The aim of this book is to demonstrate that quantum-like (QL) models, i.e., models based on the mathematical formalism of quantum mechanics (QM) and its generalizations, can be successfully applied to cognitive science, psychology, genetics, the economy, finances, and game theory.

This book is not about quantum mechanics as a physical theory. The short review of quantum postulates has merely historical value: quantum mechanics is just the first example of successful application of non-Kolmogorovian probabilities, the first step towards a contextual probabilistic description of natural, biological, psychological, social, economic or financial phenomena. I have developed a general contextual probabilistic model (Växjö model) that can be used to describe probabilities in both quantum and classical (statistical) mechanics as well as in the above-mentioned phenomena. This model can be represented in a QL way, namely, in complex and more general Hilbert spaces. In particular, quantum probability is totally demystified: Born’s representation of quantum probabilities by complex probability amplitudes, wave functions, is simply a special representation of this type. QL representation of data is very convenient; it can be used in any domain of science. I have presented [180, 198] a fundamental conjecture that some biological systems might develop the ability to create QL representations of external and internal worlds. Starting with this conjecture, QL models of cognitive and psychological processes are developed.

A simple statistical test of QL probabilistic behavior based on interference of probabilities was elaborated [180, 176] and corresponding experiments have been performed by Conte et al. [66, 67]. The conjecture on the QL processing of information in the brain was confirmed: ensembles of students performing incompatible recognition tasks for recognition of ambiguous figures demonstrated nontrivial interference of probabilities, see Chapter 6.

Recently a professor of cognitive psychology, Jerome Busemeyer, conjectured that probabilistic data obtained in famous experiments on the so-called disjunction effect by Tversky and Shafir [295, 275] cannot be described by the conventional Markovian probabilistic model, and he speculated that the disjunction effect can be described by quantum formalism. This viewpoint was elaborated in works by Busemeyer et al. [48–50]. We recall that the disjunction effect is by definition (given
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by Tversky and Shafir\(^1\) an exhibition of violation of Savage’s *Sure Thing Principle* (STP) \([271]\). The latter is the basis of the modern theory of *rational decision making*. In particular, by Savage’s axiomatics, economic processes are based on actions of rational agents of the market (in particular, of the financial market), i.e., on the STP. In this book I apply the contextual approach to the disjunction effect. A QL model is presented in Chapter 7; see \([208, 206, 213, 209]\) for original publications. It seems that, in spite of Busemeyer’s conjecture, the conventional quantum formalism is too restrictive to describe the disjunction effect. It is impossible to describe this effect not only by classical (Kolmogorovian) probability theory, but even by conventional quantum probability (defined by Born’s rule in Dirac–von Neumann’s formalism of QM). I apply a generalization of the QM-formalism that is naturally generated in the contextual probabilistic framework. My model is based on the assumption that, in the process of evolution, cognitive systems developed the ability to represent contexts by probabilistic amplitudes (complex and even more general). Such amplitudes form a linear space. Thus the brain is able to linearize probabilistic images of contexts. The dynamics is described by a linear evolution equation, *a mental Schrödinger’s equation*. Consequently, decision making is described mathematically by quantum (and more general QL) theory, see, e.g., Holevo \([147, 148]\), Helstrom \([141]\) or Marley and Hornstein \([238]\). We also mention that the interest in applications of quantum and QL methods to decision making in cognitive science, psychology and economics is very large, see publications by Danilov and Lambert-Mogiliansky \([73–76]\) (utility theory), La Mura \([223]\) (utility theory) (see also \([222]\)), Franco \([109–114]\) (cognitive psychology), and Haven and Khrennikov \([137]\) (a fundamental work covering all possible paradoxes in cognitive psychology related to the disjunction effect).

The crucial point is that QL probabilistic behavior, e.g., in research on brain functioning, need not be a consequence of special physical conditions. For example, the hot brain can still produce interference of probabilities. This is a significant advantage of the QL approach compared with quantum physical reductionism. I have named this approach the \textit{QL paradigm}. A detailed presentation of this paradigm can be found in the first chapter of this book.

This book is truly intended to be accessible to psychologists and researchers working in cognitive science, sociology or economics. Therefore, the first chapter provides a detailed review of all the basic ideas and methods used in the following chapters, without containing any mathematics. It might even be useful for philosophers interested in quantum foundations and the QL description of physical, biological, and mental phenomena.

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\(^1\) See also the excellent experimental work of Croson \([71]\) confirming and generalizing results \([295, 275]\).
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