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# Simulation of biological evolution under attack, but not really: a response to Meester

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**Abstract** The leading Intelligent Design theorist William Dembski (Rowman & Littlefield, Lanham MD, 2002) argued that the first No Free Lunch theorem, first formulated by Wolpert and Macready (IEEE Trans Evol Comput 1: 67–82, 1997), renders Darwinian evolution impossible. In response, Dembski's critics pointed out that the theorem is irrelevant to biological evolution. Meester (Biol Phil 24: 461–472, 2009) agrees with this conclusion, but still thinks that the theorem does apply to simulations of evolutionary processes. According to Meester, the theorem shows that simulations of Darwinian evolution, as these are typically set in advance by the programmer, are teleological and therefore non-Darwinian. Therefore, Meester argues, they are useless in showing how complex adaptations arise in the universe. Meester uses the term "teleological" inconsistently, however, and we argue that, no matter how we interpret the term, a Darwinian algorithm does not become non-Darwinian by simulation. We show that the NFL theorem is entirely irrelevant to this argument, and conclude that it does not pose a threat to the relevance of simulations of biological evolution.

**Keywords** Evolution · Evolutionary algorithms · Natural selection · Simulation · No Free Lunch theorems

## Background: No Free Lunch and Intelligent Design

In *No Free Lunch. Why specified complexity cannot be purchased without intelligence* (2002), the leading Intelligent Design theorist William Dembski defends the position that the first NFL theorem prohibits the evolution of complex

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adaptations by Darwinian evolution. This theorem was first published by Wolpert and Macready in 1997, and established that no optimization algorithm can outperform a random search when averaged over all fitness functions. This finding ruled out the possibility of a universal, free-for-all algorithm that outperforms a random search on any fitness function. As a consequence, for an algorithm to perform more successfully than mere chance over a particular fitness function, the algorithm has to be tailored around the fitness function (Wolpert 2002). From this, Dembski concludes that for natural selection (which can be described as an evolutionary algorithm (Dennett 1995), itself a kind of optimization algorithm (Wolpert and Macready 1997) to work as it is supposed to do, extra information about the particular fitness function is needed. Dembski thinks that the search for this necessary information is even harder to accomplish than the original search performed by the evolutionary algorithm, which he terms the *displacement problem*. To avoid infinite regress, Dembski believes this extra 'information' can only be supplied by an intelligent designer. The parameters of the environment have to be fine-tuned by this intelligence for natural selection to be successful.

Dembski's book has met with devastating critiques. Some of Dembski's critics (e.g. Shallit 2002; Wolpert 2002) complained that his writings are so vague that it is almost impossible to pinpoint his actual position. Most critics, however (Häggström 2007a, b; Orr 2002; Perakh 2002, 2003, 2004; Rosenhouse 2002; Sarkar 2007; Wein 2002a, b), have argued that the NFL theorem is simply irrelevant to biological evolution. Darwinian evolution is the result of natural selection acting over a specific fitness function; biological evolution is simply not concerned with averaging over all fitness functions. This means that, within this particular setting, nothing prevents natural selection from outperforming random search. Therefore, in principle the NFL theorem is applicable to evolutionary algorithms, but in reality it is of little concern.

## Ronald Meester, No Free Lunch and simulations

Ronald Meester, a Dutch mathematician and ID sympathizer,[1] has recently subscribed to that particular critique in this journal: "it is simply not the case that a biological fitness function can be viewed as an average over all possible fitness functions. […] Therefore, the NFL theorem simply does not apply." (2009, p. 464) However, unlike other critics, Meester believes that the "algorithmic 'NFL way' of thinking about evolution is very meaningful when it concerns computer simulations of certain evolutionary processes." (2009, p. 468).

To illustrate his own position, Meester discusses "two examples of the NFL theorem in action."(2009, p. 464) Both invoke an algorithm to find a particular

[1] Meester is not an ID proponent as such, because he refuses to infer the existence of a designer. However, he does think that ID, and the concept of irreducible complexity in particular, "poses a serious problem to a Darwinist scenario" (Meester 2003, p. 152). And he claims that "at some points, the ID movement does an excellent job, and on those points I have defended it. In particular, it successfully attacks the popular idea that evolutionary biology only needs to fill in some small gaps." (Meester 2006, p. 296).

target, similar to the well-known ME*THINKS*IT*IS*LIKE*A*WEASEL example by Richard Dawkins (1986). In that model, an algorithm combining random variation and a law of selection is shown to outperform mere chance in targeting this particular sequence from Shakespeare's *Hamlet* (Meester himself uses the word YES). Now, from the fact that this algorithm does indeed outperform random search, Meester infers:

> [the researcher's] algorithm is too efficient to be the result of averaging over all fitness functions; it is not likely that he chooses his fitness function uniformly at random over all possibilities at the start of each new search. No, it is reasonable to conclude that he uses the fitness function corresponding to the word YES, *and* that he uses the search algorithm associated with that word. Again, note that the conclusion is twofold: we know that he uses special fitness functions and we know that his search algorithm is tailored around his choice in order to get an efficient algorithm (2009, p. 466).

Meester thinks that this conclusion bears serious consequences for any simulation of the evolution of complex biological adaptations (e.g. Lenski et al. 2003). The programmer has selected a particular fitness function and a particular algorithm for reaching the target *in advance*. According to Meester, this makes the whole enterprise, including the algorithm, "intrinsically" (p. 468) or "necessarily teleological" (p. 471). No simulation, no matter how sophisticated, escapes this conclusion. Models of biological evolution have been set up in advance by a programmer. He or she selects a particular fitness function and a particular algorithm (i.e. random mutation and natural selection) to get at a particular goal. According to Meester, this makes the model automatically teleological. Darwinian evolution, by contrast, is non-teleological and undirected. Therefore, computer simulations cannot tell us anything meaningful about the nature of real-world evolution. There are, however, several difficulties with Meester's position that undermine his radical conclusion.

## Difficulties

### Setting a target

Meester acknowledges that natural selection can be understood as an algorithmic search procedure (Meester 2009, p. 464). In evolutionary models it is exactly this algorithm of random variation and natural selection that is simulated. Meester, however, argues that by mimicking this Darwinian, non-teleological algorithm in a computer simulation it all of a sudden ceases to be Darwinian. But why would this be so? The mere fact that we are dealing with a computer simulation instead of a real-life situation is irrelevant, for algorithms are substrate neutral. It does not matter whether an algorithm is implemented in a biological environment or in a silicon-based digital one. As long as the conditions of variation, differential survival and heredity apply, evolution by natural selection will take place, irrespective of the medium (see Dennett 1995). Thus, by itself, implementing the procedure of random variation and selection into a computer does not alter its non-teleological character.

Meester is ambiguous, however, about the precise meaning of the term "teleological". Throughout the article, he applies it interchangeably and inconsistently to programs, simulations and algorithms and gives it at least two related, but distinct meanings. In one sense, "teleological" applies to the algorithm and means "being aimed at a target". Meester thinks that modeling the algorithm with a preset target, makes the algorithm "intrinsically" teleological and, therefore, non-Darwinian. By contrast, simulations of evolution without such a preset target, for example for modeling bacteria resistance to antibiotics, are deemed unproblematic by Meester. Their point is "not to reach a special target, but instead to compare the 'typical' behavior of related systems." (p. 470) However, simply prefixing the word "intrinsically" to "teleological" obscures his own misunderstanding of the issue. Of course the programmers have a "goal" in mind, but as long as they make sure that the *algorithmic process* itself, in particular the source of variation, is undirected, this does not affect the validity of the simulation. Moreover, the NFL theorem is silent on the presence of targets; it applies to both kind of simulations or to neither. Either way, the distinction Meester wants to draw between simulations with and simulations without a target cannot be made on the basis of the theorem.

## Built with insight into the future?

According to Meester, not just the algorithm but the entire simulation of biological evolution is 'teleological' in another sense, as it is built or programmed "with insight into the future" (p. 470) or "the future goal". Meester argues that programmers always make sure that the search algorithm in a simulation is "very carefully tailored" (p. 469) around particular fitness functions to get at a specific target. Meester's first objection concerned the presence of a preset target, but what bothers him here is that the simulation is *designed* at all. It is under this notion that Meester thinks he can bring in the NFL theorem:

> So this is the conclusion that is connected to the NFL theorem (I emphasize that this conclusion is not part of the mathematical theorem itself): when a certain algorithm is efficient in combination with a (a class of) fitness function(s), then the algorithm must have been chosen very carefully. (p. 467) (Note that this point is independent from the presence of a 'target', which is not even mentioned here by Meester.)

Meester points out that programmers do not chose the fitness functions in the simulation "at random over all possibilities" (p. 466). This is unsurprising, however, because *neither are they in the biological world*. Fitness functions in real life exhibit a significant amount of what Häggström (2007a) terms "clustering properties", which means that the fitness values of two highly similar DNA sequences are not statistically independent. In particular, "similar DNA sequences will tend to produce similar fitness values" (2007a, p. 228), allowing a search algorithm like natural selection to perform much better than blind chance. (Perakh 2004) The same point applies to the search algorithm itself, which is only "tailored" in the sense that it is specifically programmed to mirror the *actual* biological search algorithm, i.e. random variation and selection. In fact, what Meester objects to in these simulations is precisely what makes them successful simulations in the first place: they mimic the conditions of real life. Somehow, Meester thinks this only poses a problem for simulations of biological evolution:

> I do not claim – of course – that a simulation can only be meaningful if there is no design in the simulation. Indeed, it is impossible to simulate without designing a program. Often this is no problem, but if the whole point of your simulation is to show that complexity can arise in the universe in a Darwinian (and therefore non-teleological) way, then it does become a problem, since then the above discussion applies and shows that any successful computer program must be intrinsically teleological (p. 471).

Notwithstanding Meester's claim to the contrary, his argument is far too general. It can be raised against simulations of biological evolution *without* a preset target, but also against any simulation or model, of any phenomenon or in any form. If Meester's argument is sound, they would all become 'teleological' and hence unsuited to describe purely natural processes. Weather forecasts, for example, are set up by intelligent humans, which would make them intrinsically teleological and hence useless to talk about real weather phenomena, because the latter are thought of as undirected, natural processes. Unless, of course, there is a designer at work in the real world after all. That is impossible to test, however, because, if Meester is right, models are necessarily and intrinsically teleological. As a consequence, Meester's argument actually immunizes teleology from falsification. Now, given the general implications of his critique, it makes one wonder why Meester singles out simulations of biological evolution as his main target.

## Conclusion

The NFL theorem turns out to be completely irrelevant to Meester's argument against the usefulness of computer simulations of biological evolution. In the end, Meester's point is just that computer simulations are designed, real-life is supposed to be not designed, and therefore simulations cannot be used as models for the real thing. Both the first and the second premise are trivially true, but the conclusion does not follow. A Darwinian algorithm simply does not cease to be Darwinian if simulated in a computer program. By employing the term "teleological" in an incoherent manner and presenting his argument with a mathematical twist, Meester thinks he can work this magic trick. Simulations of biological evolution, however, are in no way threatened by the first NFL theorem.

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