

```
import pandas as pd

df = pd.read_excel("retail.xlsx")
df.head()
```

	Invoice	StockCode	Description	Quantity	InvoiceDate	Price	Customer ID	Country
0	489434	85048	15CM CHRISTMAS GLASS BALL 20 LIGHTS	12	2009-12-01 07:45:00	6.95	13085.0	United Kingdom
1	489434	79323P	PINK CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom
2	489434	79323W	WHITE CHERRY LIGHTS	12	2009-12-01 07:45:00	6.75	13085.0	United Kingdom
3	489434	22041	RECORD FRAME 7" SINGLE SIZE	48	2009-12-01 07:45:00	2.10	13085.0	United Kingdom

```
#Q1. Basic Data Exploration
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

# Load dataset
df = pd.read_excel("retail.xlsx")

# Total rows and columns
print("Rows:", df.shape[0])
print("Columns:", df.shape[1])

# Missing values per column
print("\nMissing values:")
print(df.isnull().sum())

# Data types
print("\nData types:")
print(df.dtypes)
```

Rows: 525461
 Columns: 8

Missing values:

Invoice	0
StockCode	0
Description	2928
Quantity	0
InvoiceDate	0
Price	0
Customer ID	107927
Country	0

dtype: int64

Data types:

Invoice	object
StockCode	object

```
Description          object
Quantity         int64
InvoiceDate    datetime64[ns]
Price           float64
Customer ID    float64
Country          object
dtype: object
```

```
#Q2. Time Period & Transactions
# Ensure InvoiceDate is datetime
df["InvoiceDate"] = pd.to_datetime(df["InvoiceDate"])

# Earliest and latest dates
earliest_date = df["InvoiceDate"].min()
latest_date = df["InvoiceDate"].max()

print("Earliest Purchase Date:", earliest_date)
print("Latest Purchase Date:", latest_date)

# Unique invoices
unique_invoices = df["Invoice"].nunique() #counts the number of unique (distinct) values in
print("Total unique invoices:", unique_invoices)
```

```
Earliest Purchase Date: 2009-12-01 07:45:00
Latest Purchase Date: 2010-12-09 20:01:00
Total unique invoices: 28816
```

```
#Q3. Revenue Calculation
# Create TotalPrice column
df["TotalPrice"] = df["Quantity"] * df["Price"]

# Total revenue
total_revenue = df["TotalPrice"].sum()

# Average revenue per transaction
avg_revenue_per_tx = df.groupby("Invoice")["TotalPrice"].sum().mean()

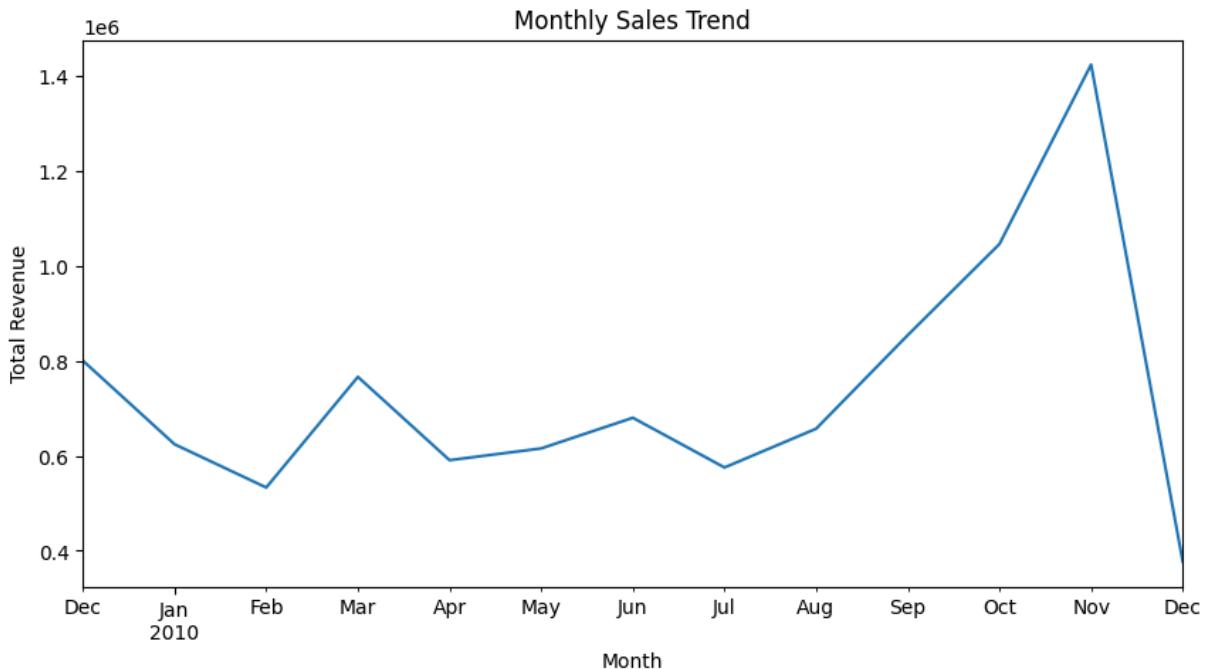
print("Total Revenue:", total_revenue)
print("Average Revenue per Transaction:", avg_revenue_per_tx)
```

```
Total Revenue: 9539484.634
Average Revenue per Transaction: 331.0481896862854
```

```
#Q4. Monthly Sales Trend
# Extract Year-Month
df["Month"] = df["InvoiceDate"].dt.to_period("M")
#.dt Pandas datetime accessor (used only with datetime columns).
#.to_period("M") Converts each date into a monthly period (YYYY-MM).

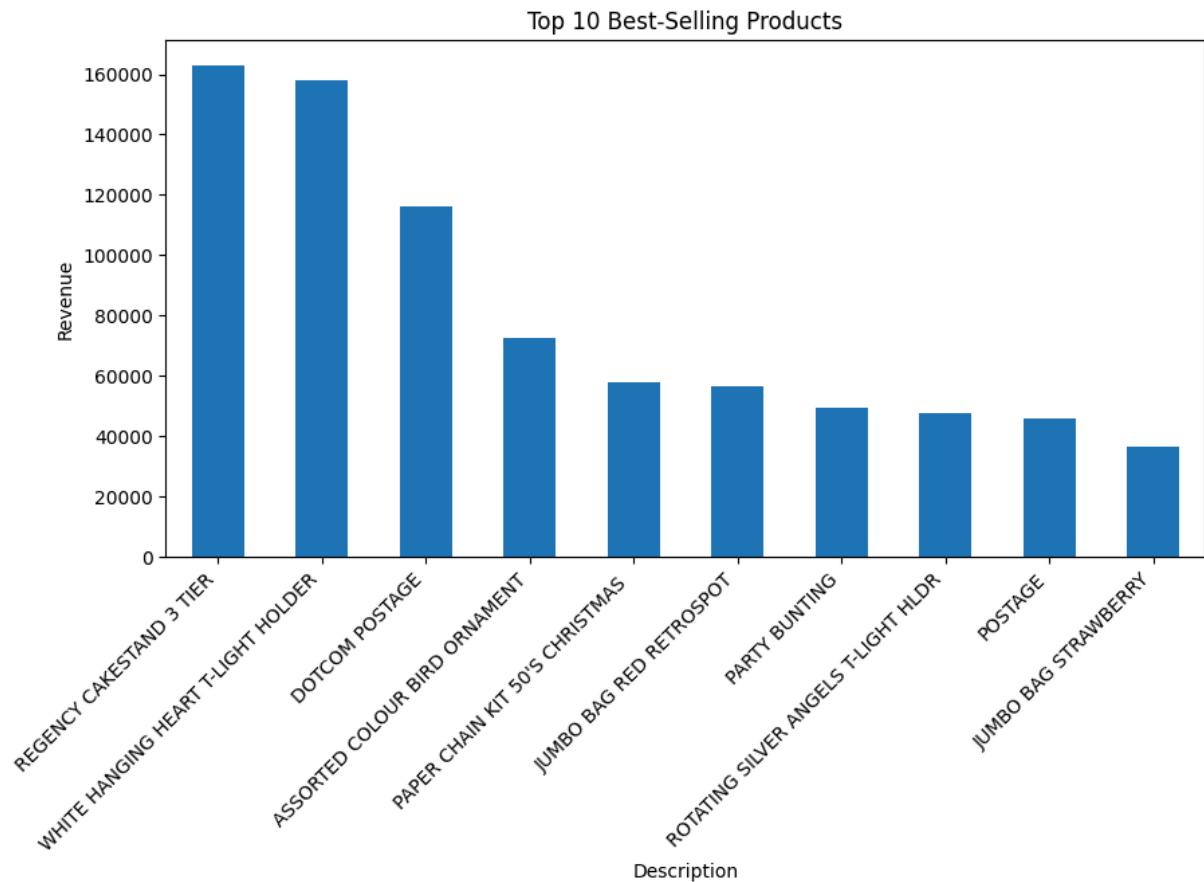
monthly_sales = df.groupby("Month")["TotalPrice"].sum()

# Plot
plt.figure(figsize=(10,5))
monthly_sales.plot()
plt.title("Monthly Sales Trend")
plt.xlabel("Month")
plt.ylabel("Total Revenue")
plt.show()
```



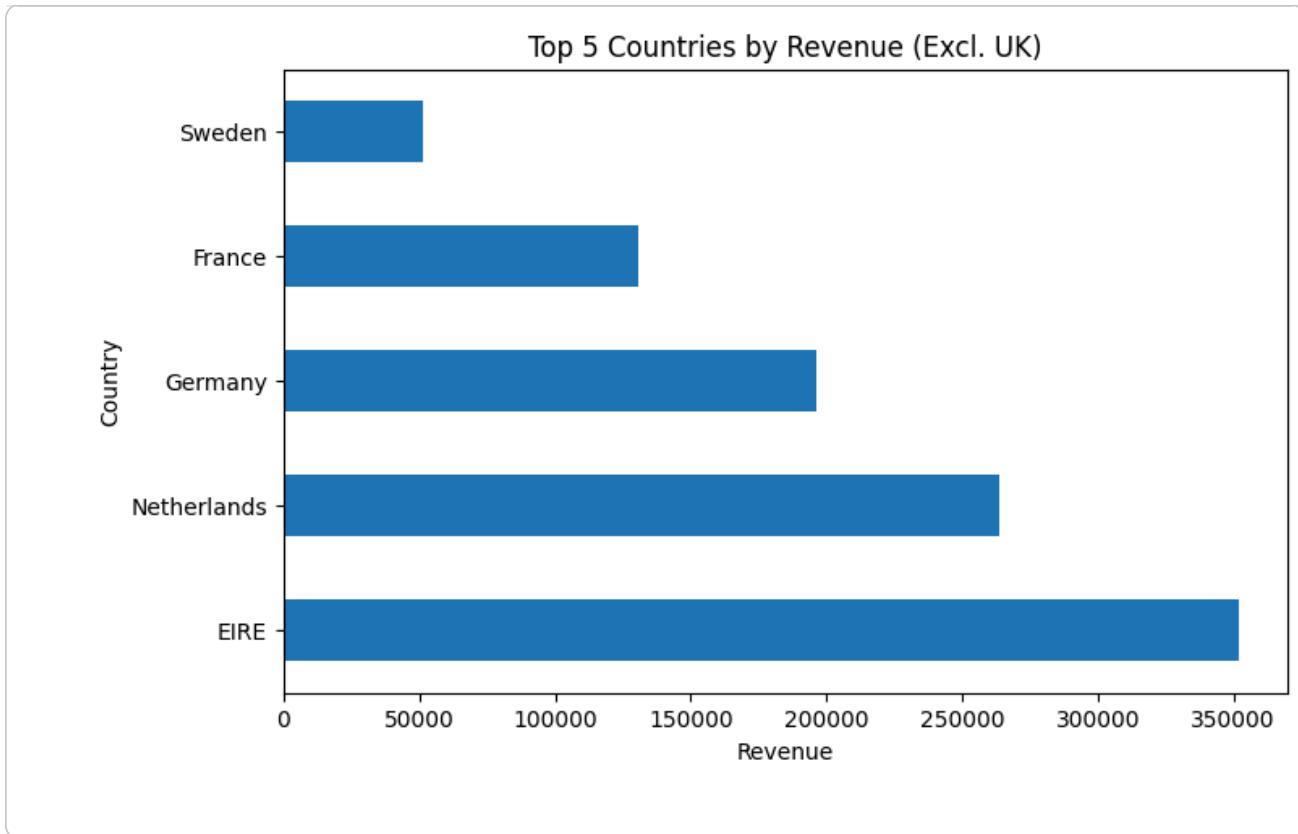
```
#Q5. Top 10 Best-Selling Products
top_products = (
    df.groupby("Description")["TotalPrice"]
    .sum()
    .sort_values(ascending=False)
    .head(10)
)

plt.figure(figsize=(10,5))
top_products.plot(kind="bar")
plt.title("Top 10 Best-Selling Products")
plt.ylabel("Revenue")
plt.xticks(rotation=45, ha="right")
plt.show()
```



```
#Q6. Country-Wise Sales (Excluding UK)
country_sales = (
    df[df["Country"] != "United Kingdom"]
    .groupby("Country")["TotalPrice"]
    .sum()
    .sort_values(ascending=False)
    .head(5)
)

plt.figure(figsize=(8,5))
country_sales.plot(kind="barh")
plt.title("Top 5 Countries by Revenue (Excl. UK)")
plt.xlabel("Revenue")
plt.show()
```



```
#Q7. Customer Behavior Analysis
# Unique customers
unique_customers = df["Customer ID"].nunique()
print("Unique Customers:", unique_customers)

# Top 5 customers by spend
top_customers = (
    df.groupby("Customer ID")["TotalPrice"]
    .sum()
    .sort_values(ascending=False)
    .head(5)
)

print("\nTop 5 Customers by Purchase Amount:")
print(top_customers)

# Average spend per customer
avg_spend_customer = (
    df.groupby("Customer ID")["TotalPrice"].sum().mean()
)

print("\nAverage Spend per Customer:", avg_spend_customer)
```

Unique Customers: 4383

Top 5 Customers by Purchase Amount:

Customer ID	Total Price
18102.0	341776.73
14646.0	243853.05
14156.0	183180.55
14911.0	137675.91
13694.0	128172.42

Name: TotalPrice, dtype: float64

Average Spend per Customer: 1904.679117955738

```
#Q8. Month-on-Month Growth Rate (NumPy)
monthly_df = monthly_sales.reset_index()
monthly_df["TotalPrice"] = monthly_df["TotalPrice"].astype(float)

# Percentage growth
monthly_df["MoM_Growth_%"] = (
    monthly_df["TotalPrice"].pct_change() * 100
)

print(monthly_df)
```

	Month	TotalPrice	MoM_Growth_%
0	2009-12	799847.110	NaN
1	2010-01	624032.892	-21.980978
2	2010-02	533091.426	-14.573185
3	2010-03	765848.761	43.661804
4	2010-04	590580.432	-22.885501
5	2010-05	615322.830	4.189505
6	2010-06	679786.610	10.476416
7	2010-07	575236.360	-15.379863
8	2010-08	656776.340	14.175039
9	2010-09	853650.431	29.975820
10	2010-10	1045168.350	22.435169
11	2010-11	1422654.642	36.117272
12	2010-12	377488.450	-73.465911

```
#Q9. Correlation Analysis
corr_matrix = df[["Quantity", "Price", "TotalPrice"]].corr()
#.corr() Computes the pairwise correlation coefficients between the columns

plt.figure(figsize=(6,4))
sns.heatmap(corr_matrix, annot=True, cmap="coolwarm")
plt.title("Correlation Heatmap")
plt.show()
```

