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Abstract

Categorical Models of Quantum Mechanics

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The report deals with the axiomatic approach to the phenomena of quantum computation and algorithms. It gives an overview of the classical approach (due to von Neumann) using the structures of Hilbert spaces, as well as mentions some major results in the field and discusses the flaws of the model and its current dominance. This leads to the introduction of a new axiomatization, first proposed by S. Abramsky and B. Coecke in 2007, which relies on the modern concepts of category theory. It is a field of mathematics originally created in the 1940s by specialists in algebraic topology but currently gaining popularity in other branches because of its abstract nature and emphasis on operations rather than objects. Most importantly, category theory is a powerful tool in functional analysis allowing mathematicians to reformulate the statements of Hilbert space theory in a more intuitive way, without matrix calculus. Finally, the logic behind quantum operations is discussed: it is revealed that the ideas of quantum algorithms have a strong connection to Jean-Yves Girard's linear logic.

References

[1] R. Duncan, Quantum Entanglement and Multiplicative Linear Logic. PRS Transfer Report. Oxon., 2003.

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