



*Editorial*

**Special issue: Informatics & data-driven medicine**

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**The special issue webpage is available at:** <http://aimspress.com/mbe/article/5823/special-articles>.

**Abstract:** The current state of the development of Medicine today is changing dramatically. Previously, data of the patient's health were collected only during a visit to the clinic. These were small chunks of information obtained from observations or experimental studies by clinicians, and were recorded on paper or in small electronic files. The advances in computer power development, hardware and software tools and consequently design an emergence of miniature smart devices for various purposes (flexible electronic devices, medical tattoos, stick-on sensors, biochips etc.) can monitor various vital signs of patients in real time and collect such data comprehensively. There is a steady growth of such technologies in various fields of medicine for disease prevention, diagnosis, and therapy. Due to this, clinicians began to face similar problems as data scientists. They need to perform many different tasks, which are based on a huge amount of data, in some cases with incompleteness and uncertainty and in most others with complex, non-obvious connections between them and different for each individual patient (observation) as well as a lack of time to solve them effectively. These factors significantly decrease the quality of decision making, which usually affects the effectiveness of diagnosis or therapy. That is why the new concept in Medicine, widely known as Data-Driven Medicine, arises nowadays. This approach, which based on IoT and Artificial Intelligence, provide possibilities for efficiently process of the huge amounts of data of various types, stimulates new discoveries and provides the necessary integration and management of such information for enabling precision medical care. Such approach could create a new wave in health care. It will provide effective management of a huge amount of comprehensive information about the patient's condition; will increase the speed of clinician's expertise, and will maintain high accuracy analysis based on digital tools and machine learning. The combined use of different digital devices and artificial intelligence tools will provide an opportunity to deeply understand the disease, boost the accuracy and speed of its detection at early stages and improve the modes of diagnosis. Such invaluable information stimulates new ways to choose patient-oriented preventions and interventions for each individual case.

**Keywords:** informatics; data-driven medicine; neural networks; machine learning; IoT; predictive modeling; classification; small data approach

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## 1. Introduction

This Special Issue was dedicated mainly on the best papers from the 3-rd International Conference on Informatics & Data-Driven Medicine (IDDM-2020) [1]. This conference is indexed by Scopus, Web of Science and dblp databases. In addition, according to the CORE list of conferences 2021 it has rank C.

Extended versions of conference's papers, which contained science-intensive solutions based on the recent advance in Informatics, has a strong theoretical basis, as well as demonstrated readiness for practical application in Medicine, have been invited for submission. The IDDM 2020 Program Committee recommended it after presentations of all participants during the conference, based on the scientific novelty, practical value and prospects for further research. However, this Special Issue was not limited conference materials. Original papers, related to this Special Issue also have been considered and after review – published in this Special Issue.

Special issue's proposed topics included:

- IT-enabled Healthcare Services
- Big Data and IoT in Medical Applications
- Medical Image Processing
- Deep Learning Models in Healthcare and Biomedicine
- Machine Learning Approaches for Medicine
- Bioinformatics for Healthcare Applications
- Analysis and Prediction for COVID-19 Data
- Complex Health Monitoring Systems

Totally, the six submissions from the scientists and medical practitioners of the Ukraine, Poland, United Kingdom, China, Slovak Republic, and South Korea were received. After strong review process, five papers were accepted for publication in this Special Issue.

## 2. An overview of the published papers

In [1], the authors improved the methodology of processing short and very short data sets. It is based on the use of only one nonlinear neural network. The method's main idea is to form an extended height and width data set based on simple manipulations with the existing training sample and the use of a nonlinear neural network to implement the training procedure. In this paper, an iterative neural network based on radial-basis functions is selected. In the application mode, there is also the formation of extended data sets by combining the input vector with unknown output with all the initial training data set vectors.

The modification consists of using two such temporary datasets, which differ in the position of the input vector of the test sample in the extended set of vectors (before the vector from the training sample and after it). The author's procedure of applying the improved method uses the principle of ensemble training, i.e., averaging the received results on all temporary vectors.

Practical experiments based on a real short set of medical data have shown a significant increase in the accuracy of the improved method. In addition, the methodology used shows promising results for the processing of short data sets from other areas of research, which are characterized by the inability to obtain a sufficient number of vectors for the application of the training procedure using artificial intelligence tools.

Paper [2] is devoted to a deeper understanding of the causes of myocardial infarction. This cardiac problem is becoming more common among the population of different countries and is often accompanied by fatal consequences. The authors attempt to explain the mechanisms of myocardial infarction from the perspective of competing endogenous RNA (ceRNA) networks. For this purpose, the authors used a scale-free lncRNA-associated ceRNA network. The authors used a random walk algorithm to detect and prioritize lncRNAs. Numerous experiments to calculate the statistical significance of the various lncRNAs have demonstrated that three of them are critical and can act as ceRNAs to play essential roles in the biological processes of myocardial infarction. The practical value of such findings provides the possibility of using them as potential biomarkers in myocardial infarction.

In [3], the authors also investigated one of the problems of cardiology. However, in this case, it was about the fetal heart rate in the womb. The authors studied the fetal heart rate (fHR) variability and fetal electrocardiogram (fECG). To date, this is one of the most informative indicators of the condition of the fetus. The main objective of this study was the fetal welfare investigation and hypoxia risk estimation. The authors propose a comprehensive approach to solving this task. It consists of the gradual implementation of the following steps: fECG extraction, fHR, and fetal heart rate variability (fHRV) calculation, hypoxia index (HI) evaluation, and risk estimation.

Experimental modeling on a real data set demonstrated the high efficiency of the developed approach. The results of this study can be used for early warning on fetus' safety. In addition, the proposed approach can serve as an additional source of information about possible complications for physicians dealing with such problems.

Paper [4] presents the results of modeling and forecasting the prevalence of COVID-19 depending on the constraints imposed by the governments of the different countries studied. To study the impact of restrictive quarantine measures of governments of different countries, the authors used an approach based on the recommendation rules. A modification of the approach uses an ensemble of machine learning methods such as clustering and a regression tree. Oxford COVID-19 Government Response Tracker and European Center for Disease Prevention and Control (ECDC) Covid-19 Cases were used as datasets. Clustering has identified three clusters of countries depending on the dynamics of morbidity and quarantine restrictions of governments. Based on the obtained regression rules, the spread of the disease over 21 days was simulated for different strategies of quarantine restrictions, and it was shown that the mean square error of such prediction does not exceed 4.2 with a total confirmed number of cases over 30,000.

The study was conducted on the example of three European countries: Poland, Italy, and Germany. In addition, the paper simulates the spread of morbidity in Sweden for two quarantine restriction strategies. The main conclusion of the work is that the dynamics of the number of confirmed cases of COVID-19 are influenced not only by restrictive government measures but also by their implementation. Thus, the paper clearly shows that while in the case of Germany the restrictive measures were implemented ahead of the increase in the incidence curve, in other cases, these measures were introduced with some delay in response to the actual epidemic, which correlates with the dynamics of COVID-19 in these countries. Forecasting the dynamics of morbidity growth and,

accordingly, the necessary actions of governments can be done based on the country's membership in one of the three identified clusters and based on guidelines for each cluster.

In [5], the authors considered the issue of IoT-based intelligent medication behavior monitoring systems. This challenge has become even more urgent in the context of the COVID 2019 pandemic. Such effective systems can monitor the patient's condition at home or in specialized facilities without visiting a hospital. This approach provides several benefits for both patients and physicians. It is a potential direction for the development of modern medicine, particularly for the monitoring and detection of medication behaviors of patients. The authors have developed their own IoT device, which combines in-depth training and provides high efficiency. The developed system is designed to determine the patient's condition in real-time and inform him to perform corrective actions. In addition, the information obtained is analyzed by doctors for the possibility of diagnosis and treatment at a distance.

## Acknowledgments

The Guest Editors thank the Editor-in-Chief of the Mathematical Biosciences and Engineering Journal, Prof. Yang Kuang, for accepting our proposal for organizing a Special Issue and publishing new research results. In addition, we would like to thank all the Journal team for the intense review process, excellent copy-editing process, and fast publication of the accepted papers.

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