Why We Should Think of Quantum Probabilities as Bayesian Probabilities

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Abstract

In a realistic, deterministic world, it is easy to argue that all probabilities are subjective Bayesian, i.e., measures of degree of belief. It's so easy, in fact, that the primary refuge for objective interpretations of probability lies in the radically nondeterministic world of quantum mechanics. The objectivist asks, "How can probabilities that are prescribed by physical law be anything but objective?" In this talk I will argue nonetheless that quantum probabilities, even those associated with pure quantum states, are best thought of as being subjective Bayesian probabilities. The viewpoint that emerges from pursuing this line of argument is called the *Bayesian interpretation of quantum mechanics.*

I will review the major arguments for viewing quantum probabilities as subjective, coming from the indistinguishability of quantum states, the apparent nonlocality of entanglement, and the nonuniqueness of ensemble decompositions of mixed states. I will discuss how the quantum de Finetti representation theorem provides a tool for banishing the notion of an unknown quantum state—and a practical tool in quantum cryptography. Finally, I will present an argument, based on the notion of inside information, which clarifies why it seems that the outcomes of measurements on a system in a pure quantum state are more random than a classical random process.

I will conclude with a summary of the Bayesian interpretation of quantum mechanics, including my view of what is objective in a quantum description of the physical world.

Key Words: Quantum probabilities, Bayesian probabilities, Bayesian interpretation of quantum mechanics