From: Seth Lloyd <slloyd@mit.edu>
To: "jeffrey E." <[redacted]>
Subject: Re:
Date: Mon, 06 Jul 2015 07:59:17 +0000

Dear Jeffrey,

My apologies for not responding sooner. I took an email vacation for a week plus which turned out to be a mistake because I fell irrevocably behind.

That was a very fun conversation with Noam in Cambridge: he is an amazing thinker (if a tad inflexible at times).

Your question about entropy is an important one. The second law of thermodynamics tells us that systems go to states of high entropy where events are random and uncorrelated, so that thermal fluctuations appear to be statistically independent. However, if you look under the hood of the second law, you find that what is really going on is that the dynamics that leads you to this high entropy state is actually generating huge amounts of correlations between the different parts of the system. In fact, the apparently random and independent fluctuations of the parts reflect large correlations with the other parts of the system. But these correlations are effectively smeared out over the whole system: to reveal the fact that they are not truly independent, one would have to make measurements on all the parts together, and tease out the extensive but subtle correlations between them.

For example, even though the apparent high entropy of a gas of molecules reflects all the correlations that are generated by the collisions of molecules over time, if one looks at just two molecules in the gas, their motions will be statistically independent to a high degree of accuracy.

On your second question, quantum superposition is indeed closely analogous to a chord in music: the strangeness and power of quantum superposition arises out of the interference between the different waves in the superposition. A classical computer can only register one set of logical values for its bits at any given time. So a classical computation is like plain chant: a single sequence of tones without interference. By contrast, a quantum computation is like a symphony: its power comes from the rich sequence of quantum `chords.'

There is a difference, however. The more waves that participate in a quantum superposition, the smaller the amplitude of each wave: the sum of the square of the amplitudes is always 1. So unlike music, where the volume can change, the total `volume' of a quantum chord is always the same not matter how many tones are added.

Hope these answers help.

You wrote earlier about life being a process of functors acting on functors. Amen! I am working on trying to prove that sets of ordinary differential equations of the kind that underlie chemical dynamics will spontaneously give rise to such a functorial dynamics.   Not so easy . . .

Hoping you are well. I am currently at the physics center in Benasque, in the high Pyrenees, where physics is done primarily on long hikes in the mountains. Very nice.

Hoping our paths cross soon,
Seth

On Tue, Jun 23, 2015 at 6:42 AM, jeffrey E. <jeevacation@gmail.com> wrote:

> seth, Ive been having many email exchanges with noam. great fun.   I am stumped. on the concept of a large probabitlity space? entropy. . ?   if the space is large enough , how does one know if there is independent events. . as the information would take so much time to travel between each and or observer.   ?   quesiton 2. in music , one has a dominant tone and then harmonics. . a chord is a combination of those . lets say 1st third and fifth? .   is that equivalent to a superpostion at the quantum level?   your ear performs a transform to tease out each tone afther the fact. ?
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> please note
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