A FIRST-ORDER EPISTEMIC QUANTUM COMPUTATIONAL SEMANTICS

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Quantum computational logics have been semantically characterized at a *sentential* level. In this framework, sentences are supposed to denote pieces of quantum information (density operators of convenient Hilbert spaces), while logical connectives correspond to quantum logical gates (unitary quantum operations that transform quantum information in a reversible way). The sentential quantum computational semantics can be extended to an *epistemic* semantics for a language expressing sentences like “Alice knows that Bob does not know that the spin-value in the x-direction is up”. We investigate the possibility of generalizing this semantics to the case of a first-order language, where sentences like “All know that somebody does not know that the spin-value in the x-direction is up” can be formalized. Both knowledge operators and logical quantifiers can be represented as Hilbert-space operations that are generally irreversible. One is dealing with a kind of theoretic “jumps” that seem to be similar to quantum measurements. Unlike most first-order semantic approaches, the quantum computational semantics does not refer to any *domain of individuals* dealt with as a *closed set* (in a classical sense). The interpretation of a universal sentence (say, “All photons have null mass”) does not require “ideal tests” that should be performed on *all* elements of a hypothetical domain. This way of thinking seems to be in agreement with a number of concrete semantic phenomena (even far from quantum physics), where the individual-domain appears highly indeterminate. Such situations, however, do not generally prevent a correct use of the logical quantifiers.

References

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