A New and Fast Index for the Quantification of Short-Range Self-Similarity in RR Time Series

Miguel Angel García-González*, Mireya Fernández-Chimeno and Juan Ramos-Castro

Group of Biomedical and Electronic Instrumentation, Department of Electronic Engineering, Technical University of Catalonia (UPC), Barcelona, Spain

Detrended fluctuation analysis (DFA) is becoming a usual tool in the analysis of RR time series although its computation can be very slow when dealing with long time series. We propose a new and very fast index (the frequency of sign changes of the mirrored differences or FSCMD) with good correlation with the short term scaling exponent (ALPHA-1) estimated among scales 4 to 16 of the DFA. FSCMD is the relative number of sign changes of the point-to-point differences between the RR time series and its corresponding reversed RR time series after a moving average detrending procedure is applied using a window of 30 samples. Linear regression results with simulated time series with Fractional Brownian Noise and length N show a very good relationship between both indices (Rsquare= 0.834 (N=300), Rsquare= 0.986 (N=3000), Rsquare= 0.995 (N=30000)). The linear regression results from Fantasia (FT), Normal Sinus Rhythm RR time series (NSR) and Congestive Heart Failure (CHF) databases after artifact correction also show good agreement (Rsquare= 0.822 (FT), Rsquare= 0.793 (NSR) and Rsquare= 0.937 (CHF)). Finally, Mann-Whitney Rank Sum tests applied to ALPHA-1 and FSCMD when comparing NSR and CHF databases show very significant differences ($p<0.001$) between groups for both indices. FSCMD is computed nearly 500 times faster than ALPHA-1 while analyzing NSR so FSCMD can be a fast alternative way to quantify the short term self-similarity of RR time series instead of a DFA.