Minds, Substrate, Measure and Value
Part 4: The *Cosmological* Many-Interpretations View

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This is the fourth in a series of articles about the nature of reality, the nature of consciousness and the relationship between minds and the rest of the world. The previous articles were *Minds, Substrate, Measure and Value – Part 1: Substrate Dependence*, available at http://www.paul-almond.com/Substrate1.pdf, Minds, Substrate, *Measure and Value – Part 2: Extra Information About Substrate Dependence*, available at http://www.paul-almond.com/Substrate2.pdf, and *Minds, Substrate, Measure and Value – Part 3: The Problem of Arbitrariness of Interpretation*, available at http://www.paul-almond.com/Substrate3.pdf. These argued that, to have a coherent view of probability, a measure view of consciousness is needed, in which an observer exists with some measure that is substrate dependent. An implication of this is that we must accept that all interpretations of reality which "find" an observer find a *real* observer, and that an observer exists in any situation with a degree of measure that depends on the substrate and the amount of information needed in an interpretation for it to find that observer. This was called the *many-interpretations view*. This may appear to be a strange panpsychical view of reality, in which every small piece of the world is "haunted" by an infinity of minds, and for this reason it may seem to be giving minds some special philosophical status, which might be considered some sort of dualism. This article resolves this issue by removing the special status from minds, not by changing the approach to minds, as we cannot avoid that for a coherent idea of probability, but instead by doing it for everything else as well. What the many-interpretations view says about minds now applies to all objects in the *cosmological many-interpretations view*, which implies that we are in an infinite, type 4 multiverse, in which every formally describable object exists, and this conclusion is unavoidable.

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1 Introduction

This is the fourth in a series of articles exploring the relationship between minds and physical systems (substrates) on which they are based. The previous articles in this series are as follows.

Minds, Substrate, Measure and Value, Part 1: Substrate Dependence. 2007.
(Available at: http://www.paul-almond.com/Substrate1.pdf or, http://www.paul-almond.com/Substrate1.doc.)

Minds, Substrate, Measure and Value, Part 2: Extra Information About Substrate Dependence. 2007.
(Available at http://www.paul-almond.com/Substrate2.pdf or http://www.paul-almond.com/Substrate2.doc.)

Minds, Substrate, Measure and Value, Part 3: The Problem of Arbitrariness of Interpretation. 2008.
(Available at http://www.paul-almond.com/Substrate3.pdf or http://www.paul-almond.com/Substrate3.doc.)

The previous articles concentrated on the relationship between minds and physical systems. An argument has been made for the *many-interpretations view*: the idea that all interpretations of a physical system should be treated equally, and any interpretation, no matter how extreme, that describes a mind should be regarded as corresponding to a real mind. This article will widen the scope of the argument and propose the *cosmological* many-interpretations view. The many-interpretations view, as described so far, makes a strange kind of special case of minds. The cosmological many-worlds view treats all of reality – all objects – in the same way, so that any object, and not just a mind, that can be found by some interpretation of a physical system actually exists.

Earlier in this series, I said that the argument implied a multiverse, and this is where the argument gets to that stage. The argument for the cosmological many-worlds view, with its multiverse implications, was also discussed in a debate between me and Steve Grand (who was sceptical of the argument) on the *Machines Like Us* website in 2009, and this is available at http://www.machineslikeus.com/forum/cryptic-ontology/ (Grand & Almond, 2009). Readers who are familiar with this debate will therefore have some understanding of the idea, but this article will discuss it in greater detail.

An implication of the cosmological many-interpretations view, if it is correct, is that we live in a type 4 multiverse in which every possible, formally describable object exists, though objects would exist with different degrees of measure. This would be a much more extensive multiverse than the one proposed in the many-worlds formulation of quantum mechanics (Everett, 1957). There is a clear similarity between this and

Tegmark's mathematical universe proposal (Tegmark, 1998). There also seems to be some similarity between this and the *UDASSA* multiverse proposal by Wei Dai. I should therefore be clear about what I am trying to do with this series of articles. I am not just proposing the many-interpretations view and the cosmological many-interpretations view, with its implication of a multiverse. I am trying to make an argument to show that there is no way of avoiding this: that the many-interpretations view must be accepted to have a coherent view of probability and the relationship between minds and physical systems, and that the cosmological many-interpretations view follows from this.

The previous articles have met some objections, as they must do if we are to arrive at this truth in this matter. In a discussion with Michael Fridman, at http://anadder.com/what-i-believe, I said that Part 4 of this series would provide further justification for the many-interpretations view and Part 5 would develop it into the cosmological many-interpretations view. Instead, Part 4, this article, is being used to introduce the cosmological many-interpretations view: further justification will come later.

2 The *Cosmological* Many-Interpretations View

2.1 Minds should not get special treatment.

Up to this point, the many-interpretations view has been suggested to deal just with minds. All the thought experiments have been about observers in situations such that different interpretations would be needed to find them, or an observer who does not know which situation he/she is in, but knows that he/she could be in one of a number of situations corresponding to different interpretations.

This suggests a spooky, panpsychical kind of reality in which a physical world exists, and an infinity of interpretations can be applied to any small or large piece or pieces of this world to generate an infinity of minds. This should seem disturbing. It may disturb you because of the simple fact that it seems panpsychical and this is something to which we are unaccustomed in technological societies, but that is not what I mean: if a logical analysis suggests that things are a certain way then that should be all we need. When I say that we should find it disturbing, I am talking about the way in which the many-interpretations view, as described so far, makes minds special.

Minds are special in the view presented so far, because a whole, separate philosophical approach is needed to deal with them. Some readers will have found that unacceptable: well, I do as well. However, we are forced into the many-interpretations view by thought experiments involving probability, discussed in the previous articles, that show probability to be incoherent otherwise – unless you make arbitrary decisions about what does and does not constitute a valid interpretation corresponding to existence of an object. There is only one way out of this.

The many-interpretations view needs to be applied not just to minds, but to everything.

This generalization of the many-interpretations view will be referred to as the *cosmological* many-interpretations view.

2.2 Description of the *Cosmological* Many-Interpretations View

The *cosmological* many-interpretations view is the same as the many-interpretations view described in previous articles, except that it is more general. The many-interpretations view was about minds, and implied a weird, panpsychical reality in which minds are everywhere, being implied by everything. The *cosmological* many-interpretations view is about everything and implies an extensive reality – a multiverse – in which all things that can be found by interpretations actually exist. As with the

previously described many-interpretations view, the cosmological many-interpretations view does not distinguish between extreme interpretations – ones for which the "finding" algorithm is long – and less extreme ones: any interpretation is as valid as any other. Importantly, this means that the interpretations applied to an object can contain much more information than was in the original object: a small, relatively simple piece of reality, such as a single atom, can imply the existence of hugely complicated objects. This will be counter-intuitive to many people who will regard it as absurd, as if it is a form of "cheating", for interpretations to find things in an object when the interpretation itself contains more information than is actually in the object, but I suggest that our intuition actually fails us here. More will be said on this later.

Our intuition about concepts of space and time is called into question by the cosmological many-interpretations view. We tend to think of space and time as some fundamental "framework", but objects described internally in terms of space and time could be found by interpretations of parts of the world that are not themselves extended over time: some part of the world at some instant of time, with an appropriate interpretation, could imply a temporal object.

I will give a simple example of this. We are used to the idea of static objects that depict the passage of time. A graph may show how some event unfolds over time. The narrative of a book, or a DVD containing a film will typically describe how events involving various characters occur over time. The point here is that the matter in a piece of paper with a graph on it, in a novel or in a DVD, can be easily interpreted to obtain a description of something that is extended over time. A DVD player actually contains the algorithm for doing this, so that the disc can be played back.

With the cosmological many-interpretations view, objects that can in principle be found by appropriate interpretations are regarded as "real", but we should avoid making any exceptions for special cases that we do not need to make. If objects found by interpretations are real, then any objects described in temporal terms that are found by interpretations, even if the original part of reality being interpreted is not extended over time, should also be regarded as real. A DVD can be on a desk, not being played, but the time "found" by an appropriate interpretation of the DVD is still real, whether anything actually performs such an interpretation or not. The same view should be taken of space. Objects might be found that are described in terms of space and time, and that space and time actually exists because it is implied by the logical possibility of doing the interpretation. Space and time do not need to be fundamental. In fact, interpretations of parts of our world could find objects described with a different "setup" of space and time to our own. Other objects would exist that are more abstract and cannot be described in anything like spatial or temporal terms. According to the cosmological many-interpretations view, such objects still exist.

If space and time need not be fundamental, an infinity of objects described in spatio-temporal terms is logically implied by the smallest piece of reality. The smallest piece of

each such object similarly implies an infinity of objects. Some of these objects would be describable in spatio-temporal terms, and some of them would have complexity equivalent to the observable universe: the smallest part of reality, at any instant, implies an infinity of different worlds with histories that extend over time.

If the smallest part of our world implies an infinity of worlds, some of these worlds will have embedded observers (though I will discuss the idea of "embedded" observers more, later). There is no reason why we should doubt that such observers would be real and that the flow of time in such a worlds would be real to them.

At first sight, this may seem to suggest that we have a special status in reality: that we are in the "basement level" of reality, with the fundamental space-time, while the logical possibility of an infinity of interpretations implies the existence of an infinity of worlds, with their own space-times, "built" on top of ours. We should have no illusions that we are so special. Commonsense should tell us that we are not. Statistics should also tell us that we are not. If such a situation existed, almost every observer who thought that he/she was in a fundamental space-time would be wrong, and therefore if we think this, we should realize that we will be wrong. There is an implication here about our own status in reality: our own world is no more fundamental than anyone else's, and our space and time is no more fundamental than anyone else's. Just as an infinity of objects is implied by interpretation of our own world, so our own world is merely one of an infinity of objects implied by interpretation of something else. Our space and time is not fundamental, but is merely logically implied as a feature of an object. Given that our space-time, the only space-time of which we know, is not fundamental, we should not think that *any* space-time is fundamental. Reality is atemporal and is merely a collection of objects implying objects, some of which are structured in spatio-temporal ways.[1]

While an object described in spatio-temporal terms can be "found" by an appropriate interpretation of an object that is not structured spatially or temporally, it does not follow that any spatial/temporal object is found in such a way. If an object is structured spatially and temporally, then it will be possible to construct relatively short interpretative algorithms that exploit its spatio-temporal nature to make further spatio-temporal interpretations of it. This means that a spatio-temporal object will tend to imply many further spatio-temporal objects of comparable measure.

In the cosmological many-interpretations view, everything we know, including space-time itself, is just part of an object that can be "found" by an appropriate interpretation of some other object.[2] This gives us justification for thinking that patterns of previous

[1] Discussion of internal, complex properties of an object like this really requires the idea of an "embedded" property to be qualified, and this is discussed in 2.3, next.

[2] Again, this needs the further discussion that it will be getting in 2.3.

behaviour can be used to predict the future. This has implications for the status of minds in the cosmological many-interpretations view, as will be discussed later.

2.3 Worlds as Single Objects and Many Objects and the Status of Embedded Objects

There are two ways in which something resembling a world could be implied by an interpretation. An interpretation might "find" an entire world as a single object, or objects might exist, being implied by interpretations, that correspond to parts of world, and it is possible for one part of a world to imply another part.

With regard to a world like ours, one or more objects might correspond to an event or events in space-time in some world, and an appropriate, relatively simple, interpretation of this object or objects might imply the existence of another object corresponding to an *another* event which is nearby in space or time: any parts of a world which already exist can imply other parts of that world. This has implications for certain arguments about causality, which will be discussed later. As an example, one or more events in space time might be interpreted to "find" a later event, which in turn allows a further event to be found and so on – or events could imply earlier events, or objects could imply other objects with different spatial locations.

There is no end to the hierarchy of interpretations. Asking whether a universe like ours exists as a single object or as a network of interpretation of many objects is meaningless. If a world exists as a single object, it will be possible to make interpretations of it to produce individual objects. For example, if there is a single object corresponding to this world, with my table "embedded" in it, then some interpretation of it would be possible that would "find" my table, in the sense of producing it as a separate object in its own right. Likewise, if a collection of separate objects existed corresponding to a world like this, then some interpretation of them would be able to produce a single object. This means that any world which existed as a single object would also imply a collection of many objects, linked by interpretation, and vice versa.

Some readers may have noticed an issue here of how a world which is a single object could get "discrete thingness", or how any object which is supposed to have some internal structure could have that internal structure meaningfully. Using the example of my desk again, if a world with my desk in it exists as a single object, with my desk "embedded" in it, what does it even mean to say that my desk is "embedded" in this world? The world is just a collection of 1s and 0s! How can we say that some pattern in those 1s and 0s corresponds to an embedded desk? Surely, some interpretation would be needed to give any of this meaning – which is how we got into all this in the first place! We have just been discussing, however, the idea of an interpreting algorithm "finding" an embedded object in a larger world, thereby meaning that this object exists in its own right. This is actually what gives the idea of an embedded object its meaning: if some interpretative algorithm can "find" my desk in another object, and produce it as

a separate object in its own right, it is the very fact that some interpretation can find my desk like this that means it is embedded in the first object: the internal structure of an object is only relevant with regards to the logical possibility of interpretative algorithms finding things in it.

It may seem that I am trying to invent ontological rules here. How do we know that one object is "embedded" in another if it can be found by interpretation? The answer is that *we do not know* in any profound way. Talking about an object being "embedded" in another is merely a matter of semantic convenience. Ultimately, if my desk can be found in another object, it may be convenient to say that it is "embedded" in that object, as a way of saying that it can be found, but it means nothing more. The same applies for any embedded properties of an object: they can only mean anything with regard to interpretation possibilities. This idea is important when it comes to dealing with minds and observers: saying that an observer's mind is "embedded" in some other object will likewise only mean anything with regard to interpretation possibilities, and this tells us how to deal with observers. This will be discussed later in this article, in 2.5.2.

Some readers may object that even when an object can be found by an interpretation, and exists in its own right, it is still meaningless to talk about that object existing. Considering my desk as an example again, even if we consider it as a separate object, found by an interpretation, all we have is just more 1s and 0s. How does this map onto the idea of a desk? [3]

2.4 The Cosmological Many-Interpretations View and Measure

In the cosmological many-interpretations view, an object exists if it can be "found" by an interpretation of some other object. The measure with which objects exist with some feature will tend to depend on the specificity of that feature. Suppose there is some feature that an object might have, and a lot of information is needed to describe that feature. The proportion of all possible interpretations of any object that have that feature will tend to be low. This is because a feature that needs a lot of information to describe it is specific: any interpretation that finds it has to describe a very specific object. On the other hand, if we imagine some feature of an object that needs much less information to describe it, the proportion of interpretations that describe it, and therefore the measure of objects with that feature in the multiverse will be relatively high. This is not because objects with that feature are themselves simple: some objects with the feature will be much more complex than the feature itself. However, by not

[3] I have just said that the idea of embedded objects and properties is really just a convenience and we might even go further and saying that statements of existence and non-existence only mean anything useful when they apply to objects corresponding to the minds of observers.

making such specific demands of an object to have it, the feature will be found in more objects.

2.5 The Status of Minds in the Cosmological Many-Interpretations View

2.5.1 Minds as Physical Objects

The status of a mind in the cosmological many-interpretations view is essentially the same as it was in the previous, less general version of the many-interpretations view. The only real complication, now, is that, in addition to minds, everything else is being implied by interpretations as well, so the status of minds needs some clarification.

I will start by saying that the existence of a mind is an object consisting of a mental state that changes over time, though this is actually a slightly simplified view. By "mental state" I merely mean "what the mind's experience is at any time". A mind has this experience, and then this experience, and then this experience and so on. This should be intuitively obvious to us. Our experience as conscious beings is that of thinking in time, and I suggest that it is inconceivable to us to imagine thinking otherwise.

Because a mind's existence consists of state changes over time, it is obvious that we might think of it in algorithmic terms: an algorithm is used to direct the state changes of a computer over a period of time, and an algorithm can be used to describe something, formally, that changes over time. This is why computers are considered to be such a good match for minds by those working in artificial intelligence. However, this does not mean that there is anything special about minds that makes them algorithmically describable like this: all the things in the world around us, which exist over periods of time and undergo state changes, could be similarly algorithmically described, and this is exploited in simulations of, for example, weather.

Rather than getting too focused on the idea of minds as algorithms, we are better just seeing things in terms of the basics: the history of a mind is an object that consists of states structured temporally to describe an appropriate pattern of state changes. This can be described algorithmically, but so can the history of a tree or a tropical storm. There is nothing *especially* computational about it.

Importantly, the many-interpretations view allows the existence of a mind's history, as an object that extends over a period of time and consist of temporally structured states, to be implied by an interpretative algorithm like any other object. The history of a mind is therefore as much a physical object as the history of a tree is. We should differentiate a mind from the underlying system, the substrate, on which it is based. The mind's history is implied by an appropriate interpretation of the substrate's history. For example, if your mind exists because a brain exists, then this means that your mind's history over time is an object produced by an appropriate interpretation of the object corresponding to your brain's history over time. Both the brain and the mind are

regarded as equally real, physical objects. The fact that the mind is "found" by an interpretation of the brain does not detract from its reality or physicality at all: the underlying brain itself would equally be dependent on the logical possibility of an appropriate interpretation.

Minds are intrinsically temporal, meaning that a mind can only exist as an object comprising state changes in a temporal way, but this does not mean that a mind *must* be produced by interpretation of an underlying temporal object. A mind can be produced by an appropriate interpretation of any object. In practice, however, consideration should be given to the issue of measure. A relatively simple interpretation should be able to imply something like a universe, with structured laws of physics, which is structured temporally, and this would imply many temporally structured objects, some of which will be things like brains or computers. Interpretative algorithms which "find" minds in such systems will tend to need less information content, so should make up a higher proportion of all possible algorithms that find minds: if you are here, it is likely that you are here for a fairly conventional reason, in that you are based on a brain, a computer or something that is existing as a temporal object in a temporal world.[4]

2.5.2 Minds, Embedded Objects, Observers and Reference Class

In the cosmological many-interpretations view, a mind's history is an object corresponding to a history of an observer's mental experiences, which is implied by the logical possibility of interpretation of a substrate's history. What was just said in 2.3 about the idea of one object embedded in another only meaning anything in terms of facilitating interpretations which imply the existence of that object is relevant here. To say that a mind is "embedded" in some object would make little sense unless we understood it as meaning that an appropriate interpretative algorithm, applied to that object, could produce an object corresponding to that mind. An object corresponding to your mind should be a formal description of your mental experience, and should therefore map onto your mental experience.

We could go further than this, however. Histories of minds are of particular interest as objects because they map onto our experience, but our experience at any time is less than what would be described by an object corresponding to a mind existing over a period of time. At any time you have a particular mental state – what you are experiencing right now – and for it to be meaningful to say that such an object corresponds to your mind, you should require that any object that is supposed to correspond to your mind should agree with that mental state. For an object corresponding to your mind existing over some period of time, this would mean that your mental state right now should be "embedded" in that object, along with all the mental states that you have, or will have, at different moments. The problem with this is

[4] This kind of consideration relates to the issue of Boltzmann minds, and more will be said about it later in the article, in Section 4.2.

that we have seen how the idea of objects being "embedded" makes little sense, other than as a way of talking about the ease of "finding" them with appropriate interpretations. In this case, it makes little sense to talk about a mental state at some instant of time being "embedded" in an object which is supposed to correspond to mental experience over a period of time, and it only makes sense to talk about a mental state being "embedded" in such an object if there is an appropriate interpretation which will "find" it and imply it as a separate object in its own right. There will, of course, always be such an interpretation for any object, so we may consider that this relates to reasonably short interpretative algorithms which will find objects that exist with relatively high measure. This means that we should demand that a mental state for any particular instant exists as a separate object, which then readily maps onto the experience of an observer.

We might take this still further. The mental state that you are experiencing right now will have separate features. We may demand that the most basic element of a mental state which can be conceived exists as an object in its own right, implied by the appropriate interpretation or sequence of interpretations of some substrate, and we may demand this on the basis that it would otherwise be meaningless to talk of this feature being "embedded" in some other object. This suggests that you should consider the most basic elements of your state of mind at any time as corresponding to real, physical objects implied by interpretation of some underlying system.

2.5.3 Minds and Reference Class

The issue of what objects should be regarded as corresponding to our mental states may seem to be removed from any practical considerations. In fact, some readers may think that any discussion like this is meaningless, on the basis that we could never know exactly which objects are responsible for our mental states. If I think that some aspect of my mental state is due to some very basic object rather than some embedded feature of some more complex object corresponding to my entire mind existing over time, am I not merely just *preferring* one approach on fairly abstract grounds? It may seem that there is no *empirical* reason preferring one approach over another. It is not the case, however, that the decision we make about which kinds of object correspond to our mental state have no empirical significance. This decision is important with regard to *reference class*.

At any time, you know that you have a given mental state. According to the cosmological many-interpretations view, you should regard your mental state as having actual, physical existence. Your mental state should therefore correspond to an object or objects in the hierarchy. This object or objects will exist because it is implied by the logical possibility of a particular interpretation of something else, and so on. For any situation in which you find yourself, there is a particular explanation for your mental state, based on the interpretations that "produce" that mental state from something else.

Your knowledge of your situation at any time, if properly expressed to match the cosmological many-interpretations view, would therefore consist of a "map" of the hierarchy, with an identification of the part of the hierarchy that is supposed to correspond to your mental state: we might imagine an arrow pointing to the relevant part of the hierarchy, with the label "You are here."

The hierarchy is infinite, and you could never have knowledge of all of the hierarchy in which your mental state exists. You only have enough information to be able to describe the hierarchy partially. You will be able to say something about your mental state, and something about the situation "local" to it in the hierarchy. You will know *something*, but not *everything* about your situation. As you have limited knowledge about your situation, there will be many different candidates for your situation: your partial map of the hierarchy could fit into the unknown, infinite map in many different ways and these different ways form the *reference class* of possible situations in which you could exist. This reference class is important, because it allows you to assign probabilities to future observations, and it is on this that our expectations about the future are based. To say that an event has some probability, p, of occurring in your future really means that, out of the entire reference class of situations in which you could be, a certain fraction, p, are situations in which that event is going to happen in the future. Each member of the reference class needs an object or objects corresponding to your mental state, and the issue of how that reference class is constructed – what objects are admitted as candidates for your mental state – is therefore important. In other words, all questions about the future ultimately come down to the question: "Where am I?" To make a prediction of the future, you need to consider the reference class of different ways in which your mental state could be explained, and look at the future for each of these. It is not necessary to analyse the entire, infinite reference class: instead statistical approximations can be used and a subset of the reference class can be analysed. I suggest, actually, that our brains do something roughly equivalent to this when we make predictions of the future.

2.5.4 Future Expectation and Continuity of Self: Mind the gap

An issue may seem to arise from what has just been discussed in 2.5.3. I have said that different situations – different candidates for our mental state – could imply different future expectations for observers, but this would require us to be able to say what the future expectation was for any given situation. The problem, here, is that, to do this, if the objects corresponding to our mental state just describe the experiences that we are having *now*, we need some way of relating these to objects describing a future mental state to be able to make predictions: given some object corresponding to the mental experience that you are having now, you need to be able say, "This object corresponds to some future experience." The issue here is one of continuity of self.

What may make this issue easier to approach is that our experience is of things happening: we experience the passage of time, and this seems to be a fairly basic thing.

It is hard to imagine some experience so fundamental that it can be described atemporally. We might expect, therefore, that an object in the hierarchy that is supposed to be a candidate for some fundamental, mental experience should not just correspond to an instant of experience like a "snapshot", but should correspond to the experience and the way that it is changing at that instant. As an analogy, if an object just corresponded to some point on a graph then there would be nothing in that object that would connect it to any other point on the graph, but if an object corresponded to a point on the graph and the graph's derivative (gradient) at that point, then the object has some kind of natural association with objects corresponding to points immediately before and after it. The idea here is that the same would apply for any basic object corresponding to some aspect of our mental experience, because the idea of experience as something occurring in time is a basic one.

If a basic object corresponding to mental experience also corresponds to the way that experience is *changing*, then the object's description is specifying criteria that objects corresponding to experience in the immediate past and the immediate future should meet: the object is indicating what has just happened and what comes next, so any object that is supposed to be a candidate for an immediately following mental state can be required to match up with this. This does not mean that an object corresponding to some mental experience at some instant has a single object corresponding to the mental experience that occurs immediately afterwards: for an object corresponding to a single instant of mental experience there may be many objects corresponding to the mental experience that occurs next. An observer should view all this in probabilistic terms, and consideration should be given to the measure with which experience of various future events is represented in the multiverse. Measure should also be an issue when considering how each instant of mental experience was implied.

We might demand more than this, however, for continuity. For two objects to correspond to mental experience at different instants, we might demand that some interpretation "bridges the gap" between them – and the measure with which such interpretations occur might be regarded as relevant when an observer is calculating the probability that he/she will find himself in a given situation. For example, we might demand that both objects are found by interpretations of some common object – the history of a mind over time. Requiring some interpretation to bridge the gap would never mean that there is no continuity: you can always find anything in anything with a sufficiently extreme interpretation. However, the more extreme an interpretation needs to be to bridge the gap, the less will be the *measure* of such interpretations; that is to say, the smaller will be the proportion of all possible interpretations which actually bridge the gap. (I have just said that an object corresponding to a basic mental experience should describe the change in experience, and this would presumably deal with it.)

The implications of requiring some kind of interpretation to "bridge the gap", or not requiring it, would be apparent if we considered the case of mind uploading.

Suppose that a scan is made of your brain, stored for a while, and then used to create a computer simulation somewhere else. From the moment that the scan is made, you have two plausible paths of continuity: the one in which you "stay in your own brain" and the one where you find you have been uploaded into a computer. If we assume that each of these is a possible continuation, before the scan is made you should view this probabilistically: you should think there is some probability that you will continue to be the biological original and some probability that you will find yourself as the uploaded copy.

Now, suppose we say that the only thing that matters, with regard to continuity, is finding suitable observer moments anywhere: objects in the multiverse that are plausible continuations of your mental state. Such objects can be implied by reasonable interpretations of your brain and they can also be made by reasonable interpretations of the computer, after the copy is installed in it (because it is deliberately set up for this purpose). There may be differences in relative measure between objects corresponding to your mental experiences when you find yourself in each kind of situation, and these would affect the probability. What would matter, here, is the substrate. Some property of the computer may make it more or less likely that you would find yourself "in" it. (This is what was discussed in the first article in this series.) Suppose we assume, for the sake of argument, that the relative measure afforded by the substrate is the same in each case: before the scan occurs, you should expect it to be equally likely that you will find yourself "continued" as the biological original or the uploaded copy.

Suppose we now have extra requirements for an object to correspond to a continuation of your experiences. We now demand that some interpretation "bridges the gap". The complexity of the interpretation required to "bridge the gap" – to describe the transition from one situation to another – would have an effect on relative measure. For a straightforward, continued existence with a human brain, where the experience stays in the brain, this should not make much difference, but in scenarios like mind uploading it could make a considerable difference. As well as worrying about the relative measures of mind uploaded versions of you compared with the original biological version, we would also have to worry about the amount of information needed to describe the transition from one situation to the other, and the extra complication of this with mind uploading could result in a decrease in measure.

Perhaps uncomfortably for some people, we might consider a similar issue to arise in extreme cases where consciousness and the functioning of the body is disrupted. An example of this would be the hoped-for, hypothetical revival from cryonic suspension. If we require an appropriate interpretation to "bridge the gap" could that mean that measure reduction issues arise here?

We have just been exploring the idea that requiring extreme interpretations to "join together" instants of experience might cause a loss of measure, but does this really matter? People will have different views on this. Measure relates to the probability of

finding yourself in a situation. If the measure of finding yourself continued in one way is low, relative to the measure of finding yourself continued in other ways, you should consider it more likely that you will be continued in these other ways. This does not necessarily mean that you should never expect to find yourself mind-uploaded if you make a copy and your biological body continues to live. If the copy is made such that it provides sufficient measure, and if the gap between your brain and the copy can be bridged by a reasonably high-measure interpretation (or if it is simply not the case that the gap needs bridging – I have not committed to this view) then continuity which results in you finding yourself uploaded may have higher measure than the continuity of just staying "in" your biological body. You might order a copy made and rationally think that from your point of view it is likely you will become the copy, even while your biological body continues to live. Whether such a high relative measure for a mind uploading process could ever practically be achieved is, however, a matter for debate.

An issue which will arise here is that of mortality. Being continued in different ways may have different relative measures, and therefore probabilities, and a measure reduction should cause you to think it is less likely that you will be continued in a given way, but what if there are no other ways? What if all the ways in which you could be continued, combined, involve a massive reduction of measure? For example, you may arrange to have your mind uploaded to a computer in an attempt to survive the death of your biological body. If, for some reason, continuity into the uploaded version involves a massive reduction in measure you could interpret this in two different ways. One interpretation would be that, as your biological body is dead, you are not there to observe those continuations, so they do not count – meaning that you should expect to survive biological death and find yourself uploaded, regardless of the collapse in your measure: in other words, you only need to count futures in which you are alive. A different, probably more widely held view would be that the continuations in which you die *do* count, whether you end up being there to observe them or not, and any significant reduction in measure in uploading means that you should expect to end up going down the higher measure route of being dead. This is essentially the same as the quantum suicide or quantum immortality issue in the many-worlds interpretation of quantum mechanics. No position will be taken on it in this article, as the outstanding issue of continuity needs to be resolved to decide about something like this.

The cosmological many-interpretations view, *as it currently stands*, does not attempt to address the issue of continuity. It simply attempts to deal with the ontology of what is there: what this means for future expectations is a matter for further consideration. In general, the kind of view taken on continuity will not make much difference for everyday situations. For example, if you want to know the probability of obtaining a certain number when you roll a pair of dice, then you might view your "future" experiences as corresponding to any objects that seem to be "plausible" future experiences for you, regardless of "where" they are in the multiverse, or you may demand that any future experiences correspond to objects that are associated with an interpretation of some object with which your current experiences are associated. There

is no reason why either of these should skew the dice – why it should prefer some particular combination of numbers – and for routine matters we could assume that standard probability applies. In fact, a commonsense view of continuity will be usable even in situations that many people would regard as unusual, such as the situation of being an artificial intelligence dependent on a computer. The philosophy of continuity would become an issue, however, when some kind of *transfer* was involved.

2.5.5 The Mind-Body Problem

With the relationship between minds and substrates just described, the cosmological many-interpretations view takes a firm position on the mind-body problem. A mind exists because an appropriate interpretation of some underlying physical system can find it, and this gives it physical existence. In the cosmological many-interpretations view, all abstractions are real – and minds are abstractions of brains, just as brains are abstractions of *their* underlying components and so on.

One way of viewing this would be to say that minds and brains are separate entities, though both are physical and minds are implied by brains. In fact, this is how the cosmological many-interpretations view itself would describe things. This might seem to be *slightly* like dualism, in that brains and minds are separated, but there is an important difference: nothing philosophically special is being added to explain minds, with them instead just being physical objects like everything else in reality.

This kind of view is not how we normally think of abstraction, however. We do not tend to think of an abstraction of some system as separate from it. For example, according to the cosmological many-interpretations view, a tree exists because some interpretation can "find" it when applied to some underlying physical system. A sequence of interpretations would take us from the atoms making up a tree to the tree itself. We would not usually say that the tree is separate from the underlying system on which it is based; for example, that it is separate from the underlying atoms or tree cells. Instead, in everyday language, we would say that the tree is made up of its underlying parts; for example, that it is made up atoms or tree cells.

In the cosmological many-interpretations view, a mind is a separate object to the underlying substrate, but we should realize that this is far from giving minds any profound property. A tree would similarly be a separate object to the underlying collection of atoms on which it is based, so a mind is only a separate object to a brain, in the cosmological many-interpretations view in the same way that a tree is a separate object to the underlying collection of atoms, or a tropical storm is a separate object to the underlying individual movements of air molecules. Just as we would say, in everyday language, that a tree is made of its underlying atoms, we would say that a mind is made of the underlying components of the brain. This does not mean that it is *just* those components, any more than a tree is just the underlying atoms: both exist at a more abstract level.

When we think in everyday terms and view the mind as made up of the underlying brain components, this does not mean that the description of a mind is somehow dependent on brain physiology – that we can say that this part of the mind is this brain component and so on. The description of a mind is more abstract than the description of the underlying brain. The same kind of mind might also be made up of different kinds of underlying components. Some people may object to this saying that a mind obviously does not seem physical, in the way that a tree or a rock seems physical: we can touch a tree or rock, but a mind is a more abstract entity. Such thinking is flawed. Trees and rocks are themselves merely abstractions of the underlying reality. We would generally say that you can touch a tree or rock, but when you do that you are really touching the underlying matter. Similarly, you can touch the underlying matter of a mind by tapping your knuckles against someone's skull, and you might have some justification for saying that you just knocked your knuckles against a mind, on the basis that the individual parts of the object you have just been tapping also make up a mind. We do not tend to think like this, however, because we tend to think of minds more in terms of their interaction with the world through things like intentionality and beliefs, rather than the crude interaction of presenting a surface on which people can tap their knuckles. This is not really due to anything profound about minds, but is more about how we view things.

By way of analogy, let us consider a computer program running on some underlying computing hardware. The cosmological many-interpretations view would say that that some interpretation can "find" the program in the computing hardware, so the program is implied by the computing hardware. The computing hardware and the program are both physical objects. The kind of everyday idea that most people would have would probably be that the program is non-physical, that it is something "abstract", that it is there because of the underlying physical computing hardware. Another everyday idea that some people might have could be that the program does not have any real existence, and that it is a way of describing what the hardware is doing. The cosmological many-interpretations view, however, does not regard abstract things as different to any other things: in fact, *everything* in the cosmological many-interpretations view is an abstraction of something. To be consistent, therefore, if we are going to describe things in everyday language, we should view the program as being as "real" and "physical" as anything else: we should simply say that the instance of the computer program running here is a physical object that is made up of the underlying hardware components. We could also say that the behaviour of the program over time is a physical object made up of the underlying hardware behaviour. Some people might object to the idea that a computer program can be a physical object, but that is just prejudice about what a "physical" object is. A computer program may seem abstract to us, but it does not exist without something underlying it. It can be understood as some pattern in the underlying reality, just as a tree or rock can be understood as a pattern. The fact that a computer program seems different to us is merely due to it being a bit further removed from our normal experience and the complications involved in

interacting with it. Yes, a computer program may seem extremely abstract to us, but the hardware of a computer may seem extremely abstract to an ant: it would be a poor argument for giving the computer hardware some special ontological status – and in the cosmological many-interpretations view, *nothing* gets any special ontological status.

After all this, we can be clear about what the cosmological many-interpretations view says about the mind-body problem. Looking at things from the point of view of the cosmological many-interpretations view, rather than in everyday terms, the mind is a physical object, and the history of a mind over a period of time is also a physical object. The history of a mind over a period of time is described without any reference to an underlying substrate: it is simply a description of mental states changing over a period of time. The conscious experience of any observer over a period of time corresponds to such an object. The relationship with the "body" is explained by interpretation, which would be understood by most people as emergence. The history of a mind over a period of time is implied by the logical possibility of some interpretative algorithm finding it when applied to the underlying substrate or "body". In the cosmological many-interpretations view, implication and actual, physical existence are the same.

2.6 Weak Substrate Dependence

The weak substrate dependence discussed in the first article of this series is still in effect: in fact it was that that launched us down the path of this argument in the first place. In the first article, a thought experiment was described involving probability and computations being run on different numbers of computers, to show that the nature of the substrate on which an observer in some situation is based must affect the measure with which that observer exists. With the cosmological many-interpretations view, as with the previous many-interpretations view, this weak-substrate dependence is merely a special case of the dependency of the measure of an observer in some situation on the proportion of interpreting algorithms which can find such an observer. The measure with which a given observer is implied by some physical system will clearly depend on the complexity of an interpretation needed to "find" that kind of observer, as has been discussed, but it will also depend on other features of that system. For example, just as two similar computers would seem to allow more scope for different interpretations to find an observer than would be allowed by a single computer, *all else being equal*, an electronic computer with thicker wires allows more scope for different interpretations to be made of different parts of it to find an observer. Things like encryption are also still an issue: an observer who has made him/herself made "harder to find" in some system in some way should realize that he/she is reducing the measure with which he/she is implied by that system.

2.7 Space, Time, Causality and the Anthropic Principle

Space and time are usually regarded as part of some "fundamental framework" of reality. To many people, the idea of things existing without space or time is inconceivable. The cosmological many-interpretations view, however, does not require objects to be spatial or temporal. An object will be something that we would consider to be spatial and/or temporal if it is structured in a spatial and/or temporal way, but many objects could be described in abstract terms to which the concepts of space and time cannot be meaningfully implied. If space and time can just be features of an object, the idea of space and time as fundamental features of reality becomes an unnecessary philosophical complication, and we should assume that our own space-time is not part of any fundamental framework and is just as contingent as anyone else's: our own world is reduced to the status of just being one of the objects in the hierarchy of interpretation that makes up the multiverse.

As well as no longer being fundamental, the concepts of space and time are no longer universal. We may be able to conceive of many objects which are structured spatially and temporally, like our world, but we would be able to conceive of many more objects that are not structured in any such way, and to which it would make no sense to try to apply ideas of "space" and "time". In the cosmological many-interpretations view, space and time are reduced to provincial concepts: things that occur in some parts of reality. The same can be said for all our laws of physics: they just happen to be a feature of our local reality. If space and time are non-fundamental, then neither is causality.

If there is no requirement for an object to be structured spatially or temporally, or to have laws of physics resembling ours, the question may be asked of why our local reality is like this. The answer is provided by the weak anthropic principle. The idea of thinking is fundamentally temporal, so an observer can only exist in a world where there is time. Similarly, an observer is more likely to come into existence when there is a reasonably coherent reality, so there should be more observers where there is something like space and coherent physics. Observers like us should expect to find themselves in spatially and temporally structured worlds with coherent physics – like ours.

2.8 Alternative Statement of the Cosmological Many-Interpretations View

The cosmological many-interpretations view can be considered in two ways. So far, in this article, it has been assumed that interpretative algorithms "find" objects by constructing them, using other, underlying objects as input data. An interpretative algorithm might work in a different way: instead of "finding" an object by actually constructing it, it may just indicate that it has found an object. The two views would be very similar to each other.

3 A Justification: Emergence and Arbitrariness

Justifications for the many-interpretations view and the cosmological many-interpretations view have already been given, and more will be given in the next article. For now, however, I will give one justification of the cosmological many-interpretations view.

The cosmological many-interpretations view, in as much as it relates to objects in general, is the idea that patterns correspond to real, physical things, that a pattern is formally describable in terms of an interpretative algorithm needed to find it, and that all patterns should be admitted, regardless of how extreme the corresponding interpretation is.

Patterns are an important part of how we perceive the world. For example, suppose that you see a tree. You do not directly perceive a tree. Instead, your eyes detect the intensity of light of different wavelengths coming from different directions, obtaining something analogous with a "bitmap" image of the world, but this image has no meaning: it is merely a table of light intensities for different wavelengths. Through a staged process of interpretation, objects are found in all this data, and ultimately the idea that you are seeing a "tree" forms in your brain. What is important here, though, is that "seeing" this tree involved nothing more than finding an appropriate pattern: in principle, though the methods are messier than what has been discussed here, and undoubtedly involve a lot of complexity, this is no different to finding an object using an appropriate interpretative algorithm.

This brings us to an interesting question: how do we know that trees actually exist? Most people would probably regard this as a fairly silly question, and that is the point I am making here. Our only evidence of the existence of trees is that our brains detect an appropriate pattern, which happens to be of some significance in how it relates to other patterns that are important to us in making predictions, *but that is enough for almost everybody*. The idea that finding patterns is the same as finding objects is accepted by us, every day, without even thinking about it, when those patterns are relevant and can be found without any deep thought.

We can look at this a bit more deeply and think about what "causes" a tree to be here. If we look deeply at a tree, on the microscopic level, we will not see basic "tree atoms" which, when combined, form trees. Instead, we see basic particles of matter such as protons, neutrons and electrons which, by being arranged in the right ways, give rise to higher-level objects such as atoms, molecules, cells, and so on, with the component objects being arranged in *the right pattern* at each stage, until ultimately a tree *emerges*. This idea of emergence is quite commonsensical to us: we understand that some objects can be abstractions of other objects. If we accept emergence like this in

the case of a tree we are buying into this philosophical idea that *abstractions of things are real things*. The problem now is what to do about extreme abstractions: ones not immediately obvious to us, but which can only be described in complex ways. The commonsense view would be that such abstractions are merely figments of our imagination, but this should appear weak. The abstraction needed to "find" a tree would be just as beyond our ability to perceive it if our brains were less powerful, and imposing our own neurology on reality as a way of deciding what is and what is not should appear suspect. Likewise, a commonsense view may be that abstractions are relevant if they find things that seem to meaningfully interact with the "everyday world" but this should appear similarly anthropocentric. What constitutes the "everyday world" in the first place is defined by our situation in it and our neurological limitations, so this is again an attempt to impose our own limitations on reality. In the previous articles, arguments like this were made about interpretations that find minds, and these ideas apply to things in general: we should avoid any arbitrariness of interpretation. A consequence of this is that all interpretations should be admitted and we live in an infinite multiverse.

It should be remembered, as well, that all this did not just start from an argument about arbitrariness of interpretation, but with an argument about probability becoming incoherent when issues of observers based on different substrates are raised. Many-interpretations was proposed as a way of resolving that issue, and that issue will not go away because some people have trouble with the idea of a multiverse that is, ultimately, based on nothing else but generalizing the everyday idea of abstraction to which we already hold.

4 General Discussion

4.1 Why is there something rather than nothing?

People often claim that a god is needed to explain "why there is something instead of nothing". People who say this there seems to be claiming that a "state of nothingness" would be the natural state of existence and that some kind of special explanation is needed to explain why things are different from this "natural" state. I am not at all sure that this kind of commonsense idea is as sensible as people think it is. Why should a state of "nothingness" be preferred? Why should "nothing" need explaining any less than "something"? It may not be very sensible to ask why there is something rather than nothing, and I do not think that God contributes anything to such a discussion anyway.

Regardless of the merits of the question, the ideas that we have been discussing so far allow us to give a clear answer to it. The way that the cosmological many-interpretations view defines physical existence means that any object which can be produced by interpretation of another object or objects is regarded as physically existing in its own right, no matter how extreme the interpretation: all interpretations are admitted. A table physically exists because a particular interpretation of its constituent molecules describes a table. A mental state has physical existence because a particular interpretation of the particles in the brain, or some other thinking system, describes a mental state. There is no difference between the physical and the abstract. I pointed out earlier that the interpretation does not have to be based on very much. A complex interpretation applied to an object described by a very small amount of data could produce a complex object. This was relevant in the discussion about people saying that it was invalid to say that a particular algorithm was running in some physical system if the interpretation needed to find the algorithm was more complicated than the algorithm itself. I pointed out that such a requirement was artificial and imposed an arbitrary cut-off point. This brings us to the following question.

For some object, X, if X is going to be "found" by some interpretation of an object, Y, how much information needs to be in Y?

Y does not need to contain as much information as X: it could have a lot less than X. Even if X contains much more information than Y, all of this information can be produced from the minimal amount of information in X, if the interpretation itself is complex enough. Y may be describable by only 100 bits of information, but by applying a suitably complex interpretation to Y, we could "find" an object, X, containing 100 *billion* bits of information. Almost all the information is coming from the interpretation algorithm, rather than from Y itself. So how far can we go? Is there any minimum amount of information we need in Y to allow X to be produced from it by an interpretation, thereby meaning that the existence of Y implies the existence of X?

Suppose we went down to a single binary digit (one bit) of data as the description of Y. By applying various interpretations to it we can construct an infinity of other objects, and by applying interpretations to any one of these we can construct a further infinity of objects and so on. An object described by just a single bit of information implies an entire multiverse. Many readers will find this absurd. To such readers, I would ask again: where is the cut-off point? If we try to impose one, we are just trying to bend things towards our intuitive expectations. If all we need is a single bit of information though, that still does not explain why there is something rather than nothing. It just seems to suggest that a single bit of information implies the existence of a lot of other stuff. So, from where does this object, described by a single bit come?

If we are reducing the amount of information we need to be in an object to be interpreted, why stop at a single binary digit? If an interpretative algorithm can be applied to one binary digit of information input, it can be applied to zero binary digits of information input. Applying the interpretative algorithm to some information means that the interpretative algorithm is run with that information as an input, so applying it to nothing just means that the interpretative algorithm can be imagined as "running" without taking any input at all, and producing the "found" object: the object that it had found in nothing.[5] While it may seem strange, there is nothing in the rules of the game, as defined by the cosmological many-interpretations view, which stops us from "finding" objects in nothing by interpreting nothing. This does not just mean that it is "permissible" in some sense to "use" these algorithms: the cosmological many-interpretations view would regard them as valid interpretations that, regardless of whether anyone runs them or not, correspond to the physical existence of objects. Just as there is no obvious cut-off point which stops us from using an interpretative algorithm containing more information then is in some object to find that object, then there is no obvious cut-off point reached when we go down to one bit. The most general, consistent methodology that we can use to deal with all this would regard interpretative algorithms applied with no input at all, applied to *zero* bits of data, as being just as valid as any other interpretative algorithms.

We can now answer the (dubious) question of why is there something rather than nothing. Suppose that no physical object existed in any fundamental way, and that there was nothing except mathematical truths. Interpretative algorithms could still be applied to this "nothing". Of course they would not really be being "applied" to anything, but would rather just be describing interpretations not built on anything – ones that did not have any input. Such interpretations would describe an infinity of objects and, according to the cosmological many-interpretations view, all these objects would exist, because that is all that physical existence is. A further infinity of interpretations could be applied to any one of these objects, constructing yet another layer of objects. If physical existence means no more than being findable by an interpretative algorithm, then,

[5] Note that this does not mean that an interpretative algorithm *actually* has to run.

because an interpretative algorithm has no minimum amount of data to which it can be applied, and can therefore be applied to nothing at all, a state of nothingness is actually logically impossible because even if you start by assuming the physical existence of nothing, interpretative algorithms can be applied to it to generate an entire infinite multiverse.

Theists would obviously ask, rhetorically, who is doing the applying of the algorithms, suggesting that the many-interpretations position requires God to do it. That would be a misunderstanding of the many-interpretation position. Interpretative algorithms do not need to run on hardware. They do not have to go through somebody's mind or some kind of information processing. Nothing has to "run" or "apply" interpretative algorithms. The physical existence of an object is associated with the logical possibility of the algorithm being applied, whether anyone does it or not. There is no "causality" behind this. The interpretative algorithm does not cause an object to exist. It merely describes how the existence of one object logically implies another.

As an analogy for this, if we have one apples and another apple we would say that we have two apples. We are used to the idea that when you have the logical capability of adding one thing to another thing you have two things. There is nothing in this which demands that some observer or great adder has to come along and actually done the adding up to make the mathematics work. The physical existence of things is implied by interpretative algorithms whether anybody actually runs these algorithms or not. In a way, physical existence is just reduced to a branch of mathematics. Statements about physical existence are merely particular statements about mathematical truth. Earlier, in 3, we considered how a tree is considered to "emerge" from its constituent parts being arranged in a particular pattern, and how that pattern can be recognized by humans running an appropriate algorithm – yet hardly anyone would suggest that the algorithm needs running to make the tree real. We are used to the idea, with real emergence, that patterns can imply things without anyone needing to "run" anything – and the cosmological many-interpretations position is just a generalization of this.

There can never be "nothing", because by the process of interpretation even nothing implies something: in fact it implies an infinite amount of "somethings" – every possible something imaginable.

This is not a disproof of God. I suggest, however, that it weakens some religious arguments, by making the existence of the physical world mandatory simply from mathematics.

Some readers may note some similarity with what I am saying here and what other, more well-known people have said. The idea that physical existence is just part of mathematics is relatively common these days. You could compare what I have said with what Tegmark says (Tegmark, 1998). Tegmark suggests that all mathematical objects exist and that an object exists physically by being in the set of mathematical objects.

What I am saying is a bit different. I am saying that an object exists physically if it is mathematically implied by the physical existence of another object – and this "other object" could even be nothing at all. There is clearly some similarity in the views, and there may well be some kind of equivalence, but I will leave that issue alone for now.

We can reduce all this to two simple statements.

1. **Abstractions of things are themselves physically real.**
2. **"Nothingness" is inconceivable, because it could be abstracted and would imply *something*.**

It should be noted that *all this results from nothing more than a formalization and generalization of our existing concept of emergence*. [6]

4.2 Order Laws of Physics and Boltzmann Minds

One objection to some multiverse proposals is that, if all possible worlds exist, there is no reason why we should expect our world to be ordered: we might expect to find as many observers in disordered worlds as ordered ones, and it should therefore seem unlikely to us that we should find ourselves in an ordered world. Greg Egan has given this as a reason for him not taking the "dust" hypothesis, introduced as a plot device in his science fiction novel, *Permutation City*, seriously (Egan, 1994).

The issue of *Boltzmann brains* is also relevant here. Some cosmological models suggest that the observable universe is merely a high entropy state in a generally more chaotic system, occurring due to random fluctuations. The problem with this is that the amount of order needed to put a single observer's brain together should be much less than is needed to put together a full, ordered universe, so this should be achieved more frequently. The typical experience of an observer, then, should be that of a disembodied mind, thrown together by chance, existing as a single observer in a disordered universe. This disagrees with our experience of living in an ordered universe with other people (Linde, 2006).

The cosmological many-interpretations view is immune to this problem, because the reference class of possible worlds is not constructed by just "sticking bits of worlds together". Instead, an object exists if it can be "found" by an interpretation of some other object and, as previously discussed, the measure with which objects exist with some feature will tend to depend on the specificity of that feature – the amount of information needed to describe that feature. An interpretation which produces an observer's mental states in an arbitrary way, without any reference to underlying rules, will need to contain a lot of information: it will be very specific. Such interpretations will be extremely rare. On the other hand, an interpretation which finds a world with a

[6] as previously discussed in 3.

coherent space-time and ordered laws of physics which *imply* the formation of observers by processes such as Darwinian evolution will not need much information to describe it: we should expect such worlds to be much more common than arbitrarily found observers, and once such a world exists, many interpretations may be possible that find observers in it. Any observer should therefore consider him/herself, almost certainly, to be in a world in which his/her existence is subject to some underlying rules – where there is some underlying physics. While Boltzmann brains will exist, it is extremely unlikely that you are one.

Saibal Mitra, an astrophysicist, has considered this issue, although he approaches it in a different way to me: he looks at this more from a point of view of physics than philosophy. Nevertheless, he proposes a type 4 multiverse and seems to have reached a similar kind of conclusion about Boltzmann brains (Mitra, 2010).

Another way of looking at this is that the Boltzmann brain argument naively ignores the role of *abstraction* – of emergence – in the underlying reason for an object's existence.

4.3 Hume's Problem of Induction

The view that has been given so far can easily be used to dispose of a problem that seems to concern a lot of people – Hume's problem of induction – or at least it can be used to dispose of the most serious expression of the problem.

Hume's problem of induction is the idea that observations of past events give you no more basis for predicting the future and thinking that the future will conform to those predictions. For example, seeing the sun rise many times might lead you to think that there must be some kind of law saying that the sun is going to rise everyday, but you have no reason to think that the universe agrees with you. For all you know, the sun might stop rising tomorrow.

People often respond to this by saying that we do not need to be sure, and that past events allow us to make statistical predictions about the future with a lot of confidence. We may sometimes may able to put quantitative probabilities on these numbers, or we may often lack the ability to do such detailed calculations, but nevertheless have the qualitative idea that some future behaviour of the universe is likely. A common objection to this is that we have no philosophical grounds for any future expectations of the universe's behaviour – even statistical ones – that there is no philosophical reason at all for thinking that what has happened in the past tells us anything about the future.

Two different versions of the problem of induction are involved here, one more serious than the other. I know that there has been some discussion about what Hume really meant, but rather than worry about that, I will simply state the two versions of the problem of induction which are now raised by people.

- **The strong problem of induction** – Past events give us no philosophical justification for having any expectation at all, probabilistic or otherwise, about future events.
- **The weak problem of induction** – Past events give us no philosophical justification for having any certainty about future events, but it is admitted that we might have philosophical justification for having probabilistic expectations about future events.

I actually accept that the weak problem of induction, but I do not think that we *need* to resolve it, and that we can live with it. I do not accept that the *strong problem of induction* is really a problem. The position taken by people proposing this version of the problem of induction is unjustified, and involves a naïve, simplistic view of reality.

People often reply to the strong problem of induction by invoking statistics: the previous behaviour of reality is statistical evidence which supports expectations of what it will do in the future. Another reply involves the idea that it is simpler for the universe to behave in the same way in the future as it did in the past, so that it is simpler, for example, for gravity to continue to apply than for it not to apply. People who think that the weak problem of induction is a problem tend to reply to answers like this by saying that they still involve some assumption that reality is following some rule that requires the future to be anything like the past. In the absence of such a rule, statistics would be useless as a guide and observations of simplicity would count for nothing: reality could do anything in the next second, regardless of what it had done so far.

A good way of thinking about the strong problem of induction is that it is offering alternative possibilities for the kind of world in which we are living, which are consistent with what we have observed. Let us consider the law of gravity as an example. This seems to have applied in the past, so we might consider it to apply in the future. We tend to imagine ourselves existing in a "sensible" world, in which the law of gravity applies in the past, and it continues to apply in the future. However, we might also imagine lots of "non-sensible" worlds in which the law of gravity applied in the past, but will not apply in the future. If we think that the weak problem of induction is a problem we are effectively asking why we have any reason at all for thinking that we live in a sensible world as opposed to a non-sensible one. If we live in a non-sensible world, past statistics and appeals to simplicity would be irrelevant, because the world would not have to cooperate with such things: a non-sensible world need not behave in future in any way suggested by its past statistics and need not cooperate with any idea of simplicity. The idea seems to be that you need to assume that you are living in a sensible world to get ideas such as statistical expectation off the ground in the first place.

Thinking about things in terms of sensible and non-sensible worlds like this is helpful, because it suggests that we should be thinking about things in terms of a set, or reference class of possible worlds. Suppose we wrote down a description of every possible world that we could imagine existing, and the descriptions indicate what has

happened in the past and what will happen in the future: they are written from the perspective of some hypothetical observer, outside time, who can see all of the world's history as a single thing. Most such worlds will be ones in which we could not possibly be living: they will be inconsistent with what we experience; for example, they will not contain observers, or they will contain observers who do not remember our experiences. We need to remove all the descriptions of worlds that are not consistent with our experience. That leaves us with a collection of descriptions of worlds that are consistent with our experience, some of which will be sensible and some of which will not be sensible.

Now, if most of these worlds that are left were sensible we would have a good justification for thinking that we probably live in a sensible world: we should think that if we assume nothing more than that our world is randomly chosen from this reference class, it will probably be sensible because most of the possible worlds are sensible. There would be a prejudice in favour of sensible worlds in the way that that the reference class is constructed. Is there such a prejudice?

People who buy into the weak problem of induction must say, "No," because as soon as they say, "Yes," the weak problem of induction is gone. We can ask why such a person would think that there is no prejudice in the reference class, but the response could, quite reasonably, be that it is up to us to show that there is a prejudice in the reference class. To deal with this we need to look at how the reference class is constructed – how all these word descriptions are encoded.

An advocate of the strong problem of induction is likely to assume that the description of a world should be thought of as specifying each "bit" a world individually, so that the description says something like, "At time t, there is a particle here, a particle here, a particle here, and so on. At time t+1, there is a particle here, a particle here, a particle here, and so on." with each instant of time being specified independently – and every bit of the universe in some instant of time being specified independently. There are problems with this approach, however. We need to have some agreement about what the "bits" of the universe are. What should they be? Fundamental particles? Can we even be sure that there are fundamental particles? If we make some rule about what the little bits are supposed to be – and we need one to work like this – any future state of the universe is restricted to being some of the arrangement of those bits. For example, if we say that the description is going to be the positions of all the fundamental particles (as soon we can find some) at some instant of time, we are claiming that any future state of the universe must be some arrangement of fundamental particles: any decision we make about expressing the description as an exhaustive list of all the bits of reality in every moment is assuming a particular cosmology and assuming that this cosmology will always apply in the future. Ironically, this is assuming that reality is at least going to continue comply with this basic cosmology, that in the next instant it will still be made of the same kinds of little pieces,

because the only way it can be described is in terms of these little pieces – yet we are not supposed to know what reality is going to do next: the position defeats itself.

A further problem is how we are supposed to decide what the individual bits of reality are? Who decides that part of reality is one piece and not two or more pieces? This may seem obvious, but it is not. Suppose, for example, that two observers, in different places, observe what would normally be considered the "same" particle of matter. How do we decide that it should be considered the "same" particle of matter, and should just be listed once in some description of reality? Most people would probably say that our views of space and geometry would allow us to work out that both observers are looking at the same particle, but these views are themselves based on empirical experience – something we have to throw out if there is a strong problem of induction. To advocate the strong problem of induction, you need to be claiming the right to define how things in space are divided into little pieces, so that each can be listed separately in some description of a world – and if you cannot do that, you have no basis on which to build the reference class on which this all needs to rest. The problem does not just arise with individual particles. Even if two particles are a considerable distance apart, how do we know that they should really be considered as separate pieces of reality, and not the same thing being observed in two different ways? Your only justification for saying that there are separate objects, and not the same object in some sense, would need to be based on some kind of scientific model: the very thing that you are trying to argue is based on faith. Such a view need not just be restricted to things in space. We can apply it over time too. If we observe two events happening at different times, what is the justification for saying that they are different things, and need to be listed individually in some exhaustive description of reality? How do we know that to some observer, able to look at things from outside our time, it would not be natural to view these two events as the same object in some sense?

What I should have established here is the arbitrariness of thinking that you can divide reality, spatially and temporally, into separate objects, into little pieces, and then say that any way of putting these pieces together is as valid as any other. We should, in fact, view the reference class as containing all the possible *formally expressed descriptions* of worlds with their space-times.

If we assume that the world with its space-time should have a formal description, saying that any formally described world with its space-time that is consistent with our experience is as valid and likely as any other does not imply the same chaos and lack of predictability that previously resulted. One formal world-description may be as valid or likely as any other, but some features of a world-description will require minimal information to express and will therefore appear in a high proportion of world-descriptions: different features of the world will have different measure in the set of possibilities. Even without assuming that any single world with its space-time is more likely than any other, statistics will emerge: some features will be more likely to be

characteristics of our world than others because they occur in a higher proportion of all possible worlds. Predictability therefore emerges.

I intend to develop this argument in greater detail, and present it in a stronger form, in a later article. For now, I will point out that, while the above argument did not assume the cosmological many-interpretations view, the cosmological many-interpretations view is entirely consistent with it, and actually suggests it.

4.4 Time Travel

The idea of backward time travel is controversial. One objection to it is that it would result in causality paradoxes, leading to a description of reality that is internally inconsistent. However, answers to the issue of causality paradoxes exist. Science fiction writers use various plot devices in novels. The philosopher David Lewis has suggested that, if backward time travel is permitted, any attempt to change the past, in a way that contradicts what we already know to be true about it, will meet with failure (Lewis, 1976). If all possible worlds are realized by various interpretations does this allow time travel, and should we expect time travel in our world?

The first issue that may arise here is whether we are talking about "real" time travel or just the appearance of time travel. I suggest that the distinction is meaningless. In the cosmological many-interpretations view, everything that exists is just an abstraction of something else, so there is not really anything there beyond an appearance. A table exists, for example, because some interpretation – some abstraction – which describes it is possible, and it is meaningless to think that a *more* real table can exist somewhere: this is all that the ontology of reality will give us. Similarly, all we can say of time travel is that a particular world has the appearance of time travel happening within it to observers or it has no such appearance.

With the cosmological many-interpretations view, space and time are not fundamental, but are just features of an object – part of the pattern making up a world. We can clearly conceive of worlds in which "time-travel-like phenomena" occur: science fiction writers have been doing it for years. We should therefore assume that appropriate interpretations would find objects corresponding to worlds in which observers exist who see backward time travel occurring. All the evidence is that we do not live in such a world, but should we expect to live in one?

We can approach this first by imagining time travel without any of the clever plot devices used in science fiction to keep the story coherent. The description of the world has to be consistent, of course. The problem with this is that it is hard to imagine intelligent observers even existing, or time even making much sense. For example, my finger pressed a key on my computer keyboard at the start of this sentence. That was caused by events in my brain in the past, and further events that affected my brain, further back in the past and so on. If we allow time travel, however, the movement of

my finger could just as validly be explained in terms of something that happens next week – and such explanations would have just as much importance. Any concept of thermodynamics would break down. Issues would be caused by observers making decisions: if I know that some event in the past, which I know to have happened, can be prevented from happening by something that I can do now, what if I choose not to do it? Such a situation cannot occur, because an interpretation cannot describe something that is incoherent. Some readers may point out that I may be compelled to behave so as to avoid paradox, or that paradoxes are resolved by splitting reality, etc. These, however, would count as "clever plot devices used in science fiction to keep the story coherent" and the rules of the game, for now, are that we are not allowing these. It may be apparent, here, that we should really expect a mess for such a world, where the organization of events in time is so messy that it may be hard even to say that time exists or to distinguish past from future. Worlds with time travel, but without the clever plot devices of science fiction, would therefore not contain any observers, so we should not expect to be in one.

What then, if we allow the clever plot devices of science fiction? The world might behave in such a way that observers must act in various ways to ensure that they do not interfere with the past, or there may be some kind of "dampening" mechanism in operation. We should think, here, about *measure*. For backward time travel to be coherent, we have to add extra information to our view of reality – and if we do not have actual evidence for time travel, we are adding such information needlessly. We are making our description of the world more specific, and therefore *reducing the proportion of such worlds that exist*. Worlds would exist in which time travel is possible, and in which something ensures coherence, but the extra information needed to specify such worlds would give them much lower measure than worlds which simply lack backward time travel. As the proportion of worlds which have observers and lack backward time travel is going to be much larger than the proportion of worlds which have backward time travel and observers, we should expect to find ourselves living in a world without backward time travel.

Backward time travel, then, is possible, but almost certainly not in our world.[7]

4.5 Causality, Time and Theistic Arguments

Causality is often considered to be a universal feature of reality. This idea is used by William Lane Craig in his Kalam cosmological argument, which attempts to prove God by showing that the universe must have had a start and, therefore, a cause (Craig, 1979). The cosmological many-interpretations view, however, makes such no assumption. In the cosmological many-interpretations view, space, time and causality are not regarded as fundamental features of reality: they are merely provincial features of our part of

[7] ☹

reality. According to the cosmological many-interpretations view, therefore, arguments like the Kalam cosmological argument, in their current form, fail because they wrongly assume a universal causality.

If causality is not universal, this does not mean that an object which is uncaused must be *unexplained*. The explanation for the existence of an object is that it is implied by the logical possibility of an interpretation of another object or objects, regardless of whether any entity actually performs the interpretation. Interpretations can relate objects in many different ways, and causal relationships are only a special case of the relationships that can exist. Thinking that causality is a universal, or even important feature of reality is therefore naïve, because it is merely a special case in a vast set of possible relationships between different objects in reality.

Theistic apologists may respond by trying to extend arguments about causation into the realm of reality as seen in the cosmological many-interpretations view. For example, William Lane Craig argues that an actual infinity cannot exist, and that time therefore had a start. We might imagine an attempt to apply similar reasoning with the cosmological many-interpretations view. This would cause issues, however. The cosmological many-interpretations view requires that reality is infinite: objects exist merely due to the logical capability of finding them by interpretation, without anything being needed to run the interpreting algorithm, so there is no way of "turning off" these interpretations when they are not "running" in the first place. There is nothing to prevent reality being infinite. The cosmological many-interpretations view is therefore in direct opposition to views like Craig's that an actual infinite cannot exist.

It should also be noted that the Kalam cosmological argument in particular relies on an assumption that the A-theory of time is correct, as has been noted by Luke Muehlhauser (Muelhauser, 2010). Everything that has been said in this article about time being a property of only certain objects in an atemporal hierarchy of objects means that the cosmological many-worlds interpretation takes a B-theory view of time. This is another way in which it is incompatible with arguments like the Kalam cosmological argument.

Multiverse theories, combined with the weak anthropic principle, are sometimes used as an answer to the fine tuning argument for the existence of God. Cardinal Christoph Schönborn, of the Catholic Church, has argued that such multiverse theories have actually been devised to try to avoid the need for a creator (Schönborn, 2005). This is incorrect: multiverse theories have been suggested for various scientific and philosophical reasons well before they were used in arguments with theists, as is pointed out by Luke Muelhauser (Muelhauser, 2010). The cosmological many-interpretations view is a multiverse view that is particularly hostile to religion. God is generally proposed to answer some perceived need for a "cause" or "creator" of everything, but with time and causality reduced to the status of local, and not even fundamental, phenomena in the cosmological many-interpretations view, any reasoning like this becomes an absurd generalization from something that is merely provincial. In

the wider, atemporal reality there is nowhere for God to be in any coherent way. If we allowed God to be an object in the hierarchy, he would then just be another "thing". We might think that God somehow exists outside the hierarchy, but the concept of causation does not even extend beyond those objects in the hierarchy that happen to be describable in causal terms: it would be absurd to extend the idea of causation outside the hierarchy when it does not even mean anything for most of the things *in* the hierarchy. Furthermore, the concept of "outside" the hierarchy is meaningless. The entire hierarchy is logically required without any causing for God to do, and it has been shown in 4.1 how this even deals with the "Why is there something rather than nothing?" question. There is no coherent way for God to "cause" things in a system that is almost completely acausal, and where any causality that does exist is merely a pattern, and it is wrong to assume some universality of causal explanations in a system where such explanations are the exception rather than the rule. Even worse: causality is not merely unusual, but is in fact going to be extraordinarily rare. Proposing a God, in the many-interpretations view, is like arguing that a wallpaper pattern tells you something profound about architecture on other planets.

5 Conclusion

The cosmological many-interpretations view has been described. Previous articles in this series have discussed the many-interpretations view, which regards the minds of observers as being implied by appropriate interpretations of physical systems that "find" them. It is not necessary for any entity to perform these interpretations: rather the logical capability for them to be performed is what does the implying. All interpretations that find minds are admitted, and this results in weak substrate dependence, in which the nature of the substrate affects the measure with which an observer is implied by it, as well as what some people would regard as an extreme consequence: any mind can be found in any system, given a sufficiently extreme interpretation. It should be noted that considerations of measure apply here: the possibility of finding a mind does not, in itself, mean that the mind exists with high measure. Nevertheless, this may appear to be a strange form of panpsychism, in which every smallest piece of reality is "haunted" by every possible mind. The most awkward aspect of this is not that all these minds exist: we should go wherever a valid argument takes us. Rather, it is that minds seem to be getting a special ontological platform: they are getting this special process to find them, and they are getting to "haunt" everything. This seems too close to dualism. The cosmological many-interpretations view resolves this, not by getting rid of all these minds, or the way they are implied by interpretations, but by extending the many-interpretations approach to everything. In the cosmological many-interpretations view, any object which can be "found" by an interpretative algorithm, no matter how extreme the interpretation is, has real, physical existence. This may seem an extreme solution, but it ensures that minds are not receiving special philosophical treatment. In fact, minds and mental experiences are now reduced to the status of physical objects, found by interpretations of other physical objects.

If all interpretations are admitted, every object that can be formally described can be found by some interpretation in any piece of reality. The cosmological many-interpretations view therefore necessarily implies that we live in an infinite, type 4 multiverse, in which even the smallest piece of reality, because of the logical possibility of subjecting it to appropriate interpretations, implies the existence of entire worlds.

Although the cosmological many-interpretations view implies that all formally describable objects exist, this does not mean that all objects are equal. Objects will exist with different degrees of measure. If a relatively simple interpretation of some system – one which can be performed by a short algorithm – can find an object, then a relatively high proportion of all interpretations of that system will also find that object, because the requirements for an interpretation to do this are less specific. This means that the configuration of the underlying system will be important. For example, if a group of atoms are configured in an appropriate way, a relatively short interpretative algorithm will find a tree. Similarly, relatively simple interpretations of computers and human brains will find program states and mental states, respectively.

In the cosmological many-interpretations view, minds and mental experiences are regarded as physical objects in their own right, but this does not imply what most people would think of as dualism: minds are just regarded as objects as is anything else that can be found by an interpretation. In views like this, minds and mental states are often thought of as "embedded" in other objects. The cosmological many-interpretations view does not maintain that this is the ultimate explanation of observers' mental states. It is meaningless to talk of one object being embedded in another other than as a way of saying that the first object can be found by relatively simple interpretations of the second, and can therefore be found with relatively high measure. Ultimately, whatever we regard as the most basic form of mental experience conceivable should correspond to an object that exists in its own right, although such an object will exist due to the logical capability of it being found by appropriate interpretations of objects corresponding to things like brains or computers.

The cosmological many-interpretations view gives a final answer to the "mind-body problem", though probably not one that would satisfy everyone: a mental experience exists as an object and is implied by interpretation of an underlying substrate *just as everything else is*. We might ask why an object corresponding to mental experience should deliver real mental experience, but this will be a pointless question. All we could ever say, ultimately, is that an object exists that maps onto our mental experience, and has some kind of logical relationship with the rest of reality that explains its existence. We might discuss this in some more detailed argument, and I probably will eventually, but the philosophical trail must really end there. The issue of what objects could correspond to our mental states may seem far removed from any practical consideration, but it is relevant to determining the reference class of our possible situations, which is important with regard to any predictions that we make.

Continuity of self remains an issue in need of answers, and these answers are needed to be able to make predictions in unusual situations where continuity might be atypical. A simple view is that if an object corresponds to some basic mental experience at some instant, then any object corresponding to a basic mental experience at a later instant is a member of the reference class of "next possible experiences", regardless of the substrate on which this object is based, or where it is in the multiverse. Another view would say that this is not enough – that some interpretation is needed to "bridge the gap" somehow. Which of these two views is correct has implications for the measure involved in various possible paths of continuation. For example, if an interpretation is needed to bridge the gap, the extra complexity of an interpretation needed to describe the "transfer" in mind uploading could cause a dramatic decrease in measure, with a resulting decrease in the probability that anyone should expect to undergo such a transfer if alternative continuation pathways are available – and many people would regard ending up dead as an alternative continuation pathway that is available, though people who take ideas such as quantum suicide and quantum immortality seriously may differ.

The cosmological many-interpretations view takes a position on the nature of space-time and causality. Space and time are not regarded as part of any fundamental framework of reality, but are instead merely part of the internal "narrative" of the particular world in which we live. They are provincial, rather than universal. Causality is similarly a special case. That we live in a world which does behave like this is explained by the weak anthropic principle.

The cosmological many-interpretations view provides an explanation of why there is something rather than nothing (though it is debatable that this is a sensible question). Any abstraction of an object or objects, as described by an interpretative algorithm, corresponds to an object that actually exists, but there is no minimum requirement for the object on which the abstraction is based. That object could be an atom, an electron – or even nothing. The idea of an interpretation of nothing may seem strange, but we should realize that an interpretative algorithm is applied to some object merely by using it as a source of input data. There is no reason why we should not admit an interpretative algorithm which accepts just one bit of input data, but if we do that there is no reason why we should not admit an interpretative algorithm that does not use any inputs at all, meaning that the question of what it is being applied to has become irrelevant. If we try to impose some rule to prevent this we are making an unjustified special case. For this reason, a state of "nothingness" is logically impossible, because even in such a state, interpretative algorithms would be logically conceivable that would imply the existence of an infinite multiverse.

The cosmological many-interpretations view also deals with issues relating to Hume's problem of induction, time travel and the use of causality in theistic arguments. Hume's problem of induction is resolved when we realize that worlds which have an ordered past and yet behave chaotically will require more information to describe them than worlds which continue to behave in an ordered way, and so will exist with lower relative measure, making it less likely that we are in such a world. The issue of time travel can be answered by saying that, while backward time travel is possible in principle, and must be possible in *someone's* world, the extra complexity of the laws of physics needed to allow it to happen while causing reality to behave coherently will reduce the relative measure of any world in which this happens, making it extremely unlikely that we are in such a world. Some theistic arguments, such as the Kalam cosmological argument, make a big issue of some claimed universal rule of causality, but this issue disappears with the cosmological many-interpretations view because causality is reduced to the status of a local phenomenon, only observed by us due to anthropic reasons. Similarly, the Kalam cosmological argument requires an A-theory of time, something which does not hold in the cosmological many-interpretations view where time is not even cosmologically important.

Numerous criticisms can be made of the many-interpretations view, and by implication this extension of it, and some of these have been answered in the previous articles. Rather than spend more time answering criticisms or possible criticisms, I considered it

better to develop the argument into the cosmological many-interpretations view – which is where it was supposed to be. One brief attempt at justification has been made here: the cosmological many-interpretations view is, in essence, nothing more than a formalization and generalization of the concept of emergence that most of us accept in everyday life without thinking about it. Some further criticisms and possible criticisms will be addressed in the next article in this series.

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