The Rules of Contagion: Why Things Spread—And Why They Stop

by Adam Kucharski

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In *The Rules of Contagion: How Things Spread—and Why They Stop*, Adam J. Kucharski takes the reader on a journey through a contagious world. Ripe with personal anecdotes, historical context, and small mathematical examples, the journey touches on everything from communicable diseases to the stock market, online propagation of memes, and the social contagion of crime. At the end of this journey, the reader is left with a sense of both similarities and differences between contagions in these different realms.

The text is aimed at a general nonscientific audience, but the scope is broad enough that professionals might also find it enlightening—especially since a large fraction of working scientists have become epidemiologists (armchair or otherwise) during the Covid-19 pandemic.

The beginning of the book is just excellent. Kucharski begins his text by introducing fundamental epidemiological concepts in the context of communicable diseases. Questions like What is contagion? What does it take for a disease to spread? and How can the spread be mitigated? are answered in a clear and concise fashion. It feels strangely refreshing—via the examples about zika, malaria, and many other diseases—to be reminded that Covid-19 is not the only disease in the world.

One of the things that distinguishes this text from other popular-science books is that it invites the reader into the life of an epidemiologist. What mathematical methods are used to project outbreak sizes? What types of data are necessary in order to make projections about those outbreaks, and what are the challenges in obtaining high-quality data? It becomes clear that epidemiology consists in both messy field work and long hours crunching numbers. Accounts from expeditions to tropical regions make the more technical parts easy to swallow. For more technically adept readers, we suspect that the technical parts may even become small highlights. For us, one such highlight is Kucharski's debunking of the myth that reducing the expected number of secondary cases per infected—the effective reproduction number of a disease—to below 1 is sufficient to control an epidemic. Kucharski expertly demonstrates the connection between the geometric series and the expected size of an epidemic in this context. He then uses this to show that the epidemic size diverges when the reproduction number approaches 1 from below. Conveying such technical points to a general audience is no easy challenge, but Kucharski is a master of the discipline.

As scientists dedicated to studying spreading phenomena in social systems, we find the latter part of the book less compelling. It is devoted to demonstrating the applicability of concepts from epidemiology in social settings very different from communicable diseases and even biology.

The key example is online diffusion: how memes and other content spread among online users. But the range of phenomena is much wider. Leafing through the book to find examples, we learn of contagion in finance, ideas, smoking behavior, political opinions, inner-city gang killings, hygiene behavior in medicine, riots, terrorism and crime, rumors, bot-nets and cyber worms, storytelling, online privacy, and many others. At some point, the text begins to feel a bit like a collection of detached tales, and the use of epidemiological concepts can feel forced. And this is in spite of the fact that it is clear that Kucharski has an excellent overview of the literature. All the right papers are cited, but the progression of the text does not quite feel natural. Moreover, when describing social contagion in terms of epidemiological concepts, Kucharski tends to focus on the similarities between the various kinds of contagion, often leaving out important differences.

Let us illustrate this last point with a concrete example—the treatment of financial contagion. Here the difference between the general social phenomenon of the spread of fear among traders and spreading processes on the disassortative network of transfers between banks is not expounded clearly. In order to learn the right lessons about spreading in financial systems, however, it is crucial to underscore that the contagious fear leading to collective action among traders does not just spread on the interbank trading network—it spreads via face-to-face conversations, telephone calls, social networks, newspapers, and so on. The bank-to-bank network's structure is important for phenomena like cascading failures and unexpected dependencies, but not for the spread of fear.

Furthermore, in the context of fear transmission, an important realization over the past decade is that while contagion in social systems and disease transmission were initially considered similar, they are now known to be substantially different. Contagion in social systems is complex, meaning that our susceptibility to ideas does not depend only on the amount of exposure to an idea, but also on how many different sources of the idea we encounter. Thus, if one of my friends starts using Twitter 18 hours a day, it may not impact my likelihood of using Twitter, but if 18 friends start using Twitter for one hour a day, it might make me consider using the platform. It is likely that the spread of fear among a population of individuals—including a population of stockbrokers—is driven by complex contagion. But complex contagion is not included in Kucharski's treatment of financial contagion; instead, the topic appears later in a different context.

We hope that the details of this example convey a sense of what feels out of balance in the latter part of the book. First, information is provided bit by bit and not integrated into a coherent narrative. Second, in mainly underscoring

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the presence of spreading phenomena everywhere, important distinctions are sometimes neglected. An overview of similarities and differences, lessons learned from all the examples, would have elevated the book, but one never materializes.

In our work, we have found that while the notions from classical epidemiology are useful and informative, the subtleties and differences that arise when one is analyzing social systems are crucial for building models that reflect the behavior observed in the social realm. This could have been a main message in Kucharski's treatment of contagion in a social systems setting. Instead, the author ended up with a narrower focus on the similarities between classical epidemiology and social contagion.

In the final analysis, then, the book under review is not wholly successful. The lack of a coherent thread through the second half makes our main takeaway the thorough and engaging description of the life, work, and thoughts of a twenty-first-century epidemiologist. The first half of the book makes for an excellent and highly enjoyable read and makes the book recommendable in itself. The average pandemic-struck science enthusiast will appreciate the pleasant mix of hard facts, historical context, and would-be Indiana Jones tales. Furthermore, early-career scientists working on projects related to contagion in social contexts will find, in the second half of the book, a treasure trove of references and descriptions of relevant literature from the past 20 years.

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