IESE Business School
University of Navarra

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Time Series Sales Forecasting

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1. Introduction

The goal of this technical note is to discuss how to make forecasts for the sales of a company when we have data on its sales in previous periods.

Companies normally keep records of their monthly, quarterly and yearly sales in the form of time series. A time series is any sequence of observations of a (generally economic) function x(t) over time. The sequence of a company's annual sales in dollars or euros over a period of time would be an example of a time series.

We shall assume that the time interval between successive observations or values of the economic function x(t) is constant or sufficiently constant. The interval may be a day, a month, a quarter, four months, a year, etc.

The values of a time series are represented by

$$x(1), x(2), \ldots x(t) \ldots$$

Throughout this note we will consider that the series x(1), x(2), ... x(t), represents the yearly sales of a company, where x(t) is the total sales for year t.

Sometimes we will have monthly or quarterly data. In that case, the series is usually represented using two indices: x(i, j). The first index, i, is the indicator of the year and the second, j, the period within the year.

For example, in the case of a monthly series, x(2, 3) indicates sales in the month of March in the second year.

Obviously, if we have a series of quarterly data and x(i, j) denotes sales for year i, quarter j, then the total sales for the fifth year x(5) satisfy that

$$x(5) = x(5, 1) + x(5, 2) + x(5, 3) + x(5, 4)$$

This technical note was prepared by Professors Pere Agell and Miguel Angel Ariño. February 2015.

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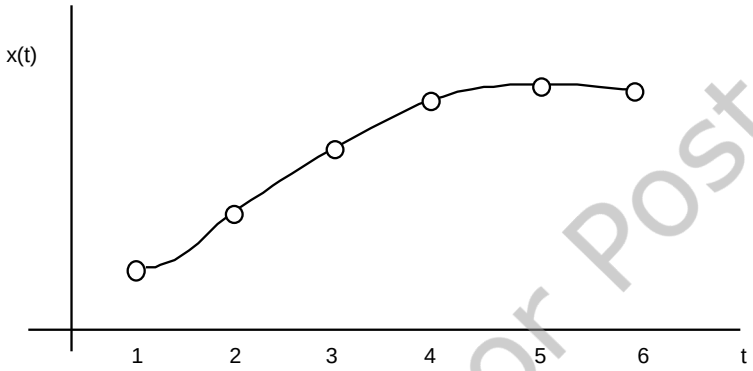
2. The First Step

The first step when trying to make a forecast of sales for a company is to understand how x(t), the time series for yearly sales, has changed over time. To that end, it is useful to graph the points [t, x(t)] on a sequence plot.



If x(t) is the annual demand for a product, the plot of the points [t, x(t)] will be part of the product's life cycle curve. Therefore, this plot may help us find out where the product is in the stages of its life cycle (introduction, growth, maturity or decline), which will make it easier to predict future demand for the product.

Plots that resemble the ones shown in Figures a, b, c, d, e, and f will lead us to suspect that the product is in the stage of:

Figure a: introduction-growth
Figure b: growth
Figure c: growth-maturity
Figure d: maturity
Figure e: decline
Figure f: complete cycle

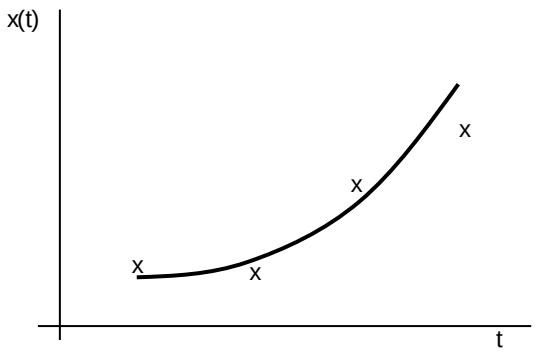


Figure a

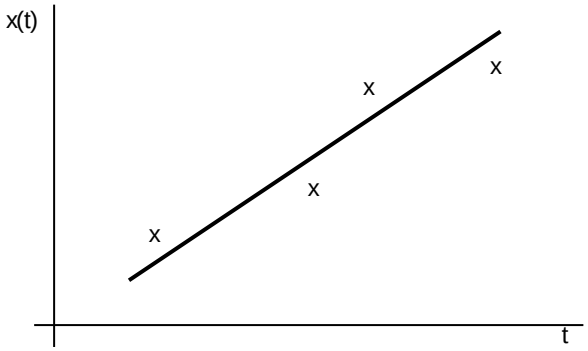


Figure b

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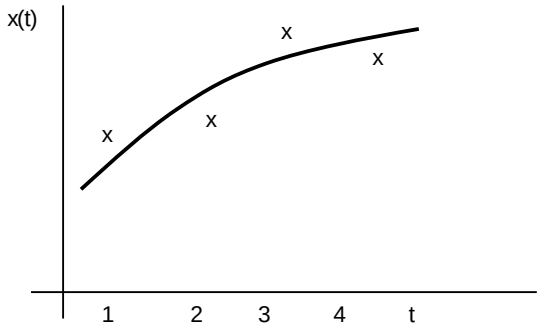

Figure c

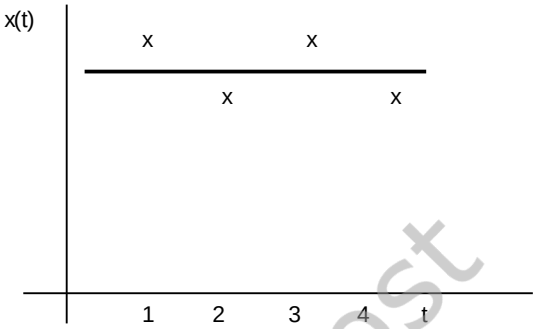

Figure d

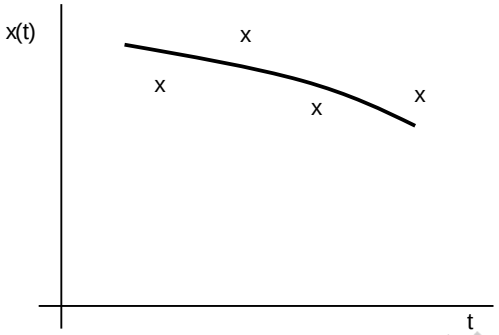

Figure e

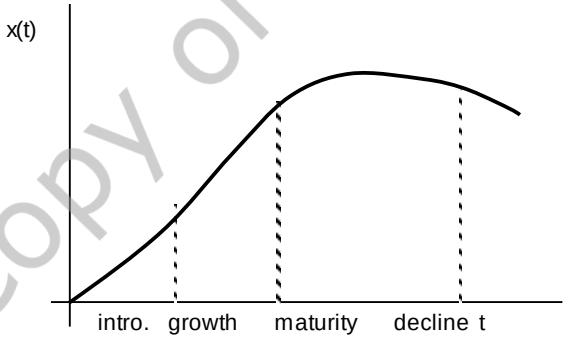

Figure f

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3. Choosing and Calculating the Trend

We will model the sales of a company through three components: the annual trend, the seasonal factors and the random component.

Let us start with the trend. The trend of the sales in a company is a smooth line that captures the yearly evolution of the company's sales. The trend at year i will be denoted as f(i).

3.1. Choosing a Trend

Although there are many possible trends to reflect this evolution, we are going to consider only three of them:

a) Linear $f(i) = a + b * i$

b) Parabolic $f(i) = a + b * i + c * i^2$

c) Exponential $f(i) = a + b * c^i$