LEIBNIZ'S BEST WORLD CLAIM RESTRUCTURED

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What is it that breathes fire into the equations
and makes a universe for them to describe?
—Stephen Hawking 1998, p. 190

1. LEIBNIZ'S CLAIMS

Almost uniquely among philosophers, Gottfried Leibniz tried to reason from God's nature to a description of the physical world. He began by observing that the world could have only "one source, because of the interconnection among all . . . things" (*1989,* p. 152). This source must be God, who would select only the best of worlds: "If only we could sufficiently understand the order of the universe, we should find that it surpasses all the desires of the wisest, and that it is impossible to make it better than it is" (1991, § 90, p. 29). Leibniz's rationale was clear: "This is the cause of the existence of the best: that his wisdom makes it known to God, his goodness makes him choose it, and his power lets him produce it" (*1991,* § 55, p. 24).

Many philosophers have found this reasoning sound.[1] In fact, some see it as a reductio ad absurdum of divine perfection (Flew 1989, p. 240). To avoid the reductio, theists invent objections like this one: no world can be "the best" because, regardless of which world God would create, another could be better. "Perhaps for any world you mention, replete with [presumably happy] dancing girls and deliriously happy sentient creatures, there is an even better world, containing even more dancing girls and deliriously happy sentient creatures" (Plantinga 1974, p. 61). According to this *impossibility objection*, no best world is logically possible; we should therefore not be surprised that ours seems improvable.

If a world's merit depended on its embodying the largest possible amount of some single desideratum, the impossibility objection might well be valid. Since there is no highest number, it seems that God could always add more of any single, desirable quality.[2] If the best world had to have the largest number of sentient creatures, the maximum quantum of virtue or happiness, or the most dancing girls, no best world would be possible. However, the impossibility objection loses logical force if, to be best, a world had to have the optimal combination of two or more desiderata—e.g., happiness *and* virtue—or was otherwise constrained by multiple criteria. If more of one desirable quality means less of another, or if they limit one another in other ways (i.e., if they are countervailing), then some unique combination could be the best (see Strickland 2005a).

In real world optimization problems—e.g., those involving aircraft speed, cost, and payload—countervailing factors relate to each another in very complicated ways. A

review of many such problems points to the following conclusion: if we want to find the optimal combination of two or more desiderata (e.g., speed and payload), we need to consider both how these criteria interrelate (e.g., payload loss per increment of speed) and the goal of combining them (e.g., are we building a crop duster or a passenger jet?).[3]

Leibniz thought of world optimality in abstract terms. He wrote that "the most perfect world is the one which is at the same time the simplest in hypotheses and the richest in phenomena, as might be a line in geometry whose construction is easy and whose properties and effects are extremely remarkable and widespread" (1989, p. 39). Elsewhere, he wrote that God "has chosen the best possible plan in producing the universe, a plan which combines the greatest variety together with the greatest order . . . with the greatest effect produced by the simplest means" (1991, p. 195). Nicholas Rescher calls this Leibniz's "two-factor assessment of perfection" (2003, p. 27); it involves both richness of *phenomena* (events/modes of being) as an end and simplicity of *hypotheses* (physical laws/initial conditions) as a means.[4] In Rescher's view, Leibniz held ends and means to be equally important: "For the wisest mind so acts as far as is possible that the means are also ends of a sort, i.e., are desirable not only on account of what they do, but on account of what they are" (*Leibniz* 1985, § 208, p. 257). God would choose the optimal combination.

Unlike "soft" criteria such as goodness or happiness, each component of Leibnizian optimality (simple hypotheses and rich phenomena) has a mathematically definite meaning. This is critical because only combinations of mathematically definite quantities are optimizable without regard to subjective judgment.

We turn first to *hypotheses*, the "means" or "devices" that generate and govern a world. These include both a world's initial condition (e.g., our world's state at the big bang) and its rules of change (e.g., our world's laws of physics). Read one way, the term "simplest in hypotheses" might refer to the single, simplest combination of these two components. However, there may be reasons for focusing instead on rules and initial conditions separately. For one thing, Leibniz seems to have thought of rules and initial conditions in distinctive ways.[5] For another, rules and initial conditions may each need to be simple for a different reason and therefore to a different degree. Whether we consider rules and initial conditions separately or together, the simplest hypotheses will be the ones that we can specify or calculate using the shortest computer program. These will have the lowest *Kolmogorov complexity* or *algorithmic information content*.[6]

Leibniz did not see richness of phenomena, or "quantity of reality," in the mere bulk or mass of a world's phenomena, but rather in the diversity and complexity of physical forms or modes of being (*1973*, p.146).

> Perfection is not to be located in matter alone, that is, in something filling time and space, whose quantity would in any way have been the same; rather, it is to be located in [quantity of] form or variety. So it follows that matter is not everywhere alike, but is rendered dissimilar by its forms; otherwise it would not obtain as much variety as it can (*1973*, p. 146)

Today, we would say that Leibniz saw richness in informational terms. Physicists Julian Barbour and Lee Smolin have tried to capture Leibnizian richness in a metric they call *the variety of the system* (Barbour and Smolin 1992; Barbour 2003). Barbour-Smolin variety "is a non-local and non-additive quantity, which can only be applied to [a] system as a whole. It measures, in a certain sense, how unique, one from another, the different parts of the system are" (Barbour and Smolin, p. 3). It "distinguishes highly structured, but asymmetric, configurations such as one finds in biological systems from both random configurations and [ordered] configurations such as crystals"

(Barbour and Smolin, p. 1). The biological configurations are higher in variety.

The variety of a system also increases if the total number of "atoms" (lowest-level constituents) in the system increases. Imagine three cities: In City A, the houses stand in irregular clusters on narrow, winding streets; we do not, on average, need to place many houses on a map to identify or specify a unique neighborhood. City B has the same number of houses but arranged uniformly, on straight streets with square intersections. Here each neighborhood map would need to include more houses to be unique. Finally, City C looks like City A, but with far more houses. Taking houses as the "atoms" of these systems, City A would be higher in variety than City B, while City C would be higher than A or B. "A universe with a great deal of variety is one in which it is easy to tell where you are just by looking around," says Lee Smolin (1997, p. 220). It also includes many unique places to visit.

While variety measures the number and arrangement of atoms, it does not reflect their interaction. The static variety of a large pile of dead computers might exceed that of a patch of forest. To capture the forest's dynamic interactivity we can turn to *variety over time* (Lane 2006, pp. 268–269). To transform variety into variety over time, we can take an equal number of instantaneous "snapshots" of each system. We then combine each set of snapshots into a separate "mosaic" and calculate the variety of each mosaic. This gives us the variety over time of each system. Since only complex, dynamic processes can produce the constant change needed to make each neighborhood map differ from maps of the same neighborhood elsewhere in the mosaic, this procedure captures system interactivity and emergent behaviors as well as static complexity. A junkyard will either remain unchanged or else disintegrate to a static state. In a forest, on the other hand, "endless forms most beautiful and most wonderful

have been, and are being evolved" (Darwin 1993, p. 649).

We can say that Leibnizian optimality is the optimal combination of simple hypotheses and rich phenomena as measured by these or some other appropriate metrics.[7] However, which combination is optimal? Should we add the richness of a world's phenomena to the simplicity of its hypotheses and seek the highest total? Should we divide richness by simplicity and seek the highest quotient? Or should we combine these factors in some other, more complicated way?[8] Should we treat all hypotheses the same in our calculation of optimality, or should we treat the world's initial conditions and its rules (laws of physics) separately?

2. Tightening Leibniz's Claims

At first, these subtle and specific questions seem less significant than the remarkable extent to which our actual world comports with Leibniz's simplest-richest claim. Many modern scientists have marveled at the extreme simplicity of our physical laws and initial conditions and the vast phenomenal richness that they engender.[9] One of these, physicist Paul Davies, says we enjoy "very special laws that guarantee a trend toward greater richness, diversity and complexity through spontaneous self-organization" (2004, p. 106). Davies states that our "laws of physics produce order—the order of simplicity—at the micro, reductionist level, while the felicitous interplay of chance and necessity leads to the emergence of *a different sort of order*—the order of complexity—at the macro, holistic level" (2004, p. 105). He also notes that the big bang was "a state of exceptionally high symmetry. Indeed, the initial state of the universe could well have been the simplest possible" (1984, p. 8). All of this leads him to suggest that "in a certain scientific sense we may well live in the best of all possible worlds" (2004, p. 104). While these remarks and similar comments by others suggest that

Leibniz was on the right track, they also point out the reason for tightening his claims. To be scientific, a claim must be testable; to be testable, it must be specific. Because Leibniz's simplest-richest claim involves optimizing design parameters, we need to answer two questions to make it more specific: How do those parameters interrelate? How do they relate to whatever goals or objectives the world might serve? The second question points to a third: Might simplicity and richness emerge from other, deeper desiderata?

a. The Interrelation of Simplicity and Richness

Physicist Max Tegmark has considered how the simplicity of a world's rules (which he gives as the number of "axioms" in a world's laws of physics) might affect the richness of the phenomena that those rules generate (which he gives as the world's "complexity"). Figure 1, taken from his article, gives his view of this relationship (1998, p. 7).

The wavy, ascending line on the left side of the graph shows that, up to a certain point, more complex rules ("axioms") would generate richer phenomena ("complexity"). Eventually, however, the ascending line reaches a peak. Adding more axioms after this point would cause richness to decline. Beyond this point, overly complicated rules would trip over each other, with new exceptions
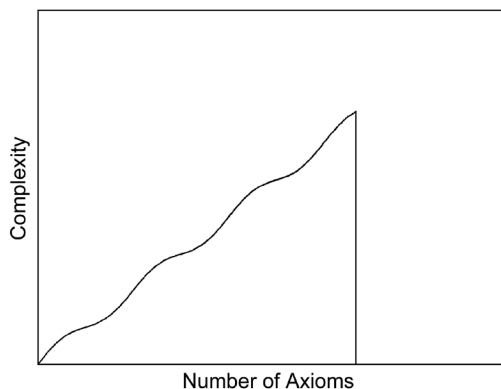

Figure 1. Relationship between axioms and complexity.

and constraints wiping out more phenomenal richness than they create. To envision how this might happen, imagine a legal system becoming so complicated that the economy it governs slides into gridlock. Tegmark's view of the relation between rule complexity and phenomenal richness finds support in recent empirical studies of cellular automata.[10]

Leibniz reached a similar conclusion: "God makes the most things he can, and what obliges him to seek simple laws is precisely the necessity to find a place for as many things as can be put together" (Strickland 2006, p. 75).[11] This does not mean that God would choose the absolutely *simplest* laws. There is a point beyond which simpler rules would generate less phenomenal richness or even no phenomena at all. We can see this in Figure 1, where both the complexity of a world's laws and its resulting phenomenal richness fall to their minima at the left edge of the graph. Instead, Leibniz was making the less obvious point that, like overly simple laws, overly complex laws could also reduce a world's complexity and diversity. He was the first to see that simplicity and richness could be both complementary and countervailing.

If Figure 1 is a roughly correct depiction of the relation between the simplicity of a world's laws and the richness of its phenomena, then only solutions to the left of the peak will be relevant to a search for the optimal combination of simple laws and rich phenomena. Even if richness does not decline after the peak as abruptly as Figure 1 shows, some solution on the left side of the graph would always dominate any solution on the right. This is because some solution on the left slope would always have at least the same richness as the competing solution on the right, but would obtain that richness more simply.

Figure 1 therefore leads to two observations: (i) for a system's rules, the range of nondominated candidate solutions to the simplicity-richness problem appears to be

finite, and (ii) *over this range*, greater richness of phenomena requires rules that are more complex. If these observations are true, then, over the relevant range, simplicity of rules and richness of phenomena *could* be jointly optimizable at some unique point. However, these observations neither specify the point of optimality nor preclude the possibility that many different solutions might be equally optimal. No point on the upward slope of Figure 1 seems special except the peak, but that is just the point at which richness is greatest. We have no reason (yet) to believe that it is also the point at which the trade-off between the simplicity of a world's rules and the richness of its phenomena is optimal.

What about the relation between the simplicity-complexity of a world's initial conditions and the richness of its phenomena? At present, we have little empirical data on which to base *any* claim about this.[12] However, we will argue later that this relationship, whatever it is, has little practical impact. A different consideration will govern the initial condition of the actual world.

b. The Value Problem

Thus far, we have no real basis for describing Leibniz's best of worlds. To find one, we need to uncover the purpose or goal that Leibniz thought this world would maximally achieve. If we assume with him that the world is God-created, we can find that purpose only by answering questions like these: Why would God make qualities like simplicity and richness the world's design criteria? What deeper value or values would require a world in which such abstract considerations play a leading role? These questions state the *value problem* posed by Leibniz's claims. They go to God's motive for creation.

The value problem is vital from two perspectives. One of these is *religious*. Unless the world's design criteria arise from a motive that seems worthy of God, even the knowledge that we live in a mathematically

optimal world would carry little theological meaning. Solving the value problem is also vital from an *engineering* perspective. Making simplicity and richness the design parameters for the universe is much like making speed and payload design parameters for an airplane. A designer might optimize either set of parameters in any number of ways. Just as an aircraft designer cannot know how to optimize cost, speed, and payload unless he knows *why* the proposed airplane is to exist, we cannot say how the optimal world should combine simplicity and richness unless we understand why it is to exist.

Leibniz addressed the value problem in at least two ways. His first approach honored the life of the mind. Intelligent minds can only contemplate ideas that have some basis in physical reality. The reality that minds inhabit therefore limits and guides their thoughts. From this perspective, the best world would offer the largest possible array of suggestive images and possibilities to the minds that inhabit it, but would present these images in an orderly way. Since it would contain as much as could compossibly exist, it would extend the possibility of thought as much as possible. Because it would operate on simple principles, its operations would be accessible to reason. It would therefore be a "cosmos, full of ornament . . . made in such a way that it gives the greatest possible pleasure to an intelligent being" (1973, p. 146). "Delight or pleasure is the perception of harmony. . . . Harmony is diversity compensated by identity. . . . Variety delights, but only when it is reduced to a unity, symmetrical, connected. Agreement delights, but only when it is new, surprising, unexpected" (Rutherford 1995, p. 13). These arguments from delight suggest the human value of a high-variety universe that changes according to simple laws. Leibniz thought that the optimal combination of simple hypotheses and rich (variegated) phenomena would make the world "not only the most wonderful machine, but also in regard to

minds . . . the best commonwealth, by whose means there is bestowed on minds the greatest possible amount of felicity or joyfulness" (1973, p. 141).[13] We can call this Leibniz's *minds solution* to the value problem.

Although Leibniz sometimes wrote as if intelligent minds were God's only concern, he more often said that minds were *not* the only or final reasons for God's selection of the simplest-richest cosmos: "God has more than one purpose in his projects. The felicity of all rational creatures is one of the aims he has in view, but it is not his whole aim, nor even his final aim" (*1985,* § 119, p. 189). God's further, "final aim" involves the intrinsic goodness of actualized reality:

> One may say that as soon as God has decreed to create something there is a struggle between all the possibles, all of them laying claim to existence, and that those which, being united, produce [the] most reality, most perfection, most significance carry the day. [However,] all this struggle can . . . only be a conflict of reasons in the most perfect understanding, which cannot fail to act in the most perfect way, and consequently to choose the best (1985, § 201, p. 253).

This *plenitude solution* rests on the notion that existence is good per se. This idea was hardly original with Leibniz. In the *Timaeus*, Plato connected goodness with fecundity. Then, "throughout medieval theology the love of God tends to be thought of in metaphysical rather than personal terms. It is not so much the love of the personal Infinite for finite persons, as the inexhaustible creative divine fecundity, expressed in the granting of being to a dependent universe with its innumerable grades of creatures" (Hick 1966 , p.77).[14] Leibniz's distinctiveness was in his emphasis on the abstract, potentially measurable quality of "variety" or "richness" as the measure of God's fecundity. He was the first to suggest that some measure of the uniqueness, number, and variability of all individual things rather than the metaphysical completeness of a list of actualized ideas would best measure God's creative goodness.

Neither the minds solution nor the plenitude solution seems wholly persuasive today. Mathematician Ivar Ekeland crystallizes a common reaction to Leibniz's minds solution: "Leibniz belongs to this category of philosophers who claim that happiness lies in contemplating the wonders of God in his creation, an idea that is certainly far away from the everyday concerns of most human beings" (2007, p. 42). This "far away" quality makes the minds solution, for many, an inadequate answer to the problem of human suffering. The victim of a chronic illness is unlikely to feel wonder and joyfulness at the subtle complexity of her pathogen. The claim that the world exists to benefit minds also sounds narrowly anthropocentric. As far as we now know, we are the only minds who benefit in the ways that Leibniz describes. To say that the world exists for "minds" sounds much like saying it exists for us.[15]

The plenitude solution faces different problems. For one thing, it seems to require God to create *everything*. As Spinoza pointed out, "God's omnipotence has been actual from all eternity and will remain in the same actuality to eternity" (1994, I P17, p. 14). This being the case, "infinitely many things in infinitely many modes—that is, all things—have necessarily flowed, or always flow by the same necessity and in the same way as from the nature of a triangle it follows . . . that the sum of its three angles is equal to two right angles" (1994, I P17, p. 14).[16] The leading historian of plenitude agrees: "If a literal realization of all genuine possibles is essential to a reasonable world, everything and everybody should have existed, and every event should have occurred, from all eternity" (Lovejoy 1964, p. 155). This sort of *plenary* world, in which every possible event, series of events, and set of physical laws already exists somewhere (call it an *omniverse*), was not what Leibniz would call optimal. He said it "would oblit-

erate all the beauty of the universe and all choice" (*1970*, p. 263).

To preserve divine choice, Leibniz tried to exclude the coexistence of everything as a logically possible option. He partially succeeded. By making certain ontological assumptions, he was able to show that all self-consistent phenomena could not coexist in a single spacetime manifold, or even in a single set of intercommunicating manifolds (Rescher 2003, pp. 92–105). In modern parlance, his ontology let him rule out the possibility that a *multi-domain universe*—a single world whose many regions are locally causally interconnected—could be an omniverse.[17] However, this was not enough, for he knew of a different arrangement that *would* allow an infinite number of worlds to coexist: "There could exist an infinity of other spaces and worlds entirely different [from ours]. They would have no distance from us [nor other special relations to us] if the minds inhabiting them had sensations not related to ours" (Rescher 2003, p. 95).[18] In short, there could be a *multiverse*, a state of things consisting of many separate worlds, none of them locally causally connected to any of the others.[19] Leibniz did not believe in an actual, infinite multiverse, but he could not logically exclude the possibility that the omniverse might exist in that form.

More than that, the value structure of his plenitude solution could not rule out an omniverse. To see why, consider two objections that Leibniz might raise against the claim—whether based on God's goodness or just on God's infinitude—that God should and would actualize the omniverse. First, he might argue that an endless number of diverse, causally separate universes would offend the desideratum of simplicity. An infinite, plenary multiverse certainly seems like an overly complicated structure. However, there are two problems with this objection:

First, it requires Leibniz to show *why* simplicity is independently desirable. Yet in the context of the plenitude solution, it seems that simple laws have only an instrumental function: their role is to generate maximal richness. As Leibniz put it, "[W]hat obliges [God] to seek simple laws is precisely the necessity to find a place for as many things as can be put together" (Strickland 2006, p. 75).[20] If that is their only function, then simple laws cannot be an independent desideratum. If simplicity is only an instrumental value, it cannot constrain God from including ever more phenomena, even if those phenomena would complicate the world's rules.

Second, an opponent could reply that the omniverse *is* maximally simple. In support of that position, Tegmark argues that, "an entire ensemble is often much simpler than one of its members" (1998, p. 25). From the standpoint of its Kolmogorov complexity, the set of all integers is simpler than the set of integers from 2 through 36. It takes a shorter computer program to specify the infinitely larger set. Like the command, "Print all the integers," the command, "Create everything" looks to be maximally simple.

As a second values-based objection, Leibniz might maintain that some self-consistent worlds contain inordinate amounts of creaturely pain and suffering. Since these superpainful worlds do not deserve actualization, God would not actualize every possible world.[21] This argument has force, but it rests on a consideration that is not part of the plenitude solution. It makes God balance what, from our perspective, are incommensurable factors: how much reality should exist versus how much suffering? This is really a third solution to the value problem: a *balancing solution*. Leibniz may have had something like that in mind when he rejected Spinoza's omniverse. He certainly believed that God could perform calculations of value far beyond our mental powers. However, because the qualities that God would need to balance are incommensurable from our perspective, this solution cannot help with the engineer-

ing problem. It cannot make Leibniz's claim specific and testable.

Nor is the balancing solution satisfying in principle. It suggests that God would create a world that was suboptimal both from a plenitude standpoint and from the standpoint of its effect on minds just because it would be the best available compromise. Yet why should we settle for a compromise until we have ruled out the possibility that some world might be best from both standpoints, properly understood?

The solutions considered so far do not persuasively connect Leibniz's claims to our understanding of God. Nor do they tell us how simplicity and richness ought to combine in the optimal world. From both the religious and engineering perspectives, we need a new approach to the value problem.

3. A New Approach

We cannot say what trade-off among speed, payload, and other factors should characterize an airplane unless we know its mission. However, given an existent airplane, we could write down the combination of design requirements that it would need for some specified mission and then test to see if it had that combination of qualities. If the fit were excellent, we might reasonably conclude that its designers had intended it for that mission. If we take this approach, our initial hunch about the airplane's purpose need not derive from anything except personal belief. As with any scientific hypothesis, it "may initially be put forward for aesthetic or metaphysical reasons, but the real test is whether it makes predictions that agree with observation" (Hawking 1998, pp. 141–142). We can follow this same approach with our existent universe.

If, as Leibniz thought, our world began with God, then its mission or purpose must flow out of the value (or values) that motivated God to actualize it. Since that value must reflect God's nature, we should be able to frame

a testable claim about the world's physical structure by considering God's nature. This is just what Leibniz thought. He said, "It is sanctifying philosophy to make its streams flow from the fountain of God's attributes. Far from excluding final causes and the consideration of a being acting with wisdom, it is from there that everything must be deduced in physics"(*2006*, pp. 131–132).

Any serious reflection on God's nature must consider this profound comment from the philosopher Nikolai Berdyaev:

> Can God be said to have no inner life, no emotional and affective states? The static conception of God as *actus purus* . . . is a philosophical, Aristotelian, and not a biblical conception. The God of the Bible, the God of the revelation, is by no means an *actus purus*: He has affective and emotional states, dramatic developments in His inner life, inward movement—but all this is revealed exoterically. It is extraordinary how limited is the human conception of God. Men are afraid to ascribe to Him inner conflict and tragedy characteristic of all life, the longing for His "other," for the birth of man, but have no hesitation in ascribing to Him anger, jealousy, vengeance and other affective states which, in man, are regarded as reprehensible. . . . We can only think of God symbolically and mythologically. And a symbolic psychology of God is possible—not in relation to the Divine Nothing of negative theology, but in relation to God-the-Creator of positive theology (1937, pp. 37–38).

Berdyaev says that God is beyond human understanding; he accepts the *via negativa*. He observes, however, that all religious thought analogizes from the human to the divine, and does so mythologically. He then says (but only from this limited, *via positiva*, viewpoint) that God must act out of some desire, some motive akin to a human emotion.

Leibniz made "goodness" God's motive for creation. However, goodness is not an emotion; it is a *mono-polar* virtue. It involves giving but not sensing or suffering. A God who acts only out of goodness may act self-

lessly on behalf of others, but the actions of those others and the events that befall them will have no consequent impact on God. For Berdyaev, this is an inadequate portrait of God's inner life. It ignores God's "inner conflict and tragedy," God's mythological joy and tears on behalf of "His 'other.'" If God is *both* actor and emotionally acted upon, then God's motive for creation must involve the desire to sense the experiences of others as well as the desire to give to them; it must involve an emotion, not a bare ethical principle.

For a Christian, God *is* love (I John 4:16). Meister Eckhart explained that "all of the commandments of God proceed from love and from the goodness of his nature, for if they did not come from love then they could not be the commandments of God" (1994, p. 119).Yet love is action and reaction. It is *doing for* others, but also involving oneself with them, *being and experiencing with* them. Paul wrote to the church at Corinth, "May the [*charis*] of the Lord Jesus Christ and the [*agape*] of God and the [*koinonia*] of the Holy Spirit be with you all" (II Corinthians 13:14). *Charis* means favor, grace, or loving-kindness; *koinonia* means solidarity, participation, "joining with" or fellow feeling; *agape* means selfless sacrifice. All of these are aspects of that single, unitary quality that we can, if only by analogy, call divine love.

Leibniz wrote of human love in a similar vein: In love, he said, "the happiness or the perfection of others, in giving us pleasure, immediately forms part of our own happiness" (*2006*, p. 163). Elsewhere, he described love as "that act or active state of the soul which makes us find our pleasure in the happiness or satisfaction of others" (Rutherford 1995, p. 56). He also said that "to love truly and in a disinterested manner is nothing else than to be led to find pleasure in the perfection or in the happiness of the object, and consequently to experience grief in what is contrary to these perfections" (Rutherford

1995, p. 57. In these passages, Leibniz sees love as both a doing for others (an "active state of the soul") *and* an experience of participating with others (a "pleasure" or "grief"). In the latter mode, the happiness and perfection (or unhappiness and imperfection) of our beloveds "immediately forms part of our own."

In theology, Leibniz more often accepted a mono-polar view of God. In this view—which had then been standard for a millennium—God is an impassible actor, never enjoying or suffering from events in the world. However, on at least one occasion, he admitted that—"so to speak" or "to speak humanly"—God might experience joy or sorrow at worldly events (Riley 1996, pp. 153–154. This view has come into greater favor recently. The monopolar view of an impassible God has been seen as severely limited, while the view that God is *both* an emotionally driven actor and emotionally acted upon is more satisfying, both logically and religiously.[22] *Dipolar* divine love would urge God *to benefit others*, to act on their behalf, but it would also draw God *to be with those others* in their perfection or happiness (or the opposites). Dipolar love would lead God to share fully in created events. The desire to be with one's beloved is central to human love; we have no reason to imagine that divine love does not in some sense share this desire.

4. A Thought Experiment

To see how divine love might affect God's choice of design parameters, we can perform a thought experiment. Imagine the God of ethical theism, infinite in all qualities but alone at Creation. Imagine God, motivated by infinite love yet constrained by the principle of noncontradiction. This principle not only precludes God from doing inconsistent things, like creating systems that defy logical consistency. It also precludes God from acting inconsistently with the divine nature.[23]

Our only guides to that nature are theology and religious tradition. These compel us to regard three aspects of God's nature as so fundamental that God would not act inconsistently with them: God is real; God is one; God can never perish.[24] Given these suppositions, what would the God of love actualize, and how would that occur?

a. Love and Fecundity

We begin with love in the sense of conferring benefits on others. "Before" creation, God was the only reality; there was nothing existent for God to love. The only available objects of God's love were possibilities: every self-consistent event or thing that might exist in any circumstance. Loving all, God would wish to benefit, and hence to actualize, as widely as possible.

In our common experience, love gives what it has to those it seeks to benefit. A person who loves and has money will give money; a person who loves and has time will give time. God has existence and the power to actualize possibilities. Motivated by infinite *agape*, God would wish to actualize as much as possible. It would be self-contradictory for infinite *agape*, armed with the power to act, *not* to act on as wide a scale as possible (see Kretzmann 1997, pp. 223–224). The thirteenth-century philosopher Muhyiddin 'Ibn al-Árabi wrote, "The lover loves to bring the nonexistent thing into existence." In short, the *doing for* aspect of love implies a universal, Platonic fecundity.

This claim differs from the scholastic account. Aquinas wrote, "God loves all existing things. For all existing things, *insofar as they exist*, are good" (PI, Q20, A2; emphasis added). This implies that the *unactualized* possibilities are not so good, or perhaps that God does not love them.[25] However, on what rational basis should we believe that Mars with two moons is good, but Mars with three moons would not have been good, or that Queen Elizabeth was good but a Queen Lydia

would not have been good? There appears to be none.

Leibniz said that God would only actualize the "best" set of possibilities, but he predicated that claim on the impossibility of actualizing all the possibles in a single, causally interconnected world.[26] However, we are not yet considering what God could actualize; we are only asking what God would *wish* to actualize considering only the *agape* aspect of love. The only coherent answer to that question would seem to be, "All."

b. Love and Becoming

An all-loving, personal God would desire closeness to the beloveds, would want to experience them directly. The degree of closeness that human love desires depends on its intensity. A lover who loves with infinite intensity would desire infinite closeness. In mathematics, when two points are infinitely close there is no difference between them. God's desire for infinite closeness would incline God to actualize possibilities by becoming them.

Theism casts God as a very close *observer*. However, no outside observer can be infinitely close to you or to any other actualized possibility. No observer, however close, can experience your experiences, think your thoughts, or feel your emotions exactly as you do.[27] No omniscient observer can fear the unknown as an ignorant creature can; no eternal, indestructible observer can fear destruction as one that stands in danger of it can. It seems that God could be infinitely close to actualized phenomena only by becoming them. Only in this way could God experience *everything* they experience—their births, deaths, and dissipations, their victories and defeats—just as they do.

The idea of divine becoming has theological advantages. It avoids the deistic claim that God creates the world and then leaves it to its own devices. Yet it also avoids the sort of theism where God reaches into the world on behalf of some individuals but abandons

others to their fates. If we envision God becoming the world, God could truly say to us, "Whatever you do for one of the least of these brothers of mine, you do also for me" (Matthew 25:40).

In the Christian tradition, the divine becoming of the Incarnation reveals God's infinite love. Theologian Charlene Burns argues that God's Incarnation in Christ was not a unique, one-off event; instead, it revealed how God's love fills the whole world (2002, p. 136). Revelation aside, divine becoming comports with our empirical experience. We only ever experience becoming; we never experience changeless things or things created from no-thing. Louise Young writes that, in the actual world, "Becoming stands forth as the essential reality" (1986, p. 96).

If divine becoming were complete, God's *kenosis*—God's self-emptying for the sake of love—would be total. In this *pandeistic* view, nothing of God would remain separate and apart from whatever God would become.[28] Any separate, divine existence would be inconsistent with God's unreserved participation in the lives and fortunes of the actualized phenomena.

c. Problems of Becoming

We can define a *phenomenon* as any existent thing or event. Possibilities become phenomena when (if) they are actualized. There is no single, right way to delimit a phenomenon. The striking of a match is a phenomenon, but so is the excitation of electrons in a few thousand atoms at the leading edge of the match head. So is everything that happens from the lighting of the match to the burning of the bonfire to the smoldering embers. Thus, all phenomena are composed of other phenomena and are parts of others still; none is completely separate or entirely distinct.

If God became the actualized phenomena, God would exist as each of them. God's experience would be their experiences. If one phenomenon were to rejoice, God as that phenomenon would rejoice; if another were to be shattered, God as it would be shattered. If still others would decay, die, or dissolve, God as those phenomena would decay, die, or dissolve. William Blake's words, "Eternity is in love with the productions of time," capture the essence of this step (p. 7). Love draws the unlimited into the limited; infinite love, out of love, becomes the limited "productions."

To understand how God could become the phenomena, we need to solve the *problem of perishing* and the *problem of unity*. The problem of perishing runs this way: because there are infinitely more ways to be limited than to be unlimited, virtually all actualized phenomena will be limited. Since its limits are part of the complete description of any limited phenomena, it is only because of its limits that any limited phenomena can exist at all. Karl Barth calls this the "shadow side" of created things: their limits are intrinsic to their natures.[29] Since one way to be limited is to be limited in time, virtually all actualized phenomena will die, decay, dissolve, or be shattered. A mayfly would not be a mayfly if it lived forever. The same is true of mountains and stars. None of these could be eternal and still be what it is. Nor can such phenomena be static, even during their limited existence. To exist at all they must change in themselves, and their relations with other phenomena must change. To be with the beloved phenomena fully, every step of the way, God would need to experience their existence, including their shattering, dissolution, and death as fully as they do. These experiences would therefore need to be real for God. Yet if God survives such experiences, how could they be real? On the other hand, if God did *not* survive them, how could God experience anything else? It seems that a full experience of one real perishing would both violate God's eternal nature and end God's ability to experience others. That is the problem of perishing. The problem of unity is closely related. God is one, but there are infinitely many possibili-

ties. Loving all of them, God would wish to become as many as possible. How could God do that and remain one?

d. A Waveform World

An ocean wave transmits information, not things. No individual water molecule travels with the wave. The molecules just move up and down according to motions imparted by other molecules close to them. Only the wave moves forward. We can think of the wave as *information* that tells molecules how to move. At one moment, a set of many trillions of molecules composes the wave; at a later moment, it is composed of a different set. Nevertheless, a wave is as real and as singular as an oak tree. It is one because it has *informational unity*.

Imagine a large pond of irregular shape, with a few stumps and boulders at the bottom. If we drop a steel ball into the center of the pond, waves will spread from the center to the edges. As they race around the pond hitting the stumps, boulders, and edges, local regions of turbulence—call them eddies or *waveforms*—will form. These waveforms will take on many different shapes and sizes. They will collide or interfere with each other; some will overwhelm or engulf others. Yet at each stage of its existence, this whole, interactive process will form a single, cohesive history. Each component waveform, including those that were overwhelmed, will play its part in this history, which will be slightly different because of it. Even if that difference is unrecognizable to a historian of the pond, it will still be there. Leibniz used a wave analogy to explain this:

> With the universe being a kind of fluid, all of one piece . . . all motions in it are conserved and propagated to infinity, though insensibly, just like the circles of which I have spoken (which came about by a stone thrown in the water) are propagated visibly for some distance, and although they become invisible in the end, the impression does not cease spreading. (*2006*, p. 82)

Just as an oak tree spreads from an acorn, the sequence of waveforms in the pond spreads from its origin to generate a single, connected history. Like the oak tree, this sequence of waveforms has a branching, intertwining informational unity.

Imagine (as Leibniz did) a world analogous to a pond. In it, every phenomenon exists as a waveform. Eventually, each waveform will die or dissolve, but each will generate information that it will leave behind. Other waveforms will transform that information and pass it forward along with information that they in turn will generate. This single, evolving process constantly creates information, but none is ever lost. This waveform world resolves both the problem of unity and the problem of perishing. In it, phenomena will, from their own perspectives, change, dissipate, and die, but the reality that includes them will continue. The information they are now will continue to shape the single reality that is the world in all later moments.

e. Transactions and Rules

A waveform world could be one (unitary) only if it were a continuing, integrated process. To be such a process, it would need to conserve information in and through its transactions. A *transaction* occurs when one phenomenon (waveform) impinges upon, generates, destroys, influences, or becomes another. If the result of a transaction were entirely indeterminate, if it might result in just any outcome, information from the phenomena that entered into it would not pass on to those that emerge from it. That information would be lost. Any part of a world in which unreliable transactions occur would therefore become causally isolated. An isolated system would entirely perish when it died or dissolved; a world in which systems became isolated could not remain one. For both reasons, God would not become such a world. A fortiori, God would not become two

or more causally isolated worlds; God would not become a multiverse.

Reliability cannot be uncaused. For physical transactions to be reliable, some *rule* must specify or govern them. A rule must do more than describe a world in general terms; it must describe how transactions work in specific circumstances.[30] In a world with no rules, anything might emerge from anything else. Such a world could not conserve information through transactions; it could not be one. Thus, any world that God becomes must have rules.

When can we say that a world has rules? Leibniz wrote that *any* world must have rules in the loose sense that all possible physical relationships are describable after the fact:

> If someone draws an uninterrupted curve which is now straight, now circular, and now of some other nature, it is possible to find a concept, a rule, or an equation common to all the points of the line, in accordance with which these changes must take place. . . . But when the rule for this movement is very complex, the line which conforms to it *passes for* irregular. Thus, we may say that no matter how God might have created the world, it would always have been regular and in a certain general order. (*1989*, p. 39; emphasis added)

A curve described by a "complex" rule "*passes for* irregular" when it *appears to be* ungoverned, i.e., when an observer cannot deduce the rule that describes it from the information available to her. By contrast, a curve (by which Leibniz meant any continuous line) *is* regular if an observer can deduce its rule (the algorithm that governs it) from what she can see of its twists and turns.

Deciding whether a rule is regular is not always easy. Consider this number series: 2, 3, . . . 31. Perhaps some rule governs this series, but without more data, we cannot say what that rule is. Does the series consist only of prime numbers, or of all the integers from 2 to 31, or of some other progression? In much

the same way, if some complex rule governed Leibniz's "uninterrupted curve," an observer might not be able to discern it. However, this would not necessarily mean that the curve *was* in fact "irregular" (i.e., governed by no rule); it might just mean that she had too little information. Perhaps a sheet of paper is covering part of the curve.

However, what if no observer could deduce the rule(s) that govern(s) a world, even with complete access to *all* the information embodied in that world? The transactions governed by this undiscoverable rule really *would be* irregular; they would not just appear to be so. Why should the inability of an observer to discover a rule mean that the rule does not exist? The answer turns on God's *kenosis*. If God becomes a world and *kenosis* is complete, then no information about that world (or the rules that govern it) can exist *anywhere* except in that world. Smolin describes how this works:

> The definition or description of any entity inside the universe can refer only to other things in the universe. If something has a position, that position can be defined only with respect to the other things in the universe. If it has a motion, that motion can be discerned only by looking for changes in its position with respect to other things in the universe. (2001, pp. 17–18)

If no information can exist outside a world, then only the information in it can be used in deciding the regularity of its transactions. A rule that remained undiscoverable in principle, even given all the information embodied in such a world, would not be a rule in that world. From the world's perspective (the only one that matters), transactions governed by this nonrule would be unpredictable and hence unreliable; the world would lose information through such transactions.

An example from Boolean logic shows another way in which information can be lost. The AND operation requires that if and only if all inputs are on, the output will be

on. The output will be off if any input is off. Now consider four sets of inputs to an AND operation and what we can know about them by studying only their output and the setup of the computer system. (Here, 1 represents *on* and 0 represents *off*.)

Inputs	Output	Reverse
0, 0	0	?
0, 1	0	?
1, 0	0	?
1, 1	1	1, 1

As shown in the above table, if the output of an AND operation is 1, we will know with logical certainty that its two inputs were 1 and 1. This operation is *logically reversible*. However, if the output is 0, we have no way, after the fact, of knowing its inputs. They might be any one of three possible combinations. Thus, given a 0 output, the operation is *logically irreversible*. Even though the AND operation is reliable—the output always reflects the input—some information about its inputs is necessarily lost.[31] On the other hand, reversibility implies reliability; reversibility is the tighter requirement.

A computer system loses information when a logically irreversible operation occurs and the input information is erased.[32] A waveform world would be a spreading network of physical operations (transactions) rather than purely logical ones. Such a world would pass from one state to another, with earlier states automatically erased. Such a world could preserve information only if all its transactions were *physically reversible*; that is, only if its former state could be retrodicted from all the information embodied in its present state. Importantly, this definition of physical reversibility does not require the needed information to be available to an observer in any practical sense; it does not even require an observer to exist. It only requires that all information needed to retrodict earlier waveforms from later ones must be retained somewhere in the world. This is nevertheless a very tight specification. It is easy to construct reliable but irreversible rules. To take a simple example, we can often retrodict the history of a game of chess if the game has only progressed two or three moves. However, after six or seven moves, retrodiction most often becomes impossible. Since the present state of the board no longer picks out its prior state, information has been lost.[33]

The proportion of complex rules that support nothing but reversible transactions is far smaller than the proportion of simple rules that support nothing but such transactions. Exploring logical reversibility in the context of cellular automata, Wolfram 2002 (p. 436) examined 256 of the simplest type of rules by which one row of black and white cells can generate another row. Of these 256 very simple rules, he found six to be reversible, or about 2.3 percent. On the other hand, out of about *7.6 trillion* slightly more complex rules, only 1,806 were reversible, or about one *100 millionth* of 2.3 percent. This empirical observation holds two important implications. First, out of all possible rules as complex as the ones that govern our universe, the proportion that permit only reversible transactions is likely to be quite small. Since it seems unlikely that only completely reversible rules could support the evolution of complex life, the reversibility (or not) of our physical laws will offer a means of testing the claims made here. Second, we now see a pressure for the simplicity of physical law that does not depend on either the elegance and comprehensibility of such laws or on their fecundity. Instead, this pressure takes root in God's desire to be with the beloveds, in the *koinonia* element of divine love.

Subject to being reliable and reversible, the rules that God selects must generate the greatest richness, the maximum possible variety. Reversibility can be consistent with richness.

While most of the 1,806 slightly complex, reversible rules that Wolfram identified did not generate much structure, a few of them did. Thus, "even though only a very small fraction of possible systems have the property of being reversible, such systems can still exhibit behavior just as complex as one sees anywhere else" (2002, p. 441).

Reliability-reversibility and fecundity are independent constraints because a different aspect of God's love requires each. The first is absolute; the second is a maximization constraint. Each is very tight, and they oppose each other in a number of ways. To see this, consider the question of whether rules should be variable or invariant. Up to a point, a rule that varies between period X and period Y (e.g., a law of gravity that changes in strength at a certain time) might generate greater richness than an invariant rule. The variable rule, by generating two distinct sets of phenomena, might result in greater cumulative richness. On the other hand, events in the X period might become irretrievable after the Y period commences. From this perspective, a simpler, invariant law might be better. To assure both reliability-reversibility and maximal fecundity, a selected rule could not be *maximally* simple. Instead, it would need to balance simplicity and fecundity to satisfy *optimally* the countervailing demands of love.

f. Simple Initial Conditions

Some writers claim that the world could be eternal into the past. If so, it would have no initial condition. Whether this could be true of any world is uncertain, but it cannot be true of a world that God has become. Any such world must be in some state when God becomes it. That state (whatever it is) would be its initial condition.

Given God's *koinonia*, God's desire to be with creation, the actualized world's initial state must meet a tight specification: it must be both one and radically simple. To see why,

imagine again the waveform world found in our pond. This world has informational unity because all of the waveforms in it share a common history. We can trace them through a series of causal connections, back to the initial dropping of the ball. This shared history *is* the world; in it, the many waveforms are one. The same would hold true in a wider waveform world. All its animate and inanimate inhabitants would be ripples and eddies in a single, common history.

Now consider the moment that God becomes a world. In the pond analogy, this is the moment the ball enters the water. Right then, the world has no prior, common history. If it had two separate origins—if two balls splashed into the pond at two different locations—those two points would not (could not) be one *right then*. At that moment there would be two worlds, a result forbidden by God's unity. To avoid this, the world must have a single origin. This explains why God would not add things to a world (e.g., a chain of islands) or change the things that exist to enhance its variety (or for some other purpose) in disregard of its rules. Any added or changed entity would be a second origin.

What would the world's single origin look like? As we have already seen, information can only exist inside the world, embodied (encoded) in the relations that compose it. Now imagine that a certain world's single origin has two distinct parts: call them A and B.[34] Upon actualization, each of these parts becomes a phenomenon. Call these phenomena A1 and B1. Each can trace its history back to one part of the origin but not to the other. From the standpoint of the phenomena, it would be as if the world had two separate origins. Once again, that is the only standpoint that matters, for there is no outside observer. Thus, the world cannot originate from a single, complex origin. While simplicity is only a derivative or emergent feature of the world's rules, it must

be the central feature of the world's origin. Since the simplest geometrical figure is a point, we can say that the world God would become must have a point origin.[35]

As noted above, little empirical evidence or theoretical reasoning has as yet addressed the relation between the simplicity of a world's initial conditions and the richness of its phenomena. If there were no relation at all or if a maximally simple origin were consistent with maximal phenomenal richness, there would be no conflict between the simple origin required for unity and the goal of maximal richness. If, on the other hand, multiple or complex initial conditions would produce greater phenomenal richness, the conflict would be resolved in favor of unity. Divine love could consistently fulfill itself only in a unitary world. Since a single, simple origin is essential to the world's unity, the world's origin needs to be radically simple. God would become only one, locally causally connected world.

Since simplicity is just the absence of structure, a maximally simple origin must contain as little structure as possible. On the other hand, a maximally rich universe would need to contain a great deal of nested, complex structure. These opposing requirements can coexist only if the world *changes* from simplicity to richness. This overall, directional change would be one of the best world's dominant features.

In summary, God would become the one world that: (i) has a single, maximally simple, origin; (ii) obeys reliable rules that permit only physically reversible transactions; and (iii) obeys rules that, subject to (ii), generate the maximum possible richness (variety over time). This world would have relatively simple, potentially discernable rules and would exhibit no phenomena not governed by those rules. It would be a world of constant change, including a global change from initial simplicity to later richness. From the standpoint of divine love, this would be the best of worlds.

5. The Real World

Our actual world seems to meet these specifications. It had a single origin that—physicists now believe—embodied very little information, perhaps none at all.[36] Since that maximally simple origin, our world has expanded and variegated. The Hubble expansion, its dominant physical feature, began to engender complex structure out of the random fluctuations that occurred right after the big bang.[37] Through a series of emergent, structural, and chemical processes, all governed by a few, simple rules, these fluctuations have given rise to a universe in which we "not only find structure on a variety of scales, *we find structure on every scale we have so far explored*" (Smolin 1997, p. 163; emphasis in original).[38] This structure extends far beyond our gaze; our visible universe is only a tiny part of the whole (Cornish, Spergel, Starkman, and Komatsu 2004). Moreover, most of it seems inessential to our existence. Stephen Hawking has remarked:

> Our solar system is certainly a prerequisite for our existence, and one might extend this to the whole of our galaxy to allow for an earlier generation of stars that created the heavier elements. But there does not seem to be any need for all those other galaxies, nor for the universe to be so uniform and similar on the large scale. (1998, p. 130)

We continually discover additional structure, which seems to be there for its own sake and not for ours, as the range and power of our instruments increases.[39]

Information transfer should play a critical role in the world that God becomes. Physicist Seth Lloyd says that it is central in our actual world. We do not live in a world of separate, freestanding things and events, but rather in a world of information exchange (interrelation) that occurs at all scales and across a

wide range of modalities. Lloyd regards our world as a quantum computer: "Although the basic laws of physics are comparatively simple in form, they give rise, because they are computationally universal, to systems of enormous complexity" (2007, p. 176).

In this vast computational system, information is never lost. If we throw a deck of cards high into the air, they will scatter as they fall; their original order will become unknowable. From the standpoint of an observer, that information is now "hidden" (see Susskind 1997; Lloyd 2007, p. 80). However, that hidden information still exists in the detailed positions and movements of the cards on the floor, the surrounding air molecules, the carpet fibers, etc. Reversing the motions of all these systems would restore the deck to its initial condition. No information has actually vanished. This principle is universal. For example, when a computer erases the inputs to a logically irreversible operation, the erased information is not lost to the world; instead, it smears across the thermal energy of the environment. Part of it is in the air around the computer; another part may be in the programmer's coffee. No observer could ever retrieve all the deleted information, but reversing every motion in the computer and its environment would restore it intact (Susskind 2008, pp. 180–182; Astakhov 2007). Because no information ever disappears, no phenomenon comes to an absolute end. Contrary to a claim once made by Hawking (but now abandoned by him), this principle of *information conservation* seems to hold everywhere in our world, even inside black holes (Hawking 2005; Susskind 2008).[40]

Additional tests of the claim that God became our world out of love will become practical as our knowledge increases. Finding a single example of absolute information loss from our actual world would be enough to falsify it. So would the discovery of an alternative physics that describes a self-consistent world with a maximally simple origin and reversible laws that would be more fecund than ours.[41]

A third method of falsification would be to discover that, within a widening range of investigation, life exists only on Earth. Pound for pound, biological systems are far higher in variety than other, naturally occurring systems. Therefore, all else being equal, a universe that hosts widespread life would be far richer than one that hosts none or one in which life was extremely rare. Yet biologists remain of two minds about life's origin. Some, like Francis Crick, call it "almost a miracle, so many are the conditions that would have had to be satisfied to get it going" (1981, p. 88). Others disagree. Christian de Duve argues that "life is an obligatory manifestation of matter, bound to arise where conditions are appropriate" (1995, p. 428). Since the vastness of our universe would allow even very improbable events to occur somewhere, either view is consistent with our existence (Dawkins 2006, pp. 156–166). Yet it seems probable that some set of reliable, reversible physical laws *could* make life "an obligatory manifestation of matter." So, if life were really unique to Earth our laws would probably *not* be maximally fecund.[42]

6. Minds

Unlike their medieval forebears, many modern theologians imagine that God has a special love for animals with high-functioning brains, animals that philosophers call "rational minds." Some go so far as to find Creation's purpose in humanity's evolution toward a more "rational" or "enlightened" state. This article argues that God's love is boundless, embracing rocks and stars as well as men and women. However, rational minds may play a unique role even in a nonanthropocentric world. For one thing, human and other high-functioning brains are the most physically complex objects that we know.

The mere existence of such complex objects would materially enhance a world's overall richness. For another, a world might become richer through the efforts of rational creatures, i.e., through the art and technology that they create.[43] If so, then, as between otherwise similar worlds, the one that favored intelligent life would be preferred. In that world, rational minds could become co-creators of the richness beloved by God.

Turning from "doing for" to "being with," God would only become a world if there were "something it is like" to exist in the world, i.e., if conscious awareness somehow existed within it. If nothing in a world had conscious awareness, God could share nothing by becoming that world. It follows that God could experience a world fully only if some capacity for experience, however minimal, existed throughout it. What evidence do we have that this is true of our world?

Modern writers on consciousness hold one of two divergent views. Most attribute it solely to the sort of complex computation that occurs in the brains of higher animals. In this theory of *emergence* or *neurocomputation*, consciousness depends entirely on neural structure. A minority take a different view, the approach of *protopanpsychism*. Following Leibniz and Alfred North Whitehead, they argue that even the tiniest bits of matter must possess something remotely akin to awareness. In this view, no amount of complex structure can conjure subjective experience out of mere, dead existence. Unless some minimal precursor of consciousness inheres in every bit of matter, emergent processes would have nothing from which to build.

Protopanpsychism runs up against a strong, Western prejudice, an assumption that only humans, or perhaps only humans and "higher" animals, are capable of conscious awareness. However, there is little real evidence for this assumption. We cannot equate consciousness with behaviors that reflect consciousness: some inadequately anesthetized patients are conscious of operative pain but unable to move or communicate their distress (Sandin, Enlund, Samuelsson, and Lennmarken 2000). Nor can we assume that consciousness requires a very complex brain: evidence of it has been found in the brains of fruit flies (van Swinderen 2005).[44]

Leibniz thought that the world's elemental constituents, its *monads*, were in some way conscious. He appealed to a thought experiment involving a conscious machine:

> In imagining that there is a machine whose construction would enable it to think, to sense, and to have perception, one could conceive it enlarged while retaining the same proportions, so that one could enter into it, just like into a windmill. Supposing this, one should, when visiting within it, find only parts pushing one another, and never anything by which to explain a perception. Thus, it is in the simple substance, and not in the composite or in the machine, that one must look for perception. (*1991*, 83, § 17)

Some modern scientists still seek a link between conscious awareness and "simple substance." Today, this search proceeds in the fields of neuroscience and quantum physics.

Those engaged in this search argue that (i) conscious awareness cannot be reduced to brain chemistry and neural structure; and/or (ii) a complete understanding of quantum physics requires attention to consciousness (see, e.g., Wigner 1967, Penrose 1989, Chalmers 1996, Squires 1994, Rosenblum and Kuttner 2008). Some suggest specific, quantum mechanical processes that might have a functional role inside the brain (see, e.g., Squires 1990, Penrose 1994, Beck and Eccles 1992, Walker 2000, Malin 2001, Stapp 1993, Lockwood 1990).[45] While they agree with the neurocomputationists that full organismic awareness depends on special structures in the brain, most of these writers would argue that these structures, like Leibniz's windmill, could not generate consciousness if they could not correlate

and amplify simpler events that invoke it in some rudimentary form. If they are right, some degree of consciousness may pervade the universe.

As noted above, this is not a consensus view. Most neuroscientists would deny that quantum processes play an important role in brain function, whether that involves consciousness or anything else (see, e.g., Litt, Eliasmith, Kroon, Weinstein et al. 2006; Churchland 1998). They would say, for example, that temperatures inside the brain are too high: the random (classical) motions of molecules must collapse quantum superpositions so quickly that they can have no meaningful role in brain function (Litt, Eliasmith, Kroon, Weinstein et al. 2006; Tegmark 2000). However, other scientists dispute this claim (Hameroff 2007, p. 1038; Hagan, Hameroff, and Tuszynski 2002). Like many other questions about consciousness, this one remains unresolved.

Given our present state of knowledge, the debate over the roots of consciousness is unlikely to be resolved soon. Nevertheless, the competing camps offer *potentially* falsifiable claims. Most obviously, the discovery of a complete, empirically tested, purely neurocomputational explanation of conscious awareness in the human brain would remove the main argument for the protopanpsychist view. It is therefore worth noting that we have no such theory now.

Besides enriching the world, fully self-conscious minds could also serve another purpose. Through them, God could be with actualized reality more completely than through mere "monadic" protoconsciousness. Since stars have neither organs of perception nor central nervous systems, any proto-experiences that might occur within them (or elsewhere in the nonliving universe) would seem to be quite limited in scope and depth. Beavers and barracudas may have rich experiential lives, but only limited understanding. Rational minds encounter a vastly

wider range of experiences and can integrate and process their experiences in ways that let them gain even more. These enhanced abilities, which might take diverse forms in different individuals and species, would let God experience the world through a variety of lenses. A world that never produced minds capable of observation, intuition, empathy, and reason would not be one that God could "be with" as fully as possible.

7. Our Goodness and God's

Our function in the world process should now be clear. We are here to co-produce, preserve, and enhance the world's phenomenal richness and to experience and understand the world on God's behalf. Human goodness has two unambiguous meanings, both of which derive from God's purpose for the world: (i) our unique physical complexity and constructive potential make each of us intrinsically good; and (ii) we become instrumentally good when we actually serve God's purposes, when we add to the world's richness and observe it with compassionate understanding.

This conclusion grounds ethics and human purpose in physical cosmology to an extent not achievable by any traditional worldview. Materialism cannot do this at all. Physicist Steven Weinberg has stated its credo: "The more the universe seems comprehensible, the more it also seems pointless" (1978, p. 154). Theists have always appealed to the world's beauty and structured complexity as evidence of God's existence. However, they derive no substantive direction from that cosmological evidence. Instead, they tend to see revelation—even if it must be symbolically interpreted—as the principal source of religious and ethical content. Traditional pantheism does little better. In his apology for Vedantic pantheism, Alan Watts tells a children's story about the world's origin:

> God . . . likes to play hide-and-seek, but because there's nothing outside God, he has no one

but himself to play with. But he gets over this difficulty by pretending that he is not himself. . . . He pretends that he is you and I and all the people in the world, all the animals, all the plants, all the rocks, and all the stars. In this way he has strange and wonderful adventures, some of which are terrible and frightening. But these are just like bad dreams, for when he wakes up they will disappear. (1989, p. 15)

On the logic of this story, we can do nothing to help God "play hide-and-seek." We might enjoy ourselves hedonistically, do our duty as we see it, or do nothing at all; whatever choice we make, the world will go on the same. None of these traditional stances offer meaning or direction that is grounded in the structure of the world.[46]

The approach described here does just that. It tells us that we are intrinsically good because of our complexity and potential, but only become instrumentally good when we fulfill our potential, when we actually perform our observational and creative roles. It says that our ethic is that of the landscape gardener. However, this conclusion is subject to one caveat. Leibniz wrote, "Those who believe God has established good and evil by an arbitrary decree, deprive God of the designation *good*. For what reason could one have to praise Him for what he does, if in doing something quite different He would have done equally well?" (*1985*, § 176, p. 236). If this is so, then it follows that our work on a divine project (the universe), even if faithfully performed, would not make us good unless the project itself could be seen as good. The leading arguments against the world's goodness are the claim that it contains gratuitous suffering and the presence of moral evil. What can we say against those arguments?

a. Gratuitous Suffering

An instance of suffering would be gratuitous if God could exclude it and still fulfill love's purposes. We have seen that love would impel God to become a world that (i)

constantly changes and (ii) contains fully conscious creatures. As change will bring death, dissipation, and loss for individual phenomena, at least some of which will be conscious, this best of worlds will necessarily contain some awareness of loss and hence some suffering. Yet must it contain as much as is found in our actual world?

To show that a great deal of suffering is gratuitous, William Rowe envisions a fawn who, horribly burned in a forest fire, suffers for days before she dies. He argues that God could mitigate this suffering by, for example, granting the fawn a quick and merciful death. God's failure to do that, he says, militates against God's goodness, power, or both (1979, p. 337). In rebuttal, theists say that God must have good reasons for letting the fawn suffer. Some (e.g., Swinburne 1996, pp. 236–272) try to imagine what those reasons might be; others just appeal to the gulf between God's wisdom and our own. Against both rebuttals, Rowe points to billions of similar (or more horrible) instances of suffering and argues that no reason or set of reasons seems likely to require them all (1979, p. 338 n.5).

Despite the objections that have been raised against it, Rowe's remains a powerful, evidential argument against ethical theism. However, it does not count against pandeism. In pandeism, God is no superintending, heavenly power, capable of hourly intervention into earthly affairs. No longer existing "above," God *cannot* intervene from above and cannot be blamed for failing to do so.[47] Instead, God *bears* all suffering, whether the fawn's or anyone else's.

Even so, a skeptic might ask, "Why must there be *so much* suffering? Why could not the world's design omit or modify the events that cause it?" In pandeism, the reason is clear: to remain unified, a world must convey information through transactions. Reliable conveyance requires relatively simple, uniform laws. Laws designed to skip around suffering-causing events or to alter their natu-

ral consequences (i.e., their consequences under simple laws) would need to be vastly complicated or (equivalently) to contain numerous exceptions. Such laws would not be discernable from within the world. From that standpoint, the only one that matters, they would not be laws at all. Absent laws, transactions would not reliably convey information and the world could not be one. God could not consistently become such a world. Since God becomes the world to be with the beloveds, suffering is the price that God pays for love. For us, a world without suffering would be one from which information would constantly vanish. Our actions would have unpredictable effects and so could have no meaning.

b. Moral Evil

Most theists would say that, to be worthy of worship, God should be free of moral imperfection. Yet the world includes morally evil actions: actions that willfully or wantonly destroy value or cause suffering to serve a lesser, parochial end. Aside from the suffering and destruction that such actions cause, their mere occurrence seems to stain God's character. God's creation and preservation of a world that includes them seems to make God responsible for them.

Theists address this *holiness problem* by focusing on the ontological distance between God and the free creatures who commit the evil acts. However, this shift of responsibility does not work for pandeism. Because pandeism posits a deep identity between God and the phenomena, it gains nothing by merely throwing blame on the latter. To address the holiness problem, pandeism must explain why evil acts must occur in a world that *is* God in all its aspects. The following is one tentative explanation.

As we have seen, the world's diverse phenomena arise through emergent processes grounded in simple rules. These processes do not foreordain specific events (e.g., where and when a star will form). Instead, largely

because of the continuous input of quantum indeterminacy into world history and the existence of chaotic processes (the butterfly effect), such events are unpredictable in principle (see Astakhov 2007). Natural selection is the emergent process that most directly affects the evolution of life. It is an open-ended process with no fixed or determinate goal. Instead, it favors any trait that promotes successful reproduction in the immediate environment. It does not just select for physical phenotypes; in creatures with minds, it also selects for attitudes and behaviors (Wilson and Wilson 2007).

In a world governed by natural selection, each individual has to look out for herself. This was as true of our human ancestors as it is of all animals. Erich Fromm explains that this fact of life favors self-love, or *narcissism*:

> How could the individual survive unless his bodily needs, his interests, his desires, were charged with much [psychic] energy? Biologically, from the standpoint of survival, man must attribute to himself an importance far above what he gives to anybody else. (1964, p. 72)

Yet other factors often counterbalance this narcissistic pull. For example, humans can survive only as members of a group, and groups can impose severe penalties for antisocial behavior. "We arrive then at the paradoxical result that [individual] narcissism is necessary for [individual] survival, and at the same time [because it urges us to put our interests ahead of the group's] that it is a threat to survival" (1964 p. 73). To resolve this conflict, individual narcissism often transforms into group narcissism. "The clan, nation, religion, race, etc., become the objects of narcissistic passion instead of the individual. Thus, narcissistic energy is . . . used in the interests of the survival of the group" (1964, p. 73).

Whether it fastens on the group or the individual, narcissism presses us to see our needs and interests as more important than

those felt by others. Ordinarily, the tug of reason and the pull of competing emotions conspire to keep our narcissism in check. However, humans and the groups they form vary quite widely. Those for whom reason and regard for others are far less compelling than self-love may progress from garden-variety narcissism to something more toxic. They imagine themselves or their group to be vastly better, brighter, or more moral than all the others and better than they really are. To defend their false and fragile self-regard, they lie about themselves and denigrate or scapegoat others. To justify their deceit, they either assign no value to others or else portray them as deadly dangers. Evil acts follow evil words. Some behavioral scientists have come to see this *malignant narcissism* as the main source of moral evil. In other words, they see moral evil as a specific, diagnosable psychological disease or dysfunction (see, e.g., Peck 1998, Klose 1995, Stone 1989, and Flemmer 2004).[48]

This disease model of evil does not excuse evil actions. To the contrary, it says that evil-doers choose evil incrementally over time. They often begin with small lies and cruelties, but those soon escalate. Their growing narcissism and deceit make it hard to change course but do not foreordain the outcome. As with other diseases (e.g., diabetes), a series of small choices—a small lie, a piece of cake—can eventually cause irreversible damage. Thus, despite its horrific character, evil has its roots in a human dysfunction that is not unlike many others (Peck 1998, pp. 120–130). It resembles autoimmune disease, in that it is a destructive perversion of an essential human system: not the immune system in this case, but the systems of thought (neural structures) that let us look out for our own interests.

However, this understanding of severe moral evil points up a deeper question. Why must the processes that drive life's evolution depend on each participant looking out for itself? Why cannot each know that it is a part of the whole and shape its behavior accordingly? A Buddhist would say the reason is *maya*, the veil of ignorance that obscures our knowledge of the world's (and our own) true nature. Yet the Buddha never explained the source of this *maya*.

Information is physical. Just as information about the world must be embodied in the world, so the information available to a phenomenon must reside in it or in phenomena it encounters. This means that every phenomenon, including every living being, must "view" the world from its own partial and limited perspective. This perspective puts it at the world's apparent center, and this self-centering illusion makes its needs primary. Because everything shares this illusion, any successful emergent process must take the illusion to be real. Ultimately, nature is red in tooth and claw because a lioness cannot know that she is also a gazelle. Her ignorance as to her true nature causes her to behave as a lion. This can be hard on gazelles, but without this limitation lions could not exist for long. And the world would be poorer without them.

God does not choose or sustain evil. God only chooses a world in which very many things coexist, and this must be one in which phenomena vary widely. To vary, each must have access to limited information. Life evolves through a series of processes that start from this precondition. This can result in dysfunction and open the way to terrible consequences. However, it also leads to construction, richness, and variety. As in the case of suffering, excising all moral evil from the best of worlds would be impossible in principle. The detailed and directive rules needed to excise evil are not the simple ones needed to generate richness and retain information. As Leibniz wrote, "if God had willed to do more here [to eliminate evil] he must needs have produced either fresh natures in his creatures or fresh miracles to change their natures, and this the best plan did not allow" (*1985*, Ans. Obj. V, p. 384).

In short, evildoing does not pollute God. While evildoers are aspects of God, they are also limited creatures. In their doing of evil, their limitations are paramount. Their victims are also aspects of God, and God suffers in them. While God experiences both perspectives, this is no game of hide-and-seek. There is no moral equivalence between perpetrator and victim. Evil destroys without creating and therefore works against God's purpose. In fighting for self-preservation, victims fight to preserve the world's richness. They thereby serve God's purpose. Evil actors pass away and new construction replaces the destruction they entail. Even defeated and forgotten victims are not entirely lost to the world; God preserves them forever in altered form. Thus, neither the problem of suffering nor the holiness problem impeaches our a priori impression that a world actualized out of maximal love would be maximally good.

NOTES

1. See the listing of articles pro and con at Strickland 2005b, p. 5.

2. However, see Rescher 2006, pp. 56–57.

3. See Eppen, Gould, and Schmidt 1979 or any standard text on operations research.

4. Rescher 2003, p. 27. Other scholars disagree, saying that Leibniz understood optimality to involve only "quantity of reality." See, e.g., Rutherford 1995, pp. 22–45.

5. Leibniz never used the term "initial conditions." However, he did distinguish between "rules" and other "means" or "devices." See Strickland 2006, chap. 5.

6. These are two names for the same procedure for measuring relative complexity. See Gell-Mann 1994, pp. 34–36.

7. This discussion does not purport to show the only right ways to quantify these two qualities; it only shows that, in principle, each *can* be stated quantitatively. An actual calculation of the variety of a world governed by quantum physics and general relativity would require resolving conceptual and technical questions that are beyond the scope of this article.

8. For differing approaches, compare Gale 1976, Rescher 2005, and Lane 2006.

9. See, e.g., Gell-Mann 1994, pp. 99–100; Lane 2006, pp. 263–264; and Squires 1981.

10. In creating the cellular automata game called "Life," mathematician John Conway used just two simple rules to support a wide variety of patterns. He found that adding more rules only reduced the game's complexity and diversity (Gardner 1970, pp. 121–122). For a more general investigation of the topic, see Wolfram 2002, pp. 23–113.

11. Letter to Malebranche.

12. Both experiments with cellular automata and the history of our universe show that complex structure can result from fecund rules of change and a maximally simple origin. See Wolfram 2002, pp. 32–39, and sec. 5 below. However, no research predicts the directional effect of making simple initial conditions more complex.

13. Reflecting on which puzzles give the greatest pleasure, the *New York Times*'s puzzle editor concludes, "The elegance of a logic puzzle is determined by the ratio of two things: the simplicity of its rules versus the variety and depth of logic needed to solve it" (Shortz 2007).

14. For another statement of the same idea, see Benedict Spinoza 1994, II, D6, 32.

15. For a thorough discussion of this point, see Manson 2000.

16. For Spinoza, the production of all things in all modes flowed from God's infinitude rather than from God's goodness.

17. Each region (or *domain*) in a multi-domain universe may have its own laws of physics, but each is part of a causally interconnected ensemble or structure. See Stoeger, Ellis, and Kirchner 2006.

18. The interpolated words are Rescher's.

19. This article follows Stoeger, Ellis, and Kirchner 2006 in distinguishing between a multiverse and a multi-domain universe. See note 17, supra.

20. Letter to Malabranche.

21. For a defense of this argument, see Kraay 2007.

22. See Hartshorne and Rees 2005, esp. pp. 1–25, 499–514.

23. This is why theists say that God cannot sin. An infinitely powerful God would have the power to sin, but sin would contradict God's nature.

24. These ideas permeate all theistic traditions. Exodus 3:14, Deuteronomy 6:4, and Revelation 22:13 are exemplary citations.

25. Either that or it represents a verbal sidestep around Spinoza's argument.

26. Modern cosmologists (Stoeger, Ellis, and Kirchner 2006) argue that, just as Leibniz thought, no infinite, plenary multi-domain universe is possible. However, just as he did, they leave open the possibility of a plenary multiverse.

27. For a compelling defense of this point, see the selections by Patrick Grim in Martin and Monnier 2003, pp. 349–378, 381–421.

28. The nineteenth-century philosophers Moritz Lazarus and Heymann Steinthal coined the word "pandeistic" (*Pandeisten* in German) to designate a pantheistic deism in which a personal God becomes the world.

29. For a synopsis of Barth's argument, see Hick 1966, pp. 128–130.

30. Here we see the flaw in Tegmark's claim that the omniverse would be maximally simple. The command, "Create everything," is simple, but it is not a rule. The infinite number of detailed rules needed to govern reliable transactions in each of a plenary, multi-domain universe's infinite number of divergent domains would not be simple at all. See Stoeger, Ellis, and Kirchner 2006 for a more extensive discussion of this point.

31. Not all: we still know they are not 1 and 1.

32. Typically, information must be erased to make room for new information.

33. For reasons explained below, this information has not been lost from the world; it has only been lost from the game board.

34. As a very rough analogy, we might imagine a dumbbell falling into the pond instead of a steel ball. In this case, A and B would be the two ends.

35. Leibniz suggested this possibility. See letters to Louis Bourguet, *Leibniz 2006*, pp. 198–200.36. See the brief discussion of this point in Lloyd 2007, p. 45.

37. See, generally, Layzer 1990, pp. 138–146; and Lloyd 2007, pp. 176–204.

38. The processes referred to here include gravitational clustering into primordial galaxies, nucleo-synthesis, and the formation of stars. Later processes include natural selection and the development of language. See Layzer 1990, pp. 133–251; Morowitz 2002.

39. A recent example is the widely reported discovery that very many (perhaps most) G- and M-class stars have planets.

40. Astakhov refers to the "semi-conservation" of information because, while the past can in principle be derived from the present, the future cannot be so derived. By contrast, energy is conserved in both directions.

41. While scientists routinely undertake such thought experiments (see, e.g., Harnik, Kribs, and Perez 2006; and Smolin 1997, pp. 301–306), the simulation needed to falsify this claim would need to far exceed currently published work in scope and detail. It would need to consider the net impact of an alternate physics on *all* significant classes of structure in *all* epochs of universal history.

42. Other means of testing the claim that our laws are maximally fecund have also been suggested. See Lane 2006, pp. 272–274.

43. For this to be true, intelligent life would need to generate more structural diversity (richness) than it destroys. See sec. 7, below.

44. As used here, the terms "consciousness" and "conscious awareness" do not imply self-consciousness or other mental powers. They mean only that there is *something* it is like to be the entity, that the entity has some sort of experience at some (perhaps minimal) level.

45. The neurocomputationist view is that, at a functional level, all relevant brain processes could be simulated or described using classical physics. The "specific, quantum mechanical processes" referred to in the text differ from theory to theory, but most theorists would point to quantum superposition, quantum entanglement, or both, what Einstein called "spooky action at a distance."

46. One nontraditional worldview, panentheism, differs from pantheism in seeing God as both the world in being and an external "lure" toward the good. Thus, it posits an ongoing purpose or moral direction to the universe. However, it does not derive that direction from the world's physical structure.

47. This inability is not a limit on God's power; it reflects God's once-and-for-all choice.

48. Though he does not use the term "malignant narcissism," Samenow 2004 (pp. 169–182) portrays evil in much the same way.

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