

## 1 Stationarity and Transformations

In this exercise, we will conduct an exploratory analysis of time series data to determine the appropriate transformations that can make the series stationary.

## 2 Questions

In this quiz, we will analyze a set of time series datasets. These datasets are available in the series repository within the subject area on ATENEA.

- **GDPUSA:** (<http://www.bea.gov/national/index.htm>) **Gross Domestic Product-GDP of the United States.** These are quarterly data that represent the chained volume in dollars (2009) in billions and are seasonally adjusted.
- **GDPUSAv:** (<http://www.bea.gov/national/index.htm>) **Percent change from prior period in United States Gross Domestic Product (GDP)**, based on chained prices. The series is seasonally adjusted.
- **EURODOL:** (<https://www.bde.es/webbde/en/estadis/infoest/tipos/tipos.html>) **Average monthly exchange rate of the EURO (ECU before 1999) with respect to the DOLLAR.**
- **EURIBOR:** (<https://www.bde.es/webbde/es/estadis/infoest/tipos/tipos.html>) **mortgage interest set by the interbank market through the EURIBOR index**
- **ATUR:** (<https://expinterweb.mites.gob.es/series/>) **individuals registered as unemployed at INEM offices**
- **AIRBCN:** (<https://apps.fomento.gob.es/BoletinOnline/?nivel=2&orden=03000000>) **monthly passengers of international flights in El Prat Airport (BCN).**

For each series, you are required to explore the transformations needed to achieve stationarity.

1. Upload the file containing the series. Define the data as an object of type `ts` (time series), specifying the origin and frequency of the series.
2. Plot the time series and provide a description of the key patterns and trends observed.
3. Consider the possibility that the variance of the series may not be constant. Create a mean-variance plot and boxplots for each period. For quarterly data, group the observations into two-year intervals to ensure at least eight observations per period. If you choose to apply logarithmic transformations, store the transformed series in an object with the appropriate prefix `ln`.
4. Next, investigate the potential presence of a seasonal pattern. In addition to plotting the series, use the `monthplot` function and the autocorrelation function (`acf`) of the original series. For series exhibiting a seasonal component, perform seasonal differencing with the appropriate order ( $s = 4$  for quarterly data or  $s = 12$  for monthly data), and store the result in a new object with the prefix `d4` or `d12`.

5. Determine whether the mean of the current series is constant. To do this, plot the series and apply first-order differencing. For each differenced series, use the prefix d1. Examine the variances of each transformation and decide which one results in a stationary series.