THINKING ABOUT COMPLEXITY

Grasping the Continuum through Criticism and Pluralism

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The image on the front cover is a stylized snap shot of a particular cellular automata configuration referred to as Meteor Guns. It was generated using Golly, which is an open source, cross-platform application for exploring Conway's Game of Life and other cellular automata. Golly is freely available at: http://golly.sourceforge.net/.

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INTRODUCTION

Traditionally the natural sciences, particularly physics, have been regarded as the Gatekeepers of Truth. As such the legitimacy of other forms of knowledge have been suppressed, particularly those methods that characterize the 'softer' sciences, such as sociology, psychology, soft systems, and organization theory for example. This essay begins with a discussion concerning the main features of a complex system, and the nature of the boundaries that emerge within such systems. Subsequent to this discussion, and by assuming that the Universe *at some arbitrarily deep level* can be well-described as a complex system, the essay explores the notion of ontology, or existence, from a complex systems perspective. It is argued that none of the traditional objects of science, or any objects from any discipline, formal or not, can be said to be real *in any absolute sense* although a *substantial realism* may be associated with some of them. Out of this problematization of the concept of 'existence', the limitations of the natural sciences is discussed as well as the deep connection between the 'hard' and the 'soft' sciences.

The basic argument presented concerning the relationship between soft and hard paradigms is that they are both concerned with pattern extraction from abstracted data sets (which extend in both space and time). It is these patterns that form the basis of scientific laws and understanding. The principle difference between the two approaches is that they tolerate different levels of 'noise' in the original data set. In the language of a communications engineer, the two approaches accept different signal-to-noise ratios (SNRs), where the 'signal' is the extracted pattern, and the (so-called) 'noise' is whatever is removed during the extraction process (there is a tendency to regard the resulting signal as somehow more 'real' than the noise even though the applied extraction process is often arbitrarily chosen). Clearly, to suggest that there are two ways (hard and soft) is a gross oversimplification.

In this essay these labels are used loosely to represent two 'fuzzy' regions in a notional 'boundary-stability' continuum. The 'hard' region includes those methods (primarily from the natural sciences) that work effectively with data sets that—after an abstraction process—yield stable reproducible laws that can be used to predict future behavior in a precise manner. In this region it is often possible to choose one abstraction over all others, or at least privilege a certain set of abstractions.

The 'soft' region, on the other hand, includes those methods (primarily from the social and human sciences) that are designed to cope with the inherent ambiguity of the abstraction process for data sets that do not easily yield to a dominant abstraction (and where personal preferences and value judgments can play a central role in methodological choice—although this certainly isn't completely absent in the 'hard' region—even the lofty physical sciences are affected by politicization). In these situations, there are often many potentially overlapping—and potentially contradictory—abstractions that seem equally plausible (leading to the significance of multi-paradigmatic approaches in the social sciences for example).

We might say that the 'hard' region represents situations where the data is merely complicated (or can be reasonably assumed to be so), whereas the 'soft' region represents situations where the data is genuinely complex (in the nonlinear dynamical sense). The numerous methodologies that fall into these two broad (overlapping) categories lead to various levels of understanding that tolerate various levels of SNR depending upon the data set (and therefore data collection approach) utilized. Although it may appear that I am generating support for some kind of 'context type vs. method choice' matrix here (akin to the *system of systems methodologies* in soft systems thinking), I am not. Any method has the potential to shed some light in any context of interest *if* applied in a critical fashion. The importance of being able to determine to some degree where on the 'boundary-stability' continuum the context of interest lies, is that this has implications for how we might utilize the understanding derived from the application of our chosen method. In a sense, it gives us a feel for the risk associated in believing our understanding to be True (with a capital 'T')—it is a 'measure' of the efficacy of our supposed knowledge (the difference between knowledge and understanding I am using here is degree of humility; knowledge is understanding with all the caveats removed).

Beyond the 'soft' region the SNR is so low that practical knowledge is very difficult (if not impossible) to come by. This leads to the question of whether any knowledge of one-off events is indeed possible, or whether there are limits to knowledge when understanding of the 'whole', and how it changes over time, are necessary for progress to be made.

Along the way, the notion of 'intrinsic emergence' will be introduced to block the path to a *localized* 'anything goes' radical relativism.

The aim of this essay, then, will be to describe a general philosophy of complexity, and place complexity science in context. Although, be warned, a general theory of everything often provides very little in the way of useful detail. As the systems scientist Kenneth Boulding remarked more than 50 years ago when considering the idea of a general theory of systems, "[such] a theory would be almost without content, for we always pay for generality by sacrificing content, and all we can say about practically everything is almost nothing," (Boulding, 1956: 197). So in a sense, following Boulding, this essay might be regarding as little more than a complex systems argument for adopting an epistemological position that contains nothing. Although, it is hoped that embracing 'nothing' actually leads to many considerable 'somethings'.

Realism versus Constructivism

There are at least two broad perspectives from which the status of our scientific knowledge claims can be understood. The first is a purely realist view of scientific knowledge, referred to as *scientific realism*. According to this view the "theoretical entities that are characterized by a true theory actually exist even though they cannot be directly observed. Alternatively, that the evidence that confirms a theory also serves to confirm the existence of any theoretical or 'hypothetical' entities characterized by that theory" (Fetzer & Almeder, 1993: 118). This definition suggests that scientific knowledge gives us *direct* knowledge of entities that exist independent of the existence of any observer, i.e., rigorous application of scientific methods yields theories of certain entities that exist mind-independently (independently of what we believe or feel about those entities). In this view an objective reality does exist, and as Francis Bacon pointed out in 1620 in his *Novum Organum*, it is through the application of method that we can escape our physiological, psychological, sociological and linguistic biases and acquire objective scientific knowledge of 'reality'.

In complete opposition to the realist position is idealism. This position argues that, although there may exist an objective reality, we can never have direct objective knowledge of that reality. Accordingly, knowledge is totally manufactured rather than discovered. The manufacturing process is inherently biased by our methods of production and is incapable of delivering objective knowledge of some external reality: objectivity is reduced to myth, or wishful thinking. Social constructivism, which is a form of idealism, in its extreme form regards scientific knowledge as merely a socially-constructed discourse that is inherently subjective in nature. As there can be no objective knowledge, there can be no dominant discourse because there can be no test or argument that could conclusively support the dominance of one discourse over another. As such, science is just one approach from many for making sense, and should be treated with no more reverence than any other approach.

The Relationship between Language and Objective Reality

An alternative way to distinguish between realism and idealism is to consider the relationship between the language we use to *describe* reality and reality itself. Realists argue that there is a one-to-one correspondence between our language and 'reality'. This leads to a number of interesting consequences like, for example, the belief that there is a best, or universal, language for describing reality and that, that language happens to be the language of science, namely mathematics and logic.

Idealists, specifically relativists, on the other hand argue that there is no relationship whatsoever between our language and reality. The terms or labels we use are no more than useful sense-making tools that, though convenient, have no intrinsic basis in a hypothetical objective reality.

Although I do not believe that anyone who supports either of these positions is naïve enough to believe in them wholeheartedly, this is generally how the debate between realism and idealism is set up. Physical scientists are criticized for their intellectual arrogance/imperialism, which is justified through strongly realist beliefs, and idealist critics are ridiculed for their apparently wild and poorly argued descriptions of what they think science actually is, as well as their omission of 'reality' in their theories.

Primarily because of the success of science-driven technology there is an enormous wealth of a certain type of evidence that supports the privileging of scientific discourse over every other. This success has perhaps blinded us to the shortcomings of the scientific process, and has lead to an unquestioned belief that because science has successfully explained so much it can probably explain everything. Every facet of human life can supposedly be productively examined through the eyes of science. This position is commonly referred to as scientism (although practical science—as opposed to some popularized caricatures of science—is not synonymous with scientism). And, although indirect evidence of these shortcomings is becoming more widespread, putting the brakes on the train of scientism is no trivial undertaking. Too often the failures of science, which are considerable when we consider social planning or environmental policy, are put down to the bad application of scientific methods rather than seeing these failures as the result of applying scientific methods to inappropriate subject matter.

Contrary to popular belief science is not capable of considering all phenomena. In fact, it is quite inflexible in its requirements. The principle requirement that will be considered herein is that scientific methods require that the object of interest is stable, i.e., the boundaries (or, patterns) that delimit the object from the 'background' (the object's complement) must be stable and assumed to be *real*. This stability allows repetitive examinations to be undertaken that allow the knowledge concerning that object to be refined and tested, so much so, that our confidence in our knowledge of that object becomes so great that we might begin to unquestionably assume that we have an accurate (or, absolute) description to hand. In a more generic way, what I am saying is that scientific knowledge can only be obtained for contexts which are incredibly stable. This approach yields a tremendous amount of practical understanding that can be turned to the development of cars, computers, building methods, etc.—just about anything that can be constructed from parts that behave qualitatively in much the same way whatever context they are placed within. What about the objects of interest that have far less rigid boundaries? Social systems for example change and evolve. The boundaries, or patterns, that describe such systems continuously change and emerge, such that the extraction of uniformities is far from a trivial matter. By their very nature the context changes and repetitive examinations are at worse impossible, and at best highly problematic. To apply science to such systems we have to enforce stability. We are forced to reduce the system of interest to an idealized caricature that remains steady over a certain period of time. Of course this is what we really do when we look at any system, be it an atom or an ecology, but for some reason our reductions seem to be more harmful when considering ecologies (i.e., complex systems) as the differences between a description that would allow a scientific analysis, and a notional 'real' description, are huge.

These cracks in the scientific façade have been made more apparent with our ability, supported through incredible growth in computer power (and, ironically, through the dogmatic application of reductionist science) to construct models of simple[1] complex systems. The emerging science of complexity directs us to revisit the nature of scientific knowledge, and at the same time presents us with an alternative approach to understanding the limits of scientific, or more specifically reductionist, methods. The interest for me personally is that, though many criticisms of science have been made by those whom the scientific community has regarded as outsiders and non-scientists, complexity science leads to a critique of science couched in the language of science itself. In a sense, the scientific language contains within it the clear evidence of its own limitations.

1. The concept 'simple complex system' may seem contradictory, but what I am trying to emphasize is that the models we create of complex systems are still very much simplifications of what actually is. We are capable of modelling/representing only the simplest aspects of complex systems.

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