Analyzing Consumer Behavior in Online Retail: Insights from a UK E-Commerce Dataset

Data Analyst Project

Presenter

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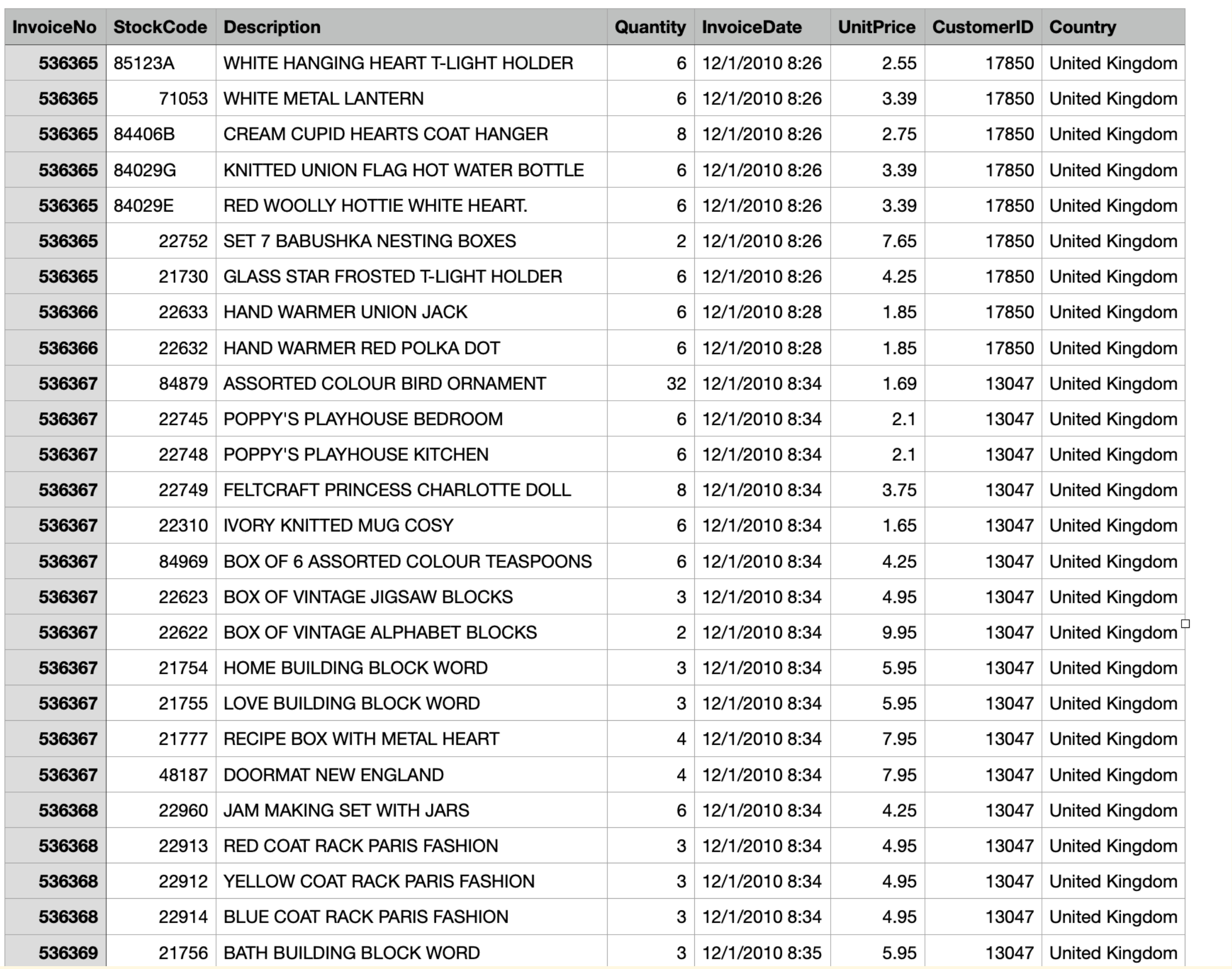
Task I: Topic and Data Set

Data Set Info

- The dataset chosen is "E-commerce Data".
- It is available in the following link.



InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country
536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	12/1/2010 8:26	2.55	17850	United Kingdom
536365	71053	WHITE METAL LANTERN	6	12/1/2010 8:26	3.39	17850	United Kingdom
536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	12/1/2010 8:26	2.75	17850	United Kingdom
536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	12/1/2010 8:26	3.39	17850	United Kingdom
536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	12/1/2010 8:26	3.39	17850	United Kingdom
536365	22752	SET 7 BABUSHKA NESTING BOXES	2	12/1/2010 8:26	7.65	17850	United Kingdom
536365	21730	GLASS STAR FROSTED T-LIGHT HOLDER	6	12/1/2010 8:26	4.25	17850	United Kingdom
536366	22633	HAND WARMER UNION JACK	6	12/1/2010 8:28	1.85	17850	United Kingdom
536366	22632	HAND WARMER RED POLKA DOT	6	12/1/2010 8:28	1.85	17850	United Kingdom
536367	84879	ASSORTED COLOUR BIRD ORNAMENT	32	12/1/2010 8:34	1.69	13047	United Kingdom
536367	22745	POPPY'S PLAYHOUSE BEDROOM	6	12/1/2010 8:34	2.1	13047	United Kingdom
536367	22748	POPPY'S PLAYHOUSE KITCHEN	6	12/1/2010 8:34	2.1	13047	United Kingdom
536367	22749	FELTCRAFT PRINCESS CHARLOTTE DOLL	8	12/1/2010 8:34	3.75	13047	United Kingdom
536367	22310	IVORY KNITTED MUG COSY	6	12/1/2010 8:34	1.65	13047	United Kingdom
536367	84969	BOX OF 6 ASSORTED COLOUR TEASPOONS	6	12/1/2010 8:34	4.25	13047	United Kingdom
536367	22623	BOX OF VINTAGE JIGSAW BLOCKS	3	12/1/2010 8:34	4.95	13047	United Kingdom
536367	22622	BOX OF VINTAGE ALPHABET BLOCKS	2	12/1/2010 8:34	9.95	13047	United Kingdom
536367	21754	HOME BUILDING BLOCK WORD	3	12/1/2010 8:34	5.95	13047	United Kingdom
536367	21755	LOVE BUILDING BLOCK WORD	3	12/1/2010 8:34	5.95	13047	United Kingdom
536367	21777	RECIPE BOX WITH METAL HEART	4	12/1/2010 8:34	7.95	13047	United Kingdom
536367	48187	DOORMAT NEW ENGLAND	4	12/1/2010 8:34	7.95	13047	United Kingdom
536368	22960	JAM MAKING SET WITH JARS	6	12/1/2010 8:34	4.25	13047	United Kingdom
536368	22913	RED COAT RACK PARIS FASHION	3	12/1/2010 8:34	4.95	13047	United Kingdom
536368	22912	YELLOW COAT RACK PARIS FASHION	3	12/1/2010 8:34	4.95	13047	United Kingdom
536368	22914	BLUE COAT RACK PARIS FASHION	3	12/1/2010 8:34	4.95	13047	United Kingdom
536369	21756	BATH BUILDING BLOCK WORD	3	12/1/2010 8:35	5.95	13047	United Kingdom

Data Set Description

1. This dataset contains actual transaction data from a UK-based online retail store.
2. It contains transaction data from **November 2010** to **December 2011**.
3. There are approximately **500,000** records.

Dataset Attributes

- **InvoiceNo**: *Invoice number (a unique identifier)*
- **StockCode**: *Product code*
- **Description**: *Product description*
- **Quantity**: *Quantity of product purchased*
- **InvoiceDate**: *Date and time of purchase*
- **UnitPrice**: *Product price per unit*
- **CustomerID**: *Unique customer identifier*
- **Country**: *Country from where the order was placed*

Read File

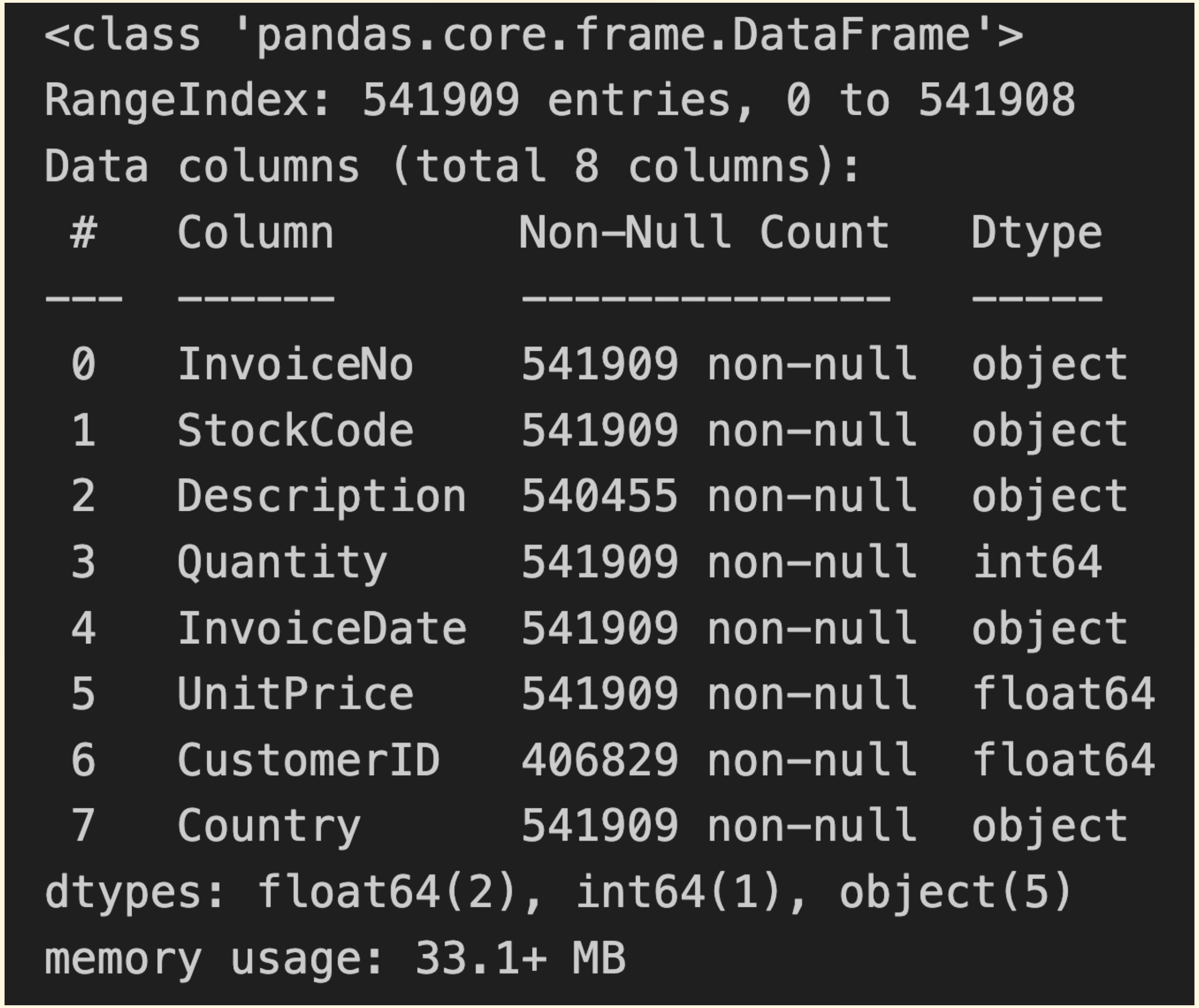
- Import the CSV file as a DataFrame using the pandas library.

```python
# import library
import pandas as pd

# read file
data = pd.read_csv('data.csv',encoding = "ISO-8859-1")

# view file
data.head()
```

Basic Info

- The info() method in pandas was used to inspect the details.

```
# find data info
data.info()
```

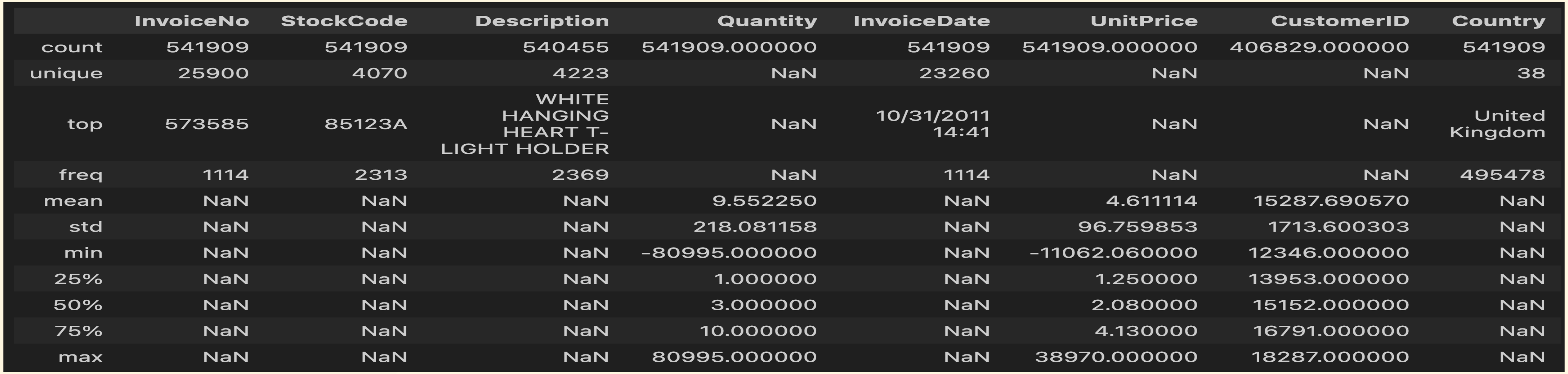


```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 541909 entries, 0 to 541908
Data columns (total 8 columns):
 #   Column       Non-Null Count   Dtype
---  ------       --------------   -----
 0   InvoiceNo    541909 non-null  object
 1   StockCode    541909 non-null  object
 2   Description  540455 non-null  object
 3   Quantity     541909 non-null  int64
 4   InvoiceDate  541909 non-null  object
 5   UnitPrice    541909 non-null  float64
 6   CustomerID   406829 non-null  float64
 7   Country      541909 non-null  object
dtypes: float64(2), int64(1), object(5)
memory usage: 33.1+ MB
```

Statistical Description

- The describe() method was used to obtain a statistical summary.

```
# statistical description
data.describe(include='all')
```



	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country
count	541909	541909	540455	541909.000000	541909	541909.000000	406829.000000	541909
unique	25900	4070	4223	NaN	23260	NaN	NaN	38
top	573585	85123A	WHITE HANGING HEART T-LIGHT HOLDER	NaN	10/31/2011 14:41	NaN	NaN	United Kingdom
freq	1114	2313	2369	NaN	1114	NaN	NaN	495478
mean	NaN	NaN	NaN	9.552250	NaN	4.611114	15287.690570	NaN
std	NaN	NaN	NaN	218.081158	NaN	96.759853	1713.600303	NaN
min	NaN	NaN	NaN	-80995.000000	NaN	-11062.060000	12346.000000	NaN
25%	NaN	NaN	NaN	1.000000	NaN	1.250000	13953.000000	NaN
50%	NaN	NaN	NaN	3.000000	NaN	2.080000	15152.000000	NaN
75%	NaN	NaN	NaN	10.000000	NaN	4.130000	16791.000000	NaN
max	NaN	NaN	NaN	80995.000000	NaN	38970.000000	18287.000000	NaN

Potential Business Hypothesis

Quantity and *UnitPrice* Relationship:

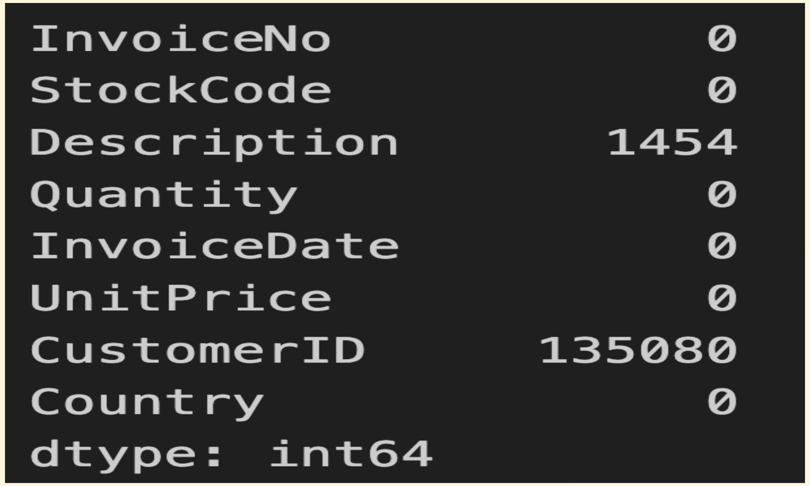
- **Hypothesis**: *There is a relationship between the quantity of a product sold and its unit price*
- **Dependent Variable**: *Quantity*
- **Independent Variable**: *UnitPrice*

Task II: Data Analysis & Prediction

Handling Missing Values

- No missing value found in *Quantity* and *UnitPrice*.

```
# find missing value
missing_values = data.isnull().sum()
missing_values
```



```
InvoiceNo           0
StockCode           0
Description      1454
Quantity            0
InvoiceDate         0
UnitPrice           0
CustomerID     135080
Country             0
dtype: int64
```

Removing Outlier

Outlier Detection Method

- To detect outliers in the *Quantity* and *UnitPrice* columns, the **Interquartile Range (IQR)** method was used. This involves:

Based on the **IQR** method:

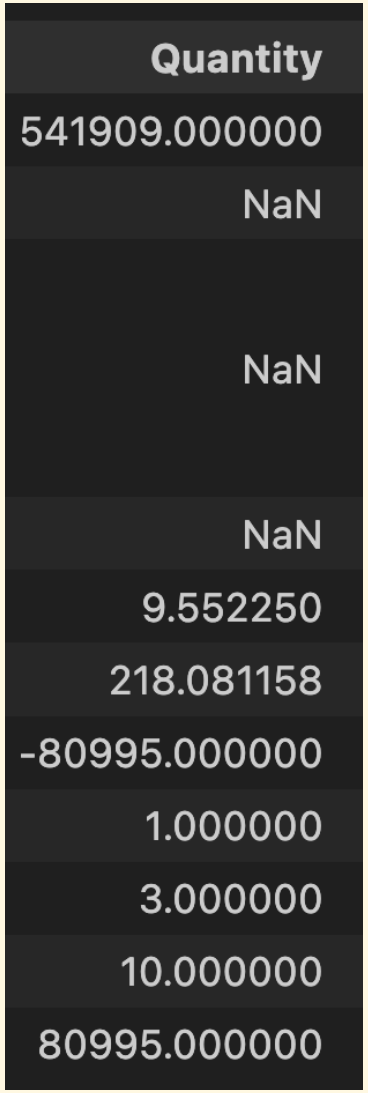
- *Quantity* = **58,619** outliers detected/ removed
- *UnitPrice* = **39,627** outliers detected/ removed

Removing Unusual Values

Negative values in the *Quantity* can represent a few different scenarios:

1. Returns or Cancellations
2. Discounts or Adjustments
3. Data Entry Errors

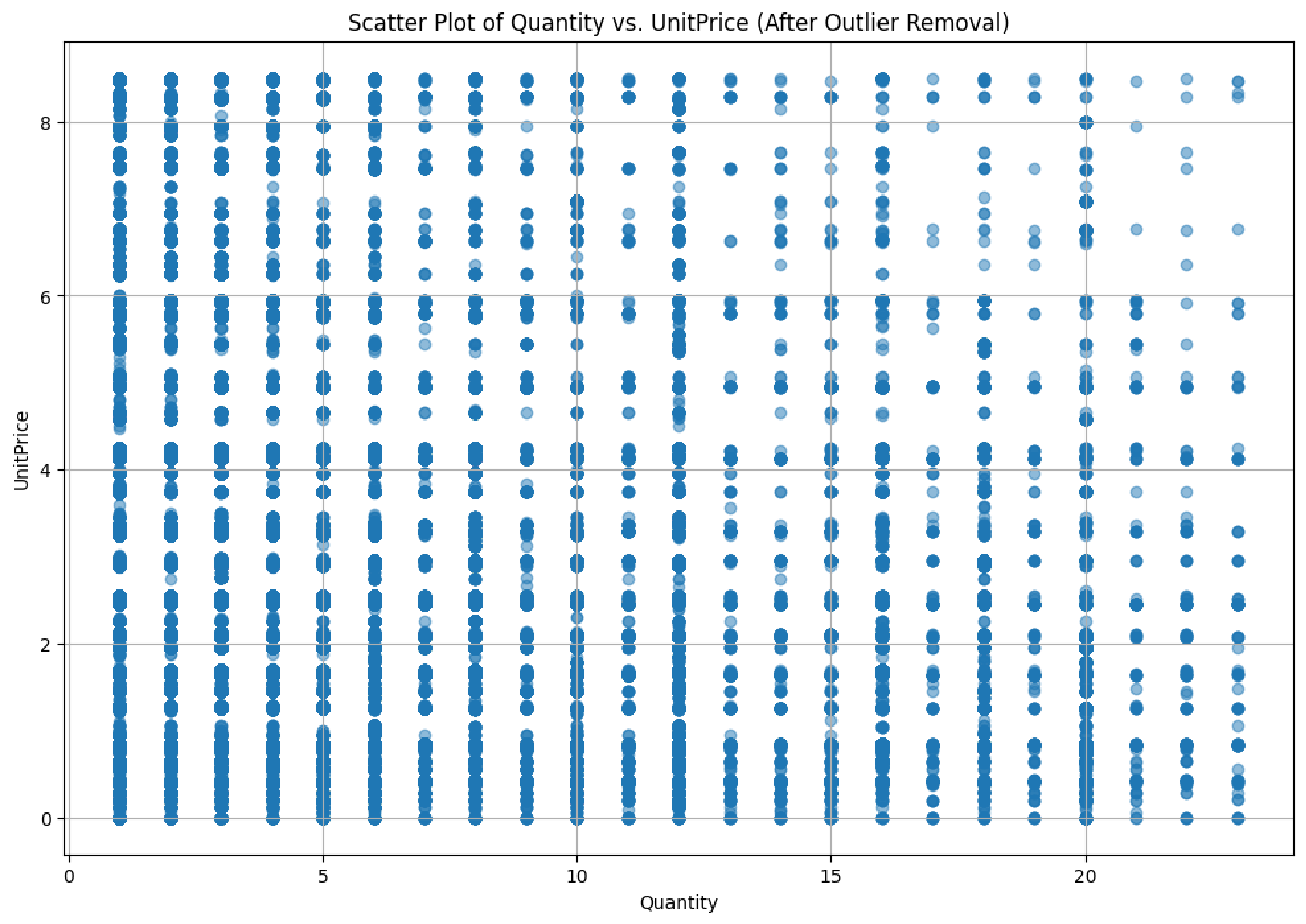
```
# Remove rows where "Quantity" is negative
data_cleaned = data_cleaned[data_cleaned["Quantity"] >= 0]
```



Quantity
541909.000000
NaN
NaN
NaN
9.552250
218.081158
-80995.000000
1.000000
3.000000
10.000000
80995.000000

Scatter Plot

- It is difficult to observe any pattern or linear relationship.
- Clearly this will have no or weak relationship.



Testing Relationship

```
# find Pearson correlation coeeficient
correlation_coefficient = data_cleaned["Quantity"].corr(data_cleaned["UnitPrice"])
```

- The Pearson correlation coefficient between *Quantity* and *UnitPrice* in the cleaned dataset is approximately **-0.294**
- This indicates a **weak negative correlation** between the two variables.
- As the quantity increases, the unit price tends to decrease slightly.

Updated Business Hypothesis

Quantity and *TotalSales* Relationship:

- **Hypothesis**: *There is a relationship between the quantity of a product sold and its total sales*
- **Dependent Variable**: *Quantity*
- **Independent Variable**: *TotalSales*

Feature Engineering: TotalSales

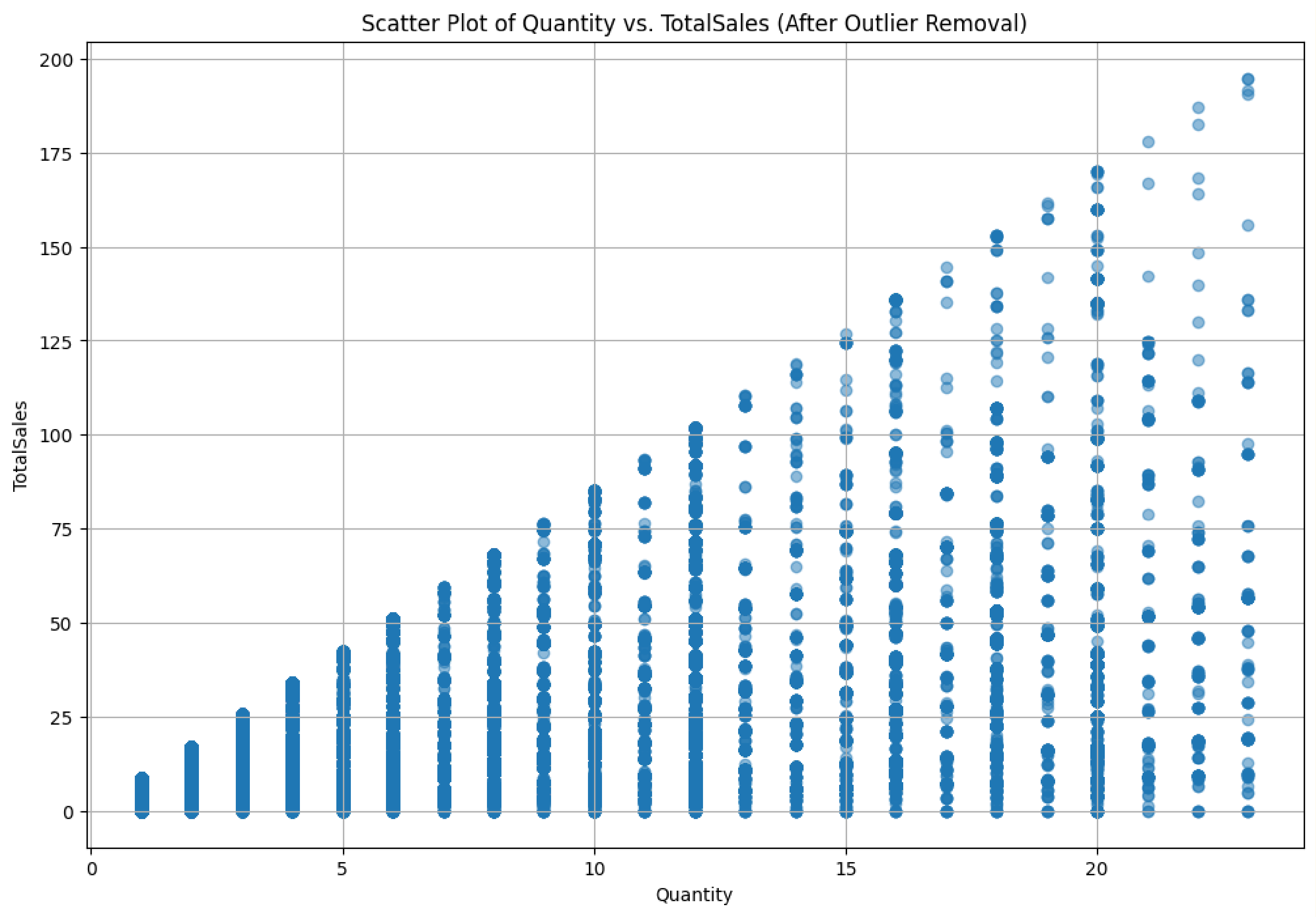
The new variable, *TotalSales*, will be computed as:

$$TotalSales = Quantity \times UnitPrice$$

```python
# Create the new "TotalSales" variable
data_cleaned["TotalSales"] = data_cleaned["Quantity"] * data_cleaned["UnitPrice"]

# Display the first few rows of the dataset with the new variable
data_cleaned.head()
```

Scatter Plot

- Now, the linear relationship is much more visible.
- Clearly this will have moderate or strong positive linear relationship.



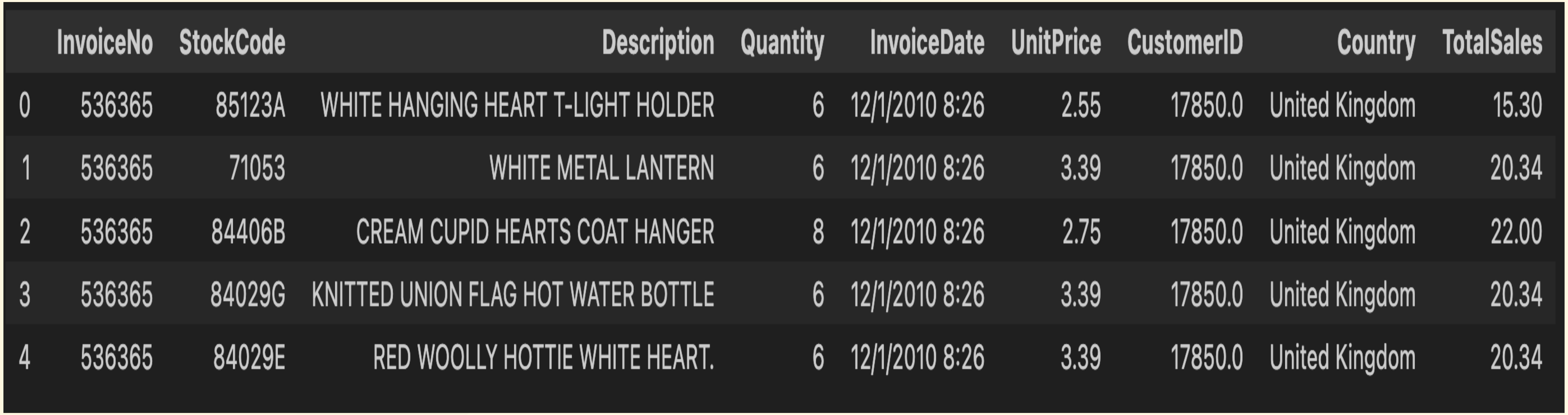
Testing Relationship

```
# Compute the Pearson correlation coefficient between "Quantity" and "TotalSales"
correlation_total_sales_quantity = data_cleaned["TotalSales"].corr(data_cleaned["Quantity"])
```

- The Pearson correlation coefficient between *Quantity* and *TotalSales* in the cleaned dataset is approximately **0.588**.
- This indicates a **moderate positive correlation** between the two variables.
- As the quantity increases, the total sales also tend to increase, which is expected since *TotalSales* is derived from *Quantity*.

New Cleaned Dataset

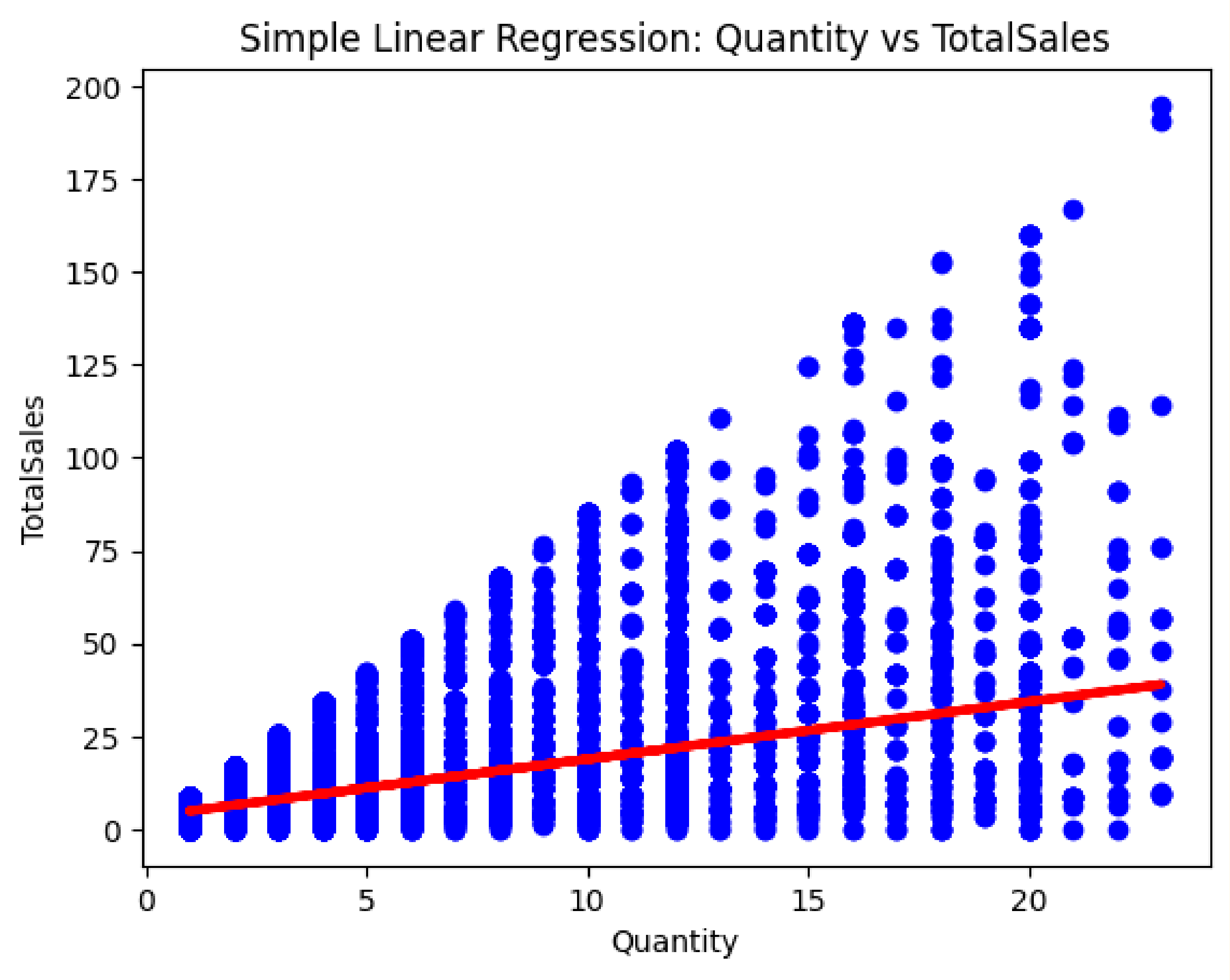
```
# View new cleaned data
data_cleaned.head()
```



	InvoiceNo	StockCode	Description	Quantity	InvoiceDate	UnitPrice	CustomerID	Country	TotalSales
0	536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	12/1/2010 8:26	2.55	17850.0	United Kingdom	15.30
1	536365	71053	WHITE METAL LANTERN	6	12/1/2010 8:26	3.39	17850.0	United Kingdom	20.34
2	536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	12/1/2010 8:26	2.75	17850.0	United Kingdom	22.00
3	536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	12/1/2010 8:26	3.39	17850.0	United Kingdom	20.34
4	536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	12/1/2010 8:26	3.39	17850.0	United Kingdom	20.34

Prediction

- Predictions were made using a Simple Linear Regression (SLR) model.



Model Evaluation: R^2

- The R^2 score, or coefficient of determination, measures how well the independent variables explain the variation in the dependent variable.
- For this model, the R^2 score is approximately **0.346**.
- This means that around **34.6%** of the variation in *TotalSales* can be explained by *Quantity*.
- While this shows some level of correlation, it suggests that other features not included in the model might also be influencing *TotalSales*.

Model Evaluation: MSE

- The Mean Squared Error (MSE) quantifies the average squared difference between the predicted and actual values.
- For this model, the MSE is approximately **90.66**.
- An MSE value closer to zero indicates better model performance and more precise predictions.
- The relatively higher MSE of **90.66** suggests that there is room for improvement in the model's predictions, as the predicted values deviate from the actual values to some extent.

Enhancing Model Performance

1. **Incorporate Additional Variables:**
   Integrate other relevant features, such as product category, time of purchase, or customer demographics, which may provide additional insights into total sales.

2. **Address Negative Values in Quantity:**
   Investigate the context and reasons behind negative values in the *Quantity* variable.

Task III: Results Visualisation

Tableau Dashboard

- We have created dashboard using the cleaned dataset
  Link

Bar Chart

Scatter Plot I

Scatter Plot II