017-07-09 First Class           2.0
3783     5934 2017-07-07 2017-07-09 First Class           2.0
8949     5935 2017-07-07 2017-07-09 First Class           2.0
...       ...   ...   ...   ...
1370     5438 2014-07-05 2014-07-08 First Class           3.0
6363     5439 2014-07-05 2014-07-08 First Class           3.0
3958     5437 2014-07-05 2014-07-08 First Class           3.0
7537     428   2014-09-12 2014-09-13 First Class           1.0
1398     6252 2014-12-02 2014-12-04 First Class           2.0

```

[712 rows x 5 columns]

In [159]:

```
#Re-check after corrected
criteria_1st = (df_Order['Ship Mode'] == 'First Class') & ((df_Order['Delivery Duration'] < 0) | (df_Order['Delivery Duration'] > 4))

filtered_rows_1st = df_Order.loc[criteria_1st, ['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']]
len(filtered_rows_1st)
```

Out[159]: 0

After swapping the day (DD) with the month (MM) in 'Order Date' and 'Ship Date' for entries in df\_Order where the 'Delivery Duration' is more than 4 days or less than 0 days for the 'First Class' ship mode, the delivery times for each ship mode now appear accurate.

## df\_Order['Ship Mode'] == 'Second Class' and 'Standard Class'

Identify df\_Order where 'Delivery Duration' is greater than 5 days or less than 0 for 'Second Class' shipments

In [160]:

```
criteria_2nd = (df_Order['Ship Mode'] == 'Second Class') & ((df_Order['Delivery Duration'] < 0) | (df_Order['Delivery Duration'] > 5))
criteria_std = (df_Order['Ship Mode'] == 'Standard Class') & ((df_Order['Delivery Duration'] < 0) | (df_Order['Delivery Duration'] > 7))

filtered_rows_2nd = df_Order.loc[criteria_2nd, ['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']]
filtered_rows_std = df_Order.loc[criteria_std, ['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']]
filtered_rows_2nd.head()
```

Out[160]:

	Row ID	Order Date	Ship Date	Ship Mode	Delivery Duration
8564	7516	2017-09-12	2017-12-12	Second Class	91.0
5998	7515	2017-09-12	2017-12-12	Second Class	91.0
8214	7518	2017-09-12	2017-12-12	Second Class	91.0
2868	7520	2017-09-12	2017-12-12	Second Class	91.0
2074	7519	2017-09-12	2017-12-12	Second Class	91.0

In [161]:

```
filtered_rows_std.head()
```

Out[161]:

	Row ID	Order Date	Ship Date	Ship Mode	Delivery Duration
4174	4598	2017-08-28	2017-01-09	Standard Class	-231.0
7309	4599	2017-08-28	2017-01-09	Standard Class	-231.0
4197	8294	2017-03-11	2017-07-11	Standard Class	122.0
1755	2121	2017-07-01	2017-01-13	Standard Class	-169.0
3119	7171	2017-08-10	2017-10-14	Standard Class	65.0

In [162]:

```
len(filtered_rows_std)
```

Out[162]: 3078

```
In [163...]
def swap_day_month_if_valid(date):
    if pd.isnull(date):
        return date # Return the original date if it's NaT
    # Ensure the swap only happens if the day is within the 1-12 range, making it a valid month
    if 1 <= date.day <= 12:
        try:
            # Attempt to create a new date with the swapped values
            new_date = pd.Timestamp(year=date.year, month=date.day, day=date.month)
            return new_date
        except ValueError:
            # If the swap results in an invalid date, return the original date
            return date
    else:
        # If the day is not a valid month, return the original date without swapping
        return date

# Apply the function to swap day and month in 'Order Date' and 'Ship Date' for rows matching the criteria
df_Order.loc[criteria_2nd, 'Order Date'] = df_Order.loc[criteria_2nd, 'Order Date'].apply(swap_day_month_if_valid)
df_Order.loc[criteria_2nd, 'Ship Date'] = df_Order.loc[criteria_2nd, 'Ship Date'].apply(swap_day_month_if_valid)
df_Order.loc[criteria_std, 'Order Date'] = df_Order.loc[criteria_std, 'Order Date'].apply(swap_day_month_if_valid)
df_Order.loc[criteria_std, 'Ship Date'] = df_Order.loc[criteria_std, 'Ship Date'].apply(swap_day_month_if_valid)

# Recalculate 'Delivery Duration' after potentially correcting the 'Ship Date'
df_Order['Delivery Duration'] = (df_Order['Ship Date'] - df_Order['Order Date']).dt.days
```

```
In [164...]
second_class_corrected = df_Order[criteria_2nd]
print(second_class_corrected[['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']]

   Row ID Order Date  Ship Date     Ship Mode  Delivery Duration
8564    7516 2017-12-09 2017-12-12 Second Class           3.0
5998    7515 2017-12-09 2017-12-12 Second Class           3.0
8214    7518 2017-12-09 2017-12-12 Second Class           3.0
2868    7520 2017-12-09 2017-12-12 Second Class           3.0
2074    7519 2017-12-09 2017-12-12 Second Class           3.0
...
4737    3277 2014-04-05 2014-04-09 Second Class           4.0
8097    5193 2014-11-28 2014-12-01 Second Class           3.0
7975    5194 2014-11-28 2014-12-01 Second Class           3.0
7014    5196 2014-11-28 2014-12-01 Second Class           3.0
3599    5195 2014-11-28 2014-12-01 Second Class           3.0

[911 rows x 5 columns]
```

```
In [165...]
standard_class_corrected = df_Order[criteria_2nd]
print(standard_class_corrected[['Row ID', 'Order Date', 'Ship Date', 'Ship Mode', 'Delivery Duration']]

   Row ID Order Date  Ship Date     Ship Mode  Delivery Duration
8564    7516 2017-12-09 2017-12-12 Second Class           3.0
5998    7515 2017-12-09 2017-12-12 Second Class           3.0
8214    7518 2017-12-09 2017-12-12 Second Class           3.0
2868    7520 2017-12-09 2017-12-12 Second Class           3.0
2074    7519 2017-12-09 2017-12-12 Second Class           3.0
...
4737    3277 2014-04-05 2014-04-09 Second Class           4.0
8097    5193 2014-11-28 2014-12-01 Second Class           3.0
7975    5194 2014-11-28 2014-12-01 Second Class           3.0
7014    5196 2014-11-28 2014-12-01 Second Class           3.0
3599    5195 2014-11-28 2014-12-01 Second Class           3.0

[911 rows x 5 columns]
```

After swapping the day (DD) with the month (MM) in 'Order Date' and 'Ship Date' for entries in df\_Order where the 'Delivery Duration' is more than 6 days or less than 0 days for the 'Second Class' and 'Standard Class' ship mode, the delivery times for each ship mode now appear accurate.

## Re-check after corrected

```
In [166...]
# Calculate the difference between 'Ship Date' and 'Order Date'
df_Order['Delivery Duration'] = (df_Order['Ship Date'] - df_Order['Order Date']).dt.days

# Filter the DataFrame for shipments
Same_Day_orders = df_Order[df_Order['Ship Mode'] == 'Same Day']
First_Class_orders = df_Order[df_Order['Ship Mode'] == 'First Class']
```

```

Second_Class_orders = df_Order[df_Order['Ship Mode'] == 'Second Class']
Standard_Class_orders = df_Order[df_Order['Ship Mode'] == 'Standard Class']

# Calculate max, mode, and min of
Same_Day_max_duration = Same_Day_orders['Delivery Duration'].max()
Same_Day_mode_duration = Same_Day_orders['Delivery Duration'].mode()[0]
Same_Day_mean_duration = Same_Day_orders['Delivery Duration'].mean()
Same_Day_min_duration = Same_Day_orders['Delivery Duration'].min()
print(f"Maximum delivery duration for Same Day : {Same_Day_max_duration} days")
print(f"Mode of delivery duration for Same Day : {Same_Day_mode_duration} days")
print(f"Mean of delivery duration for Same Day: {round(Same_Day_mean_duration, 1)} days")
print(f"Minimum delivery duration for Same Day : {Same_Day_min_duration} days")
print('-----')

# Calculate max, mode, and min of
First_Class_max_duration = First_Class_orders['Delivery Duration'].max()
First_Class_mode_duration = First_Class_orders['Delivery Duration'].mode()[0]
First_Class_mean_duration = First_Class_orders['Delivery Duration'].mean()
First_Class_min_duration = First_Class_orders['Delivery Duration'].min()
print(f"Maximum delivery duration for First Class : {First_Class_max_duration} days")
print(f"Mode of delivery duration for First Class : {First_Class_mode_duration} days")
print(f"Mean of delivery duration for First Class : {round(First_Class_mean_duration, 1)} days")
print(f"Minimum delivery duration for First Class : {First_Class_min_duration} days")
print('-----')

Second_Class_max_duration = Second_Class_orders['Delivery Duration'].max()
Second_Class_mode_duration = Second_Class_orders['Delivery Duration'].mode()[0]
Second_Class_mean_duration = Second_Class_orders['Delivery Duration'].mean()
Second_Class_min_duration = Second_Class_orders['Delivery Duration'].min()
print(f"Maximum delivery duration for second Class : {Second_Class_max_duration} days")
print(f"Mode of delivery duration for second Class : {Second_Class_mode_duration} days")
print(f"Mean of delivery duration for second Class : {round(Second_Class_mean_duration, 1)} days")
print(f"Minimum delivery duration for second Class : {Second_Class_min_duration} days")
print('-----')

Standard_Class_max_duration = Standard_Class_orders['Delivery Duration'].max()
Standard_Class_mode_duration = Standard_Class_orders['Delivery Duration'].mode()[0]
Standard_Class_mean_duration = Standard_Class_orders['Delivery Duration'].mean()
Standard_Class_min_duration = Standard_Class_orders['Delivery Duration'].min()
print(f"Maximum delivery duration for standard Class : {Standard_Class_max_duration} days")
print(f"Mode of delivery duration for standard Class : {Standard_Class_mode_duration} days")
print(f"Mean of delivery duration for standard Class : {round(Standard_Class_mean_duration, 1)} days")
print(f"Minimum delivery duration for standard Class : {Standard_Class_min_duration} days")
print('-----')

```

```

Maximum delivery duration for Same Day : 1.0 days
Mode of delivery duration for Same Day : 0.0 days
Mean of delivery duration for Same Day: 0.0 days
Minimum delivery duration for Same Day : 0.0 days
-----
Maximum delivery duration for First Class : 4.0 days
Mode of delivery duration for First Class : 3.0 days
Mean of delivery duration for First Class : 2.2 days
Minimum delivery duration for First Class : 1.0 days
-----
Maximum delivery duration for second Class : 5.0 days
Mode of delivery duration for second Class : 2.0 days
Mean of delivery duration for second Class : 3.2 days
Minimum delivery duration for second Class : 1.0 days
-----
Maximum delivery duration for standard Class : 7.0 days
Mode of delivery duration for standard Class : 4.0 days
Mean of delivery duration for standard Class : 5.0 days
Minimum delivery duration for standard Class : 3.0 days
-----
```

In [167...]

```

# Set up
fig, axes = plt.subplots(2, 2, figsize=(14, 10))
axes = axes.flatten() # Flatten the axes array for easy iteration
ship_modes = ['Same Day', 'First Class', 'Second Class', 'Standard Class']
orders_by_ship_mode = [Same_Day_orders, First_Class_orders, Second_Class_orders, Standard_Class_order]

# Titles
titles = ['Same Day', 'First Class', 'Second Class', 'Standard Class']

# Iterate each Ship Mode
for i, orders in enumerate(orders_by_ship_mode):
    max_duration = orders['Delivery Duration'].max()
    mode_duration = orders['Delivery Duration'].mode()[0]

```

```

mean_duration = orders['Delivery Duration'].mean()
min_duration = orders['Delivery Duration'].min()

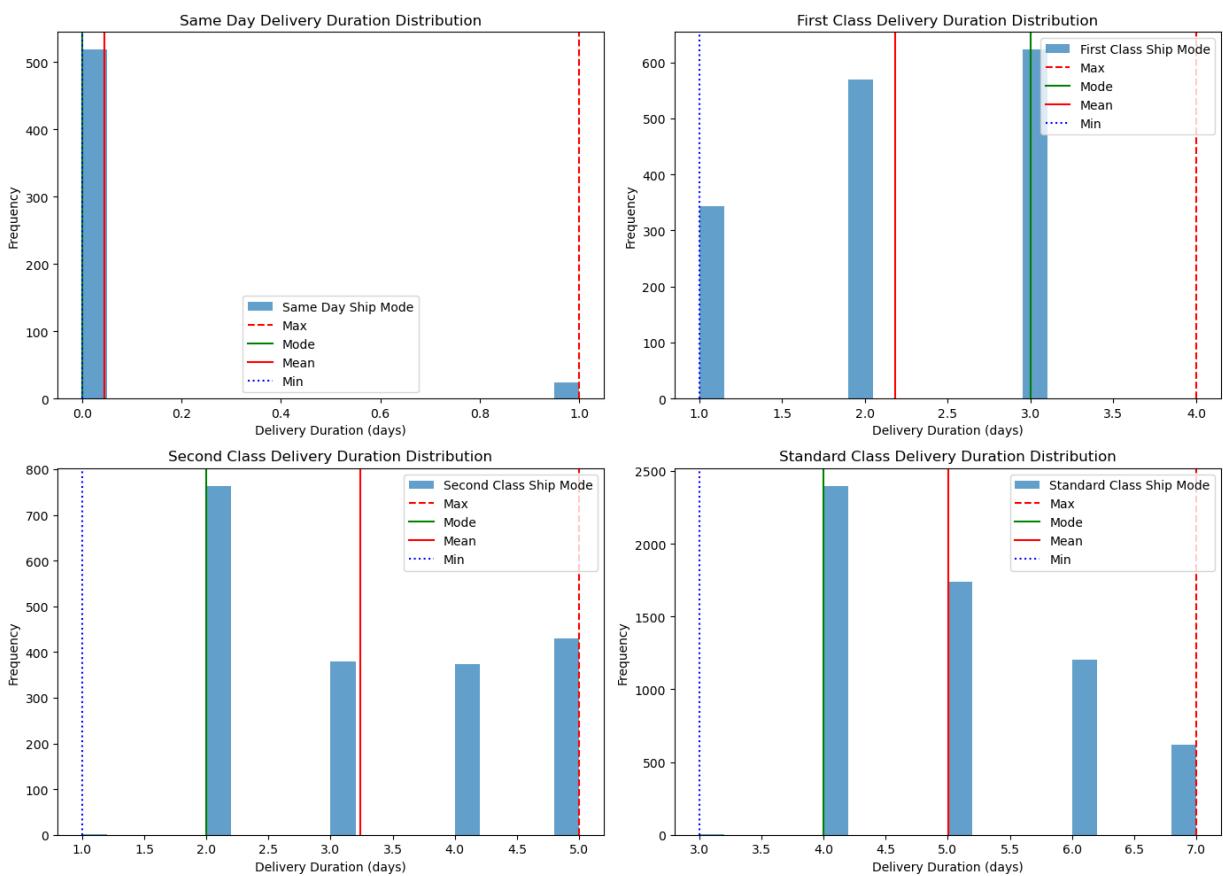
# Plot for delivery durations
axes[i].hist(orders['Delivery Duration'].dropna(), bins=20, alpha=0.7, label=f'{titles[i]} Ship Mode')

# Add Lines for max, mode, and min
axes[i].axvline(x=max_duration, color='r', linestyle='--', label='Max')
axes[i].axvline(x=mode_duration, color='g', linestyle='-.', label='Mode')
axes[i].axvline(x=mean_duration, color='r', linestyle='-', label='Mean')
axes[i].axvline(x=min_duration, color='b', linestyle=':', label='Min')

# Titles & labels
axes[i].set_title(f'{titles[i]} Delivery Duration Distribution')
axes[i].set_xlabel('Delivery Duration (days)')
axes[i].set_ylabel('Frequency')
axes[i].legend()

plt.tight_layout()
plt.show()

```



## Maximum of delivery duration for each Ship Mode

```

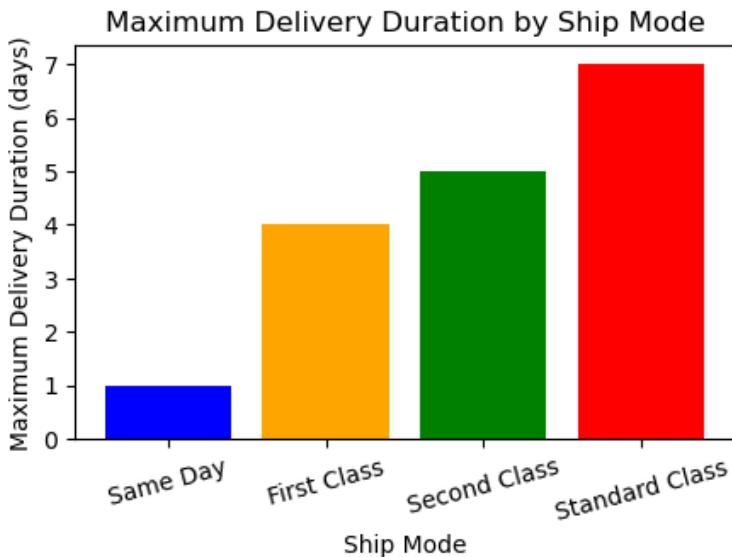
In [227...]
maximum_durations = {
    "Same Day": Same_Day_max_duration,
    "First Class": First_Class_max_duration,
    "Second Class": Second_Class_max_duration,
    "Standard Class": Standard_Class_max_duration
}

ship_modes = list(maximum_durations.keys())
maximum = list(maximum_durations.values())

plt.figure(figsize=(5, 3))
plt.bar(ship_modes, maximum, color=['blue', 'orange', 'green', 'red'])

plt.title('Maximum Delivery Duration by Ship Mode')
plt.xlabel('Ship Mode')
plt.ylabel('Maximum Delivery Duration (days)')
plt.xticks(rotation=15)
plt.show()

```



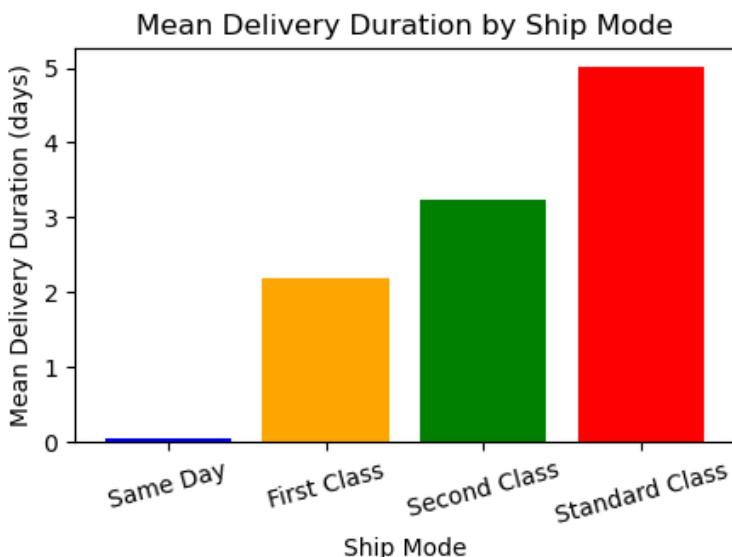
### Mean of delivery duration for each Ship Mode

```
In [225...]: # Mean delivery duration for each Ship Mode
mean_durations = {
    "Same Day": Same_Day_mean_duration,
    "First Class": First_Class_mean_duration,
    "Second Class": Second_Class_mean_duration,
    "Standard Class": Standard_Class_mean_duration
}

ship_modes = list(mean_durations.keys())
means = list(mean_durations.values())

plt.figure(figsize=(5, 3))
plt.bar(ship_modes, means, color=['blue', 'orange', 'green', 'red'])

plt.title('Mean Delivery Duration by Ship Mode')
plt.xlabel('Ship Mode')
plt.ylabel('Mean Delivery Duration (days)')
plt.xticks(rotation=15)
plt.show()
```



### To Merge df\_Customer and df\_Order into df\_Customer\_Order

```
In [170...]: df_Customer_Order = pd.merge(df_Customer[['Row ID', 'Customer ID', 'Customer Name', 'Segment', 'Country',
                                                'Postal Code', 'Region']],
                                         df_Order[['Row ID', 'Order ID', 'Order Date', 'Ship Date', 'Ship Mode']])
```

```
In [171...]: #Check updated missing value in df_Customer_Order  
df_Customer_Order_missing_values = df_Customer_Order.isnull().sum()  
print(df_Customer_Order_missing_values)
```

```
Row ID          0  
Customer ID    0  
Customer Name   0  
Segment         0  
Country         0  
City             0  
State            0  
Postal Code     0  
Region           0  
Order ID        0  
Order Date      1  
Ship Date       0  
Ship Mode       0  
dtype: int64
```

```
In [172...]: # Filter df_Customer_Order to show rows with missing 'Order Date'  
missing_order_date_rows = df_Customer_Order[df_Customer_Order['Order Date'].isnull()]  
missing_order_date_rows[['Row ID', 'Order ID', 'Order Date', 'Ship Date', 'Ship Mode']]
```

```
Out[172]:
```

	Row ID	Order ID	Order Date	Ship Date	Ship Mode
9321	4821	CA-2015-140025	NaT	2015-11-04	Standard Class

Fill in the missing 'Order Date' value by adding the mean of delivery duration, which is 5 days for the 'Standard Class' ship mode to the corresponding 'Ship Date'

```
In [173...]: df_Customer_Order.loc[9321, 'Order Date'] = '2015-10-30'  
  
# Display the specified columns for the updated row  
df_Customer_Order.loc[[9321], ['Row ID', 'Order ID', 'Order Date', 'Ship Date', 'Ship Mode']]
```

```
Out[173]:
```

	Row ID	Order ID	Order Date	Ship Date	Ship Mode
9321	4821	CA-2015-140025	2015-10-30	2015-11-04	Standard Class

```
In [174...]: print(df_Customer_Order.dtypes)
```

```
Row ID          int64  
Customer ID    object  
Customer Name   object  
Segment         object  
Country         object  
City             object  
State            object  
Postal Code     object  
Region           object  
Order ID        object  
Order Date      datetime64[ns]  
Ship Date       datetime64[ns]  
Ship Mode       object  
dtype: object
```

```
In [175...]: #Check updated missing value in df_Customer_Order  
df_Customer_Order_missing_values = df_Customer_Order.isnull().sum()  
print(df_Customer_Order_missing_values)
```

```
Row ID      0
Customer ID 0
Customer Name 0
Segment      0
Country      0
City          0
State         0
Postal Code  0
Region        0
Order ID     0
Order Date   0
Ship Date    0
Ship Mode    0
dtype: int64
```

Every column in the df\_Customer\_Order is now complete with no missing values

## To Merge df\_Product\_Sales with df\_Customer\_Order

In [176...]

```
print(df.columns)

Index(['Row ID', 'Order ID', 'Order Date', 'Ship Date', 'Ship Mode',
       'Customer ID', 'Customer Name', 'Segment', 'Country', 'City', 'State',
       'Postal Code', 'Region', 'Product ID', 'Category', 'Sub-Category',
       'Product Name', 'Sales', 'Quantity', 'Discount', 'Profit'],
      dtype='object')
```

In [177...]

```
print(df_Product_Sales.columns)

Index(['Row ID', 'Product ID', 'Category', 'Sub-Category', 'Product Name',
       'Order ID', 'Sales', 'Quantity', 'Discount', 'Profit'],
      dtype='object')
```

In [178...]

```
print(df_Customer_Order.columns)

Index(['Row ID', 'Customer ID', 'Customer Name', 'Segment', 'Country', 'City',
       'State', 'Postal Code', 'Region', 'Order ID', 'Order Date', 'Ship Date',
       'Ship Mode'],
      dtype='object')
```

In [179...]

```
df1 = pd.merge(df_Product_Sales[['Row ID', 'Product ID', 'Category', 'Sub-Category', 'Product Name',
                                    'Sales', 'Quantity', 'Discount', 'Profit']], df_Customer_Order, on='Row ID', how='inner')
```

In [180...]

```
print(df1.columns)

Index(['Row ID', 'Product ID', 'Category', 'Sub-Category', 'Product Name',
       'Sales', 'Quantity', 'Discount', 'Profit', 'Customer ID',
       'Customer Name', 'Segment', 'Country', 'City', 'State', 'Postal Code',
       'Region', 'Order ID', 'Order Date', 'Ship Date', 'Ship Mode'],
      dtype='object')
```

In [181...]

```
df1_missing_values = df1.isnull().sum()
print(df1_missing_values)
```

```
Row ID      0
Product ID   0
Category     0
Sub-Category 0
Product Name 0
Sales        0
Quantity     0
Discount     0
Profit       0
Customer ID 0
Customer Name 0
Segment      0
Country      0
City         0
State        0
Postal Code 0
Region       0
Order ID    0
Order Date   0
Ship Date    0
Ship Mode    0
dtype: int64
```

In [182...]

```
#df.head()
df1[df1['Row ID'].isin([8209, 8633, 7727, 5725])][['Row ID', 'Product ID', 'Sales', 'Quantity', 'Dis
```

Out[182]:

	Row ID	Product ID	Sales	Quantity	Discount	Profit
2318	7727	OFF-ST-10002574	331.536	3	0.2	-82.884
2321	5725	OFF-ST-10002574	331.536	3	0.2	-82.884
6446	8209	OFF-BI-10000545	1369.764	6	0.7	-913.176
6453	8633	OFF-BI-10000545	1369.764	6	0.7	-913.176

'Row ID' after the merge matches the 'Row ID' before the merge

In [183...]

```
print(df1.dtypes)
```

```
Row ID          int64
Product ID      object
Category        object
Sub-Category    object
Product Name    object
Sales           float64
Quantity        int32
Discount        float64
Profit          float64
Customer ID    object
Customer Name  object
Segment         object
Country         object
City            object
State           object
Postal Code    object
Region          object
Order ID        object
Order Date      datetime64[ns]
Ship Date       datetime64[ns]
Ship Mode       object
dtype: object
```

## Save cleaned version as a csv file

In [184...]

```
df1.to_csv('sample-superstore_2023_T3_clean.csv', index=False)
```

## Load cleaned version

In [185...]

```
input_file1 = "sample-superstore_2023_T3_clean.csv"
df1 = pd.read_csv(input_file1, header = 0)
df1.head()
```

Out[185]:

	Row ID	Product ID	Category	Sub-Category	Product Name	Sales	Quantity	Discount	Profit	Customer ID	...	Segment	C
0	9798	TEC-PH-10004977	Technology	Phones	GE 30524EE4	235.188	2	0.4	-43.1178	CS-12490	...	Corporate	
1	5065	TEC-PH-10004977	Technology	Phones	GE 30524EE4	391.980	2	0.0	113.6742	CA-12265	...	Consumer	
2	7502	TEC-PH-10004977	Technology	Phones	GE 30524EE4	470.376	3	0.2	52.9173	TC-21295	...	Consumer	
3	9728	TEC-PH-10004977	Technology	Phones	GE 30524EE4	979.950	5	0.0	284.1855	KM-16720	...	Consumer	
4	582	TEC-PH-10004977	Technology	Phones	GE 30524EE4	470.376	3	0.2	52.9173	DV-13465	...	Consumer	

5 rows × 21 columns

In [186]:

```
print(df1.columns)

Index(['Row ID', 'Product ID', 'Category', 'Sub-Category', 'Product Name',
       'Sales', 'Quantity', 'Discount', 'Profit', 'Customer ID',
       'Customer Name', 'Segment', 'Country', 'City', 'State', 'Postal Code',
       'Region', 'Order ID', 'Order Date', 'Ship Date', 'Ship Mode'],
      dtype='object')
```

In [187]:

```
#Check updated missing value in df
df1.isnull().sum()
```

Out[187]:

```
Row ID      0
Product ID  0
Category     0
Sub-Category 0
Product Name 0
Sales        0
Quantity     0
Discount     0
Profit       0
Customer ID  0
Customer Name 0
Segment      0
Country      0
City         0
State        0
Postal Code  0
Region       0
Order ID     0
Order Date   0
Ship Date    0
Ship Mode    0
dtype: int64
```

In [188]:

```
df1['Order Date'] = pd.to_datetime(df1['Order Date'])
df1['Ship Date'] = pd.to_datetime(df1['Ship Date'])
print(df1.dtypes)
```

```
Row ID           int64
Product ID      object
Category         object
Sub-Category    object
Product Name    object
Sales            float64
Quantity         int64
Discount         float64
Profit           float64
Customer ID    object
Customer Name   object
Segment          object
Country          object
City             object
State            object
Postal Code     object
Region           object
Order ID         object
Order Date       datetime64[ns]
Ship Date        datetime64[ns]
Ship Mode        object
dtype: object
```

## Univariate analysis & Visualization

### Distribution of Sales

```
In [189]: sales_stats = df1['Sales'].describe()
sales_stats
```

```
Out[189]: count    9994.000000
mean     229.858001
std      623.245101
min      0.444000
25%     17.280000
50%     54.490000
75%     209.940000
max     22638.480000
Name: Sales, dtype: float64
```

### Distribution of Category

```
In [190]: category_counts = df1['Category'].value_counts()
print(category_counts)
```

```
Office Supplies    6026
Furniture          2121
Technology         1847
Name: Category, dtype: int64
```

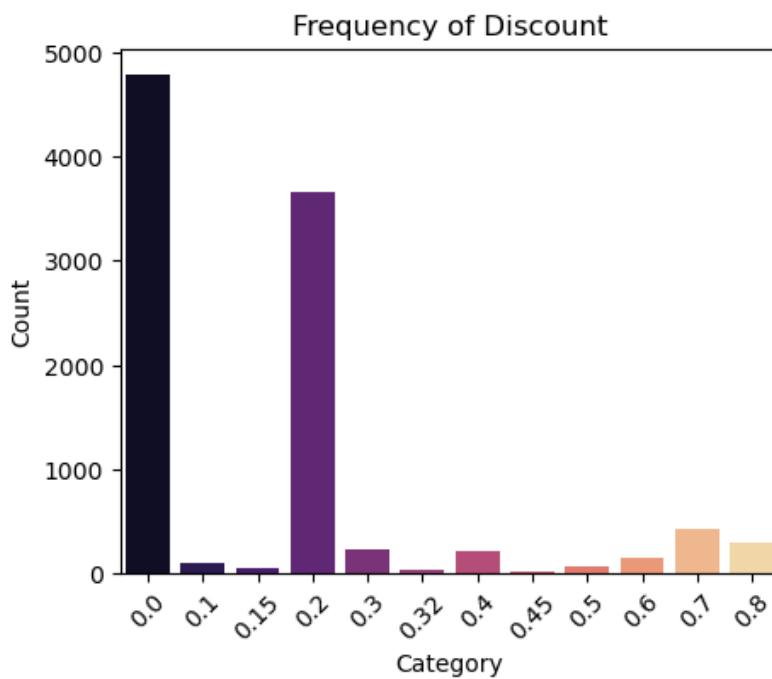
### Distribution of Discount

```
In [191]: discount_counts = df1['Discount'].value_counts()
print(discount_counts)
```

```
0.00    4798
0.20    3657
0.70    418
0.80    300
0.30    227
0.40    206
0.60    138
0.10    94
0.50    66
0.15    52
0.32    27
0.45    11
Name: Discount, dtype: int64
```

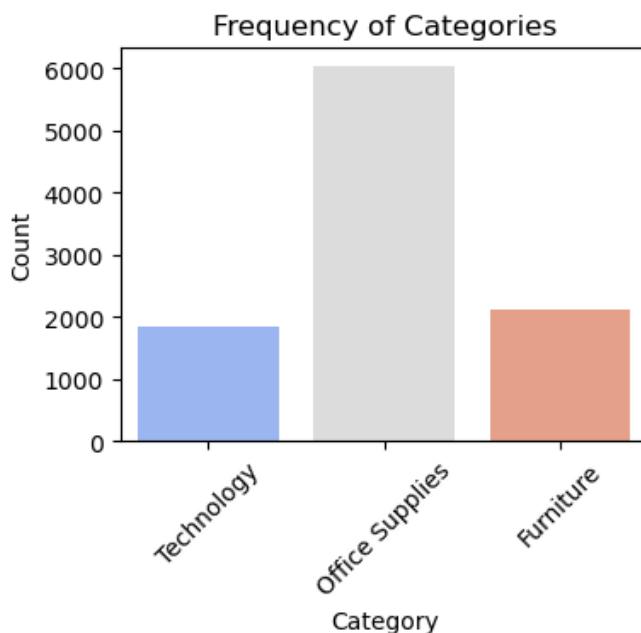
```
In [192]: # cmap: viridis, plasma, magma, inferno, Blues, Greens, Greys, coolwarm, RdBu, Spectral, cividis, twi
plt.figure(figsize=(5, 4))
```

```
sns.countplot(data=df1, x='Discount', palette='magma')
plt.title('Frequency of Discount')
plt.xlabel('Category')
plt.ylabel('Count')
plt.xticks(rotation=45)
plt.show()
```



## Distribution of Categories

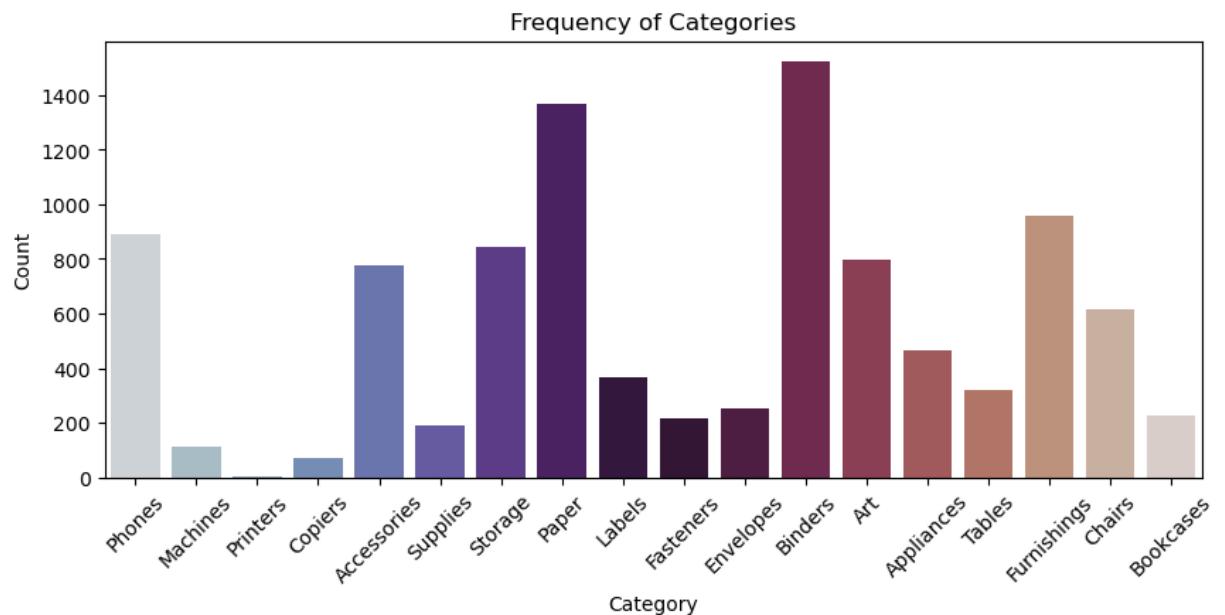
```
In [193...]
plt.figure(figsize=(4, 3))
sns.countplot(data=df1, x='Category', palette='coolwarm')
plt.title('Frequency of Categories')
plt.xlabel('Category')
plt.ylabel('Count')
plt.xticks(rotation=45)
plt.show()
```



## Distribution of Sub-Categories

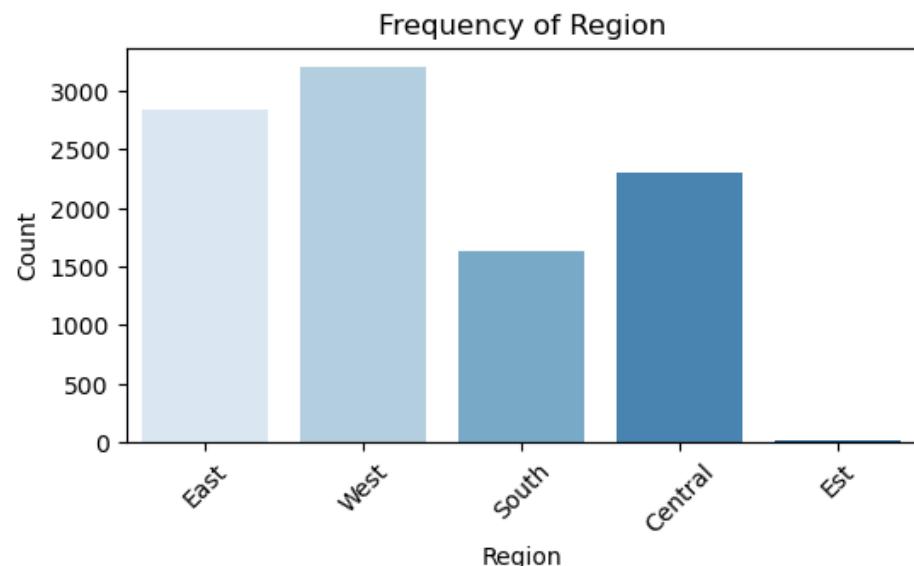
```
In [194...]
plt.figure(figsize=(10, 4))
sns.countplot(data=df1, x='Sub-Category', palette='twilight')
plt.title('Frequency of Categories')
plt.xlabel('Category')
```

```
plt.ylabel('Count')
plt.xticks(rotation=45)
plt.show()
```



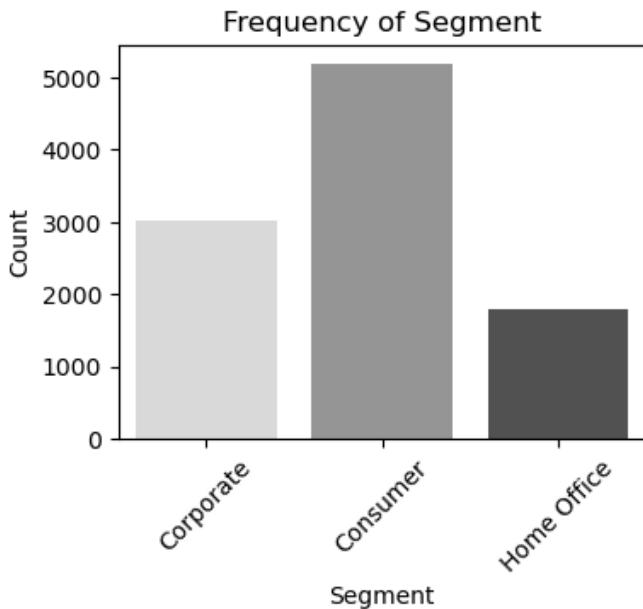
## Distribution of Region

```
In [195...]: plt.figure(figsize=(6, 3))
sns.countplot(data=df1, x='Region', palette='Blues')
plt.title('Frequency of Region')
plt.xlabel('Region')
plt.ylabel('Count')
plt.xticks(rotation=45)
plt.show()
```



## Distribution of Segment

```
In [196...]: plt.figure(figsize=(4, 3))
sns.countplot(data=df1, x='Segment', palette='Greys')
plt.title('Frequency of Segment')
plt.xlabel('Segment')
plt.ylabel('Count')
plt.xticks(rotation=45)
plt.show()
```



## Removing Outliers and Normalizing

Use z-score to identify and remove outliers in ['Sales', 'Quantity', 'Discount', 'Profit']

```
In [197]: z_scores = zscore(df1[['Sales', 'Quantity', 'Discount', 'Profit']])
df1_no_outliers = df1[(abs(z_scores) < 3).all(axis=1)]
```

## Standardize/ Normalize/ Scaling the variables

```
In [198]: scaler = MinMaxScaler() # Apply Min-Max scaling
numerical_vars = ['Sales', 'Quantity', 'Discount', 'Profit']
df1_no_outliers[numerical_vars] = scaler.fit_transform(df1_no_outliers[numerical_vars])
df1_no_outliers[numerical_vars].head(3)
```

```
Out[198]:
```

	Sales	Quantity	Discount	Profit
<b>0</b>	0.112740	0.111111	0.571429	0.450216
<b>1</b>	0.188174	0.111111	0.000000	0.565907
<b>2</b>	0.225890	0.222222	0.285714	0.521077

## Descriptive Statistic

```
In [199]: df1_no_outliers.describe()
```

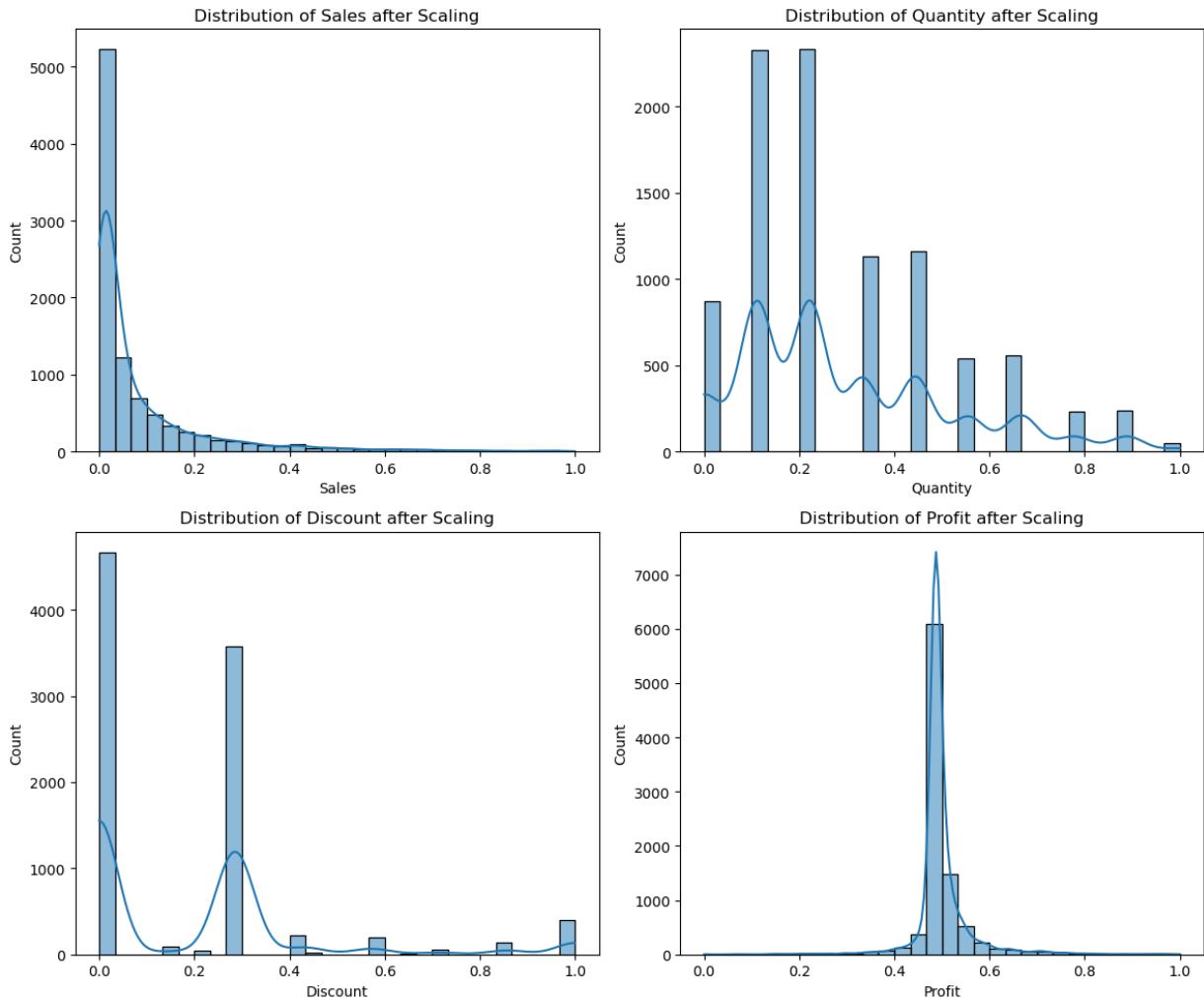
```
Out[199]:
```

	Row ID	Sales	Quantity	Discount	Profit
<b>count</b>	9436.000000	9436.000000	9436.000000	9436.000000	9436.000000
<b>mean</b>	4984.802459	0.085236	0.294663	0.194221	0.498942
<b>std</b>	2878.527850	0.140869	0.223277	0.249483	0.059542
<b>min</b>	1.000000	0.000000	0.000000	0.000000	0.000000
<b>25%</b>	2483.750000	0.008202	0.111111	0.000000	0.483687
<b>50%</b>	4990.500000	0.025755	0.222222	0.142857	0.488583
<b>75%</b>	7462.250000	0.095801	0.444444	0.285714	0.503250
<b>max</b>	9994.000000	1.000000	1.000000	1.000000	1.000000

```
In [200...]
plt.figure(figsize=(12, 10))

for i, var in enumerate(numerical_vars):
    plt.subplot(2, 2, i + 1)
    sns.histplot(df1_no_outliers[var], bins=30, kde=True)
    plt.title(f'Distribution of {var} after Scaling')

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

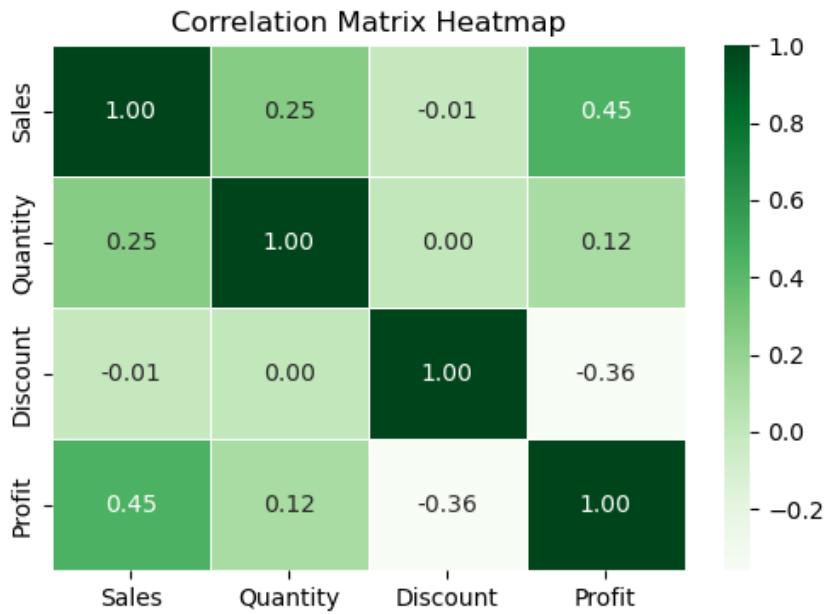


## Correlation Analysis for Numerical Dataset

```
In [201...]
correlation_matrix = df1_no_outliers[numerical_vars].corr()
print(correlation_matrix)
```

	Sales	Quantity	Discount	Profit
Sales	1.000000	0.253176	-0.010596	0.449966
Quantity	0.253176	1.000000	0.003297	0.119402
Discount	-0.010596	0.003297	1.000000	-0.359503
Profit	0.449966	0.119402	-0.359503	1.000000

```
In [202...]
# Plotting the correlation heatmap
# cmap: viridis, plasma, magma, inferno, Blues, Greens, Greys, coolwarm, RdBu, Spectral, cividis, twi
plt.figure(figsize=(6, 4))
sns.heatmap(correlation_matrix, annot=True, cmap='Greens', fmt=".2f", linewidths=.5)
plt.title('Correlation Matrix Heatmap')
plt.show()
```



Interpretation:

Discount and Profit (-0.359503): A moderate negative correlation between Discount and Profit. The higher discounts associated with lower profits. Discounts might increase sales volume or quantity, it may reduce profit margins.

Discount and Sales (-0.010596): Here is a negative correlation between Sales and Discount. Discounts may not have a strong direct impact on increasing sales volume.

Sales and Profit (0.449966): A moderate positive correlation between Sales and Profit.

## TASK 3

### Sumarization of the methods (200 words)

The dataset can be utilized for analysis about customer behavior, providing valuable insights for optimizing efficiency and market strategies. For example to compare how much items were purchased at discount prices, compared to regular prices, the profit generate, to investigate consumer preferences by region, preferred shopping times (specific dates/months), and identifies the most profitable products.

#### Bivariate Analysis

Several forms of bivariate analysis are likely performed to explore relationships between two variables at a time. This could include:

##### Numerical vs. Numerical Variables:

Calculating correlation coefficients to identify the strength and direction of relationships between pairs of numerical variables, potentially visualized through scatter plots or regression lines.

##### Categorical vs. Numerical Variables:

Analyzing how numerical outcomes, such as sales or profit, vary across different categories. This might involve grouping data by categorical variables and comparing means or sums, visualized through bar charts or pie carts..

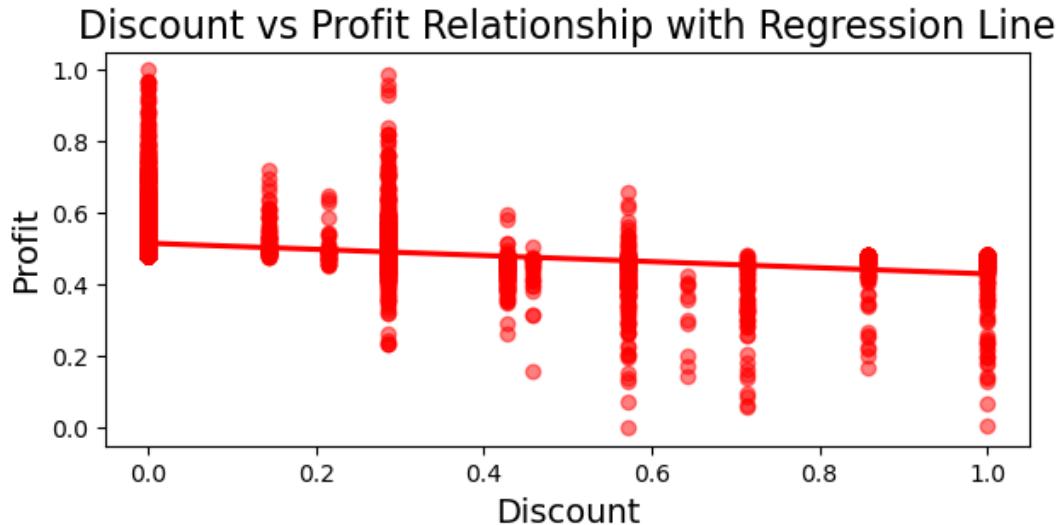
##### Categorical vs. Categorical Variables:

Examining the relationship between two categorical variables, potentially through cross-tabulation or stacked bar charts.

## Bivariate Analysis of Numerical vs Numerical Variables

## Discount vs Profit Relationship

```
In [203...  
plt.figure(figsize=(7, 3))  
sns.regplot(x='Discount', y='Profit', data=df1_no_outliers, color='red', scatter_kws={'alpha':0.5})  
  
plt.title('Discount vs Profit Relationship with Regression Line', size=16)  
plt.xlabel('Discount', size=14)  
plt.ylabel('Profit', size=14)  
plt.show()
```



Interpretation: Offering greater discounts does not lead to increased Profit

## Discount vs Sales Relationship

```
In [204...  
plt.rcParams["figure.figsize"] = [7, 3]  
plt.scatter(df1_no_outliers['Discount'], df1_no_outliers['Sales'], color='purple', label='Discount v  
plt.title("Discount vs Sales Relationship", size=14)  
plt.xlabel("Discount", size=14)  
plt.ylabel("Sales", size=14)  
plt.legend()  
plt.show()
```



Interpretation: Providing higher discounts does not lead to increased sales.

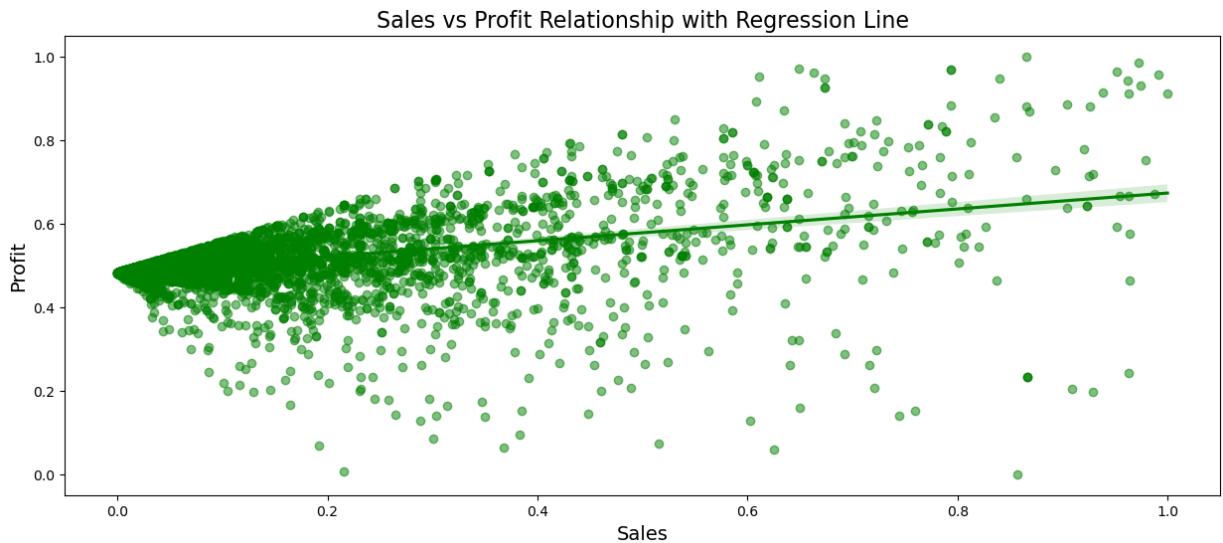
## Sales vs Profit Relationship

```
In [205...  
plt.figure(figsize=(15, 6))  
sns.regplot(x='Sales', y='Profit', data=df1_no_outliers, color='green', scatter_kws={'alpha':0.5})
```

```

plt.title('Sales vs Profit Relationship with Regression Line', size=16)
plt.xlabel('Sales', size=14)
plt.ylabel('Profit', size=14)
plt.show()

```



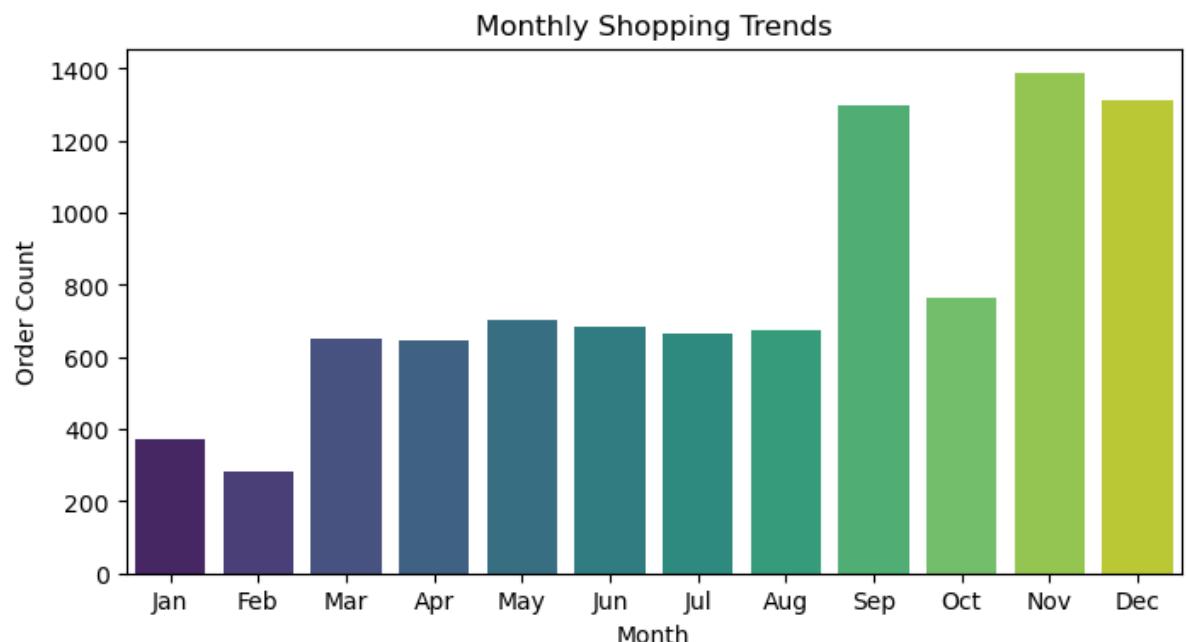
Interpretation: As Sales increase, Profit tends to increase as well.

## To investigate the preferred shopping times (specific dates/months)

```

In [206...]:
df1_no_outliers['Year_Order'] = df1_no_outliers['Order Date'].dt.year
df1_no_outliers['Month_Order'] = df1_no_outliers['Order Date'].dt.month
df1_no_outliers['Day_Order'] = df1_no_outliers['Order Date'].dt.day
monthly_trends = df1_no_outliers.groupby('Month_Order')['Order ID'].count().reset_index()
monthly_trends.columns = ['Month_Order', 'Order Count']
daily_trends = df1_no_outliers.groupby(['Year_Order', 'Month_Order', 'Day_Order'])['Order ID'].count
daily_trends.columns = ['Year', 'Month', 'Day', 'Order Count']
plt.figure(figsize=(8, 4))
sns.barplot(x='Month_Order', y='Order Count', data=monthly_trends, palette='viridis')
plt.title('Monthly Shopping Trends')
plt.xlabel('Month')
plt.ylabel('Order Count')
plt.xticks(range(0, 12), ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun', 'Jul', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec'])
plt.show()

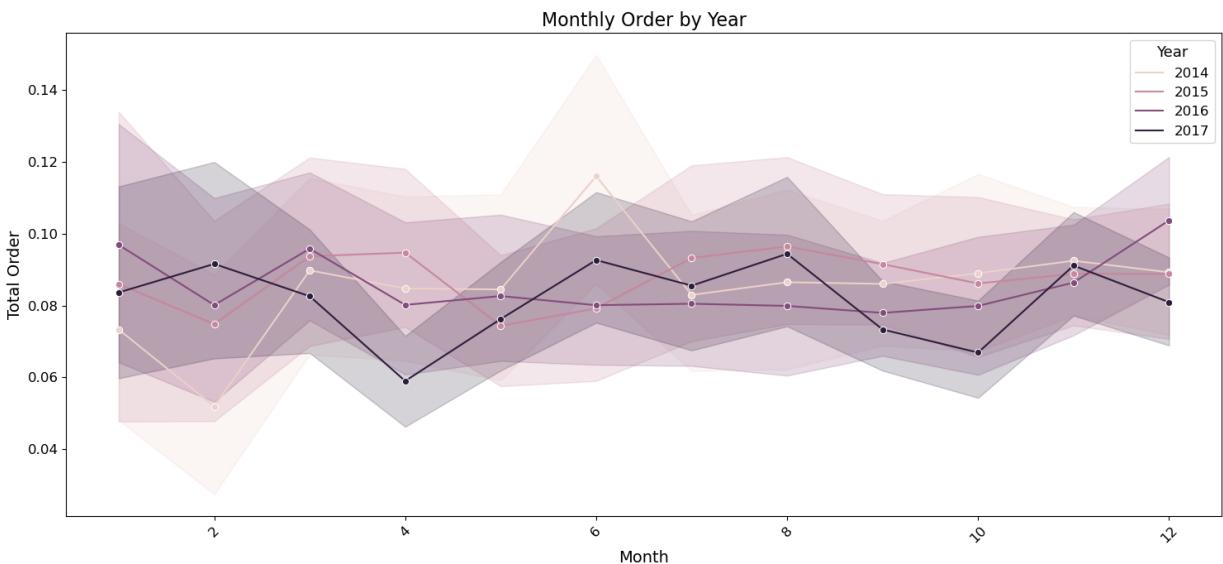
```



Interpretation: Most order in September, November, December.

## Monthly Order by Year

```
In [207...]: df1_no_outliers['Month_Order'] = pd.Categorical(df1_no_outliers['Month_Order'], ordered=True,
                                                    categories=sorted(df1_no_outliers['Month_Order'].unique()))
plt.figure(figsize=(15, 7))
sns.lineplot(data=df1_no_outliers, x='Month_Order', y='Sales', hue='Year_Order', marker='o')
plt.title('Monthly Order by Year', fontsize=16)
plt.xlabel('Month', fontsize=14)
plt.ylabel('Total Order', fontsize=14)
plt.xticks(rotation=45, fontsize=12)
plt.yticks(fontsize=12)
plt.legend(title='Year', title_fontsize='13', fontsize='12')
plt.tight_layout()
plt.show()
```



## Bivariate Analysis of Two Categorical Variables

To find the most profitable 'Product Name' in each 'Region'

```
In [208...]: # Group by 'Region' and 'Product Name', summing up the profits
profit_by_product_region = df1_no_outliers.groupby(['Region', 'Product Name'])['Profit'].sum().reset_index()

# Sort the results within each 'Region' by 'Profit' in descending order to get the most profitable product per region
profit_by_product_region_sorted = profit_by_product_region.sort_values(['Region', 'Profit'], ascending=False)

# Drop duplicates keeping the first most profitable entry for each 'Region'
most_profitable_product_per_region = profit_by_product_region_sorted.drop_duplicates(subset=['Region'])
most_profitable_product_per_region
```

```
Out[208]:
```

	Region	Product Name	Profit
320	Central	Easy-staple paper	6.511216
2278	East	Staple envelope	8.448828
2543	Est	Catalog Binders with Expanding Posts	0.815133
2837	South	Easy-staple paper	4.490521
4767	West	Staples	6.319771

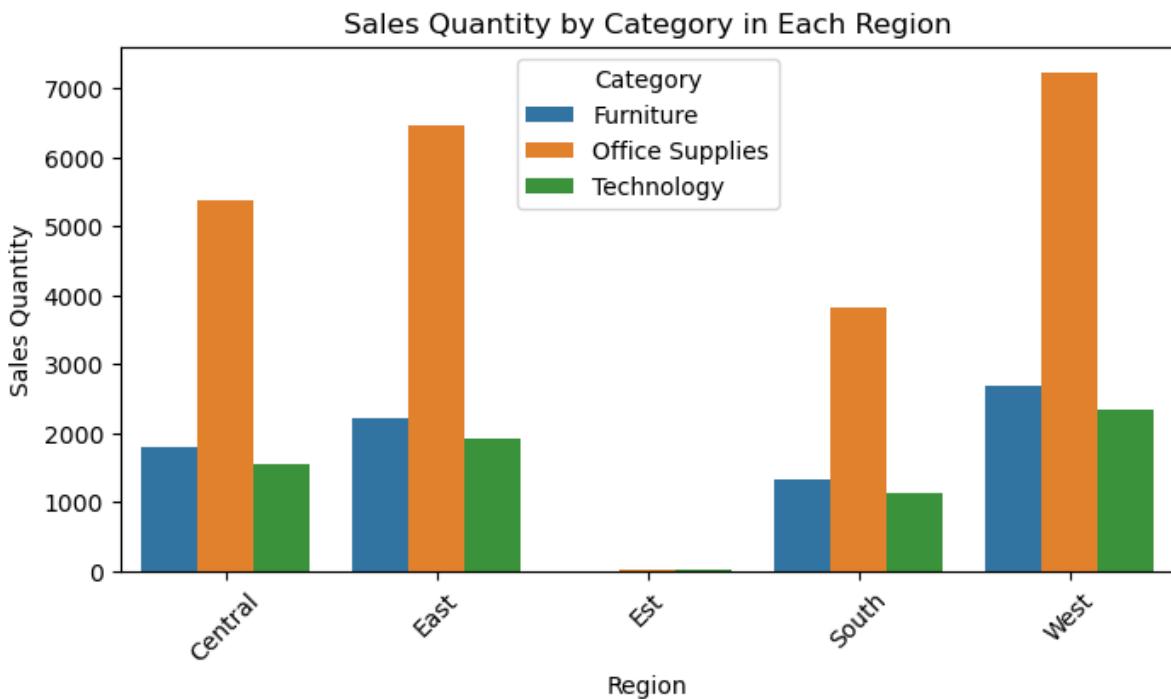
## Sales by Category in each Region

```
In [209...]: category_sales_region = df1.groupby(['Region', 'Category'])['Quantity'].sum().reset_index()
category_sales_region
plt.figure(figsize=(8, 4))
sns.barplot(x='Region', y='Quantity', hue='Category', data=category_sales_region)
plt.title('Sales Quantity by Category in Each Region')
```

```

plt.ylabel('Sales Quantity')
plt.xlabel('Region')
plt.xticks(rotation=45)
plt.legend(title='Category')
plt.show()

```

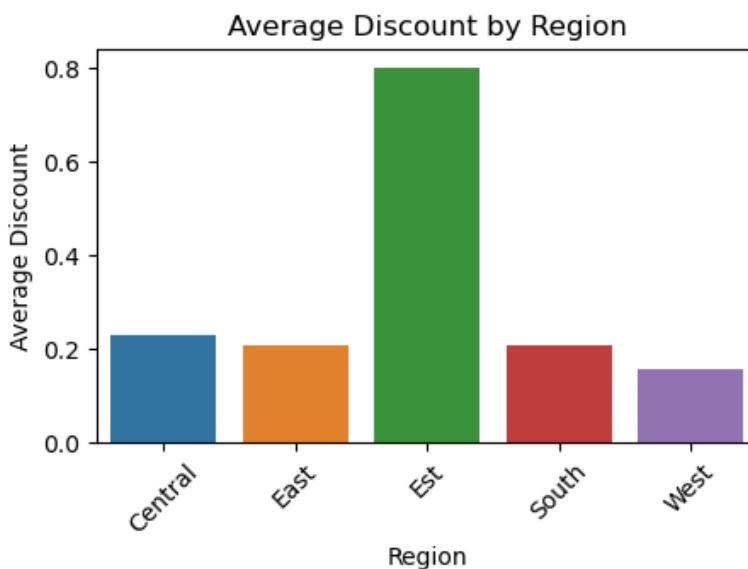


## Analyze Consumer Preferences for Discounts by Region

```

In [210...]
average_discount_region = df1_no_outliers.groupby('Region')['Discount'].mean().reset_index()
plt.figure(figsize=(5, 3))
sns.barplot(x='Region', y='Discount', data=average_discount_region)
plt.title('Average Discount by Region')
plt.ylabel('Average Discount')
plt.xlabel('Region')
plt.xticks(rotation=45)
plt.show()

```



## Distribution of Ship Modes Accross Segments

```

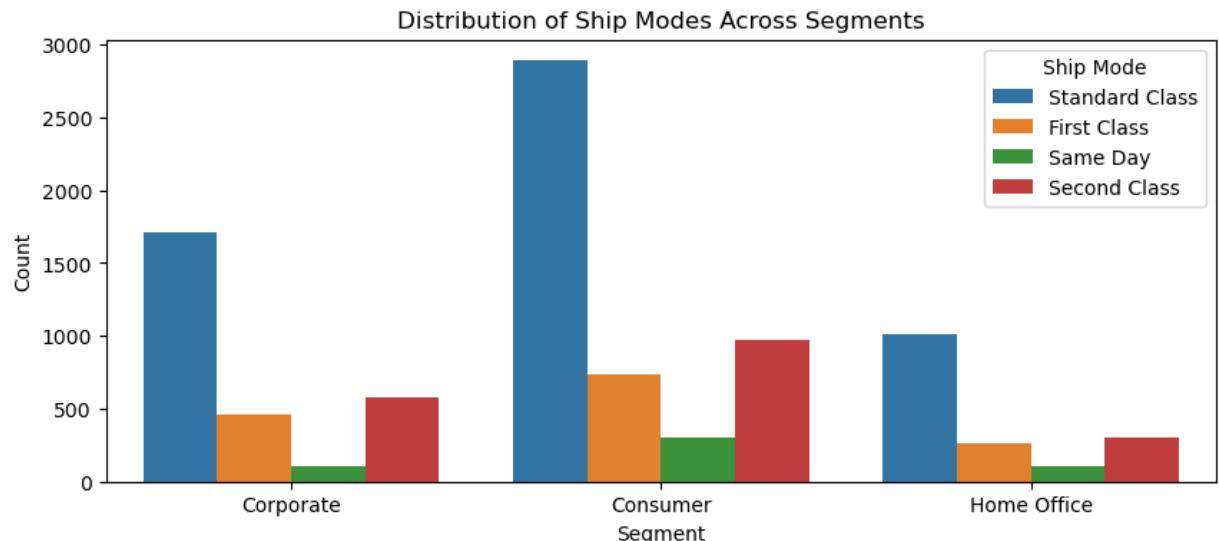
In [211...]
crosstab = pd.crosstab(df1_no_outliers['Segment'], df1['Ship Mode'])
#crosstab
plt.figure(figsize=(10, 4))
sns.countplot(x='Segment', hue='Ship Mode', data=df1_no_outliers)
plt.title('Distribution of Ship Modes Across Segments')

```

```

plt.xlabel('Segment')
plt.ylabel('Count')
plt.legend(title='Ship Mode')
plt.show()

```



Interpretation: Standard Class is the preferred mode of shipping across all segments.

## Bivariate Analysis of Categorical vs Numerical Variables

### Finding Sales by State

In [212...]

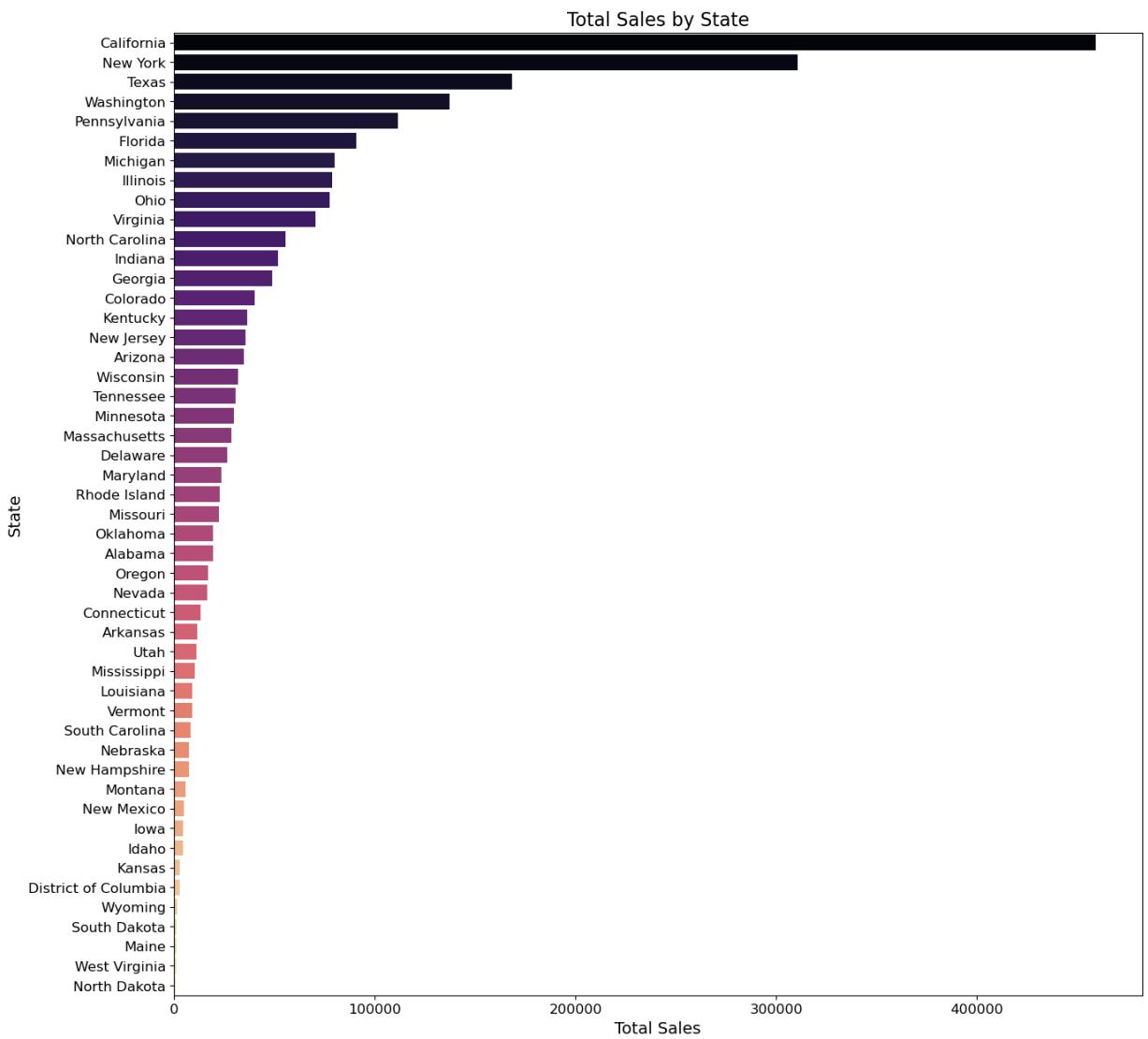
```

# Group the data by 'State' and sum the 'Sales'
sales_by_state = df1.groupby('State')['Sales'].sum().reset_index()

# Sort the results by 'Sales' in descending order
sales_by_state_sorted = sales_by_state.sort_values('Sales', ascending=False)

plt.figure(figsize=(15, 15))
sns.barplot(x='Sales', y='State', data=sales_by_state_sorted, palette='magma')
plt.title('Total Sales by State', fontsize=16)
plt.xlabel('Total Sales', fontsize=14)
plt.ylabel('State', fontsize=14)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()

```



To compare how much items were purchased at discount prices, compared to regular prices

```
In [213]: # Count items purchased with a discount
discounted_items = df1_no_outliers[df1_no_outliers['Discount'] > 0]['Quantity'].sum()

# Count items purchased without a discount
regular_price_items = df1_no_outliers[df1_no_outliers['Discount'] == 0]['Quantity'].sum()

print(f"Items purchased at discount prices: {discounted_items}")
print(f"Items purchased at regular prices: {regular_price_items}")

Items purchased at discount prices: 1392.111111111113
Items purchased at regular prices: 1388.333333333335
```

Result: More items purchased at discount prices, compared to regular prices

To find the most profitable products

```
In [214]: profit_by_product = df1_no_outliers.groupby('Product Name')['Profit'].sum().reset_index()
profit_by_product_sorted = profit_by_product.sort_values('Profit', ascending=False)

top_5_profitable_products = profit_by_product_sorted.head(5)

labels = top_5_profitable_products['Product Name']
sizes = top_5_profitable_products['Profit']
colors = ['lightblue', 'lightgreen', 'orange', 'pink', 'purple'] # You can customize the colors as you like
explode = (0.1, 0, 0, 0, 0) # Only "explode" the first slice (i.e., the most profitable product)

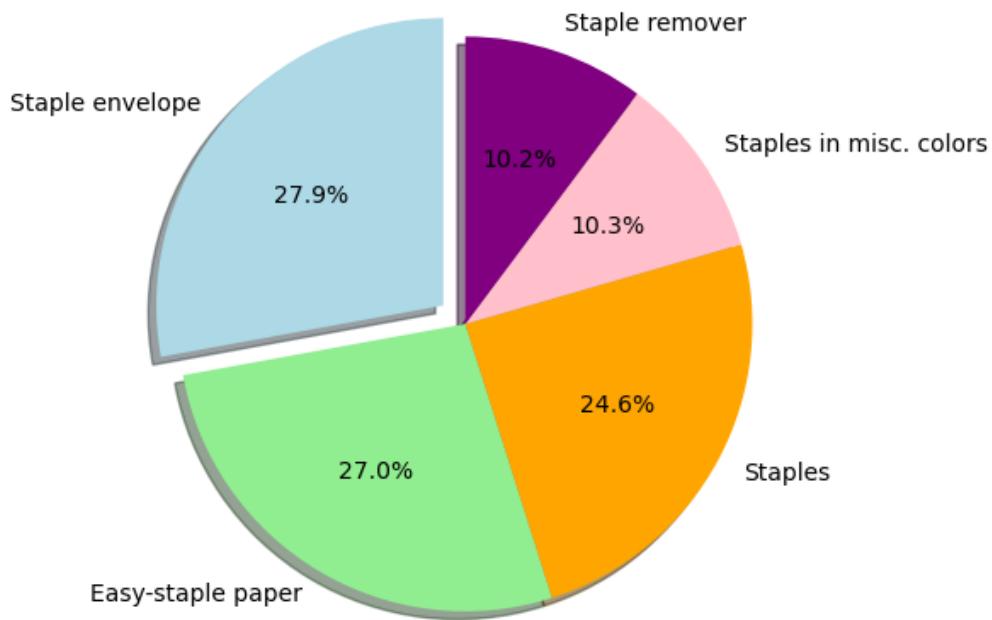
plt.figure(figsize=(5, 5)) # Adjust the figure size as necessary
plt.pie(sizes, explode=explode, labels=labels, colors=colors, autopct='%1.1f%%', shadow=True, startangle=90)
```

```

plt.title('Top 5 Most Profitable Products', fontsize=16)
plt.axis('equal') # ensures that pie is drawn as a circle.
plt.show()

```

## Top 5 Most Profitable Products



## Finding Profit by Category

```

In [215...]
# Group the data by 'Category' and sum the 'Profit'
profit_by_category = df1_no_outliers.groupby('Category')['Profit'].sum().reset_index()

# Sort the results by 'Profit' in descending order
profit_by_category_sorted = profit_by_category.sort_values('Profit', ascending=False)

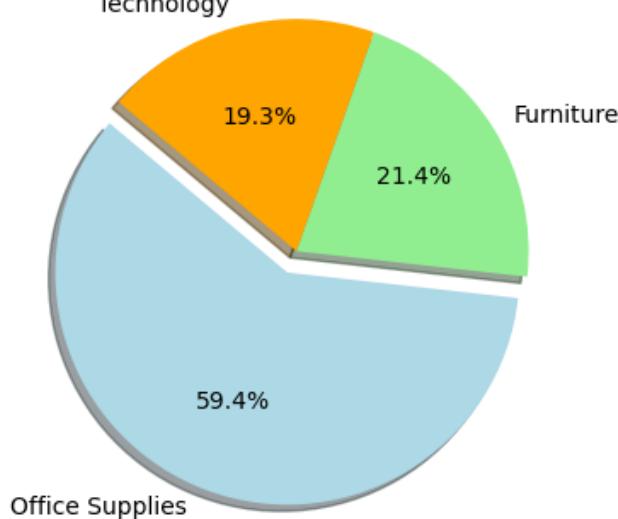
labels = profit_by_category_sorted['Category']
sizes = profit_by_category_sorted['Profit']

colors = ['lightblue', 'lightgreen', 'orange']
explode = (0.1, 0, 0) #Explode the Largest Category

plt.figure(figsize=(4, 4))
plt.pie(sizes, explode=explode, labels=labels, colors=colors, autopct='%1.1f%%', shadow=True, startangle=90)
plt.title('Total Profit by Category', fontsize=16)
plt.axis('equal')
plt.show()

```

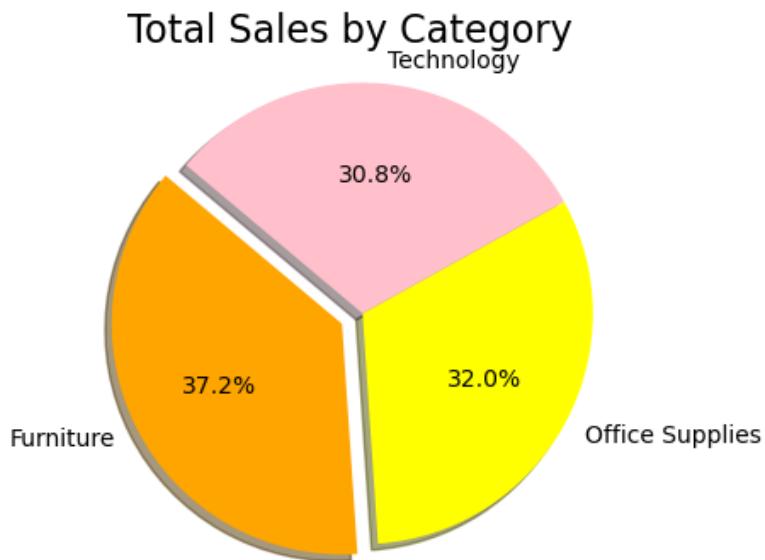
## Total Profit by Category



## Finding Sales by Category

In [216...]

```
# Group the data by 'Category' and sum the 'Sales'  
sales_by_category = df1_no_outliers.groupby('Category')['Sales'].sum().reset_index()  
  
# Sort the results by 'Sales' in descending order  
sales_by_category_sorted = sales_by_category.sort_values('Sales', ascending=False)  
  
labels = sales_by_category_sorted['Category']  
sizes = sales_by_category_sorted['Sales']  
  
colors = ['orange', 'yellow', 'pink']  
explode = (0.1, 0, 0) #Explode the Largest Category  
  
plt.figure(figsize=(4, 4))  
plt.pie(sizes, explode=explode, labels=labels, colors=colors, autopct='%1.1f%%', shadow=True, startangle=90)  
plt.title('Total Sales by Category', fontsize=16)  
plt.axis('equal')  
plt.show()
```

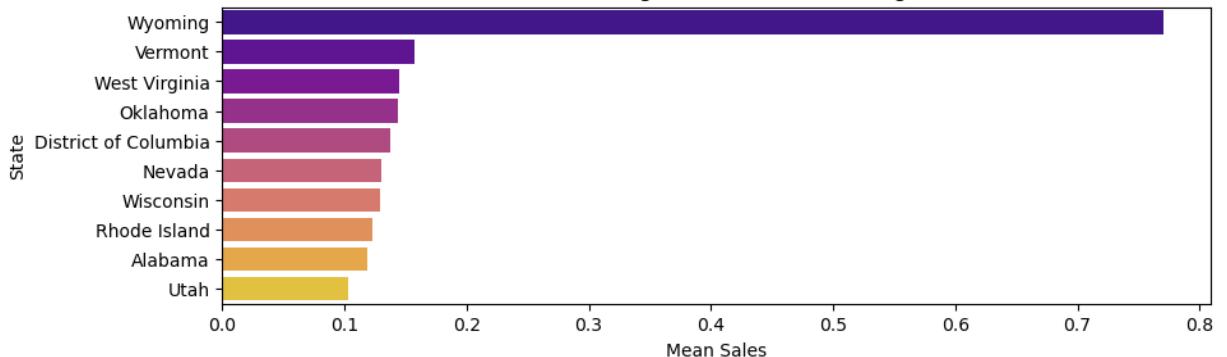


## Sales by States

In [217...]

```
# Group by 'State' and calculate mean Sales  
mean_sales_by_state = df1_no_outliers.groupby('State')['Sales'].mean().reset_index()  
  
# Sort states by mean sales in descending order  
mean_sales_by_state_sorted = mean_sales_by_state.sort_values('Sales', ascending=False)  
top_state_by_mean_sales = mean_sales_by_state_sorted.head(10)  
#top_state_by_mean_sales  
plt.figure(figsize=(10, 3))  
sns.barplot(x='Sales', y='State', data=top_state_by_mean_sales, palette='plasma')  
plt.title('States with the Highest and Lowest Average Sales')  
plt.xlabel('Mean Sales')  
plt.ylabel('State')  
plt.show()
```

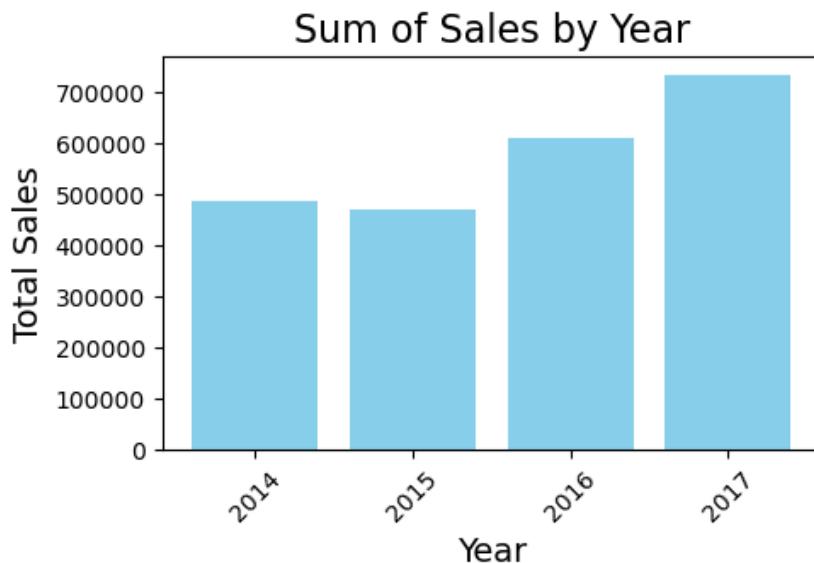
States with the Highest and Lowest Average Sales



## Order by Year

```
In [218...]: df1['Order Date'] = pd.to_datetime(df1['Order Date'])
# Extract the year from 'Order Date'
df1['Year'] = df1['Order Date'].dt.year
# Group by 'Year' and sum 'Sales'
sales_by_year = df1.groupby('Year')[['Sales']].sum().reset_index()
#sales_by_year

plt.figure(figsize=(5, 3))
plt.bar(sales_by_year['Year'].astype(str), sales_by_year['Sales'], color='skyblue')
plt.title('Sum of Sales by Year', fontsize=16)
plt.xlabel('Year', fontsize=14)
plt.ylabel('Total Sales', fontsize=14)
plt.xticks(rotation=45)
plt.show()
```

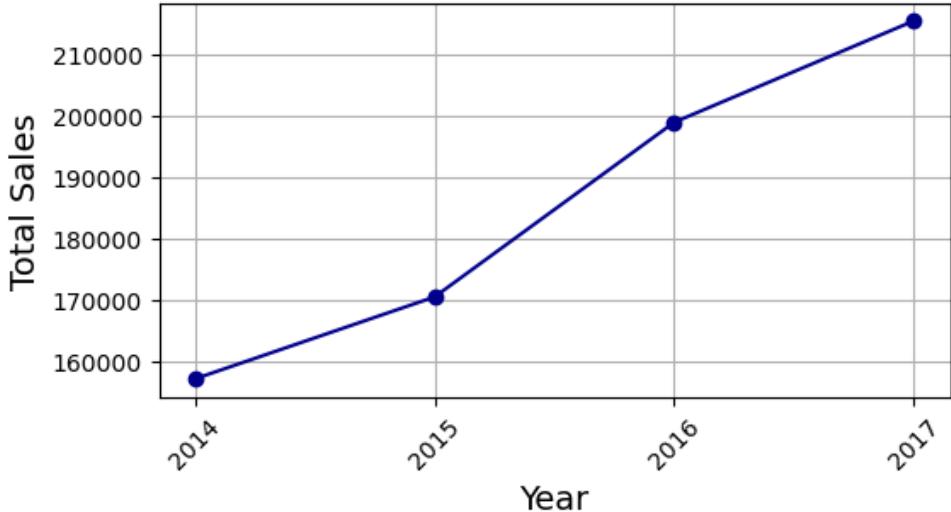


## Furniture Sales by Year

```
In [219...]: # Extract the year from 'Order Date'
df1['Year'] = df1['Order Date'].dt.year
# Filter for Furniture sales
furniture_sales = df1[df1['Category'] == 'Furniture']
# Group by 'Year' and sum 'Sales'
furniture_sales_by_year = furniture_sales.groupby('Year')[['Sales']].sum().reset_index()

plt.figure(figsize=(6, 3))
plt.plot(furniture_sales_by_year['Year'].astype(str),
         furniture_sales_by_year['Sales'], marker='o', linestyle='-', color='darkblue')
plt.title('Furniture Sales by Year', fontsize=16)
plt.xlabel('Year', fontsize=14)
plt.ylabel('Total Sales', fontsize=14)
plt.grid(True)
plt.xticks(rotation=45)
plt.show()
```

## Furniture Sales by Year



To find the most profitable 'Product Name' in each 'Region'

```
In [220]: # Group by 'Region' and 'Product Name', summing up the profits
profit_by_product_region = df1.groupby(['Region', 'Product Name'])['Profit'].sum().reset_index()

# Sort the results within each 'Region' by 'Profit' in descending order to get the most profitable product
profit_by_product_region_sorted = profit_by_product_region.sort_values(['Region', 'Profit'], ascending=False)

# Drop duplicates keeping the first most profitable entry for each 'Region'
most_profitable_product_per_region = profit_by_product_region_sorted.drop_duplicates(subset=['Region'])
most_profitable_product_per_region
```

```
Out[220]:
```

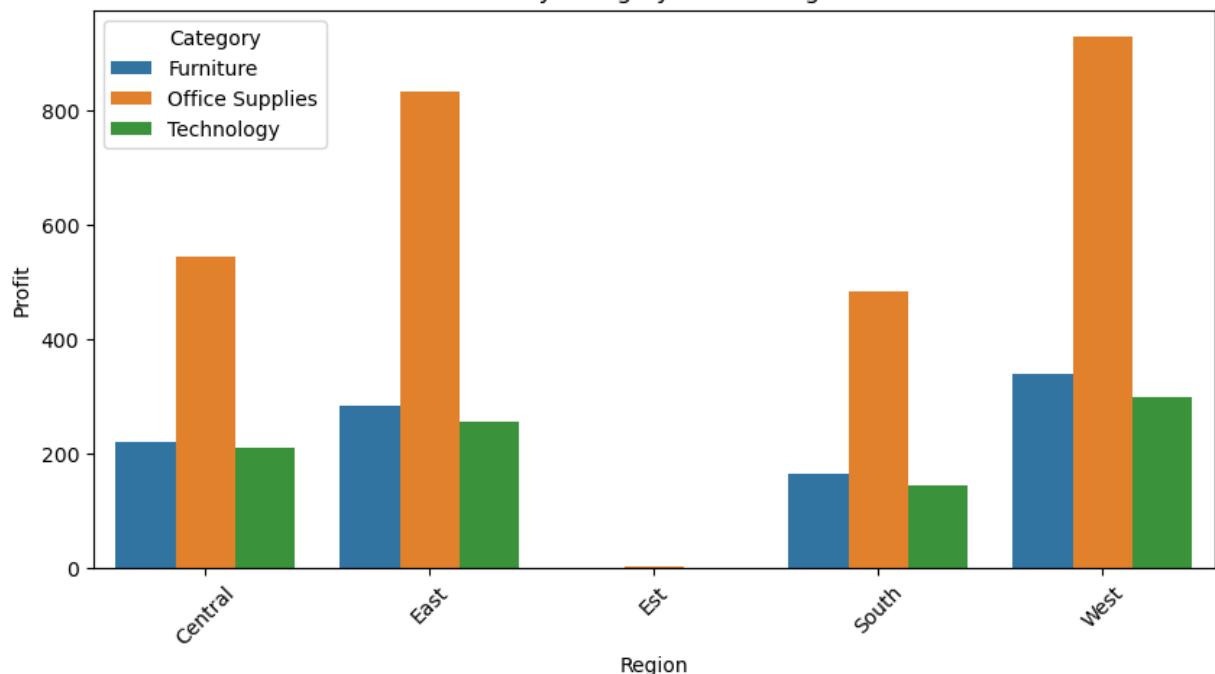
	Region	Product Name	Profit
283	Central	Canon imageCLASS 2200 Advanced Copier	8399.9760
1602	East	Canon imageCLASS 2200 Advanced Copier	10079.9712
2705	Est	GBC Recycled Grain Textured Covers	-22.7964
3084	South	Fellowes PB500 Electric Punch Plastic Comb Binding Machine with Manual Bind	3812.9700
4081	West	Canon imageCLASS 2200 Advanced Copier	6719.9808

## Profit by Region

```
In [221]: # Group data by 'Region' and 'Category' to see profit margins
profit_by_region = df1_no_outliers.groupby(['Region', 'Category'])['Profit'].sum().reset_index()

plt.figure(figsize=(10, 5))
sns.barplot(x='Region', y='Profit', hue='Category', data=profit_by_region)
plt.title('Profit by Category in Each Region')
plt.ylabel('Profit')
plt.xlabel('Region')
plt.xticks(rotation=45)
plt.legend(title='Category')
plt.show()
```

Profit by Category in Each Region



In [ ]: