Logan Grove

I am currently studying how the effects and special properties of the Bell experiment can be applied through coding in Python to real life applications. I am writing a code that simulates the conditions of Bell's experiment in order see how that can be applied to real life situations to enhance communication. I'm a senior in the Science Research Program at Pawling High School. I find this project interesting because understanding quantum mechanics gives a glimpse into how the world functions on the most basic level. It also brings up interesting philosophical arguments, as the concept of realism blurs. I've always loved science, and discovering how things work. Quantum mechanics, despite its challenging and convoluted nature, is appealing because of what it reveals about the true nature of reality.

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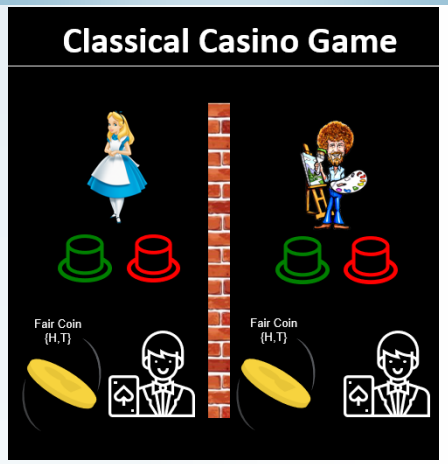

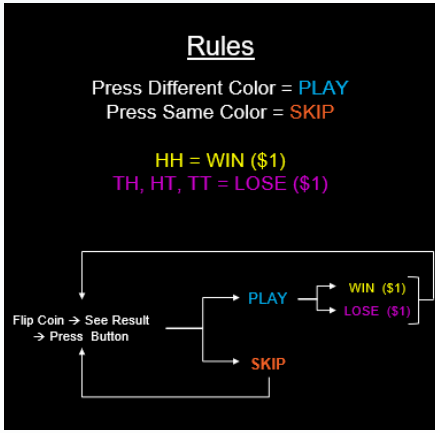

Example of the structured layout of a tailor-made classical casino game. Quantum games would replace coins with measurements of quantum bits, and results of those measure-ments would reveal the best strategy with quantum aid

Finding Quantum Solutions to Classical Problems: How Quantum Mechanics Can Solve Problems That Are Classically Impossible To Solve

A Research Project By Logan Grove[1] and Rodrigo Cortiñas[2]
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Image Citation https://home.cern/news/news/physics/fifty-years-bells-theorem

Introduction/Research Problem

In 1935, the famed EPR (Einstein/Podolsky/Rosen) Paradox shook the foundations of modern physics. The theory concerned the communication of particles and the theory of entanglement, which allows physicists to link particles in measurements over arbitrary distances[1]. Many believed that some parts of quantum mechanics were unknowable. However, in 1964, John Stewart Bell developed a set of equations which disproved the EPR model of physics[2]. Bell's theorems remain an important part of physics and information theory to date. Physicists have used the ideas behind the theory to develop games which violate Bell Inequalities, classical mathematical expressions that are violated only through the principles of QM[3]. This research aims to identify similar scenarios where Bell Inequalities and game theory can be formatted to achieve an advantage when compared to classical mechanics.

Goals, Methods, and Results

Goals Overview:

My research explores winning associated with quantum suggestion in applicable scenarios. It is predicted that, if such a situation could be correctly identified, the two players of the game would be able to use a device which relies on entanglement and decoding Bell Inequalities to win the game through partial communication.

Methods Overview:

In Python we have coded classical versions of a casino game in an attempt to compare quantum sister scenarios. We have also used QuTiP (Quantum Toolbox in Python) to simulate and code quantum versions of the casino game in order to prove the mathematical advantage gained in specific tailor made scenarios when compared to classical states. We hope to identify a series of tests and checkpoint used to identify real world applications for these Bell violations.

Results Overview:

We have demonstrated the impossibility of generating any long-term classical strategy in any two player scenario. We have also found that it is possible to develop a strategy where players can achieve a quantum advantage when compared to classical states. We hope to be able to expand this situational analysis in order to develop a checklist to identify real-world cases where Bell Inequality information suggestion could provide aid in communication scenarios.

Future Projects

In the future, we hope to be able to expand our analysis of these quantum scenarios to include a basic outline of criteria which must be satisfied in order to provide a quantum advantage. While tailor made cases are useful for providing theoretical explanations, they have little impact on the physical world. We hope to be able to identify more general classes of scenarios where two "players" would benefit from this quantum enhanced decision making where classical communication is insufficient, impractical, or impossible.

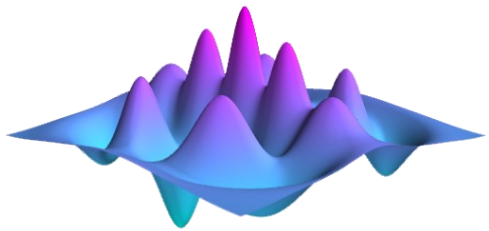

Image citation: http://qutip.org/docs/latest/

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