Perfect matrices of Lagrange differences for the interpretation of dynamics of the cardiovascular system

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Abstract

ECG analysis is the main and the most studied noninvasive technique used for the contemporary investigation of the functionality of the cardiovascular system. ECG parameters are effectively used for the identification of various heart rate and conductivity defects, different heart hypertrophies and ischemic processes. Cardiac time intervals are sensitive markers of cardiac dysfunction, even when it goes unrecognized by conventional echocardiography [1]. Furthermore, interrelations between ECG parameters is still an active area of research.

In this talk we present the concept of perfect matrices of Lagrange differences which are used to investigate the relationships between two ECG parameters RR and JT intervals that are recorded during the bicycle ergometry experiment. The concept of the perfect matrix of Lagrange differences, its parameters, the construction of the load function and the corresponding optimization problem, the introduction of internal and external smoothing, embedding of the scalar parameter time series into the phase plane - all these computational techniques allow visualization of complex dynamical processes taking place in the cardiovascular system during the load and the recovery processes.

The proposed technique allows to observe the ”collapse of complexity” at the end of the bicycle stress test, temporary stabilization of transient attractors during the load, rich dynamical behavior of the heart system during the recovery process.

References

[1] Biering-Srensen T, Mogelvang R, de Knegt MC, Olsen FJ, Galatius S, et al. (2016) Cardiac Time Intervals by Tissue Doppler Imaging M-Mode: Normal Values and Association with Established Echocardiographic and Invasive Measures of Systolic and Diastolic Function. PLOS ONE 11(4): e0153636.