

Study of Sample Entropy Ideal Computational Parameters in the Estimation of Atrial Fibrillation Organization from the ECG

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Sample Entropy (SampEn) is a nonlinear regularity index that requires the a priori selection of three parameters: the length of the sequences to be compared, m , the patterns similarity tolerance, r , and the number of samples under analysis, N . Given that no guidelines exist for the selection of that values, a thorough analysis on the optimal values for m , r and N is presented within the context of noninvasive atrial fibrillation (AF) organization estimation. Recently, the evaluation of AF organization, through SampEn, has revealed clinically useful information that could be used for a better treatment of this arrhythmia. This work analyzes optimal SampEn parameters within two scenarios, such as the prediction of paroxysmal AF termination and the electrical cardioversion outcome in persistent AF.

As a result, recommendations about the selection of m , r and N , together with the relationship between N and the sampling rate (f_s) will be given. More precisely, (i) the proportion between N and f_s should be higher than one second and f_s higher than 256 Hz, (ii) overlapping between adjacent N -length windows does not improve organization estimation and (iii) values of m and r maximizing classification should be considered within a range wider than the proposed in the literature for heart rate analysis, i. e. $m = 1$ and $m = 2$ and r between 0.1 and 0.25 times the standard deviation of the data. Thus, for paroxysmal AF, the maximum accuracy was 96%, which was obtained with $m=3$ and $r=0.4$ ($p=3.4567 \cdot 10^{-13}$) for $f_s=256\text{Hz}$ and $m=2$ and $r=0.35$ ($p=4.2134 \cdot 10^{-13}$) for $f_s=1024\text{Hz}$, respectively. Regarding persistent AF, maximum accuracy of 82.54% was achieved for $f_s=256\text{Hz}$, $m=3$ and $r=0.3$ ($p=5.2483 \cdot 10^{-3}$) and, for $f_s=1024\text{ Hz}$, with the pairs $m=2$ and $r=0.4$ ($p=9.3892 \cdot 10^{-4}$) and $m=3$ and $r=0.25$ ($p=8.7756 \cdot 10^{-4}$), respectively. Finally, both the methodology and the outcomes provided by this study could serve, not only in AF studies, but also as a startup framework in the application of SampEn to other biomedical signal processing scenarios.