Preface

Quantum neural technology is a hypothetical but promising new field of informatics, which combines together the main ideas of both quantum and neural computing. Actually, this field is in its early infancy, when only a few dozens of studies are published. These studies are very different in approaches, in the degree of connections with classical neural technologies and quantum computing, and also in the directions of possible applications. Surely, this substantially complicates the problem of writing a book devoted to this problem, in particular because it seems to be a first book in this domain.

It could be possible, of course, to present a review of current studies, but in this case the book surely can be rather mosaic and eclectic. We choose another approach trying to present some (to our opinion) basic ideas which can govern the future development of quantum neural technologies. One of the main difficulties in understanding of the most of the approaches used so far is partly connected with the fact that while these approaches are close to the *quantum computing* itself, the notion and ideas of neural computing sometimes appear artificially as "bolt from the blue". In general, the *language of neural networks* is so universal, that it seems can be used to present any field, including those which can be hardly seen as really "neural".

However we shall try to demonstrate, that main models of quantum neural systems can be considered as *natural generalization* of models well known in classical neural technology. In particular, they further generalize the forms of model neuron inputs and outputs enhancing their complexity and, what is most surprising, give the possibility to decrease dramatically the complexity of the *neural systems* by replacing the *networks of classical neurons* by *single quantum neuron*.

Also, quantum neurons probably reflect the tendency to change multi-class classical neural systems by first single-class and finally by single-pattern systems, which are trained by using one example only.

Moreover, it turns that the use of quantum neural systems allows to solve many problems which demand exponential resources in classical approach. This can be done in the case of Boolean function implementation, content-addressable memory and function approximation.

To trace the development of main ideas of neural technologies we start in Chapter 1 with the short overview of main models of classical neurons and their networks, trying to demonstrate, first of all, that the increase of

complexity of basic element of these systems allows to solve more and more complex problems.

In Chapter 2 we outline main concepts of quantum mechanics in relation to quantum computing, and also touch the problems of realization of quantum computers.

These first two chapters are rather fragmentary, because there exist many excellent books in which all needed topics are comprehensively considered. But we tried to discuss in these two chapters all ideas which are substantial for understanding of the material presented in the last Chapter 3.

In Chapter 3 we outline how the problems typical for classical neural technology can be solved using quantum neural technology. We consistently consider such topics as quantum associations, realization of Boolean functions, quantum content-addressable memory, and function approximation. We conclude this chapter by considering the application of quantum neural systems to realization of trainable and controllable quantum gates (this application seems to be completely inherent to quantum neural technology), and by discussing possible applications of quantum neural technologies in physical modeling.

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