Bell inequality violations: the QBist view

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The B in QBism

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- Bayesian?

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- Bayesian? **NO**
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- Bettabilitarian? **Excellent, but it won't catch on...**
- B? **YES!** (QBism is a noun, not an acronym)

QBism in 2 words

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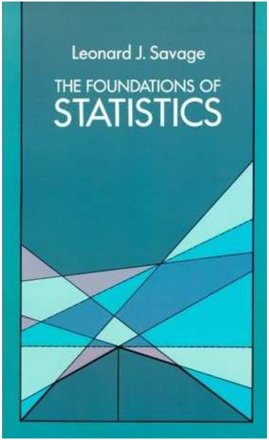
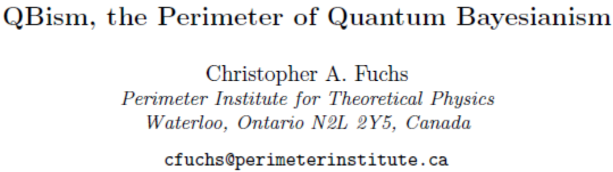
The world is bettable.

Personalist decision theory



Bayes 1755 de Finetti 1931 Savage 1954

QBism 2010


QBism, the Perimeter of Quantum Bayesianism
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Bell's theorem

Bell's theorem is the most famous example of what is now often called a no-go theorem.

Lambda

The assumption of an ontological model:

For any measurement on a physical system, either the outcomes or their probabilities are determined by the system's real properties, λ. (Harrigan and Spekkens, 2007).

(Potentially misleading alternative labels for the same idea: "hidden variables", "realism".)

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Bell

Assuming λ and locality contradicts quantum mechanics.

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where $|0\rangle$ and $|1\rangle$ are the eigenstates of the spin Z operator.

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Einstein:

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Implication, assuming locality (Caves,Fuchs,RS 2002):

$|\psi^B\rangle$ is not a function of "the real state at B", i.e., $|\psi^B\rangle$ is not a real property of the system at B.

A choice: do you give up locality or λ?

If you accept the validity of quantum mechanics, you have to give up either locality or λ, i.e., the assumption of an ontological model.

(There are many good reasons to accept the validity of quantum mechanics. For instance, loophole-free Bell tests.)

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QBism rejects λ, i.e., in QBism,

- quantum states
- measurement outcomes
- probabilities

are not determined by a system's real properties.

What is quantum mechanics?

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QBism:

Quantum mechanics is a decision theory. It guides agents in their actions. (But its mathematical form tells us about the character of the world. QBism is a form of "participatory realism".)

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Users of quantum mechanics are agents

- capable of applying the quantum formalism normatively.

Quantum measurement

The mainstream approach:

A measurement is modeled by unitary interaction between a system and a meter,

$$\rho \otimes |0\rangle\langle 0| \longrightarrow U(\rho \otimes |0\rangle\langle 0|)U^\dagger ,$$

followed by a readout of the meter. The outcome is objective.

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QBism:

A measurement is an action an agent takes on a system. The meter is an extension of the agent. Outcomes as well as outcome probabilities are personal to the agent.

Participatory Realism

The mainstream approach:

Quantum mechanics describes the world from an agent-independent perspective. Third person.

QBism:

The quantum formalism is a tool that I can use to make decisions regarding the consequences for me of my measurement actions. First person.

Quantum dynamics

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Unitary evolution is fundamental and well understood, but there is a "measurement problem".

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Measurement is fundamental. Unitary (and non-unitary) dynamics can be understood by analysing an agent’s current decisions regarding future measurements.

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Accepted Paper

QBism’s account of quantum dynamics and decoherence

Phys. Rev. A

John B. DeBrota, Christopher A. Fuchs, and Rüdiger Schack

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Thank you!