Thinking, knowledge, awareness and intelligence are the biggest mysteries of the human psyche. The human mind is able to very quickly associate, reason, control and process large amounts of data and information that come to him all the time. Since many years we try to understand the secrets of the human mind to use its efficiently working computational mechanisms in computer science. In addition, the human mind is the seat of intelligence that is able to solve a variety of difficult tasks, whereas today computer science is dependent on human intelligence. On the other hand the human mind, in spite of its high capabilities, also has its limitations of perception, memory and association. People undertake cooperation with each other dividing complex tasks into simpler that the human mind can encompass and resolve. Sometimes, the difficulty to deal with certain problems lies in the possibility of rapid search and effective analysis of large data sets, consideration of many possible combinations, variations or permutations, or in the semantic data binding to derive conclusions or find optimal results. In such cases, we meet the problems of the computational complexity or specification of the semantic data binding, since there is no possibility of their references to well-known concepts, such as it is in the human mind. Semantics arises only in the context of the knowledge and needs of some particular individual and is also dependent on its perception ability. Mode of perception and meaning of the same data can be very different for various individuals. Information defined separately from the specific knowledge of the given individual is controversial, too. Intelligence and its level depend on the associative capabilities and knowledge, enabling to determine the meaning of incoming data or information. The interpretation of information is also influenced of its recipient individual needs, which may be different as well as the interpretation and conclusions drawn from it. Artificial intelligence similar to human will not come into being without the possibility of forming a knowledge, modelling needs and existence of associative system working in a similar way as the human mind. If artificial intelligence shall be created in the image of our own intelligence and around human needs then there is the possibility of communication and cooperation with it and exchange valuable information.

The level of global intelligence, awareness and knowledge of the people has increased as a result of possibility of rapid transmission of information through electronic media. This speeded up the development of scientific researches, new technologies and more efficient cooperation. Access to reliable information influences rapid formation of a coherent, credible and consistent knowledge in the human mind whereas broadening knowledge is an essential component of intelligence. The current human intelligence allows us to communicate, not always to reach an agreement and establish a satisfactory solution for all sides. Egocentrism slows down development, causes rationing of information and inefficient use of resources, competition, which motivates, but it has a negative impact on the human psyche and moral values of people. Even with nonegocentric intentions our mind is not always able to take into account all relevant factors for a given business. The vastness of surrounding businesses, tasks and problems requires ability of computational systems to automate of association, knowledge formation and need recognition to achieve more effective development of civilization and faster processing of information, automatic reasoning and undertake of suitable actions in the possibly broadest context of the needs of people and the whole environment.

Despite the ever increasing speed of modern computers and increasingly sophisticated data processing algorithms, the human mind is still irreplaceable in many tedious tasks where automation would be desirable given or could increase safety and efficiency. It is also amazing how a group of neurons is capable of so quickly and efficiently processing the data and information reaching activation maximally several dozen times per second in comparison to multi-threaded, multi-core and several hundred million times faster clocked CPU of modern

computers. Even on the assumption that the brain consists of 40 billion neurons, some of which can perform calculations in parallel, it is difficult to explain such an effectiveness of computation on the ground of modern computer science, because many algorithms cannot be made efficiently parallel based on the Turing machine that is an abstract model of today's computers. In addition, neurons do not perform whatever kind of parallel computing in a way comparable to CPU or GPU. Architecture of the brain and computers is also completely different. The algorithms vary in computational complexity whereas most of the associative processes in the brain seem to occur more or less in the same very short time. Computers perform calculations in the processor cores using memory as a store of passive cells that store data that are sometimes searched through and processed, whereas the brain is composed of reactively acting neurons that carry out discrimination. The differences between today's computers and the brains are significant as well as a way of data processing, suggesting that computational processes happen differently inside them.

This monograph raises several important issues relating to the operation of the human mind, knowledge formation and modelling of associative processes to enable us to process data in a different way than it is now used in computer science. There is defined a new model of a neuron mapping the biological functionality relevant to the association and the formation of associative systems. There are described plasticity processes that take place in neurons related to their synaptic connections and perikarion size that enable them the change of their discrimination level and selective determination of input data combinations and arrangements that will cause their activation. There is shown that the gradual process of returning to a resting state of neurons and their refractive state take a very important role in associative processes. The introduced associative data structure allows mapping the relationships between the data and performing of associative computation after their transformation into a special graph of reactive and plastic neurons. It has been shown the comparison of computational complexity of some classical algorithms and the computational processes that take place in artificial associative systems that use knowledge. There is explained the methodology of associative graph neurocomputation that makes possible to eliminate the nested iterative loops, numerical error multiplication and the computational complexity problems. Due to the fact that this associative computational model uses different assumptions than those for the Turing machine then the postulates of the way of computation and computational complexity also change. This model also changes the treatment of data, which are not passively stored in the memory but have an active impact on the associations and the formation of associative systems changing the way of next data processing. Also, data that carry information make sense with reference to knowledge forming in these systems by calling the suitable associations and activations of neurons as a response. Potential of associative artificial systems is illustrated in the example of associative sort, associative classifier and a few examples of linguistics operating on natural languages. The introduced psycholinguistic taxonomy of personality as an important component that directs the development of intelligence allowing a suitable response of future artificial intelligence systems to the human needs. Finally, the associative artificial intelligence has been defined on a basis of knowledge, association capabilities defining new interesting research issues for modern computer science.