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Variability in Biomedical Signals

FUNCTIONAL DATA ANALYSIS APPLIED TO BIOMEDICAL SIGNAL VARIABILITY

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Abstract: The variability of a set of biomedical signals, assumed to be functions of time associated to the same phenomenon, is analysed following some criterions. Firstly, when the signal source is unique, the variability may be, for one sensor in function of the time occurrence of the signals, for several sensors at the same time a spatial variability. The case of several sources corresponds to the inter subject variability, and the comparison of populations. Then the distinction between amplitude variability, time variability and shape variability is introduced. Functional Data Analysis is viewed as modelling the variability through time warping functions. These functions are either composed with the signals, leading to a lot of curve registration techniques well fitted to time variability cancellation, or composed with the normalised integral functions of the signals when they can be assumed to be positive. The later case is well suited to shape analysis and shape variability estimation around an averaged shape. The Integral Shape Averaging (ISA) an Corrected Integral Shape Averaging (CISA) algorithms are recalled. Two applications are then presented, including shape clustering. The first one is a very good correlation observed between the appearance of an obstructive sleep apnoea and a shape change of the P-waves of the ECG. The second one is related to the Ensemble Spontaneous Activity (ESA) recorded in the round window (near the cochlea). It is shown, by simulation, that the shape of the histogram of the ESA amplitude is very sensitive to a localised correlated firing of the fibres, possibly associated to Tinnitus, on the contrary of the classical objective index, i.e. the PSD amplitude at 1 kHz.