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In physics, energy is that which is causally invariant or symmetric with respect to time. Said differently, energy is never created or destroyed, it is conserved in the universe.

Now there is a question about information. Is information causally invariant? Does information remain the same with respect to time? To understand this, let's first understand what energy is, then attempt to understand what information is.

The strange thing about energy is that it is this universal currency that seems to be interchangeable between the different forces in nature (i.e. electromagnetic, strong, weak and gravity). It is that thing that makes change possible.

Now let's assume that the universe is computational in nature. That is, anything we see in nature is a consequence of computation. That is, there is computation underneath the physics that is driving the universe to change.

What does it mean then that information is conserved in this computational universe? Also, how is energy conservation related to information conservation?

Information conservation implies that it is that thing that does not change in time. That there is this bit that can't be changed. This is different from energy in that it is not an agent of change. Energy can be transformed, it's just the overall quantity remains the same.

Energy is what we would call a value and not something with an identity. When we speak however of information, that is of a bit, do we also imply an identity? That one bit over here is different from another bit elsewhere?

Are we speaking of the difference between a fermion (that has identity) and a boson (one that does not). A fermion is that elementary particle that is uniquely defined by its quantum features. The universe has a rule that fermions are unique (hence identity).

So when we speak about information, are we referring to uniqueness? If so, then information is different from energy. Energy is to bosons as information is to fermions.

How do fermions change their identity (i.e. change their quantum state)? Through energy that comes from the force carriers (i.e. bosons).

So to conclude, when you use the word conservation you imply a value, that is a quantity. When you speak of information, you imply a unique state.

That unique state is not time-invariant. It is incorrect to say that information is conserved. It's more apt to say that information is 'reconfigured'.

Now it takes exchange of energy to get to a specific quantum state. An atom can receive a photon or release a photon, this happens when its quantum state changes. There is no reconfiguration of information without an exchange of energy.

In a digital computer, we typically don't concern ourselves with the energy cost of transforming from one information state into another state. It is of course always present. Information in a computer always requires energy to change.

We also never care to use energy conservation rules to analyze the mechanisms of an algorithm. A computer is not a closed system. It draws energy from the wall that it is plugged into. (note: Wall is connected to the grid)

But here's the rub. A biological brain cares about energy conservation. A biological brain cares about where it's going to get its next meal. A biological brain isn't plugged into the wall that gets a steady influx of energy. (note: plants get it from the sun)

A biological brain cares about information about sources of energy. Information that is relevant for a brain is not the same as the information that is relevant to physics. Although both are related to energy.

A brain cares about information about energy. In physics, information is configured because of energy. These are just two different things. One is about energy and the other is the effect of energy. Let's not confuse the utterly obvious!

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