We live in a time of rising complexity both in the internal workings of our social, economic and political systems and in the outcomes that those systems produce. Increasing complexity has implications for social science: it hinders our ability to predict and explain and to prevent large deleterious events. To make headway on the problems that animate social and behavioral scientists: economic inequality, health disparities, achievement gaps, segregation, climate change, terrorism, and polarization among voters we must acknowledge their complexity through interdisciplinary teams. Harnessing complexity will require several changes: we must develop practical measures of social complexity that we can use to evaluate systems; we must learn how to identify combinations of interventions that improve systems; we must see variation and diversity as not just noise around the mean, but as sources of innovation and robustness; and finally, we must support methodologies like agent-based models that are better suited to capture complexity. These changes will improve our ability to predict outcomes, identity effective policy changes, design institutions, and, ultimately, to transform society.
Introduction

Confronting and harnessing complexity will be among the greatest challenges facing social scientists over the coming decades. What, though, is complexity? Complexity can refer to either the attributes of a system or to the outputs a system produces: the social life of a city can be characterized as complex because it has diverse actors, whose behaviors are interdependent, as can prices in the stock market, a non stationary time series that features unpredictable booms and busts.

No mere metaphor, complexity has been formally defined in dozens of ways. Some characterize output complexity as lying between ordered and random, others as being difficult to explain, to describe or to predict. According to any of these many definitions, the outcomes of our social, political, and economic systems have become more complex. So too have the inner workings of those systems. We’re more interconnected and more adaptive than ever before. Technology has been a major cause. We are now much less geographically limited in our friendships and lags in information have all but disappeared. For example, just a few decades ago businesses received quarterly inventory updates. Now it is said that when you purchase milk, Wal-Mart phones the cow.

To the extent that rising complexity means a lack of predictability, it limits the efficacy of social science. How do we predict the unpredictable? To the extent that it implies more large events, it has enormous implications for society. We need only consider the damage wrought by the home mortgage crises and the resulting recession. And, to the extent that it means incomprehensibility, it means that we have little chance of designing effective policies.

Take just one example, the problem of rising obesity. Social and behavioral science research reveals scores of causes ranging from the economic (the low price of corn syrup infused Big Gulps) to the genetic (the tendency for some people to store fat). Individually, these causes have small magnitude, they explain little of the variation, and they act on each person differently. We therefore expect that individual policy interventions such as taxing sugary drinks, will have only modest effects. We also know that collectively, these scores of factors have a large effect. How then do we design interventions? How can we pull levers in combination to reverse the trend?

Implications of Increasing Complexity

We can see the increasing complexity as creating problems, as making it hard for us to predict and design, and as making us more susceptible to large, deleterious events. We can also see it as an opportunity. The opportunity derives from the potential for complex systems to produce emergent functionalities, such as the consciousness and cognition that emerges from interacting neurons and
The physicist Phillip Anderson famously commented "more is different", i.e. the whole can be more than its parts. Yet, human society has only begun to learn to harness the potential of more.

Current social science models cannot help us harness complexity because, for the most part, they rely on an equilibrium paradigm. Changes in outcomes are seen as movements in equilibria and not as natural progressions in a dynamic process. The relevance of complexity does not deny the value of equilibrium models. Equilibrium may well remain at the core of our disciplines. However, even the most casual observer recognizes that most markets, political systems, and social systems do not sit at rest but are constantly in flux.

To account for this incommensurability between our models and reality, social scientists add in randomness in the form of shocks or uncertainty. Most, though not all, equilibrium models that toss in noise see the internal complexity of systems as disorganized. As Warren Weaver pointed out over sixty years ago, disorganized complexity cancels out, so it cannot add up to more than the parts. Yet, the large unexpected outcomes produced in complex systems are anything but random.

The economy and other social systems contain organized complexity, in which the whole not just exceeds but transcends the parts. For this reason, complex systems scholars often refer to social outcomes as generated from the bottom-up. Hence, the term self-organization has become widespread within complexity research. Self-organized systems can produce cooperative, robust outcomes, but they can also spiral into chaos. We need to understand how to encourage the former and guard against the latter.

How Social Science Must Change to Include Complexity

The challenge and the opportunity for social science are to build in the robustness necessary to limit the damage of large events and to harness complexity to produce better social outcomes. To accomplish these tasks requires at least four changes in practice. First, we must advance our methodologies for measuring and categorizing the complexity of social processes. At present, we make little or no effort to measure and categorize the complexity of social processes. How complex is our welfare system or the international financial system? How complex is the U.S. tax code or our legal system?

Why should we care about these questions? Organizational theorists have long claimed that if you can measure it, you can manage it. Managing the complexity of systems may be just as important as working to maintain their efficiency.
In addition, once we know the complexity of a system, we have some idea about how predictable it is and how likely it will produce large unexpected events. We can even consider complexity as a policy consideration in and of itself. We might even ask whether a new policy will make a system more complex, and if so, whether or not the cost of the complexity is worth the potential costs.

As mentioned, physical and computational measures of complexity exist in abundance. These can provide a starting point for creating social complexity metrics, but they need refinement for the simple reason that electrons don’t think. Thus, it’s relatively easy to understand how their behaviors aggregate. People, on the other hand, do think. We base our behaviors on mental models, belief systems, and passion. We can also copy others whom we perceive as being successful.

This last observation, that we often mimic others, implies a positive feedback and a close link between social and evolutionary systems. Positive feedbacks along with interdependencies are a major driver of large events. Hence, social and evolutionary systems may be more prone to fluctuations than physical systems.

Second, we must promote interdisciplinary research on specific problems, such as improving education. Educational success depends on individual, family, peer, and community influences. Empirical studies of educational performance include psychological variables (IQ), social variables (crime rates), health variables (presence of lead in bloodstream and obesity), and economic variables (family income).

As in the aforementioned case of obesity, to explain academic success we can create a comprehensive model with lots of weak individual effects but strong collective effects. But if we break a complex system into disciplinary parts, we ignore the complex interactions that enable the whole to be more than its parts. To harness complexity, to borrow a term from Robert Axelrod and Michael Cohen, we must take a generative perspective and see social outcomes as produced by purposive actors responding to incentives, information, cultural norms, and psychological predispositions. We need interdisciplinary teams to unpack how those many forces interact.

A large part of that process of taking a generative perspective will be rethinking variation and diversity, the third necessary change. Social and behavioral scientists must think more like ecologists who see variation as central and less like statisticians, who perceive variation from average effects as noise or individual differences that average out.

In complex systems, variation (differences within types) and diversity (differences in the number and distribution across types) drive innovation and contribute to system level robustness. Robustness, or what some call resilience, refers to the ability of a system to maintain functionality in response to external shocks and
internal adaptations. Note that robustness differs from stability – the capacity for a perturbed system to return to the same equilibrium. Robust systems often maintain functionality by locating a new arrangement of their parts.

Variation and diversity also provide the building blocks for emergent phenomena and for complexity itself. Thus, empirical studies that assume a single type of actor or behavior may be woefully inaccurate in their estimations if in fact the systems contain multiple types of actors.

Finally, we must advance computational agent-based modeling even though this methodology is not, as some claim, a panacea. Agent based models consist of a set of object – agents – situated in place and time that follow and adapt rules of behavior. The modeler designs a system, sets the agents loose, and watches what transpires. The behaviors included in the models need not be ad hoc, mechanistic rules. They can be calibrated to actual behaviors revealed in the laboratory, identified in field studies, or discerned from empirical studies.

Many people conflate computational methods with complexity. This is a mistake. We must disconnect scientific methodologies from the properties of the systems that they are used to study. In point of fact, agent based models produce aggregate outcomes that fall into one of four broad categories: static equilibria, periodic equilibria (patterns), random paths, or complex trajectories. Social systems exhibit all these four behaviors as well. We see phenomena ranging from stable market prices, to random walks on Wall Street, to political cycles, to complex intra-industry dynamics. A goal of social science should be to explain why some processes produce outcomes that fall into one category and others fall into another.

Summary

On the positive side, increased engagement with complexity research can enable social scientists to better explain and predict what occurs in our increasing complex world and anticipate large events. On the normative side, a deeper engagement with complexity can help us to identify and pull levers within systems to effect change, to design rules, laws, and incentive structures that limit the prevalence of large deleterious events, and to leverage the potential for emergence to improve outcomes.

References


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