Chapter 10

Multivariate Brain Signal Analysis

All the brain analyses described and investigated in this book require researchers to collect signals (or observations) of many sensors (or variables) to measure *in vivo* the cognitive activity in the human brain. In other words, brain data inherently include simultaneous measurements on several variables and consequently to understand the complexity of their information we have to disclose the relationships between these variables in a multivariate way. In this chapter, we present a number of mathematical concepts from linear algebra, information theory and feature extraction that are important within multivariate statistical analysis and have been applied throughout this book to generate whole brain mappings.

The chapter is organised in three parts. The first part, consisting of Sections 10.1 and 10.2, provides some definitions and results of linear algebra, more specifically matrix algebra, that have been used in the study of multivariate statistical analysis. A comprehensive exposition of these topics can be found in Strang (1988). The second part of the chapter, consisting of Sections 10.3 and 10.4, discusses briefly the idea of entropy as a quantitative measure of information, which leads to the electroencephalogram (EEG) summarization technique used in this book. For a broad treatment of information theory, the reader is referred to the book of Cover and Thomas (1991). In the third and final part, consisting of Sections 10.5–10.7, we describe in detail some feature extraction multivariate techniques relevant to formulate solutions to EEG whole brain mapping.