The mystery of Neural Network: linked with quantum mechanics and universe

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Abstract

This short literature puts light on the conceptual connections between the neural networks (NNs), quantum mechanics, and the universe. It underlines the fact that share reliance on the high-dimensional and the probabilistic principles. Neural networks, as a computational models, shows complex behavior through the non-linear transformations in high-dimensional spaces, where the interchange of weights and the activations replicates the abstract representations found in the quantum systems. Similarly, to the way the quantum mechanics operates with a probabilistic framework, emphasizes the uncertainty and entanglement at the microscopic scales. Drawing on these analogies, this literature puts forward an idea that the universe itself may be viewed as a vast computational framework, where the inter-related processes resemble the layered operations of NNs. By understanding these interdisciplinary connections, we focus to shed light on the underlying mechanisms of the complex systems. This can further inspire new approaches in artificial intelligence and physics, which can open new dimensions toward a unified understanding and explanation of information, computation, and the nature of reality.

Keywords: Neural Networks, Machine Learning, Quantum Mechanics, Universe, Computer Science

In examining the complexities of the neural networks (NN)s there emerges an analogy between their operations with the probabilistic nature of the quantum mechanics and the structural dynamics of the Universe. At the quantum levels, the things gets highly probabilistic the same like the inner workings of the NNs which are very complex due to their high dimensional representations. Both the NNs and the Universe at the quantum levels is full of uncertainties where the things does not operate in a deterministic approach as we understand them at real

life. The NNs and the Deep Learning (DL) models works in a high dimensional spaces. The activation of the neurons denotes the data points in high dimensional spaces and the transformations which happens through the hidden layers of the NNs are essentially mapping these points through complex and non-linear operations. In some sense, the abstract representations of the data in the NNs can be viewed as an analogy to how the matter and the energy in the universe remains entangled and intersected in a way that we don't understand fully. Just like the space-time is complex and a multi-dimensional built in the fields of Physics, the weights and the activations of a NN operates across the multi-dimensions which doesn't necessarily link to any direct evident facts. It is in-fact that the feature space in the NNs often remains abstract much like the hidden layers of the reality in the quantum physics.

The quantum mechanics is probabilistic by nature. The particles and the quantum state don't have any deterministic positions or velocities and they define by the probability distributions. The NNs in complex architectures like that of an attention mechanism show behavior which may seem probabilistic as well. For eg., the attention mechanism don't have any deterministic way to decide which part of an input to focus on rather it depends on the learned probabilities from the past training instances to put attention to the various parts of an input.

The non-linearity in NNs like the activation function can be linked to the quantum superpositions where the various features interact and combine in a non-inherent way. The training of a NN is like the behavior of the quantum systems which is not deterministic and largely depends on the past training data, weights, etc.

The connection between the NNs, quantum mechanics and the universe also has some philosophical advantages. The NNs much like the universe are systems that processes information in a complex, non-linear technique across multiple dimensions. If we consider the training of a NN as a quantum system, then we may think the weights in the NN as a quantum state which evolves based on the interaction (data) and the back propagation as the type of feedback that updates the states for reaching a more optimized state (solution).

The universe from a computer science perspective can be viewed as a large interconnected network of information processing systems where each individual element like the planet, star or particle can be considered as a neuron in a NN which is processing and transmitting information across the various scales and dimensions. So in this approach the internal working of the NNs and the universe may be part of a deeper and a more fundamental computational framework. The unknowns in the quantum mechanics and the NNs can be lined to the fact that we struggle to predict and explain the behavior of a particle at the quantum levels due to the high dimensionality and probabilistic nature, similarly we also struggle to fully understand the fact how a specific neuron in a Deep Neural Network (DNN)

contribute to the final decision because the network also operates in a similar degree of abstraction and high-dimensional space.

The Theory of Everything (TOE) in the Physics attempts to connect the general theory of relativity (describing the large scale phenomena like the gravity) with the quantum theory (behavior of particles at the smallest levels). If we have to connect this theory with the NNs then we can think of deep learning as a part of a large and a more deep computational framework which is mimicking or is inspired by, the dynamics of the universe at both the large and the small scales. There can also be drawn resemblances to the fact that the NNs could represent a soft computing model for the universe. NNs can be viewed as a simplified model of complex systems which captures behaviors and patterns emerging from systems operating in high dimensional spaces just like the Universe itself. The feedback loops like the back propagation in NNs resembles the feedback loops in the nature like the ecosystems or the feedback in the quantum measurements. Ultimately it can be viewed as a point that the universe and the NNs operates in high dimensional spaces where the actions are often not understandable or explainable by the human intuition.

Here ideas can also be developed on the context that the mysteries of the universe, whether be it in computer science, physics or human brain can be part of a larger computational structure. If we can bridge the gap between the machine learning, quantum physics and the human brain then we may start to visualize an unified way to understand and explain how the complex systems like the NNs or the Universe evolve, learn and make sense of the areas around them.

The thing is that NNs, quantum mechanics and the universe shares a fundamental quality where all of them operates in high dimensional spaces where the behavior emerge in a non-linear and probabilistic ways. The exact connections among them remains unexplored but it is clear that both the NNs and the quantum mechanics operates on the principles that is reflected by the complexity of the Universe itself.

Finally, it can also suggested that fully understanding and explaining the complete practical working of the NNs might eventually need bridging these concepts which can lead to new dimensions in both the artificial intelligence and the fundamental physics.