Name: Umesh Dhakal

Course: MSCS634

Professor: Dr. Satish Penmatsa

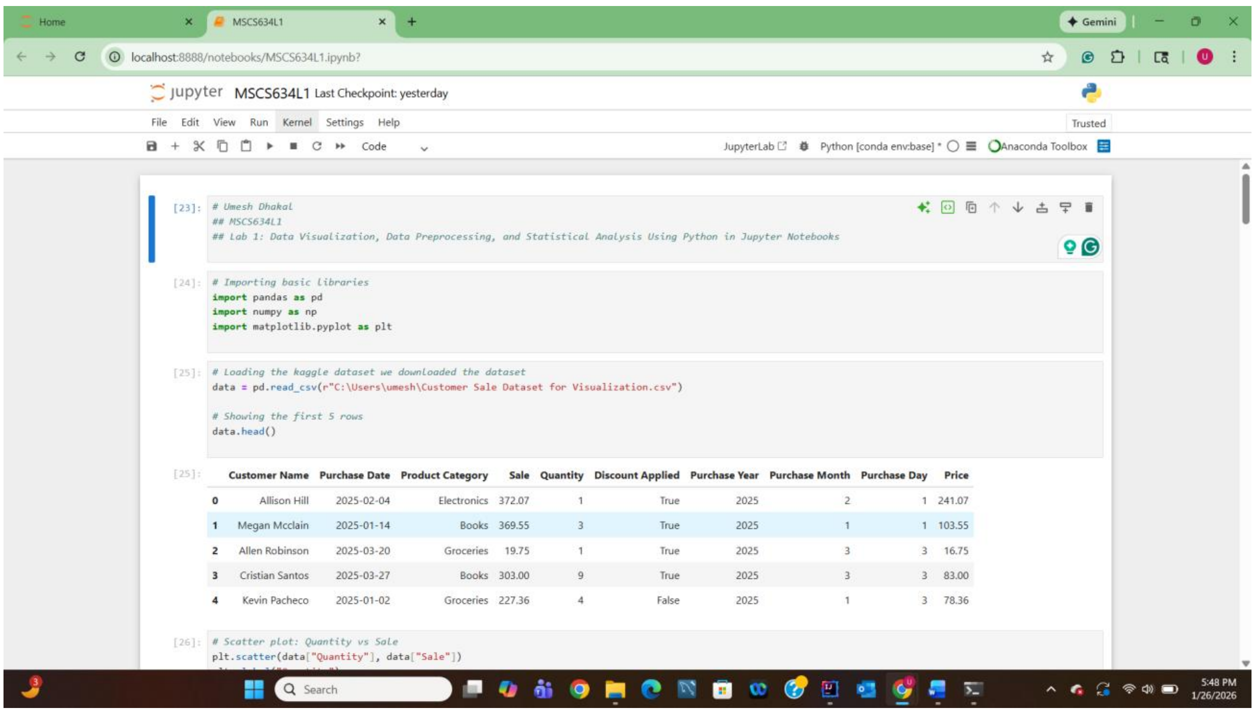
January 30,2026

Lab 1- Data Visualization, Data Preprocessing, and Statistical Analysis

GitHub links-

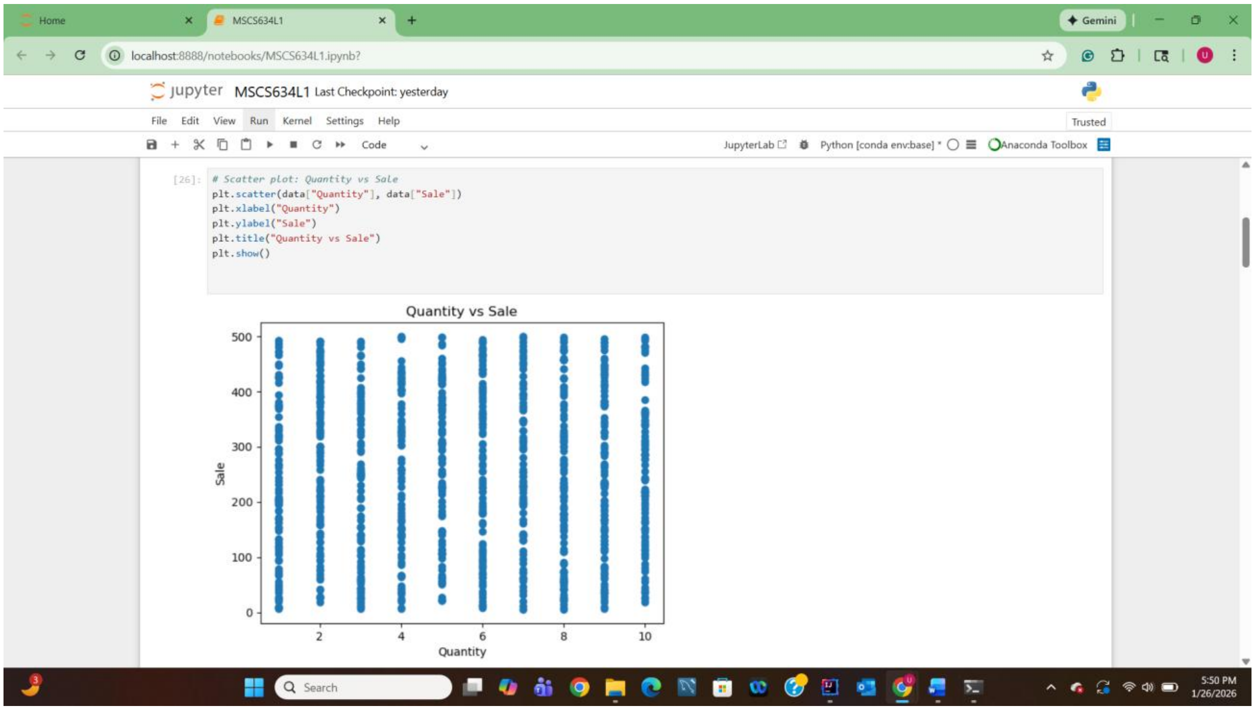
1. Data Collection

First five rows of data



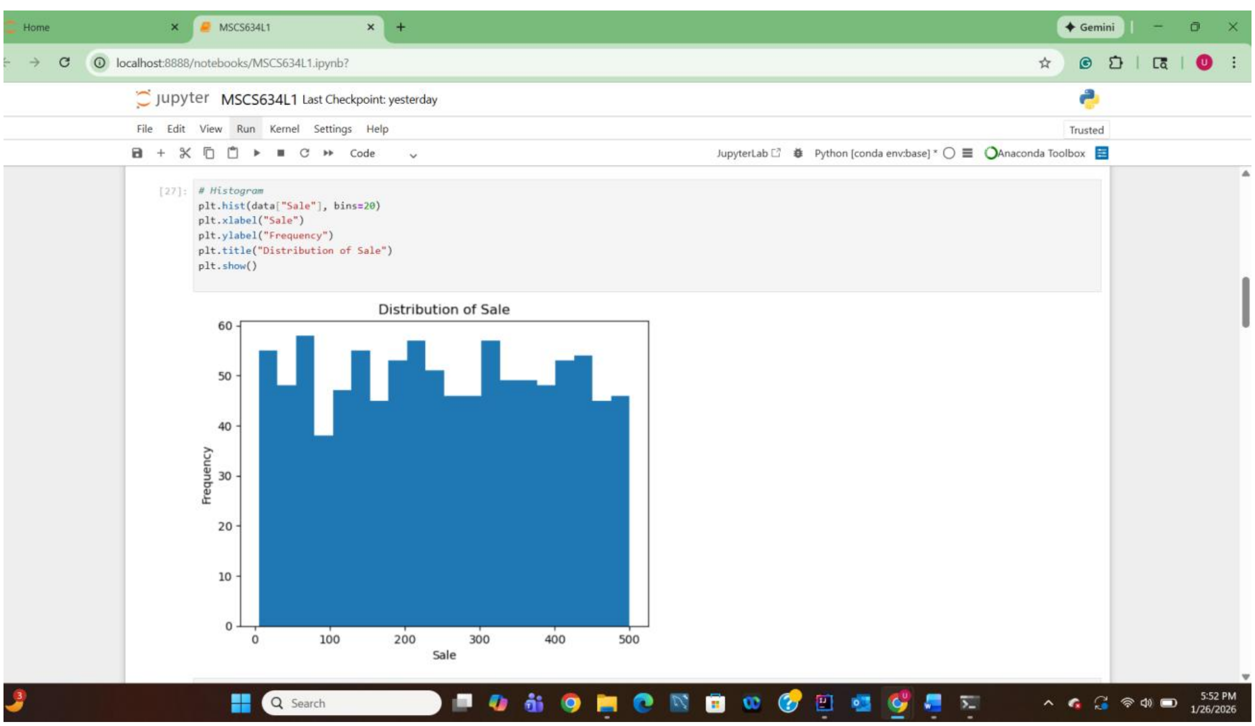
2. Data Visualization

Scatter Plot



This scatter plot shows how sale amount changes with quantity. As quantity increases, the sale amount generally increases, which shows a positive relationship.

Histogram

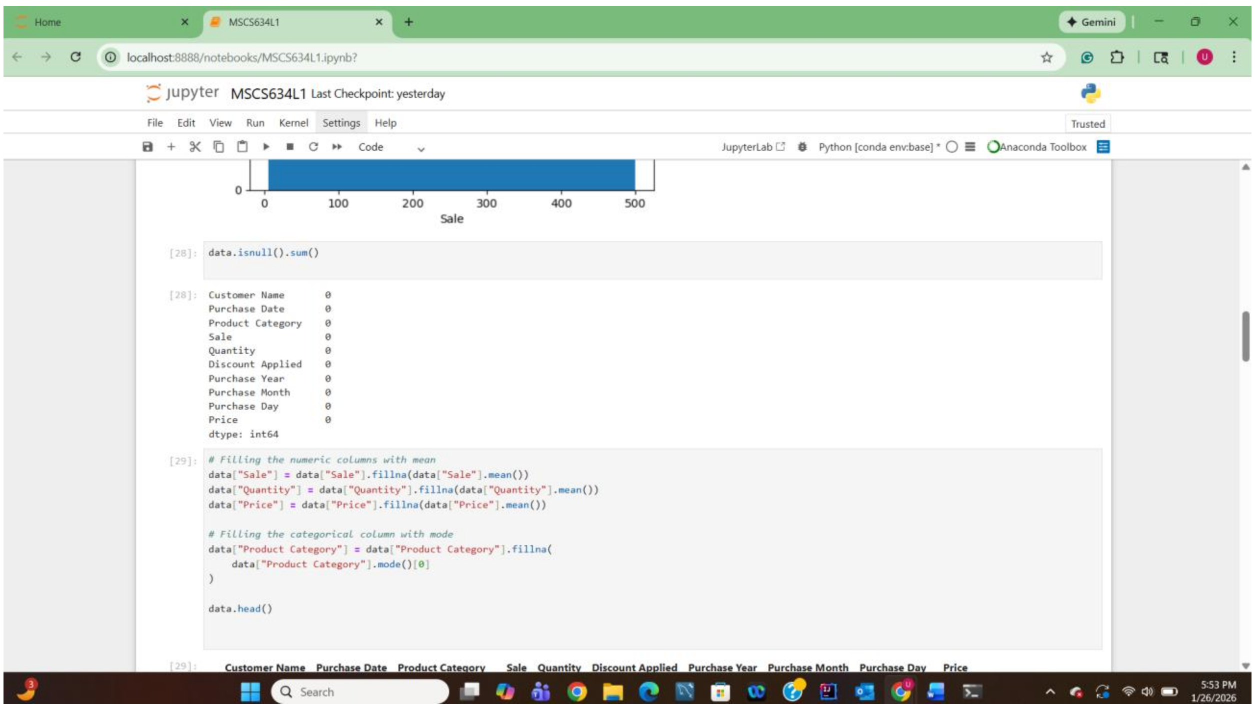


The histogram shows how sale amounts are distributed. Most sales fall in the lower to mid-range, while very high sales occur less frequently.

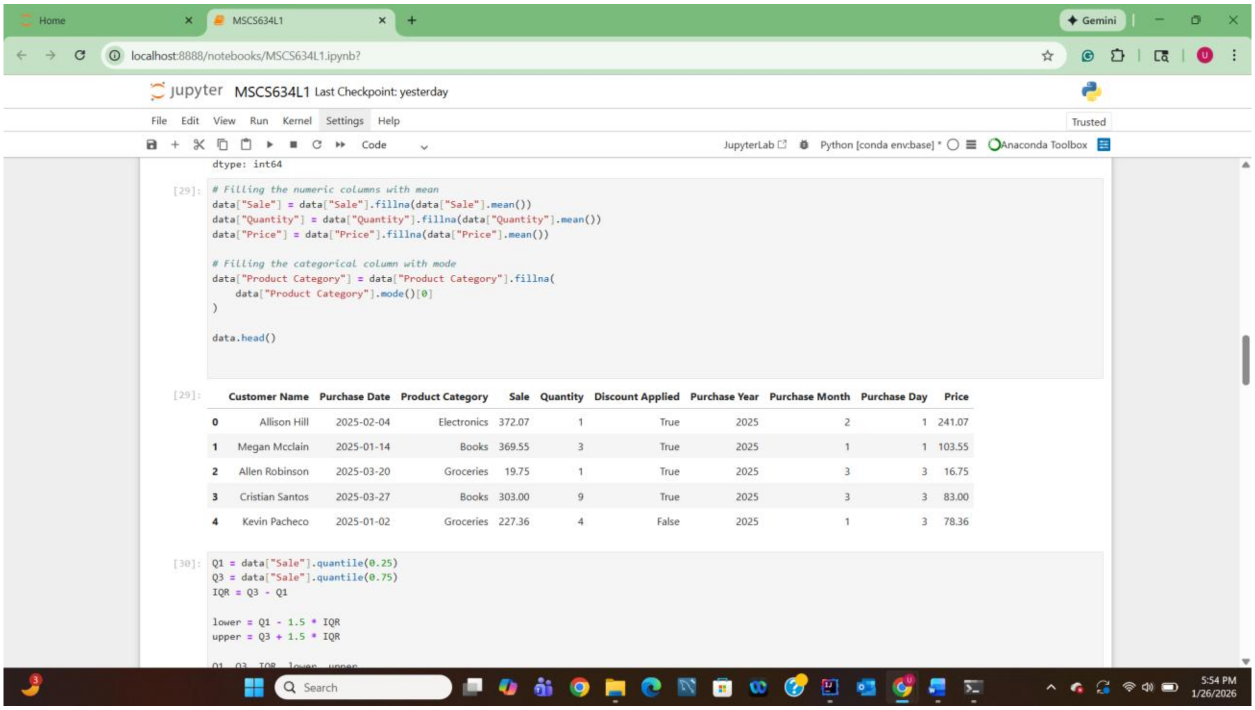
3. Data Preprocessing

Handling Missing Data

Before



After



```
dtype: int64
```

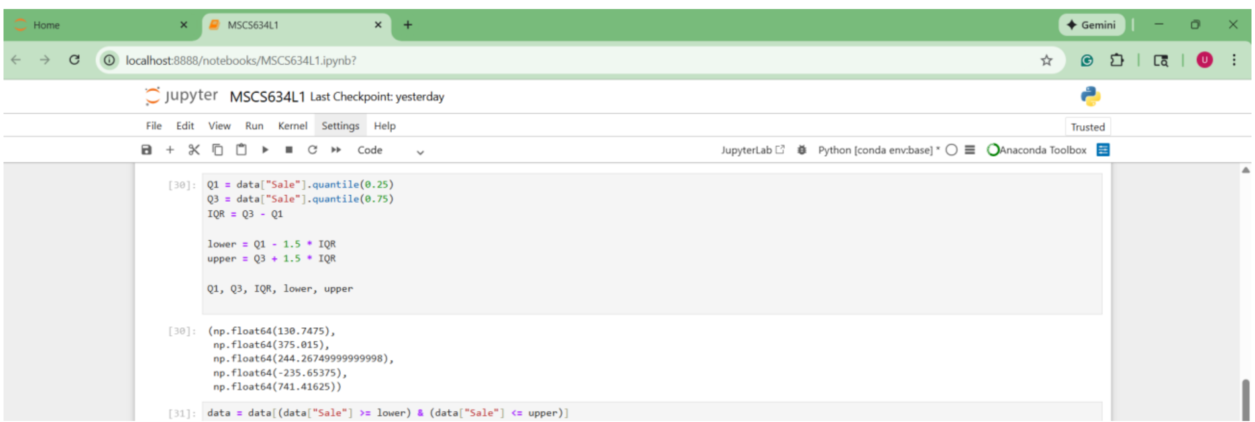
```
[29]: # Filling the numeric columns with mean
data["Sale"] = data["Sale"].fillna(data["Sale"].mean())
data["Quantity"] = data["Quantity"].fillna(data["Quantity"].mean())
data["Price"] = data["Price"].fillna(data["Price"].mean())

# Filling the categorical column with mode
data["Product Category"] = data["Product Category"].fillna(
    data["Product Category"].mode()[0]
)

data.head()
```

[29]:

	Customer Name	Purchase Date	Product Category	Sale	Quantity	Discount Applied	Purchase Year	Purchase Month	Purchase Day	Price
0	Allison Hill	2025-02-04	Electronics	372.07	1	True	2025	2	1	241.07
1	Megan Mcclain	2025-01-14	Books	369.55	3	True	2025	1	1	103.55
2	Allen Robinson	2025-03-20	Groceries	19.75	1	True	2025	3	3	16.75
3	Cristian Santos	2025-03-27	Books	303.00	9	True	2025	3	3	83.00
4	Kevin Pacheco	2025-01-02	Groceries	227.36	4	False	2025	1	3	78.36

```
[30]: Q1 = data["Sale"].quantile(0.25)
Q3 = data["Sale"].quantile(0.75)
IQR = Q3 - Q1

lower = Q1 - 1.5 * IQR
upper = Q3 + 1.5 * IQR
```

Outlier Detection and Removal

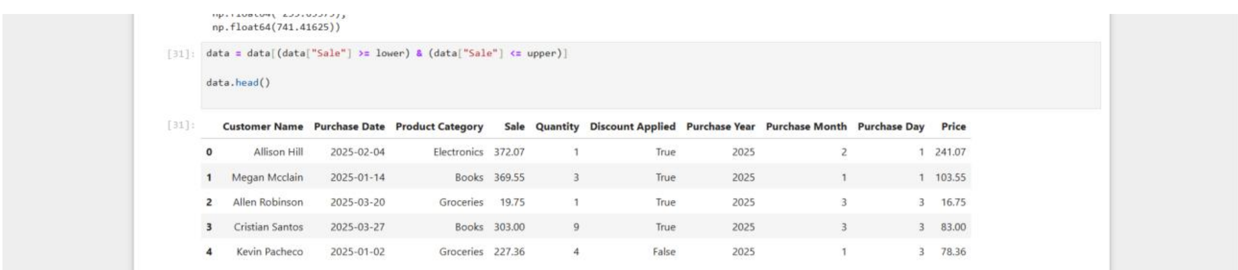


```
[30]: Q1 = data["Sale"].quantile(0.25)
Q3 = data["Sale"].quantile(0.75)
IQR = Q3 - Q1

lower = Q1 - 1.5 * IQR
upper = Q3 + 1.5 * IQR

Q1, Q3, IQR, lower, upper
```

```
[30]: (np.float64(130.7475),
 np.float64(375.015),
 np.float64(244.26749999999998),
 np.float64(-235.65375),
 np.float64(741.41625))
```

```
[31]: data = data[(data["Sale"] >= lower) & (data["Sale"] <= upper)]
```

After removal



```
 np.float64(741.41625))
```

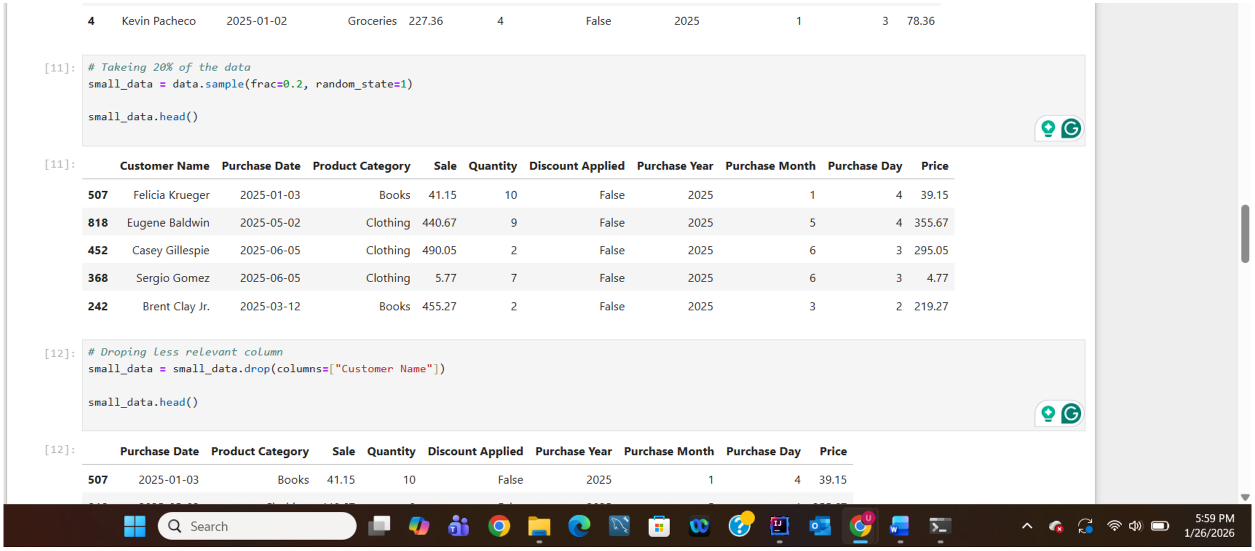
```
[31]: data = data[(data["Sale"] >= lower) & (data["Sale"] <= upper)]

data.head()
```

[31]:

	Customer Name	Purchase Date	Product Category	Sale	Quantity	Discount Applied	Purchase Year	Purchase Month	Purchase Day	Price
0	Allison Hill	2025-02-04	Electronics	372.07	1	True	2025	2	1	241.07
1	Megan Mcclain	2025-01-14	Books	369.55	3	True	2025	1	1	103.55
2	Allen Robinson	2025-03-20	Groceries	19.75	1	True	2025	3	3	16.75
3	Cristian Santos	2025-03-27	Books	303.00	9	True	2025	3	3	83.00
4	Kevin Pacheco	2025-01-02	Groceries	227.36	4	False	2025	1	3	78.36

Data Reduction

Before



4	Kevin Pacheco	2025-01-02	Groceries	227.36	4	False	2025	1	3	78.36

[11]:
```
# Takeing 20% of the data
small_data = data.sample(frac=0.2, random_state=1)

small_data.head()
```

[11]:

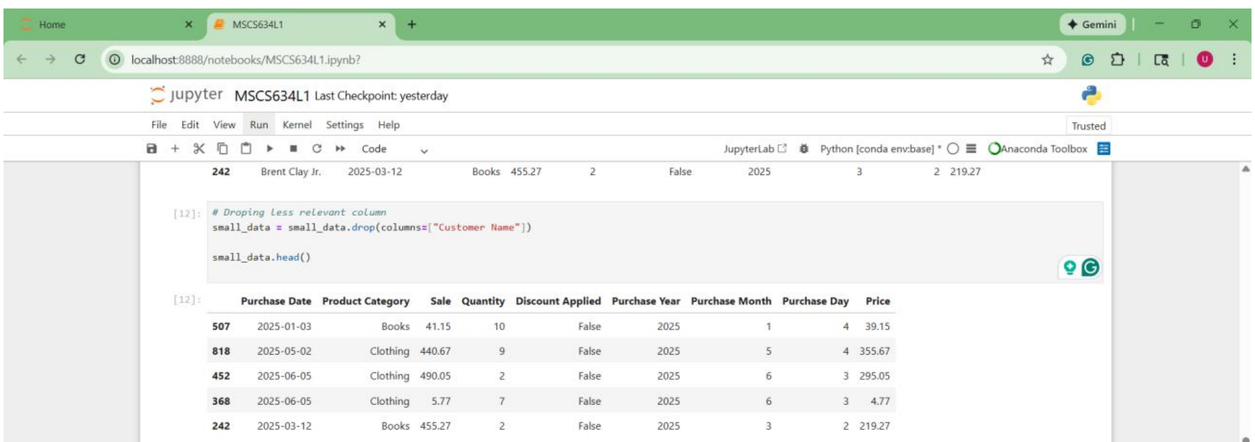
	Customer Name	Purchase Date	Product Category	Sale	Quantity	Discount Applied	Purchase Year	Purchase Month	Purchase Day	Price
507	Felicia Krueger	2025-01-03	Books	41.15	10	False	2025	1	4	39.15
818	Eugene Baldwin	2025-05-02	Clothing	440.67	9	False	2025	5	4	355.67
452	Casey Gillespie	2025-06-05	Clothing	490.05	2	False	2025	6	3	295.05
368	Sergio Gomez	2025-06-05	Clothing	5.77	7	False	2025	6	3	4.77
242	Brent Clay Jr.	2025-03-12	Books	455.27	2	False	2025	3	2	219.27

[12]:
```
# Droping less relevant column
small_data = small_data.drop(columns=["Customer Name"])

small_data.head()
```

[12]:

	Purchase Date	Product Category	Sale	Quantity	Discount Applied	Purchase Year	Purchase Month	Purchase Day	Price
507	2025-01-03	Books	41.15	10	False	2025	1	4	39.15

After



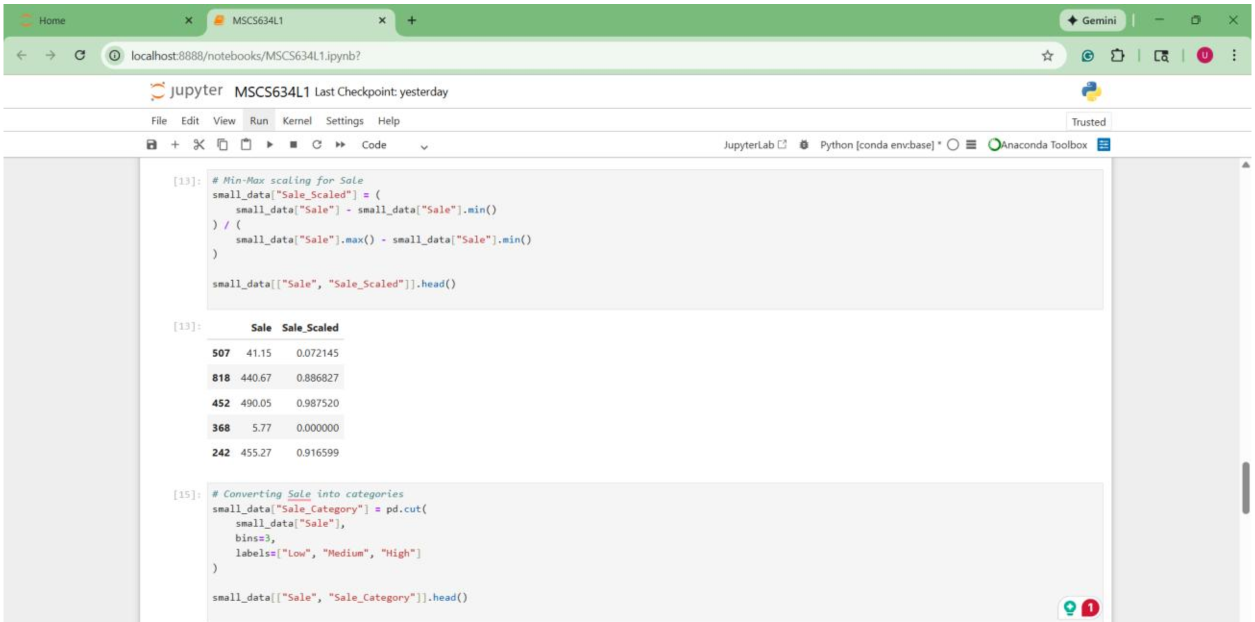
242	Brent Clay Jr.	2025-03-12	Books	455.27	2	False	2025	3	2	219.27

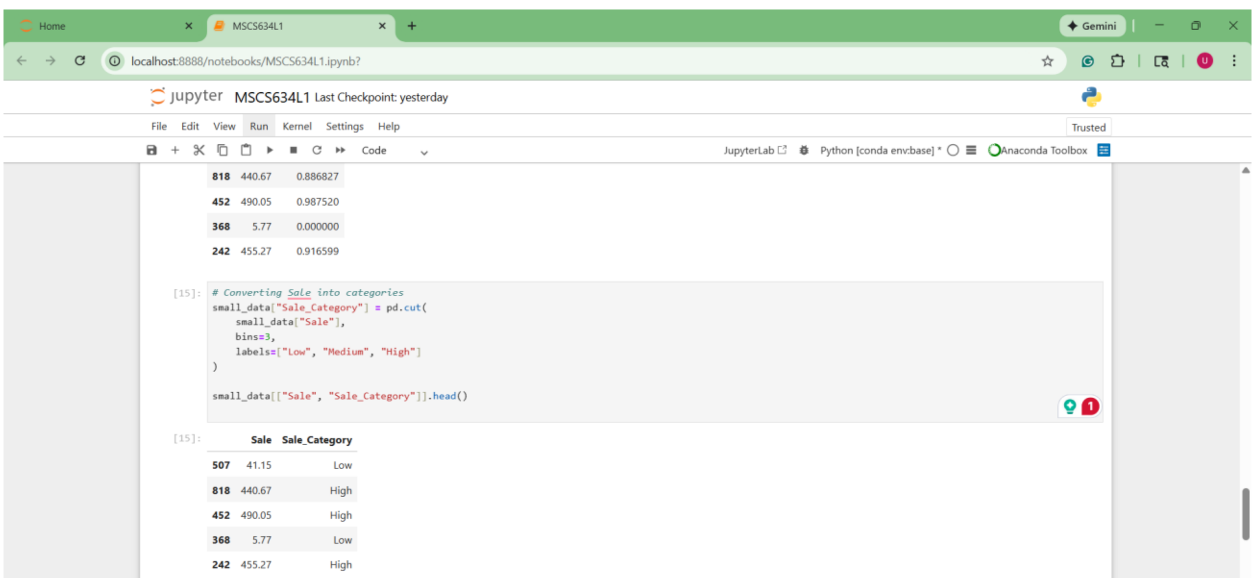
[12]:
```
# Droping less relevant column
small_data = small_data.drop(columns=["Customer Name"])

small_data.head()
```

[12]:

	Purchase Date	Product Category	Sale	Quantity	Discount Applied	Purchase Year	Purchase Month	Purchase Day	Price
507	2025-01-03	Books	41.15	10	False	2025	1	4	39.15
818	2025-05-02	Clothing	440.67	9	False	2025	5	4	355.67
452	2025-06-05	Clothing	490.05	2	False	2025	6	3	295.05
368	2025-06-05	Clothing	5.77	7	False	2025	6	3	4.77
242	2025-03-12	Books	455.27	2	False	2025	3	2	219.27

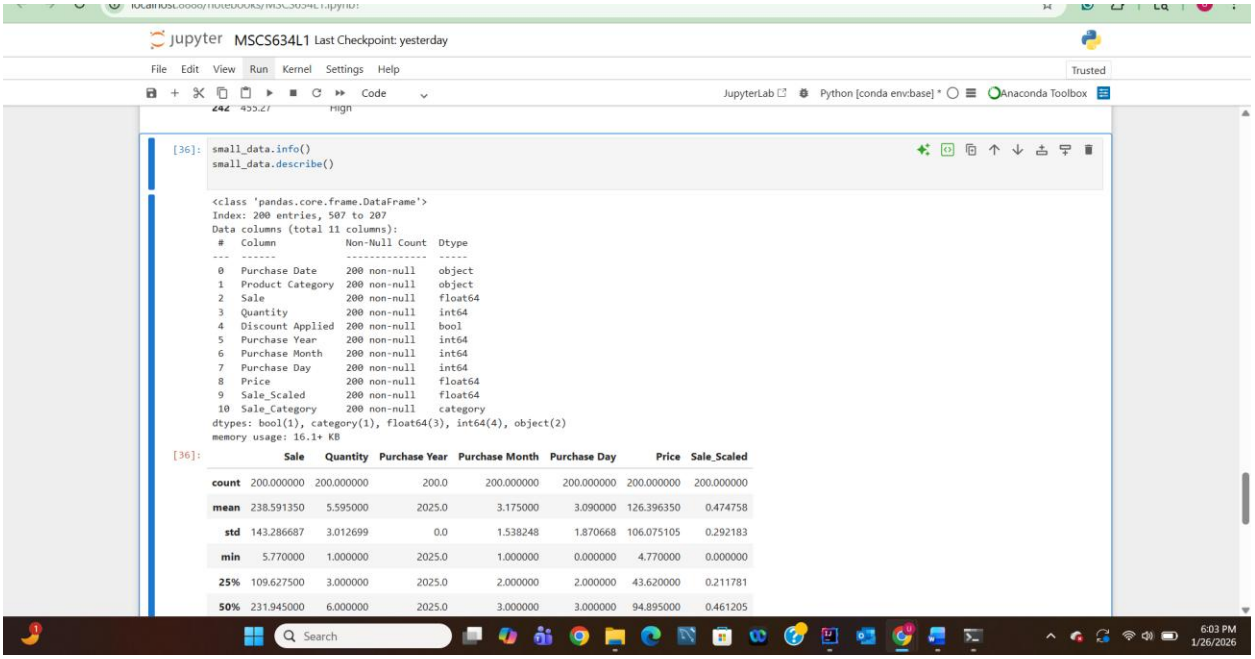
Data Scaling and Discretization





4. Statistical Analysis

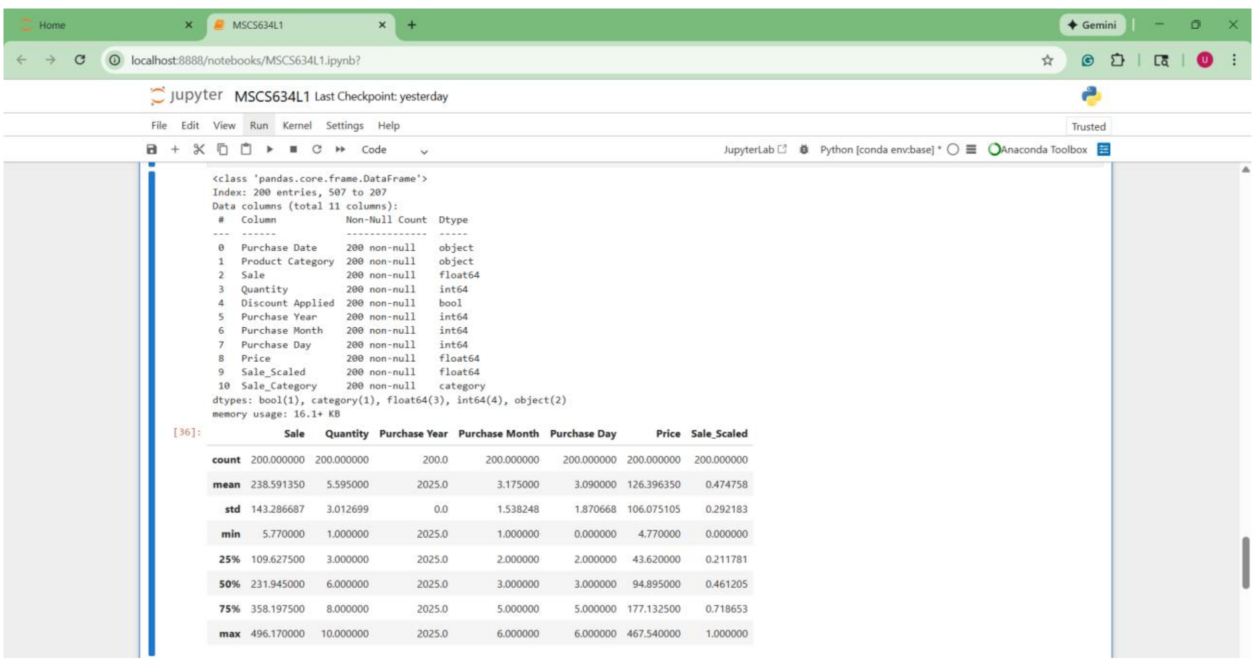
General Overview



```
[36]: small_data.info()
      small_data.describe()

<class 'pandas.core.frame.DataFrame'>
Index: 200 entries, 507 to 207
Data columns (total 11 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
 0   Purchase Date      200 non-null    object
 1   Product Category   200 non-null    object
 2   Sale               200 non-null    float64
 3   Quantity           200 non-null    int64
 4   Discount Applied   200 non-null    bool
 5   Purchase Year      200 non-null    int64
 6   Purchase Month     200 non-null    int64
 7   Purchase Day       200 non-null    int64
 8   Price              200 non-null    float64
 9   Sale_Scaled        200 non-null    float64
 10  Sale_Category      200 non-null    category
dtypes: bool(1), category(1), float64(3), int64(4), object(2)
memory usage: 16.1+ KB
```

[36]:

	Sale	Quantity	Purchase Year	Purchase Month	Purchase Day	Price	Sale_Scaled
count	200.000000	200.000000	200.0	200.000000	200.000000	200.000000	200.000000
mean	238.591350	5.595000	2025.0	3.175000	3.090000	126.396350	0.474758
std	143.286687	3.012699	0.0	1.538248	1.870668	106.075105	0.292183
min	5.770000	1.000000	2025.0	1.000000	0.000000	4.770000	0.000000
25%	109.627500	3.000000	2025.0	2.000000	2.000000	43.620000	0.211781
50%	231.945000	6.000000	2025.0	3.000000	3.000000	94.895000	0.461205

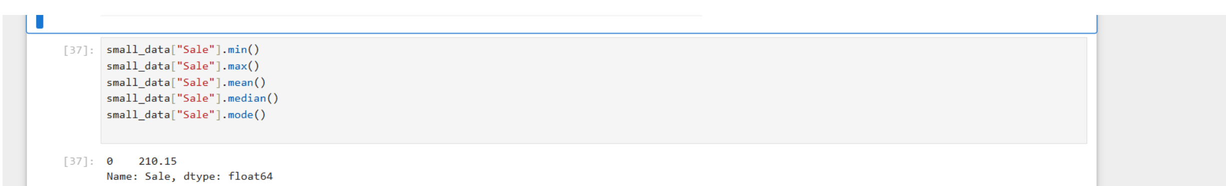



```
<class 'pandas.core.frame.DataFrame'>
Index: 200 entries, 507 to 207
Data columns (total 11 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
 0   Purchase Date      200 non-null    object
 1   Product Category   200 non-null    object
 2   Sale               200 non-null    float64
 3   Quantity           200 non-null    int64
 4   Discount Applied   200 non-null    bool
 5   Purchase Year      200 non-null    int64
 6   Purchase Month     200 non-null    int64
 7   Purchase Day       200 non-null    int64
 8   Price              200 non-null    float64
 9   Sale_Scaled        200 non-null    float64
 10  Sale_Category      200 non-null    category
dtypes: bool(1), category(1), float64(3), int64(4), object(2)
memory usage: 16.1+ KB
```


[36]:

	Sale	Quantity	Purchase Year	Purchase Month	Purchase Day	Price	Sale_Scaled
count	200.000000	200.000000	200.0	200.000000	200.000000	200.000000	200.000000
mean	238.591350	5.595000	2025.0	3.175000	3.090000	126.396350	0.474758
std	143.286687	3.012699	0.0	1.538248	1.870668	106.075105	0.292183
min	5.770000	1.000000	2025.0	1.000000	0.000000	4.770000	0.000000
25%	109.627500	3.000000	2025.0	2.000000	2.000000	43.620000	0.211781
50%	231.945000	6.000000	2025.0	3.000000	3.000000	94.895000	0.461205
75%	358.197500	8.000000	2025.0	5.000000	5.000000	177.132500	0.718653
max	496.170000	10.000000	2025.0	6.000000	6.000000	467.540000	1.000000

Central Tendency Measure

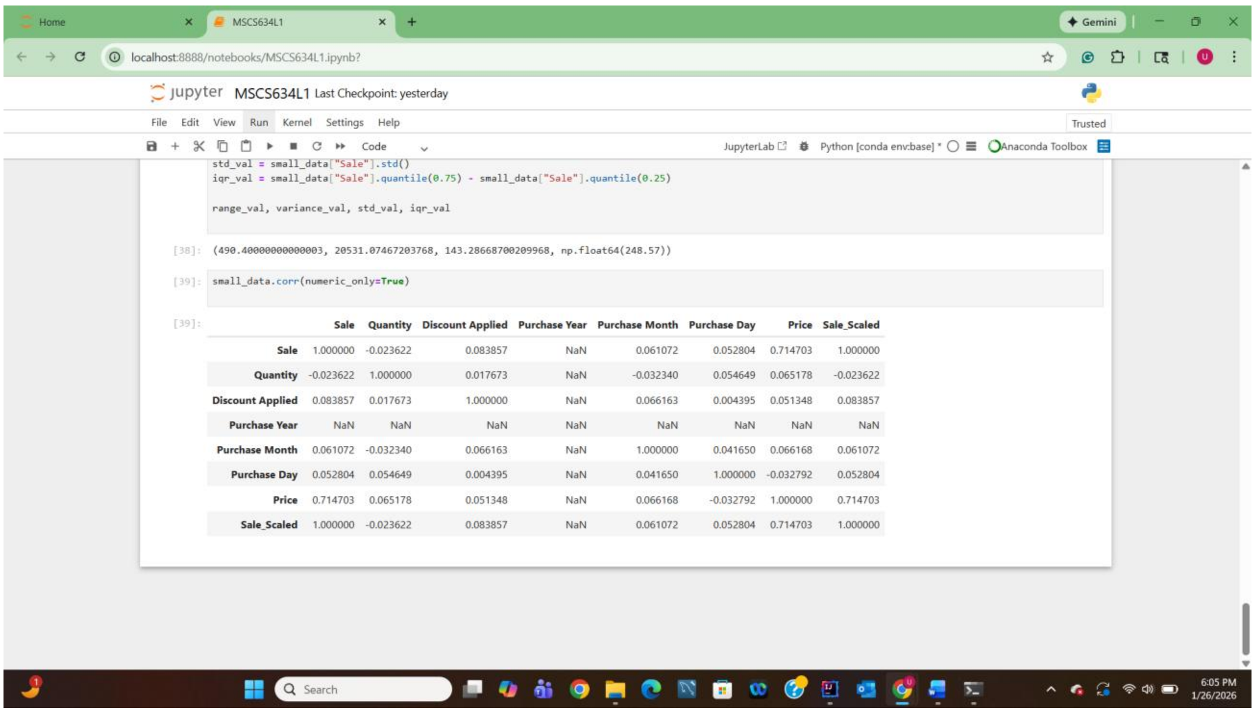


```
[37]: small_data["Sale"].min()
      small_data["Sale"].max()
      small_data["Sale"].mean()
      small_data["Sale"].median()
      small_data["Sale"].mode()

[37]: 0    210.15
      Name: Sale, dtype: float64
```

Dispersion Measures

```
[38]: range_val = small_data["Sale"].max() - small_data["Sale"].min()
      variance_val = small_data["Sale"].var()
      std_val = small_data["Sale"].std()
      iqr_val = small_data["Sale"].quantile(0.75) - small_data["Sale"].quantile(0.25)

      range_val, variance_val, std_val, iqr_val

[38]: (490.40000000000003, 20531.07467203768, 143.28668700209968, np.float64(248.57))
```

Correlation Analysis



```
std_val = small_data["Sale"].std()
iqr_val = small_data["Sale"].quantile(0.75) - small_data["Sale"].quantile(0.25)

range_val, variance_val, std_val, iqr_val

[38]: (490.40000000000003, 20531.07467203768, 143.28668700209968, np.float64(248.57))

[39]: small_data.corr(numeric_only=True)
```

[39]:

	Sale	Quantity	Discount Applied	Purchase Year	Purchase Month	Purchase Day	Price	Sale_Scaled
Sale	1.000000	-0.023622	0.083857	NaN	0.061072	0.052804	0.714703	1.000000
Quantity	-0.023622	1.000000	0.017673	NaN	-0.032340	0.054649	0.065178	-0.023622
Discount Applied	0.083857	0.017673	1.000000	NaN	0.066163	0.004395	0.051348	0.083857
Purchase Year	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Purchase Month	0.061072	-0.032340	0.066163	NaN	1.000000	0.041650	0.066168	0.061072
Purchase Day	0.052804	0.054649	0.004395	NaN	0.041650	1.000000	-0.032792	0.052804
Price	0.714703	0.065178	0.051348	NaN	0.066168	-0.032792	1.000000	0.714703
Sale_Scaled	1.000000	-0.023622	0.083857	NaN	0.061072	0.052804	0.714703	1.000000