Lab 4: Data Visualization and EDA

CPE232 Data Models

1. Load all Superstore datasets.

Note: The same datasets used in Lab 3

```
#%pip install missingno
#%pip install plotly
#%pip install -upgrade nbformat
```

```
# Write your code here
import pandas as pd
import numpy as np
import missingno as msno

df_superstore_order = pd.read_csv('superstore_order.csv')
df_superstore_people = pd.read_csv('superstore_people.csv')
df_superstore_reutrn = pd.read_csv('superstore_return.csv')
```

2. Determine shape of each dataset (print out the results as well).

```
df_superstore_order.shape, df_superstore_people.shape, df_superstore_reutrn.shape
```

```
((8880, 21), (4, 2), (296, 2))
```

3. Show information of the dataset.

```
# Write your code here
print(df_superstore_order.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8880 entries, 0 to 8879
Data columns (total 21 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   Row ID         8880 non-null   int64  
 1   Order ID       8880 non-null   object 
 2   Order Date     8880 non-null   object 
 3   Ship Date      8880 non-null   object 
 4   Ship Mode      8880 non-null   object 
 5   Customer ID    8880 non-null   object 
 6   Customer Name  8880 non-null   object 
 7   Segment        8880 non-null   object 
 8   Country        8880 non-null   object 
 9   City           8880 non-null   object 
 10  State          8880 non-null   object 
 11  Postal Code    8880 non-null   int64  
 12  Region         8880 non-null   object 
 13  Product ID     8880 non-null   object 
 14  Category       8880 non-null   object 
 15  Sub-Category   8880 non-null   object 
 16  Product Name   8880 non-null   object 
 17  Sales          8880 non-null   float64
 18  Quantity       8880 non-null   int64  
 19  Discount       8880 non-null   float64
 20  Profit         8880 non-null   float64
dtypes: float64(3), int64(3), object(15)
memory usage: 1.4+ MB
None
```

```
print(df_superstore_people.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4 entries, 0 to 3
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype 
---  ------  --------------  ----- 
 0   Person  4 non-null      object
 1   Region  4 non-null      object
```

```
dtypes: object(2)
memory usage: 196.0+ bytes
None
```

```
print(df_superstore_reutrn.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 296 entries, 0 to 295
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   Returned  296 non-null    object
 1   Order ID  296 non-null    object
dtypes: object(2)
memory usage: 4.8+ KB
None
```

4. Are there any missing values? If so, in which column?

Ans: No, there have no any missing values in the dataset.

5.

- 5.1 List unique segments
- 5.2 List unique segments and their corresponding count
- 5.3 Create a pie chart to demonstrate unique segments and their count
- 5.4 Briefly describe what could be interpreted from this pie chart

Note: please create additional cells to answer 5.2 - 5.3

```
# Write your code here (5.1)
# 5.
# - 5.1 List unique segments
# - 5.2 List unique segments and their corresponding count
# - 5.3 Create a pie chart to demonstrate unique segments and their count
# - 5.4 Briefly describe what could be interpreted from this pie chart

# *Note: please create additional cells to answer 5.2 - 5.3*
df_superstore_order['Segment'].unique()
```

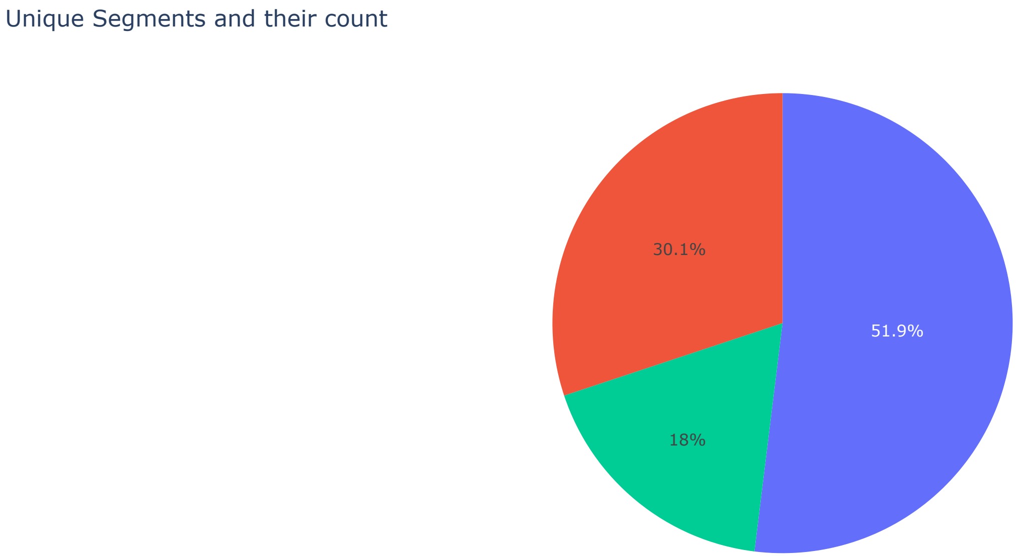
```
array(['Consumer', 'Corporate', 'Home Office'], dtype=object)
```

```
# 5.2 List unique segments and their corresponding count
df_superstore_order['Segment'].value_counts()
```

	count
Segment	
Consumer	4613
Corporate	2673
Home Office	1594

dtype: int64

```
# (5.3) Create a pie chart to demonstrate unique segments and their count
import plotly.express as px

labels = df_superstore_order['Segment'].unique()
data = df_superstore_order['Segment'].value_counts()[labels]

fig = px.pie(values=data, names=labels, title='Unique Segments and their count')
fig.show()
```



Answer for the question 5.4

Ans: The pie chart shows that the Consumer segment has the highest count, followed by Corporate and Home Office segments.

6.

- 6.1 List unique states
- 6.2 List top-10 unique states and their corresponding count
- 6.3 Create a bar chart (vertical) to demonstrate the count of top-10 unique states
- 6.4 Based on 6.2, also include the total sales of these states (show your result as a dataframe)
- 6.5 Using the result from 6.4, if you were the owner of this superstore, what information could be interpreted from this result?

Note: please create additional cells to answer 6.2 - 6.4

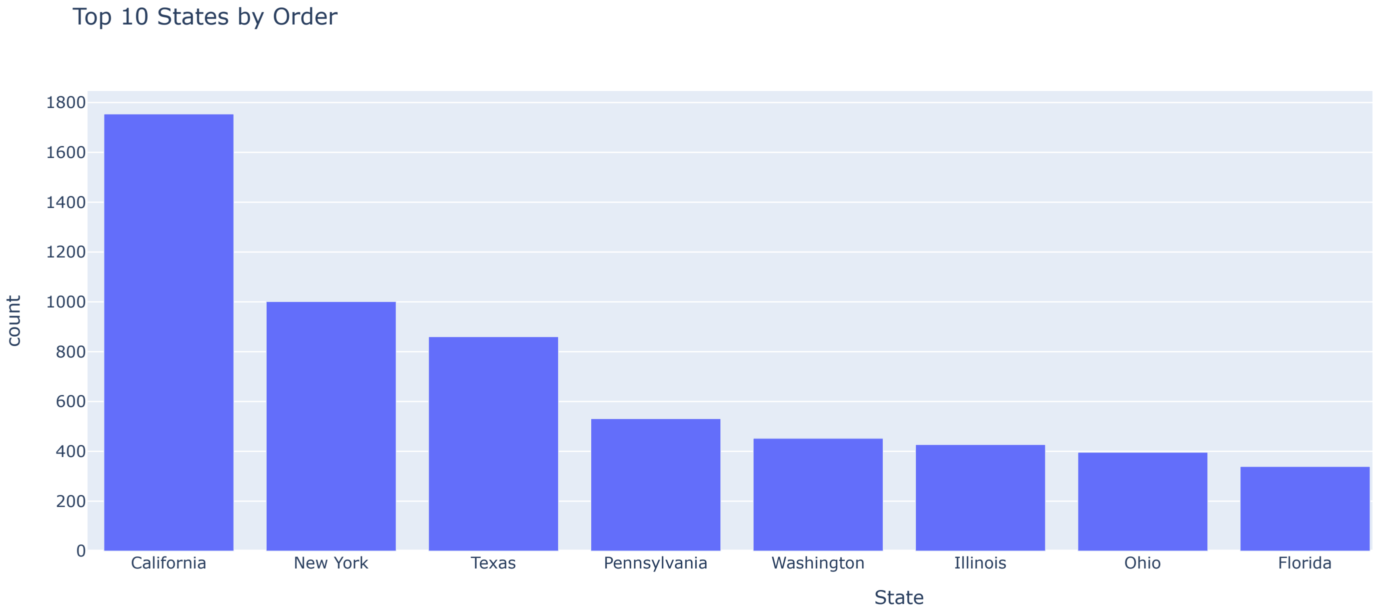
```
# Write your code here (6.1)
df_superstore_order['State'].unique()
```

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

```
# Write your code here (6.2)
t10 = df_superstore_order['State'].value_counts().sort_values(ascending=False)[:10].reset_index()

print(t10)
```

```
            State  count
0      California   1754
1        New York   1001
2           Texas    860
3    Pennsylvania    531
4      Washington    452
5        Illinois    427
6            Ohio    396
7         Florida    339
8        Michigan    230
9  North Carolina    229
```

```
# Write your code here (6.3)
import plotly.express as px

fig = px.bar(t10, x='State', y='count', title='Top 10 States by Order')
fig.show()
```



```
# Write your code here (6.4)
# include the total sales of these states (show your result as a dataframe)
t10_state = t10['State'].tolist()
t10_state_sales = df_superstore_order[df_superstore_order['State'].isin(t10_state)].groupby('State')['Sales'].sum().reset_index()
t10_state_sales
```

	State	Sales
0	California	399195.4555
1	Florida	84083.0880
2	Illinois	71456.1780
3	Michigan	62147.6960
4	New York	274866.8190
5	North Carolina	49962.1580
6	Ohio	67924.2140
7	Pennsylvania	103852.5210
8	Texas	147855.0282
9	Washington	124497.7780

Next steps: Generate code with `t10_state_sales` View recommended plots New interactive sheet

Answer for the question 6.5

Ans: from the top 10 state total sales owners can see the highest sales state and lowest sales state and plan some startegy to increase the sales in the lowest sales state or can increase the sales in the highest sales state to increase the profit.

7.

- 7.1 List unique categories
- 7.2 Create a bar chart (horizontal) to demonstrate the proportion of these categories
- 7.3 Compute the ratio of these categories in percentage and print the results

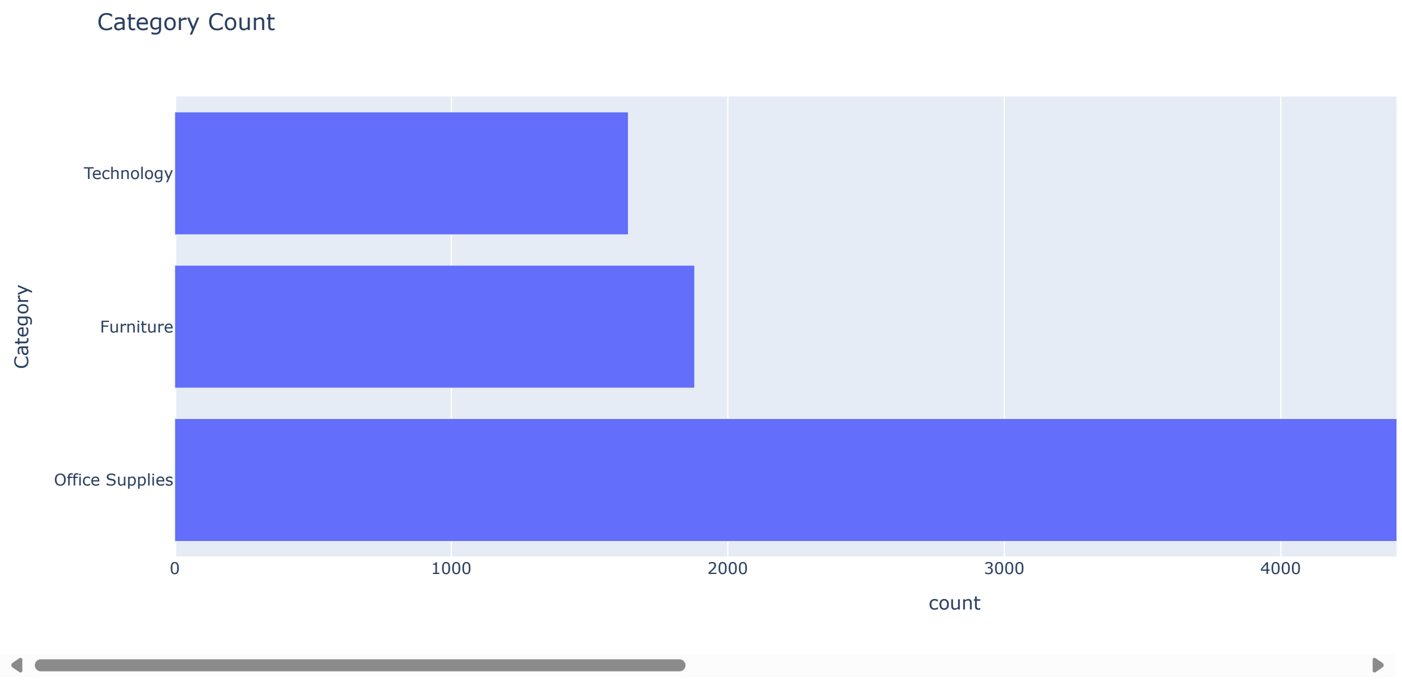
Note: please create additional cells to answer 7.2 - 7.3

```
# Write your code here (7.1)
df_superstore_order['Category'].unique()
```

```
array(['Furniture', 'Office Supplies', 'Technology'], dtype=object)
```

```
# Write your code here (7.2)
categeory_count = df_superstore_order['Category'].value_counts().reset_index()
print(categeory_count)
px.bar(categeory_count, x = 'count', y='Category', title='Category Count', orientation='h')
```

```
          Category  count
0  Office Supplies   5360
1        Furniture   1880
2       Technology   1640
```



```
# Write your code here (7.3)
total = df_superstore_order['Category'].count()

Furniture = df_superstore_order[df_superstore_order['Category'] == 'Furniture']['Category'].count()
Technology = df_superstore_order[df_superstore_order['Category'] == 'Technology']['Category'].count()
Office_Supplies = df_superstore_order[df_superstore_order['Category'] == 'Office Supplies']['Category'].count()

print(f"Ratio of each Category: \nFurniture: {(Furniture/total * 100):.2f} % \nTechnology: {(Technology/total * 100):.2f} % \nOffice Supplie
```

```
Ratio of each Category:
Furniture: 21.17 %
Technology: 18.47 %
Office Supplies: 60.36 %
```

8. Update the type of all columns that contain dates to *datetime* and show information after an update.

```
# write your code here
for col in df_superstore_order.columns:
    if 'Date' in col:
        df_superstore_order[col] = pd.to_datetime(df_superstore_order[col], format='%d/%m/%Y')

df_superstore_order.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8880 entries, 0 to 8879
Data columns (total 21 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Row ID         8880 non-null   int64
 1   Order ID       8880 non-null   object
 2   Order Date     8880 non-null   datetime64[ns]
 3   Ship Date      8880 non-null   datetime64[ns]
 4   Ship Mode      8880 non-null   object
 5   Customer ID    8880 non-null   object
 6   Customer Name  8880 non-null   object
 7   Segment        8880 non-null   object
 8   Country        8880 non-null   object
 9   City           8880 non-null   object
 10  State          8880 non-null   object
 11  Postal Code    8880 non-null   int64
 12  Region         8880 non-null   object
 13  Product ID     8880 non-null   object
 14  Category       8880 non-null   object
 15  Sub-Category   8880 non-null   object
 16  Product Name   8880 non-null   object
 17  Sales          8880 non-null   float64
 18  Quantity       8880 non-null   int64
 19  Discount       8880 non-null   float64
 20  Profit         8880 non-null   float64
dtypes: datetime64[ns](2), float64(3), int64(3), object(13)
memory usage: 1.4+ MB
```

```
df_superstore_order[[x for x in df_superstore_order.columns if 'Date' in x]].head()
```

	Order Date	Ship Date
0	2016-11-08	2016-11-11
1	2016-11-08	2016-11-11
2	2016-06-12	2016-06-16
3	2015-10-11	2015-10-18
4	2015-10-11	2015-10-18

9. Create a new column "Processing time day" to show number of days taken to ship an order and show your result in a dataframe format.

Hint: The duration starts as soon as the item has been ordered and ends once the order has successfully shipped.

```
# write your code here
df_superstore_order['Processing time day'] = (df_superstore_order['Ship Date'] - df_superstore_order['Order Date']).dt.days
# why .dt.days? because we want to get the difference in days
df_superstore_order['Processing time day'].head()
```

	Processing time day
0	3
1	3
2	4
3	7
4	7

dtype: int64

10. Based on the result in 9.

- 10.1 How many orders are there that take more than 5 days to process?
- 10.2 Show the top 5 rows (expected output should contain these columns: Order ID, Order Date, Ship Date, Processing time day, Quantity)
- 10.3 Plot the histogram based on the column Quantity

Note: please create additional cells to answer 10.2 - 10.3

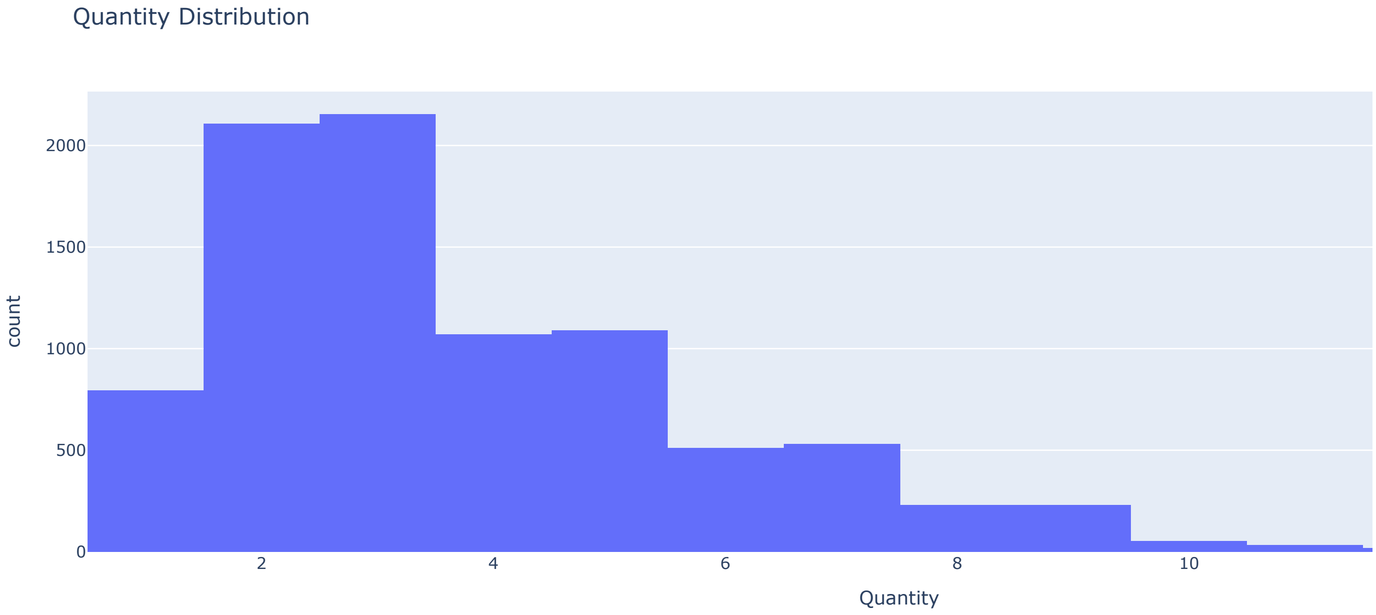
```
# Write your code here (10.1)
df_superstore_order[df_superstore_order['Processing time day'] > 5].shape
# so the answer is 1656
```

```
(1656, 22)
```

```
# write your code here (10.2)
df_superstore_order[['Order ID', 'Order Date', 'Ship Date', 'Processing time day', 'Quantity']].head(5)
```

	Order ID	Order Date	Ship Date	Processing time day	Quantity
0	CA-2016-152156	2016-11-08	2016-11-11	3	2
1	CA-2016-152156	2016-11-08	2016-11-11	3	3
2	CA-2016-138688	2016-06-12	2016-06-16	4	2
3	US-2015-108966	2015-10-11	2015-10-18	7	5
4	US-2015-108966	2015-10-11	2015-10-18	7	2

```
# write your code here (10.3)

px.histogram(df_superstore_order['Quantity'], x='Quantity', title='Quantity Distribution')
```


Quantity Distribution

11. Total sales compare across different regions

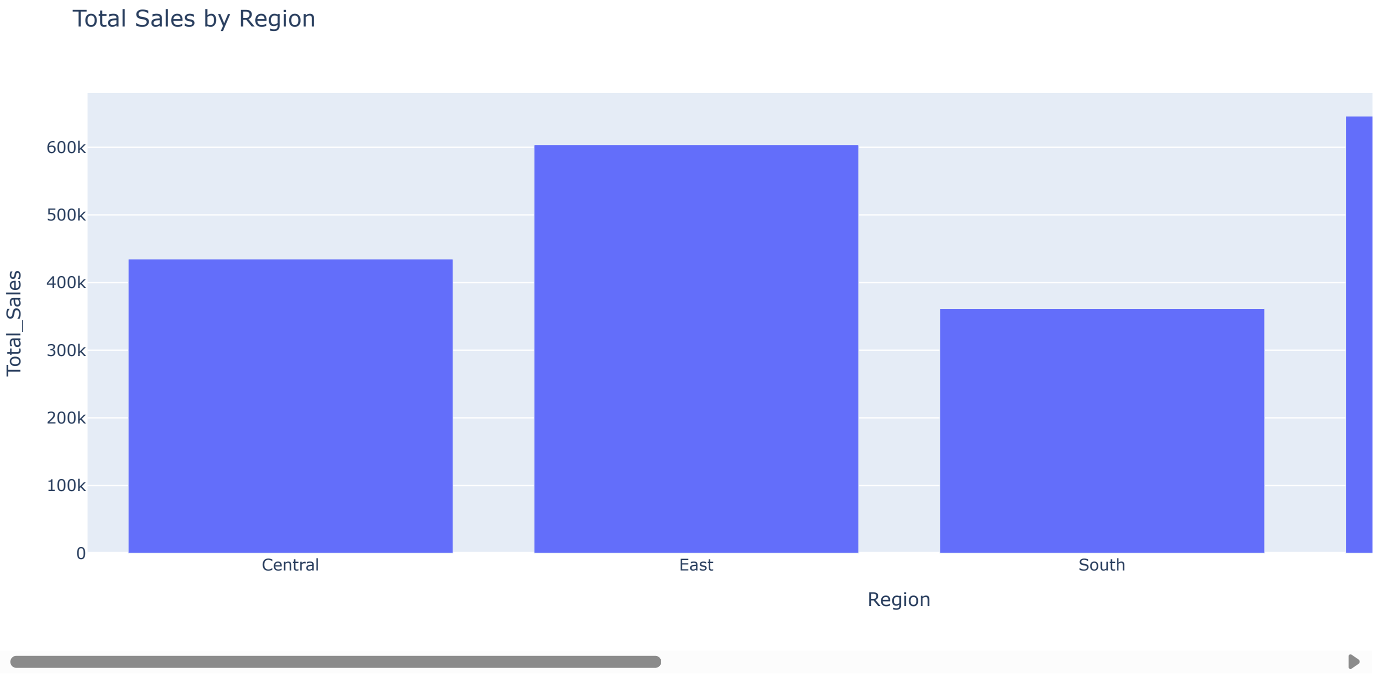
- 11.1 Create a bar chart to visualize.

```
# Write your code here (11.1)
sales_region = df_superstore_order.groupby(by = 'Region').agg(Total_Sales = ('Sales', 'sum')).reset_index()
sales_region
```

	Region	Total_Sales
0	Central	434723.2222
1	East	603648.0590
2	South	361376.7910
3	West	645943.7905

Next steps: Generate code with sales_region View recommended plots New interactive sheet

```
px.bar(sales_region, x='Region', y='Total_Sales', title='Total Sales by Region')
```



- 11.2 How do total sales compare across different regions? Explain in as much detail as possible.

  Ans: The total sales in the West region is the highest with a total of 645943.79, followed by the East region with a total of 603648.06, then the Central region with a total of 434723.2222, and the lowest total sales in the South region with a total of 361376.79.

12.Which states have the highest number of returns? Use a horizontal bar chart.

Ans:

```
# Write your code here (12)
order_return = pd.merge(df_superstore_order, df_superstore_reutrn, on='Order ID', how='left')
order_return.fillna('No', inplace=True)
order_return.head()
```

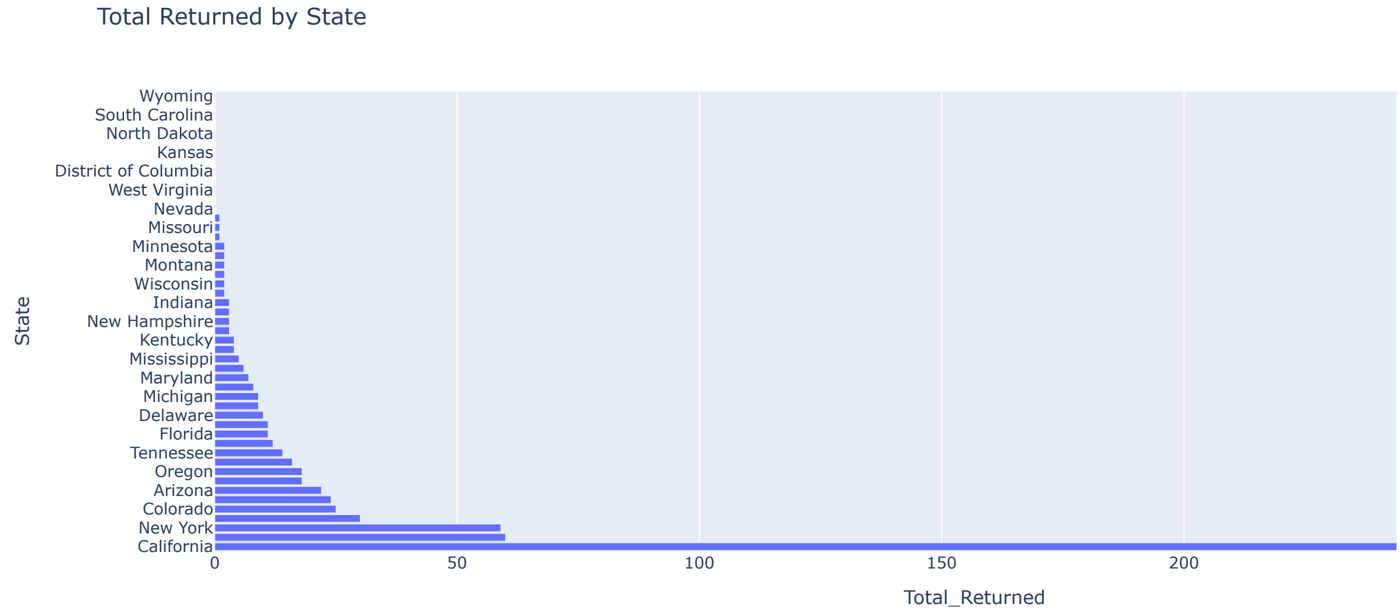
	Row ID	Order ID	Order Date	Ship Date	Ship Mode	Customer ID	Customer Name	Segment	Country	City	...	Product ID	Category	Sub-Category	Product Name
0	1	CA-2016-152156	2016-11-08	2016-11-11	Second Class	CG-12520	Claire Gute	Consumer	United States	Henderson	...	FUR-BO-10001798	Furniture	Bookcases	Bush Somerset Collection Bookcase
1	2	CA-2016-152156	2016-11-08	2016-11-11	Second Class	CG-12520	Claire Gute	Consumer	United States	Henderson	...	FUR-CH-10000454	Furniture	Chairs	Hon Deluxe Fabric Upholstered Stacking Chairs ...
2	3	CA-2016-138688	2016-06-12	2016-06-16	Second Class	DV-13045	Darrin Van Huff	Corporate	United States	Los Angeles	...	OFF-LA-10000240	Office Supplies	Labels	Self-Adhesive Address Labels for Typewriters b...
3	4	US-2015-108966	2015-10-11	2015-10-18	Standard Class	SO-20335	Sean ODonnell	Consumer	United States	Fort Lauderdale	...	FUR-TA-10000577	Furniture	Tables	Bretford CR4500 Series Slim Rectangular Table
4	5	US-2015-108966	2015-10-11	2015-10-18	Standard Class	SO-20335	Sean ODonnell	Consumer	United States	Fort Lauderdale	...	OFF-ST-10000760	Office Supplies	Storage	Eldon Fold N Roll Cart System

5 rows × 23 columns

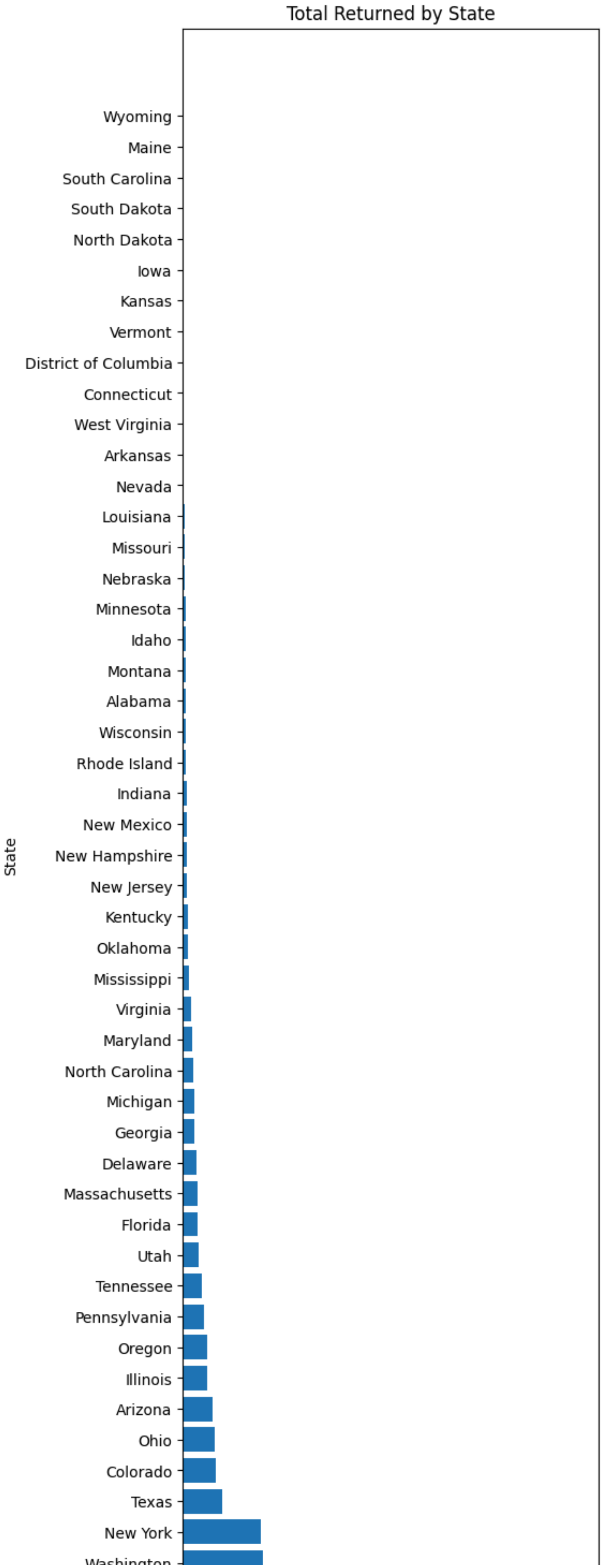
```
order_return.columns
```

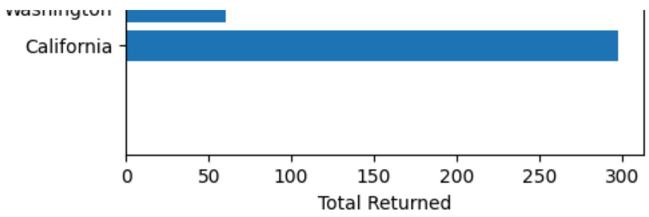
```
Index(['Row ID', 'Order ID', 'Order Date', 'Ship Date', 'Ship Mode',
       'Customer ID', 'Customer Name', 'Segment', 'Country', 'City', 'State',
       'Postal Code', 'Region', 'Product ID', 'Category', 'Sub-Category',
       'Product Name', 'Sales', 'Quantity', 'Discount', 'Profit',
       'Processing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

```
order_return_state = order_return.groupby(by = 'State').agg(Total_Returned = ('Returned', lambda x: (x == 'Yes').sum())).sort_values(by = 'T

#horizontal bar chart
px.bar(order_return_state, x='Total_Returned', y='State', title='Total Returned by State', orientation='h')
```



```
import matplotlib.pyplot as plt

plt.figure(figsize=(5, 20))
plt.barh(order_return_state['State'], order_return_state['Total_Returned'])
plt.xlabel('Total Returned')
plt.ylabel('State')
plt.title('Total Returned by State')
plt.show()
```


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

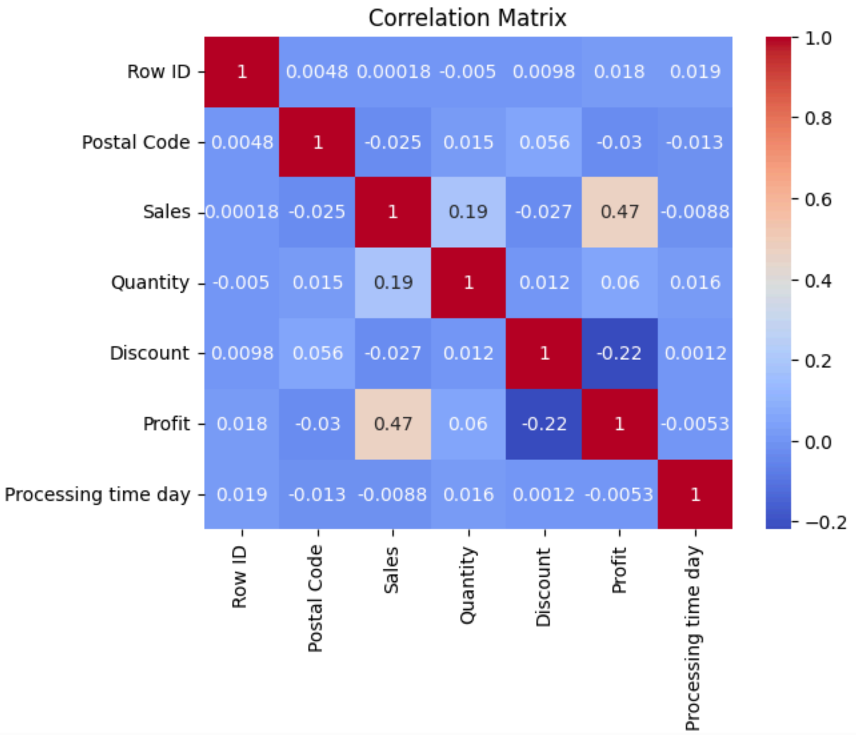


13. What is the correlation between numerical variables in the superstore_order dataset? Use a heatmap

Hint: Use seaborn to create a heatmap :)

```
# Write your code here (13)
import seaborn as sns

numeric = df_superstore_order.select_dtypes(include=['number']).columns
corr = df_superstore_order[numeric].corr()

sns.heatmap(corr, annot=True, cmap='coolwarm')
plt.title('Correlation Matrix')
```

```
Text(0.5, 1.0, 'Correlation Matrix')
```



14. Create a USA State-Level Choropleth Map to visualize total sales per state.

- The darkest color represents the highest total sales.
- The lightest color represents the lowest total sales.
- Use a continuous gradient scale (e.g., dark blue to light blue, dark red to light red, or any custom gradient of your choice).

Hint: Use plotly.express

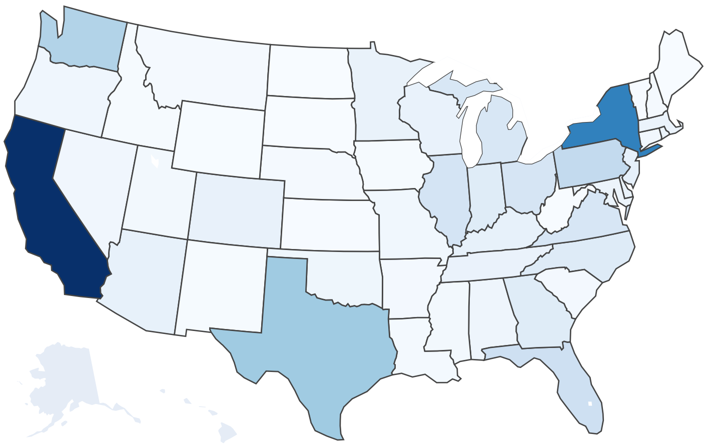
```
import plotly.express as px
state_sales = df_superstore_order.groupby(by = 'State').agg(Total_Sales = ('Sales', 'sum')).reset_index()
state_sales.head(10)
```

	State	Total_Sales
0	Alabama	19272.4900
1	Arizona	32990.1060
2	Arkansas	9427.4400
3	California	399195.4555
4	Colorado	31080.8060
5	Connecticut	12829.0570
6	Delaware	26379.4290
7	District of Columbia	2865.0200
8	Florida	84083.0880
9	Georgia	47940.1900

Next steps: Generate code with state_sales View recommended plots New interactive sheet

```
us_state_abbrev = {
    'Alabama': 'AL', 'Alaska': 'AK', 'Arizona': 'AZ', 'Arkansas': 'AR', 'California': 'CA',
    'Colorado': 'CO', 'Connecticut': 'CT', 'Delaware': 'DE', 'Florida': 'FL', 'Georgia': 'GA',
    'Hawaii': 'HI', 'Idaho': 'ID', 'Illinois': 'IL', 'Indiana': 'IN', 'Iowa': 'IA', 'Kansas': 'KS',
    'Kentucky': 'KY', 'Louisiana': 'LA', 'Maine': 'ME', 'Maryland': 'MD', 'Massachusetts': 'MA',
    'Michigan': 'MI', 'Minnesota': 'MN', 'Mississippi': 'MS', 'Missouri': 'MO', 'Montana': 'MT',
    'Nebraska': 'NE', 'Nevada': 'NV', 'New Hampshire': 'NH', 'New Jersey': 'NJ', 'New Mexico': 'NM',
    'New York': 'NY', 'North Carolina': 'NC', 'North Dakota': 'ND', 'Ohio': 'OH', 'Oklahoma': 'OK',
    'Oregon': 'OR', 'Pennsylvania': 'PA', 'Rhode Island': 'RI', 'South Carolina': 'SC',
    'South Dakota': 'SD', 'Tennessee': 'TN', 'Texas': 'TX', 'Utah': 'UT', 'Vermont': 'VT',
    'Virginia': 'VA', 'Washington': 'WA', 'West Virginia': 'WV', 'Wisconsin': 'WI', 'Wyoming': 'WY'
}

# Convert Full State Names to Abbreviations
state_sales['State'] = state_sales['State'].map(us_state_abbrev)

fig = px.choropleth(locations=state_sales['State'], locationmode='USA-states', color=state_sales['Total_Sales'], scope='usa', title='Total Sa
fig.show()
```

Total Sales per State



14.2 Answer the following questions:

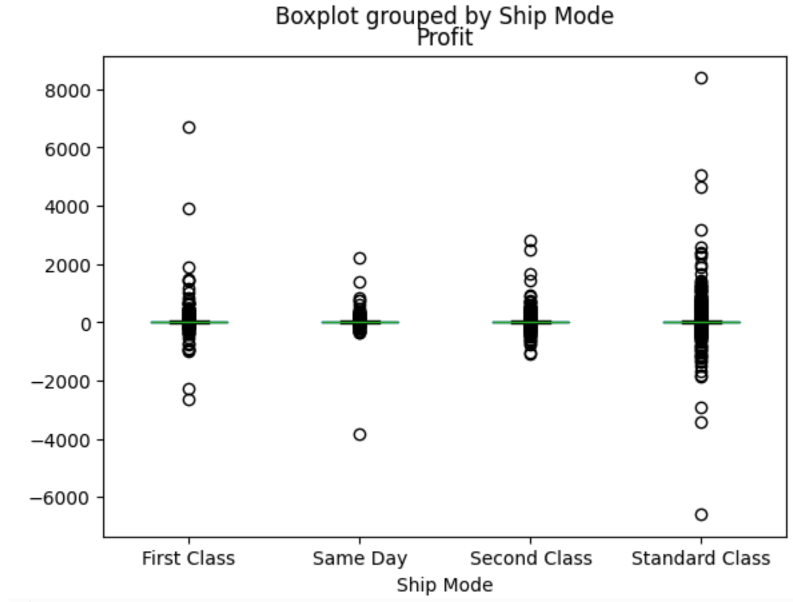
1. Which state has the highest total sales?
2. How do sales anomalies affect the gradient color shading on the map?
3. If you change the color scale, does it impact readability? Why or why not?

Ans:

1. CA: California
2. Sales anomalies affect the gradient color shading on the map because it will make the map harder to read and interpret.
3. Yes, it will impact readability because the color scale will make the map more readable and easier to interpret. If the color scale is not chosen correctly, the map will be harder to interpret and understand.

15. Create a box plot to compare the different shipping modes based on total profit.

```
#Write your code here (15)

profit_shipMode = df_superstore_order[['Ship Mode', 'Profit']]

profit_shipMode.boxplot(by='Ship Mode', column='Profit', grid=False)
plt.show()
```



15.2 Which shipping mode has the highest median profit?

Ans: First Class

[BONUS 20 pts] Determine the percentage of customers who:

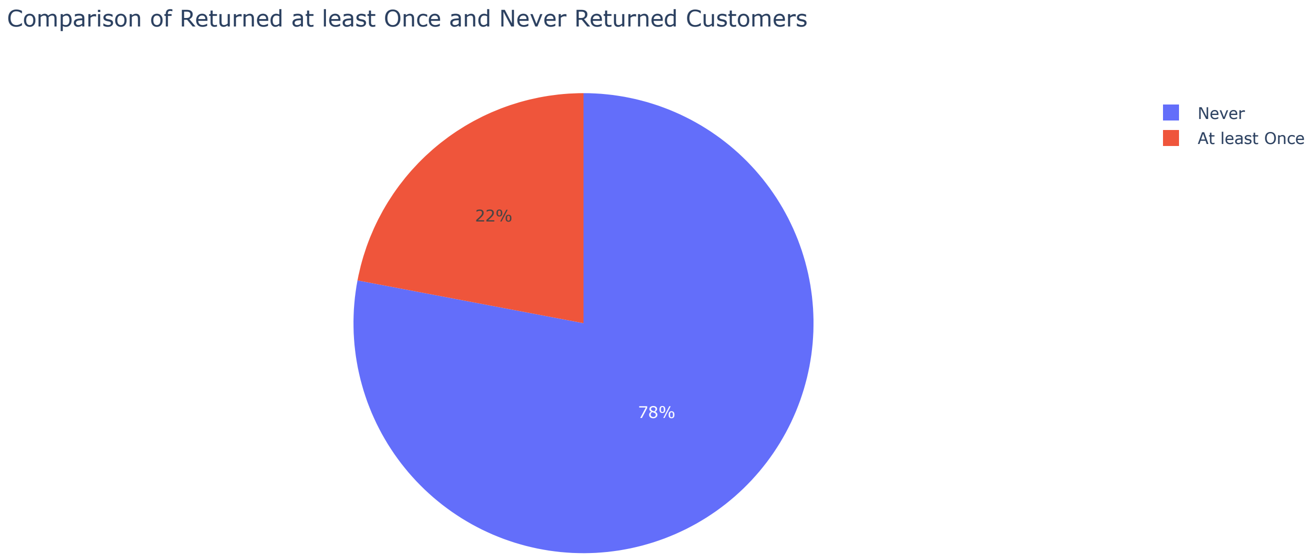
- B1)returned the product once
- B2) returned the product at least once
- B3) never returned the product
- Finally, Plot a comparison of B2 and B3

Note: please create additional cells to answer the above points

```
# Write your code here
Returned = order_return[order_return['Returned'] == 'Yes'].groupby('Customer ID').agg(return_count = ('Returned', 'count')).reset_index()
Returned_once = Returned[Returned['return_count'] == 1].shape[0]
Returned_atleast_once = Returned[Returned['return_count'] >= 1].shape[0]
Returned_never = order_return[order_return['Returned'] == 'No']['Customer ID'].unique().shape[0]

Returned_once_ratio = Returned_once / (Returned_once + Returned_atleast_once + Returned_never) * 100
Returned_atleast_once_ratio = Returned_atleast_once / (Returned_once + Returned_atleast_once + Returned_never) * 100
Returned_never_ratio = Returned_never / (Returned_once + Returned_atleast_once + Returned_never) * 100

Returned_once_ratio, Returned_atleast_once_ratio, Returned_never_ratio
```

```
(5.794392523364486, 20.747663551401867, 73.45794392523365)
```

```
# plot a comparison returned at least once, and never returned customers
px.pie(values=[Returned_atleast_once_ratio, Returned_never_ratio], names=['At least Once', 'Never'], title='Comparison of Returned at least
```


Comparison of Returned at least Once and Never Returned Customers
22%
78%
Never
At least Once