Time Series Analysis

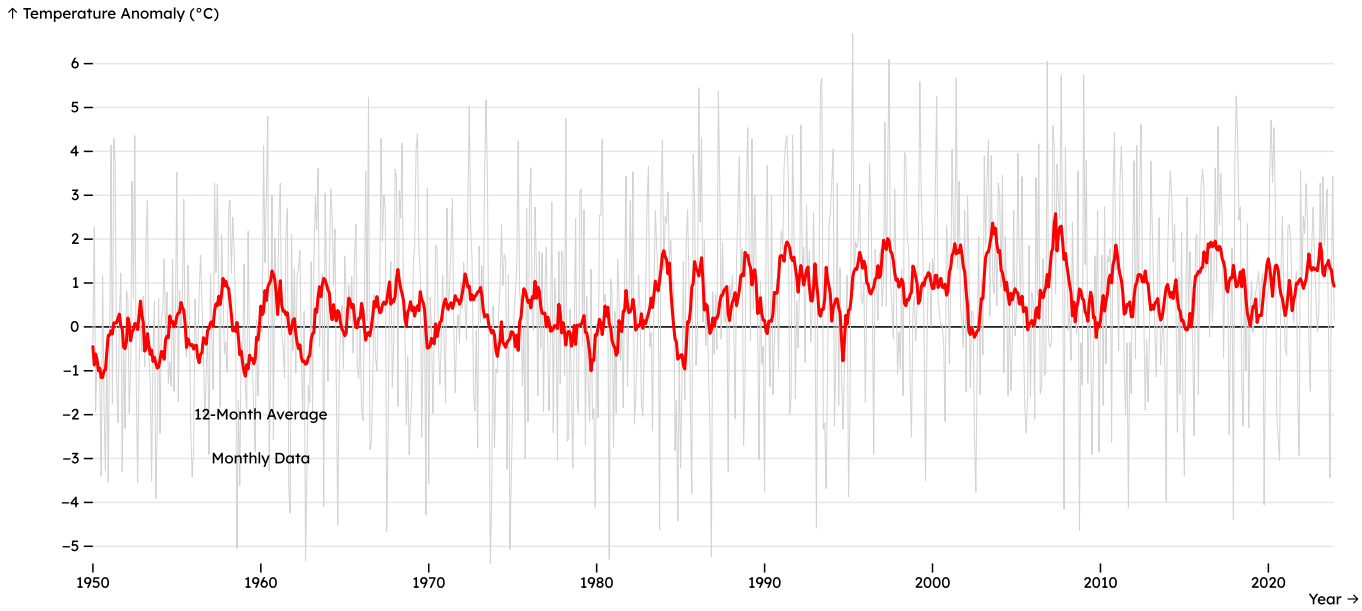
Time series data is ubiquitous in research, from economic indicators to climate measurements. This page demonstrates various techniques for analyzing and visualizing temporal data[1].

Climate Data Analysis

Temperature Anomalies Over Time

Global Temperature Anomalies (1950-2024)

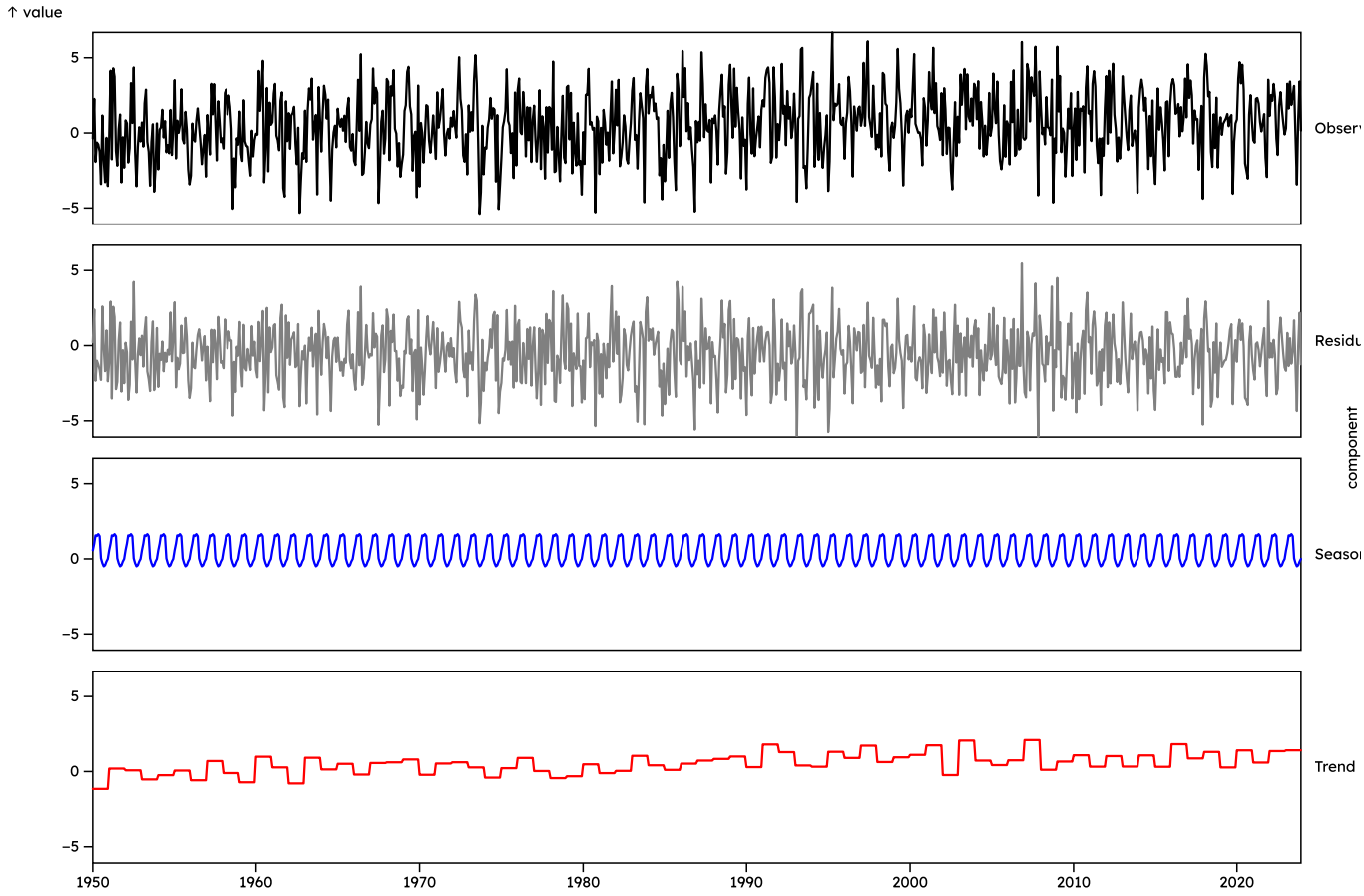
Monthly observations with 12-month moving average



Seasonal Decomposition

Time series often contain trend, seasonal, and irregular components[2]. Here we decompose the signal:

Seasonal Decomposition of Temperature Data

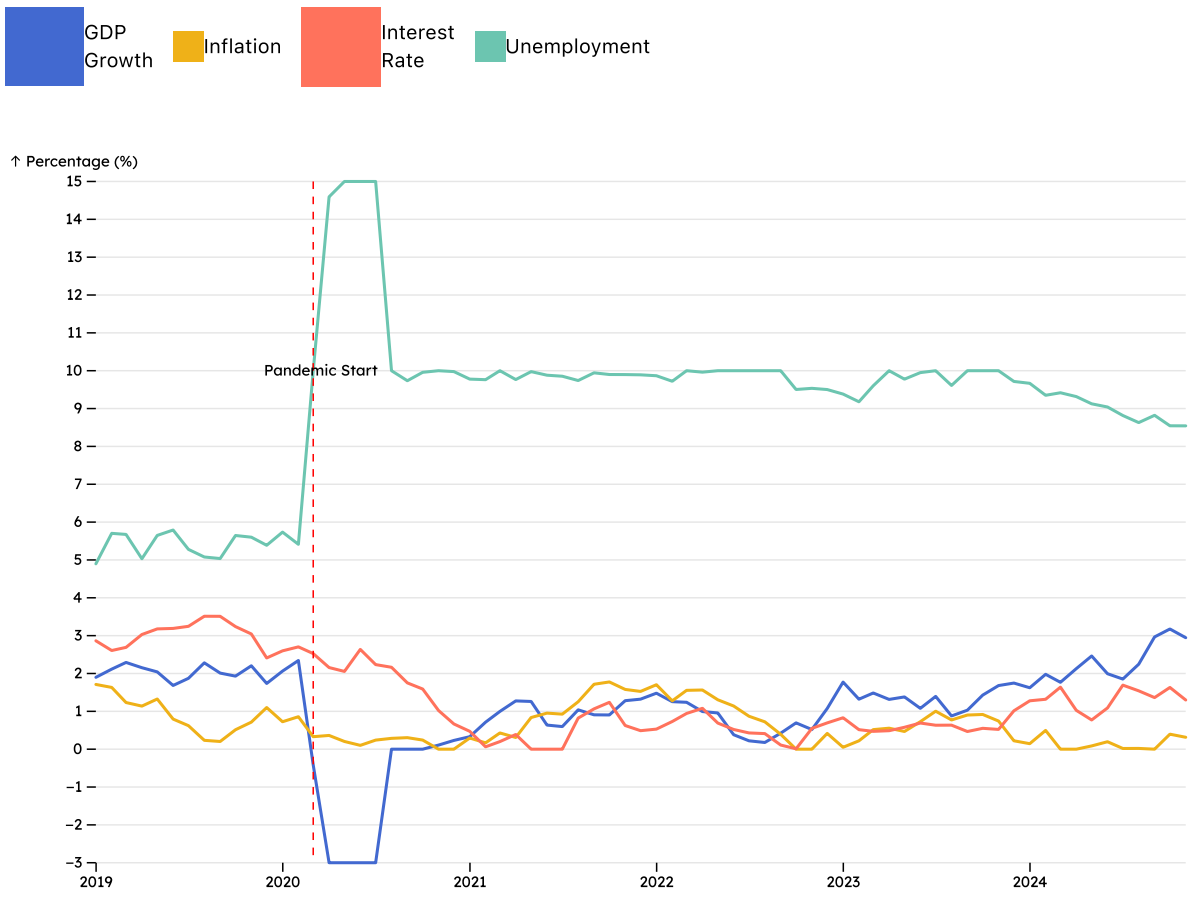


Economic Indicators

Multiple Time Series Comparison

Economic Indicators (2019-2024)

Comparing key economic metrics over time

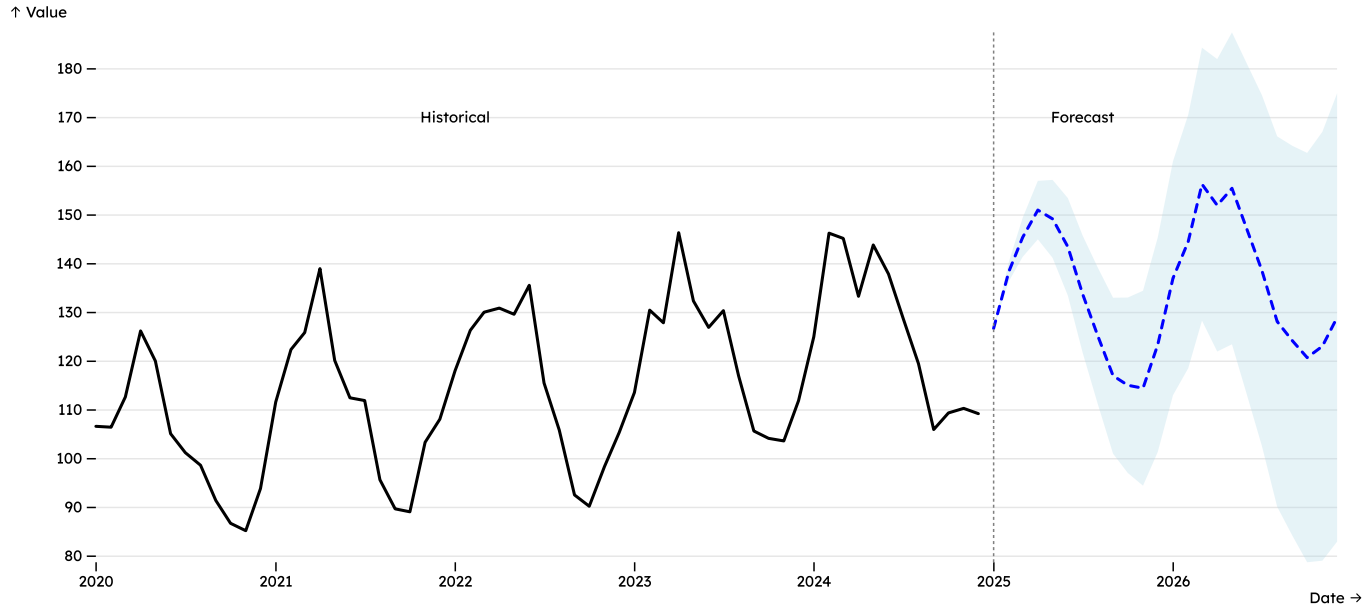


Forecasting

Time Series Forecasting with Confidence Intervals

Time Series Forecast with Prediction Intervals

24-month forecast with 95% confidence bands



Event Timeline

Using our custom Timeline component to show research milestones[3]:

```
TypeError: Timeline is not a function
```

Autocorrelation Analysis

ACF and PACF Plots

Autocorrelation helps identify patterns and dependencies in time series data[4].

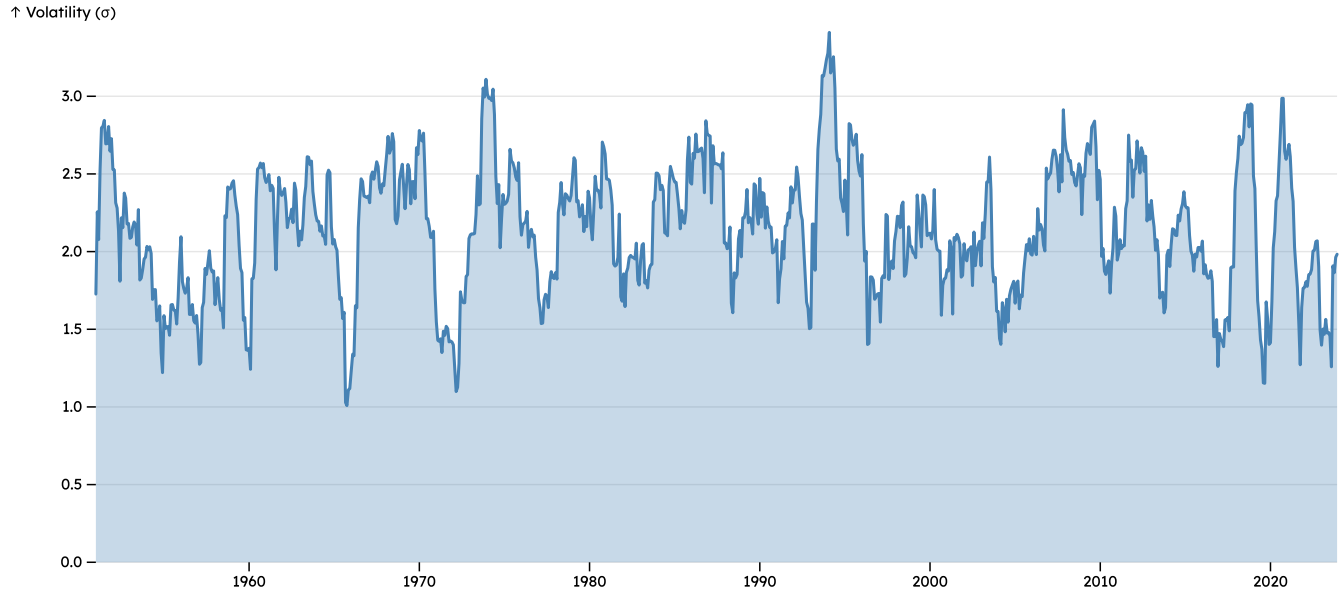
```
TypeError: Cannot use 'in' operator to search for 'length' in null
```

Volatility Analysis

Rolling Standard Deviation

Temperature Volatility Over Time

12-month rolling standard deviation

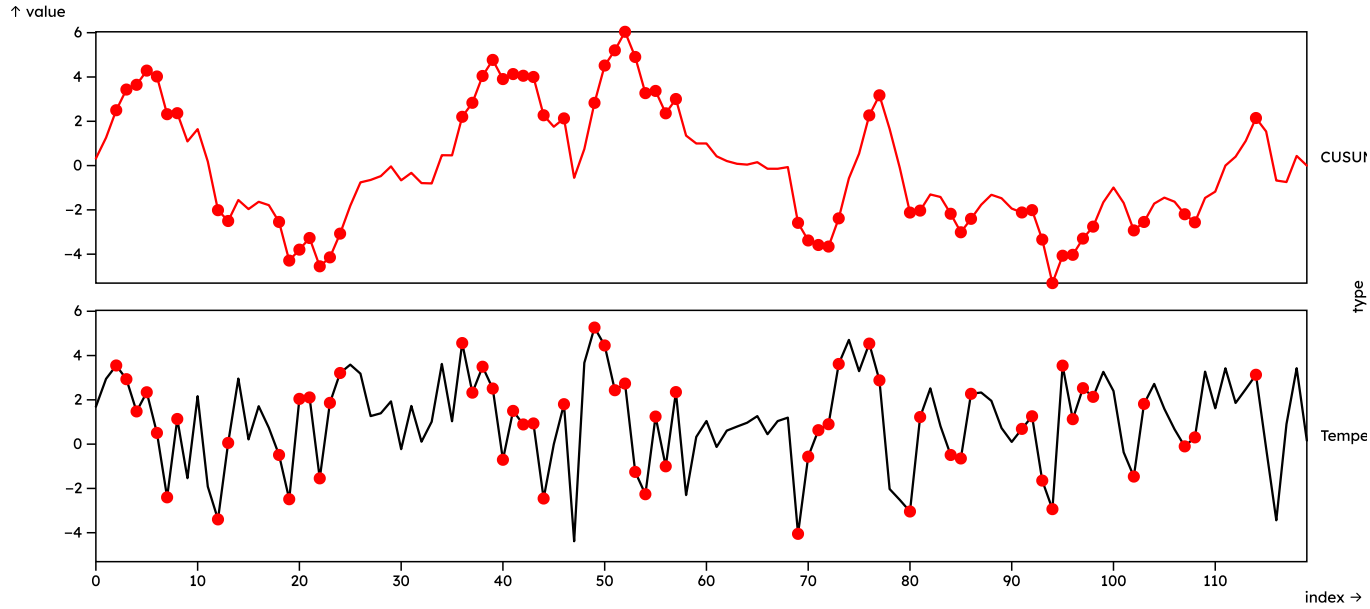


Change Point Detection

Identifying structural breaks in time series[5]:

Change Point Detection using CUSUM

Identifying structural breaks in the time series



Summary Statistics by Period

	Decade	Mean Temp	Std Dev	Min	Max	Trend
	1950s	-0.229	1.938	-5.052	4.358	-0.0008
	1960s	0.381	2.286	-5.326	5.237	0.0267
	1970s	0.120	2.138	-5.391	5.176	-0.0045
	1980s	0.507	2.240	-5.295	5.451	-0.0041
	1990s	0.962	2.268	-4.582	6.684	0.0315
	2000s	0.946	2.206	-4.640	6.051	-0.0369
	2010s	0.842	2.088	-4.385	5.264	0.0030
	2020s	1.195	2.014	-3.439	4.706	-0.0154

Methods and Applications

Time series analysis is crucial for understanding temporal patterns in data[6]. Key applications include:

1. **Climate Science**: Analyzing temperature trends and detecting climate change signals
2. **Economics**: Forecasting GDP, inflation, and market indicators
3. **Epidemiology**: Tracking disease spread and seasonal patterns
4. **Engineering**: Monitoring system performance and detecting anomalies

---

1. Time series analysis involves statistical techniques for analyzing time-ordered data points. Box, G.E.P., Jenkins, G.M., Reinsel, G.C., & Ljung, G.M. (2015). Time Series Analysis: Forecasting and Control (5th ed.). Wiley.
2. Seasonal decomposition separates a time series into trend, seasonal, and residual components. The STL (Seasonal and Trend decomposition using Loess) method is particularly robust. Cleveland, R.B., Cleveland, W.S., McRae, J.E., & Terpenning, I. (1990). STL: A seasonal-trend decomposition procedure based on loess. Journal of Official Statistics, 6(1), 3-73.
3. Timeline visualizations help communicate the temporal sequence of events in research projects. They are particularly useful for project management and presenting research progress to stakeholders.
4. The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) are essential tools for identifying the order of ARIMA models. Ljung, G.M., & Box, G.E.P. (1978). On a measure of lack of fit in time series models. Biometrika, 65(2), 297-303.
5. Change point detection identifies times when the statistical properties of a time series change. The CUSUM (Cumulative Sum) method is one of the simplest approaches. Page, E.S. (1954). Continuous inspection schemes. Biometrika, 41(1/2), 100-115.
6. For comprehensive coverage of modern time series methods, see: Hyndman, R.J., & Athanasopoulos, G. (2021). Forecasting: Principles and Practice (3rd ed.). OTexts. Available online at **https://otexts.com/fpp3/**