Understanding in ICT

By Magdalena Les and Zbigniew Les

In the era of rapid development of the scientific knowledge and utilization of this knowledge in the industry and business there is a need to look for some tools that make it possible not only to use this knowledge but also to be able to understand technological processes, business problems as well as the world in all its phenomenal manifestations. This will require the shift of our interests from pragmatically oriented, directed to narrowly understood in terms of business and technology, toward more epistemologically oriented, directed toward the reflection on the more general issues, concerning our being in the world. We are witnessing not only small fluctuation of changes in our culture influenced by appearance of the computers but the beginning of the shocking transformation from the analogue into digital environment. Our working environment becomes more and more sophisticated, crowded with not only complex computer hardware but, what is the most significant, with software that requires the continuous learning not only the simple commands but more often very different domains of knowledge. The knowledge learned at school or university becomes more often obsolete for specialists in IT (ICT) and they need spending most of their time looking for new opportunities to learn very new professional knowledge. Looking from our professional perspective, from the time when we graduated from mathematics and engineering at Jagiellonian and AGH Universities, not only vast amount of new knowledge from many different domains such as machine learning, computer vision or neural networks, but also many different software packages such as SAS, SPSS, STATGRAF, Mathematica and programming languages such as Pascal. Fortran, C, C++, Prolog, were necessary to learn. In many cases, when working on the contracts, due to strong market demands for professionals with a very good knowledge of the latest versions of just released software packages, we had to spend our own money and private time to keep us with upgrading our computer/programming skills and knowledge.

The dreamers, writing about the university courses supplying the knowledge (to students) that is needed by some businesses or industries, do not understand neither the role of university nor the times in which we are living. One of our first papers presented at the conference at the University of Melbourne, addressed the issue of building of the proper learning university environment by introducing of the system of integrated packages (SIP) that, at that time, included software packages such as MAPINFO, SPSS, Mathematica and Excel. In that conference paper, which was the result of our research in Poland, we pointed out to the never before occurred strength dependence between effectiveness of learning and the ability to apply existing software packages in solving problems. This proposed new paradigm of learning indicated the necessity of revision of the existing curriculum in order to eliminate the material which could be no longer important in the context of application of the SIP. In parallel we conducted our very new research concerning understanding the aim of which, among other, was to build the most advanced new generation of robots – thinking and understanding machines. In the film by S. Kubrick "*The Cosmic Odyssey -2001*" the robot HALL was performing the tasks that required understanding the world in order to make the complex decisions. It was science-fiction film, however we are living in the times when the science-fiction becomes reality and there is a need to adapt not only the obsolete program of the existing educational system but, what is more important, our way of thinking and understanding. Recently there is a lot of discussion and speculation about future of the technological development and the changes in educational program at each educational level however most of the discussion is dominated by

politicians or business people that leads to one-sided proposals of the solutions, very often without proper understanding of the complexity of the problems. One such very popular view, connected with misunderstanding of the essence of problems of knowledge and understanding, is view that university should be a factory for production of human-machines able only to fulfil the requirements of the business or industrial expectations. We selected a small sample of divers views of the business people concerning the skills that will be needed in the near future: "*digital skills, life skills, fundamental business skills, entrepreneurial and business skills, social skills [communication], ability to get ideas across and create a vision, leadership and the ability to elicit a vision, ability to show up and excite others, relentless, persistent, resilient self-belief, being able to perceive and take risks and sense risk both individually and collectively*". This indicates how differently these skills are defined and understood. In the near future, dominated by classical robots and thinking machines, the old paradigm of learning (learning only these skills that can be very quickly sold on the market) need to be replaced by the new one. The new paradigm of learning at school and university will be referring to the well-known method of learning, namely, learning for understanding. In the lecture given at the University of Melbourne this month, we presented a new research domain which we call machine understanding, in the very broad context of philosophical inquiries concerning human understanding as well as existing attempts to build the systems with rudimentary ability to understand. In this lecture, based on our books published by Springer and our latest research in machine understanding, the main focus was on presentation the new paradigm of scientific production and self-activity of knowledge being able to understand itself that is learned during process we call knowledge implementation. Proposed machine understanding approach is based on the assumption that only some of the problems that human can understand and solve can be suitable for a machine to understand. Machine understanding, in general, is based on the results of investigations of logical positivists. According to logical positivists, claims of ethics, aesthetics and theology were pseudo-statements, neither true nor false but simply meaningless. In this context, we can assume that problems of ethics, aesthetics and theology cannot be suitable for a machine, that means, these are problems that the machine cannot solve or understand. Although the possibility exists that the machine, to some extent, can imitate human ability to understand some of these problems, there is no ground to believe that the machine will be able to understand these problems in the way humans understand them. One of the aims of machine understanding is to build a machine with the ability to understand, the shape understanding system (SUS). SUS is designed to understand and to solve problems that can be formulated in a rigorous form of the scientific statements by applying the well-defined categories of scientific knowledge. Even if there is the possibility of limited understanding by a machine of selected areas of human activities that cannot be represented in the form of scientific statements, there is however very difficult to find the way of proving that the machine really understands these problems.

SUS learns knowledge that is part of knowledge learned by students within the framework of curriculum program. In the light of our research it is easy to notice the tendency of existing educational institutions in supplying of the learning environment that is more suitable for a machine (robot) than for a human being. Results of our research indicate that when an ability to solve a problem by a machine can to some degree prove that the machine can understand, the very important part of proving this is testing if the machine is able to explain how to solve the problem and to explain the causes, context, and consequences of given facts. Most of educational tests applied for testing students' performance at school only to a small degree deal with testing students'

ability to explain how to solve problems. The results of our research in machine understanding and the experienced gained in development of the system “Lumen”, designed to test student’s understanding of learned material by testing the ability to explain the solving problem process, indicate that some changes in educational program will be inevitable.

Current research in ICT gravitates towards problems that are part of philosophical enquiry. Problem of understanding is strictly connected with problem of mind and problem of consciousness. Machine understanding provides the suitable model of understanding that can be approached using scientific methods. It should be noted, however, that the understanding model (SUS), as every scientific model, only to some degree can approximate the modelled phenomenon. The information processing (neural network) approach attempts to explain human understanding by comparing the mind to a sophisticated computer system. Neural networks can be very promising approach for modelling some of understanding processes. However the main drawbacks of neural networks are that learned knowledge can be very easy degraded by new learned facts and it is very difficult to evaluate and test if neural networks can understand.

Machine understanding Is a very new area of research, however it came to being as the result of our research that started in Poland through building the expert system in Prolog for mineral recognition, mathematical and statistical modelling, designing and implementation of the scientific and educational software in C, and C++, designing and implementing the system for aesthetic evaluation of the picture with application of the neural networks and, at the end, the development of the shape understanding method implemented as the shape understanding system (SUS). As Deloitte report shows “…Australian research expenditure is relatively low”. In the case of our research and our St. Queen Jadwiga Research Institute of Understanding (SQJRIU) this statement is too optimistic. For more than fifteen years of research we have not received any government’s financial support. Leaving this fact without any comment we will expect that it will change for better in the context of the recent proposals of the new Prime Minister.