

Infinity, Causation, and Paradox, Alexander R. Pruss, Oxford: OUP, 2018, vi-207.

In *Infinity, Causation, and Paradox* Alexander Pruss undertakes a sweeping defense of the metaphysical thesis Causal Finitism. According to causal finitists, nothing can be affected by infinitely many causes. Pruss argues for causal finitism by way of a cumulative case: accepting causal finitism allows us to eliminate a large class of paradoxes. There are broadly two types of paradoxes Pruss aims to eliminate. The first consists in paradoxes where an infinity of physical things cooperate to produce a paradoxical situation. The paradigm is the Grim Reaper paradox. The second type involves paradoxes of rationality that can occur in infinitistic situations. The paradigm is a fair countable lottery.

The opening chapters of the book introduce causal finitism and provide an overview of the kinds of situations causal finitism rules impossible. This is followed by a discussion of physical paradoxes in chapter 3. Chapters 4-6 are devoted to paradoxes of rationality. Chapter 7 provides further refinement of the precise thesis of causal finitism, while chapters 8 and 9 discuss interesting metaphysical upshots: if causal finitism is true, then space and time are discrete and there is a first cause. The bulk of the book's argumentative work is done in chapters 3-6, since the primary selling point for causal finitism is its ability to eliminate many paradoxes in one fell swoop.

The book's subject matter is fairly technical, and Pruss has made some accommodations to account for that. Chapters typically begin with informal discussion, with technical material relegated to later sections that have been designed to be skippable by less formally inclined readers, as well as a few appendices. Nevertheless, this is not a book for beginners. Knowledge of basic set theory is required, especially for the discussion in sections 4-6. Some knowledge of probability theory is likewise required. For the researchers in metaphysics and formal epistemology to whom this material is most relevant, that shouldn't be a problem, and I would consider using this book alongside supplementary materials in a graduate course, but it would be difficult for undergrads.

Overall, I found Pruss's discussion of the paradoxes of infinity interesting and often illuminating, but I was not convinced by the book's overall argument. As Pruss himself acknowledges (p. 2), it is often preferable to resolve paradoxes without adopting revisionary metaphysical or logical theses. Thus, the defender of causal finitism must persuade us that it is difficult enough to reckon with the paradoxes of infinity that adopting causal finitism is the best option. My worries about Pruss's argument differ slightly by which class of paradox we are considering. I will begin with some discussion of the paradoxes involving infinities of things in a physically paradoxical situation before moving on to the paradoxes of rationality.

To focus our discussion of the first type of paradox, we will consider one of Pruss's more important example: the Grim Reaper Paradox. The patterns of argumentation we see with the grim reaper will recur in other similar paradoxes. A grim reaper is a machine with an alarm. In this version of the paradox, they light lamps. When a grim reaper's alarm goes off, it activates, checks to see if the target lamp is on, and if so deactivates. If the lamp is off, it turns the lamp on. Consider an infinity of grim reapers with alarms set as follows: they are all set between 10 AM and 11 AM. The last one is set to 10:30:00. The one before it is set to 10:15:00. The one before it is set to 10:07:30. This continues, with the interval between each consecutive pair of reapers cut in half. At 10 AM, the lamp is off. With infinitely many Grim Reapers between 10 AM and 11 AM, the lamp must be on at 11 AM; after all, any reaper to activate with the lamp off will turn it. But which reaper did the turning? Not the 10:30 reaper; if it had been off at 10:14, the 10:15 reaper would have turned it on. Not the 10:15 reaper, for if it had been off at 10:07, the 10:07:30 reaper would have turned it on. We may reason likewise for every reaper. The lamp is on, but there is no reaper that turned it on. Impossible.

Causal finitism eliminates the paradox. If infinitely many grim reapers cannot target the same lamp, we have no paradox. This gives a tidy explanation for the impossibility, but in the process it rules out a good many other situations that have nothing paradoxical about them. Is a better explanation available? It seems to me that there is. The grim reaper situation is not just impossible, it is inconsistent. An existential claim like 'some grim reaper turned the lamp on' must have a witness, but once we work through the infinitely long list of potential witnesses, we find none. The situation's inconsistency explains its impossibility.

Pruss entertains a reply along these lines and responds: suppose that we add to the original grim reaper case a single reaper whose alarm is set for 10 AM. Now the case is no longer contradictory; the 10 AM reaper activates and turns the light on, then each reaper wakes up, sees the light on, and deactivates. If this case is possible, Pruss claims, the original grim reaper case should be too. The alarms on grim reapers are just a physical mechanism (perhaps a dial adjusted by a tinkerer), and should be able to move independently of each other. Accepting that there could be infinitely many grim reapers focussed on a single lamp, but that certain arrangements of their alarms is impossible, he argues, is more implausible than simply rejecting that there could be infinitely many grim reapers focussed on a single target.

I disagree for two reasons. First: it is not as clear to me that non-paradoxical variants of the grim reaper situation should be impossible. While physical dials should be able to move independently, their movements cannot fit into a pattern that would cause a contradiction. Consider a wholly finite case: there are two switches connected to a lamp, and each works the same way: if the switch is up, the lamp must be on, and if the switch is down, the lamp must be off. Even though the switches are physical mechanisms that should be able to move independently, putting them in opposite positions is impossible since it would cause the lamp to be both off and on. No metaphysical thesis is required to explain this impossibility; the fact that it would lead to a contradiction is enough.

Second: causal finitism is not the only metaphysical thesis that would explain the impossibility of the grim reaper situation. Full blown finitism would too. Pruss rejects full blown finitism (Ch. 1, Section 4). The full-blown finitist may parody Pruss's response as follows: say that grim reapers not only set their alarms with dials, but also use a dial to set which lamp they target. The physical dials should be able to move freely. If causal finitism is true but full blown finitism is false, there's no reason to rule out an infinity of grim reapers all targeting different lamps. But if that's possible, then it should be possible for each reaper's tinkerer to adjust its dial so that they all target the same lamp. In order to deflect the parody argument, Pruss must say something that cannot be adapted by the one who thinks the grim reaper situation is impossible simply because it is inconsistent, and it's far from clear what that would be.

Neither of these considerations is decisive. It is undeniable that the causal finitist has a solution to the grim reaper paradox and other paradoxes like it that is more unified than rivals that don't embrace a revisionary metaphysics. But they do affect the cost/benefit analysis that is the book's central argument.

Next, paradoxes of rationality. Consider a fair lottery with a countable infinity of tickets. Through some creative constructions, Pruss shows how such a lottery could be constructed if causal finitism is false, and then draws out a number of counterintuitive consequences from applying standard norms of rationality and good decision to fair countable infinite lotteries. He argues that a perfectly rational agent facing fair infinite lotteries would be subject to Dutch Books (Chapter 4 Section 2.3), would face paradoxical epistemic symmetries (Chapter 4 Section 2.4), and could be manipulated by true statements using only conditionalization as an updating procedure into becoming nearly certain that a string of 100 fair coins landed all heads, without knowing the result of any of the coin flips (Chapter 4 Section 2.5). He also shows how to change a fair countable lottery into a rigged one by increasing everyone's odds of winning (Chapter 4 Section 2.6). The explanations of how these follow from a fair countably infinite lottery are clear and accessible, and don't depend on whether the probabilities are given using standard or non-standard numbers.

However, in contrast to cases like the grim reaper, it is not clear to me that causal finitism eliminates the paradoxes. The main reason Pruss gives to think it does is that causal finitism renders a countable infinite lottery impossible. But the paradoxical results are simply the consequences of applying standard rules of rationality to infinitistic situations. At no point in the derivation is the possibility of the infinitistic situation presupposed. It is fairly normal to apply our powers of counterfactual reasoning to situations we know we will never encounter, from physicists hypothesizing about frictionless claims to mathematicians exploring alternative set theories. Unlike in the grim reaper, what we get is not literal contradiction but instead generally reliable reasoning processes suddenly leading to bad results. The fact that the situation is impossible does not change this, nor does it render the reasoning suddenly nonsensical. The causal finitist response to these paradoxes strike me as being in the same boat as Richard Jeffrey's quip that anyone who offers me a chance to

play St. Petersburg Game is a liar, since he represents himself as having an indefinitely large bank.¹ Good practical advice, perhaps, but it does not get at the heart of the problem the game poses for expected utility theory. So it is with these.

To summarize: *Infinity, Causation, and Paradox* is a careful and well-written exploration of the paradoxes of infinity and a campaign on behalf of causal finitism. And while I have raised some concerns for the book's central argument, I found working through it illuminating and productive. I recommend it to the library of anyone interested in the three title topics.

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¹ Richard Jeffrey, *The Logic of Decision*, 2nd Edition, (Chicago, University of Chicago Press, 1983), 154.