No Free Lunch

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Abstract

In the first part of this paper I present a brief analysis of goal-oriented systems in the context of history and philosophy of science. In the second part I discuss their practical limitations. A fundamental question is considered in the first part: Do goal-oriented systems make sense in a universe that obeys relativity? I argue that in the block universe of relativity these systems lack intelligence because they are deterministic. Intelligent goal-oriented systems can be founded on a dual model of physical reality in which there is interaction between the phenomena and a mechanism that establishes causality. On this basis the existence of goal-oriented systems in a metaphysical sense is ultimately related to whether our physical reality is autonomous or guided by another level of reality. In the second part of the paper I claim that while goal-oriented systems may have served an important role in human evolution, they can also be highly dysfunctional. A simple mathematical model of multi-variable goal-oriented systems suggests that attaining goals may be impossible and this has significant implication for policy design.

Introduction

Goal-oriented systems are characterized by aims and intentions. Due to the high diversity of the subject there is no unifying theory of goal-oriented systems. *Goal-orientation* is a term used frequently in social sciences. In physics and engineering these systems usually appear with different names, such as adaptive, learning, anticipatory or self-regulating. In biology related terms are evolution and reproduction [1]. Our civilization may advance to the next level when we will have a unifying theory of complex multi-variable goal-oriented systems. However, it appears that we are far from that stage as some fundamental questions must be answered first. For example, one of them is the following: Do goal-oriented systems make any sense in a macrocosm that obeys relativity? The notion of a goal implies agency and volitional actions. If actions are no volitional but part of the block universe of relativity, also known as a *Parmenidean* universe[2], then goal-oriented systems reduce to unintelligent deterministic processes. Intelligence in a block universe is an ambiguous notion since actions, aims and goals preexist in a certain sense. This gives rise to the hypothesis that intelligent goal-oriented systems can exist in a non-autonomous universe that has an arrow of time. Specifically

1. Goal-oriented systems in an autonomous universe are unintelligent deterministic processes
2. Goal-oriented systems in a non-autonomous universe can be intelligent if guided by a mechanism

According to the above two alternatives, the existence of goal-oriented systems is related to the question of whether or not our physical reality is autonomous. This will be the main issue dealt with in the first part of this paper. In the second part of the paper I will argue that although goal-oriented

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systems may have played a decisive role in the evolution of humans, they also pose great dangers at the social, political and economic level. Specifically, since systems in these domains usually deal with a large number of variables, due to their complexity decisions turn out to be either random or in worst case extreme. Increasing popularity of extremist political parties and economic inequality are partly results of the inability of multi-variable goal-oriented system to attain their goals. Apparently, without coherent guidance and constraints, goal-oriented systems are not viable. An example at the economic level is the European Union that is being challenged nowadays by extremes. I include a mathematical model of this tendency of multi-variable goal-oriented systems to fail.

Part 1. Goal-oriented systems in the context of history and philosophy of science

1.1. Antiphon's failure, the return of the atomists and the search for the impetus force

The nature of physical reality was an important issue at the time of the Eleatic philosophers in fifth century BC. Parmenides, the founder of the Eleatic school of philosophy, argued that what exists, can only be one, motionless, indestructible, immutable, finite and indivisible. Zeno of Elea, one of his students, undertook the task of proving via the use of logical arguments that motion is impossible either in plenum or vacuum. Being a consultant to Pericles, the elected governor of Athens during the Golden Age of democracy, Zeno was giving frequent speeches. During one of those speeches the philosopher Antiphon became frustrated with Zeno's arguments, got up from his seat and started to silently walk back and forth in front of the audience in an effort to demonstrate that motion is possible. Yet, Antiphon failed to rebut Zeno's claims and the audience was convinced that motion is impossible [2].

During the time of Zeno philosophical inquiry objectives were not mandated or financed. There was not peer pressure to abide by any specific doctrines. The frequent naïve claim in literature is that Zeno's paradoxes are solved. This claim comes with a generous dose of obscurantism. Although relativity has in some special way solved Zeno's paradoxes this was achieved at the high price of four-dimensionalism. Briefly, relativity solves Zeno's paradoxes by submitting to their ramifications. In that theory, material objects also have temporal parts and motion is defined in terms of sequences of spacetime points, also called *processes*. Motion preexists in this Parmenidean universe, it does not have to start or finish and this is the (null) solution to Zeno's paradoxes of motion [3]. Everything that exists, in past, present, or future is already part of the processes of this universe and the notion of free will is ambiguous.

After a detailed analysis of Zeno's paradoxes in his book, Jonathan Barnes concludes that in order to resolve them one must disprove the fundamental premise of Zeno that nothing *can perform infinitely many tasks* [4]. Zeno's paradoxes indirectly challenged the autonomy of this world. Cartesian philosophers, although they never mentioned the paradoxes directly, attempted to solve them and concluded that the only way this world could exist is if it is continuously recreated at every instance, a doctrine known as *the continuous recreation of the world by an immutable God* [5]. Nearly 350 years before computers and simulation, Cartesian philosophers spoke about those processes in a universal context. A continuously recreated world requires intervention of some mechanism. This provocative for its time idea was fiercely opposed by the proponents of the autonomous universe: the natural philosophers and their predecessors. Thomas Hobbes pushed forward the idea that everything is material including human beings and *agency* can be explained in terms of interactions of matter. Gassendi revived Greek atomism and the notion that everything is made of particles that move in voids. The mechanistic autonomous world idea gained ground and soon served as the basis of scientific inquiry and even human values. Isaac Newton, although it is not entirely clear from his *Principia* whether he believed in an autonomous universe, offered a system of laws of motion that were subsequently used by the promoters of the autonomous universe doctrine as a basis for their defense. However, philosophers of science know that Newton only provided a mathematical model of motion and not a solution to the issue of autonomy. Despite that, Newton's model was elevated by the educational establishment to the status of laws of a material and autonomous physical reality where forces govern all interactions. Furthermore, philosophers of science also understand that force is a metaphysical notion and the laws of motion of Newton are part of a theory that relates a primitive ontology (particles and their mass) to a *nomological variable* called *momentum* [6]. In essence, there is no explanation how motion is imparted in particles via interactions in that model. This was an issue considered long ago by Aristotle in an effort to rebut Zeno's paradoxes that motion is impossible and later referred to as the search for the *impetus force*. A few centuries after Aristotle, John Philoponus, who had also demonstrated the universality of free fall (weak equivalence principle) with high accuracy long before Galileo[3], extended Aristotle's ideas and asserted that the impetus force is due to an impressed inclination for motion. In the 14^{th} century, Jean Buridan defined the impetus force as the product of weight and velocity and claimed that this force is also implanted by the agent of motion who imposes a force on body.

The next notable attempt to identify an innate property of matter that empowers motion was made by Leibniz who defined the living force, or *vis viva*, as the quantity mv^2 and argued it is conserved [7]. This effort also failed because velocity is a frame-dependent quantity since its value depends on the relative motion of an observer. Because of this empirical fact, *vis viva* could not serve the purpose of an innate active force in an autonomous universe[4]. The search for an impetus force continues nowadays even though the physicists who are involved in the experiments may not be aware of all the philosophical details. For example, the search for the Higgs field and associated boson particle was related to this endeavor in some indirect way. But modern science still cannot explain how particles impart motion to other particles. One argument is that motion preexists since the time of the Big Bang and it is only "altered" by collisions of particles. This does not resolve Zeno's paradoxes and how motion takes place in either vacuum or plenum. Particles cannot move in "nothingness" or in an infinitely divisible space. Motion requires either continuous recreation in time at successive space intervals or it preexists. In the former case, there is autonomy within limits of physical laws but reality is the outcome of a process akin to computer simulation. In the latter case, there is no autonomy and physical reality is like a movie replayed in a theater. There is no free lunch.

[3] For details see https://en.wikipedia.org/wiki/Equivalence_principle#Tests_of_the_weak_equivalence_principle

[4] Since *vis viva* can assume different values depending on observer frame, there is no preferable value unless there is an absolute reference frame, a sort of a container, in which case autonomy is challenged.

1.2 Goal-oriented systems and intelligent interaction

If physical reality is non-autonomous, then causality is epiphenomenal. Cartesian occasionalists in the seventeenth century proposed that causes can be explained in terms of occasions on which God acts to bring about the effects [8]. The modern version of Cartesian occasionalism is an intelligent mechanism that is the true cause of all interactions [9]. In this context, goal-oriented systems are manifestations of a dual reality and so are their intentions and aims. Volition exists in a limited sense and aims and intentions may arise at the physical reality level, guided or enforced by intelligent interaction. This is as opposed to the block universe of relativity where volition cannot exist. Mainstream science is reluctant to consider the idea of a non-autonomous universe with an arrow of time imposed by intelligent interaction and instead elects to adopt the idea of a block universe in which all interactions preexist and there is no volition. However, the hypothesis of intelligent interaction is falsifiable because it makes certain predictions about the nature of space and time. For example, if space is digitized, then the recreation hypothesis is corroborated[5]. Further corroboration can be obtained by experimental demonstration of an upper limit in the frequency of maintaining coherent interactions. A related experiment was proposed in [3].

This was a very brief account of some of the issues that arise from the notion of goal-oriented systems in the context of history and philosophy of science. The most important issue is that goal-oriented systems make sense only if there is causality and an arrow of time. In an acausal world aims and intentions preexist and goal-oriented systems are deterministic processes. In a non-autonomous universe agents have limited power in determining their future but in an autonomous one, the future is prescribed. In the former case autonomy is exchanged for limited freedom of choice. This may sound counter-intuitive but as we will see in Part II, it is the principle on which some large-scale goal-oriented systems are based. There is no free lunch when it comes to the tradeoff between autonomy and free will.

Part 2. The perils of multi-variable goal-oriented systems

2.1 Goal-oriented systems and evolution theory

In evolution theory, species change in time in order to survive and reproduce. The changes are guided by a process called natural selection. Evolution is a goal-oriented system only in the context that species are better fit to survive in a specific environment with limited resources. Although most evolutionists argue that due to random mutations evolution is not a goal-oriented process, it is possible that they do this in an attempt to disassociate from the claims of the non-falsifiable doctrine of *intelligent design*. Modern evolution theory also rejects "Lamarckism" and the notion of a goal-oriented process that strives for perfection. But perfection is not the sole objective of goal-oriented systems. Any process that maximizes some fitness function subject to constraints is goal-oriented in that sense. Evolutionists further try rebutting claims of a goal-oriented system by

[5] Theories can never be proven, only corroborated or falsified

arguing that evolution is an effect and not a cause. However, causality is irrelevant if evolution is part of a block universe and becomes relevant only if it is part of a non-autonomous universe manifested by (intelligent) interaction, as discussed in Part 1. In this latter case, intelligent design may be a partly true but a redundant hypothesis [9]. Therefore, the claim that evolution is not goal-oriented hides a contradiction when analyzed in the context of the nature of physical reality: if physical reality at the level of macrocosm is autonomous, then there are no random mutations because everything is deterministic. Only in a non-autonomous universe there can be random mutations guided by a natural selection process. There is no free lunch.

2.2 The rise of the extremes: Economics unions, globalization, immigration and education

In this section I consider goal-oriented systems in social sciences. These systems attempt to find a solution to multi-variable problems that have a performance objective (goal) and are subject to constraints. For example, in economics the main problem is determining a policy of allocation of resources so that prosperity is maintained or increased. One example is the European Union, where a relatively large number of member nations have agreed to surrender policy sovereignty to a central mechanism that decides what the input variables and constraints are. The objective of this union is prosperity of member nations but the outcome has been recently questioned and the first exit from the union has occurred (Brexit.) The reason that this type of multi-variable goal-oriented systems usually fail is their high complexity and the inability of the central mechanism to juggle many variable simultaneously. Typical variables include deficit and inflation limits, import taxes for non-member nation trade, immigration quotas, regulations in education, product manufacturing, housing, etc. There are hundreds or even thousands of variables the central mechanism deals with at the macro and micro economic levels. Solutions to such complex systems rarely exist and the goals are almost never reached. In reality these systems only buy time until they fail and the next scheme is envisioned to buy more time. Below I provide a proof of why multi-variable goal-oriented systems fail based on the use of a simple model and along the lines found in [10].

Proposition 1. The solution space of multi-variable systems shrinks asymptotically to zero as the number of variables increases.

Proof: Consider x_n input variables to a system with $n \geq 4$. We define the n-hypersphere as the set of n-tuples of points $(x_1, x_2, \ldots, x_n)$ such that

$$x_1^2 + x_2^2 + \cdots + x_n^2 = R^2$$

where R is the radius of the hypersphere.

The content[6] V_n of the n-hypersphere of radius R is given by

[6] Also known as *volume*

$$V_n = \frac{R^n S_n}{n}$$

where S_n is the hyper-surface area [11].

It is known that the content V_n of hypersphere asymptotically falls towards 0 as n becomes large. If the input variables are normalized in [-1,1] then the content of the resulting *unit n*-hypersphere reaches a maximum for n equal to 7.25695, then decreases and asymptotically shrinks to 0 as n becomes large[7]. This implies that the solution space shrinks to zero as the number of input variables the system tries to juggle becomes large. *QED*.

Corollary 1 to Proposition 1. Multi-variable goal-oriented systems cannot attain their goal.

Proof: From Proposition 1 we know that for a large number of variables the solution space is for all practical purposes zero. Therefore, there are no solutions that satisfy the goals and all solution choices are essentially arbitrary or random. *QED.*

From corollary 1 we conclude that the only viable goal-oriented systems may be those that deal with a small number of input variables. This means that unless these systems are decentralized, their goals are never reached. In the example of the European Union, the lack of solutions to guarantee prosperity for all of its member nations has transformed into social backlash and rise of the extremes. Central authority juggling too many variables and prosperity are incompatible in the longer-term; this is what the mathematical model in Proposition 1 tells us. I call this mathematical result the *curse of the hypersphere*. Decentralized control that deals with a limited number of inputs of maximum importance has higher probability of success. However, in the case of the European Union example, the central control mechanism has grown in size over the years and the number of input variables is increasing. The goals cannot be accomplished in the context of the model of Proposition 1.

United States of America is another example where central control has been increasing in recent years. This fact is partly responsible for rising prosperity of only a small percentage of the population. Tight bank regulations versus relaxed regulation, low income tax versus high income tax, ceiling on CEO salaries versus no ceiling, legal versus illegal abortion, free borders versus closed borders, are just some of the extremes that arise due to the failure of central control to attain its goal. The mathematics of Proposition 1 indicates that a better system should involve freedom of electing the number of variables of importance in exercising local control. Otherwise, the rise of extreme choices is inevitable due to failure of central control and the outcome is increasing inequality and social backlash. Similar effects were present in all centrally controlled empires in human history and eventually drove them to failure. Delegation of authority at the local level is necessary to reduce the number of input variable and the central control mechanism should focus

[7] For n = 20 the content *V* is for all practical purposes zero.

on a few important variables, such as security, macroeconomic policy at the highest level, regulation of financial markets and infrastructure planning. For example, since immigration is important and contributes to economic output, it should be left up to local communities to decide how many immigrants they are willing to accept and assume responsibility for them. A central immigration policy facilitates backlash because while some appear to support free borders they also do not desire that immigrants are located in their communities but in other far away communities. This creates contention and a burden for those "other" communities and the goal of the central authority fails locally and eventually on a larger scale.

Globalization via free movement of capital, goods and services is another multi-variable goal-oriented system. The goal is increased global prosperity driven by international trade and investment. I call globalization a *goal-oriented supertask*. These supertasks fail with high probability but in the process may inflict damage and harm. In addition to the null solution space as shown in Proposition 1, these supertasks can be gamed by sub goal-oriented systems that act as their components and have *hidden objectives*. An example is the globalization process that started in the 1990s [12]. China pegged its currency to the US dollar in 1994 to game the process. The result was massive wealth-transfer from USA to China facilitated by an undervalued currency. By 2005 the Chinese understood the severity of gaming a global goal-oriented system supertask and let their currency appreciate a little. However, it was then too late and the extreme solution adopted several years before led to the 2008 financial crisis, which was a chaotic bifurcation that tested the modern financial system foundations and required other extreme solutions, such as quantitative easing by central banks. Besides the mathematical result of Proposition 1, it is also an empirical fact that multi-variable goal-oriented systems frequently assume extreme solutions due to guaranteed lack of any solutions to attain their goals. Another financial stress of similar magnitude as that of 2008 may have much more serious consequences, including the adoption of the extreme solution of geopolitical conflict. The perils of goal-oriented systems and related supertasks are real, especially when sub-tasks are allowed to game the process.

The backlash caused by goal-oriented systems that attempt to exercise central control is nowadays also evident in education. Universities should be given the freedom of drafting their own admission policies and schools should be allowed to decide locally whether they want to teach specific subjects via their local goal-oriented system. In this way local backlash will not turn into global as there will be alternative choices to those who disagree. Mathematics favors distributed local control as opposed to central; otherwise the solution space shrinks down to zero. Local control may be viewed as a variant of *anarchy* by proponents of central control. However, the consequences of trying to simultaneously juggle too many variables are inescapable and failure is certain. Multi-variable goal oriented systems are doomed unless they are lucky and the random solutions that emerge do not create significant large-scale distortions and bifurcation (chaotic) effects. There is no free lunch.

3. Discussion

In Part 1 of the paper I discussed the tradeoff between autonomy and goal orientation in the context of history and philosophy of science. I argued that if the world is autonomous and acausal, which are the philosophical consequences of relativity theory, then goal-oriented systems degenerate to deterministic and unintelligent processes. In a non-autonomous world with externally imposed causality, goal-oriented systems are possible but such world alludes to some kind of virtual reality. There is a third alternative of an autonomous and causal world that is not well-founded due to paradoxes that arise but a detailed discussion is beyond the scope of this paper[8]. Therefore, in the context of goal-oriented systems the important issue from a philosophical perspective is whether our world is autonomous or not. Although this is a metaphysical subject, it has implications at a pragmatic level. I also showed in Part 2 of the paper based on a simple model that multi-variable goal-oriented systems are doomed to fail since their complexity reduces the solution space to zero and any solutions reached are essentially arbitrary. An answer to this important problem is delegation of authority at a local level through a decentralized architecture. Large-scale goal-oriented systems that are centrally controlled, such as the European Union, will fail with high certainty since they depend on luck for the choice of variable values to achieve their goals in the presence of a null solution space. Central control cannot escape its mathematical limitations. The history of mankind is a graveyard of fallen empires and unions of all sorts that have attempted to exercise central control. The last empire will be the one that will implement decentralized goal-orientation, will intelligently delegate authority and control while at the central level will deal only with a minimum number of variables that allow high probability for an optimal solution. We may be far from that point given that wishful thinking continues to dominate the decisions of central control. However, the reality of the *hypersphere cur*se is that there is no free lunch.

[8] This is an interesting alternative but to be viable relativity theory and especially the constancy of the speed of light must be falsified, something that appears not possible at this point.

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