Chapter 1

Introduction

Seasonal adjustment is widely applied around us. In the area of economics, people need to deal with numerous time series data everyday and analyzing and forecasting are two very important parts. It is not hard to understand that one time series data could be decomposed into different components, such as the trend, the seasonal series and the irregular series. In signal processing of engineering, we also call them signals. Due to the influence of seasonal movements and some other calendar effects like the Christmas, the Easter and the Chinese New Year, the raw data is usually hard to utilize for analysis directly. Therefore, removing those undesired signals is important for our analysis. Meanwhile, to obtain a good forecasting, we have to ensure that the decomposition of our original data is accurate.

To illustrate the significance of the decomposition, we suppose the distribution of the observed data is

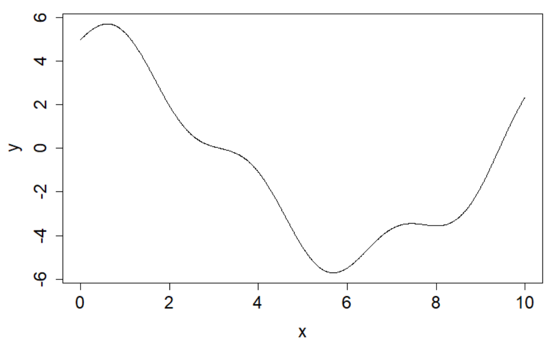

Figure 1.1: Observed Data Distribution

It seems that there is barely no pattern behind it, and the only reasonable prediction we could make is that it would increase later. But actually the raw data is simulated from the function

$$y = sin2x + 5cos\frac{x}{2} \tag{1.1}$$

which means if we could find the expression of these two parts, then our prediction would be prefect!

Therefore, if we could find the accurate expression of our components, it would not only help us with analysis but also for the future prediction.

The history of seasonal adjustment problem could be traced back to 1960s, at which time the first method X-11 was proposed by Statistics Canada.[reference,] Then U.S. Census Bureau developed X-12-ARIMA[reference,] based on the the previous one. Almost at the same time, the Bank of Spain came up with an ARIMA model-based method called TRAMO-SEATS[reference,], which is used widely in official statistics. In 2007, U.S. Census Bureau brought up X-13ARIMA-SEATS[reference], which combined the previous work together and is another method applied widely in official statistics.

Generally speaking, because of the existence of outliers, calendar effects and other factors, we usually need to preprocess our raw data at first when dealing with seasonal adjustment problem. In both widely used methods TRAMO-SEATS and X-13ARIMA-SEATS, they use ARIMA model-based methods, TRAMO and RegARIMA, to achieve the preprocessing process separately. The next step is to decompose the time series obtained in the last step. For TRAMO-SEATS, this is handled by SEATS. For X-13ARIMA-SEATS, you can either choose X-11 or SEATS to decompose. But users need to notice that X-11 is a non-parametric universal method which use linear filters to decompose one time series data. The theories behind these methods are given in Chapter 2.

However, state space modelling is also an efficient way to solve seasonal adjustment problem. As we mentioned before, the components in seasonal adjustment are also referred to as signals, so basically the method used for signal extraction could be applied for seasonal adjustment as well. Specifically, the Kalman filter, which is based on the state-space model is one of the commonest methods and we shall mainly utilize it in this paper.

Compared with the filter-based method and the ARIMA model-based method, state-space modelling is more general and allows more underlying improvement in the future.[reference, Bell, Hillmer, 1984] And this is the reason why we explore it instead of sticking with conventional methods. But due to its complexity and other shortcomings, it hasn't been applied widely in the area of official statistics and industries. This paper will provide you with an intuitive sense of SSM's drawbacks by example at first and show the idea that we come up with to improve SSM's behavior in practice. We shall illustrate SSMs and the Kalman filter in Chapter 3, and then introduce how our novel method works in the following Chapters.

SHOULD TALK MORE ABOUT THE FOLLOWING CHAPTERS