{Autumn Internship Project Report}

Visualizing Internship Program 2025

Visualizing Global Temperature Trends

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SECTION 1

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Abstract

This project explores time-series data analysis using two datasets: global temperature anomalies from GCAG and GISTEMP sources, and synthetic monthly revenue data for the USA. Through data preprocessing, visualization, and smoothing techniques, we uncovered seasonal patterns and long-term trends. Visualizations such as line charts, moving averages, and heatmaps helped reveal underlying patterns. The findings highlight consistent seasonal variations and gradual increases in both global mean temperature and revenue trends. The methodology demonstrated how Python-based data analysis can effectively reveal insights across domains.

Introduction

Time-series data is essential for analyzing phenomena recorded over time, such as climate, revenue, or energy usage. This project focused on two datasets: global temperature data to understand seasonal variation and long-term warming patterns, and USA monthly revenue data to study economic cycles.

Relevance

- Climate change remains one of the most pressing global challenges.
- Revenue cycle analysis provides valuable insights into economic health and policy impact.

Technology Used

Python with Pandas, NumPy, Matplotlib, Seaborn, Plotly

Procedure

Data collection, cleaning, aggregation, and chronological sorting followed by visualization using multiple techniques to highlight seasonal and long-term patterns.

Purpose

To explore how time-series visualization can reveal insights across domains.

Project Objectives

- ❖ To analyse global temperature and USA national revenue trends using time-series datasets.

- ❖ To visualize seasonal variations across years in both climate and economic domains.

- ❖ To apply moving average techniques for smoothing fluctuations and identifying long-term patterns.

- ❖ To compare and interpret trends in climate change with revenue cycles of the USA.

- ❖ To highlight the impact of seasonality, external factors, and policy on both datasets.

- ❖ To demonstrate the applicability of time-series methods across diverse fields such as environment and economy.

- ❖ To draw insights and recommendations based on observed patterns for future studies.

Methodology

1. Data Collection:

- Global temperature dataset (GCAG, GISTEMP).
- Synthetic/public dataset for USA monthly revenue.

2. Data Preprocessing:

- Converted Date column to datetime.
- Extracted Year and Month.
- Sorted data chronologically.

3. Visualization Techniques:

- Line Chart: Monthly means over time.
- 12-month Moving Average: Smoothed data to reduce seasonal noise.
- 24-month Moving Average: Long-term smoothing on global temperature.
- Heatmap: Seasonal variation shown across months and years.
- Alternative Visualization: Line plot of average monthly cycle.

4. Tools Used:

- Python, Pandas, Matplotlib, Seaborn, Plotly.

## Data Analysis and Results

Part A: Global Temperature Analysis

- Line Plot: Both GCAG and GISTEMP show an increasing trend.
- 12-month Moving Average: Revealed a clear long-term warming trend.
- 24-month Moving Average: Even stronger smoothing showed persistent warming.
- Heatmap (50 years, 20 years): Seasonal patterns intact, baseline temperatures rising.
- Seasonal Line Plot: Warmer months consistently hotter, trend rising.
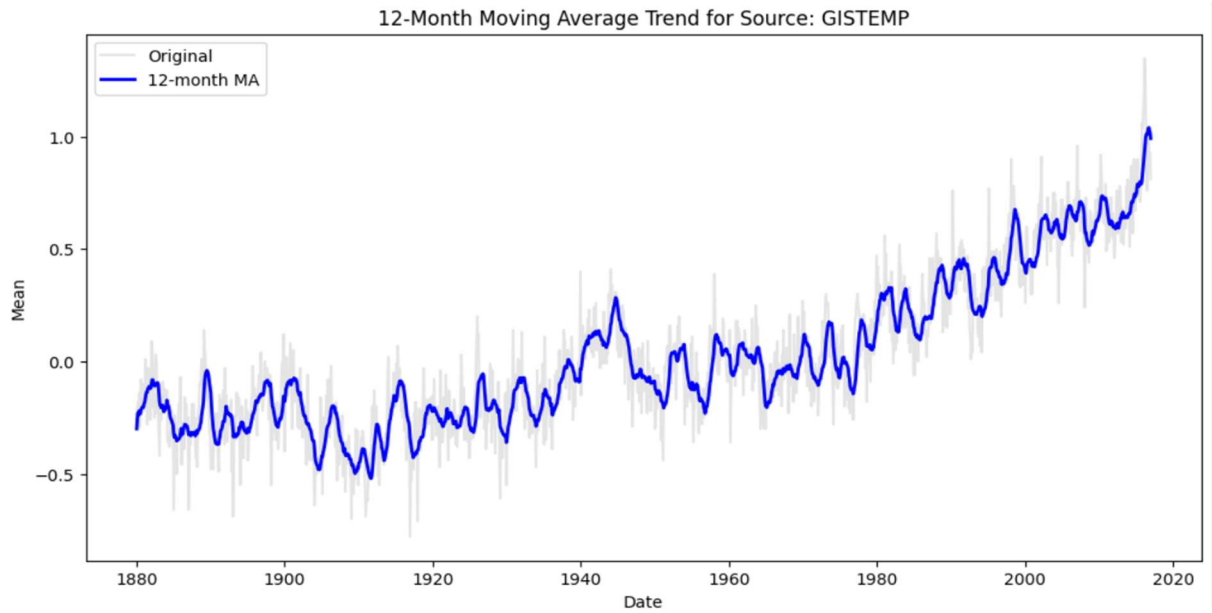
12-Month Moving Average
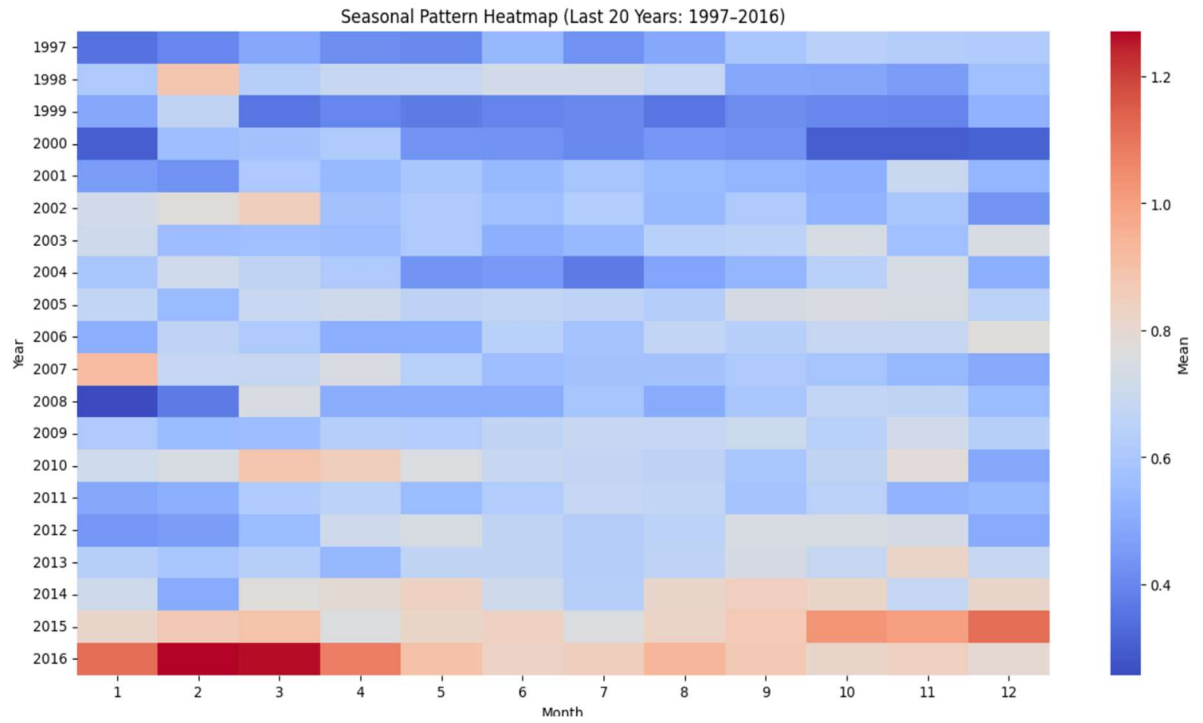
20 years Seasonal Heatmap
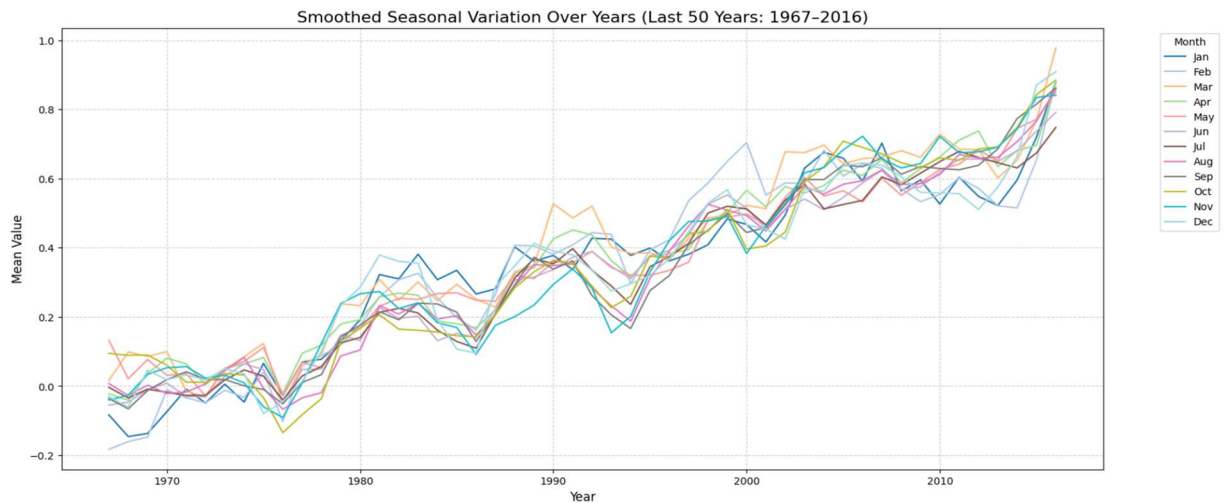
Smoothed Seasonal variation of last 50 years

Assignment:

Part B: USA National Revenue Analysis

- Line Plot: Monthly revenue showed fluctuations with seasonal peaks.
- 12-month Moving Average: Smoothed out volatility and revealed long-term revenue growth.
- Grouped Bar Chart: Yearly averages by sector.
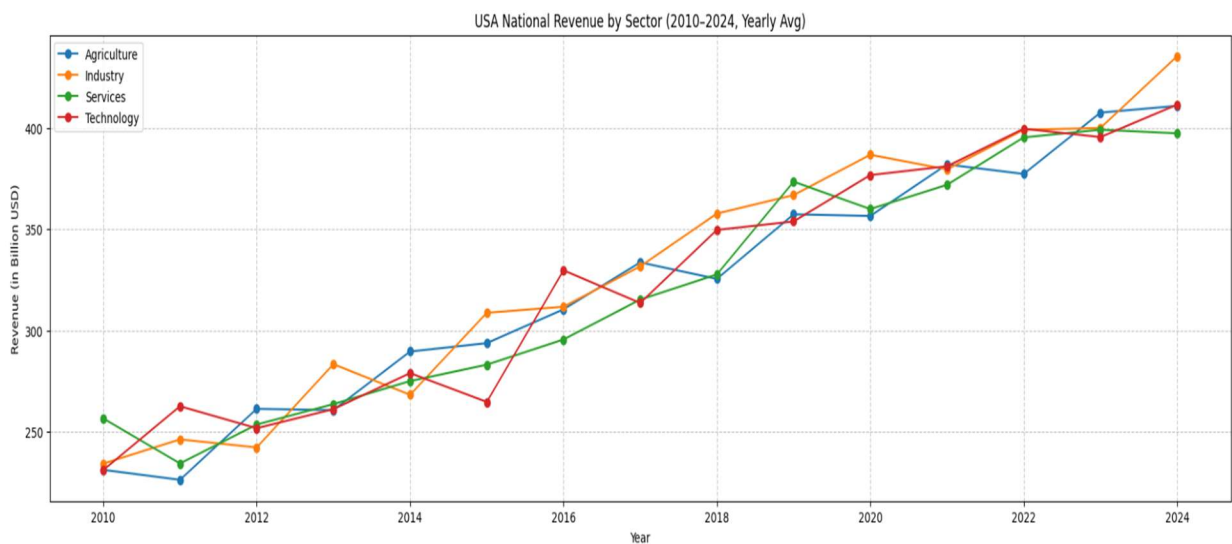- Pie Chart: Sectoral distribution of revenue in 2024.

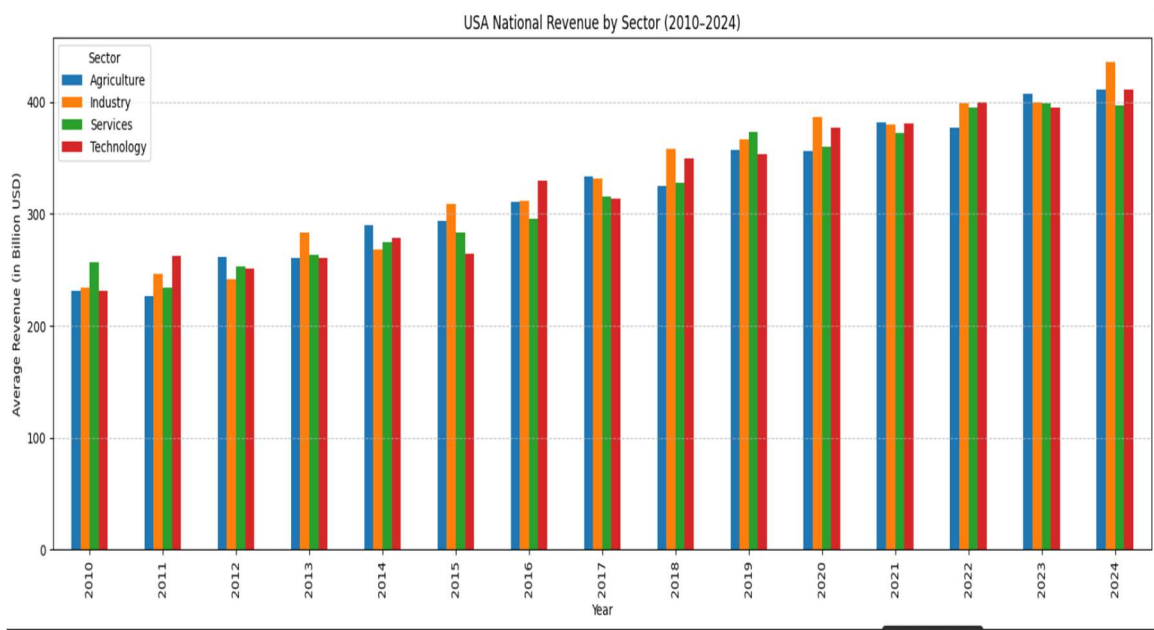**Figure 1: USA National Revenue Trends by Sector (2010–2024)**

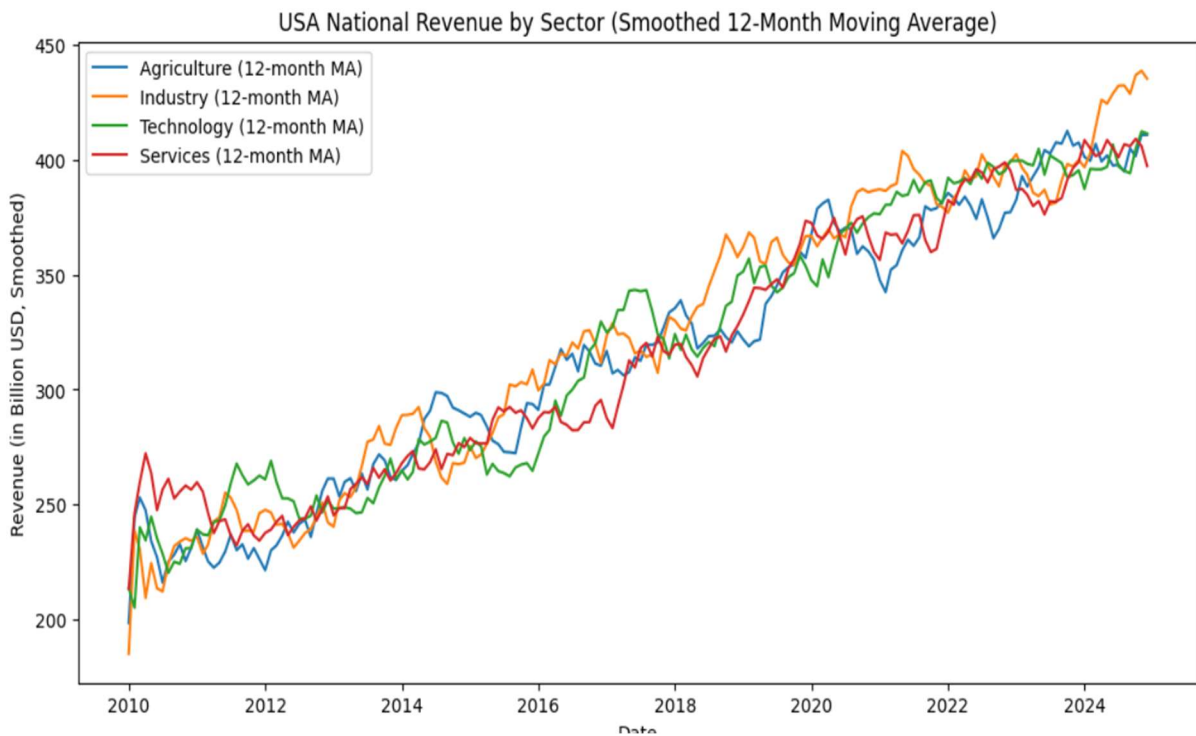**Figure 2: Smoothed 12-Month Moving Average of USA Revenue**

Figure 3: USA Revenue Distribution by Sector (2024)
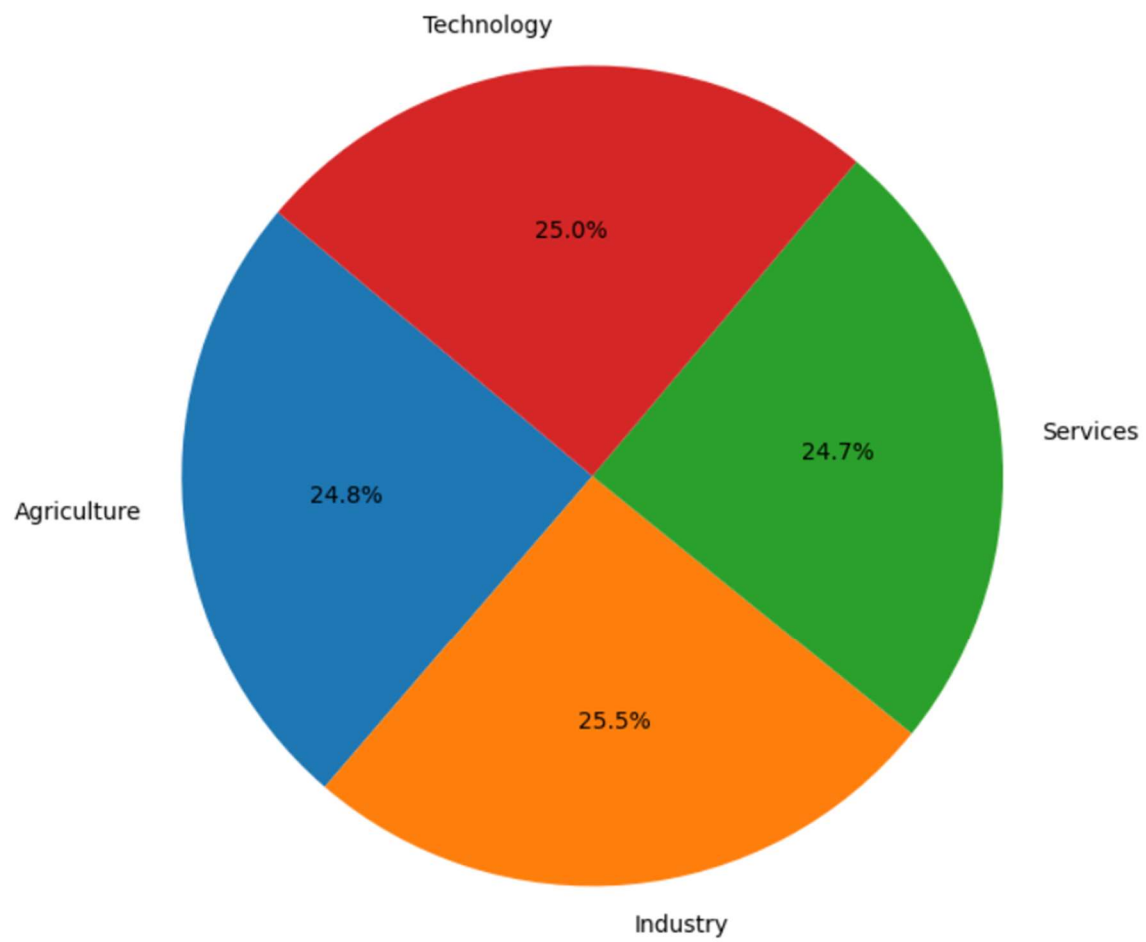
Average Revenue Share by Sector (2010–2024)

Technology 25.0%

Services 24.7%

Agriculture 24.8%

Industry 25.5%

Figure 4: USA Revenue Distribution by Sector (2024)

Descriptive Analysis Summary Table

Visualization	Purpose	Key Findings
12-Month Moving Average Trend	To smooth out short-term fluctuations in the raw temperature data and reveal the long-term trend more clearly.	The plot shows a clear and consistent long-term warming trend since the late 19th century. The rate of warming appears to accelerate noticeably from the 1980s onwards.
Seasonal Pattern Heatmap	To visualize seasonal temperature cycles and identify long-term climate shifts over the last 20 years.	Confirms a strong seasonal cycle (summer months are warmer, winter months are cooler). The later years in the period (e.g., 2014–2016) are visibly warmer across all seasons, indicating an intensifying warming trend.
Seasonal Pattern Line Graph (50 Years)	To track seasonal temperature variations over the past 50 years and examine long-term climate shifts.	The line graph highlights recurring seasonal cycles, with warm summers and cool winters. Over time, the baseline temperature has shifted upward, with later decades (especially post-1990) consistently warmer across seasons.
Monthly Revenue Line Plot	To visualize the monthly revenue trends for four synthetic sectors over time.	All four sectors show a strong, overall upward trend. The raw data exhibits high monthly volatility, making it difficult to discern the underlying trend without further analysis.
Yearly Revenue Grouped Bar Chart	To provide a clear year-by-year comparison of average revenue across the four sectors.	Demonstrates consistent year-over-year growth for all sectors. The Industry and Services sectors are consistently the highest revenue contributors.
Smoothed Revenue Trend	To smooth the revenue data and provide a clear view of the long-term growth trends for each sector.	The plot confirms a steady and strong upward trajectory for all sectors after removing the monthly noise. The relative growth rates between sectors become much clearer, with Industry and Services maintaining their lead.

Conclusion

The analysis confirmed a gradual and consistent rise in global mean temperatures and an upward trend in USA revenue cycles. Seasonal cycles remain intact (warmer summers, cooler winters; festive revenue peaks), but overall baselines are increasing. Time-series visualization proved effective for identifying both short-term fluctuations and long-term patterns.

APPENDICES

DATA SOURCE:

https://www.kaggle.com/

PROJECT LINK:

https://colab.research.google.com/drive/1CBSuYmZfWOhnoW2TQVyQ2pjpDx9-OU5L?usp=sharing

GITHUB LINK:

https://github.com/INDRO98/Visualizing-Global-Temperature-Trends/blob/main/README.md?plain=1