The Infinite Universe and Dembski's Design Inference

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Did God create life? Or did life arise via naturalistic processes, along the lines of random mutation and natural selection as suggested by Darwin? Intelligent design proponents attempt to use William Dembski's design inference to argue that the existence of intelligent life is due to design. I will argue that the design inference is flawed, because it does not take into account the fact that the universe is spatially infinite.

The Design Inference

To determine that some events are due to design, Dembski utilizes what he calls "the Law of Small Probability": "specified events of small probability do not occur by chance" (Dembski 1998, 48). Dembski concludes instead that specified events of small probability occur by design. I will argue that this so-called law is false, thus calling into question the validity of Dembski's inferences to design.

I will start by explaining what Dembski means by "specified". His precise criterion is complicated, but the basic idea is easy to grasp. If you flip a coin a bunch of times, you'll get a certain sequence of heads and tails. For a fair coin, each particular sequence is as probable as any other sequence. But nevertheless, some sequences we would find surprising. For example, if you flipped a coin a million times, and you got heads, then tails, then heads, then tails, and so on, we would be surprised. Similarly, if you flipped a coin a million times, and got all heads, we would be surprised. The reason we would be surprised is that these sequences match a particular pattern. In Dembski's terminology, these sequences are *specified*.

Now, Dembski knows that events of small probability occur by chance. John's winning the lottery is a small probability event, and yet it can happen by random draw that John wins. Dembski would say that John's winning the lottery is not a specified event; it doesn't fit a pattern. However, Dembski would say that the existence of intelligent life is a specified event, and it's a low-probability event, hence the existence of intelligent life is due to design.

Dembski fills in the details of this characterization of specificity, but let's not bother; let's take for granted that this concept is legitimate. What I want to focus on is the notion of low probability. Is it really right to say that specified events of low probability *do not* occur by chance? Note that this is a *much* stronger claim than, for example, the claim that specified events of low probability *are unlikely* to occur by chance. How small does a probability have to be in order for a specified event with that probability to *never* occur by chance?

Dembski gives a number: the probability has to be less than 1 in 10^{150}. Specified events with higher than that probability may be able to occur by chance; specified events with lower than that probability cannot occur by chance. By looking at the reasoning that goes into generating this cutoff, we'll be able to see what's wrong with Dembski's design inference.

Dembski says that physical constraints restrict how many possible events can occur. Here is how he explains the constraints:

> within the known physical universe there are estimated to be no more than 10^{80} elementary particles. Moreover, the properties of matter are such that transitions from one physical state to another cannot occur at a rate faster than 10^{45} times per second.

> Finally, the age of the universe is about a billion times younger than 10^{25} seconds. (Dembski 1998, 209)

Dembski multiplies these three numbers together, and gets the result that "the total number of specified events throughout cosmic history cannot exceed ... 10^{150}." (p. 209)

The problem here is that Dembski's restriction to the "known" physical universe is parochial; he's only taking into account the part of the universe that we can directly observe. Interestingly, he quickly ignores this restriction. On the very next page after the quoted passage, he writes:

> "Technically, 10^{150} is the total number of state changes that all the elementary particles in the universe can undergo throughout the duration of the universe."

Look at that phrase: "all the elementary particles in the universe." What happened to the restriction "*known* universe"? Dembski is assuming that there are only 10^{80} particles in the universe. In fact, as I will now argue, the evidence actually suggests that there are an infinite number of particles in the universe.

The Infinite Universe

The evidence from physics is strongly in favor of the hypothesis that the universe is spatially infinite. This is not just my own opinion; I'm describing the mainstream view of contemporary cosmologists. I will discuss two sorts of evidence, observational and theoretical.

The observational evidence consists of various experiments all of which suggest that on a large scale space is not curved. In other words, space is not like the surface of a sphere, it's like a plane – it goes on forever. For example, as one looks further and further out in space, one is looking backwards in time, since it takes time for light (or other forms of electromagnetic radiation) to reach us. The Cosmic Microwave Background (CMB) is the part of the universe that we can measure furthest back in time. We see the CMB whichever direction in space we look; how the CMB changes as we look in different directions gives insight into the structure of space. Recent measurements of the temperature fluctuations in the CMB strongly suggest that space is flat, and hence infinite.

The most important measurements were done by the Wilkinson Microwave Anisotropy Probe (WMAP), a satellite that NASA launched into space in June 2001. In February 2003, the first set of data was released, and that strongly confirmed that the universe is spatially infinite. Specifically, before the WMAP results the universe was predicted to be spatially infinite with a 15% margin of error; WMAP has reduced that margin of error to an impressive 2%.[1]

The theoretical evidence for the universe being spatially infinite comes from inflationary cosmology, which is now the most widely accepted theory cosmologists use to describe the evolution of the universe after the big bang. Inflationary cosmology predicts that the universe is spatially infinite. (See for example Guth 2000, p. 571 or Garriga and Vilenkin 2001 for details.) There are various motivations for inflationary cosmology; it explains various features of the universe (like the large-scale-uniformity of the universe, and the density of photons in the universe) that are left unexplained given a non-inflationary picture. I'm not going to go into the details of the motivations for believing the inflation theory, in part because the issues are complicated, and in part the argument for inflation is an indirect theoretical one. The fact is that the inflationary picture is widely accepted by cosmologists, and it predicts that the universe is

[1]General information on WMAP is at http://map.gsfc.nasa.gov/m_mm.html. The 2% margin of error is cited at http://map.gsfc.nasa.gov/m_uni/uni_101shape.html.

spatially infinite. Moreover, the detailed empirical data gathered from WMAP strongly suggests that the universe is spatially infinite. I conclude that the universe is probably spatially infinite.

Unfortunately, we can only observe a part of the universe – in fact, if the universe is infinite, we can only observe an infinitesimally small part. Light does not travel infinitely fast – it only travels at about 186,000 miles per second. So the further away an object is from us, the longer light from the object takes to reach us. It follows that when we look at an object that's very far away, we're seeing the object as it was in the distant past. Since the universe is only 13.7 billion years old (according to the standard big bang theory) that automatically places a constraint on how far away the things we can see are. The objects we can see can't be further away than the distance it would take light to travel for 13.7 billion years. (This distance it takes light to travel for one year is conveniently called "a light-year". A light-year is about 5,866,000,000,000 miles.) So 13.7 billion light-years is a long way to go. Nevertheless, compared to the whole infinite universe, it's not far at all.

So, with respect to the whole universe, we're parochial – we only know about what's happening in our own little region. Nevertheless, we can make educated guesses about what's going on in the other regions. The educated guess I want to make is that things in the other parts of the universe aren't that different from how they are in our own part. The universe looks pretty much the same wherever you go within the regions we can observe, so there's no reason to think that the universe looks any different in the regions we can't observe. It follows that, just as there are stars and planets in this region of the universe, so there are stars and planets elsewhere in the universe too. Since the universe is spatially infinite, my educated guess is that there are an infinite number of stars and planets.

This educated guess follows from a principle physicists like to use: the “Copernican principle”, which holds that “we are not special”. The idea behind the principle is that we should not think of ourselves as being at a special location in the universe. The most famous application of the principle was when Edwin Hubble discovered that other galaxies were receding from us – and the further away the galaxies were, the faster they were receding. Would you conclude that we are at the center of the universe, and everything is moving away from the center? That’s compatible with the observations, but it’s not compatible with the Copernican principle. Instead, physicists (correctly) concluded that the whole universe is expanding – so no matter where you were in the universe, galaxies would appear to be receding from you.

So, based on WMAP, inflationary cosmology, and the Copernican principle, I conclude that there are an infinite number of planets in the universe. What consequences does this have for the existence of life in the universe?

Life in an Infinite Universe

Let’s start with a story.

Fred is not very good at darts. Sure, Fred can hit the dartboard every time, but other than that Fred’s aim isn’t very impressive; only about 1 in 1000 throws of his hit bullseye. But Fred likes to throw darts a lot. For example, one morning the other day Fred threw a dart 10,000 times. How many bullseyes would you guess that Fred got that morning? Well, if he gets bullseye on average of 1 in 1000 throws, and he throws 10,000 times, then you should guess that Fred got about 10 bullseyes. Similarly, if Fred throws 100,000 times, you should expect about 100 bullseyes, and if Fred throws 1,000,000 times, you should expect about 1000 bullseyes.

What if Fred throws an infinite number of times? (OK, I admit, no real person could do this, but Fred isn't a real person, he's just a character in a story. But if you nevertheless want the details regarding how Fred does this, here they are. It turns out Fred can throw darts quickly – arbitrarily quickly, in fact. His first throw takes one second, his second throw takes half a second, his third takes a quarter second, and so on. In two seconds he'll have thrown an infinite number of times.)

If Fred throws infinitely many times, he'll get infinitely many bullseyes. If this isn't obvious, then tell me how many bullseyes you think Fred will get. I'll take that number, multiply by 1000, and tell you that that's about the number of throws it would take for Fred to get the number of bullseyes you mentioned. But Fred's throwing many more times than that; Fred's throwing infinitely many times.

So I conclude that if Fred throws infinitely many times, he'll get infinitely many bullseyes. Note that this argument goes through regardless of how unlikely it is for Fred to hit bullseye – as long as that probability is not zero. Even if Fred will only hit bullseye 1 in 1,000,000,000,000 times, he'll still hit bullseye infinitely many times if he throws infinitely many times. It doesn't matter how many more zeros you tack on.

So what does this have to do with life in the universe? Well, take some planet in the universe – how likely is it that life would come to exist on that planet? For some arbitrary planet, that probability is exceedingly small. There's no good way to get an accurate number, but that hasn't stopped various scientists from trying. Some are optimistic, and say it would happen 1 in 10^{40} times. Some are less optimistic, and say it would happen 1 in $10^{100,000,000,000}$ times. (For discussion of these estimates see Shapiro 1981, 128.) The crucial point I want to make is that *it* *doesn't matter what the number is* – as long as the probability is not zero, then we should fully expect life to arise *somewhere* in the infinite universe, just as we can fully expect Fred to hit a bullseye. In fact, we can draw a much stronger conclusion. We should fully expect life to arise *an infinite number of places* in the universe – just as we can fully expect Fred, when he throws infinitely many times, to get infinitely many bullseyes.

The same sort of reasoning leads to the conclusion that we should fully expect *intelligent life* to arise an infinite number of places in the universe. Note that this holds even if it's unlikely for intelligent life to arise on a planet that has life. If you could look at a very large but finite region of space, you would see various planets with life, but comparatively few of those planets would have intelligent life. Nevertheless, within the whole universe, there are an infinite number of planets with intelligent life.

Note that there's a certain assumption of randomness that's going into my reasoning here, but I think the assumption is a completely reasonable one. To explain the assumption of randomness, let's go back to the dart example. We estimated that the probability of Fred hitting the bullseye is 1 in 1000. It doesn't follow, though that Fred is definitely going to hit the bullseye, regardless of how many throws he makes. He could throw 1,000,000 times and get unlucky and never hit the bullseye. The chances of this happening are extremely unlikely, but still, it could happen. Similarly, he could throw an infinite number of times and never hit the bullseye. This would be highly unlikely, but nevertheless it's logically possible; the world could turn out that way.

Similarly, it could turn out that, even in an infinite universe, intelligent life doesn't arise on an infinite number of planets. I have been assuming that one can treat the conditions on any particular planet as randomly chosen, just as in the dart case I was assuming that Fred's dart would land at some random place on the dartboard. But in principle it could happen that the conditions on every planet are such that they exclude life, just as it could happen that Fred's dart throws always exclude the bullseye. This isn't what we would expect to happen, but I wanted to point out that possibility, just so you get clear on how exactly my argument works.

So, here's my conclusion. Despite the fact that the existence of intelligent life on any particular planet is highly improbable, we should fully expect intelligent life to exist, in an infinite number of places in the universe. This conclusion may seem outlandish, but I'm absolutely serious. The only reason the conclusion seems outlandish is that, as an intellectual community, we haven't yet incorporated into our worldview the natural consequences of the fact that the universe is spatially infinite.

Dembski and the Infinite Universe

Once one takes into account the probabilistic resources one gets from an infinite universe, one can see that specified events of small probability *do* occur by chance. The origin of life from non-life on any particular planet is a specified event of small probability, and I'm willing to grant that the probability is smaller than 1 in 10^{150}. But it doesn't matter how small the probability is: as long as the probability is non-zero, the event would be expected to occur somewhere in the universe. (In fact, it would be expected to occur an infinite number of places in the universe.) It follows that Dembski's so-called Law of Small Probability is simply false. Thus, it follows that we can't use Dembski's design inference to conclude that the origin of life is due to design, not chance.

Dembski is dimly aware of this response to his argument. What he focuses on are people who postulate other universes as a way of getting more probabilistic resources. Moreover, he suggests that people are postulating these other universes “simply because chance requires it”. He says that “the only evidence in their favor is their ability to render chance plausible.” Well, there are two problems here. First of all, we don’t need to postulate other universes to get more probabilistic resources. We can look simply to this universe, and point out that this universe is spatially infinite. The second problem is that it’s not the case that we think this universe is spatially infinite simply because chance requires it. We think this universe is spatially infinite due to experimental results from the WMAP satellite and theoretical results from inflationary cosmology.

There’s an unpublished paper by Dembski where he takes issue with this sort of reasoning. Dembski (2003) argues that there are “no empirical grounds” for thinking that the universe is infinite. Basically, his argument is that we can only make a finite number of observations, and hence these finitely many observations are compatible with both an infinite and a finite universe. He says that the evidence can’t favor one hypothesis over the other, and hence the hypotheses are metaphysical claims, not empirical claims.

There’s a sense in which I agree with Dembski; the evidence isn’t conclusive. But that’s how science works; evidence in science is never conclusive. Dembski is being unreasonable when he says that the proposition that the universe is infinite “is not an empirical proposition”; it’s unreasonable to hold that we can’t get *any* evidence to favor one hypothesis over the other. Consider a less contentious example: the evidence isn’t conclusive for the claim that electrons exist, and the evidence never will be. But it seems unreasonable to say that the proposition that electrons exist is not an empirical proposition.

In *The Design Inference,* Dembski was embracing science. He asked the question "Are there more than 10^{80} elementary particles in the universe?" and he replied "Our current best science answers a firm No" (p. 217). But now, Dembski seems to be rejecting science: our current best science says that the universe is spatially infinite, with an infinite number of elementary particles, but Dembski doesn't like that answer. So instead he makes the questionable claim that we can't get evidence for the hypothesis that the universe is spatially infinite.

The whole point of contemporary intelligent design theories is to take science seriously, and to work within science to show that science provides evidence for the existence of God. Even though one might disagree with the conclusions of *The Design Inference*, one can admire the fact that Dembski was utilizing science in formulating his argument. It's disappointing to see that Dembski changed his tune once he recognized that science was generating results he didn't like.

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