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Research article

The Emergence of Justice and Self-Organized Criticality in Plato's Republic

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Abstract

I argue that justice, as defined by Plato in the Republic, does not meet the rigor required to be defined as an emergent phenomenon until the city has fully developed [7]. The first part of my argument uses contemporary views drawn from the sciences to establish criteria for distinguishing non-emergent from emergent phenomenon, while the second part of my argument is framed around Stuart Kauffman's theory of self-organized criticality (SOC) [10]. I will use the theory of SOC as an analog to determine when justice is and is not emergent as a function of the complexity of the city. Here, the defining characteristic of an emergent system is that some of its global behaviors, which are a result of interactions between large numbers of relatively simple parts, cannot be predicted simply from the rules of those underlying interactions [4]. The findings of my research, namely that justice, as defined by Plato in the Republic cannot be defined as emergent until the city has fully developed. Applications of my argument include, but are not limited to its use as a tool for exploring the concept of emergence and SOC in other philosophical systems, in addition to other naturally occurring systems in nature.

Key words: Plato's Republic; Justice; Emergence; Self-Organized Criticality; City; Global behavior

Introduction: The Soul, City and Emergent Justice

Socrates, Plato's muse, in his debate with Adeimantus [7], and latter with Glaucon [7], partitions justice into two distinct parts: (1) the irreducible parts of the tripartite soul, which include rational, spirited, and competitive elements, and (2) the tripartitecity, made up of the reducible classes including philosophers, guardians, and artisans. Together, parts (1) and (2) give rise to a form of irreducible justice, where justice is defined as "having and doing one's own and what belongs to one" [6, p. 110] [7]. As the city evolves, it becomes clear that "Where earlier the principle of justice was meant to ensure that the crafts worker did not do one another's work, now that the city has grown to such an extent in size and complexity, that kind of interchange is relatively harmless" [6, p. 110] [7].

Clearly, a demarcation exists: in the cities infancy, justice as a function of the cities complexity begins as a non-emergent phenomenon stemming from interactions between a small number of relatively simple parts [7,14]. As the city develops and becomes more complex, global behavior gives rise to an emergent justice, where the size and complexity of the city makes it unnecessary to consider this exchange. In effect, the demarcation represents the point where justice switches or tips from a non-emergent to an emergent phenomenon. As a result, one has to consider if the member of a class is required to do the work of another. Here, I defineaproperty of a system as emergent whenever that system has a physical basis, but it is not merely a logical consequence of that physical basis [3], and distinguish between emergent and non-emergent systems if properties of the system have a physical basis, and are not merely a logical consequence of their physical basis (see above). In what follows, I describe the physical criteria required for distinguishing emergent from non-emergentphenomena.

Distinguishing Non-emergent from Emergent Phenomena

Many kinds of natural things are arranged in a hierarchy of existential dependence: biological things depend on their chemical and physical basis, psychological phenomena depend on biological processes, social occurrences depend on psychological events, ad infinitum. One can get a preliminary hold of the concept of emergence by looking at how it is used. Emergence plays many roles in the sciences. Most importantly, it has been used to attribute a material basis to phenomena that have resisted reduction to fundamental physics. To satisfy this role, one can call a property emergent whenever it has a physical basis, but it is not merely a logical consequence of that physical basis [3].

When a complex system has a physical basis, its emergent properties, if they exist, must meet the following canonical or rule based criteria: (1) novelty of the properties in the system, [1](2) that the properties result from 'essential interactions' of constituent parts of the system, and (3) that the laws governing the properties be irreducible to laws about lower-level properties [16, 9, 11, 15].

[1]The evolutionary process where there is heritable change in the nucleotide sequence of a chromosome.
[2]The evolutionary process whereby environmental or genetic influences determine which type of organism reproduces better than another organism.

Self-Organized Criticality and Justice

In what follows, I argue that justice, as defined by Plato in the *Republic*, not only meets the requirement of an emergent phenomenon, as prescribed by Socrates [7], but also possesses characteristics analogous to systems that have reached self-organized criticality (SOC) [10,5,12]. SOC is typical of emergent systems in evolutionary biology. It applies specifically to the evolution of living organisms. For example, the evolution of a species can occur when a massively disordered biological system, like the genomic system of a higher metazoan, which consists of 10,000–100,000 structural and regulatory genes, work together through time to spontaneously crystalize a very high degree of order. Order is perpetuated through the generation of a developmental program that underlies ontogeny from the fertilized egg to adulthood via random mutation[1]and selection[2] [1]. In what follows, I show that justice is analogous to ontogeny, while the soul and city of philosophers is analogous to the disordered genomic system. Hence, I argue that the dynamical evolutionary behavior of an individual organism is a powerful analogy for describing Plato's system of the soul, city, and emergent justice.

Justice as an Evolving Organism

As stated in previously, justice is defined as "having and doing one's own and what belongs to one" [6]. Much like a biological organism, Plato's justice emerges or crystallizes into a system that is irreducible (i.e. a mature biological organism) and contains a high degree of order, which is a function of the interaction between the tripartite city and soul (i.e. the interaction between structural and regulatory genes possessed by the biological organism). During its early development, the city lacks size and complexity (i.e. it lacks large numbers of individuals in each class, and fully functional class types). Though justice exists, its reducibility makes its existence tenuous. Much like the evolution of a biological species through random mutation and selection, justice becomes irreducible once the numbers of each class in the tripartite city becomes large and complex, and there is continuous growth and turnover of each class of individuals as a function of their importance to the stability of the city through time (i.e. selection). By importance, I place the guardian class as most important to the stability of the city, followed by philosophers and artisans, respectively.

The interaction between the fully developed soul and city acts to perpetuate a "poised" state near the boundary between order and chaos [10]. The state optimizes the complexity of tasks the system can perform while simultaneously optimizing evolveability. By analogy, optimization of the evolution of the city occurs when it is no longer necessary for philosophers, guardians or artisans to do the work of another. Hence, the individual has and does his or her own and retains what belongs to him or her.

The Soul, City and Justice as a Dynamical System

Previously, I intimated that Socrates definition of justice as an emergent phenomenon changed in debates with Adeimantus [7], and latter with Glaucon [7].As the number of classes within the tripartite city increased in size and complexity, it was not necessary for individuals within a class to the job of another. Hence, an increase in the size and complexity of the city precipitated in tipping justice from a non-emergent to emergent phenomenon.

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Dynamical systems [13] are the mathematical language used to describe the integrated behavior of systems coordinating the actions of many parts (e.g. the integrated behavior of the elements of the soul and classes of the city). Dynamical systems theory describes the behavior of an integrated system of high complexity. Unlike the soul, whose virtues are stable in time and space (a steady state attractor[3]), the city continuously changes as it grows in size and complexity. Hence, dynamically, the city exits in an oscillatory limit cycle[4] around which the system flows repeatedly (Figure 1) [8].

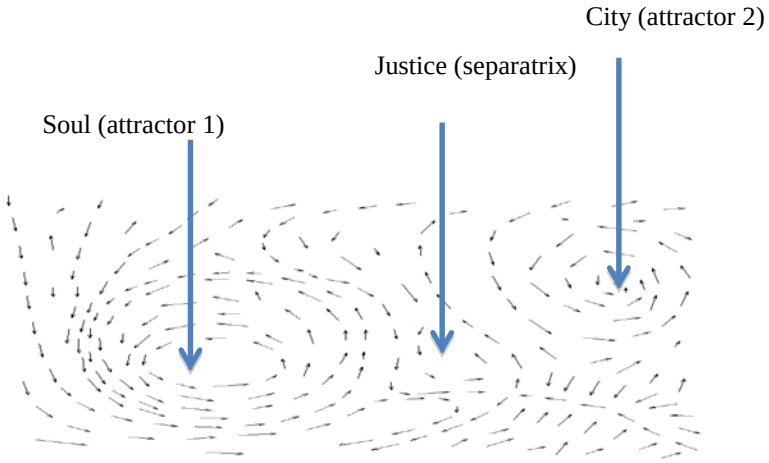

Figure 1. Three-dimensional state space illustrating the emergence of justice. There are two basins of attraction (the soul and the city), separated by a wall or separatrix (justice). Within each basin of attraction, arrows are the trajectories (i.e. elements of the soul and classes of the city), that flow deterministically toward an attractor and remain on the attractor (attractor 1 or 2) through time unless disturbed by an outside perturbation. Attractor 1 corresponds to a steady state (the soul), while attractor 2 corresponds to an oscillatory limit cycle (the city) around which the system flows repeatedly. The separatrix (justice) separates the flow of trajectories into attractor 1 or 2. The flow of trajectories from attractor 1 and attractor 2 into the separatrix creates justice.

[3]A steady state attractor is an attractor in state space where points or trajectories (i.e. elements of the soul) flow continuously in a cyclical manner and do not change in time.

[4]An oscillatory limit cycle is an attractor where points or trajectories (i.e. classes of the city) flow continuously in a loop and change in time.

Conclusion

Given more precise definitions of what distinguishes emergent from non-emergent phenomena, I have argued that the complexity of the city in Plato's Republic must be at a level that gives rise to global behavior that cannot be predicted by the individual parts of the city. In the Republic, the initial construction of the city is based on a tripartite class system, but lacks size and complexity to give rise to emergent justice. As the city grows, the

tripartite structure remains in tack, but added complexity in the form of increased numbers of philosophers, guardians, and artisans works in unison with the tripartite elements of the soul to create an emergent phenomenon in the form of justice. As Socrates states,

What has come to light for us there let us apply to the individual, and if there is agreement that will be fine. But is something different manifests itself in the individual we will return again to the city to test it, and perhaps by examining them alongside each other and rubbing them together like fire sticks we may make justice blaze forth, and when it has come to light confirm it for ourselves [7].

In the second part of this paper, I have argued that the dynamical biological evolution of an organism is a powerful analogy for the dynamical processes that lead to the emergence of Plato's justice. Like a living and breathing organism subject to the rules of evolution, the soul and city are subject to rules analogous to the biological processes of mutation and selection. "The regular unfolding of ontogeny (justice) alone suffices to say that biological systems cannot wander randomly and ergodically over their space of possibilities. The essence of development form the fertilized egg is its astounding combination of complexity and utter regularity. Evolution is an adaptive, or drifting, process which searches across the space of biological systems" [10]. Similarly, the development of emergent justice is a function of the evolution of the soul, and in particular, the city. Once each has evolved through time and reached a place in state space where each exists in an attractor, they can combine to produce a biological organism in the form of emergent justice if one or other is perturbed from its state space attractor. In essence, this perturbation could result from a change or shift in city structure (i.e. an increase in size and complexity).

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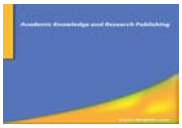

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