Complexity

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Abstract

In the text "Complexity", I create a definition for complexity and a standard to measure how complex a specific entity is. By using this method, we can easily compare the complexity of different objects and explain clearly why certain objects are more complicated than others. Moreover, I also suggest that we shall use Complexity to replace the Entropy because there is no such thing as order or disorder in the real world.

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Keywords

Complexity; elementary component; unique combination;

1. Introduction

Why I want to talk the complexity, because we are living in complex world. Is this world simpler or less complicated before? I believe the answer is yes. Is this world will be more complicated? Or is this complexity remains the same or it will be more complex? Does the complexity have an ultimate end or it will grow more and more complex? These questions are the reasons I want to discuss this theme. To answer these questions, I need a definition for complexity and a standard to measure it.

2. Definition of Complexity

Here is my definition for complexity: The complexity can be defined as the number of unique combinations of the elementary components contained within a closed system. The greater the number of unique combinations, the more complex it is. The term “Unique” refers to the combination that is the only one within the system; no other combination is identical. The term “Combination” refers to the relationship among all the elementary components within the system; and the relationship can be distance between the components, or the connections between the components. By using the definition I mentioned above, we can determine which object is more complicated, and why, and how much more complicated than the other.

3. How to Measure Complexity

As shown in the Figure 1 below, each dot is one elementary component within the system. In the following example, I just present two geometric figures; one is five dots along a straight line with equal distance between dots, and the other is five dots forming a cross with equal distance between all four dots in the four directions and central dot. In the figure below, a is an arrangement of 5 dots in a straight line, and b is an arrangement of 5 dots in a cross. It can be seen from the blue boxes on the right that the number of unique combinations contained in a is 5, and the number of unique combinations contained in b is 7. It can be concluded that b is more complicated than a. If one of the dots is changed to red, as shown in c, the number of unique combinations will increase further. And if I change the plane space where the dots locate into a three-dimensional space, then I can get more and more unique combinations. I think there is no need to draw any more figure to illustrate this point.

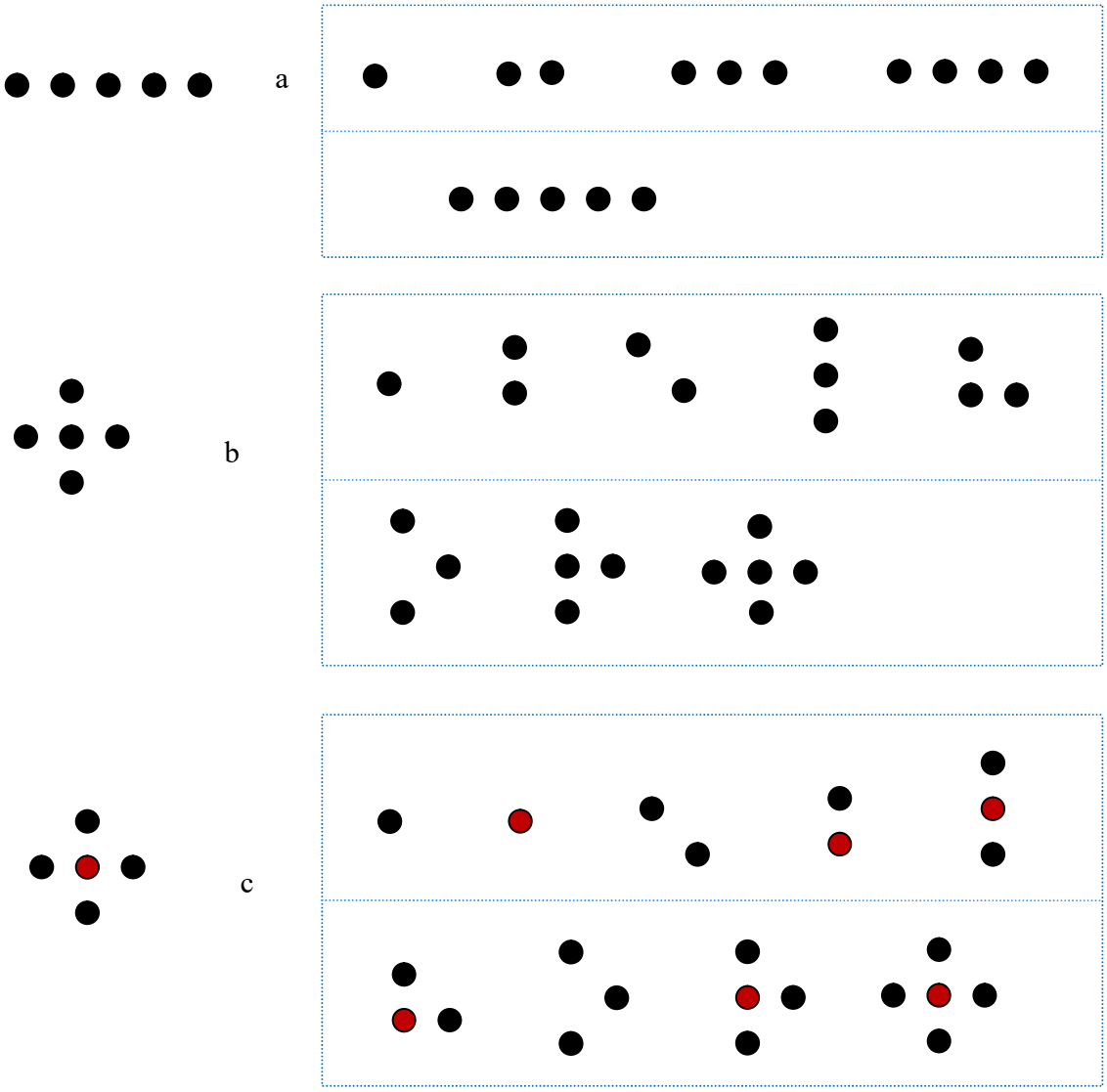

Figure 1: How to measure complexity

Now, if I replace all these dots with particles in real world, then I can use this standard to measure the complexity of matters in real world. For example, a glass of water and a glass of milk, we all know that milk is much more complicated than water. Now we know that there are many kinds of amino acids that make up protein, and there are many morphological differences in this composition, while liquid water only has water molecules, so the numbers of unique combinations extracted from the two should be very different. Likewise, we can also explain why when a piece of glass is broken, it is more complicated than when it is not broken. These examples can go on and on.

4. Complexity and Entropy

Entropy is the measure of the disorder of a system. However, the problem is that there are no definitions of "chaos", "order" and "disorder". Moreover, even if someone gives their definitions, I believe these definitions are also given from the human perspectives. For example, clothes placed in order and clothes piled together in disorder, obviously the former is more orderly than the latter, and the latter is more chaotic or disorderly than the former. But this measurement is totally from our human perspective for the purpose of practicality. We human beings can create our own standard for order and disorder, but this is not the standard for the real world. Or order and disorder are just another concept created by our human imagination, and they do not exist in the real world. For the five dots connected in a straight line and arranged in a cross shape in the above Figure 1, which arrangement is more orderly or disorderly? Different people may have different opinions about which one is more orderly, and we can never have an absolute answer. But if we discard the concept of "Order and Disorder" and replace it with "complexity", we can get a unified standard and then answer this question.

5. Conclusions

In addition to explain the matters, what I am really interested is why the real world runs from less complicated to more complicated. Countless elementary particles of only several kinds (to be exact, just three kinds) follow some simple rules of interactions that govern them to run for billions of years to form today's universe. This direction from simple to complex over time can be seen everywhere in the universe, and I don't need to argue on this point. So if this is true, why the universe does this? What is the purpose of the universe? Of course I have no good guess, that is why I bring up this question here for other to think.

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References
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