# Retail Sales and Customer Behavior Analytics

MSDS-632-M51: Big Data
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# Introduction

Retailers today collect vast amounts of data from POS systems, online platforms, and customer interactions. This project focuses on using Apache Spark, Pandas, and Matplotlib to analyze a real-world retail dataset for insights into product performance and customer behavior.

# Preview

Analyzed 500,000+ retail transactions (UCI Online Retail dataset)

Objectives and Goals: : Clean, transform, and analyze retail transaction data, understand customer behavior, sales trends, seasonal patterns

Technologies and Tools: Apache Spark, PySpark, Pandas, Matplotlib, SQLite, Google Colab

# Big Data Characteristics – 5Vs

Volume: 500k records – simulates mid-size retail platform

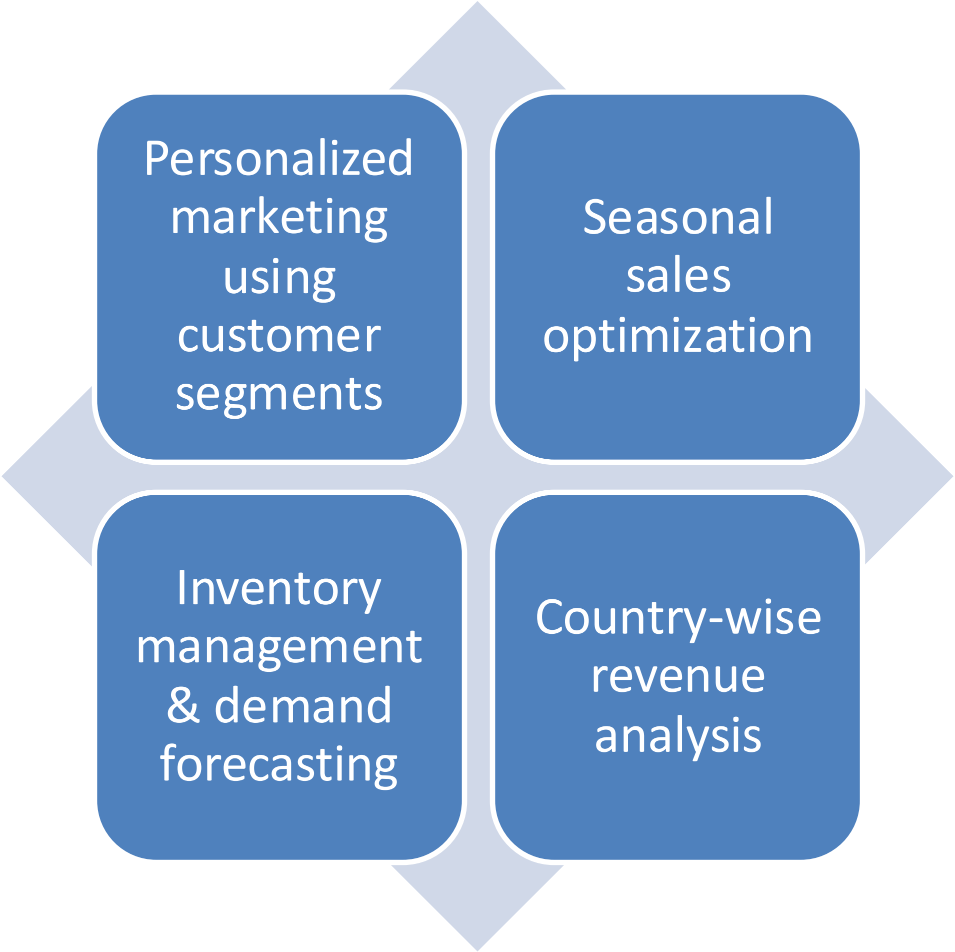
Velocity: Mimics real-time transaction flow

Variety: Structured fields (e.g., InvoiceNo, Date, Price)

Veracity: Data cleaning needed (nulls, returns)

Value: Insight into customer segments and sales drivers

# Business Goals & Drivers



Personalized marketing using customer segments

Seasonal sales optimization

Inventory management & demand forecasting

Country-wise revenue analysis

# Technical Architecture

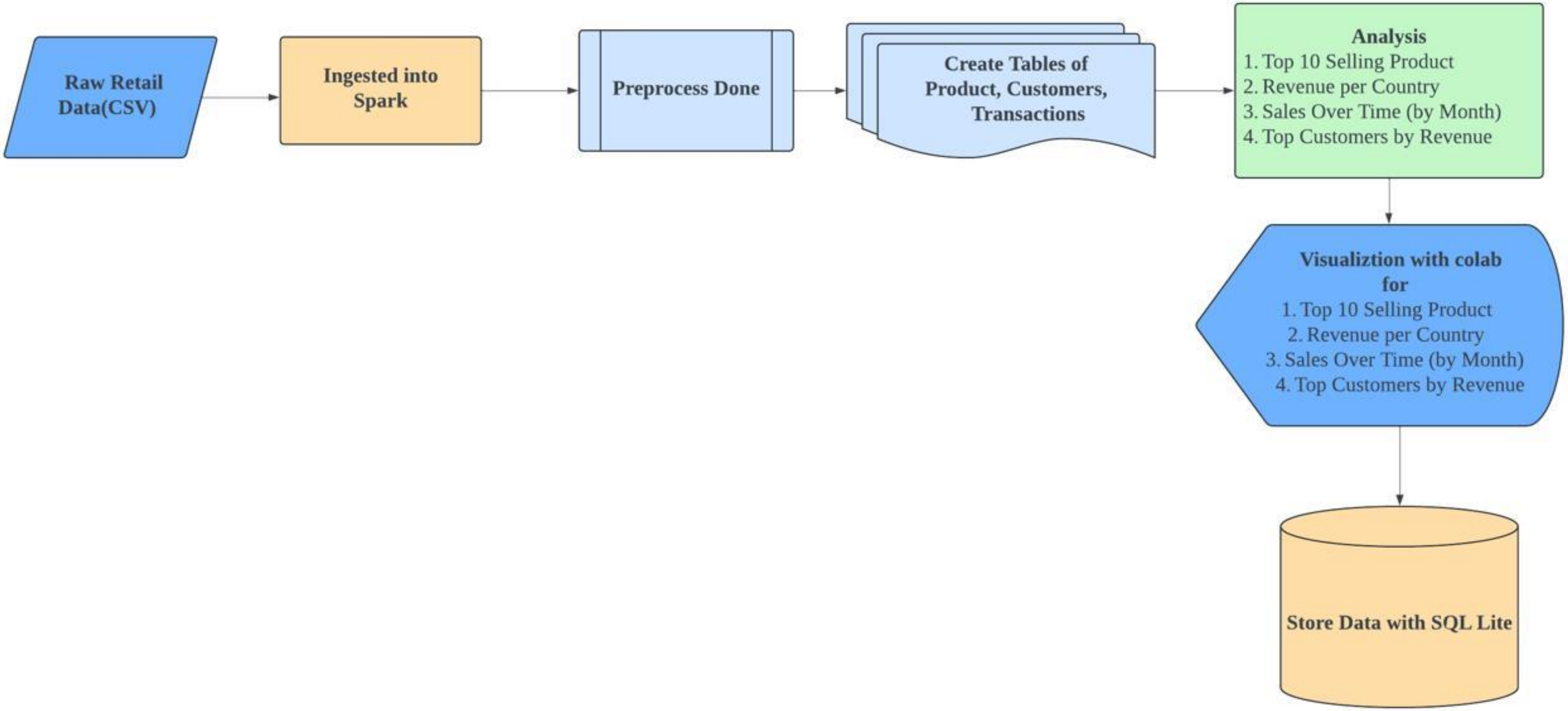
Foundation: Java 11, Spark 3.5.6, Winutils

Processing: Apache Spark (local mode), PySpark

Extension: Pandas, Matplotlib, Google Colab, SQLite

Seamless Spark–Python interoperability

# Architecture Diagram


Raw Retail Data(CSV)
Ingested into Spark
Preprocess Done
Create Tables of Product, Customers, Transactions
Analysis
1. Top 10 Selling Product
2. Revenue per Country
3. Sales Over Time (by Month)
4. Top Customers by Revenue
Visualiztion with colab for
1. Top 10 Selling Product
2. Revenue per Country
3. Sales Over Time (by Month)
4. Top Customers by Revenue
Store Data with SQL Lite

# Big Data Lifecycle

1. Business Case Evaluation

2. Data Identification (UCI Retail CSV)

3. Acquisition & Filtering (cleaning nulls, malformed entries)

4. Data Transformation (revenue metrics)

5. Analysis (top products/customers, time series)

6. Visualization (line, bar, histograms)

7. Interpretation & Deployment (SQLite storage)

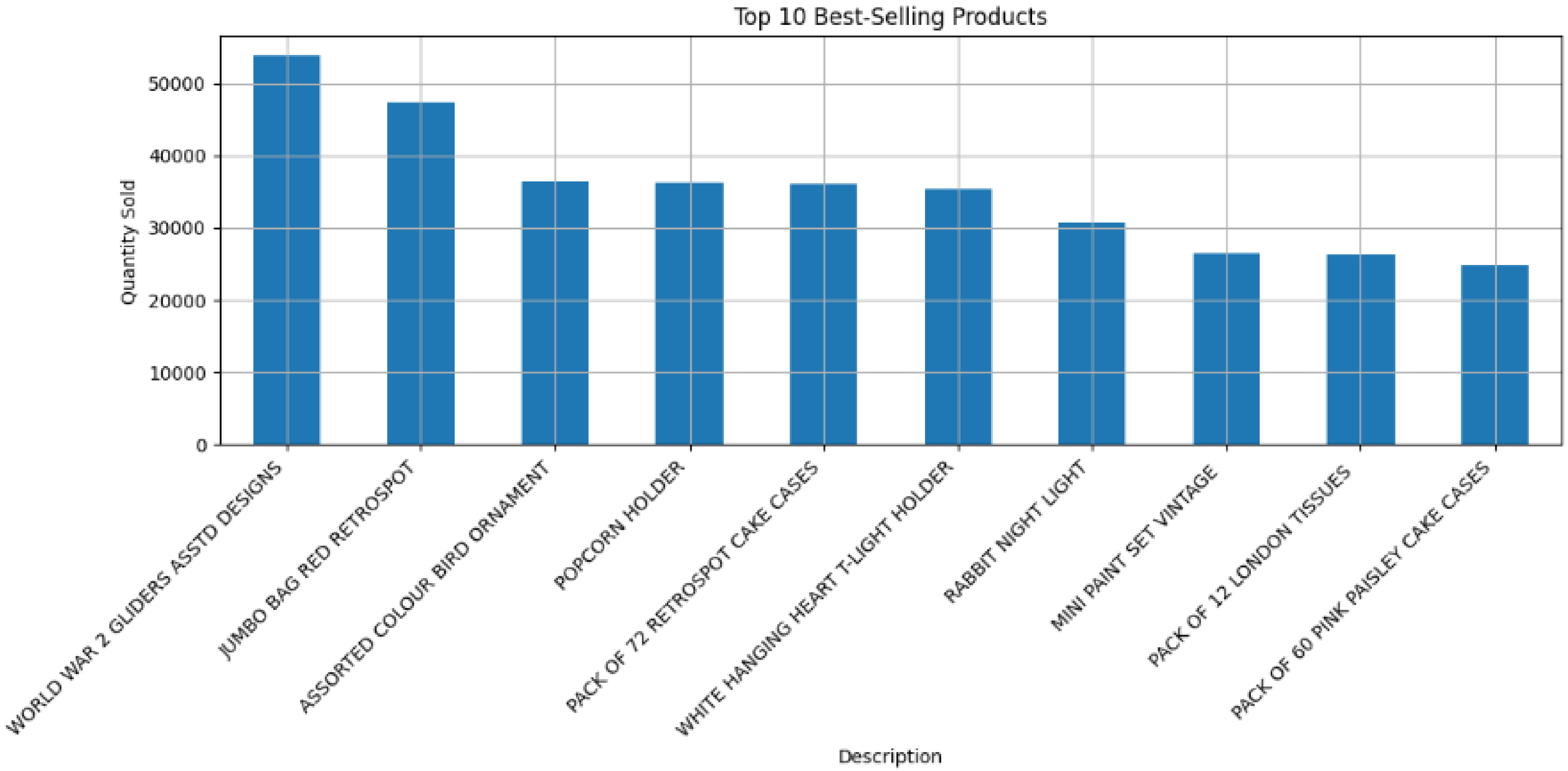
# Key Analysis & Results

- Top 10 Selling Products by Quantity
- Total Revenue by Country
- Sales Trend by Month (Total Quantity)
- Top Customers by Revenue

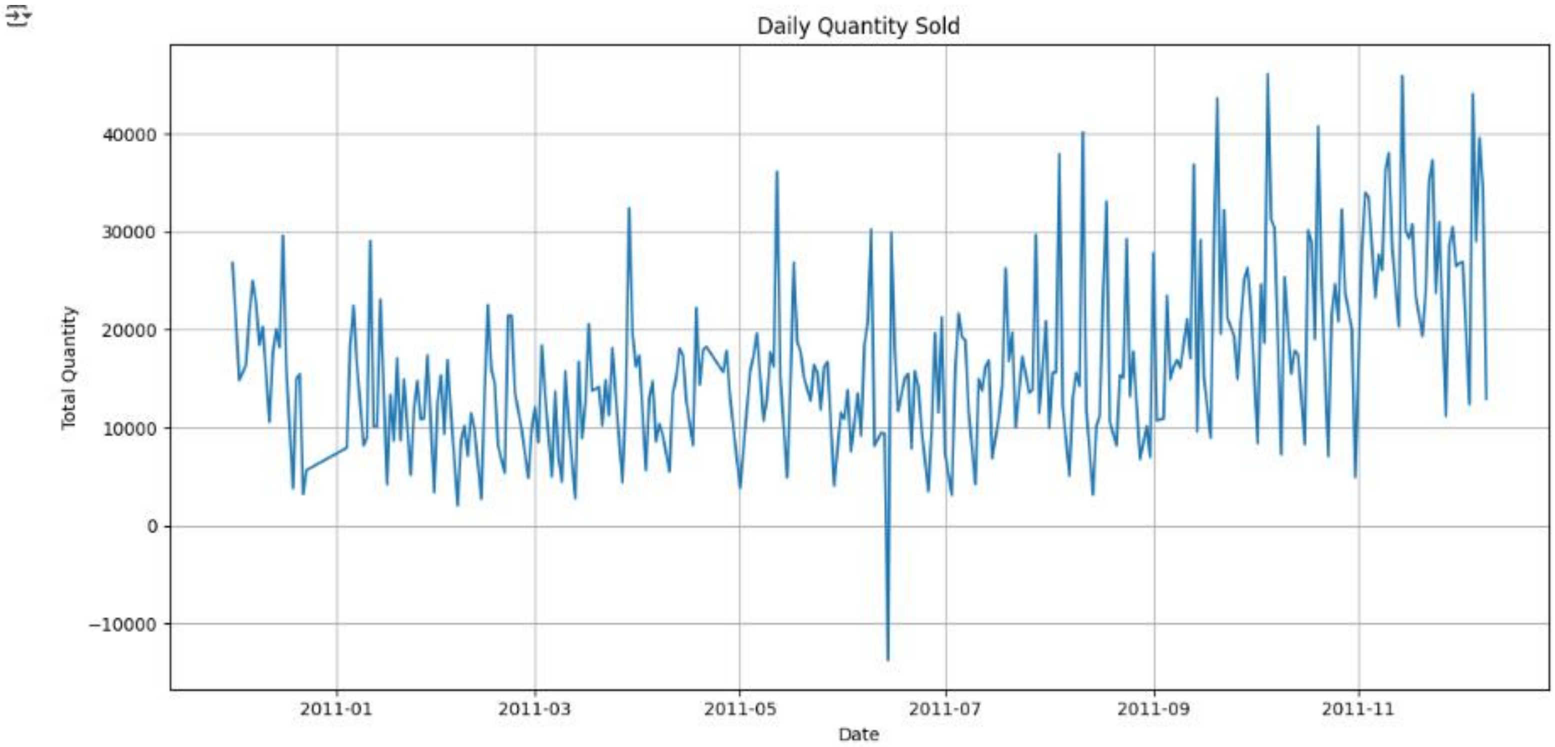
# SQLite + Pandas Visualizations

- Daily Quantity Sold (Line Chart)
- Top 10 Products by Quantity (Bar Chart)
- Top Countries by Revenue (Bar Chart)
- Customer Revenue Distribution (Histogram)

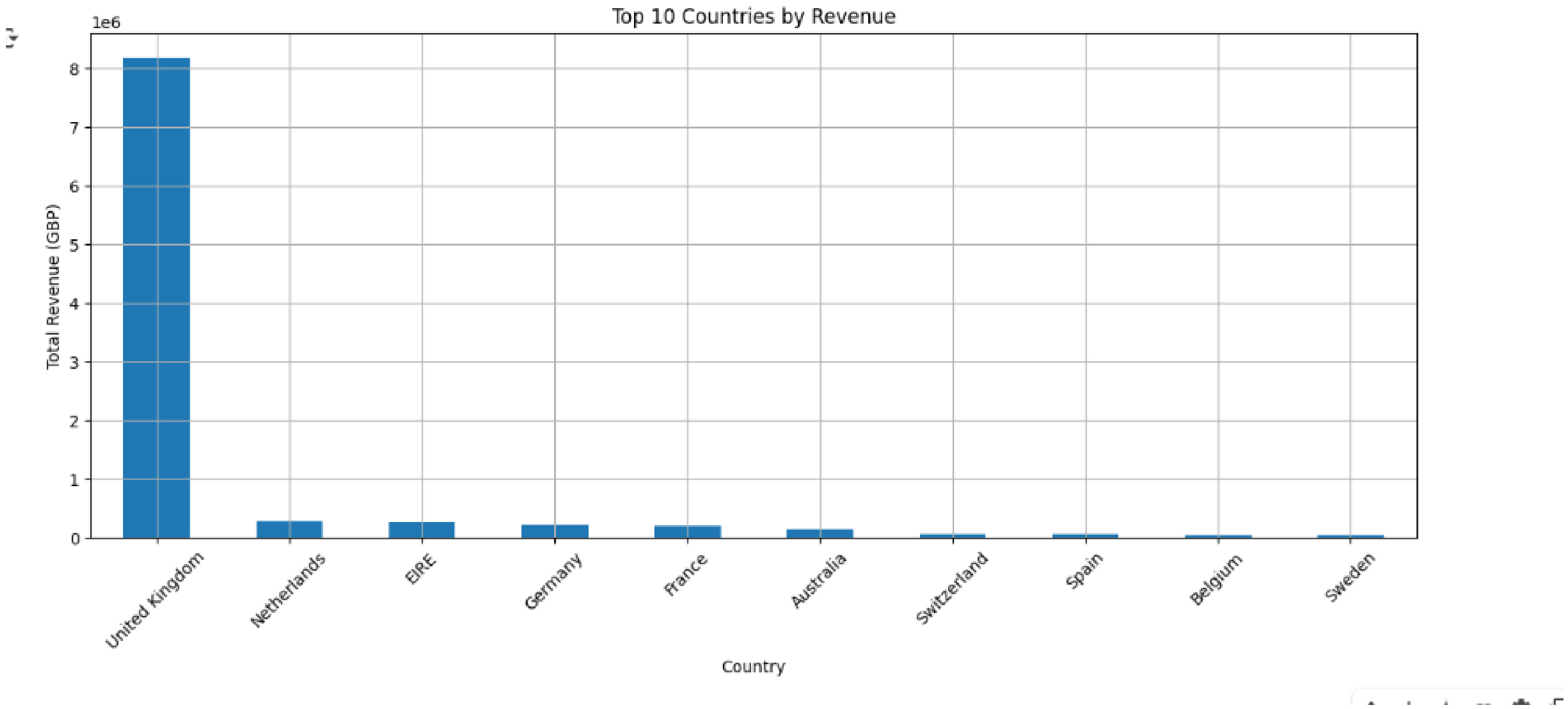
# Top 10 Best-Selling Products



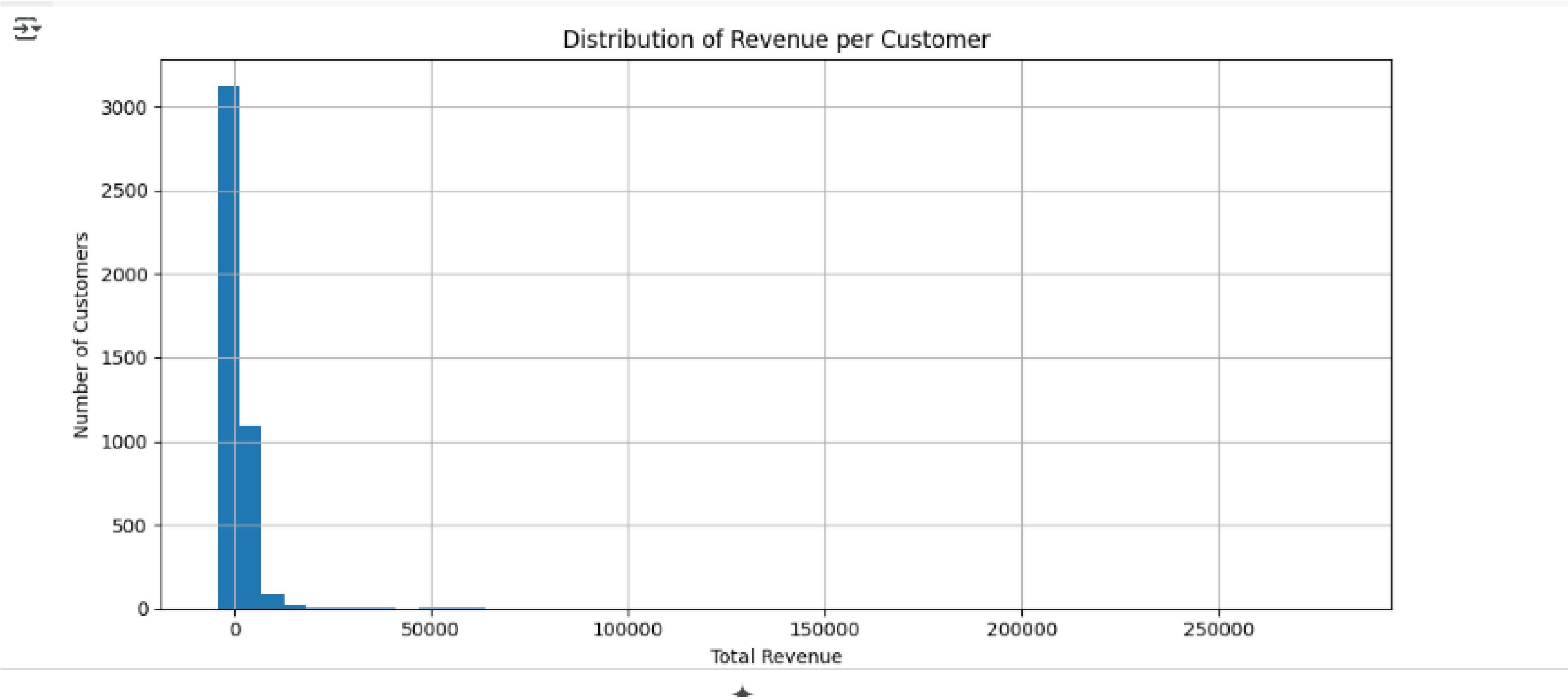
# Daily Quality Sold



# Top 10 Countries by Revenue



# Distribution of Revenue per Customer



# Key Takeaways

- Spark enables scalable data processing
- Revenue and sales insights easily derived
- Visualizations help communicate data trends
- Retail analytics is effective for customer behavior insights

# Challenges Faced in the Project

- **Data Volume**: Retail dataset with 500k+ rows.
- **Data Quality**: Missing values and product returns required cleaning.
- **Infrastructure Setup**: Spark installation and JVM/winutils configuration were time-consuming.
- **Tool Interoperability**: Data needed to be transferred between Spark and Pandas.
- **Visualization Accuracy**: Ensuring proper time intervals and avoiding clutter in Matplotlib.
- **Performance**: Pandas DataFrames had performance issues with large volumes.
- **Learning Curve**: Required skills in Scala, SQL, and Python.

# Technologies Used

Apache Spark – Distributed data processing

PySpark – Python API for Spark

Pandas – Exploratory data analysis

SQLite – Lightweight relational storage

Matplotlib – Data visualization

Google Colab – Cloud collaboration

# Conclusion

Effective hybrid workflow (Spark + Python)

Real-time business use cases simulated

Big Data tools helped uncover actionable insights

Skills gained: Spark setup, lifecycle management, visualization

# References

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