

Complex Systems Dynamics: Implications for Sustainability, conception and policy

Cliff Hooker and Joshua Skewes

While research on complexity has for some time been providing insights on the deeper dynamical nature of physical, chemical, and even biological systems, complex systems considerations have never really been satisfyingly applied to understanding such “humanistic” issues as agency and personal autonomy. Precisely because agency is seen as a humanistic issue, it is most often taken to be amenable only to investigations conducted at a relevantly humanistic level – that of rarefied functional analysis – and it is assumed (tacitly or otherwise) that agency is impenetrable to rigorous dynamical analysis. In rare cases where complex systems considerations are taken into account, most often dynamical notions are applied only as methodological tools, with the deeper theoretical framework still operating at an abstract functional level. Despite the ancient vintage, and for all the lasting popularity of the general approach, all actual theories of agency developed in this way have been notoriously unsatisfactory, both theoretically and empirically. It is at this point that a new approach, deeply rooted in complex dynamical systems process, is beginning to make a revolutionary contribution.

The model that most often functionally grounds notions of agency in this way is that of a programme running internally, using motivational and informational inputs to generate action outputs. While nowadays the programme is often conceived in terms of a control module performing computations on something like a universal Turing machine, we only have to substitute a broader notion like agenda or plan to understand that this modular control model has ancient roots and widespread currency in commonsense. A broadly logical sense of programme design, and practical reasoning in particular, are given a central role in functioning, so that reasons to act are central to explicating action.

A more dispositional version of this model, inspired by motives as forces rather than as information, can be formed by supposing that reasoning is replaced by dispositional capacities to selectively interact with motivational and informational states and interrelate them in an organised way so as to dispose to action. The control programme is replaced by something closer to the plan for a car engine, but the sense of an abstract systematic functional design remains at the core of the model. In either case a separable mechanism is specified whose inherent rationale is internal to its functional specification and can in this sense be abstracted from the material details.

The conceptual purpose of a notion of agency is to limn what is distinctive about creatures such as ourselves. This rests at bottom on our autonomy. People are fundamentally agents, where agency is the capacity for being autonomous with respect to one’s actions, that is, the capacity for efficacious self-governance of action.

According to the dominant modular control models, agency is deliberative (runs through a coherent programme/agenda), where agents are autonomous with regard to their actions insofar as these actions are the consequences of agent deliberation, e.g. of practical reasoning processes.

These models are only lightly touched by complex systems considerations and then only formally, that is, in terms of programme/agenda/functional design. Typically this is confined to coping with informational complexity for finite processors. Of course, some will accept that implementation/realisation is dynamical, e.g. neurally, and those interested in this may well be more immersed in complex dynamical considerations, but this is separable from the study of agency itself and the key functional gloss over the dynamics required for that can be made without losing any real explanatory value.

For all their popularity these models have proven neither empirically nor theoretically satisfactory. Empirically, their dynamical underpinnings do not comport with their simple design order and they fail to ground their key aspects, e.g. motivational and informational saliency for realised agents, in ways that generate genuine autonomy. That this is problematic is evidenced by the fact that their robotics has never progressed beyond artificially supported simple functions without being faced with computational explosion and design incoherence. Theoretically, merely running a programme/agenda cannot furnish a satisfying form of autonomy, especially (notoriously) not one that reconciles freedom with grounded deliberation (reason) while acceptably explaining various departures from coherent deliberation like akrasia.

However, a new approach, grounded in complex dynamical systems process, offers hope of progress and a fundamental challenge to orthodoxy. It reverses the standard approach, first providing a notion of autonomy that is rooted in the non-linear dynamical cohesion of irreversible, far-from-equilibrium dissipative systems. The essential idea is that of a self-organised emergent organisation in such a system that captures and directs ordered energy (negentropy) into system-regenerative processes whose functional (but not material) closure ensures that the entire system is regenerated, including this regenerative capacity. Properly developed, the first claim is that this concept empirically identifies the basis of all and only living systems within the class of all complex systems, and hence as an essential organisational foundation for the bio-social sciences.

Of more salience here, the second claim is that this conception of autonomy provides the proper grounding for the emergence of inherent system norms – as indicators of the autonomy performance envelope - and thence of intention and cognition as autonomy-referenced self-regulatory processes. This then permits the development of a new conception of agency whose functional characterisation emerges from, and remains uniquely grounded in, its actual dynamical realisation.

The potential import of these ideas is briefly surveyed. For instance, it generates new multi-dimensional process or flow conceptions of intention and cognition that reveal each as a complementary aspect of an evolving unified capacity for self-regulation, in contrast to their traditional fracture into formal referential and problem-solving capacities. Further, this conception of agency succeeds in reconciling freedom with deliberation (reason) while acceptably explaining various departures from coherent deliberation like akrasia. And a certain class of self-directed processes, defined on this basis, is able to resolve open cognitive problems – the foundational property of intelligence that has proven to be inherently inaccessible to programming and/or functional design. Moreover, the application of these ideas to science itself is shown to lead to a fresh and fundamental new understanding of how science progresses.

