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A Note on the Difference Between Complicated and Complex Social Systems

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Abstract

The distinction between complicated and complex systems is of immense importance, yet it is often overlooked. Decision-makers commonly mistake complex systems for simply complicated ones and look for solutions without realizing that 'learning to dance' with a complex system is definitely different from 'solving' the problems arising from it. The situation becomes even worse as far as modern social systems are concerned. This article analyzes the difference between complicated and complex systems to show that (1) what is at stake is a difference of type, not of degree; (2) the difference is based on two different ways of understanding systems, namely through decomposition into smaller parts and through functional analysis; (3) complex systems are the generic, normal case, while complicated systems are highly distinctive, special, and therefore rare.

1. Introduction

During the past five or six decades, 'complexity' has been defined in many different ways.[*] As a consequence, the difference between 'complex' and 'complicated' problems and systems has become unclear and difficult to trace. The following is possibly the golden rule for distinguishing 'complex' from 'complicated' problems and systems. Complicated problems originate from causes that can be individually distinguished; they can be addressed piece-by-piece; for each input to the system there is a proportionate output; the relevant systems can be controlled and the problems they present admit permanent solutions. On the other hand, complex problems and systems result from networks of multiple interacting causes that cannot be individually distinguished; must be addressed as entire systems, that is they cannot be addressed in a piecemeal way; they are such that small inputs may result in disproportionate effects; the problems they present cannot be solved once and for ever, but require to be systematically managed and typically any intervention merges into new problems as a result of the interventions dealing with them; and the relevant systems cannot be controlled – the best one can do is to influence them, learn to "dance with them", as Donella Meadows aptly said.[†]

* Here I use "complexity" with regard to both non-linear phenomena (complexity proper) and infinite sensibility to initial and boundary conditions (what is usually called "chaos" or "deterministic chaos"). Both are based on an internal machinery of a predicative, algorithmic, i.e. mechanical, formal nature.

† The following are some further aspects that a less cursory analysis will have to consider: (1) the "complicated" perspective point tends to work with closed systems, while the "complex" perspective point works with open systems; (2) the former naturally adopts a zero-sum framework, while the latter can adopt a positive-sum framework; (3) the former relies on first-order systems, while the latter includes second-order systems, that is systems that are able to observe themselves (which is one of the sources of their complexity).

Unfortunately, the vast majority of decision-makers ask their consultants to give them 'solutions' that can solve problems once and for all. That is, they ask their consultants to treat complex problems as if they were complicated ones. Complexity and the nature of contemporary science show that the claim to 'solve' (complex) problems is often ungrounded.[1] 'Learning to dance' with a complex system is definitely different from 'solving' the problems arising from it.

The situation becomes even worse as far as modern social systems are concerned – not the least because "most modern systems are both hideously complicated and bewilderingly complex".[2] According to the golden rule above, the difference between 'complicated' and 'complex' systems is a difference of type, not a difference of degree. In this sense, a complex system is not a system that is remarkably more complicated than a customarily complicated system. A complex system is a system of completely different type from a complicated system. This understanding is apparently at odds with the quotation from Mulgan and Leadbeater. According to that quote, a system can be *both* complicated and complex. The apparent contradiction vanishes as soon as one recognizes that the qualities or properties that make a system complicated are different from the qualities or properties that make a system complex. The properties used to classify a system as complicated are different from the properties used to understand a system as complex. This difference explains why the same system can be classified as pertaining to two otherwise different categories – and explains also why decision-makers tend to keep their focus on the side of complicatedness and downsize or misinterpret the issue of complexity. Many contemporary problems are made worse by trading one type of problem for the other, because the problems arising from what makes a system complicated can eventually be solved, while those arising from what makes a system complex can at best be transformed or modified, but not solved once and for ever. This is precisely the meaning of Meadows' learning to 'dance with them'.

In this regard, reductionism is the thesis that the type-difference between complicated and complex systems is only apparent because the properties that make a system complex are based on the properties that make a system complicated. Or that the latter can simulate, or approximate, as far as one likes, the former. On the other hand, a non-reductionist position maintains that the difference between complicated and complex systems is a type-difference that cannot be bridged, and all simulations of the latter from the former miss relevant information.

This observation introduces the theme of 'adequate' models. In short, one can always use physical models in non-physical contexts. This does not mean, however, that these models are able to capture the *proprium* of different situations. One can measure the weight and volume of a cat – and these measures provide authentic information – but neither the weight nor the volume of a living being properly characterizes the human being's nature. Similarly, it is always possible to quantify psychological and social phenomena, without being able to capture their nature.

It is our claim that the difference between complicated and complex systems is of the same kind: one can always exploit complicated systems to understand complex ones – e.g.

by developing simulations of the latter that come as close as possible – but in doing so, something essential is systematically lost.

To see what is at stake, I shall now dig deeper into the difference between complicated and complex systems.

2. The Difference between Complicated and Complex Systems

If, as we claim, the difference between complicated and complex systems is a difference of type and not of degree, suitable reasons should be provided. As a matter of fact, quite a few reasons can be proposed. The following are the three most obvious reasons for the difference between complicated and complex systems:

1. The primary way to understand complicated systems is through their structural decomposition – that is, through the segmentation of the whole system into disjoined structural parts and their relations, and the further subdivision of these parts into smaller subparts and their relations. On the other hand, the primary way to understand complex systems is through functional analysis – that is, through the activities exerted by the system. Structural and functional analyses mirror each other only in very special cases. In general, they are different, and the relations among them are far from trivial. One way to see their difference is to note that the same structural part can perform different functions, and the same function can be performed by different structural parts. The 'one structure-one function' assumption works only in very rare cases, which implies that it is a highly non-generic assumption.

"Everything changes, but not everything is creative."

2. Whilst systems have a definite number of structural parts, the functions that a system is able to perform are potentially unlimited. The primary way to constrain the range of functions that a system can perform is to delimit its environment, e.g., by allowing the system to interact with only selected types of systems. That is to say, functions can be delimited either by closing the system (no interaction) or closing its environment (limited or constrained interactions).
3. The above two reasons show that the complexity of a system is not directly connected to the amount of available data or knowledge. Collecting more data or developing better theories will not transform complex systems into complicated ones. This introduces the third reason for the difference between complex and complicated systems. Complicated systems can be – at least in principle – fully understood and modeled. They can be entirely captured by suitable models. Whilst it may not be feasible to build these models with all the necessary details – e.g. because it will be too costly or because some information would be missing – in principle they can be constructed. Complex systems, on the other hand, are such that they are never fully graspable by any model whatsoever: models of them – even in principle – are always incomplete and diverge over time.

The main reason why complex systems have these apparently strange features is that they are creative. Being creative includes the capacity to change, learn, and over time become different from what one was before. But it is more than this. Everything changes, but not everything is creative. To mention but one component of creativity, the capacity to (either implicitly or explicitly) reframe is one of the defining features of creativity. Creativity also includes some capacity to see values and disvalues, and to accept and reject them. Therefore, it is also the source of hope and despair. None of these properties are possessed by complicated systems.

"The first is the idea that "physics is the queen of science" – meaning that the other sciences are authentic sciences only if they force themselves into the straitjacket of the physical framework (the positivist or reductionist attitude)."

3. Which Systems are Generic?

The proposed acceptance of complexity (and complex systems) is far less trivial than it may at first appear. According to our understanding of complexity, almost everything that falls under the heading of complexity pertains instead to the science of complicated (even extremely or 'hideously' complicated, as Mulgan and Leadbeater put it) systems. Complexity is an entirely different matter. The irony is that complex (in the proposed acceptation) systems are not rare. Complex systems are the usual, normal case. All living systems, all psychological systems, all social systems are complex. It is complicated systems that are highly distinctive, very special, and therefore rare.*

Two obstructions block our capacity to acknowledge that complex systems are the generic – i.e. the usual – type of system. The first is the idea that "physics is the queen of science" – meaning that the other sciences are authentic sciences only if they force themselves into the straitjacket of the physical framework (the positivist or reductionist attitude). This is not meant to be a criticism of physics, not even an implicit one: physics deals with complicated systems, not with complex ones, and its methods have proven exceedingly successful in yielding an understanding of complicated systems. There is no reason, however, to believe that its methods can be used to understand complex systems as well. When the objects are remarkably different, this may happen, and it should not be surprising that different viewpoints and methods are required.

By further developing this train of thought, one arrives at an idea of science that is more general than the competing mainstream acceptance of science presently available: to wit, instead of distinguishing between the Queen (physics) and the pawns (all the rest), the new vision distinguishes between the general framework underlying all sciences (what Rosen called the modeling relation) and a variety of different concretizations of that framework

* During the past fifty years or so, many scholars have tried to contribute to this body of ideas, including Bateson, Capra, Hofstadter, Luhmann, Maturana, Rashevsky, Rosen, and Varela. The clearest and most complete treatment, however, is Rosen's (1991).

where each concretization depends on specific assumptions or constraints. In this view, physics is a highly specific – that is, non-generic – science, while other sciences, notably biology and all the sciences that rely on it (i.e. all the human and social sciences), will require less demanding constraints.

The foregoing is a highly compressed presentation of Rosen's ideas as developed in his groundbreaking trilogy (see references). Needless to say, I have had to omit many otherwise necessary details.

"Science is for the most part a set of techniques for closing open systems in order to scrutinize them."

The second reason is that, willy-nilly, most decision-makers are positivists, and they regularly ask their consultants to give them definitive 'solutions' to problems. What they have in mind are (again!) complicated systems, and they want complex systems to be managed as if they were complicated ones. Complexity and the nature of contemporary science show that the claim that (complex) problems can be 'solved' is ungrounded.

To call attention to one of the major transformations exhibited by contemporary science, I have found it helpful to contrast the present situation with the basic understanding of traditional modern science. In a variety of papers I have presented the following summary, according to which Newtonian science teaches us that natural systems are closed (only efficient causality is accepted; bottom-up, top-down, 'final' causes are forbidden), atomic (fractionable), reversible (no intrinsic temporal direction), deterministic (given enough information about initial and boundary conditions, the future evolution of the system can be specified with any required precision), and universal (natural laws apply everywhere, at all times, and on all scales). By contrast, contemporary science shows that these claims are *all* false, in the literal sense that they work only for some special kinds of systems (technically, they are not generic).[3, 4, 5, 6, 7] The framework currently under development in many scientific quarters includes open, non-fractionable, irreversible, non-deterministic and context-dependent systems.[*]

Since, as they say, the devil is in the details, this is the point to note: there is something even more important than the static opposition between closed and open systems. It is the opposition between the *processes* of opening or closing a system.[8] More often than not, when dealing with a system, we have to modify it in order to be able to understand its functioning or develop a policy. The ways in which a system is opened or (more usually) closed is of utmost importance. Science is for the most part a set of techniques for closing open systems in order to scrutinize them. The problem is, it is in this way we study other systems, systems that are different from the original ones.

* While the traditional, reductionist strategy has proved enormously successful and cannot be simply abandoned, the problems that prove refractory to a reductionist treatment are growing, and this calls for complementary non-reductionist strategies. Reductionist methods work well when a system can be decomposed (fragmented) without losing information. On the other hand, for many systems, any fragmentation causes a loss of information (Poli 2011b). The most promising alternative strategy is to substitute analysis via decomposition (the reductionist mantra) with analysis via natural levels (i.e. the theory of levels of reality), introduce indecomposable wholes and substitute Humean causation with powers and propensities. Note that, since indecomposable wholes are not (entirely) understandable from their parts, manipulation of parts may engender unexpected consequences (Popper 1990, Rosen 1985, Bhaskar 1988, Poli 2010a,b, Poli 2011a, Louie and Poli 2011, Poli 2012a,b).

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