Fine Tuning Indexical Evidence

Abstract: Proponents of the this-universe objection to fine-tuning arguments for a multiverse claim that while the multiverse hypothesis raises the probability that *some* universe is fine-tuned for life, it fails to raise the probability that *this* one is. Because that is so, they further argue, those who take the fine-tuning of this universe as evidence for the multiverse hypothesis are guilty of a probabilistic fallacy. I argue that a proper evaluation of the this-universe objection requires the development of a general, formal framework for reasoning probabilistically with evidence statements expressed using indexical terms (such as the statement *This universe is fine-tuned*). I proceed to develop such a framework and then to apply it to the this-universe objection. While my primary aim is to defend the this-universe objection from recent rebuttals, a secondary aim is to exhibit the utility of the framework itself, which has the potential for wider application.

Introduction

Our best physical theories contain free parameters that had to take on extremely precise but apparently physically arbitrary values in order for our universe to be life permitting. Since our universe is one in which those parameters have such values, it is sometimes said to be "fine-tuned" for the existence of life.[1] According to many physicists and philosophers, the fact our universe is fine-tuned provides evidence that it is part of a multiverse.[2] Because of the extraordinary degree of fine-tuning required, the argument goes, the

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[1] For a recent overview of the evidence for fine-tuning, see (Barnes and Lewis 2016).

[2] See for example (Leslie 1989), (Rees 2003), and (Tegmark 2014: 140, 362-363).

likelihood of the parameters taking on the life-permitting values in a single universe is extremely low. But if there is a sufficiently large number of universes whose constants vary widely, almost certainly, some will be life permitting.

Ian Hacking (1987) accused those who take fine-tuning as evidence for a multiverse of committing a probabilistic fallacy. Roger White (2000; 2003) later took up and expanded upon a similar charge. Those who take fine-tuning as evidence for a multiverse are, according to this charge, like a gambler who rolls a pair of dice and then infers it is more likely that many rolls have occurred upon observing that the outcome is a double six. The problem with that reasoning, of course, is that the outcome of any particular roll of a fair, standard pair of dice is independent of how many dice rolls occur. Likewise, claim Hacking and White, the probability of *this particular* universe being fine-tuned is independent of how many universes there are.

There is now a sizeable literature concerning whether the this-universe objection succeeds.[3] In one of the most recent contributions, Yoaav Isaacs, John Hawthorne, and Jeffrey Sanford Russell (2022) argue that a proper evaluation of the this-universe objection requires us to turn our attention to the issue of how to reason probabilistically with so-called "*de se*" or "self-locating" evidence. That is, they argue, we need to turn our attention to how to reason probabilistically with evidence couched in terms of first-person indexical statements such as *I exist in a fine-tuned universe*. When we do, they contend, things do not look promising for the this-universe objection.

[3] For an overview see (Manson 2022). The label "this-universe objection" was introduced in (Manson and Thrush 2003).

In this paper, I argue, by contrast, that a proper evaluation of the this-universe objection requires the development of a more general framework for reasoning probabilistically with indexically couched evidence – not just with statements that employ the indexical ‘I’, but also with statements that employ indexical terms such as ‘here’, ‘now’, ‘actually’, ‘this’, and the like. I proceed to develop such a framework and then to deploy it in defense of the this-universe objection. While my primary aim is to lend support to the this-universe objection, a secondary aim is to display the utility of the framework itself, which has the potential to shed light on other debates concerning how to reason with indexical evidence.

1. The Problem of Indexical Evidence

The this-universe objection, as stated above, centrally involves the claim that the multiverse hypothesis fails to raise the probability that *this* universe is fine-tuned. How should we think, however, about the evidential impact of a statement such as *This universe is fine-tuned*? Is that statement epistemically equivalent to *The universe I am in is fine-tuned*? Does it have the status of a contingent *a priori* claim (at least relative to background information that includes the fact that our existence requires fine-tuning)? Does it essentially involve reference to the particular universe in which we actually find ourselves? Isaacs, Hawthorne, and Russell (“IHR” from now on) maintain that our hesitancy concerning how to answer such questions casts doubt on the intuition upon which the this-universe objection relies. As they put it, “We just don’t understand how singular evidence like this works nearly well enough to be confident in such judgements” (2022: 245).

White (2000: 262) himself did not originally cast his argument in terms of the indexical phrase 'this universe' but instead introduced the term 'α' as a rigid designator for our universe. He further argued that since our background information informs us that, for any given possible universe that exists, whether *it* is fine-tuned is independent of how many universes there are, we are entitled to conclude that whether α is fine-tuned is independent of how many universes there are.

But, as Kripke taught us, our background information concerning how a rigid designator was introduced can carry information about the non-essential properties had by its referent. IHR (245-246) further argue that this can lead to cases in which epistemic probabilities pertaining to statements with rigid designators introduced in a manner similar to 'α' come apart from known objective probabilities. (I will consider one such purported case in Section 5).

Similar difficulties eventually led White (2003: 243-244) to abandon relying on the use of terms such as 'α' and to focus instead on statements that employ first-person indexicals. In particular, according to White, what is most important to think about when evaluating whether a given observation O supports a given statement M (from a first-person perspective) is whether *I* am more likely to make O given M. By focusing on I-statements, however, White makes the fate of his argument turn on the question of how we should reason probabilistically with *de se* information, or with what has also come to be known as "self-locating evidence."

IHR demonstrate, furthermore, that three of the most commonly proposed rules for reasoning probabilistically with such evidence deliver the result that the statement *I exist in a fine-tuned universe* raises the probability of the multiverse hypothesis. They also provide powerful formal considerations in favor of the conclusion that *any* plausible rule of this sort delivers the same result. On the basis of these preliminary investigations, they tentatively conclude that there are no plausible ways of thinking about how to reason probabilistically with self-locating evidence that vindicate the this-universe objection.

2. On the Need to Bring Back 'This Universe'

Even if IHR's formal results are correct, however, it is not clear that they succeed in undermining the this-universe objection. The problem is that the information *I exist in a fine-tuned universe* is accompanied by numerous other items of indexical information. It is accompanied, for example, by the information *I exist*, *This universe exists*, and *This universe is fine-tuned*. Perhaps some but not all these statements are evidentially relevant to the multiverse hypothesis. The importance of teasing apart just which of these items of information are evidentially relevant was highlighted, furthermore, in some of the earliest discussions of the this-universe objection.

Shortly after the publication of White's original paper on this topic, Rodney Holder (2002) objected that the universe we call ours was more likely to exist (and therefore also more likely to be fine-tuned) given a multiverse hypothesis. In a subsequent article, Kai Draper, Paul Draper, and Joel Pust (2007) responded to Holder on White's behalf as follows:

> White takes the existence of our universe to be a part of the background information … Further, he does this presumably for the good reason that he is interested in evaluating a *fine-tuning* argument for [the multiverse hypothesis]. He does not address the question of whether the mere existence of our universe confirms [the multiverse hypothesis over the single-universe hypothesis]. (9)

Thus, on the Draper-Draper-Pust reading of the this-universe objection, the crucial issue is not whether the statement *I exist in a fine-tuned universe* confirms the multiverse hypothesis on an empty body of background information, but whether it does so on background information that already includes the fact that this universe exists. That is because we are not interested in evaluating a *cosmological* argument for the multiverse hypothesis but a *fine-tuning* one.

If this is indeed the best way to understand the this-universe objection, however, then it is a mistake to attempt to state that objection without employing talk of "this universe." What needs to be done instead is to keep such talk while facing head on the problems associated with how to think about reasoning probabilistically with indexical information, not just with *I*-statements, but also with *this*-statements, *here*-statements, *now*-statements, statements expressed using *actually* operators, and the like.

In the remainder, I proceed to develop a formal framework for reasoning with probabilities pertaining to such items of information, and then to deploy that framework in defense of the this-universe objection. My defense comes primarily in the form of an existence proof. Contrary to what IHR maintain, I demonstrate there is at least one plausible way of formally modeling reasoning with indexical evidence that vindicates the this-universe objection. In the process, I also aim to exhibit the utility of the framework itself, which in turn lends further support to its results.

3. A More General Framework for Reasoning Probabilistically with Indexical Evidence

3.1. Basic Elements

Like many other participants in this debate, I take for granted that evidential reasoning is best modeled in a Bayesian manner, in which evidential support is construed in terms of the raising or lowering of epistemic probabilities. I further take for granted that epistemic prior probabilities are well-defined even with respect to extremely sparse bodies of background information, in particular, with respect to background information that excludes a great deal of what we might consider "old evidence." Such background information must be allowed to exclude even such "Cartesian" facts as that there are conscious beings.[4] The claim that there are epistemic probabilities defined relative to such sparse bodies of background information is controversial.[5] But it is frequently taken for granted in debates concerning fine-tuning arguments.

I will assume that the prior probability functions at issue take as their domain a class of statements. Statements are construed as sentence types that are truth-evaluable at contexts. When it comes to how we will think about the semantics of *statements*, we will help ourselves to David Kaplan's (1989) distinction between a statement's content and its character. The *content* of a statement is the proposition it expresses at a given context. The *character* of a statement may be modeled as a (at least partial) function from contexts to contents.

I will also assume that the correct account of how statements acquire their character is a compositional one in which statements are conceived of as ordered arrangements of subsentential components that also have characters (modeled as functions from contexts to referents for referring terms, from contexts to properties for predicates, etc.). Thus

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[4] See (Monton 2006) and (Meacham 2016) for further discussions of such conceptions of epistemic probabilities.

[5] See Pust (2007) for an argument against this claim.

statements may be conceived of as ordered arrangements of subsentential components, where the latter are (at least for modeling purposes) to be identified with their characters.

While I will make no attempt to provide such a compositional account, I will at times take for granted certain intuitive claims about how such an account would go. E.g. I will assume that at contexts at which a given individual, b, occupies the subject position, the referent of the first-person indexical term 'I' is b. I will assume that statements have contents even at contexts in which their subjects fail to utter or even so much as entertain the statement in question. E.g. I will assume that the statement *I am hungry* has, at contexts at which a given individual, b, occupies the subject position, the content that b is hungry, regardless of whether b utters or entertains that statement.

There may well be some cases in which a statement fails to have a content at a context because that context fails to supply what is needed to select one. E.g. the statement *that object is red* might fail to have a content at a context in which no object is being gestured toward, appropriately attended to, etc. Nevertheless, in the remaining discussion I will restrict myself to statements that clearly do get assigned a content at every context found in the relevant model.[6]

For modeling purposes, I will adopt the standard device of identifying contents with sets of possible worlds. Characters are, therefore, to be modeled as functions from contexts

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[6] I will also not fuss overly much about just what counts as an indexical term. Even if our overall semantic theory ought to distinguish between indexicals and demonstratives, for example, I plan to ignore such distinctions, as they do not matter for my present concerns.

to sets of possible worlds. *Contexts* may, in turn, be modeled as ordered triples containing a subject, a possible world in which that subject exists, and a time (or perhaps time interval) at which that subject exists in that world. I do not insist that the worlds that figure into our models be regarded as *metaphysically* possible. Some alternative modality, such as a species of epistemic possibility, might serve better.

It is important for our modeling purposes, however, that possible worlds are not distinguished from one another for reasons having solely to do with contextual variation in or uncertainty about the contents of expressions. Suppose, for example, that I am not identical to Jane (where the character of 'Jane' assigns the same referent to each context) but (owing to amnesia) find myself rightfully wondering whether I might be Jane. There is a sense in which it is an epistemic possibility for me that I am Jane. Even so, our models will have it that the set of possible worlds assigned by the character of *I am Jane* to any context at which I am the subject is the empty set.

Each model will be assumed to contain at least one context (and therefore at least one subject, one world, and one time). A significant limitation on the sort of models I will discuss is that they will all be assumed to contain only a *finite* number of possible worlds and a finite number of contexts. A complete treatment of the issues at hand would involve finding a way of generalizing to the infinite case. But that is a project for another occasion.

3.2. Absolute Probabilities

So far the models recognized by our framework contain individuals, times, and possible worlds, out of which are set-theoretically built contexts, contents, and characters (or at least model theoretic representations thereof). We may now introduce probabilities into these models by imposing an epistemic probability measure on the sets of worlds they contain. This will be done as follows:

Each set of worlds included in a model is assigned a measure. The set of all possible worlds found in the model is assigned measure 1. The empty set is assigned measure 0. Every other set is assigned some measure greater than 0 but less than 1. These measures are to be assigned so as to ensure that for any given set of worlds, S, with a measure, m, the measures of the subsets included in any given partition of S add up to m.

The *absolute probability* of a given set of worlds is to be identified with its measure. Note that (as our current terminology would have it) *absolute* probabilities are not to be conflated with *unconditional* probabilities. As the discussion below will make clear, absolute probabilities come in both unconditional and conditional varieties. Rather, absolute probabilities are to be contrasted with what (in the next section) we will refer to as "indexical probabilities".

Statements are also to be assigned absolute probabilities relative to contexts. E.g. Contexts at which Jane occupies the subject position will assign to the statement *I am Jane* the absolute probability corresponding to the set of worlds at which Jane exists (at the time included in that context). And contexts at which someone other than Jane occupies the subject position will assign an absolute probability to that statement corresponding to the measure of the empty set (i.e. they will assign an absolute probability of 0).

More generally, for each context, C_i, there is an associated absolute probability function, $A_i(\ldots)$. For any given statement, r, $A_i(r)$ is the probability of the set of worlds that r's character assigns to C_i. For any statements r and k, $A_i(r \mid k) = \frac{A_i(r \& k)}{A_i(k)}$. Furthermore, the statement $A(r) = \phi$ is true at a given context, C_i, when $A_i(r) = \phi$. Likewise, the statement

$A(r/k) = \phi$ is true at a given context, C_i, when $A_i(r \mid k) = \phi$. We may say, metaphorically speaking, that each context has an "opinion" about what the referents of the relevant indexical terms are and thus an "opinion" about which assignments of probability are appropriate.

3.3. Indexical Probabilities

Absolute probabilities do not themselves encode any epistemic uncertainty about the referents of indexical terms. Nevertheless, because such uncertainty can arise, one might find oneself rationally uncertain of the absolute probability of a given statement, even in the absence of other forms of uncertainty. E.g. if I am uncertain about whether I am identical to Jane, then I will be aware that the absolute probability that I am Jane given that Jane exists at the current time is either 1 or 0, but I will be uncertain as to which is the case.

What I am calling "indexical probabilities" correspond to epistemic (prior) probabilities that are capable of encoding such uncertainty. I will use the notation 'P(…)' to represent the indexical probability function. E.g. let 'J' stand for the statement *Jane exists at the current time*, let 'I_J' stand for the statement that *I am Jane*, and let 'B' stand for a statement that encapsulates my background information. While it must be that $A(I_J \mid J\&B) = 1$ or $A(I_J \mid J\&B) = 0$, it can also be true that $0 < P(I_J \mid J\&B) < 1$.

Note that here conditional absolute probabilities are being thought of as being defined by unconditional absolute probabilities. Indexical probabilities are, in turn, being thought of as absolute probabilities with uncertainty concerning the referents of indexical terms layered into them. Thus absolute unconditional probabilities serve as the most fundamental kind of epistemic probability recognized by the framework.

We have also seen that since different contexts make different assignments of referents to indexical terms, each context may be thought of as having its own "opinion" as to what the values of unconditional absolute probabilities happen to be. A natural thought, then, is that the values of indexical probabilities are (somehow) to be extracted from these opinions. But just exactly how should this be done?

3.4. Averaging Rules

If we had no reason to prefer the opinion of any given context over any other, then the most natural way of assigning an indexical probability to a given statement would be simply to take the average value of the absolute probability each context assigns to that statement. If we do have reason to prefer the opinions of some contexts over others, then we might take the appropriately weighted average instead. The result of this intuitive suggestion is that we arrive at a class of rules for extracting indexical probabilities that I will refer to as "averaging rules."

More formally, an averaging rule may be characterized as follows: For each context, C_i, there is a weighting function that assigns some real number, ψ_i, to that context, where $0 \leq \psi_i \leq 1$, and $\sum_i \psi_i = 1$. For any given statement, *r,* furthermore, its unconditional indexical probability is the ψ-weighted sum of the opinions that each context has regarding its unconditional absolute probability. I.e. $P(r) = \sum_i \psi_i A_i(r)$. Accordingly, for any given statements *r* and *k*, the conditional epistemic probability of *r* given *k* is given by $P(r|\,k) = \frac{\sum_i \psi_i A_i(r\&k)}{\sum_i \psi_i A_i(k)}$. Different averaging rules (for a given model) correspond to different weighting functions.

Aside from being intuitively natural, averaging rules turn out to have many attractive properties. We will see, for example, how various weighting functions correspond to intuitively natural generalizations of standard rules for thinking about self-locating evidence. We will also see how averaging rules allow us to make fine-grained distinctions between just which items of indexical information are evidentially relevant to a given hypothesis.

Other attractive features include the manner in which averaging rules vindicate intuitive relationships between indexical and absolute probabilities. Given that indexical probabilities are being conceived of as absolute probabilities with additional uncertainty concerning the referents of indexical terms layered into them, we should expect the values of such probabilities to coincide for statements that contain no indexical terms. That is, for any non-indexical statement, *r*, we should expect that $P(r) = A(r)$. Averaging rules vindicate this result.

It is proven in Appendix A, furthermore, that averaging rules vindicate a deference principle regarding the relationship between conditional indexical probabilities and conditional absolute probabilities that is analogous to David Lewis's (1980) famous Principal Principle. This principle ("The Absolute to Indexical Probability Principle") may be stated (schematically) as follows:

(AIP) $P(r \mid k\&A(r \mid k) = \phi) = \phi$, provided that $P(k\&A(r \mid k) = \phi) > 0$.

In Section 5, we will also see how averaging rules allow us to naturally deflect alleged counterexamples to this principle.

4. Simple Averaging and a Toy Model

In order to help the reader become acquainted with how all of this apparatus works, as well as to obtain some interesting results in their own right, I will begin by applying a rule that I will refer to as "Simple Averaging" to the this-universe objection. This will in turn help set the stage for a consideration of how other rules apply in Sections 7 and 8. According to Simple Averaging, the weighting function remains constant. That is, it gives the opinion of each context exactly the same weight. For conditional indexical probabilities, Simple Averaging yields the result that, for any statements r and k, $\mathrm{P}(r|\,k) = \frac{\sum_{\mathrm{i}} \mathrm{A_i}(r\&k)}{\sum_{\mathrm{i}} \mathrm{A_i}(k)}$.

I will proceed by considering a simple, toy model. I prove in Appendix B, however, that the results of my discussion generalize to more realistic models. So as not to get distracted by some potentially irrelevant metaphysical and scientific questions, the toy model revolves around a modified version of one of White's (2000: 268) own analogies, one that replaces universes with "rooms" and possible occupants with "sleepers" who may or may not wake up.

Here is the setup:

> Possibly, either one (or both) of two rooms, Room 1 and Room 2, exist. Whether each room exists is determined as follows: Two fair coins are tossed simultaneously, Coin 1 and Coin 2. Room 1 is brought into existence iff Coin 1 lands heads. Room 2 is brought into existence iff Coin 2 lands heads. If Room 1 exists, it is occupied by the sleeper Una. If Room 2 exists, it is occupied by the sleeper Dua. For each sleeper who exists, a pair of standard six-sided dice are then simultaneously rolled, and the sleeper is awakened iff the roll comes up a double six. Any sleeper who awakens is aware of the details of this setup but unaware of whether she is Una or Dua. The sleeper who is the central protagonist of our story — call her "Jane" (as in "Jane Doe") — finds herself awake.

There are two questions we may ask regarding this scenario. First, does Jane acquire evidence for the existence of multiple rooms relative to background information that includes only the details of this setup? Second, does Jane acquire evidence for the existence of multiple rooms relative to background information that includes not only these details but also the indexical statement *This room exists* (where this is a statement that Jane can express upon awakening)?

For modeling purposes, we may regard this situation as one in which there are only nine possible worlds: (W1) Neither Room 1 nor Room 2 exist. (W2) Only Room 1 exists and Una wakes. (W3) Only Room 1 exists and Una does not wake. (W4) Only Room 2 exists and Dua wakes. (W5) Only Room 2 exists and Dua does not wake. (W6) Both rooms exist and both sleepers wake. (W7) Both rooms exist and only Una wakes. (W8) Both rooms exist and only Dua wakes. (W9) Both rooms exist and neither sleeper wakes. I will also assume that Una and Dua are the only possible subjects throughout these worlds.

Below is a pictorial representation of the resulting model. Each awakened sleeper in each world corresponds to a unique context.[7] These contexts are labeled and numbered (with who occupies their subject position also indicated for further clarity).

	Room 1	Room 2	Absolute Probability	Contexts
W1	X	X	1/4	X

[7] I assume that unconscious individuals are not appropriate candidates to occupy the subject positions of contexts. If one does not like this, one could modify the setup so that the individuals are not awakened but brought into existence from preselected gametes.

W2	[U]	X	(1/4)(1/36)	C1 (Una)
W3	[X]	X	(1/4)(35/36)	X
W4	X	[D]	(1/4)(1/36)	C2 (Dua)
W5	X	[X]	(1/4)(35/36)	X
W6	[U]	[D]	(1/4)(1/36)(1/36)	C3 (Una), C4 (Dua)
W7	[U]	[X]	(1/4)(1/36)(35/36)	C5 (Una)
W8	[X]	[D]	(1/4)(1/36)(35/36)	C6 (Dua)
W9	[X]	[X]	(1/4)(35/36)(35/36)	X

Let 'K' stand for a body of background information that encapsulates the details of the setup but nothing else of epistemic relevance. Let 'I' stand for the statement *I am awake in this room*. Let 'T' stand for *This room exists*. Let 'M' stand for *There are multiple rooms*. If we conceive of evidence as that which raises the indexical probability of a hypothesis, our two questions now become:

(Q1) Is it the case that $P(M \mid I\&K) > P(M \mid K)$?

(Q2) Is it the case that $P(M \mid I\&T\&K) > P(M \mid T\&K)$?

Concerning the first question, it follows from Simple Averaging that $P(M \mid I\&K) = \frac{\sum_{i=1}^{6} A_i(M\&I\&K)}{\sum_{i=1}^{6} A_i(I\&K)}$. Note that the statement M&I&K's character assigns the set {W6, W7} to contexts in which Una occupies the subject position, and the set {W6, W8} to those in which Dua occupies the subject position. The absolute probability of each of these sets is (1/4)(1/36). So $\sum_{i=1}^{6} A_i(M\&I\&K) = (6)(1/4)(1/36)$. Similarly, for each context in which Una occupies the subject position, I&K's character assigns {W2, W6, W7}. And for each context in which Dua occupies the subject position, the corresponding set of worlds is {W4, W6, W8}. The absolute probability of each of these sets is (2)(1/4)(36). So $\sum_{i=1}^{6} A_i(I\&K) =$

(6)(2)(1/4)(36). Thus P(M│I&K) = 1/2. The reader may follow a similar procedure to verify that according to Simple Averaging, P(M│K) = 1/4. Thus the answer to Q1, "Is it the case that P(M│I&K) > P(M│K)?", is "Yes".

It is also true according to Simple Averaging that $P(M \mid I\&T\&K) = \frac{\sum_{i=1}^{6} A_i(M\&I\&T\&K)}{\sum_{i=1}^{6} A_i(I\&T\&K)}$. Since, for each context, the set of worlds that M&I&T&K's character assigns to that context is identical to the one assigned by M&I&K's character, and likewise when it comes to the sets assigned by I&T&K's and I&K's characters, P(M│I&T&K) = P(M│I&K). Thus (by what has already been established) P(M│I&T&K) = 1/2. Simple averaging also has it that $P(M \mid T\&K) = \frac{\sum_{i=1}^{6} A_i(M\&T\&K)}{\sum_{i=1}^{6} A_i(T\&K)}$. M&T&K's character assigns {W6, W7, W8, W9} to every context. And the probability of that set is 1/4. For contexts at which Una occupies the subject position, T&K's character assigns {W2, W3, W6, W7, W8, W9}. For contexts in which Dua occupies the subject position, T&K's character assigns {W4, W5, W6, W7, W8, W9}. The probability of each of these sets is 1/2. So $P(M \mid I\&T\&K) = \frac{\sum_{i=1}^{6} A_i(M\&T\&K)}{\sum_{i=1}^{6} A_i(T\&K)} = \frac{(6)(1/4)}{(6)(1/2)} = 1/2$. Thus the answer to Q2, "Is it the case that P(M│I&T&K) > P(M│T&K)?", is "No".

Here we see that (at least for this toy model) Simple Averaging vindicates the this-universe objection as construed by Draper, Draper, and Pust. While the statement *I am awake in this room as a result of a fortunate roll of the dice* confirms the multiple-room hypothesis relative to background information that contains only the details of the setup, it does not do so relative to background information that also includes the indexical statement *This room exists*.

5. An Alleged Counterexample

Above I noted that any averaging rule vindicates the Absolute to Indexical Probability Principle. Some cases raised by IHR (2022: 245-246) can be used, however, to generate apparent counterexamples to that principle. IHR point out that there are situations in which what I am calling "indexical probabilities" diverge from the values of known objective chances. If we assume that absolute probabilities conform to something like David Lewis's (1980) Principal Principle, such situations can also be employed to generate apparent counterexamples to AIP.

Here is one such case:

> There are two rooms, Room 1 and Room 2. In each room, a fair coin was tossed. The lights in that room were turned on (i.e. "the room was lit") iff the coin toss that occurred in it came up heads. Let 'Alpha' rigidly denote Room 1 iff Room 1 is lit. Let 'Alpha' rigidly denote Room 2 otherwise. I am not in either of these rooms and have no information about whether their lights are on. But my background information informs me of all of the above (including the manner in which the referent of 'Alpha' is fixed). Question: What should be my credence that Alpha is lit?[8]

Note that in this example 'Alpha' has the same content as the following rigidified description: *The actual room that is identical to Room 1 iff Room 1 is lit but is identical to Room 2 otherwise*.

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[8] A case like this was mentioned by Yoaav Isaacs in a talk given at *[omitted for purposes of blind review]*.

Here is an intuitive picture of situation. If a box in the diagram below has an 'L' in it, the room indicated is lit. If a box has a 'D', the room is not lit (i.e. it is "dark"). Corresponding to each world, furthermore, is a context. We may, as an idealization, assume there is only one context per world. If the box has an 'α' subscript, the corresponding room is the referent of 'Alpha' at the context associated with that world.

World	Room 1	Room 2	Context
W1	$[L]_\alpha$	[L]	C1
W2	$[L]_\alpha$	[D]	C2
W3	[D]	$[L]_\alpha$	C3
W4	[D]	$[D]_\alpha$	C4

Note that each row corresponds to an epistemic possibility. My evidence leaves each possibility equally likely. In three out of four possibilities, Alpha is lit. So the indexical probability that Alpha is lit given my background information appears to be 3/4.

Averaging rules contradict this result. Let 'L_α' stand for the statement *Alpha is lit* and 'K' for the relevant body of background information. According to any averaging rule, $P(L_\alpha | K)$ is the (perhaps weighted) average probability of a set of worlds assigned to a context by L_α's character. For any given context, that set is either {W1,W2} or {W1,W3}, and the absolute probability of each of these sets is 1/2. Therefore averaging rules have it that $P(L_\alpha | K) = 1/2$. Indeed this is just what we would expect given AIP, since our background information informs us that $A(L_\alpha | K) = 1/2$. Here both averaging rules and AIP seem to conflict with intuition.

In fact, there is no conflict. We can consistently maintain that averaging rules deliver the correct value of $P(L_\alpha | K)$, while also denying this value is the one most relevant to what an ideally rational agent's credence should be. Any sufficiently self-reflective, rational agent, in the described scenario, will be aware not only of the information found in K, but also of the indexical statement *I am in this context*. And so here another principle that Hacking (1987: 335-336) and White (2000: 264-265) have emphasized comes to the fore, namely, the *Principle of Total Evidence*, which requires that we make use of the logically strongest encapsulation of the evidence available to us.[9]

If we let '$I_@$' stand for *I am in this context*, then (given the Principle of Total Evidence), the indexical probability most relevant to such an agent's credence is not $P(L_\alpha \mid K)$ but rather $P(L_\alpha \mid I_@\&K)$. According to Simple Averaging, $P(L_\alpha \mid I_@\&K) = \frac{\sum_{i=1}^{4} A_i(L_\alpha\&I_@\&K)}{\sum_{i=1}^{4} A_i(I_@\&K)}$. For each context, Ci, other than C4, $L_\alpha\&I_@\&K$'s character assigns the singleton set {Wi}. In the case of C4, $L_\alpha\&I_@\&K$'s character assigns {}. Since the probability of each of the first three sets is 1/4 and the probability of the last is 0, $\sum_{i=1}^{4} A_i(L_\alpha\&I_@\&K) =$ 3/4. For each of the four contexts, Ci, $I_@\&K$'s character assigns the singleton set {Wi}, and each of these sets has a probability of 1/4. And so $\sum_{i=1}^{4} A_i(I_@\&K) = 1$. Thus, $P(L_\alpha \mid I_@\&K) =$ 3/4, exactly in line with what intuition tells us. This result holds not only for Simple Averaging, but for any averaging rule that makes the weighting function constant in this model.

This analysis does cast some initial doubt on the relevance of the results in the previous section. It suggests that the indexical probability most relevant to Jane's

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[9] For critiques of the Principle of Total Evidence, see (Manson and Thrush 2003: 74-76) and (Epstein 2017). For defenses of the Principle of Total Evidence, see (Draper, Draper, and Pust 2007: 293-295), (Barrett and Sober 2020), (Draper 2020).

credences is not P(M | I&T&K) but rather P(M | $I_@$&T&K). Fortunately, it turns out, according to Simple Averaging, that (for the toy model considered in the previous section), P(M | $I_@$&T&K) = P(M | I&T&K) = 1/2.[10]

6. Revisiting the This-Universe Objection

We are now in a position to see that Simple Averaging, combined with the Principle of Total Evidence, becomes a generalization of a rule for updating on self-locating information which IHR (2022: 256), following standard nomenclature, refer to as "Self-Indication." When updating on self-locating information, Self-Indication instructs one to assign each context not ruled out by one's evidence the probability of the singleton set of the world it is in, to add those probabilities together, and then to renormalize so that all of the relevant probabilities add up to 1.

The fact that Simple Averaging ends up being a generalization of Self-Indication renders unsurprising the result that it deems fine-tuning evidentially irrelevant to the multiverse hypothesis. As IHR themselves point out, while Self-Indication yields the result that the statement *I exist in a fine-tuned universe* raises the probability of the multiverse hypothesis, it also has it that the statement *I exist* does the same, and exactly to the same degree, with or without fine-tuning.

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[10] Note that M&$I_@$&T&K's character assigns {W6},{W6}, {W7}, {W8} to C3, C4, C5, and C6 (respectively) and {} to each of C1 and C2. Also keep in mind that $I_@$&T&K simply assigns to each context the singleton set of the world it is in. Thus, $\sum_{i=1}^{6} A_i(M\&I_@\&T\&K)$ = (2)(1/4)(1/36) and $\sum_{i=1}^{6} A_i(I_@\&T\&K)$ = (4)(1/4)(1/36). So P(M | $I_@$&T&K) = 1/2.

IHR (2022) do not regard this outcome as a victory for the this-universe objection however. They write:

> We should distinguish two ideas. One is that being in a universe that contains fine-tuned life is strong evidence for a multiverse. The second idea is that the *fine-tuning* part of this evidence plays a crucial role, over and above being in a universe that contains life… But the second idea is less robust: it is supported by [some] rules, but not Self-Indication… But at least we can see that if fine-tuning does *not* provide support for the multiverse, it is not for the reason that Hacking and White defended. For their main arguments attack the *first* idea: both of them contend that *our universe contains fine-tuned life* does not provide evidence for the multiverse at all. (267-268)

But the above analysis tells a different story. Since we are interested in a fine-tuning argument for the multiverse hypothesis and not a cosmological one, we are to evaluate the Hacking-White point relative to background information that already includes the fact that this universe exists. When we do, we find that, according to Simple Averaging, the statement *I exist in a fine-tuned universe* fails to confirm the multiverse hypothesis, and it does so for exactly the sort of reason that Hacking and White suggest.

Thus I take myself to have achieved the goal of offering the existence proof that I set out to provide at the end of Section 2. I have shown that there is at least one plausible, systematic way of modeling how to reason probabilistically with indexical information that vindicates the this-universe objection.

7. A Comparison with Other Rules

Aside from Self-Indication, IHR countenance two other commonly proposed rules for thinking about self-locating belief, which they (following common nomenclature) refer to as "Self-Sampling" and "Compartmentalized Conditionalization." In this section I offer natural generalizations of these as averaging rules and then explore some of their implications.

According to Self-Sampling, when updating on self-locating information, for any world that contains contexts at all, one first divides the probability of the singleton set of that world evenly between those contexts. Then one reassigns a probability 0 to all those contexts whose subject's purely qualitative evidential situation does not match one's own. Finally, one renormalizes so the final probabilities assigned to each context add up to 1 (IHR 2022: 258).

According to Compartmentalized Conditionalization, one is to take any world that contains contexts with subjects whose purely qualitative evidential situation matches one's own and divide the probability of the singleton set of that world evenly between those contexts. One is to assign all other contexts a probability 0. Finally, one should renormalize so the resulting probabilities add up to 1 (254).

We may construct a weighting function for an averaging rule that serves as an intuitively natural generalization of Self-Sampling as follows: Let Ψ be a non-normalized weighting function such that for each context, C_i, Ψ_i equals 1 over the total number of contexts found in the same world as C_i. Then normalize by taking each Ψ_i and dividing it by $\sum_i \Psi_i$ in order to obtain the value of each ψ_i.

In order to generalize Compartmentalized Conditionalization, for each C_i, let Ψ be a non-normalized weighting function such that each Ψ_i equals 1 over the total number of contexts found in the same world whose subjects share the same qualitative evidence as does the subject of C_i. Then normalize to obtain each ψ_i. Note that since the subjects in each context of the toy model are assumed to have exactly the same qualitative evidence, Compartmentalized Conditionalization yields the same results for that model as does Self-Sampling.

When it comes to the toy model, all three rules considered so far agree that $P(M|K) = 1/4$ and $P(M|T\&K) = 1/2$. All three further agree that $P(M|I\&T\&K) = 1/2$. So all three agree that (in the toy model) the indexical statement *This room exists* raises the indexical probability of the multi-rooms hypothesis and, furthermore, that the indexical statement *I exist in this room* offers no additional confirmation of that hypothesis. But they diverge when it comes to how they treat the impact of adding the extra indexical information *I exist in this context*.

We have already seen that the generalization of Self-Indication has it that $P(M|I_@\&T\&K) = P(M|T\&K) = 1/2$. Self-Sampling and Compartmentalized Conditionalization, by contrast, both have it that $P(M|I_@\&T\&K) = 71/143 \approx .4965$. Thus, according to these rules, while $P(M|I_@\&T\&K) > P(M|K)$, it is also true that $P(M|I_@\&T\&K) < P(M|T\&K)$. Transposing the analogy over to the multiverse case, we have the suggested result that, relative to background information that includes the indexical fact that this universe exists, the further indexical information that one exists in this particular context provides some evidence *against* the multiverse hypothesis!

If we eliminate fine-tuning from the model (i.e. if we make the awakening of each occupant guaranteed on the condition that her room comes into existence), this effect becomes more dramatic. In that case, there are only four worlds, each with 1/4 absolute probability: (i) the empty world, (ii) the world in which Una exists and there is a single room, (iii) the world in which Dua exists and there is a single room, and (iv) the world in which both Una and Dua exist in their respective rooms. For this model, all three rules continue to agree that $P(M \mid K) = 1/4$ and that $P(M \mid I\&T\&K) = P(M \mid T\&K) = 1/2$. But Self-Sampling and Compartmentalized Conditionalization deliver the result that $P(M \mid I_{@}\&T\&K) = 1/3$. This is of course greater than 1/4, but dramatically less than 1/2 than is .4965. Indeed, 1/3 just is the prior probability of the multiple-rooms hypothesis (with or without fine-tuning) given background information that already includes the fact that some room or other exists. Thus (the analogy suggests), according to these other two rules, *without fine-tuning*, the extra indexical information found in the statement *I am in this context* exactly cancels out the positive evidential contribution that learning *This universe exists* adds to the multiverse hypothesis (above and beyond the contribution made by the information that *some* universe exists). What explains these results?

What we have here is a synchronic version of the much-discussed doomsday argument: There are fewer contexts at which the single-universe hypothesis is true than there are at which the multiverse hypothesis is true. So (the reasoning supported by these rules goes), assuming that the single-universe hypothesis is true, for any given context in which I might find myself, the indexical probability that I am in *that* context is relatively high. Whereas, assuming the multiverse-hypothesis is true, for any given context in which I might find myself, the indexical probability that I am in that context is relatively low. Thus (according to these rules) the extra indexical information that I am in this context (on top of the indexical facts that this universe exists and that I exist) tends to favor the single-universe hypothesis over the multiverse hypothesis.

8. A More General Consideration Against Fine-Tuning Arguments for a Multiverse

All the rules considered so far are motivated by something in the neighborhood of a principle of indifference: when there are several possibilities and no good reason to favor one or another, weigh them all equally. Contexts may be thought of as *de se* possibilities. And each candidate for a weighting function countenanced by each of the above rules corresponds in its own way to an egalitarian division of probability. It is this intuitive principle that motivates rules according to which contexts in more populated worlds receive a lesser share of their world's probability.

But what sort of plausible motivation could there be for assigning contexts in less populous worlds less of the share of their world's probability? Such a rule would seem to violate the intuitive principle that probabilities should be divided equally between symmetrical possibilities. So, until someone is able to provide a such a motivation, I conclude that any plausible weighting rule will be one according to which the indexical information *I am in this context* either fails to confirm the multiverse hypothesis or disconfirms it (relative to background information that includes the fact this universe exists).

These considerations suggest that if anything tends to confirm or disconfirm the multiverse hypothesis relative to background information that includes the fact that this universe exists, it is the rather refined sort of indexical information found in the statement *I am in this context*. Our investigation further suggests that, if anything, this information is apt to disconfirm the multiverse hypothesis. If fine-tuning is relevant at all, it is only by way of mitigating this disconfirming effect. This too appears not merely to be a feature of the rules considered, but of any well-motivated averaging rule. These results suggest that while there *may* be a good cosmological argument for the multiverse hypothesis, things do not look promising for a distinctively fine-tuning one.

Appendix A: A Proof that Any Averaging Rule Vindicates AIP

Lemma

For any statement r, any value, ϕ, such that $0 \leq \phi \leq 1$, and for any context, C_i, $A_i(r\&A(r) = \phi) = A_i(r\&A_i(r) = \phi)$. And furthermore, if $A_i(r) = \phi$, then $A_i(r\&A_i(r) = \phi) = \phi$; otherwise $A_i(r\&A_i(r) = \phi) = 0$.

Proof of Lemma

Consider some arbitrary statement, r, some arbitrary value ϕ such that $0 \leq \phi \leq 1$, and some arbitrary context C_n. By definition, $A_n(r\&A(r) = \phi)$ is the absolute probability of the set of worlds the statement $r\&A(r) = \phi$'s character assigns to C_n, which is the intersection of the set of worlds that r's character assigns to C_n and the set that $A(r) = \phi$'s character assigns to C_n. Likewise, *mutatis mutandis*, regarding $A_n(r\&A_n(r) = \phi)$.

Now assume that $A_n(r) = \phi$. It follows that according to C_n, it is true at all worlds that $A(r) = \phi$. It is also true at all worlds according to C_n that $A_n(r) = \phi$. So the intersection of the set of worlds that r's character assigns to C_n and the set that $A(r) = \phi$'s character assigns just is the intersection of the set assigned by r's character and $A_n(r) = \phi$'s which in turn just is the set of worlds assigned by r's character. And since $A_n(r) = \phi$, the absolute probability of that set is ϕ. It follows that $A_n(r\&A(r) = \phi) = A_n(r\&A_n(r) = \phi) = \phi$.

Now assume instead that it is not the case that $A_n(r) = \phi$. In that case, according to C_n, it is false at all worlds that $A(r) = \phi$. Of course, it is also false at all worlds according to C_n that $A_n(r) = \phi$. So the intersection of the set of worlds that r's character assigns to C_n and the set that $A(r) = \phi$'s character assigns to C_n just is the intersection of the set assigned by r's character and $A_n(r) = \phi$'s which in turn just is the empty set. So it follows that $A_n(r\&A(r) = \phi) = A_n(r\&A_n(r) = \phi) = 0$.

So it follows either way that $A_n(r\&A(r) = \phi) = A_n(r\&A_n(r) = \phi)$. It also follows that if $A_n(r) = \phi$, then $A_n(r\&A_n(r) = \phi) = \phi$; otherwise $A_n(r\&A_n(r) = \phi) = 0$.

Proof

Let P(…) be an indexical probability function defined in terms of an averaging rule with a weighting function ψ. It is to be shown that for any statements *r* and *k* and for any value, ϕ, such that $0 \leq \phi \leq 1$, $P(r \mid k\&A(r \mid k) = \phi) = \phi$, provided that $P(k\&A(r \mid k) = \phi) > 0$.

Consider some statements r and k and some value ϕ, where $0 \leq \phi \leq 1$, such that $P(k\&A(r \mid k) = \phi) > 0$. Note that $P(r \mid k\&A(r \mid k) = \phi) = \frac{P(r\&k\&A(r \mid k) = \phi)}{P(k\&A(r \mid k) = \phi)}$. By definition, $P(r\&k\&A(r \mid k) = \phi) = \sum_i \psi_i A_i(r\&k\&A(r \mid k) = \phi)$ and $P(k\&A(r \mid k) = \phi) = \sum_i \psi_i A_i(k\&A(r|k) = \phi)$. It follows from Lemma furthermore that $\sum_i \psi_i A_i(r\&k\&A(r \mid k) = \phi) = \sum_i \psi_i A_i(r\&k\&A_i(r \mid k) = \phi)$ and that $\sum_i \psi_i A_i(k\&A(r \mid k) = \phi) = \sum_i \psi_i A_i(k\&A_i(r \mid k) = \phi)$. So it follows that $P(r \mid k\&A(r \mid k) = \phi) = \frac{\sum_i \psi_i A_i(r\&k\&A_i(r \mid k) = \phi)}{\sum_i \psi_i A_i(k\&A_i(r \mid k) = \phi).}$.

Note that since $P(k\&A(r \mid k) = \phi) > 0$ there must be at least one context, C_i, such that $\psi_i \neq 0$ and $A_i(r \mid k) = \phi$. Since, for any such context, $A_i(r \mid k) = A_i(r\&k)/A_i(k)$, the statement $A_i(r/k) = \phi$ is equivalent to the statement $A_i(r\&k) = \phi A_i(k)$. Accordingly, $\sum_i \psi_i A_i(r\&k\&A_i(r \mid k) = \phi) = \sum_i \psi_i A_i(r\&k\&A_i(r\&k) = \phi A_i(k))$. It follows from Lemma that for any i, if $A_i(r \mid k) = \phi$, then $A_i(r\&k\&A_i(r\&k) = \phi A_i(k)) = \phi A_i(k)$; otherwise $A_i(r\&k\&A_i(r\&k) = \phi A_i(k)) = 0$. So let ζ be a function such that $\zeta_i = \psi_i$ if $A_i(r \mid k) = \phi$, and otherwise such that $\zeta_i = 0$. It follows from all of the above that $\sum_i \psi_i A_i(r\&k\&A_i(r \mid k) = \phi) = \phi \sum_i \zeta_i A_i(k)$.

Furthermore, it is also true that for any context, C_i, such that $A_i(r \mid k) = \phi$, $A_i(k) = (1/\phi)A_i(r\&k)$. Accordingly, $\sum_i \psi_i A_i(k\&A_i(r|k) = \phi) = \sum_i \psi_i A_i(k\&A_i(k)= (1/\phi)A_i(r\&k))$. So it also follows from Lemma that for any i, if $A_i(r \mid k) = \phi$, then $A_i(k\&A_i(k) = (1/\phi)A_i(r\&k)) = (1/\phi)A_i(r\&k)$; otherwise $A_i(k\&A_i(k) = (1/\phi)A_i(r\&k)) = 0$. So it also follows that $\sum_i \psi_i A_i(k\&A_i(r|k) = \phi) = \frac{1}{\phi}\sum_i \zeta_i A_i(r\&k) = \frac{1}{\phi}\sum_i \zeta_i \phi A_i(k) = \sum_i \zeta_i A_i(k)$. So it follows that $P(r \mid k\&A(r \mid k) = \phi) = \frac{\phi \sum_i \zeta_i A_i(k)}{\sum_i \zeta_i A_i(k)} = \phi$.

Appendix B: A Proof that Simple Averaging Vindicates the This-Universe Objection

Notation

$H_n \equiv_{def}$ there are exactly n universes; $I_@ \equiv_{def}$ I exist in this context; …#...[...] $\equiv_{def}$ individual … occupies universe … at time …; ‘s’ is an indexical term with the same character as ‘myself’; ‘α’ is an indexical term with the same character as ‘this universe’; ‘τ' is an indexical term with the same character as ‘this time’; N is the maximal number of universes that could possibly exist; $Eu \equiv_{def}$ universe u exists; $E_t u \equiv_{def}$ universe u exists at time t; ‘K’ stands for a body of background knowledge that entails the assumptions stated below but contains no other relevant information.

Assumptions

The first assumption is often presupposed in discussions of the this-universe objection but less often explicitly stated.

> (Isolation) No possible agent possibly exists without existing at a time, or possibly exists at a given time without occupying exactly one universe, or possibly transitions from occupying one universe at a given time to occupying another at a different time.

Isolation sets aside the possibility of agents who might exist without being in time, or by occupying multiple universes at once, or without occupying a universe at all. It also sets aside possibilities such as agents traveling between universes. Isolation should be regarded as an idealization rather than as a substantive commitment.

The remaining assumptions are straightforwardly in the same spirit as the independence assumptions made by Hacking and White. Some multiverse models violate these assumptions.[11] Nevertheless, they are dialectically appropriate, given the claim targeted by the this-universe objection, namely, that multiverse hypotheses are confirmed solely by way of random variation combined with an observation selection effect.

(Occupational Independence) For each time, t, and for any given integer n such that $1 \leq n \leq N$, and for any possible agent a_x, and possible universe u_y, either $A(a_x\#u_y[t]\&K) = 0$ or $A(H_n \mid a_x\#u_y[t]\&E_tu_y\&K) = A(H_n \mid E_tu_y\&K)$.

According to this assumption, the fact that a given universe is occupied by a given agent at a given time is absolutely probabilistically relevant to how many universes there are only to the extent it entails that the universe in question exists at that time.

(Time Independence) For each possible universe u_x, and for each time t, and for each integer n such that $1 \leq n \leq N$, $A(H_n \mid E_tu_x\&K) = A(H_n \mid Eu_x\&K)$.

According to this assumption, at most, it is the mere fact that a given universe exists that is absolutely probabilistically relevant to how many universes there are, not the fact that it exists at a given time.

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[11] E.g. the model proposed by (Smolin 1997).

(Identity Independence) For any possible universes u_x and u_y, and for each integer n such that $1 \leq n \leq N$, $A(H_n \mid Eu_x\&K) = A(H_n \mid Eu_y\&K)$.

According to this assumption, at most, it is the mere existence of a universe that is absolutely probabilistically relevant to how many universes there are, not its identity.

Proof

Let P(…) be an indexical probability function defined in accordance with Simple Averaging. Let n be an integer such that $1 \leq n \leq N$. It is to be shown that $P(H_n \mid I_@\&E\alpha\&K) = P(H_n \mid E\alpha\&K)$.

According to Simple Averaging, either $P(I_@\&E\alpha\&K) = 0$ or $P(H_n \mid I_@\&E\alpha\&K) = \frac{\sum_i A_i(H_n\&I_@\&E\alpha\&K)}{\sum_i A_i(I_@\&E\alpha\&K)}$. Since (by previous stipulation) every model contains at least one context, every context is (given Isolation) one at which the statement $I_@\&E\alpha\&K$ is true, and Simple Averaging guarantees that every context receives non-zero weight, it is not the case that $P(I_@\&E\alpha\&K) = 0$.

The value of $\sum_i A_i(H_n\&I_@\&E\alpha\&K)$ is obtained by taking each context at which $H_n\&E\alpha\&K$ is true, assigning to it the absolute probability of the singleton set of the world it is in, and summing the values so assigned. Note that, given Isolation, each context is one at which a possible instantiation of $H_n\&a_x\#u_y[z]\&E_zu_y\&K$ is true, where a_x, u_y, and z are variables for terms referring to possible agents, possible universes, and possible times respectively, and the referents of the relevant instantiations of a_x and z occupy the subject and time slots of that context.

It also follows from Isolation that for each possible instantiation of $H_n\&a_x\#u_y[z]\&E_zu_y\&K$ there is at most one context per world at which that instantiation is true. So for each such instantiation, the sum of the values of the probabilities assigned to

each context at which it is true is equal to the absolute probability of the set of worlds at which that instantiation is true. I.e. for each instantiation of H_n&a_x#u_y[z]&$E_z u_y$&K, the sum of the values of the probabilities assigned to the contexts at which that instantiation is true equals the value of the corresponding instantiation of A(H_n&a_x#u_y[z]&$E_z u_y$&K).
So it follows that $\sum_i A_i(H_n \& I_@ \& E\alpha \& K)$ equals the sum of the values of each possible instantiation of A(H_n&a_x#u_y[z]&$E_z u_y$&K). A parallel argument also establishes that $\sum_i A_i(I_@ \& E\alpha \& K)$ equals the sum of the values of each possible instantiation of A(a_x#u_y[z]&$E_z u_y$&K).

Now consider a particular subject, b, a particular universe u, and a particular time, t. It follows from the standard definition of conditional probability that either A(b#u[t]&E_tu&K) = 0 or A(H_n&b#u[t]&E_tu&K) = A(b#u[t]&E_tu&K)A(H_n | b#u[t]&E_tu&K). It follows from Occupational Independence and Time Independence that, as long as A(b#u[t]&E_tu&K) ≠ 0, A(H_n | b#u[t]&E_tu&K) = A(H_n | E_tu&K) = A(H_n | Eu&K). It also follows from Identity Independence that there is some constant λ_n* such that, for every possible universe, u_x, A(H_n | Eu_x&K) = λ_n*. Let λ_n be such a constant.
It follows by way of generalization from the arbitrary case that the value of every instantiation of A(H_n&a_x#u_y[z]&$E_z u_y$&K) is identical to the value of the corresponding instantiation of λ_nA(a_x#u_y[z]&$E_z u_y$&K). So it follows that the sum of the values of each possible instantiation of A(H_n&a_x#u_y[z]&$E_z u_y$&K) equals λ_n multiplied by the sum over the values of each possible instantiation of A(a_x#u_y[z]&$E_z u_y$&K).

So it follows from all of the above that P(H_n | $I_@$&Eα&K) is equal to λ_n multiplied by the sum over the values of each possible instantiation of A(a_x#u_y[z]&$E_z u_y$&K) and then divided by the sum over the values of each possible instantiation of A(a_x#u_y[z]&$E_z u_y$&K).

So it follows that $P(H_n | I_@\&E\alpha\&K) = \lambda_n$. Since (as was already established) for every possible universe, u_x, $A(H_n | Eu_x\&K) = \lambda_n$, it also follows that it is true at every context that $A(H_n | E\alpha\&K) = \lambda_n$. So it follows (via AIP) that $P(H_n | E\alpha\&K) = P(H_n | E\alpha\&K\&A(H_n | E\alpha\&K) = \lambda_n) = \lambda_n$. So it follows that $P(H_n | I_@\&E\alpha\&K) = P(H_n | E\alpha\&K)$.[12]

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