Probabilistic Proof of an External World

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Abstract

I provide a novel internal critique of skepticism about the external world. Appealing to premises that an external-world skeptic could accept, I argue that the skeptic should (by her own lights) be extraordinarily confident that an external world exists. These premises include commitments to various forms of *a priori* reasoning—including commitments to classical logic, set theory, and probabilistic reasoning—as well as radical empiricism about evidence. As I argue, these premises entail that the skeptic should, by her own lights, be at least 99.99999% confident—just shy of certain—that an external world exists.

1 Introduction

Philosophy has long been in the business of entertaining extraordinary skeptical hypotheses that fly in the face of what we ordinarily take to be true. Perhaps the most extraordinary of all is that of solipsism—the thesis that I am all that exists. According to solipsism, there is no 'external' world of any sort—no chairs, no gods, no other minds. Only myself.[1]

While few (if any) philosophers accept solipsism, many take the possibility of solipsism to raise an important skeptical challenge. The challenge is simple:

[1]Solipsism is sometimes taken to be the view that the only mind that exists (or the only mind that I can know exists) is my own, allowing that there may exist other things that lack mentality. In what follows, however, I understand solipsism in its most radical metaphysical sense—namely, as the view that I am the only thing that exists. Equivalently, I understand solipsism as the view that no external world exists, where I take the 'external world' to be merely that which exists in addition to myself.

how can one know—or be justified in believing—that there exists an external world when one's experiences seem compatible with the hypothesis that there isn't one? Although a number of anti-skeptical arguments have been put forward to this challenge,[2] I will not discuss any of them in this paper. My aim is simply to add a new item to the arsenal of arguments.

I will formulate my anti-skeptical argument as an internal critique of skepticism about the external world. Appealing to premises that an external-world skeptic could accept, I argue that the skeptic should (by her own lights) be extraordinarily confident that an external world exists. As I elaborate further below, these premises include commitments to various forms of *a priori* reasoning—including commitments to classical logic, set theory, and probabilistic reasoning—as well as radical empiricism about evidence. My argument proceeds broadly as follows.

First, I argue that, for all the skeptic believes with certainty, there are far more ways—indeed, infinitely many times more ways—for there to exist an external world than not. Second, appealing to a restricted version of the principle of indifference, I argue that the skeptic should be just as confident in each way in which there might exist an external world as in each way in which there might fail to exist an external world. Third, employing the idea that the number of ways in which a given proposition can be true has important bearing on how confident one should be in it, I argue that the skeptic should (by her lights) be much more confident that there exists an external world than not. In particular, I argue for the following thesis:

- **Anti-Solipsism.** The skeptic should, by her lights, be at least 99.99999% confident—just shy of certain—that an external world exists.[3]

Call the argument I have just outlined the *Anti-Solipsism Argument*.

The Anti-Solipsism Argument is probabilistic in nature. Unlike many anti-skeptical arguments, the Anti-Solipsism Argument does not establish that the skeptic can know that an external world exists. Rather, it merely establishes that the skeptic should, by her own lights, be extraordinarily *confident*—yet not absolutely certain—that an external world exists. I will spell out the argument in much greater detail over the course of this paper.

[2]Historically significant examples include Descartes (1641), Kant (1787), and Wittgenstein (1969). The title of the present paper pays homage to Moore (1939).

[3]More precisely, I argue that, for any real-valued credence x less than 1, the skeptic should (by her lights) have at least credence x that an external world exists. Thus, the skeptic should, by her lights, be *almost sure* that an external world exists.

2 Preliminaries

In this section, I lay out some notions and assumptions that are necessary to formulate the Anti-Solipsism Argument more precisely. In particular, I lay out the commitments of the skeptic who is my target in this paper. Although it will take some time to go through these preliminaries, the Anti-Solipsism Argument will quickly fall into place once they are laid out.

2.1 Solipsism clarified

In what follows, I understand solipsism in a manner relativized to the skeptic:

- **Solipsism.** The skeptic is the the only thing that exists.

Equivalently, I understand solipsism as the thesis that no external world exists, where I take the 'external world' to be merely that which exists in addition to the skeptic.[4] If solipsism is true, then reality is an ontologically barren place. There are no other minds, no electrons, no ordinary objects. Nonetheless, solipsism does not imply that reality is barren in all respects, for the skeptic may still have an incredibly rich mental life—full of happiness, regret, reflectiveness, and wonder. That is, she may still undergo a rich **stream of mentality**.

Intuitively, the skeptic's stream of mentality is the totality of mental phenomena that she undergoes over the course of her life. Although I am inclined to view the notion of 'stream of mentality' as primitive, the skeptic's stream of mentality is, to a first approximation, the complete series of mental states that she undergoes over time. Her stream of mentality includes the mental state she is presently undergoing, all mental states she has already undergone (if any), and all mental states she will undergo (if any).

Terminological note. I understand 'mental state' very broadly to include any phenomenal states, non-phenomenal states, cognitive states, as well as

[4]This usage of 'external world' differs from the common philosophical usage according to which the external world is, roughly, the totality of things that occupy space. See Neta (forthcoming, §2) for more on this usage of the term. Additionally, 'external-world skepticism' is often taken to be skepticism about whether there exists an external world of the sort ordinarily believed to exist—one full of tables, other minds, and the rest. I will not attempt to defeat this sort of skepticism in this paper. My target is the still more radical skepticism about whether there exists any external world at all. I discuss the connection between these two sorts of skepticism further in §4.

non-cognitive states that the skeptic might undergo. However, I treat mental states as 'total' in the sense that the skeptic only undergoes a single mental state at once. Thus, if the skeptic is presently having a visual experience as well as an auditory experience, then she is not presently undergoing two mental states but rather a single mental state that has a visual aspect and an auditory aspect.[5] Additionally, I assume that any two mental states the skeptic undergoes can be individuated without appealing to relations they bear to external-world things (if such there be).[6] This assumption ensures that solipsism is formulated in a manner that does not beg the question whether an external world exists.

That said, all of the above is only an approximate explication of the notion of 'stream of mentality' because I do not wish to presuppose that there is a unique way to carve up the skeptic's stream of mentality into mental states.[7] Nonetheless, I will often employ 'mental state'-talk as convenient shorthand for talk about salient aspects of the skeptic's stream of mentality in what follows. Four additional clarifications are in order.

First, as formulated above, solipsism may seem analytically false. For example, it may seem that the skeptic's existence analytically *entails* the existence of mental states or relations among mental states. I will remain neutral about whether this is indeed the case, but the Anti-Solipsism Argument applies equally well to a weaker formulation of solipsism according to which all that exist are the skeptic as well as whatever the skeptic's existence analytically entails. I will note appropriate modifications to the argument when relevant.

Second, to say that the skeptic's stream of mentality is the complete series of mental states that she undergoes 'over time' is not to presuppose the existence of some objective temporal dimension, independent of her existence, over which she undergoes mental states. Rather, it is simply to say that her stream of mentality *has* temporal structure (if indeed she undergoes more than a single mental state over the course of her life). Intuitively, she does not undergo every mental state at once. Rather, she undergoes one state, and then another, and so on. The skeptic's mental states are ordered in some

[5]However, I will stay neutral whether her undergoing such a state involves having an additional 'unified' visual-and-auditory experience. See Bayne (2010) for more on the unity of consciousness.

[6]That is, I assume the methodological solipsism of Fodor (1980).

[7]See Dainton (2006, p. 23) and Bayne (2010, p. 24) for skepticism that there is a privileged way of individuating experiences.

(perhaps somewhat vague) manner, and the temporal relation may simply be understood as that relation which orders them as such.

Third, I will stay neutral whether the skeptic's stream of mentality has any structure beyond temporal structure. In particular, I will stay neutral whether her stream of mentality has any explanatory structure. Thus, I will neither assume nor deny that her cereal-eating experience this morning (partially) *causes* or *grounds* her present experience of seeming to remember having a cereal-eating experience this morning. To a second approximation, then, the skeptic's stream of mentality may be characterized as the complete series of mental states she undergoes, along with whatever structure that series has. Thus, if the skeptic undergoes all of the same mental states in stream of mentality m_1 as in stream of mentality m_2 but m_1 has explanatory structure—while m_2 lacks such structure—then m_1 and m_2 are different streams of mentality.

Fourth, the Anti-Solipsism Argument is compatible with a number of accounts of what makes one series of mental states different from one another. For example, it is compatible with an individuation criterion according to which series of mental states s_1 is different from series s_2 just in case undergoing s_1 and undergoing s_2 are phenomenologically distinguishable for the skeptic.[8] I will remain neutral as to what makes one series of mental states different from another in what follows.

2.2 Solipsistic scenarios

As I said in §1, I will argue that, for all the skeptic believes with certainty, there are far more ways for solipsism to be false than true. I now spell out a few notions that are necessary to characterize the relevant sense of 'way' more precisely.

First, say that a proposition p is **epistemically possible** (for the skeptic) just in case p might be true, for all the skeptic believes with certainty. (Note that this usage of the term differs from the common usage according to which p is epistemically possible just in case p might be true, for all one *knows*.) More precisely, say that p is epistemically possible just in case the skeptic should not, by her lights, believe with absolute certainty that p is not true.[9]

[8]This criterion is an analogue of the individuation criterion for qualia defended by such authors as Jackson and Pinkerton (1973) and Fara (2001).

[9]This conception of epistemic possibility is a certainty-based analogue of the 'permissive' conception described by Gendler and Hawthorne (2002, p. 3).

Second, call a (centered) **world** a maximally specific way for the actual world to be. To say that a given world is actual is to settle all questions (including all indexical ones) that the skeptic might ask about the actual world—about what exists, about how many things exist, about which of the existent things the skeptic is, and so on. In what follows, I will not presuppose that any given world is metaphysically possible or epistemically possible. I will not even presuppose that any given world is logically possible. Formally, a world w can be characterized merely via some (possibly infinite) conjunction of propositions that hold at w, along with a 'totality' clause stating that no other propositions hold at w. If propositions are understood (or represented) as collections of worlds, then worlds may be understood (or represented) as maximally fine-grained propositions.

Third, call a **scenario** a world that is epistemically possible—that is, a maximally specific way that the actual world might be, for all the skeptic believes with certainty.[10] More precisely, a world w is a scenario just in case it is epistemically possible that w is actual. Scenarios may be understood as maximally fine-grained propositions that are epistemically possible.

Finally, call a **solipsistic scenario** any scenario at which solipsism is true and an **anti-solipsistic scenario** any scenario at which solipsism is false. In what follows, I will assume that any solipsistic scenario is completely characterizable by the stream of mentality that the skeptic undergoes at it. This assumption is motivated by the idea that, if solipsism is true, then the facts about the skeptic's stream of mentality 'fix' all other facts (if such there be)—for example, facts about whatever the skeptic's existence analytically entails (if such there be). This assumption will ensure that the Anti-Solipsism Argument applies to both of the formulations of solipsism discussed in §2.1.

2.3 Recombination

In what follows, there is very little that I will assume the skeptic should, by her lights, believe with certainty. I will only assume that, by her lights, she should believe the following with certainty: (1) particular logical and set-theoretic propositions, which I describe in §2.6; and (2) particular propositions about her stream of mentality. The latter collection of propositions

[10] I borrow the term 'scenario' from Chalmers (2011). What I call a scenario is roughly what Chalmers calls a scenario in the 'Cartesian' sense of epistemic possibility (though Chalmers understands scenarios fundamentally in terms of knowledge rather than certainty).

may include, at any time t, just propositions about what the skeptic's stream of mentality is like at t, but it may also include propositions about what her stream of mentality is like at times before or even after t. The key point for the Anti-Solipsism Argument is simply that the skeptic ascribes *some* propositions about her stream of mentality a privileged epistemic status.

Just as there is very little I will assume the skeptic takes herself to be reasonable in believing with certainty, so I will assume that there is very much that is epistemically possible for her. In particular, I will assume that the skeptic accepts the following intuitively plausible 'recombination' principle:

> **Recombination.** For any collection A of epistemically possible streams of mentality and any non-negative integer N, there is a scenario at which: (1) the skeptic undergoes some stream of mentality in A; (2) for every stream of mentality m in A, N other minds undergo m; and (3) nothing else exists.[11]

To illustrate this principle, let $A = \{m_1, m_2, m_3\}$, for epistemically possible streams of mentality m_1, m_2, and m_3. By **Recombination**, there is a scenario at which only the skeptic undergoes m_1, exactly two minds undergo m_2, exactly five minds undergo m_3, and nothing else exists. This scenario is anti-solipsistic because more than just the skeptic exists at it. **Recombination** also entails that there is a (unique) solipsistic scenario at which only the skeptic undergoes m_1, zero minds undergo m_2, zero minds undergo m_3, and nothing else exists. Thus, **Recombination** entails that both solipsism and the negation of solipsism are epistemically possible as well as that many particular solipsistic and anti-solipsistic worlds are epistemically possible.

[11] More precisely, to remain neutral between the two formulations of solipsism discussed in §2.1, (3) should read: nothing whose existence is not analytically entailed by the existence of the skeptic and these other minds exists. I call this a 'recombination' principle because it is an epistemic analogue of recombination principles that figure in discussions of metaphysical modality. See Lewis (1986), Nolan (1996), and Sider (2009). Also, it is somewhat of a misnomer to say that the skeptic 'accepts' **Recombination**. Recall that a world w is a scenario just in case w is epistemically possible, i.e., just in case the skeptic should not (by her lights) be certain that w is not actual. So, in saying that the skeptic accepts **Recombination**, I simply mean that, for any collection A of epistemically possible streams of mentality and any non-negative integer N, the skeptic should not, by her lights, be certain that (1)–(3) are not all true at the actual world. Nonetheless, in what follows, I will employ talk about claims about epistemic possibility that the skeptic 'accepts' as convenient shorthand for talk about propositions in whose falsity—or worlds in whose non-actuality—the skeptic should not, by her lights, be certain.

Note that **Recombination** only entails the epistemic possibility of various 'idealist' worlds—that is, worlds at which the only things that exist are minds. I will not assume that the skeptic accepts any claims about what worlds are epistemically possible beyond **Recombination**, but the Anti-Solipsism Argument is compatible with allowing other worlds to be epistemically possible as well.

2.4 A restricted principle of indifference

Terminology. Say that propositions p and q are **evidentially symmetric** for a subject S just in case S's evidence no more supports one than the other.[12] Similarly, say that scenarios w_1 and w_2 are evidentially symmetric for S just in case S's evidence no more supports the proposition that w_1 is actual than the proposition that w_2 is actual, nor vice versa.

In what follows, I will assume that the skeptic accepts a restricted principle of indifference. I will *not* assume that she is committed to the following epistemic principle:

> **Unrestricted Principle of Indifference (Unrestricted PI).**
> If propositions p and q are evidentially symmetric for S, then S should be exactly as confident in p as in q.[13]

Although **Unrestricted PI** may seem intuitively plausible, a number of authors have argued that **Unrestricted PI** leads to inconsistency when the space of epistemic possibilities—'epistemic space', for short—can be partitioned in multiple ways.[14] Because of these difficulties, I will not assume that the skeptic accepts **Unrestricted PI**. However, I will assume that the skeptic accepts the following restricted principle of indifference:

> **Restricted Principle of Indifference (Restricted PI).**
> If scenarios w_1 and w_2 are evidentially symmetric for S, then S should be exactly as confident in w_1 as in w_2.[15]

[12] I borrow this terminology from White (2010).

[13] This unrestricted principle of indifference is similar to that defended by White (2010).

[14] See van Fraassen (1989, Ch. 12). The style of objection is originally due to Bertrand (1889). See White (2010) and Novack (2010) for recent responses to the objection.

[15] More precisely, S should be exactly as confident in the proposition that w_1 is actual as in the proposition that w_2 is actual. For simplicity, I will use the shorter locution in what follows.

Because **Restricted PI** is formulated at the level of maximally fine-grained epistemically possible propositions—that is, at the level of scenarios—it is not susceptible to the inconsistency objection. Broadly, the reason is that, while there are many ways to partition epistemic space into evidentially symmetric coarse-grained propositions—at least, so say the objectors to **Unrestricted PI**—there is at most one way to partition epistemic space into (singletons of) evidentially symmetric scenarios. So, while **Unrestricted PI** may apply with respect to multiple coarse-grained partitions of epistemic space—and thereby entail inconsistent prescriptions of doxastic attitudes—**Restricted PI** can only be applied with respect to the maximally fine-grained partition that contains (singletons of) scenarios. Thus, it is plausible that **Restricted PI** is a consistent principle.[16]

Restricted PI is also an intuitively plausible principle. As objectors to **Unrestricted PI** argue, even if two (coarse-grained) propositions p and q are evidentially symmetric, we may still have reason not to be equally confident in them. In particular, p and q may still bear logical or probabilistic relations to other (coarse-grained) propositions that imply that we shouldn't be equally confident in p and q.[17] By contrast, because scenarios are maximally specific ways for the world to be, no two scenarios are logically consistent with one another.[18] As a result, no two scenarios bear any logical or probabilistic

[16]This is essentially the point made by Keynes (1921) in Chapter 4, §§20–21, of his *Treatise on Probability*. (Keynes employs talk of 'indivisible alternatives' rather than 'scenarios' or 'worlds'.) Although Keynes is often cited as a notable objector to indifference principles—indeed, he spends most of Chapter 4 arguing against an unrestricted principle of indifference that is similar to **Unrestricted PI**—he actually defends a restricted principle of indifference that is similar to **Restricted PI** at the end of that chapter. Williamson (2010, Ch. 3) defends a similarly restricted principle of indifference as well.

[17]For example, consider Keynes' example of the book whose color we know nothing about (*ibid.*, p. 43). Let R be the proposition that the book is red, B the proposition that the book is blue, and G the proposition that the book is green. Intuitively, R is evidentially symmetric with $\neg R$, B is evidentially symmetric with $\neg B$, and G is evidentially symmetric with $\neg G$. Now suppose we are exactly as confident in R as in $\neg R$, exactly as confident in B as in $\neg B$, and exactly as confident in G as in $\neg G$. Then, assuming our credences satisfy the axioms of probability, we should have a credence of $\frac{1}{2}$ in each of $R, \neg R, B, \neg B, G$, and $\neg G$. However, because R, B, and G are mutually exclusive, we should then have a credence greater than 1 in the disjunction $(R \vee B \vee G)$—in violation of the axioms of probability. Thus, despite our intuitive judgments of evidential symmetry, we shouldn't be exactly as confident in the members of the aforementioned pairs of propositions.

[18]More precisely, for any two scenarios w_1 and w_2, the proposition that w_1 is actual is logically inconsistent with the proposition that w_2 is actual.

relations to one another that are relevant to whether we should be more confident in one than the other. For example, no scenario implies any other scenario, no scenario is the negation of any other scenario (provided there are more than two scenarios), and so on. Thus, if two scenarios are evidentially symmetric, then plausibly we have no reason to be more confident in one than the other. So, we should be equally confident in them—just as **Restricted PI** says we should.

Note that **Restricted PI** only tells the skeptic that she should be equally confident in any two scenarios that are evidentially symmetric with one another. By itself, **Restricted PI** has no bearing on how confident she should be in any coarse-grained proposition, such as the proposition that there exists an external world. In the next section, I describe an epistemic principle that (together with probabilism) enables the skeptic to arrive at doxastic attitudes she should adopt towards coarse-grained propositions on the basis of doxastic attitudes she should adopt towards scenarios. I call this principle **Comparative Additivity**. Since skeptical worries often arise as a result of recognizing that there are vastly many ways the world might be that are compatible with one's experiences, it seems natural for the skeptic to adopt an approach to inquiry that explicitly takes these ways into account before 'building up' attitudes towards propositions of metaphysical interest. As such, **Restricted PI** and **Comparative Additivity** constitute a natural pair of epistemic principles for the skeptic.

2.5 Comparative Additivity

In what follows, I will assume that the skeptic accepts probabilism. That is, although the skeptic is uncertain in many propositions—including the proposition that an external world exists—she accepts that her credences should satisfy standard axioms of probability. Thus, for example, her credence in the proposition *an external world exists or an external world doesn't exist* is 100%. I spell out these axioms more fully in the Appendix.

In addition to standard axioms of probability, I will assume that the skeptic accepts a 'comparative additivity' principle.[19] This principle captures the idea that, other things being equal, if proposition p can be true in more

[19]I call this an 'additivity' principle because it bears superficial similarities to finite additivity and countable additivity. However, while finite additivity and countable additivity only apply to finite and countably infinite collections of propositions, respectively, the comparative additivity principle applies to arbitrary collections of propositions.

ways than proposition q, then one should be more confident in p than in q. Intuitively, the bits of confidence one should have in the ways p can be true 'add up' to a greater overall degree of confidence than that to which the bits of confidence one should have in the ways in which q can be true add up.

To spell out the principle more precisely, I will need a way of comparing the 'sizes' of two collections. I will do this in the usual way familiar from set theory.[20] First, say that collection Y is at least as big as collection X just in case there is some function from X to Y that maps any two distinct members of X to distinct members of Y. Next, say that Y is the same size as X just in case there is a one-to-one correspondence between X and Y, i.e., just in case there is a function from X to Y such that every member of X is mapped to exactly one member of Y and every member of Y has exactly one member of X that is mapped to it. Finally, say that Y is bigger than X just in case Y is at least as big, but not the same size, as X.

Here, then, is the principle:

> **Comparative Additivity**
> Let Q and R be collections of mutually inconsistent propositions.[21] Suppose:
>
> 1. R is bigger than Q.
> 2. S should be at least as confident in every proposition in R as in every proposition in Q.
>
> Then: S should be at least as confident in R as in Q.[22]

[20] In what follows, I understand collections not as sets but rather as classes, which need not be sets (i.e., which may be proper classes). Moreover, although functions are typically understood as certain kinds of sets in set theory, I understand functions more broadly as certain kinds of classes. See Lévy (1979, pp. 24–28) for details on how this may be done. I formulate matters in terms of classes because I do not wish to presuppose that the two collections I will discuss in detail later—namely, the collection of solipsistic scenarios and the collection of anti-solipsistic scenarios—are sets. For example, Chalmers (2011, p. 90) argues that, for any cardinal κ, there are at least 2^κ scenarios. Since the collection of cardinals is a proper class, Chalmers' claim plausibly implies that the collection of all scenarios is a proper class. Analogous considerations might be offered for the claim that the aforementioned collections are proper classes as well.

[21] That is, every proposition in Q is inconsistent with every other proposition in Q, and every proposition in R is inconsistent with every other proposition in R.

[22] More precisely, S should be at least as confident that there is some member of R that is true as that there is some member of Q that is true.

Although I will not appeal specifically to **Comparative Additivity** in the Anti-Solipsism Argument, I will appeal to an epistemic principle that is a consequence of **Comparative Additivity**, in conjunction with standard axioms of probability. Here is the principle:

> **Additivity***
> Let Q and R be collections of scenarios. Suppose:
>
> 1. R is infinite.
> 2. R is bigger than Q.
> 3. S should be exactly as confident in every scenario in R as in every scenario in Q.
> 4. S should be certain that the actual world is either in Q or R.
>
> Then: S should be at least 99.99999% confident that the actual world is in R.[23]

Note that if Q is smaller than R and R is infinite, then R is *much* bigger than Q, even if Q is infinite as well. Thus, informally, **Additivity*** says: if R is much bigger than Q and one should be exactly as confident in every scenario in R as in every scenario in Q, then one should be *much* more confident that the actual world is in R than in Q.

In the Appendix, I show that **Additivity*** is a deductive consequence of **Comparative Additivity**, in conjunction with standard axioms of probability. Because the skeptic accepts classical logic, she accepts **Additivity*** as well.

2.6 The skeptical package

Here I summarize the commitments of the skeptic who is my target in this paper. I will classify them roughly into 'positive' commitments and 'negative' commitments.

[23] I formulate this principle using the number 99.99999% only because that is an intuitively very high credence. However, in what follows, all of the claims that involve 99.99999% can be replaced with analogous claims that involve real-valued credences even greater than 99.99999% (but less than 1). I formulate **Additivity*** in a more general fashion in the Appendix.

2.6.1 Positive commitments

First, I assume that the skeptic accepts various forms of *a priori* reasoning. In particular, I assume that the skeptic accepts the following:

1. Classical logic. More precisely, I assume that the skeptic accepts that she should be *certain* in all classical tautologies. For example, I assume that the skeptic accepts an epistemic version of the law of excluded middle: for any proposition p, one should be certain that either p or not-p is true.[24]

2. Some set theory. In particular, I assume that the skeptic accepts that she should be certain in Cantor's theorem—that is, that any collection has more sub-collections than members.[25]

3. Probabilistic reasoning. In particular, as I said in §§2.4–2.5, I assume that the skeptic accepts that her credences should satisfy standard axioms of probability, along with **Restricted PI** and **Comparative Additivity**.

Additionally, as I said in §2.3, I assume that the skeptic accepts that she should be certain in various propositions about her stream of mentality. However, as before, I will not assume anything about the nature of these propositions—whether, at any time t, they only include propositions about what the skeptic's stream of mentality is like at t, or whether they include additional propositions as well. According to the skeptic, these propositions

[24]That said, I do not assume that the skeptic is logically omniscient. That is, I do not assume that the skeptic *is* certain in every classical tautology. I only assume that, by her lights, the skeptic *should* be certain in every classical tautology. Whether or not the skeptic, *qua* imperfect epistemic agent, achieves this ideal is a separate (and irrelevant) question.

[25]More precisely, I assume that the skeptic accepts a class-theoretic generalization of Cantor's theorem, according to which any class has more subclasses than members, even if that class is proper. I do not assume that the skeptic accepts any particular theory of classes and sets in what follows, but it is worth observing that Bernays (1942) proves a class-theoretic analogue of Cantor's theorem in what is now known as Bernays-Gödel (BG) set theory. (BG set theory notably differs from the more familiar von Neumann-Bernays-Gödel (NBG) set theory in that it does not posit the axiom of limitation of size.) See Uzquiano (2015, p. 9; pp. 14–15) for illuminating discussion of Bernays' result. Though he admits that the case is not decisive, Uzquiano argues that Bernays' result is not merely an analogue of Cantor's theorem but indeed generalizes it in the above sense.

about her stream of mentality have a privileged epistemic status, alongside the aforementioned logical and set-theoretic propositions.

2.6.2 Negative commitments

As I said in §2.3, I assume the skeptic accepts that there are many worlds that she should not, by her lights, rule out with certainty. That is, I assume that the skeptic accepts that there are many epistemically possible worlds. In particular, I assume that the skeptic accepts the following recombination principle:

> **Recombination.** For any collection A of epistemically possible streams of mentality and any non-negative integer N, there is a scenario at which: (1) the skeptic undergoes some stream of mentality in A; (2) for every stream of mentality m in A, N other minds undergo m; and (3) nothing else exists.

Additionally, I assume that the skeptic adopts a radical empiricist account of evidence—namely, one on which she has no evidence about what the world is like beyond what her stream of mentality is like. More precisely, I assume that the skeptic only regards her evidence E as including the aforementioned propositions about her stream of mentality that she should, by her lights, believe with certainty. Because the skeptic only takes E to include propositions about her stream of mentality in which she should, by her lights, be *certain*, I call her evidential empiricism 'radical'.

I also assume that, for any propositions p and q that entail E, the skeptic regards her evidence as conferring no additional support to either p or q. Thus, when the skeptic has a visual experience of apparently seeing a black cat, she regards her evidence as conferring no additional support to the proposition that there is a black cat in front of her over the proposition that there isn't a black cat in front of her, nor vice versa (provided that both of these propositions entail the evidence she has acquired from the experience).

As a consequence of the skeptic's acceptance of radical evidential empiricism, the skeptic denies the epistemic significance of extra-empirical considerations that are not connected to the above forms of *a priori* reasoning. For example, the skeptic denies the epistemic significance of common theoretical virtues such as simplicity, explanatory power, and coherence with common sense. According to the skeptic, considerations of simplicity, explanatory

power, and coherence with common sense are irrelevant to figuring out what the world is like.

2.6.3 Summary

The skeptic's package of commitments can be schematically summarized as follows:

SKEPTICAL PACKAGE
=
A PRIORI REASONING
+
RADICAL EVIDENTIAL EMPIRICISM.

Although there are philosophically interesting forms of skepticism ruled out by the above package—including skepticism about *a priori* reasoning—the skeptical package I have described is a natural one. For example, those of us who flirt with skepticism about the external world are often willing to make the background assumption that classical logic is legitimate.[26] It seems a small leap to assume that set theory and probabilistic reasoning are legitimate as well. Moreover, those of us who worry that common theoretical virtues are not epistemic virtues but merely *pragmatic* virtues may find ourselves sympathetic towards a broadly empiricist account of evidence.[27] Finally, those of us who think that we should only be certain about what our present experiences are like—and who think, for example, that we should be less than absolutely certain (albeit still quite confident) that the sun will rise tomorrow—may find ourselves sympathetic towards a *radical* empiricist account of evidence. So, the skeptic who adopts the above package seems a worthy philosophical target.

Note. Although the Anti-Solipsism Argument is compatible with allowing the skeptic to have additional commitments—for example, semantic commitments or further commitments about what is epistemically possible—the above package of commitments suffices to formulate the argument.

[26]Indeed, some arguments for external-world skepticism presuppose the legitimacy of classical logic. For example, as Neta (forthcoming) notes, the 'argument from closure' relies on *modus tollens*, which is an inference rule of classical logic.

[27]See Nolan (2014) for worries of this sort.

3 The Anti-Solipsism Argument

I will present the Anti-Solipsism Argument in three phases.

- **Phase 1.** I show that **Recombination**, in conjunction with Cantor's theorem, entails:
  - **Size Disparity.** (1) There are infinitely many anti-solipsistic scenarios. (2) There are more anti-solipsistic scenarios than solipsistic scenarios.
- **Phase 2.** I show that **Restricted PI**, in conjunction with the skeptic's radical evidential empiricism, entails:
  - **Indifference.** The skeptic should be exactly as confident in every anti-solipsistic scenario as in every solipsistic scenario.
- **Phase 3.** I show that **Size Disparity**, **Indifference**, **Additivity***, and the skeptic's acceptance of classical logic jointly entail:
  - **Anti-Solipsism.** The skeptic should, by her lights, be at least 99.99999% confident—just shy of certain—that solipsism is false.

I now present each phase in full.

3.1 Phase 1: Size Disparity

In this section, I show that **Recombination**, in conjunction with Cantor's theorem, entails:

- **Size Disparity.** (1) There are infinitely many anti-solipsistic scenarios. (2) There are more anti-solipsistic scenarios than solipsistic scenarios.

My argument proceeds in two steps.

3.1.1 Step 1. There are infinitely many anti-solipsistic scenarios

Consider an arbitrary stream of mentality m—the 'm-stream', for short—that the skeptic undergoes at some solipsistic scenario. Because any solipsistic scenario is characterizable by the stream of mentality she undergoes at it (cf. §2.2), there is only one solipsistic scenario at which she undergoes

the m-stream. By contrast, **Recombination** entails that there are infinitely many anti-solipsistic scenarios at which she undergoes the m-stream.

To see this, note that **Recombination** entails that there is a scenario at which the skeptic and exactly one other mind undergo the m-stream. **Recombination** also entails that there is a scenario at which the skeptic and exactly *two* other minds undergo the m-stream. And so on, *ad infinitum*. Note that each of these scenarios is anti-solipsistic because more than just the skeptic exists at it. Hence, there are infinitely many anti-solipsistic scenarios.

3.1.2 Step 2. There are more anti-solipsistic scenarios than solipsistic scenarios

My argument that there are more anti-solipsistic scenarios than solipsistic scenarios proceeds as follows.

First, I apply **Recombination** to show that there is a function that maps any two distinct collections of solipsistic scenarios to distinct anti-solipsistic scenarios. This establishes (a): there are at least as many anti-solipsistic scenarios as collections of solipsistic scenarios. Next, I apply Cantor's theorem to show (b): there are strictly more collections of solipsistic scenarios than solipsistic scenarios. From (a) and (b), it then follows that there are strictly more anti-solipsistic scenarios than solipsistic scenarios.

To begin with, for any solipsistic scenario w, let $m(w)$ be the stream of mentality that the skeptic undergoes at w. Also, let S be an arbitrary collection of solipsistic scenarios. Note that, since any solipsistic scenario is characterizable by the stream of mentality that the skeptic undergoes at it, S corresponds to a collection of epistemically possible streams of mentality. Next, let w^* be an arbitrary scenario in S (if S is non-empty). By **Recombination**, there is a scenario at which the following is the case:

(1) The skeptic undergoes stream of mentality $m(w^*)$.

(2) For every w in S that is distinct from w^*, exactly one mind undergoes stream of mentality $m(w)$.[28]

(3) Nothing else exists.[29]

[28] If S is a singleton, (2) should read: exactly one other mind undergoes $m(w^*)$.

[29] More precisely, to remain neutral between the two formulations of solipsism discussed in §2.1, (3) should read: nothing whose existence is not analytically entailed by the existence of the skeptic and these other minds exists.

Let g be a function that maps S to a scenario at which (1)–(3) are true. That is, let $g(S)$ be a scenario at which (1)–(3) are true.[30]

Next, let S' be an arbitrary collection of solipsistic scenarios that is distinct from S. Note that $g(S)$ is a distinct scenario from $g(S')$ because there is at least one mind undergoing some stream of mentality at $g(S)$ that no mind undergoes at $g(S')$, or vice versa.[31] Additionally, let:

- SOL = the collection of all solipsistic scenarios,
- $\mathcal{P}(SOL)$ = the collection of all sub-collections of SOL, and
- $ANTISOL$ = the collection of all anti-solipsistic scenarios.[32]

Since g maps any two distinct collections of solipsistic scenarios to distinct anti-solipsistic scenarios, it follows that $ANTISOL$ is at least as big as $\mathcal{P}(SOL)$. That is, there are at least as many anti-solipsistic scenarios as collections of solipsistic scenarios.

Finally, by Cantor's theorem, $\mathcal{P}(SOL)$ is bigger than SOL.[33] Since $ANTISOL$ is at least as big as $\mathcal{P}(SOL)$, it follows that $ANTISOL$ is bigger than SOL as well. That is, there are more anti-solipsistic scenarios than solipsistic scenarios. Hence:

- **Size Disparity.** (1) There are infinitely many anti-solipsistic scenarios. (2) There are more anti-solipsistic scenarios than solipsistic scenarios.

I now consider an objection to the above argument for (2).

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[30]If S is empty, let $g(S)$ be a scenario at which, for some solipsistic scenario w, the skeptic undergoes $m(w)$, *two* other minds undergo $m(w)$, and nothing else exists.

[31]If (without loss of generality) S is empty, then exactly three minds undergo a particular stream of mentality at $g(S)$. By contrast, if S' is non-empty, no more than two minds undergo any given stream of mentality at $g(S')$. So, it is still the case that $g(S)$ is a distinct scenario from $g(S')$.

[32]Strictly speaking, if SOL is a proper class—a claim that I wish to remain neutral about—then, on most formulations of class theory, there is no class of all subclasses of SOL. So, in what follows, talk about $\mathcal{P}(SOL)$ should be understood merely as convenient shorthand for talk about the subclasses of SOL. Context will make clear the meaning of such talk.

[33]More precisely, by the class-theoretic generalization of Cantor's theorem discussed in footnote 25, there are more subclasses of SOL than members of SOL.

3.1.3 Objection: There are not more anti-solipsistic scenarios than solipsistic scenarios

It seems that, for any proposition p, it is epistemically possible for one to uniquely entertain p. (That is, it seems that there is some fixed time t such that, for any proposition p, it is epistemically possible for one to entertain p and only p at t.) After all, it seems that one should not, on pain of epistemic immodesty, be absolutely *certain* that one will not uniquely entertain any given proposition. So, if the package of commitments that the skeptic accepts is to be at all plausible, it seems that this package should include the claim that, for any proposition p, it is epistemically possible for her to uniquely entertain p. Call this claim **Entertainability**.

One consequence of **Entertainability** is that, for every anti-solipsistic scenario w, it is epistemically possible for the skeptic to uniquely entertain the proposition that w is actual (or 'uniquely entertain w', for short). Thus, for every anti-solipsistic scenario w, it is epistemically possible for the skeptic to undergo some stream of mentality in which she uniquely entertains w. Since **Recombination** entails that every epistemically possible stream of mentality corresponds to a unique solipsistic scenario—namely, the scenario at which the skeptic undergoes that stream and nothing else exists—**Entertainability** therefore entails that there are at least as many solipsistic scenarios as anti-solipsistic scenarios. However, this claim contradicts **Size Disparity**, according to which there are strictly more anti-solipsistic scenarios than solipsistic scenarios. So, something has gone wrong in the above argument for **Size Disparity**.[34]

Response. I grant that **Entertainability** is an intuitively plausible claim. However, as observed by Anderson (2009, pp. 90–92), **Entertainability** is simply inconsistent.[35] Thus, because the skeptic accepts classical logic, she

[34]The objection in question mirrors the epistemic version of Kaplan's paradox, as discussed by Whittle (2009) and Chalmers (2011, §9). See Kaplan (1995) for the original version of the paradox. One of the key premises in the original version of the paradox is a metaphysical analogue of **Entertainability**—namely, for every proposition p, it is *metaphysically* possible for one to uniquely entertain p.

[35]Bueno et al. (2014, pp. 23–26) and Uzquiano (2015, pp. 12–13) make this observation as well. More precisely, these authors show that the metaphysical analogue of **Entertainability** described in the previous footnote is inconsistent with classical quantificational propositional logic in conjunction with the claim that every classical tautology is metaphysically necessary. Their observation applies equally well to **Entertainability** since I assume that every classical tautology is *epistemically* necessary for the skeptic—that is,

should not, by her lights, accept **Entertainability**. Although it may be epistemically possible for the skeptic to uniquely entertain many propositions—perhaps even highly infinitely many propositions—it is not epistemically possible for her to uniquely entertain every proposition.

At this point, one might grant that **Entertainability** is not true in full generality but still claim that it is epistemically possible for one to uniquely entertain every *scenario*—and, hence, every anti-solipsistic scenario. Let **Restricted Entertainability** be the claim that, for every scenario w, it is epistemically possible for one to uniquely entertain w. As before, if the skeptic accepts **Restricted Entertainability**, then **Size Disparity** is false.

While I grant that **Restricted Entertainability** seems to be a consistent claim, it also seems to be *ad hoc*: why should it be epistemically possible to uniquely entertain every scenario yet not be epistemically possible to uniquely entertain every proposition? Recall that the proposition that a given scenario is actual is simply the proposition that some particular (possibly infinite) conjunction of propositions holds at the actual world and that no other propositions hold there. So, uniquely entertaining a scenario merely consists in uniquely entertaining a proposition of this sort. But it is far from clear why it should be epistemically possible to uniquely entertain every proposition of this sort yet not every proposition in general. As such, **Restricted Entertainability** seems to lack whatever intuitive plausibility **Entertainability** might have had prior to our recognition that it is inconsistent.

Moreover, as I showed above, **Recombination** and Cantor's theorem jointly entail **Size Disparity**. So, accepting **Restricted Entertainability** would require the skeptic to reject either **Recombination** or Cantor's theorem (or both). Assuming the skeptic doesn't reject Cantor's theorem, this response would require her to reject **Recombination** in its full generality.[36] That is, accepting **Restricted Entertainability** would require the skeptic to accept, at most, a significantly restricted version of **Recombination**, according to which some collections of epistemically possible streams of mentality correspond to scenarios and some do not. But which collections would correspond to scenarios, and which wouldn't? Any particular answer to this question would seem *ad hoc* and unmotivated.

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that the skeptic should, by her lights, be certain in every classical tautology.

[36] As I said in footnote 25, I assume that the skeptic accepts a class-theoretic generalization of Cantor's theorem. See Uzquiano (2015, pp. 14–15) for worries one might have about this generalization.

In sum, both **Restricted Entertainability** and **Recombination** seem to be consistent claims. However, while **Recombination** is extremely general and intuitively plausible, **Restricted Entertainability** is *ad hoc* and of questionable intuitive plausibility. Thus, it seems more reasonable for the skeptic to accept **Recombination**, reject **Restricted Entertainability**, and accept **Size Disparity** than to reject **Recombination**, accept **Restricted Entertainability**, and reject **Size Disparity**.

All of that said, I do not claim that accepting **Recombination** is completely without cost. Since at least the writing of Lewis (1986), philosophers have worried about the plausibility of unrestricted recombination principles, and such principles have received heightened scrutiny recently.[37] So, perhaps **Recombination** will turn out to be implausible on independent grounds. But it is hard to see how **Restricted Entertainability** could be the sole grounds for rejecting **Recombination**.

3.2 Phase 2: Indifference

Recall the statement of **Restricted PI**:

> **Restricted PI.** If scenarios w_1 and w_2 are evidentially symmetric for S, then S should be exactly as confident in w_1 as in w_2.

I now show that every anti-solipsistic scenario is evidentially symmetric with every solipsistic scenario for the skeptic. So, by **Restricted PI**, the skeptic should be exactly as confident in every anti-solipsistic scenario as in every solipsistic scenario.

Recall that the skeptic accepts a radical empiricist account of evidence, according to which her evidence E only includes those propositions about her stream of mentality in which she should (by her lights) be certain. Because the skeptic should (by her lights) be certain in every proposition in E, every proposition in E is true at every scenario. So, the skeptic regards her evidence as providing no additional support to any scenario over any other scenario. Thus, any two scenarios are evidentially symmetric for the skeptic. In particular, then, every anti-solipsistic scenario is evidentially symmetric with every solipsistic scenario for the skeptic. Hence, by **Restricted PI**:

[37] See Uzquiano (2015) and Fritz (2016) for recent puzzles. Note that all of the aforementioned authors are concerned with the plausibility of recombination principles concerning metaphysical possibility, not epistemic possibility. But it is not unreasonable to think that analogous puzzles arise from epistemic recombination principles as well.

- **Indifference.** The skeptic should be exactly as confident in every anti-solipsistic scenario as in every solipsistic scenario.

3.3 Phase 3: Anti-Solipsism

Recall the statement of **Additivity***:

> **Additivity***
> Let Q and R be collections of scenarios. Suppose:
>
> 1. R is infinite.
> 2. R is bigger than Q.
> 3. S should be exactly as confident in every scenario in R as in every scenario in Q.
> 4. S should be certain that the actual world is either in Q or R.
>
> Then: S should be at least 99.99999% confident that the actual world is in R.

I now show that SOL and $ANTISOL$ satisfy the antecedent conditions of **Additivity*** for the skeptic.

First, in §3.1.1, I showed that $ANTISOL$ is infinite. Second, in §3.1.2, I showed that there are more scenarios in $ANTISOL$ than in SOL. Third, in §3.2, I showed that the skeptic should be exactly as confident in every scenario in $ANTISOL$ as in every scenario in SOL. Fourth, because the skeptic accepts classical logic, she accepts that she should be certain that the actual world is either solipsistic or anti-solipsistic—that is, that the actual world is either in SOL or in $ANTISOL$. Hence, SOL and $ANTISOL$ satisfy the antecedent conditions of **Additivity*** for the skeptic.

By **Additivity***, then, the skeptic should, by her lights, be at least 99.99999% confident that the actual world is in $ANTISOL$. That is:

- **Anti-Solipsism.** The skeptic should, by her lights, be at least 99.99999% confident—just shy of certain—that solipsism is false.

Note. Although the Anti-Solipsism Argument appeals to idealist anti-solipsistic scenarios—that is, anti-solipsistic scenarios at which only the skeptic and other minds exist—the argument does not establish that the skeptic

should (by her lights) be extraordinarily confident that other minds exist. The reason is that the argument is neutral with respect to whether there are more anti-solipsistic scenarios at which other minds exist than anti-solipsistic scenarios at which *no* other minds exist. As such, the Anti-Solipsism Argument leaves the epistemological 'problem of other minds' untouched.[38]

4 Conclusion

In this paper, I have argued that anyone who accepts the skeptical package of §2.6 should be extremely confident that something other than oneself exists—that is, that an external world of some sort exists. This skeptical package includes commitments to various forms of *a priori* reasoning—including, crucially, probabilistic reasoning—as well as radical empiricism about evidence. As such, the Anti-Solipsism Argument constitutes an internal critique of external-world skepticism, requiring any skeptic who accepts this package to 'reason her way' out of skepticism.[39] I close with some remarks about the import of the argument.

First, I have argued neither that an external world exists nor that the skeptic can know that an external world exists. I have only argued that the skeptic should (by her own lights) be extremely *confident* that an external world exists. It is possible, for all the skeptic believes with certainty, that solipsism is true. But she should be extremely confident that it is false.

Second, I have only argued that the skeptic should be extremely confident that an external world of *some* sort exists. In particular, I have not argued that the skeptic should be extremely confident that there exists an external world of the sort ordinarily believed to exist—one filled with tables, other minds, and the rest. Although this fact may seem to significantly diminish the anti-skeptical force of the Anti-Solipsism Argument, I do not believe that it does. Before one asks what the external world is like, one must first ask whether there is any external world at all. If one had significant doubts about the falsity of solipsism, then metaphysical inquiry could scarcely get off the ground.

[38] See Hyslop (2016).

[39] As Rinard (forthcoming) observes, many contemporary epistemologists have thought that it is impossible to rationally persuade an external-world skeptic that her skepticism is ill-founded. Rinard's paper presents one way in which this might be done. The Anti-Solipsism Argument constitutes an alternative, probabilistic approach to this end.

Third, because the Anti-Solipsism Argument is directed at just one sort of radical skeptical hypothesis—solipsism—it does not have any bearing on the plausibility of various other such hypotheses. For example, it has no bearing on the plausibility of the hypothesis that the skeptic is a brain in a vat nor on the plausibility of the hypothesis that the entire world has just sprung into existence 5 minutes ago.[40] It may be that the probabilistic methodology of the Anti-Solipsism Argument can be generalized to address additional skeptical hypotheses, but I have not attempted to do so in this paper.

Finally, I have only attempted to convince the *skeptic* that she should be extraordinarily confident that an external world exists. I have not aimed to convince *you* to be extraordinarily confident that an external world exists. Perhaps you don't accept **Restricted PI**. Or perhaps you are not keen on radical evidential empiricism. If you don't share all of the skeptic's commitments, the Anti-Solipsism Argument will hold no sway over you. So, although the Anti-Solipsism Argument may convince the skeptic—a notoriously stubborn philosophical opponent—it may not convince *you*.

5 Appendix. Proof of Additivity*

In this section, I show that **Additivity*** follows from **Comparative Additivity**, probabilism, and a minimal constraint connecting credence to comparative confidence—that is, the attitude of being at least as confident in one proposition as in another.[41]

I understand probabilism as the thesis that a subject S's credence function P ought to satisfy Kolmogorov (1950)'s axioms of probability. To spell out these axioms, let A and B be arbitrary propositions—which I understand as arbitrary collections of scenarios—and let Ω be the collection of all scenarios. Then, P satisfies the following:

1. $P(A) \geq 0$.

[40] Thus, the Anti-Solipsism Argument does not conflict with Schwitzgebel (2015)'s claim that one should be a '1% skeptic'—that is, that one should have around a 1% credence in the disjunction of all radical skeptical hypotheses. However, the Anti-Solipsism Argument entails that the skeptic should be at least a '99.99999% *non*-skeptic' towards the solipsistic disjunct.

[41] Comparative confidence is also known as 'qualitative (subjective) probability' or 'comparative (subjective) probability'. See Fine (1973) and Fishburn (1986) for overviews.

2. $P(\Omega) = 1$.

3. Finite Additivity. If A and B are mutually inconsistent (i.e., disjoint), then $P(A \cup B) = P(A) + P(B)$.

As I said in §2.5, I assume the skeptic accepts probabilism.

Additionally, I assume the skeptic accepts the following connection between P and comparative confidence:

> **Comparative Confidence.** If S should be at least as confident in A as in B, then $P(A) \geq P(B)$.

I also assume that to be 'exactly' as confident in A as in B is just to be at least as confident in A as in B and at least as confident in B as in A.

For reference, here is the statement of **Comparative Additivity** again:

> **Comparative Additivity**
> Let Q and R be collections of mutually inconsistent propositions. Suppose:
>
> 1. R is bigger than Q.
> 2. S should be at least as confident in every proposition in R as in every proposition in Q.
>
> Then: S should be at least as confident in R as in Q.

Here is a more general version of **Additivity*** than that stated in §2.5:

> **Additivity***
> Let Q and R be collections of scenarios. Suppose:
>
> 1. R is infinite.
> 2. R is bigger than Q.
> 3. S should be exactly as confident in every scenario in R as in every scenario in Q.
> 4. S should be certain that the actual world is either in Q or R.
>
> Then: for every real-valued credence $x < 1$, $P(R) \geq x$.

Note that the consequent of this version of **Additivity*** is stronger than that described in §2.5.

I now show that **Additivity*** follows from **Comparative Additivity**, probabilism, and the above constraint on comparative confidence.

Proof. Let Q and R be classes of scenarios that satisfy the antecedent of **Additivity***. Also, let x be an arbitrary real-valued credence that is less than 1, and let N be the smallest integer greater than or equal to $\frac{1}{1-x}$. Because R is infinite, R can be partitioned into $(N-1)$-many mutually disjoint sub-collections of R such that each such sub-collection can be put into one-to-one correspondence with R. Call these sub-collections $R_1, R_2, \ldots, R_{N-1}$. Let R_i be an arbitrary such sub-collection.

Note that Q and R_i satisfy the antecedent conditions of **Comparative Additivity**. First, because scenarios are maximally specific ways for the world to be, any two scenarios are inconsistent with one another. So, Q and R_i are collections of mutually inconsistent (maximally fine-grained) propositions. Next, because R_i can be put into one-to-one correspondence with R and R is bigger than Q, R_i is also bigger than Q. Finally, because S should be exactly as confident in every scenario in R as in every scenario in Q, S should be exactly as confident—and, therefore, at least as confident—in every scenario in R_i as in every scenario in Q. So, by **Comparative Additivity**, S should be at least as confident in R_i as in Q. By **Comparative Confidence**, then, $P(R_i) \geq P(Q)$.

Next, note that $P(Q \cup R) = P(Q) + P(R) - P(Q \cap R)$. By Finite Additivity, $P(R) = P(R_1) + \ldots + P(R_{N-1})$. Also, since S should (by her lights) be certain that the actual world is either in Q or R, $\Omega = Q \cup R$. So, $P(\Omega) = P(Q \cup R) = 1$. Putting everything together:

$$\begin{aligned} 1 &= P(Q) + P(R) - P(Q \cap R) && (1)\\ &= P(Q) + P(R_1) + \ldots + P(R_{N-1}) - P(Q \cap R) && (2)\\ &\geq P(Q) + P(Q) + \ldots + P(Q) - P(Q \cap R) && (3)\\ &= NP(Q) - P(Q \cap R). && (4) \end{aligned}$$

Thus:

$$P(Q) \leq \frac{1 + P(Q \cap R)}{N}. \quad (5)$$

Some rearranging yields:

$$P(R) = 1 - P(Q) + P(Q \cap R) \quad (6)$$

$$\begin{aligned} &\geq 1 - \frac{[1 + P(Q \cap R)]}{N} + P(Q \cap R) && (7)\\ &= \frac{N-1}{N}[1 + P(Q \cap R)] && (8)\\ &\geq x[1 + P(Q \cap R)], && (9) \end{aligned}$$

using the fact that $N \geq \frac{1}{1-x}$. Finally, since $P(Q \cap R) \geq 0$, it follows that $P(R) \geq x$, which was to be proven. □

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