Quantum Information Aspects of Boolean Algebra

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Discrete mathematics is an important area of mathematics science. It explores the properties of different objects, including graphs, Boolean functions, finite-state machines, etc. From here, we can trace the deep relationship between quantum physics and discrete mathematics. The discretisation (from discrete mathematics) and quantisation (from quantum physics) have a similar significance. But, for a long time, discrete mathematics had developed without in-touch with quantum theory. The fundamental relationship between these two important areas is introduced in this article.

We described the method of transition from a Zhegalkin polynomial, which defines the algebraic normal form of a Boolean function, to the quantum logic circuit. It is shown that quantum information approach provides a simple algorithm to construct Zhegalkin polynomial using truth table. These methods are fair for an arbitrary Boolean function even for Boolean function generalisation with multibit input and multi-bit output. Our developed methods and algorithms can significantly improve quantum technology realisation. The presented approach is the baseline for a transition from classical machine logic to quantum hardware.