{AUTUMN INTERNSHIP PROJECT REPORT FORMAT}

-:Time Series Analysis of Global Historical Temperatures:-

DIPASHREE SURAI

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ABSTRACT

This study investigates long-term patterns in global city-level temperature records using historical data from 1743 onwards. The dataset includes monthly average temperatures, uncertainty margins, and geographical details across multiple cities worldwide. Employing time series analysis, the project explores historical climate variability, identifies seasonal trends, and examines long-term warming patterns. The results provide empirical evidence of global temperature changes and highlight the importance of data-driven approaches in climate research.

INTRODUCT

Climate change and global warming have become pressing issues for contemporary societies. Understanding temperature trends at a city level provides critical insights into localized climatic variations that contribute to broader environmental challenges. Historical temperature records serve as a valuable source for analyzing long-term climatic trends, seasonal fluctuations, and anomalies. This project employs a historical temperature dataset to analyze time series behavior, detect patterns, and evaluate climate shifts over time.

PROJECT OBJECTIVES

The primary objectives of this project are:

- To analyze historical city-level temperature data spanning multiple centuries.
- To identify long-term warming or cooling trends using statistical and visual methods.
- To examine seasonal and cyclical fluctuations within the dataset.

- To provide evidence-based insights into climate variability and its implications.

METHODOLOGY

The study follows a systematic methodology:

1. **Data Collection:**
   - The dataset, "TIME SERIES FOR IDEAS.csv," includes monthly temperature data with fields such as date, temperature, uncertainty, city, country, latitude, and longitude.
2. **Data Preprocessing:**
   - Handled missing values in temperature observations.
   - Standardized date formats for time series indexing.
   - Filtered subsets of data for city-level and country-level analysis.
3. **Exploratory Data Analysis (EDA):**
   - Generated descriptive statistics of temperature records.
   - Visualized trends through line plots, seasonal decomposition, and moving averages.
4. **Time Series Analysis:**
   - Examined long-term trends using rolling averages.
   - Investigated seasonality patterns using decomposition methods.
   - Evaluated anomalies and abrupt changes in historical data.
5. **Tools and Software:**
   - Python libraries: Pandas, Matplotlib, Seaborn, Statsmodels.
   - Jupyter Notebook for implementation and documentation.

5. DATA ANALYSIS AND RESULTS

- **Trend Analysis:**
  The dataset reveals an overall warming trend, particularly evident from the mid-20th century onwards. Average global city temperatures show a significant upward trajectory, consistent with global climate change studies.
- **Seasonality:**
  Seasonal decomposition indicates regular annual cycles in temperature values, with colder winters and warmer summers evident across cities in temperate regions.
- **Anomalies:**
  Periods with abnormal deviations (e.g., extreme cold spells in the 18th–19th centuries) are observed, possibly linked to volcanic activity or measurement uncertainties.
- **Geographical Variation:**
  City-specific comparisons highlight that regions at higher latitudes exhibit greater variability in temperatures, whereas equatorial regions remain relatively stable.
- **Uncertainty Margin:**
  Earlier records display higher uncertainty, reflecting limitations in historical measurement techniques. In contrast, modern records show improved accuracy.

CONCLUSION

The analysis confirms that historical city-level temperature data reflects clear evidence of long-term warming trends. Seasonal patterns remain consistent, while anomalies provide valuable insights into climatic disturbances. These findings support existing research on global warming and highlight the significance of historical temperature datasets in understanding climate dynamics. Policymakers, researchers, and environmentalists can utilize such analyses to strengthen climate change mitigation strategies.