1 Introduction

Design arguments for the existence of God begin with observations, but so do other arguments for that conclusion. What is distinctive about design arguments is that they find goal-directedness in nature; the observed facts are said to obtain because God *wanted* them to.

Design argument fall in two broad categories, corresponding to two types of observation. *Cosmic* design arguments begin with an observation about the whole universe; *local* design arguments start with an observation about planet Earth.

The most famous design argument is local. We observe that the organisms around us are well adapted to their environments, and that the features that allow organisms to survive and reproduce are often complex and delicate. By delicate I mean that an adaptive structure would be unable to perform its function if any of its parts were removed or modified. The human eye has been cited for centuries as an example. I call local arguments about the adaptedness of organisms *biological design arguments*.

A much-discussed cosmic design argument is of more recent vintage. The laws of physics contain constants whose values can be ascertained by observations. The laws are said to entail that life would be impossible if those constants had values that differed more than a little from their actual values. The conclusion is then drawn that God exists and set the values of the physical constants so that life would be possible, that being one of God's goals. This is the *fine-tuning argument* for the existence of God.

There are cosmic design arguments that do not appeal to fine-tuning; some start with the premise that the universe is governed by simple laws (Swinburne 1968). And there are local arguments that seek to explain facts that are non-biological. For example, William Whewell (1833) argued that God arranged the Earth's daily cycle of dark and light to fit the human need for rest and work, and William Buckland (1836) contended that God put coal and iron in the ground for human benefit. Their books were two of the *Bridgewater Treatises*, a series devoted to exploring the "Power, Wisdom, and Goodness of God, as manifested in the Creation" (Robson 1990).

Although design arguments start with observations and end with the conclusion that God exists, there is often an intermediate step. First the argument moves from observations to the conclusion that an intelligent designer did the deed. Then comes the inference that that intelligent designer is God. This two-step format means that a design argument can succeed in its first step but flounder in its second. For example, even if the life forms we observe were the result of intelligent design, the possibility remains that the designer in question

isn't God. Perhaps creating life from nonliving materials is something that a designer with merely human intelligence is capable of achieving. Until recently, this would have been an astonishing speculation; now the achievement seems to be just a matter of time.

Design arguments for the existence of God need to deploy some conception of what kind of being God is. I assume in what follows that if God exists, that being, by definition, intentionally created the universe. I say "intentionally" to distinguish God from a mindless Big Bang. By "universe" I mean the totality of objects, events, and processes that have spatiotemporal locations; "universe" is another name for nature. If God and nature are distinct, then God is *super*-natural (existing outside of space and time), not a part of nature at all. This means that none of the gods and goddesses of ancient Greece, who lived on Mount Olympus, was a God. Plato took that consequence in stride; he thought that immortal gods and goddesses, and mortal organisms as well, were created by a divine craftsman. Aristotle's God, however, is left out in the cold by my definition, and so is Spinoza's. Aristotle thought that the universe had no beginning; it has always existed and so it had no creator. For Aristotle, God is a pure contemplator, not a maker of things.[1] Similarly, Spinoza's God (whom he said is identical with nature) isn't a God, since his God does nothing intentionally. My working definition of "God" can be adjusted if need be; it is just a useful point of departure.[2]

Design arguments are part of *natural* theology, not *revealed* theology. They appeal to observations and theories that should be defensible without any prior religious commitment. They do not appeal to the authority of sacred texts or traditions. Design arguments are intended to obey the same rules that govern scientific arguments. The justifications they offer for thinking that God exists are supposed to be similar to the justifications that science provides for thinking that genes and electrons exist. Design arguments are miles away from the idea that religious convictions should be based on faith rather than evidence.

Different design arguments are often formulated with different competing hypotheses in mind. For example, when the biological design argument asserts that organisms have complex adaptations because God made them so, the alternative hypothesis now considered is usually the Darwinian theory of evolution by natural selection. However, when the fine-tuning argument asserts that the physical constants have their values because they were set by God, the alternative

[1] Sedley (2007) discusses the design argument in ancient Western philosophy.

[2] In Hume's 1779 *Dialogues Concerning Natural Religion*, the three protagonists define God as the cause of the universe, and they agree at the outset that God exists. My definition differs from Hume's, but, like Hume's, it leaves open whether God is omnipotent, omniscient, and perfectly benevolent.

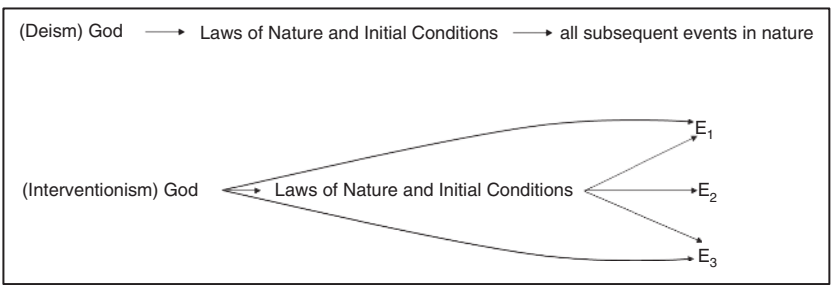

Figure 1 Deism and interventionism

hypothesis considered isn't evolutionary theory; rather, it's the hypothesis that the values of the physical constants were set by a mindless random process. Each design hypothesis competes with an alternative hypothesis that postulates a mindless process, but the two mindless processes are only superficially similar. The chance hypothesis considered in the fine-tuning argument does not invoke natural selection, mutation, or common ancestry. In addition, it's misleading to say that the results of natural selection are matters of chance (a point I discuss in Section 3).

The fine-tuning argument and the biological design argument are broadly similar. Both assume that God is well disposed to the existence of living things. The former says that God created the laws governing the universe so that organisms would be *possible*; the latter says that God contrived to make them *actual*. Yet, there are important differences between the two arguments. As noted, they consider different competing hypotheses. In addition, there are objections that apply to one of them that do not pertain to the other, or so I argue in what follows.

Another reason to separate biological design arguments from the fine-tuning argument can be seen by considering the two views of how God is related to nature that are depicted in Figure 1. The first is *deism*; it says that God creates the universe (thereby setting its initial conditions) and creates the laws of nature, and that all subsequent natural events are due to the initial conditions and the laws; God never intervenes in nature after the ball starts rolling.[3] The second view says that God creates the universe and the laws, but then sometimes intervenes in nature to influence what subsequently happens. I call this *interventionism*.[4] Interventionists don't need to assert that *everything* that happens in nature requires God's special attention. In Figure 1, event E_2

[3] The term *deism* is sometimes used to denote a rejection of revealed religion. That is not how I use the term.

[4] Theologians often use the term *intervention* to mean that God violates laws of nature. That is not how I use the term.

happens just because of the laws and initial conditions without God needing to reach in and tinker. E_1 and E_3 are different; true, the laws and the initial conditions *help* make them happen, but God lends a hand as well.

The fine-tuning argument is perfectly compatible with deism, but biological design arguments usually are not. This is because biological design arguments are usually formulated by creationists who argue that God reached into nature and created organisms. Creationists think that natural selection is incapable of producing the complex adaptive features we observe; indeed, they think that no mindless process is capable of delivering that result. Creationists reject *theistic evolutionism*, the view that Darwinian evolution is the sufficient mechanism that God chose to use so that organisms would come to have their adaptive features. Theistic evolutionism is compatible with deism, but creationism is interventionist.[5]

People who now call themselves "intelligent design theorists" do not like being called "creationists," but I sometimes do so in this Element. They bristle at that label because there are two differences between the two theories. Creationism rejects the thesis that all present life on Earth traces back to a single common ancestor, whereas intelligent design theory (Behe 1996; Dembski 1998a; Meyer 2009) is formulated so as to be neutral on that question. The second difference is that creationism asserts that God is the designer who built organisms, whereas intelligent design theory does not say who the designer is. ID theory is thus logically weaker than creationism in the technical sense that creationism entails ID, but not conversely. Although the two *theories* are different, the two groups of *theorists* are mostly on the same page. ID theorists usually reject universal common ancestry, and they usually think that God is the builder of organisms; they just don't want to put those propositions into their official theory.[6] Even though ID theory doesn't use the G-word, and this Element is about design arguments for the existence of God, the arguments made by ID theorists are relevant to the task at hand.

Deism and interventionism agree that if you look at any event in nature and trace back its causes, you will sooner or later reach the hand of God. There is no difference in this respect between the human eye and a stone found on a heath. However, this similarity between eye and stone is compatible with there being an *evidential* difference. Friends of the design argument often hold that some observations give you evidence for the existence of God while others do not.

[5] It is well known that Darwin opposed creationism; it is less widely recognized that he was a deist when he wrote *Origin of Species* (Sober 2011).

[6] For discussion of their motivation for not putting the word "God" into ID theory, see Forest and Gross (2004); for an argument that ID theory is committed to the existence of a supernatural designer, see Sober (2007b).

William Paley takes this line in his 1802 book *Natural Theology*, as do the predecessors from whom he drew and the successors who gave him undeserved credit for an argument he did not invent.[7] For them, the eye tells you something that the stone does not.[8] Friends of the fine-tuning argument are entitled to take the same stand, holding that facts about physical constants provide evidence of God's plan even though other physical facts do not.

Design arguments differ from one another by beginning with different premises, but they also sometimes differ over what they take their premises to show. Four possible conclusions might be drawn from premises that include observations:

(1) The observations prove that God exists.
(2) The observations show that God probably exists.
(3) The observations are evidence that God exists.
(4) The observations favor the hypothesis that God exists over a given alternative hypothesis.

Although (2) uses the word "probably" while (3) and (4) do not, I think the evidence mentioned in (3) and the favoring mentioned in (4) need to be understood probabilistically. This is why I provide a primer on probability in the next section. That primer helps clarify how (2), (3), and (4) are distinct. But before we get to all that, let's consider possibility (1).

Can the existence of an intelligent designer be deduced from the characteristics you observe an object to have? It can, if you add a premise:

Object *o* has characteristic *C*.
All objects with characteristic *C* are intentionally caused to have that trait by an intelligent designer.

An intelligent designer intentionally caused *o* to have *C*.

Notice that this form of argument is deductively valid, meaning that if the premises are true, the conclusion must be true.

What characteristics can plausibly be inserted into this argument form? If we let *C* be the characteristic of being well designed, and we assume that the slogan "no design without a designer" is true by definition, then the second premise is

[7] Jantzen (2014) argues that Paley copied word for word from Bernard Nieuwentyt in presenting the watch argument. Branch (2017) discusses this and other sources of Paley's.
[8] Shapiro (2009) contends that Paley intended his design argument to be compatible with deism, in that it allows there to be a proximate natural mechanism that God introduced so that adaptive contrivances would arise.

true. However, this choice makes trouble for the first premise. To avoid begging the question, design arguments need to discuss a characteristic that you can see attaches to an object without your needing to already have an opinion as to whether the object was intelligently designed. Biologists now use the term "well designed" with a more neutral meaning – that organisms have features that permit them to survive and reproduce. Biologists often take design in this sense to be evidence for the mindless process of natural selection and reject the slogan just mentioned. Biologists and other scientists often feel the same way about a similar slogan, that "there can be no laws without a law giver." They now generally think they can discuss the laws of nature without committing to the existence of an agent who put those laws into effect.

Thomas Aquinas's fifth proof of God's existence, presented in his thirteenth-century *Summa Theologica*, is deductive. He says that entities that "act for an end" and that do not have minds must have been caused to act that way by an intelligent being. For Aquinas, objects act for an end when their behavior is goal directed. Mindless plants and animals are obvious examples.[9]

Atheists, agnostics, and theists can agree that mindless organisms produce goal-directed behavior (as when sunflowers turn toward the sun), so this premise in Aquinas's argument is not in doubt. Trouble arises with the second premise. How can you tell that intelligent design is the only possible cause of what you observe? Aquinas thought that *all* mindless objects that produce goal-directed behavior must be caused to act that way by an intelligent designer, but Darwin's (1859) theory of natural selection shows that a mindless process is quite capable of yielding that result. Present-day creationists concede this point; they retreat from Aquinas's bold claim to something more modest, insisting that there is a special subclass of adaptive features that natural selection cannot produce. Sometimes they grant that mindless natural selection can produce microevolution (which includes adaptive improvements that evolve in a single enduring species), but insist that macroevolutionary novelties (the emergence of new "kinds" of organism) are beyond selection's reach (Numbers 2004). At other times, they argue that natural selection cannot produce adaptations that are "irreducibly complex" (meaning complex structures that would be unable to perform their function if any part were removed), but allow that natural selection can produce adaptations that aren't irreducibly

[9] As stated, Aquinas's argument commits a logical fallacy. The premise that each mindless object that acts for an end was created by some intelligent designer or other does not entail that there is a single designer who created all the mindless objects that act for an end. Reasoning in this way is like thinking that "everybody has a birthday" entails that there is a single day on which everybody was born. That's why I call this error *the birthday fallacy* (Sober 1990). Adding a premise can, of course, make Aquinas's argument deductively valid, and it has been argued that Aquinas had some such additional premise in mind.

complex (Behe 1996). Even if creationists were right in what they say about natural selection, that would not be enough to make the deductive argument work. The second premise in the argument displayed earlier doesn't just say that the mindless processes we now know about never produce objects that have characteristic *C*; it also says that the same is true of all the mindless processes we don't know about. Establishing that thesis is a tall order.

After describing some probability tools in the next section, I put those tools to work in Section 3 by further analyzing how design arguments differ. In Section 4, I discuss the biological design argument and the criticisms that creationists have made of evolutionary theory. In Section 5, I examine the fine-tuning argument. I don't spend much time describing the details of biological adaptations or of physical laws. This is a brief volume of philosophy, not science journalism, so broader issues about reasoning will always be at center stage.

2 A Probability Primer

Design arguments are often formulated by using the concept of probability, and even when they are not, probability is a useful tool for analyzing them. Here are the basics.

2.1 Axioms

You are about to be dealt a card from a deck. Consider the proposition that the card will be an ace of spades. Assigning a probability to that proposition requires assumptions. For example, if you assume that the deck of cards is standard and that the dealer is dealing you cards "at random," you can conclude that the probability is $\frac{1}{52}$. Change those assumptions and this probability assignment may be incorrect. To make the role of assumptions explicit, I sometimes represent the probability of proposition *H* by writing $\Pr_A(H)$, rather than $\Pr(H)$, to indicate that the probability assignment is based on the assumption that *A* is true.

Three axioms define the mathematics of probability; they are adapted from Kolmogorov (1950):

(Axiom 1) $0 \leq \Pr_A(H) \leq 1$.
(Axiom 2) $\Pr_A(H) = 1$ if *A* deductively entails *H*.
(Axiom 3) $\Pr_A(H \textit{ or } J) = \Pr_A(H) + \Pr_A(J)$ if *A* deductively entails that *H* and *J* are incompatible.

Each holds for any assumptions *A* you please. Axiom 1 indicates that probability can be understood as a mathematical function that maps propositions onto numbers between 0 and 1, inclusive. Here are three consequences of the axioms:

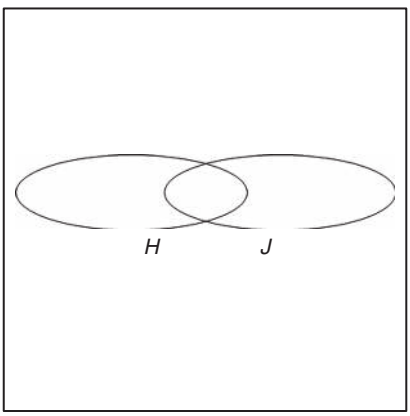

Figure 2 A Venn diagram of propositions *H* and *J*

- Tautologies have a probability of 1 and contradictions have a probability of 0.
- If propositions *H* and *J* are logically equivalent, then $Pr_A(H) = Pr_A(J)$.
- **The theorem of total probability:** $Pr_A(H) = Pr_A(H\&J) + Pr_A(H\&notJ)$.

The third consequence follows from the second and Axiom 3.

Axiom 3 describes how the probability of a disjunction is settled by the probabilities of its disjuncts if the disjuncts are incompatible. What happens if the disjuncts are compatible? You can visualize the answer by using a Venn diagram (named after John Venn, 1834–1923). Figure 2 shows a square in which each side has a length of one unit. Each point in the square represents a possible way the world might be. A proposition can be associated with a set of points in the square – the set of possible situations in which the proposition is true. The area of the square is 1, which conveniently is also the maximum value that a probability can have. Tautologies are true in all possible situations; they fill the whole unit square. The figure represents propositions *H* and *J* as two ovals. Their intersection – their area of overlap – represents the conjunction *H&J*. Since there is overlap, the two propositions are compatible; there are possible situations in which both are true. I hope the Venn diagram makes it obvious that

$$Pr(H \text{ or } J) = Pr(H) + Pr(J) - Pr(H\&J).$$

The reason for subtracting Pr(H&J) is to ensure that the area of overlap is not double-counted. When Pr(H&J) = 0, this equality reduces to the special case described in Axiom 3.

What about the probability of conjunctions? This is where the concept of **probabilistic independence** gets defined:

> Propositions *H* and *J* are probabilistically independent, according to assumptions *A*, precisely when $Pr_A(H\&J) = Pr_A(H) \times Pr_A(J)$.

If you flip a fair coin twice, the probability of getting a head on the first toss is $\frac{1}{2}$ and the probability of getting a head on the second is also $\frac{1}{2}$. The tosses are probabilistically independent, so the probability of getting heads on both tosses is $\frac{1}{4}$. The outcome of the first toss doesn't change the probability you assign to the second. That's the real world, but things might have been otherwise. Suppose you lived in a world in which there are two kinds of coin: 50% have two heads and 50% have two tails. You select a coin at random and toss it repeatedly. Under the assumptions stated, Pr_A(heads on the first toss) = Pr_A(heads on the second toss) = $\frac{1}{2}$. However, it's also true that Pr_A(heads on both the first and the second toss) = $\frac{1}{2}$. Independence fails. In this fanciful world, knowing the outcome on the first toss gives you information about the second.

Probabilistic independence and logical independence are different. Propositions *X* and *Y* are logically independent precisely when all four conjunctions of the form $\pm X\&\pm Y$ are logically possible (i.e., noncontradictory). For example, "it is raining" and "you are carrying an umbrella" are logically independent of each other. However, if you follow the advice of reliable weather forecasters, these propositions will be probabilistically dependent.

2.2 The Probability That an Improbable Event Will Happen Eventually

Assuming that the deck of cards before you is standard and that you're going to draw a card at random, the probability of your getting the ace of spades is $\frac{1}{52}$. What is the probability of getting the ace of spades at least once if you draw 100 times from the deck, each time returning the card you drew to the deck and then reshuffling? You might think that Axiom 3 (the one about disjunctions) tells you to add up 100 probabilities $(\frac{1}{52} + \frac{1}{52} + \ldots + \frac{1}{52})$, but that can't be right; this sum exceeds 1, and the first axiom tells you that no probability can do that. In fact, Axiom 3 does not lead you astray; recall that it says that the probability of a disjunction is the sum of the probabilities of the disjunctions *when the disjuncts are incompatible with each other*; that ain't so in the present problem.

To do the right calculation, you need to rethink the problem. Set the *disjunction* aside and think instead about a *conjunction*: you don't get the ace of spades on the first draw, *and* you don't get it on the second, . . ., *and* you don't get it on the 100th. Since the draws are independent, the probability of *never* getting an ace of spades in 100 tries is $(\frac{51}{52})^{100}$, which is about 0.143. Each time you multiply a probability (that is strictly between 0 and 1) times itself, the product is smaller

than the number with which you started. So the probability of getting at least one ace of spades in 100 tries is approximately $1 - 0.143 = 0.857$, which is pretty big. Improbable events have a big probability of happening if you try and try again.

This point can be put more carefully by distinguishing two propositions: (a) the single card dealt on this deal will be the ace of spades, and (b) at least one ace of spades will be dealt if you deal a single card, return it to the deck, reshuffle, and deal again, 100 times. It isn't true that (a) has a high probability if you do 100 deals. What is true is that (a) has a low probability and (b) has a high one.

2.3 Conditional Probability

Although I've said that probability assignments involve assumptions, I have yet to define the idea of *conditional* probability. I have talked about $\Pr_A(H)$, not about $\Pr_A(H \mid J)$. The latter represents the probability of H given J (where it is assumed that A is true). Take care to understand what this means. It doesn't say that J is true. The statement "if you toss the coin, then it will land heads" does not entail that you toss the coin; similarly, "$\Pr_A$(the coin lands heads | you toss the coin) $= \frac{1}{2}$" does not say that you actually toss the coin. What it means is this: *suppose* that you have tossed the coin. You then are asked how probable it is that the coin will land heads, given that supposition. The value of the conditional probability is the answer to this question.

The concept of conditional probability is related as follows to the concept of unconditional probability that our axioms define:

$$\Pr_A(H \mid J) = \frac{Pr_A(H\&J)}{Pr_A(J)}, \text{ if } \Pr_A(J) > 0.$$

The equality in this conditional is called the **ratio formula**. Since you can't divide by zero, this "definition" of conditional probability offers no advice concerning what conditional probability means when $\Pr_A(J) = 0$. I put "definition" in scare quotes because a (full) definition should provide necessary and sufficient conditions; the foregoing statement provides only the latter.

To understand why this "definition" of conditional probability makes sense, consider the ten objects described in Table 1. These objects are like pieces in a board game; some are square while others are circular, and some are green

Table 1 Each of ten objects has a color and a shape

	Green	**Blue**
Square	1	2
Circular	3	4