

TIME SERIES ANALYSIS

LECTURE 1

datascience@berkeley

Common Empirical Time Series Patterns

Pattern 1: Trend and Fluctuation Around the Trend

Example: Passenger bookings of an airline

Data:

- The number of passengers traveling on the airline increased with time (i.e., an increasing trend).
- The bookings behaved cyclically with some fixed time periods.
- The fluctuation increased over time.

Pattern to observe:

- Upward trend—a systematic dynamic in a time series that is not periodic.
- Seasonal effect—the seasonal effect is apparent in the box plot as well.

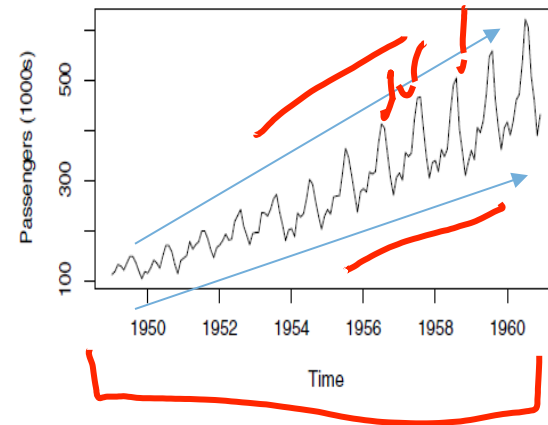
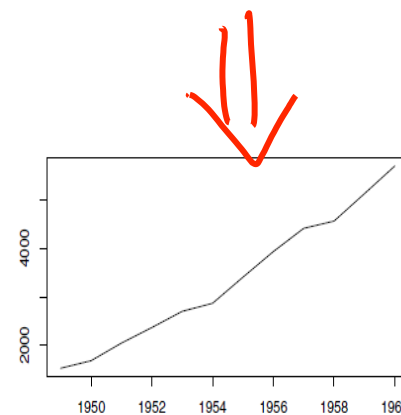
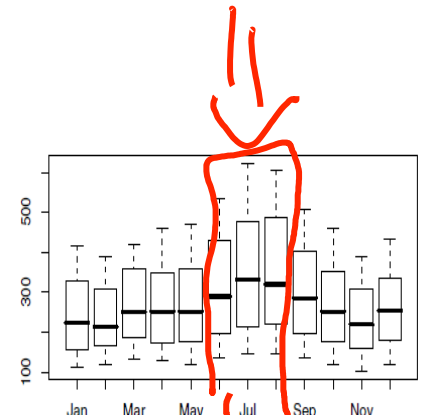


Fig. 1.1. International air passenger bookings in the United States for the period 1949–1960.



(a) Aggregated annual series



(b) Boxplot of seasonal values

Pattern 2: Change in Structure

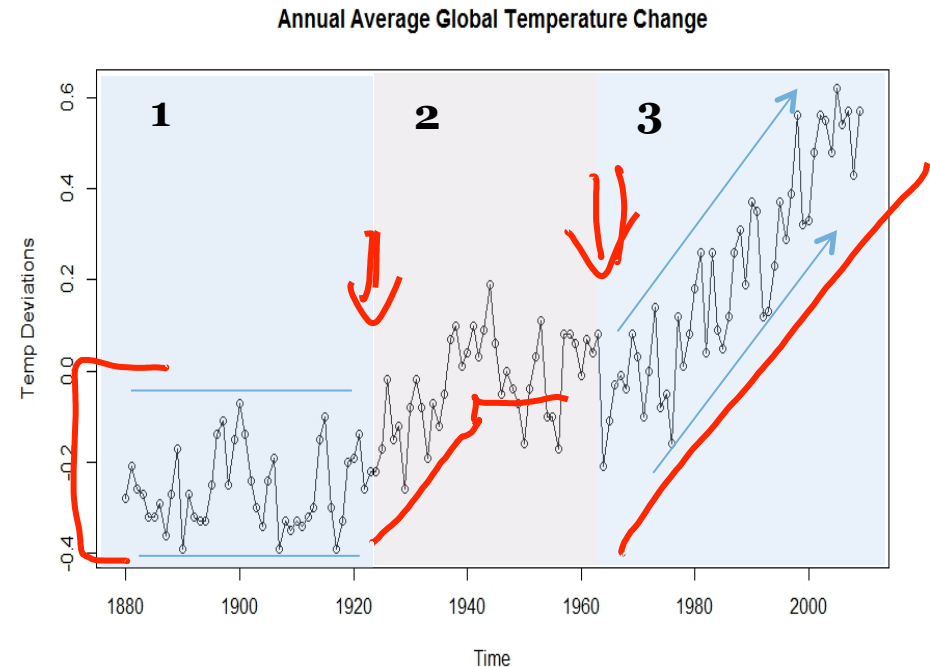
Example: Annual average global temperature change between 1880 and 2009

Observations:

- i. The temperature change was range bounded between 0 and -0.4% from 1880 to 1920.
- ii. The range of temperature change started to increase and fluctuated between -0.2% to 0.2% from 1920 to 1960.
- iii. The temperature change continued to trend up since 1960, sparking the debate on global warming.

Pattern to observe:

- Possible structural change: A consistent upward trend with variation around the trend after a long period of range-bounded fluctuation (i.e., from 1880–1920)



Pattern 3: Variation Around a Stable Mean

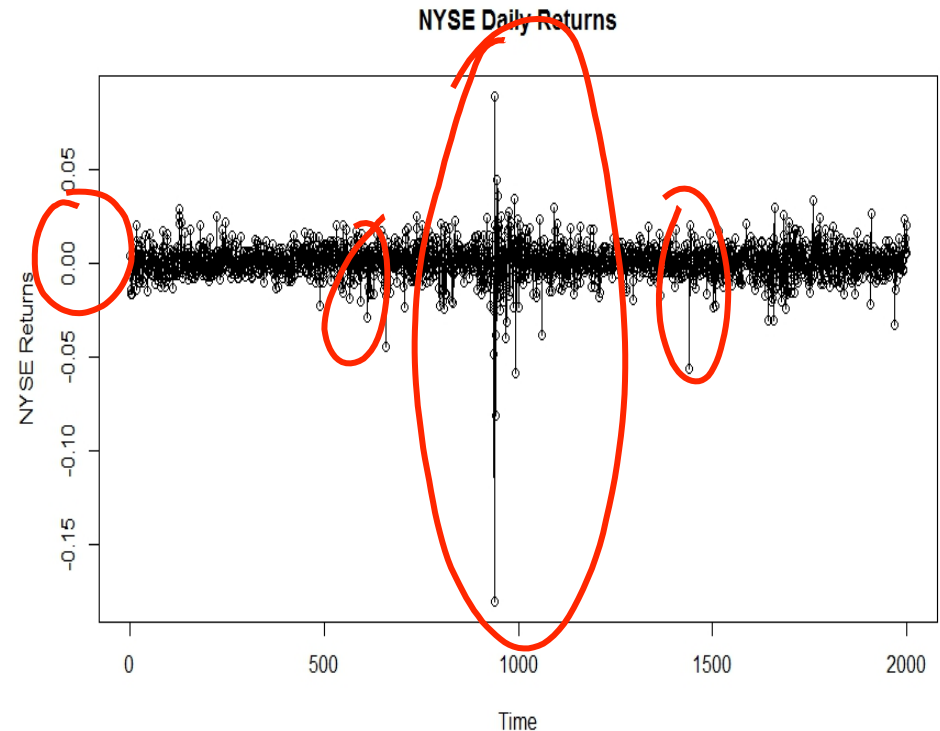
Example: New York Stock Exchange (NYSE) daily returns

Observations:

- The NYSE daily returns (in the observation window) fluctuated around zero.
- There were spikes in the fluctuations from time to time, so-called volatility clustering.

Pattern to observed:

- Stable mean—the mean of the series looks stable.
- Time-varying volatility—the volatility of the series varies over time.



Pattern 4: Periodicity

Example: Functional magnetic resonance imaging (fMRI) in different locations of the brain

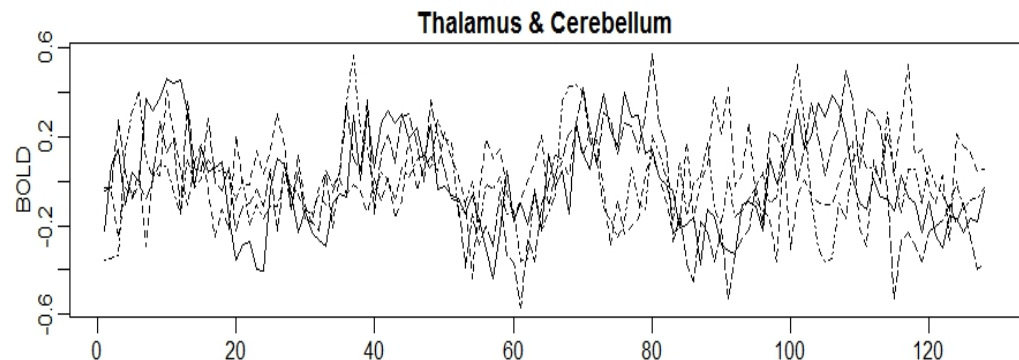
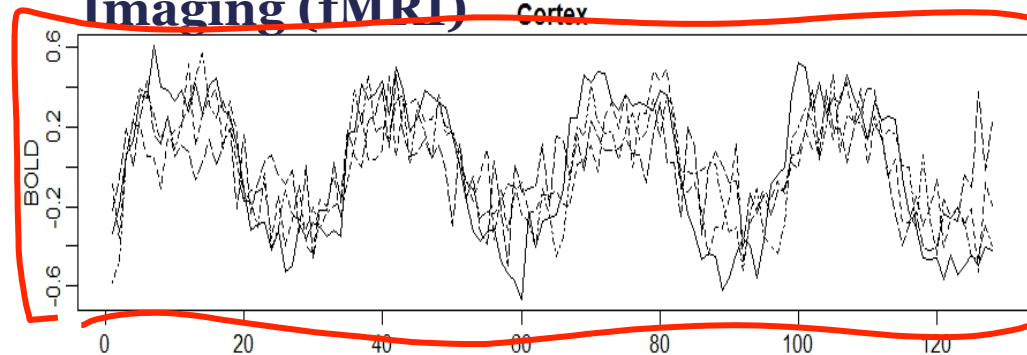
Observations:

- Periodicity appear strongly in the motor cortex series.
- Periodicity appear much weaker in the thalamus and cerebellum series.

Pattern to observed:

- Periodicity—cycles occurred in fixed frequency.

Functional Magnetic Resonance Imaging (fMRI)



Berkeley

SCHOOL OF
INFORMATION