When to use Quantum Probabilities in Quantum Cognition: a Discussion

Catarina Moreira* Andreas Wichert†

The application of principles of Quantum Mechanics in areas outside of physics has been getting increasing attention in the scientific community (Busemeyer and Bruza, 2012). These principles have been applied to explain paradoxical situations that cannot be easily explained through classical theory. Quantum principles have been applied in many different domains ranging from cognitive psychology (Busemeyer et al., 2006; Pothos and Busemeyer, 2009; Pothos et al., 2013), economics (Khrennikov, 2009; Haven and Khrennikov, 2013), biology (Asano et al., 2012; Basieva et al., 2011; Asano et al., 2015), information retrieval (Bruza et al., 2009, 2013), etc.

In quantum probability theory, events are characterized by a superposition state, which is represented by a state vector comprising the occurrence of all events. The probability of an event is given by the squared magnitude of the projection of this superposition state into the desired subspace. This geometric approach is very useful to explain paradoxical findings that involve order of effects. But do we really need quantum principles for models that only involve projections? In Information Retrieval, for example, how do quantum interference effects emerge under this projective framework? How do we measure the similarity between documents in a quantum-like manner? Do we really need quantum theory when the purpose is just to apply projections between subspaces?

In this work, we intend to explore how quantum probability theory has been applied in the different fields of the literature and make a discussion whether this application has advantages towards the existing classical models.

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*Instituto Superior Técnico, INESC-ID, Av. Professor Cavaco Silva, 2744-016 Porto Salvo, Portugal; e-mail: catarina.p.moreira@ist.utl.pt

†Instituto Superior Técnico, INESC-ID, Av. Professor Cavaco Silva, 2744-016 Porto Salvo, Portugal; e-mail: andreas.wichert@ist.utl.pt

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