

# What is quantum Markovianity?

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Markovianity versus non-Markovianity is a well-established distinction for classical systems. The same cannot be said for quantum systems. Different communities and individuals use “quantum Markovianity” to mean very different things. We argue that, to avoid confusion, it is best to avoid attributing that term any definite meaning at this stage. However, that does not mean that there is nothing to say about Markovianity for open quantum systems. We discuss a large number of concepts that have been, or could logically be, used to define quantum (non-)Markovianity, and prove hierarchical relations between them. Some are existing concepts, including “factorisation”, “quantum regression formula”, “divisibility”, and “Lindblad”. Others we introduce, including “past-future independence”, and “composability”. We also prove relations between these and other properties of interest for open quantum systems, such as the applicability of dynamical decoupling to preserve quantum information, the existence of (quantum) information backflow from the environment, and the physical reality of stochastic pure-state trajectories. Finally, we discuss in which concept the closest analogue of classical Markovianity lies.