Methods in Brain Connectivity. Inference through multivariate time series analysis
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This book mainly describes the current state of the art in connectivity analysis for multichannel EEG/MEG and fMRI providing theoretical descriptions and experimental practice. Since brain connectivity may be studied and analyzed using a broad range of network analysis approaches, this task can be a hard challenging. However, the result is nothing less than excellent. The book covers most of the aspects in which the study of connectivity analysis has contributed to expand the physiological knowledge not only applied to EEG but also in other type of physiological signals. In general, all the method descriptions focus on the advantages taken from the multivariate approach compared to the bivariate approach, which sometimes can be inadequate. This book which is written by several authors is divided into four sections. The first section (chapters 1 to 7) describes the fundamental property of the measures used for quantifying connectivity and causality such as Granger causality, partial directed coherence (PDC), directed transfer function (DTC) and direct directed transfer function (dDTC). The reading of these chapters is mandatory for everyone who wants to get into the field of the connectivity analysis. The comprehensive overview of all the advantages and disadvantages of each technique helps to choose the suitable methods for each particular case of study. In the following section, chapter 8 introduces the kernel Granger approach as an innovative non-linear modelling method while chapter 9 introduces the connectivity quantification in processes which interaction is time-variant. These two approaches are useful when linear models prove to be inadequate.

The third section covers some applications of the methods previously presented to real data. Chapter 10 reports an interesting comparison between DTF, PDC and dDTF applied to EEG, fMRI and hemodynamic data. Chapter 11, also regarding to fMRI context, compares the results of the Granger causality and correlation applied to the BOLD signal in order to assess brain connectivity. In chapter 12, the Granger causality is applied to cardiovascular time series, demonstrating that this approach can be also used to provide information about cardiovascular control and not only to assess brain connectivity. This opens the possibility to apply this approach to different type of analyses. In general, the authors remark that all the presented methods appear to be complementary and not competitive, being their choice dependent on the question to be answered. To finalize the book, in chapter 13, the editors provide further general comments and list many open questions that define some future works in order to develop and improve the methods for brain connectivity.

The reading is easy and comfortable with no grammatical or typographical mistakes. The book contains different levels of style, in this way, it is suitable for neuroscientists and researchers both experts and without in-depth knowledge of times series analysis and statistics. For example, chapters 1 and 2 are discursive and contain more explanations while chapter 3 contains more mathematical expressions and proofs. The chapters are very well organized, beginning with an introduction stating the main tone of the chapter followed by the presentation of the methods and some examples and discussions. The majority of the chapters end with a paragraph conclusion or final remarks that are very useful for synthesis of the take-home messages that can be distilled from the whole chapter. Figures are clear, with an excellent definition and

labeling. A comprehensive list of references help the reader to find more information if needed on each particular aspect. It is of interest the way that the Granger causality is discussed in many different applications through the chapters, considering both multivariate and bivariate approaches.

Chapter 7 is specifically illustrative since it reports interesting examples of PDC that the reader can try using the supplemental software provided in the form of a CD. Besides clarifying the sunspot-melanoma paradox reported in the previous chapters, the most interesting example is the connectivity study of an ictal episode. In a nice figure, the authors depict the results of the PDC applied to several EEG channels during an ictal episode and report the graph theoretical representation in the following figure that clearly illustrates the directions of the interactions between the channels.

This book offers a new framework to discuss brain connectivity concepts. Considering the neuroanatomical or structural connectivity (pattern of anatomical links), the functional connectivity (usually understood as statistical dependencies) and the effective connectivity (referring to causal interactions), the challenge of quantifying all brain connectivity properties seems almost impossible. However, the contribution of the works reported in this book opens new solutions and improvements to this hard challenge.

In summary, this book makes an enjoyable reading for those that use some form of brain connectivity for their clinical or research work, but also this book may be very helpful for researchers interested in starting work in the field of brain connectivity.

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