Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences

SUBJECT: Effective classifiers of biomedical signals derived from the Information Theory

SUPERVISORS, CONTACT, PLACE OF RESEARCH

Prof. Janusz Szczepański, Ph. D., Dr. Habil.
Pawinskiego 5B, 02–106 Warsaw, PL
tel.: +48 22 828 53 73/+48 22 826 12 81
ext. 114
e-mail: jszczepa@ippt.pan.pl
web site: http://bluebox.ippt.pan.pl/~jszczepa/

Ph. D., Eng. Agnieszka Pregowska
Pawinskiego 5B, 02–106 Warsaw, PL
tel.: +48 22 828 53 73/+48 22 826 12 81
ext. 417
e-mail: aprego@ippt.pan.pl

Name of the institute in which the topic will be realized: **Institute of Fundamental Technological Research**

Scientific discipline: **information and communication technology**

PROJECT DESCRIPTION

DESCRIPTION OF THE TOPIC: Biomedical signals (EEG, EKG, MEG, MRI, etc.) can be analyzed in several ways using different mathematical theories and tools (Statistical analysis, Fourier analysis, Wavelet analysis). Recently, Information Theory is strongly exploited. Concepts derived from **Information Theory** such as *entropy, discrete entropy, Renyi entropy, permutation entropy, mutual information, complexity, permutation complexity, and discrete Lyapunov exponents* allow us for a deeper insight into the nature of biosignals. This is since they take into account simultaneously probabilistic nature and the structures of signals (e.g. internal patterns of signals [1–4]). Besides, these techniques have a unique feature that enables for measuring the level of randomness of signals, and to distinguish deterministic traits from random features. This is extremely important in the classification of such complex signals as the ECG, EEG, MEG, MRI especially in the early stages of anomaly formation when detection of subtle differences is crucial [5,6]. Based on our previous information-theoretic research [7, 8] we set the following research hypothesis that Information Theory can be successfully applied as a **clinical tool of vital signs abnormalities classification**.

Before applying the Information Theory-based tools, biosignals have to be converted into a discrete sequence of symbols. It is known that the effectiveness of the signals classifications method strongly depends on the signal digitalization applied [9, 10]. Codification (digitalization) can take place in various ways. A **successful encoding method** of biomedical signals (e.g. being a sequence of measurements performed with some sampling frequency) into sequences of symbols from a given finite alphabet is one of the important issues.

GOAL: The Doctoral Thesis aims to develop and implement **new effective classification algorithms based on Information Theory concepts and** support these algorithms by **Machine Learning techniques**. Such algorithms should allow to **analyze and classify effectively biomedical signal online**. This software will be responsible for analyzing patient data from an electrocardiogram, heartbeat sensor, and other relevant medical data, classifying subjects' exam results, and provide a suggestion about his/her health status.

Diagnostics algorithms will be validated on:

- simulated signals modeling experimental recordings and on the *in vivo* recordings, e.g. electrical heart activity and brain signals (individual sensory neurons) and
- on signals coming from an experimental database of *Mount Sinai Hospital New York, USA, IDIBAPS Institut d'investigacions Biomèdiques August Pi i Sunyer Barcelona, Spain,* and *Peacs BV Netherland*.

EXPECTED RESULTS: The results obtained will support **intelligent monitoring of patients** and help deliver **targeted, and personalized medicine** while providing smooth communication and high productivity in medical units.

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