Explaining Free Will and Consciousness with a Modified Probability Interpretation

YoungDae Seo

Abstract

This paper explains consciousness and free will through a modified probability interpretation. According to this, consciousness arises through the collapse of a wave function, and free will arises through quantum mechanical chance. Furthermore, both synapses and microtubules play a crucial role in the formation of free will and consciousness.

1. What is Consciousness?

According to Schrödinger's cat thought experiment, the state of the cat before the observation is a superposition of a living cat and a dead cat.[1] However, according to a modified probability interpretation, the state of the cat can be determined by crossing a threshold without making an observation.[2] Below the threshold, the cat's state is a superposition of the living and dead states, and once the threshold is crossed, the cat observes its own state through the collapse of the wave function. In other words, the cat recognizes its own state through the collapse of the wave function. To recognize one's own state is to be conscious of oneself. In other words, consciousness is the observation of oneself through the collapse of a wave function.

The collapse of the wave function corresponds to the primitive computational process of representing 0 and 1. The existence of matter is observed through the collapse of the wave function. When a wave function collapses, only one part of it has an output of 1, while the other parts have an output of 0. Matter can determine its own state through the collapse of the wave function. However, since matter does not have intelligence, it simply distinguishes between the 0 and 1 states. However, Schrödinger's cat has a more complex structure than a small particle and forms a unique logical structure through neural networks in its brain. Therefore, Schrödinger's cat does not simply output 0s and 1s, but contains much more complex information, and the cat recognizes itself by observing its own information through the collapse of the wave function. In other words, for the collapse of the wave function to be conscious, the system must be sufficiently complex and have a unique logical structure.

In Schrödinger's cat thought experiment, suppose I enter with the cat, and I am a superposition of the awake cat and the sleeping cat, and when the superposition is broken by crossing a threshold, I observe either one of them, i.e., I recognize myself through the collapse of the wavefunction. Here, I have sufficiently complex information and logical structure through my brain's neural network, and I have sufficient intelligence to recognize myself. In other words, for me to recognize myself, I must have a sufficiently complex neural network, and it must be accompanied by the collapse of the wave function. The level of consciousness is inextricably linked to intelligence, but at the same time, for consciousness to exist, there must be a system that utilizes the collapse of the wave function.

For example, a candidate system that utilizes wavefunction collapse is microtubules. Dr. Hameroff argues that microtubules are responsible for human consciousness.[3] However, the presence of microtubules does not mean that all life has a sufficient level of consciousness. A sufficiently high level of information complexity and logical structure is required for life to have a high level of consciousness. The microtubule is an organ that exploits the collapse of the wavefunction rather than increasing the complexity of information, and its role in processing information is primarily driven by the plasticity of the synapse. Without synapses, organisms cannot have a high level of consciousness, and without microtubules, organisms cannot exploit the collapse of the wavefunction and thus consciousness cannot exist. Both microtubules and synapses are essential in the existence of consciousness.

2. What is Free Will?

The Libet's experiment suggests that our decisions are made unconsciously, and that free will is an illusion, but there's a premise. [4] It assumes that everything the brain does is deterministic according to the laws of physics. If you look at just a single neuron in the brain's neural network, it seems obvious that the brain's activity is perfectly deterministic. Neurons are responsible for transmitting electrical signals, and electrical signals are created by the movement of particles with electrical polarity. The movement of particles is determined by the laws of physics, so it would seem that brain's activities and thoughts are not determined by free will, but by the laws of classical physics. It would seem that there is no room for quantum chance in the brain's activities.

However, what we are missing is that the activity of the brain's neural network is not only driven by homosynaptic plasticity, but also by hetero-synaptic plasticity. The combination of homosynaptic and hetero-synaptic plasticity is mathematically very analogous to the behavior of a wave function and leaves room for quantum mechanical chance to intervene. When the wave function collapses, the probability of finding a particle at any point is 1. At all other points, the probability is zero. Expressed as an ordered pair,

$$P = (0,0,0,1,0,0,0,\dots)$$

In the case of a neural network, similarly, LTP occurs only at selected synapses and LTD occurs at the rest. Expressing this as an ordered pair,

$$w = (0,0,0,1,0,0,0,\dots)$$

The two phenomena are not the same, but they have interesting enough similarities. In quantum mechanics, the observation of particles is probabilistic, while homosynaptic plasticity is deterministic. Hetero-synaptic plasticity, however, leaves room for chance. In hetero-synaptic plasticity, the strength of the connection at the synapse is determined by the motion of the particles. In this case, the motion of the particles is determined by the collapse of the wavefunction. In other words, the motion of the particle obeys the laws of physics but is determined by quantum mechanical probabilities. This phenomenon can be found not only at the synapses of neural networks, but also in memristor devices that mimic synapses. Conventionally, a memristor is composed of an electrode/resistance change layer/electrode structure.[5] Here, the resistance change layer imitates a synapse. When electrical stimulation is applied to the resistance change layer through the electrodes, the resistance is changed. In terms of classical mechanics, when electrical stimulation is applied, resistance change will occur only in selected devices as shown in Figure 3.

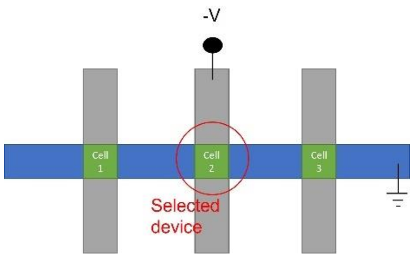

Fig3. Memristor switching. In terms of classical mechanics, resistance change should occur only in the selected device 2.

Surprisingly, resistance changes also occurred in devices 1 and 3, which were not selected. For example, when selected element 2 decreases in resistance, the unselected device 1 and device 3 randomly increase in resistance. This phenomenon is like that of hetero-synaptic plasticity, and the mechanism is likely to be similar. Homosynaptic plasticity is the change in connection strength of a synapse after an electrical stimulus is applied. Hetero-synaptic plasticity, on the other hand, changes the connection strength of unselected synapses. For example, if homosynaptic plasticity is LTP, then hetero-synaptic plasticity is LTD. Here, LTP refers to an increase in the connection strength of a synapse, while LTD refers to a decrease in the connection strength of a synapse. If this hetero-synaptic plasticity is probabilistic, then chance is involved in the brain's neural network. And chance in the brain's neural network is what makes it possible to mimic free will. In other words, quantum mechanical chance can create free will. According to this, the conclusion of the Libet’s experiment can be reinterpreted. Free will is not an illusion, but an interpretation of the brain.

3. Conclusion

This paper has attempted to explain consciousness and free will using a modified probability interpretation. According to the modified probability interpretation, consciousness is the observation of oneself through the collapse of a wave function, and free will is caused by quantum mechanical chance. The most likely candidate for an organism to exploit wavefunction collapse is microtubules, and the most likely way for the brain's neural network to involve quantum mechanical chance is through hetero-synaptic plasticity. It is also speculated that for an organism to have consciousness, it needs neural networks, not just microtubules, and for it to have free will, microtubules are likely to play a significant role in exploiting quantum mechanical phenomena. In other words, both microtubules and synapses are important for free will and consciousness to exist.

4. Reference

[1] Schrödinger, Erwin (November 1935). "Die gegenwärtige Situation in der Quantenmechanik (The present situation in quantum mechanics)". Naturwissenschaften. 23 (48): 807–81

[2] YD Seo, 'Modification of the Born Probability Interpretation

[3] S Hameroff, R Penrose, Consciousness in the universe: A review of the 'Orch OR'theory, Physics of life reviews 11 (1), 39-78

[4] Libet, B., Do we have free will?, Journal of Consciousness Studies, Volume 6, Numbers 8-9, 1 August 1999, pp. 47-57(11)

[5] Anjae Jo, Youngdae Seo, Museok Ko, Chaewon Kim, Heejoo Kim, Seungjin Nam, Hyunjoo Choi, Cheol Seong Hwang, Mi Jung Lee, Textile Resistance Switching Memory for Fabric Electronics, advanced functional materials, Volume27, Issue15, 1605593 (2017)