

Chapter 10 Forecasting hierarchical or grouped time series

Warning: this is a more advanced chapter and assumes a knowledge of some basic matrix algebra.

Time series can often be naturally disaggregated by various attributes of interest. For example, the total number of bicycles sold by a cycling manufacturer can be disaggregated by product type such as road bikes, mountain bikes, children's bikes and hybrids. Each of these can be disaggregated into finer categories. For example hybrid bikes can be divided into city, commuting, comfort, and trekking bikes; and so on. These categories are nested within the larger group categories, and so the collection of time series follow a hierarchical aggregation structure. Therefore we refer to these as “hierarchical time series,” the topic of Section [10.1](#).

Hierarchical time series often arise due to geographic divisions. For example, the total bicycle sales can be disaggregated by country, then within each country by state, within each state by region, and so on down to the outlet level.

Our bicycle manufacturer may disaggregate sales by both product type and by geographic location. Then we have a more complicated aggregation structure where the product hierarchy and the geographic hierarchy can both be used together. We usually refer to these as “grouped time series,” and discuss them in Section [10.2](#).

It is common to produce disaggregated forecasts based on disaggregated time series, and we usually require the forecasts to add up in the same way as the data. For example, forecasts of regional sales should add up to give forecasts of state sales, which should in turn add up to give a forecast for the national sales.

In this chapter we discuss forecasting large collections of time series that must add up in some way. The challenge is that we require forecasts that are **coherent** across the aggregation structure. That is, we require forecasts to add up in a manner that is

consistent with the aggregation structure of the collection of time series. In Sections [10.3](#)–[10.7](#) we discuss several methods for producing coherent forecasts for both hierarchical and grouped time series.