TIME SERIES FORCASTING

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What you will be learning today?

- **Time Series Forecasting(TSF)- ARIMA**
  - Time Series Forecasting - Intuition and Applications
  - Components of a Time Series
  - Stationarity of a Time Series and Testing for Stationarity
  - ARIMA - Assumptions and mathematical working

What is time series forecasting?

- Time series forecasting occurs when you make scientific predictions based on historical time stamped data.
- It involves:
  - Building models through historical analysis
    - Using them to make observations
    - drive future strategic decision-making.

An important distinction in forecasting is that at the time of the work, the future outcome is completely unavailable and can only be estimated through careful analysis and evidence-based priors.

Courtesy: tableau

TSF: Features

- There are two kinds of features unique to time series:
  - **TIME-STEP FEATURES**
  - **LAG FEATURES**

TSF: Features

Lagging

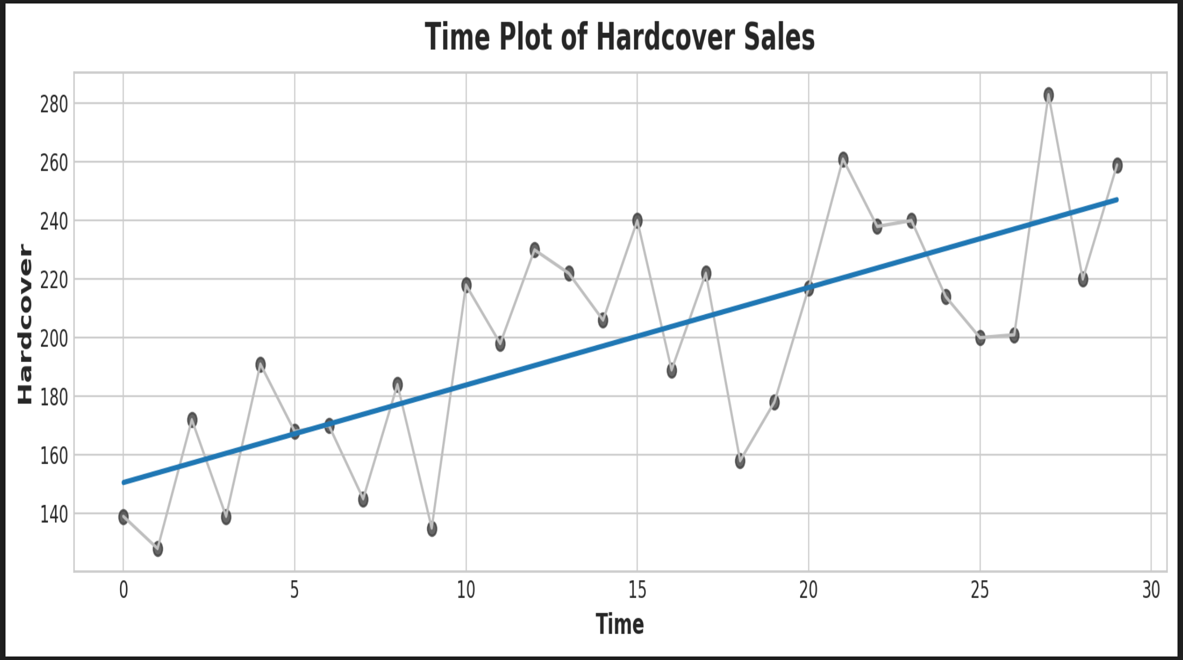
- **Lagging** a time series means to shift its values forward one or more-time steps, or equivalently, to shift the times in its index backward one or more steps.
- In either case, the effect is that the observations in the lagged series will appear to have happened later in time.

Time-step features

- **Time-step features** are features we can derive directly from the time index.
- The most basic time-step feature is the **time dummy**, which counts off time steps in the series from beginning to end

Examples

TSF



TSF: APPLICATIONS

It has tons of applications such as:

- Weather Forecasting
- Industrial Forecasting
- Retail Forecasting
- Supply chain management: Why certain location are not delivering products at the expected rates

TSF: Stationarity

Statistical properties, remain the same over the time:

- Constant Mean
- Constant Variance
- No seasonality

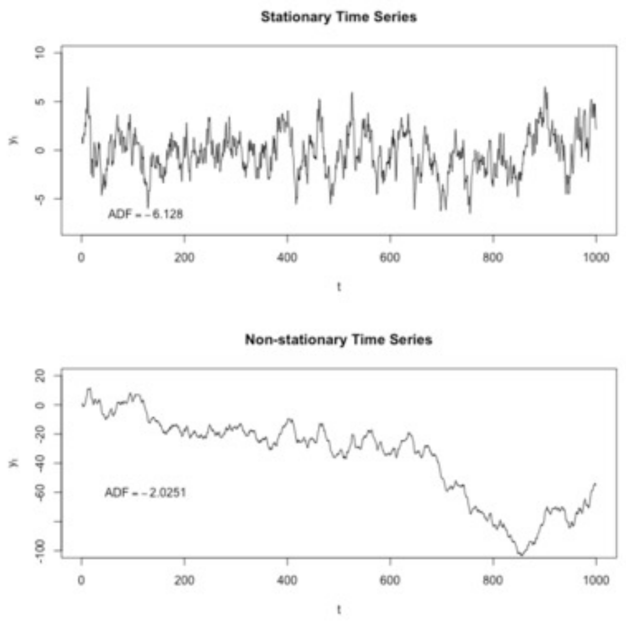


Figure 1: Time series generated by a stationary (top) and a non-stationary (bottom) processes.

Keep in mind:

The way the series does not change the over time that is the slope remains constant

TSF: ARIMA

- Arima stands for **AutoRegressive Integrated Moving Average**

- **Meaning:** a class of statistical model that captures a suite of different standard temporal structures in time series data. It is used for analyzing and forecasting time series data

ARIMA

This acronym is descriptive, capturing the key aspects of the model itself. Briefly, they are:

- **AR**: *Autoregression*. A model that uses the dependent relationship between an observation and some number of lagged observations.
- **I**: *Integrated*. The use of differencing of raw observations (e.g. subtracting an observation from an observation at the previous time step) in order to make the time series stationary.
- **MA**: *Moving Average*. A model that uses the dependency between an observation and a residual error from a moving average model applied to lagged observations.

Parameters of ARIMA

ARIMA(p,d,q)

The parameters of the ARIMA model are defined as follows:

- **p**: The number of lag observations included in the model, also called the lag order.
- **d**: The number of times that the raw observations are differenced, also called the degree of differencing.
- **q**: The size of the moving average window, also called the order of moving average.

ACF and PACF in ARIMA Model:

1. **ACF (Autocorrelation Function):**
   1. ACF measures the linear dependency between the current observation and its previous observations.
   2. It helps in identifying the MA component (q) of the ARIMA model.
2. **PACF (Partial Autocorrelation Function):**
   1. PACF measures the linear dependency between an observation and its lag, after removing the effect of intermediate observations.
   2. It helps in identifying the AR component (p) of the ARIMA model.

Identifying AR and MA Orders Using ACF and PACF:

1. **If the ACF at lag 1 is positive and decays exponentially, and the PACF has a sharp cutoff:**
   1. Suggests an **AR(p) model.**
   2. Identify *p* where PACF crosses the significance level.
2. **If the ACF has a sharp cutoff at lag q, and the PACF decays exponentially:**
   1. Suggests an **MA(q) model.**
   2. Identify *q* where ACF crosses the significance level.
3. **If both the ACF and PACF decay gradually:**
   1. Suggests a mixed ARMA model (both AR and MA terms).