



Artificial intelligence and data processing

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Artificial intelligence methods are a very actively developing area of science. It derives directly from computer science and mathematics. Nevertheless, the applications of artificial intelligence methods can be found in almost every scientific discipline. It is astonishing to observe, for example, how deep neural networks often outperform the best algorithms developed by humans. This shows the huge potential of the development of artificial intelligence methods. On the other hand, investigating why artificial intelligence methods outperform competitive techniques has an undeniable impact on our deeper understanding of problems, so that it is also possible to achieve a significant improvement in results in classical methods. The Silesian University of Technology conducts research in the theoretical area as well as applications of artificial intelligence methods in various tasks. An example here can be, among others application of artificial intelligence methods in optimization problems, construction of decision and quality systems, authentication of people, and natural language processing.

The area of knowledge, also dynamically developing, is undoubtedly bioinformatics. It is difficult to overestimate the benefits that a better understanding of the functioning of living organisms can give. Key factors include the analysis of genomes or protein sequences. The development of modern methods of genomic data compression give practical benefits, significantly reducing the costs of data storage and transfer. In the world, this topic is gaining immense popularity. Research carried out in this area by several groups of scientists from the Silesian University of Technology have a significant impact on the development of modern bioinformatics tools. In some cases, the developed tools places us among the world leaders.

Employees of the Silesian University of Technology also conduct other research in which data mining is of key importance. One example is the digital analysis of acoustic and vibrating signals. As a result, it is possible to counteract excessive noise by actively suppressing it. Much attention is also devoted to the processing of image data for both industrial and astronomical applications (e.g., for quick photometry) or satellite (e.g., super-resolution analysis of satellite images). There are also numerous research and implementation works in the mining industry.

A common element of scientific research in the areas of artificial intelligence and data processing is a very large requirement regarding computing power and storage capacity. In the case of artificial intelligence, this is associated with expensive deep network training. In bioinformatics, data from individual experiments often have

hundreds of GB, and even their representation suitable for searching or analysis is non-trivial. Also in other data processing issues we deal with multidimensional data sets of large sizes. At present, these calculations are carried out, among others using the resources of the Upper Silesian Center of Scientific and Engineering Computation located at the Faculty of Automatic Control, Electronics and Computer Science of the Silesian University of Technology. Some of the research is also conducted using Polish supercomputing centers. Due to large requirements regarding computing power, the Silesian University of Technology applied for the inclusion of the project "Construction and equipment of the Center for numerical computation and data processing and Network Center" on the Polish Road Map of Research Infrastructure. The computing power of this center will place it among the most powerful supercomputing centers in Europe.

Scientific work in this area is conducted, among others as part of numerous projects financed from the funds of the Polish National Science Center and the National Center for Research and Development. In the near future, it is planned to submit applications for European grants, e.g., ERC. The results of the research have been published in several dozen articles in journals that are among 1% or 10% of the best scientific journals according to the Scopus and Web of Science databases. In the near future, research will be developed, among others in the areas of artificial intelligence in optimization problems, analysis and compression of genomic data, decision and quality systems. It will also cover issues of person authentication, natural language processing and digital analysis of acoustic and vibrational signals. We will use our significant position in the scientific world, which has been achieved in these areas, to create new solutions, at least some of which should find direct or indirect industrial applications.

The leading experienced scientists conducting research in this area include Prof. Sebastian Deorowicz, Prof. Jacek Łęski, Prof. Aleksander Nawrat, Prof. Damian Słota, Dr. Hab. Marcin Woźniak. This group is also complemented by outstanding young scientists such as Dr. Adam Gudys, Dr. Jakub Nalepa, Dawid Połap, Dr. Adam Popowicz, Dr. Stanisław Wrona.

Scientists working in this area are conducting research in collaboration with leading research centers such as Stanford University (USA, #2 in the world according to ARWU), Nanyang Technological University (Singapore, #12 in the world according to QS) or Massachusetts Institute of Technology (MIT) (USA, #4 in the world according to ARWU). In the case of Stanford University, the cooperation relates to algorithms for the compression of huge data sets from genomic sequencing experiments. Cooperation with Nanyang Technological University concerns the processing of acoustic signals for the purpose of noise reduction.

The convenient location of the Silesian University of Technology, in the heart of a multi-million metropolis, also creates excellent conditions for conducting extensive cooperation with the economic environment. One of the latest examples is a consortium established to optimize fleet management in order to reduce traffic in cities.