Modification of the Born Probability Interpretation

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Abstract

This paper provides a new perspective by reinterpreting Born's probability analysis. Since neural networks and wave functions have mathematical similarities, Born's probability interpretation was modified into a new form. In this new interpretation, the wave function has a kind of threshold value, outputting the number 1 above the threshold and outputting the number 0 below the threshold. The new interpretation of this paper provides an explanation for the decay process of the wave function and helps us understand the creation of the universe and the formation of consciousness.

1. Introduction - The problem of the collapse of the wave function

According to the existing Born probability Interpretation, the square of the absolute value of the wave function means the probability density that a particle will be found at a certain position. When a particle is found at a certain location, the wave function collapses and has a shape with a maximum value at the location where it is found. In other words, a particle is expressed as a probability of existing in space before observation and is found at that position when observation occurs. This statistical interpretation introduces a kind of uncertainty into quantum mechanics. The question then arises whether indeterminacy is a fundamental property of nature or is due to the incompleteness of the theory. Where was the particle before the observation? How does the collapse of the wave function happen? What is Observation? These questions have been a concern for many physicists and philosophers, and many alternatives have been proposed, such as the hidden variable theory and multi-world interpretation, but the correct answer has not yet been clarified.

This paper presents a new perspective on Born probability interpretation. According to the research in this paper, the Born probability interpretation needs to be modified or supplemented. Born probability interpretation has a blind spot in that it cannot explain the collapse of the wave function. There are two different types of physical processes in quantum mechanics: one in which the wavefunction proceeds continuously according to Schrödinger's equation, and the other in which the wavefunction collapses suddenly and discontinuously. Much is known about the former, but the latter is still a mystery. Therefore, this paper focuses on the collapse of the wave function.

2. Similarities between wave functions and neural networks, and modification of interpretations.

There are many similarities between neural networks and wavefunctions. These similarities may be coincidental, but they provide new ideas in the interpretation of wave functions. Because wavefunctions and neural networks are mathematically similar, we can find something missing in Born's probability interpretation from neural networks. The simplest mathematical model of a neural network is called a perceptron. Perceptron, an early form of artificial neural network, is an algorithm that outputs one result from multiple inputs. Figure 1 shows the structure of the perceptron. The perceptron is mathematically represented as:

$$\psi(x) = \sum_{i}^{n} w_i x_i = w_1 x_1 + w_2 x_2 + w_3 x_3 + \cdots + w_n x_n$$

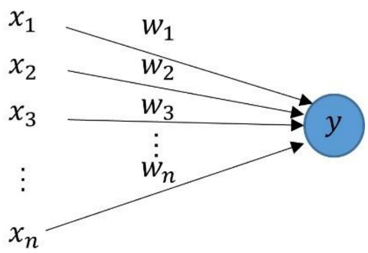

Fig1. Perceptron

An artificial neural network consists of a network of multiple perceptrons. These neural networks have a mathematical form very similar to a wave function. Like neural networks, the wavefunction has a linear equation:

$$\psi(x) = \sum_{i}^{n} c_i \phi_i = c_1 \phi_1 + c_2 \phi_2 + c_3 \phi_3 + \cdots + c_n \phi_n$$

However, unlike neural network equations, wavefunctions are not physically clear. Instead, the square of the absolute value of the wavefunction has a known physical meaning. The square of the absolute value of the wavefunction represents the probability density of locations where the particle can be found.

$$\rho(x) = |\psi(x)|^2 = \left|\sum_{i}^{n} c_i \phi_i\right|^2$$

$$P = \int_a^b \rho(x)dx$$

Here, the maximum probability is 1. Common sense knows that the probability cannot exceed 1. However, one doubt can be raised here. The probability obviously cannot exceed 1. But can't the square of the absolute value of the wave function exceed 1? We take for granted that the probability and the square of the absolute value of the wavefunction are equal. But is it really so? Let's make one assumption. What if the square of the absolute value of the wavefunction has some critical value? What if the probability represented the output rather than the square of the absolute value of the wavefunction? Then the square of the absolute value of the wavefunction can exceed 1. Then, the following inference can be made. The probability cannot exceed 1, but the square of the absolute value of the wavefunction can exceed 1. So, what should happen if the square of the absolute value of the wavefunction exceeds 1? If the square of the absolute value of the wavefunction crosses a threshold, the output should be 1. That is, the probability must be 1. In other words, the wave function must collapse. In other words, the particle is observed.

We have taken for granted that the square of the absolute value of the wave function and the probability are equal, but it may not be the case. The square of the absolute value of the wavefunction represents the density of some physical object, with a probability of 1 if this density exceeds a critical value and a probability of 0 if the density does not exceed a critical value. In other words, the wave function represents the relationship between the input and the weight, and the probability represents the output. Surprisingly, there may be similarities between wavefunctions and neural networks with respect to thresholds.

$$P = \begin{cases} 1, & for\ |\psi(x)|^2 \geq V_{th} \\ 0, & for\ |\psi(x)|^2 \leq V_{th} \end{cases}$$

According to this interpretation, the collapse of the wavefunction occurs spontaneously when the square of the absolute value of the wavefunction or a certain physical quantity exceeds a threshold. The act of observing can correspond to the act of making a certain physical quantity easily exceed a threshold, and even without a separate observation, the wave function can spontaneously collapse over time beyond the threshold. The spontaneous collapse of a wave function causes the wave function to have a maximum at a particular location.

3. Consideration of the spontaneous collapse of the wave function

Then, through what physical process does the spontaneous collapse of the wave function occur? According to Schrödinger's equation, the wave function spreads out continuously over time. At some point after the wavefunction spreads out, since a certain physical quantity reaches a threshold value, the wavefunction must collapse spontaneously. The important thing to note here is what happens when the threshold is reached. If it is assumed to occur at any point in the wave function, the amplitude of the wave function becomes infinite. This means that the energy density at one point becomes infinite. This means that the spontaneous collapse of the wave function creates a singularity. The singularity rapidly expands to form a new wave function and spreads out again according to the Schrödinger equation. The creation of the singularity is related to gravity, and the square of the absolute value of the wave function is divided into an infinite part and a finite part. Here, the infinite part represents the number 1, and the finite part represents the number 0. Let's call this process the primitive computational process. The reason for this primitive computational process is that nature cannot clearly distinguish the size of finite numbers. Unless nature is conscious of itself, it is difficult for nature to distinguish the subtle differences in numbers. However, if a singularity occurs by chance at any point above the threshold, a clear distinction is made between the infinite and finite parts. This allows nature to distinguish between two outputs, 0 and 1. In other words, nature distinguishes between infinite and finite numbers and performs calculations.

It is estimated that this primitive calculation process not only plays a very important role in the birth process of matter and the universe, but also plays a very important role in shaping human consciousness. The human brain neural network has a mathematical structure very similar to a wave function, and among them, microtubules are presumed to have a function that can store the superposition state of the wave function. In microtubules, the wave function spontaneously collapses when it exceeds a threshold value, performing primitive computational processes and storing these computational results in specific patterns to form our consciousness. In other words, human consciousness originates from the superposition and collapse patterns of wave functions.

4. Conclusion

There are two physical processes in the wave function, one is the process in which the wave function continuously changes according to the Schrödinger equation, and the other is the process in which the wave function spontaneously collapse above a threshold value. Since the wave function must reach a threshold at some point, the collapse of the wave function will inevitably occur regardless of whether it is observed or not. This process of collapse of the wave function generates a singularity, which divides the wave function into a point where the amplitude is infinite and a part where the amplitude is finite, which allows nature to distinguish between output values of 1 and 0. This process is called the primitive computational process, and it plays an important role in the birth of the universe and the creation of matter, as well as in the creation of human consciousness. However, since the assertion in this paper is only a hypothesis, further research on the collapse process of the wave function will be needed in the future.