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What science can do for democracy: a complexity science approach

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Political scientists have conventionally assumed that achieving democracy is a one-way ratchet. Only very recently has the question of "democratic backsliding" attracted any research attention. We argue that democratic instability is best understood with tools from complexity science. The explanatory power of complexity science arises from several features of complex systems. Their relevance in the context of democracy is discussed. Several policy recommendations are offered to help (re)stabilize current systems of representative democracy.

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Introduction

The *Economist* recently identified 80 countries whose democracy score declined during the last decade, including the USA and some consolidated European democracies (The Economist Intelligence Unit, 2017). While the question of how democracies arise and how such rise can be facilitated has received much research attention, little is known as yet about how democracies destabilize.[1] The conventional assumption amongst political scientists was that achieving democracy is a one-way ratchet. Only very recently has the question of "democratic backsliding" attracted any research attention (Waldner and Lust, 2018). We argue that insights from complexity science can facilitate the study of democratic processes and institutions and the design of stabilizing policies. The cross-disciplinary approach to political science that we advocate here rests on mathematical models of human societies, built with tools from statistical physics, dynamical systems, complex networks, and game theory (Wiesner et al., 2018). These tools allow scientists to focus on the salient features of the complex system at hand.

Features of complex systems in the context of democracy

It is generally accepted that complex systems defy a one-sentence definition, not least because they are found in all areas of science. However, there are features that most, if not all, complex systems have in common (Ladyman and Wiesner, 2020). All complex systems consist of many, often diverse, elements that self-organize, driven by their many random interactions, into ordered systems that exhibit feedback and nonlinearities, and many of them exhibit forms of nestedness and memory. All complex systems are generally exposed to perturbations from an environment. While being stable against minor perturbations, larger ones can cause regime changes. Many mathematical techniques are in use to model or predict such drastic changes. For example, Sinha and Pan (Sinha and Pan, 2006) model the sudden rises in popularity of particular ideas or products with the Ising model of ferromagnetism. This *sociophysics* model recovers the long-tailed distributions observed in real social systems such as the outcome of elections and the popularity of movies. The model captures how an agent's choice can be affected not only by interactions with other agents, but by how well their previous choice allowed them to coordinate with the majority. Another example is the use of renormalization group methods to illustrate the causes of minority opinion spreading (Galam, 2012). In the following, the relevance of some of these features in the context of democracy is discussed.

Randomness. Randomness of interactions is often important to self-organization. For example, the collective performance of human groups can be improved by insertion of a few autonomous agents that behave randomly (Shirado and Christakis, 2017). Democracy requires an unstructured exchange of opinion and ideas between citizens. As David Runciman writes:[2] "[t]he randomness of democracy—which remains its essential quality—protects us against getting stuck with truly bad ideas. It means that nothing will last for long, because something else will come along to disrupt it".

Consensual norms. Chaos and collapse arise only when randomness increases beyond a critical level. Democracy requires a minimum agreement on norms and confidence in its institutions. In their absence, democracy may be vulnerable to cascading beliefs about the unfairness of the democratic process. Russian probing of the security of the US electoral system[3] may have helped trigger cascading beliefs among the presumed Republican losers in the 2016 elections that the system had been "rigged" by the winners. If enough people believe that the democratic process or "establishment" has been compromised, then the shared beliefs and norms that make democracy viable may collapse. This collapse may propel people into accommodating "lying demagogues" because their brazen lies signal opposition to the disdained "establishment" (Hahl et al., 2018). Such disdain for the "establishment" may explain why Donald Trump can continue to rely on his base despite a proven record of inaccuracies and misleading statements, and why support for Brexit continues to be strong in parts of the British population notwithstanding mounting evidence that it was based on false premises (Watson, 2018). Similarly, automated "big data" techniques may make human decisions more efficient but not necessarily fairer (Barocas and Selbst, 2016). Automated predictions about recidivism, hiring, or lending often suffer from unfairness owing to what Joy Buolamwini calls the "undersampled majority" in the underlying data.[4] Perceptions of such unfairness can accelerate collapse of shared beliefs and norms.

Diversity. The more genetically diverse a bee hive, the higher is its survival probability (Mattila and Seeley, 2007). Likewise, democracy can peacefully manage social relations by drawing on diverse viewpoints that would likely be stifled in a less open setting. However, as with randomness, if diversity is too little or too great, a complex system may become unstable. Publicly shared knowledge about facts and problems, a form of interaction, may degrade to the extent that democratic agreement becomes impossible. Degradation may occur through two mutually reinforcing processes. First, sub-groups of citizens may create their own self-reinforcing knowledge structures that are antagonistic to a shared knowledge base and potential agreement. These echo chambers may result from selective sharing of information on social media, although there is scientific disagreement about their importance (Guess et al., 2018). Even so, if people interact only with like-minded others, they may consider their beliefs to be more widely shared than they actually are. This may foster the emergence of a (falsely) perceived consensus, which in turn is known to render people's opinions resilient to contrary evidence (Leviston et al., 2013). Second, the effectiveness of spreading of misinformation as a political strategy or to foster the interests of private individuals or foreign powers is reinforced by the prevalence of the internet and social media (Garrett, 2017). "Flooding" (Roberts, 2018) of social media with multitudes of quarreling perspectives may increase the diversity of perspectives in the system to an intolerable level, leading consumers of news either to political apathy or to converge on crudely simplified propaganda.

Dynamics. Dynamical systems theory underpins our understanding of ecological stability by identifying basins of attraction an ecosystem may transition between. We cannot exhaustively specify the basins of stability within which democracy can subsist although rough contours can be identified. Early classical liberal claims that democracy could not survive because the less wealthy majority would vote themselves benefits at the expense of the wealthier minority remain to be validated by history. Instead, democracy has been structurally constrained by the need to placate wealthy elites. The dominant model in political science and economics views democratic institutions as being "self-enforcing" game theoretic equilibria and hence internally stable (Crawford and Ostrom, 1995; Knight, 1992). By implication, democratic institutions are thought to provide an external set of guarantees that foster more dynamic and unpredictable activities, but they will not themselves be affected by those activities. Some

game theorists have modeled dynamical properties of institutions by analyzing social norms as equilibria in expectations, and applying this framework to empirical public-policy problems in fostering and transforming norms. Stirling (Stirling, 2016) applies a more explicit and formal modeling technology, Conditional Game Theory (CGT), to social choice settings, showing how game theorists can identify the strategic propagation of norms through social networks. This approach allows us to trace both motivated and accidental erosion of norms, and norms that are more likely to be resilient. Game theory might also provide a link between democracy and the theory of evolution (Conradt and Roper, 2007).

Precisely because it can treat social systems as dynamical systems, complexity science can also help understand (a) the circumstances under which self-reinforcing pro-democratic patterns begin to decay, and (b) how other self-reinforcing phenomena may arise in their stead. For example, in opinion dynamics, minorities can have considerable influence, in particular when they are perceived as consistent and competent (Galam, 2012). Some argue that the consequence should be to restrict the dynamics and openness of a system. We would instead agree with Tocqueville that "More fires get started in a democracy but more fires get put out, too".[5]

Feedback. The role of feedback is paramount in any complex system. Feedback underpins the pervasive "rich-get-richer" phenomenon, which often leads to highly unequal distributions (Simon, 1955), be it of wealth, social links, or links to web pages. Economic inequality readily turns into unequal political power: increased wealth inequality allows wealthy actors to pursue political changes to institutions, which can in turn be translated into increased economic power. Evidence is emerging that relatively few wealthy individuals, in apparent violation of electoral law, exerted undue influence on the outcome of the Brexit referendum in the U.K. in 2016 (Bastos and Mercea, 2019; McGaughey, 2018; Watson, 2018). Disproportionate political influence can also be wielded by unelected (and unaccountable) media outlets, such as the tabloids in the U.K. (Reeves et al., 2016). If left unchecked, such self-reinforcing feedback loops have the potential to transform a democracy into an effective oligarchy. Under some circumstances, high inequality will spur unhappy citizens to counter-mobilize, leading to anti-inequality political change. However, such a stabilizing counter-reaction requires sufficient political knowledge and access to the public space (Page and Gilens, 2017).

Policy recommendations

We offer several policy recommendations, three "top-down" and three "bottom-up", to help (re)stabilize current systems of representative democracy. (1) Entrench diversity by regulation: an increase in knowledge of diverse opinion is needed to reverse political polarization. For example, the Republic of Ireland has used citizens' assemblies to design and support a series of referenda, which ultimately led to acceptance of gay marriage and overturning of the country's abortion ban (Farrell et al., 2018). Citizens' assemblies that are composed of randomly chosen "mini publics", are given ample time for deliberation and have access to expert testimony are likely resilient to the destabilizing factors introduced above. Such processes of sortition are more likely to capture the diversity of public knowledge than reliance on political elites (who tend to have similar perspectives). (2) Monitor feedback: dampen or reverse the feedback loop between economic inequality and political power by, for example, sharply limiting political spending and only allowing it under strong transparency requirements (as is already the case in Germany and other European states). (3) Ensure connectivity: publicly visible and comprehensible reforms to the electoral system should be aimed at securing and demonstrating its fairness (e.g., with post-hoc verifiable paper ballots) and individual citizens' impact. An example is enhanced use of the web by the Icelandic government to strengthen democratic participation and direct democracy (The World Wide Web Foundation, 2014). Regulation of content to mandate balanced representation and objectivity (of the kind already implemented in European democracies, and which applied to US radio and television news before the 1980s), combined with transparency requirements for social media, would limit knowledge fragmentation.

The complexity science approach recognizes the limits of top-down control measures, such as (1)–(3). We, therefore, also offer recommendation for agents who seek reform via bottom-up influence through self-organizing networks. (4) Recruit credible communicators in estranged regions of the network: self-organized groups need to consider not just the facts and arguments they aim to get into the wider public sphere, but develop strategies to expand into multiple sub-networks. For example, efforts to explain the broad social costs of the US prison system only started to succeed when conservative elites who had been imprisoned provided their perspective (Dagan and Teles, 2016). (5) Recognize limits to message control: advocates should promote mutual acceptance that spreading influential messages through networks is not compatible with enforcing rigid commitments. Self-organized groups should acknowledge the limits to controllability of information flow and pre-identify how their messages can mutate in network regions populated by initially disagreeing or opposing individuals. For example, knowing that their private e-mail correspondence, released via Freedom-of-Information requests, would be selectively quoted and disingenuously spun in predictable ways by climate change denialists, scientists at the University of Arizona pre-emptively provided context for the e-mails to offset anticipated spin.[6] This example should be generally emulated: influence groups should maintain awareness of the likely transformations their messages encounter as they travel through distant and estranged network regions, thereby participating in reciprocal and dynamic opinion formation rather than either trying to enforce endorsement of "pure" original message preservation or being "victimized" by actors who may not always act in good faith. (6) Emphasize persistence and limits to forecasting: advocates should realize that there are no generally reliable metrics for assessing the probability that a message might become influential. Persistence in advocacy can pay off since it may prepare, more or less invisibly, a network of opinions for apparently sudden flipping under unanticipated, new conditions. Kuran's model of "preference falsification" offers an explanation of the persistence of widely disliked social structures and the occurrence of sudden unanticipated changes (Kuran, 1997).

Our recommendations do not form a hierarchy. Their effectiveness is context dependent (to spell this out goes beyond the realm of this piece). The recommendations are also not independent of each other. For example, failure in recruiting credible communicators (Recommendation 4) increases the likelihood of failure in recognizing limits of message control (Recommendation 5).

The way in which these recommendations can be put into practice will differ from country to country. While Ireland has gathered much experience with regards to Recommendation (1) and Switzerland has a long-standing tradition of participatory democracy, other countries only begin to experiment with it. Examples are "vTaiwan",[7] an online platform supported by the Taiwanese Minister for Digital Affairs to engage experts and members of the public in large-scale deliberation on specific

topics, and "Decide Madrid",[8] a platform for public participation in decision making, launched by Madrid city council.

Finally, we must recognize that democracy is an evolving project under ongoing construction and that the currently prevailing representative model need not be considered final. An active research community is developing improved democratic processes, with explorations of numerous voting rules, such as flexible majority rules, minority voting, balanced voting, assessment voting.[9] Complexity science offers an opportunity to examine the resilience of those alternative modes of governance. Complexity science also offers diagnostic tools for the evaluation of current policies, which can help us build more resilient and participatory democratic processes. Our current circumstances demand that we harness the strengths of randomness, diversity, and adaptability within the complex social system of which our political governance structures are a crucial component.

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Notes

1 There are many forms of democracy, of course. In this article, we assume the very general notion of "democracy" as a method of group decision making characterized by a kind of equality among the participants at an essential stage of the collective decision making of nation states (cf. Christiano, 2018).
2 https://www.theguardian.com/news/2018/may/01/why-replacing-politicians-with-experts-is-a-reckless-idea.
3 https://www.justice.gov/opa/pr/grand-jury-indicts-thirteen-russian-individuals-and-three-russian-companies-scheme-interfere.
4 https://ainowinstitute.org/symposia/videos/limited-vision-the-undersampled-majority.html.
5 As cited by D. Runciman in https://www.theguardian.com/news/2018/may/01/why-replacing-politicians-with-experts-is-a-reckless-idea.
6 https://www.theguardian.com/environment/climate-consensus-97-per-cent/2016/jul/07/climate-scientists-are-under-attack-from-frivolous-lawsuits.
7 https://vtaiwan.tw/.
8 https://decide.madrid.es/.
9 http://www.mip.ethz.ch/research/areap/constitutionaldesign.html.

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Additional information

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