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The Design Argument Revisited through Evolutionary Computation: Imperfection, Robustness, and Creative Emergence

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This article offers a fresh perspective on the argument from design by drawing on modern evolutionary computation, which we propose as a more fruitful analogy for divine design than traditional craftsmanship models. We focus on genetic algorithms, which mimic biological evolution through operators that emulate combination, selection, and mutation, and bring new insights from practical experience with such algorithms. Far from being easy to implement, genetic algorithms require carefully designed codifications, operators, and parameters. Very importantly, in genetic algorithms, suboptimality emerges not as a flaw but as an essential trait: exploring imperfect solutions allows uncovering better, creative designs. In addition, imperfection is also linked to robustness: evolutionary outcomes are near optimal and flexible rather than finely tuned and fragile. Because genetic algorithms evolve a population of designs, diversity is both a requisite and a result. Building on the analogy between divine design and evolutionary computation, we argue that a divine designer would appear to value growth, adaptability, robustness, diversity, and creativity above static perfection.

The Argument from Design and Its Many Lives

The argument from design posits that certain features of the universe and living organisms are best explained by an intelligent cause rather than by an undirected process. Many perceive the order in nature, life's complexity, and the apparent evolutionary trend toward higher forms as signs of teleology or design, possibly hinting at a divine creator. This intuition dates to ancient times and has shaped arguments for God's existence throughout history. Ancient and medieval philosophers, including Aristotle and Aquinas, contributed significantly to the design argument, and the discussion continues into modern times.

One of the most influential proponents of this argument was William Paley, who, in his 1802 work *Natural Theology*, presented the famous watchmaker analogy. Paley (1802) argues that just as a watch, with its elaborate construction, implies the existence of a watchmaker, the complexity of living organisms also presupposes the existence of a divine designer. This analogy laid the groundwork for many later discussions on design by highlighting nature's apparent purpose and order.

However, since the nineteenth century, scientific discoveries across many fields have made it increasingly clear that the natural world has attained its present form through a long process of evolution based on incremental change and development. These findings have led many to question the appropriateness of the watchmaker analogy and whether the complexity of the natural world suggests the existence of a designer at all (Dawkins 1986). Still, the argument from design remains central to popular apologetics, as seen, for example, in the successful new book *God, the Science, the Evidence* (Bollore and Bonnassies 2025).

This article offers a fresh perspective on the design argument by reframing traditional models of design through the lens of contemporary engineering practice. The article is a deeply interdisciplinary contribution, where we bring together theological reflection with our practical experience in evolutionary computation applied to the reality of engineering problems. Some of the insights offered, particularly with respect to robustness, the emergence and imposition of patterns, or the characteristics that make design problems more amenable to evolutionary computation, have, to the best of our knowledge, not been fully considered in the literature on the design argument.

Evolutionary computation introduces a design approach that is less mechanical and more flexible, adaptive, and open to error and correction. By examining the process of evolutionary computation and the nature of the solutions it yields more closely, the article highlights several distinctive features of this approach to design. For example, in the context of evolutionary computation, apparent imperfections, far from being flaws, may be essential for long-term adaptability and innovation.

The shift to viewing design as an evolutionary process offers a more dynamic and nuanced understanding of divine action, showing how the process of evolution can reflect a designer's ongoing, creative involvement in the world. We argue that the theological implications of this approach suggest that a divine designer may prioritize creativity, resilience, and adaptability over static perfection.

This article is organized as follows. After an introductory section that sets out the background and issues, we describe evolutionary computation in engineering practices and dispel common misconceptions that hinder conversation in natural theology. Next, we examine the theological implications of these insights and demonstrate how they can illuminate long-standing puzzles about divine action, creation, and apparent imperfection. Finally, we synthesize these concepts and propose a new framework for understanding design that matters to both science and theology.

Divine Design as a Philosophical and Theological Issue

Perceiving design in nature carries significant theological stakes. Denying any form of design obliges theologians to account for divine action (creation, providence, and miracles) within a closed naturalistic system that shows no overt trace of purpose. Such a framework risks relegating God to the margins or to a purely deistic, first-cause status. By contrast, affirming design in the cosmos, biological life, and human evolution supports a richer account of divine presence, agency, and intentionality. In recent decades, an increasing number of theologians have attempted to address this issue. Many solutions have suggested placing divine design at the beginning of creation and in its lawful character (Barbour 1997, 204–8). Another example is Alvin Plantinga's (2011, 225ff.) proposed model, which attempts to avoid the extremes of intelligent design—as an explicit apologetic inference of divine activity—and naturalism—even in its theological versions—which discards any divine reference in an orderly world. However, several issues remain unresolved.

In addition to the fundamental issue of whether design is recognized at all, the way we understand design to be carried out shapes our view of how God relates to creation and humanity. This is one of the main contributions of this article, as we argue that some contemporary approaches to design can offer new insights into what the designer (if there is one) values in His creation.

A second issue involves the problem of evil. From St. Augustine onwards, the classical discussion of this problem has contrasted God's power, wisdom, and goodness with the chaos and imperfection of creation, as well as the presence of evil. This contrast was resolved by referring to original sin and its disastrous consequences, attributing what worked well to God's wisdom and associating what went wrong with human sin. Some theological perspectives on the human condition—from Irenaeus to Athanasius—have explored the idea of human growth toward perfection, emphasizing its unfinished nature in a way that potentially circumvents the concept of original sin and instead relates more to the created essence of humanity. Moreover, recent interpretations of Augustine's theology suggest a more nuanced view in which the imperfections observed in the world are not primarily the result of original sin, the negative effects of which are confined to the anthropological and moral realms. Other limitations in nature stem from its finiteness and the expected process of its development and growth, including setbacks and corrections (Rosemberg et al. 2018. 237–42).

However, this nuance contributes little to the broader question of how we understand divine design in creation, particularly regarding the apparent limitations and even negative aspects inherent in human nature. The primary theological response has been to attribute such issues to original sin. However, with current scientific knowledge, upholding any simplistic interpretation is difficult. Some recent developments have attempted to address this challenge more effectively. For example, Francisco Ayala (2006, 154ff.) has interpreted the evolutionary process, including variation and error, as a distinct form of divine design; in that way, imperfection and even negative outcomes can be attributed to the evolutionary process as its normal development rather than to divine design and responsibility. A profound rethinking of God's work and the design process is needed for a satisfactory theological treatment of these issues. Other attempts have been made to reconsider classical theological positions, such as those held by Thomas Aquinas. For instance, Edward Feser (2009) criticizes models that suggest God designed every particular aspect of beings. He argues that creation is limited and imperfect but that the divine design can be perceived in the whole and as the first cause of subsequent causes (see also Kojonen and Malik 2024).

A third aspect concerns human nature and purpose, both of which are part of the divine plan and yet retain free will. A mechanical view of divine design, reminiscent of an expert watchmaker, would appear to suggest reduced human freedom or greater determinism, echoing old debates about predestination, grace, and autonomy. Such traditional views of design make it difficult to understand humanity's role in a world that is both designed and created, where everything is foreseen and controlled.

In contrast to popular apologetics—and defenders of "intelligent design" views—contemporary theology shows little interest in the design argument, which (unlike questions on divine design, which we will deal with later) seems largely absent from mainstream theological trends of the last fifty years and most apologetically driven accounts of the Christian faith (Haught 2003). The only design that appears to interest theologians is the one God imprinted in a history of salvation, unfolding over centuries to alleviate pain and bring hope to humanity. The so-called proofs for God's existence and the discipline of natural theology have fallen into disregard for theologians, leaving such arguments mainly to the philosophy of religion. We contend that ignoring or downplaying design arguments is a mistake, as they remain highly relevant to the theological issues arising from the special revelation described in the Bible (Swinburne 2004, 153–91).

However, several new strands in the discussion of design-related issues have emerged recently. The first concerns how experts perceive teleology in the biological realm and its implications. This featured in an animated discussion between Daniel Dennett and Jerry Fodor on teleology in evolution. David N. Livingstone (2023) summarizes the feud and its consequences. Crudely put, design has haunted evolutionary theory since Charles Darwin began *On the Origin of Species* with a metaphor comparing it to pigeon breeders' selection to produce better breeds (Dennett 1995). Dennett accepts some teleology in evolution but rejects any intentionality or designer. Fodor and Massimo Piattelli-Palmarini (2010) responded with a provocative essay and denunciation, claiming that any admission of teleology implies a designer. This debate highlights the challenges of addressing teleology while adhering to methodological naturalism, excluding supernatural causes, and acknowledging the intuitive perception that design implies control. To solve this conundrum, Livingstone suggests a dual heuristic of immediate and ultimate causes, along with a conjunctive explanation model that bridges natural/biological and theological accounts (see Mix 2022; Bikaraan-Behesht 2023). This is the approach we pursue here.

A second recent strand in the design debate concerns new discoveries in cosmology that have shown the necessity for certain parameters to take extremely precise values to achieve a stable and productive universe. This has become known as the fine-tuning argument. Some have argued that to sustain an evolutionary process that is innovative and productive, the parameters of the process must take a narrow range of values; hence, a fine-tuning argument can be made in relation to biological evolution (Kojonen 2021; Jeavons 2022). We revisit this issue later in the article.

A third issue that has become prominent in the discussion of design is the claim that the natural world exhibits many instances of poor or suboptimal design. This frequently has been cited as an argument against any form of divine design. Critics argue that the imperfections of biology suggest a flawed designer. Philip Goff (2023) highlights the bloodiest and darkest aspects of nature as arguments against theistic design. Nathan Lents's (2018) book catalogues a number of human design flaws, although some may have hidden functionality. However, other voices contest this idea, arguing that even apparent flaws often reveal hidden functionality when viewed differently (as seen in Ayala 2006; Feser 2009). Others have added more nuance and argument to counter such criticism regarding theistic views of design. Christopher Southgate's theology is one of the most elaborate to incorporate the so-called "only way" argument, the thesis that the evolutionary model is the only way to achieve God's purposes, despite the fact that it involves so much suffering and loss. Southgate (2008, 15ff.) argues that a better model that can fulfill these requirements is simply unavailable.

These former proposals and theologies provide a foundation on which to build our research, as we attempt to develop a new model based on evolutionary computation to offer a potential approach to interpreting apparent imperfection in a more positive and plausible manner, in line with recent advancements in engineering and computer science.

Evolutionary Computation and How It Changed the Concept of Design

Engineering Design and Optimization

Since antiquity, engineering design has often relied on intuitive methods, as seen in the construction of Roman aqueducts and Islamic tiles. These early designs drew on heuristics (rules of thumb) and empirical knowledge, refined through trial and error. The Scientific Revolution marked the formalization of design principles, particularly with the development of mathematical optimization, influenced by the work of Johannes Kepler and Pierre de Fermat. These early mathematical approaches enabled engineers to refine designs systematically, moving beyond purely intuitive processes.

By the eighteenth and nineteenth centuries, Leonhard Euler, Jospeh-Louis Lagrange, and Carl Friedrich Gauss introduced methods to minimize quantities and fit curves, advancements critical to engineering. Their work laid the foundation for classical optimization, which relies on mathematical equations and deterministic methods to derive optimal solutions.

The twentieth century brought a major transformation with the development of linear programming and the simplex method, pioneered by George Dantzig and stimulated by the need to solve logistical problems during World War II. These innovations revolutionized industrial design by providing efficient tools for complex optimization problems. The advent of computers further accelerated numerical optimization, enabling the solution of problems previously considered intractable. The 1960s introduced integer programming, which allowed for discrete design variables (e.g., the number of legs on a chair, rather than their length, which is a continuous variable), and nonlinear programming, which became widely applied in industries such as petrochemicals (Karloff 1991).

However, while classical optimization techniques excel at small, convex problems where a single global optimum can be efficiently found, they struggle with complex nonconvex problems, which involve multiple candidate solutions that outperform all nearby alternatives (known as local optima) (Boyd and Vandenberghe 2004). The central difficulty is that many local optima may be far less satisfactory than the best overall solution (the global optimum). This limitation became increasingly apparent as engineers confronted high-dimensional, nonlinear, and combinatorial problems, for which classical methods proved inadequate.

The Rise of Evolutionary Computation

Starting in the 1970s, several new design paradigms have emerged within engineering that aim to mimic the biological process of natural selection to identify and refine potential design choices. This broad approach is now known as evolutionary computation, and one prominent example is the idea of a genetic algorithm, introduced by John Holland (1975). Rather than relying on a predefined mathematical structure, a genetic algorithm begins with a (usually random) population of candidate solutions that evolve over many generations based on a measure of their quality, known as fitness. Through a sequence of computational operations known as selection, crossover, and mutation, the algorithm iteratively modifies the population of candidate solutions, aiming to find at least some solutions with an acceptably high level of fitness (Mitchell 1998).

Alongside genetic algorithms, other optimization techniques inspired by natural processes have emerged. These include simulated annealing, which mimics the annealing process in metallurgy (Kirkpatrick, Gelatt, and Vecchi 1983), and particle swarm optimization, inspired by collective animal behavior such as bird flocking and fish schooling (Kennedy and Eberhart 1995). Collectively known as nonclassical optimization methods, all these approaches differ from classical optimization, which relies on calculus and algebraic techniques, by incorporating stochastic elements that enable the exploration of broader and more complex solution spaces.

The schema theorem (Holland 1975) demonstrates that some forms of genetic algorithms can reliably reach optimal solutions, even for problems with multiple local optima. Unlike deterministic classical optimization, which follows a fixed sequence of steps toward a global minimum or maximum, evolutionary methods such as genetic algorithms explore various possibilities in parallel. This allows them to escape local optima and discover unexpected, highly effective solutions. Such flexibility makes evolutionary computation particularly valuable for integer and nonlinear problems, where traditional methods often fail to yield high-quality results.

A key advantage of genetic algorithms is that they require only an evaluation function (a way to measure the quality of a candidate solution), eliminating the need for an explicit mathematical formulation of the problem (that is, a mathematical function linking the design parameters to design quality). For example, in the widely cited case of antenna design at NASA, the effectiveness of a given structure was tested through simulation rather than relying on an equation to predict performance (Hornby et al. 2006).

The strength of genetic algorithms lies in their independence from any precise description of the underlying system's structure. It suffices to experiment or simulate in order to assign fitness values to candidate designs. This allows genetic algorithms to be applied to a much broader class of problems than classical optimization, which requires an explicit and tractable mathematical model linking design variables to performance. If a model includes too many continuous variables, discrete choices, or nonlinearities (e.g., synergies among decisions), classical optimization methods are often incapable of finding a solution at all.

Engineers frequently face this exact challenge: an artifact or process must be designed, but the required mathematical model is unavailable, or the system is too complex to model mathematically. In such cases, genetic algorithms and other forms of evolutionary computation have become an attractive alternative.

For instance, genetic algorithms have been successfully applied to classic industrial problems such as bin packing (Falkenauer 1999) and scheduling and logistics in large-scale scenarios (Montana et al. 1998). A notable application area is power systems design, where system complexity has led practitioners to adopt genetic algorithms for generator expansion planning, transmission planning, reactive power planning, generator scheduling, economic dispatch, and distribution system planning and operation (Ramirez-Rosado and Bernal-Agustin 2002). For a broader overview, see N. Rajkumar et al. (2008), which reviews over a thousand implementations in this field. In mechanical engineering, genetic algorithms are widely used to optimize designs from an initial sketch provided by the engineer, which is then iteratively refined to meet user specifications (Sáez-Gutiérrez et al. 2019). Another everyday use is the optimization of control parameters (Reformat et al. 1998). Control systems are ubiquitous in industry, spanning applications as diverse as automotive and aerospace, as well as chemical and biomedical engineering. Because it is often impossible to obtain a precise model of these systems, genetic algorithms and evolutionary computation may be the only practical alternatives to blind trial and error.

As a result, evolutionary computation and genetic algorithms have become extremely popular and are now integrated into most mainstream engineering design tools. MATLAB includes them in its Global Optimization Toolbox. They are also embedded in widely used platforms such as Ansys for mechanical design and OptQuest for process and infrastructure optimization.

However, this widespread adoption should not be mistaken for universal reliability. Contrary to what is assumed in some conversations in the design debate, such as in Richard Dawkins, genetic algorithms do not converge spontaneously to a suitable solution. When a problem involves numerous hard-to-satisfy constraints, making it difficult to generate feasible configurations, a genetic algorithm may fail to produce any valid candidate solutions in the initial population. Without feasible individuals to improve upon, the algorithm cannot evolve better designs and becomes useless. Moreover, the algorithm›s parameters (e.g., population size, mutation rate) often require careful tuning. If left in default settings, genetic algorithms generally fail to produce useful results (Jeavons 2022).

Additionally, although the schema theorem suggests that some forms of genetic algorithms will eventually converge to an optimal solution, this convergence is only theoretical and assumes infinite time. In practice, it is impossible to know how close a given candidate solution is to the true optimum, a metric known as the optimality gap, often returned as part of the solution in classical optimization.

Nevertheless, as Simeon D. Castle, Michiel Stock, and Thomas E. Gorochowski (2024) observe, «Complex systems are difficult for the human mind to design via traditional approaches, but useful results are also unlikely to occur if trial and error are used due to the vastness of the design landscape.» Evolutionary computation provides an alternative that can be useful in such cases.

Insights from Practical Experience with Evolutionary Computation

The design argument is an analogy: just as complex artefacts are products of human designers, so the complexity found in nature is thought to originate from an intelligent creator. In this article, we propose a reformulation of this analogy, taking into account a relatively new kind of design technique: evolutionary computation and genetic algorithms.

But how good is this analogy? When is an analogy useful? An analogy—or, in science and engineering, a model—is useful if it can either explain reality or guide our decisions (Duit 1991). For this to happen, the two systems linked by the analogy must be sufficiently similar, or at least share the relevant features being used to compare them.

Thus, knowing when an analogy is appropriate or helpful is not an easy task. And this task becomes even more difficult when the target of our understanding is no less than God. The aim of natural theology (learning about God through the understanding of creation) is inviting, but all our conclusions must necessarily be tentative. We must approach this effort with humility, acknowledging that our insights are only finite attempts to bridge an infinite distance.

In the case of genetic algorithms, the first call for humility lies in recognizing that we are using two chained analogies: one between biological evolution and evolutionary computation, and one between evolutionary computation and divine design. The first claim is that genetic algorithms are a helpful model of biological evolution. But they are, at best, simplified sketches of what is thought to occur in nature. Just as an artificial neural network caricatures the brain, reducing the complexity of a neuron to a weighted sum of variables, genetic algorithms represent only a shadow of the richness of biological mechanisms.

The survival and reproduction of organisms in the natural world is dynamic and multifaceted, far too complex for any closed, formal description of fitness. The relationship between the organism and its DNA/RNA goes far beyond the simple encoding of a candidate solution as a fixed array of numbers, as used in genetic algorithms. Our understanding of the biological genetic code remains highly incomplete, with active research areas including genetic redundancy, intron regions that influence transcription, and the multiple interactions found in genetic networks.

In addition, genetics is only a part of biological evolution. Epigenetics (the activation or deactivation of specific genes) shapes an organism's fitness in conjunction with its genes. Similarly, environmental interactions, metabolism, and the relationships within communities and ecosystems also play a role. Genetics cannot be understood in isolation.

Bearing in mind these reasons for prudence, we will now tentatively explore the implications of using genetic algorithms as a possible model for divine design. Our claim is not that genetic algorithms provide a perfect analogy for divine creation but rather that they offer a more effective one than traditional models. The following sections examine the most interesting aspects of genetic algorithms, address common misconceptions in philosophical discussions of evolutionary computation, and draw insights that may later illuminate our understanding of God as creator and designer.

Errors and Imperfection

A key strength of evolutionary computation is its tolerance for the temporary worsening of the candidate solutions. Unlike classical optimization, where each step must improve on the previous one, evolutionary methods allow occasional declines in performance. This enables exploration of broader regions of the design space and allows the algorithm to escape local optima in search of superior solutions.

In addition, classical optimization works with a single blueprint and seeks to find a single optimal solution, while genetic algorithms work with a "population" of candidate solutions that the algorithms then iteratively combine and mutate. The randomness in the initial population, as well as the operations of crossover and mutation, both require and produce diversity. However, this diversity means the process does not simply work towards a single optimal solution. Instead, an evolutionary approach requires many sufficiently different, near-optimal candidate solutions.

Allowing imperfection in the candidate solutions produced by a genetic algorithm, then, is not a flaw: it is a strength. Moreover, this imperfection is not temporary. While the best candidate solution may converge towards a global optimum, the population of candidate solutions must remain permanently dynamic, diverse, and imperfect for the algorithm to continue generating novelty and adaptability to changing conditions.

Achieving Complex Functionality

Recognizing the creative value of imperfection helps answer a familiar design-debate objection: "Complex functionality can't arise spontaneously, it must be imposed from outside the system" (Lenski et al. 2003). Indeed, Richard E. Lenski et al. (2003) showed that, in natural populations, complex traits can generally appear only when there exists a sequence of small mutations that each offers a selective advantage; without such fortuitous "stepping stones," the development of complex functionality by an evolutionary process usually stalls.

Yet, experiments with genetic algorithms reveal that suitable solutions can sometimes be found even when such gradually improving sequences of mutations are not available; however, the process must be tailored very carefully to allow sufficiently many suboptimal candidate solutions to persist. When mutation rates are too low or selection is too strict, promising but slightly disadvantageous variants are purged before they can combine into a higher-order adaptation. Raising diversity and relaxing the penalty for imperfection allows useful changes to accumulate in different parts of the genome; once they are combined, a fully functional trait can emerge (Pinar 2016). This mirrors the biological process of exaptation (traits originally evolved for one purpose being co-opted for another) a pattern common in both biological evolution and engineering design (de Santis 2020). Thus, intermediate advantages help but are not the only route to complexity. Genetic algorithms can still reach complex functionality with enough exploration and tolerance for suboptimal solutions.

Robustness and Structure

Classical design yields static, local optima—solutions that can degrade, or even fail dramatically, with minor changes in problem conditions. Evolutionary solutions, however, are often dynamic and adaptable. When conditions change, the fitness evaluations change too. This makes evolutionary approaches more robust in noisy, shifting environments where classical methods may fail altogether.

In addition, in practice, identifying a diverse set of near-optimal solutions is often more valuable than identifying a single theoretical best. Multiple viable options provide flexibility and allow for fallback. Evolutionary computation excels in this area, particularly in complex domains.

Another key difference lies in solution structure. Classical methods utilize modularity and hierarchy to simplify their search (Castle et al. 2024), resulting in minimal solutions with the fewest components possible. Evolutionary computation, in contrast, often produces highly interconnected designs resembling biological systems where genes can influence a wide range of traits, and redundancy ensures functionality is preserved even if some elements are lost (Castle et al. 2024).

Predefined Templates versus Codification

A rather misleading portrayal of an evolutionary algorithm appears in Dawkins's (1986) *The Blind Watchmaker*. To illustrate incremental selection, Dawkins evolved the phrase "METHINKS IT IS LIKE A WEASEL" from random characters.

Though possibly effective as a teaching tool, this simulation has been criticized (Dembski et al. 2009) for smuggling in teleology: the algorithm “knows” the target and compares each candidate to it at every step.

In nature, however, there is no predefined ideal that each organism is striving to match. Organisms survive or fail based on current environmental fitness, without any foresight. Genetic algorithms operate the same way: if we already knew the perfect design, we would not need the algorithm to find it for us. A more realistic example of the use of genetic algorithms is the NASA antenna project mentioned earlier (Hornby et al. 2006), where the algorithm selected antennas with good signal performance from a population of candidate solutions and refined them iteratively.

However, although engineers obviously cannot include complete descriptions of the optimal solution in their genetic algorithms, they do include something that plays a similar role in defining the fitness function. We refer to this as a codification, which defines the way in which candidate solutions are specified, typically as an array of numbers, and how this description is to be translated into a design. In the NASA case, the codification specified how to interpret an array of numbers as the places where the root of the antennae should branch to form the final product.

The importance of this often-overlooked element cannot be overstated. The codification chosen for a problem will determine many aspects of the behavior of a genetic algorithm. A good codification enables the exploration of feasible designs while avoiding “monsters” (the name engineers use for nonsensical or invalid solutions). Poor codification can prevent valid solutions from being found altogether. Designing a robust codification is rarely easy, and the difficulty grows with the complexity of the problem, particularly the constraints it must abide by.

However, the patterns initially imposed by the choice of codification are not the only ones that result from using a genetic algorithm. As soon as the algorithm starts its calculations, other patterns may begin to emerge. This is formalized in the schema theorem and illustrated more visually in systems like Lenia (Chan 2019), a continuous cellular automaton (a cellular automaton is a system where cells on a grid change their states over time by following simple rules that depend on their neighbors). Lenia simulates lifelike digital patterns that move, grow, and interact, demonstrating how structured yet surprising complexity can emerge from simple rules and well-chosen codification.

The Requirement for Fine-Tuning

Another common misconception surrounding genetic algorithms is that they require no human input and will converge spontaneously to an optimal design. In practice, it is evident that these algorithms often require extensive fine-tuning of their operation to yield meaningful results (Jeavons 2022). Crucial components of the algorithm, such as the population size, mutation rate, selection pressure, and the form of the recombination operator, must be carefully chosen and perhaps sensitively adjusted during the algorithm's operation to achieve any useful outcomes. This situation, revealed by experience with genetic algorithms over the past few decades, is reminiscent of discoveries about the constants of nature, which it now appears must be finely tuned within narrow limits to sustain a productive cosmos.

The Implications of Evolutionary Design for Theology

Having presented some key features of practical experience with genetic algorithms, we now turn to the central goal of this article: extracting insights for the design argument using evolutionary computation as a more helpful analogy for divine design than traditional design models.

As Erkki V. R. Kojonen (2021) observes, "There is a revelatory potential in Biology." If a designer exists, the design process they choose may reveal something about both the constraints imposed by the problem and the values the designer prioritizes, offering insight into their intentions. In this section, we examine the possible theological implications of an evolutionary perspective on design, considering in particular how the presence of suboptimality and apparent imperfection may reflect a designer's values and how an evolutionary perspective may clarify concepts such as divine action, theodicy, and human freedom.

Suboptimality, Imperfection, and Evil

Apparent flaws in living organisms often lead critics to reject the idea of an intelligent designer. Yet, as we have shown, no human engineer well versed in evolutionary computation would draw that conclusion. Evolutionary algorithms require imperfection: they explore many solutions, including some that perform poorly, before uncovering better ones. Embracing imperfection, therefore, is not a sign of incompetence but a precondition for progress.

If God chose an evolutionary process rather than a single, direct event to bring about current forms of life, what are the implications of that? Either (a) evolution was the only possible path to the most desirable biosphere, or (b) God preferred it for some other reason—a question we will examine later. Once an evolutionary process was selected, suboptimality and temporary setbacks became inevitable, because a dynamic evolving universe cannot reach final perfection at every stage.

Others have noted this point before (Southgate 2008). As Kojonen (2021) puts it, "If God had to (or had good reason to) create through a free evolutionary process, then this helps explain why the features of nature are not optimal, and not fully reflective of the divine character." For many, evolution provides a justification for natural evil within a broader narrative of creation and redemption. Bethany N. Sollereder (2018) observes that “the freedom of life, seen in the evolutionary process, can result in methods of survival that do not necessarily reflect God’s design or purpose, but are coherent within the freedom extended by divine love.” Robert Collins similarly (1999) notes that we have not yet grasped all the potential purposes of evil in creation.

An overlooked insight from the practice of engineering design is that trade-offs are unavoidable: a structure optimized for one function is often suboptimal for another. Likewise, an organism that thrives in one environment may struggle elsewhere. Inefficiencies and vulnerabilities in biological systems do not contradict the idea of an intelligent designer; they may instead reflect the trade-offs inherent to any complex system.

Suboptimality may therefore be a necessity, and in the context of genetic algorithms, it comes hand in hand with robustness, adaptability, and creativity. Imperfection, then, can perhaps be interpreted as an expression of divine intent, encouraging development through diversity, error, and adaptation.

Robustness and Adaptability

Solutions generated by evolutionary computation are often more robust than solutions obtained by classical optimization. As we pointed out earlier, highly optimized designs can fail when conditions shift even slightly, while a diverse population of quasi-optimal solutions can survive and adapt across many variations. This principle is especially relevant for a complex system exposed to unpredictable influences, such as the biosphere. If all organisms had been perfectly adapted to an initial environment, then the inevitable changes in that environment would likely have driven them to extinction. Mass extinctions have apparently occurred multiple times in Earth’s history, and without diversity, it is likely recovery from such events would have been impossible.

In addition, the designs generated by evolutionary computation also tend to include high levels of redundancy, while a highly optimized design will only have the components that are absolutely necessary. We also find this in living beings, which have a considerable amount of genetic redundancy, where multiple genes perform the same function. This redundancy ensures that if one gene mutates or fails, others can compensate, thereby maintaining essential processes. Genetic redundancy supports development, metabolism, and immune responses, preserving stability despite genetic changes or environmental stress. Redundancy is thus crucial to the resilience and adaptability of life (Láruson et al. 2020).

Emergence, Creativity, and Chance

Evolutionary computation typically operates with multiple solutions simultaneously, necessitating the maintenance of diversity to enable those solutions to adapt to changing conditions. If the designer chose an evolutionary process as a tool, then this choice may imply a preference for creativity and individuation. Stephen Jay Gould (1989) argues that biological evolution is highly contingent; if we were to "rewind the tape of life," the results likely would differ entirely. This perspective suggests that unpredictability (or, in other words, surprise) holds intrinsic value in the creative process.

Emergence is a key concept in complex systems, where new properties arise from interactions among simpler components. These emergent properties are novel and irreducible: they cannot be predicted or explained solely by analyzing parts in isolation. Emergence appears across biology, physics, and sociology. In theology, emergence reflects divine creativity (Mantini 2024). Peacocke (2004, 2006) argues that emergence is a means by which God becomes immanent in creation. Through self-organizing patterns, God's presence and action unfold in the cosmos.

Random variation is the driver of evolutionary improvement over generations. Without randomness, there would be no opportunity for new structures. As presented in Michael Heller's philosophy of chance, randomness is a fundamental feature of the universe that allows the cosmos to be organized into necessary and contingent rules. It is in contingency that we can have a cosmos with creativity, a cosmos with history. As Heller (2013) puts it: "Without randomness, the universe would be a dead mechanism. Chance is a condition for creativity, a necessary factor allowing the cosmos to become something more than initial conditions would dictate." M. Ebrahim Maghsoudi and Seyed Hassan Hosseini (2025) discuss various ways in which the operation of chance as a driving force behind evolution can be compatible with divine agency and design. The model developed here aims to provide an alternative way of conceiving this compatibility.

Some biologists, notably Denis Noble (2006), argue that organisms are not passive carriers of genes but active agents that use randomness to achieve dynamic stability. The evolving nature of creation also invites reflection on human agency. Just as evolution depends on variation and contingency, human choices and mistakes can play a role in an unfolding divine plan. This view aligns with theological arguments that creation is not about static perfection but dynamic participation. Sollereder (2018) suggests that evolution creates space for freedom, agency, and self-organization, which may better reflect divine intent than a completely predetermined world.

If human engineers rely on evolutionary methods to design complex artefacts, it is reasonable to ask why a divine designer might not do the same. Rather than envisioning a watchmaker who assembles each biological system in its final form, a more accurate perspective might see divine action as an ongoing process. This process allows for variation, adaptation, and emergence over time rather than enforcing a singular, fixed design. The role of divine design, then, is not to create immutable structures but to establish conditions that enable self-organization and growth. This is no small feat, as shown by the difficulties in designing well-functioning genetic algorithms for even a small problem. This view aligns with theology that emphasizes God's sustaining presence rather than constant intervention (Peacocke 2004), working through natural processes that cultivate robustness, adaptability, and diversity, and can be connected to Paul Tillich's (1951, 238) well-known idea of "God as ground of being," as it refers to the "structure" that grounds all that exists.

Conclusions and Discussion

Our study has revisited the classical argument from design by replacing Paley's increasingly inadequate watchmaker analogy with a model drawn from contemporary engineering: evolutionary computation. Observation of how genetic algorithms and related heuristics operate in practice reveals that this approach to design is fundamentally process centered rather than blueprint centered. For the complex problems for which genetic algorithms are the only feasible alternative to blind trial and error, engineers do not seek a single static optimum. Rather, they cultivate populations of candidate solutions, tolerate temporary regressions, and nourish diversity until robust, nearly optimal configurations emerge.

Read theologically, this suggests that a creator who either had to or chose to work through evolutionary processes would favor a universe characterized by dynamism, experimentation, and open-ended creativity rather than one frozen in static perfection.

Because imperfection in evolutionary computation is precisely what prevents premature convergence and secures long-term adaptability, the persistence of apparent flaws in nature need not contradict divine wisdom; it may instead be the structure of a cosmos designed for growth, resilience, and genuine novelty, where providence sustains rather than micromanages creation.

Practical experience shows that evolutionary algorithms require carefully chosen codifications, operators, and parameters; by analogy, a divine designer would have to fine tune the boundary conditions and physical constants of the universe so that self-organizing processes could in fact generate the desired complexity. This extends current fine-tuning discussions by introducing a supplementary focus on the design of processes rather than the specification of final states.

The consequences are significant. First, linking suboptimality with creative emergence encourages a shift in theodicy from defending why specific evils occur toward examining how apparently negative features may contribute to the unfolding good of the whole. A free process rather than a merely free-will defense gains empirical plausibility.

Second, the model dissolves the false dichotomy between blind chance and rigid predetermination, showing that purposiveness can reside in enabling conditions without resorting to mechanistic determinism; thus, one may speak coherently of divine intention while remaining faithful to methodological naturalism. This approach may open an alternative path in the compatibilism discussion by combining chance and divine intervention within a more complex model. It offers a way to understand chance as part of a broader process that includes a teleology or hidden aim, sustained by a powerful will that prevents the whole process from going off course.

Indeed, from a theological perspective, this model introduces a level of complexity to the relationship between God and creation that goes beyond previous simpler models. This increase in complexity could be problematic for some. Theology, like science, tends to prefer parsimonious explanations. However, this choice has been made before when conceiving of complex Christological and Trinitarian models that defy a simple representation of the divine. Our point is that a similar strategy may be required to address the issue of divine design and action in the light of both scientific discoveries and recent developments in the understanding and practice of engineering design. Our hope is that these more complex models of design could provide more helpful resources to address such issues.

We should stress again that our double analogy (between biological evolution and evolutionary computation, and between evolutionary computation and divine design) calls for epistemic humility: every conclusion remains provisional, pending further developments in both empirical science and theology. Our insights do not pretend to solve the questions related to the argument from design but only to relocate them within a richer, process-oriented vision of nature and salvation, one where design is still unfolding in a universe that fosters creativity, resilience, and freedom.

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