Quantification of coupling between heart rate and blood pressure by means of entropy-based indices

Paweł Pilarczyk[1],
joint work with Grzegorz Graff[2], José M. Amigó[3],
Katarzyna Tessmer[4], Krzysztof Narkiewicz[5], Beata Graff[5]

[1] *Faculty of Applied Physics and Mathematics & Digital Technologies Center, Gdańsk University of Technology, Poland*
[2] *Faculty of Applied Physics and Mathematics & BioTechMed Center, Gdańsk University of Technology, Poland*
[3] *Centro de Investigación Operativa (CIO), Universidad Miguel Hernández, Elche, Spain*
[4] *Faculty of Applied Physics and Mathematics, Gdańsk University of Technology, Poland*
[5] *Department of Hypertension and Diabetology, Medical University of Gdańsk, Poland*

In order to monitor mutual influence between heart rate (HR) and beat-to-beat blood pressure (BP) in patients, we propose an approach to the analysis of the pair of time series that is based on ordinal patterns and entropy.

Specifically, the two time series for each patient are aligned to each other in time, converted into ordinal patterns of a given length (e.g., 3 or 4), and then a collection of entropy-like indices is computed to measure the complexity of each time series, as well as their mutual relation. The indices are: permutation entropy, statistical complexity and self-transcript entropy computed for each individual time series; transcript entropy, mutual information, and transcript mutual information between the HR and BP series; all these indices also shifted in time by up to 9 positions.

We described this method in [1] and applied it to construct a classifier for distinguishing between healthy patients and those suffering from obstructive sleep apnea based solely on the measurement of their HR and BP taken during an outpatient exam conducted during the day.

[1] P. Pilarczyk, G. Graff, J.M. Amigó, K. Tessmer, K. Narkiewicz, and B. Graff. Differentiating patients with obstructive sleep apnea from healthy controls based on heart rate–blood pressure coupling quantified by entropy-based indices. *Chaos* **33** (2023), 103140. https://doi.org/10.1063/5.0158923