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THE LOCAL INDEX OF FRACTALITY IN THE ANALYSIS OF SHORT RR INTERVAL SERIES IN THE ASSESSMENT OF HEART RATE VARIABILITY

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The study of Heart Rate Variability (HRV) and its underlying structure and function with regard to regulatory systems is getting ever more important for clinical diagnosis and outcome predictions of various diseases, the evaluation of pathologic strains exerted on a system in conditions of emotional stress, and the choice and assessment of the most effective treatment.

Today it is possible to claim that the classical methods of RR interval series analysis in the temporal and frequency range have reached the limit of further development. Recently, however, burgeoning research interest in the practical application a nonlinear dynamics of Heart Rate Variability offers a new approach.

As presently known, the stability of a heart rhythm is ensured by three regulating mechanisms; the parasympathetic, the rather weak β-sympathetic mechanism, and the α-adrenergic mechanism with different constants of time. This physiological complex produces scale invariance (lack of a chosen scale) of short RR intervals series. The reliable evaluation of pertinent dimensions needs too long series of RR intervals, but it is impossible to receive them, as during measurements it can change the character of the behavior.

This new approach to the analysis of Heart Rate Variability through the study of nonlinear dynamics is based on the local index of fractality that can be calculated on rather short RR intervals series. As a first

approximation, the behavior of RR intervals series can be modeled in a system with several branches of lagging feed-backs the concrete aspect of which being defined during the analysis of experimental data.
The local index of fractality can thus be used for the detection of transitional states in the regulatory systems of rhythms allowing a correct assessment of the respective roles of the sympathetic and parasympathetic control system.
The advantage of the index of fractality is its research application of RR intervals series not only on stationary segments, but also on the analysis of transitional (non stationary) segments.
Key words: ECG, Heart Rate Variability, nonlinear analysis, local index of fractality.

Imperfect balance: Musical composition by exciting periodic and near-chaotic regimes in coupled metal cymbals

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This paper demonstrates the compositional possibilities from generating sustained systems of oscillating pitch patterns through the excitation of coupled metal cymbals by variable sinusoidal waves. The physical system requires two or more cymbals mechanically combined to maximise coupling and minimise loss of acoustic energy. Transducers are used to create a drive-and-capture feedback system: sinusoidal waves drive the cymbals and the resulting vibrations are captured and fed back into the system at a level that allows sustainable vibration. Frequencies of the sinusoidal waves are derived from pre-analysis of the resonant frequencies of the specific cymbals. Compositional variables for the piece include the set of derived frequencies, along with a range of amplitudes that keep the system between silence and the threshold of chaotic vibration.
The compositional interest lies in the audible pattern generation possible through locating systems of periodic oscillation, typically these are found near the bifurcation points of the system. There is a performative element in keeping the overall system gain from “running away” into chaotic oscillation. Previous research—Chaigne, Touzé and Thomas (2005)—found a positive Lyupanov exponent under certain conditions, showing that with cymbal vibrations can become chaotic. While chaotic