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Metaphor-based metaheuristics, a call for action: the elephant in the room

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Taking inspiration from natural behaviors to devise new optimization algorithms has played an important role in the history of the field of metaheuristics (Sörensen et al. 2017). Unfortunately, in the last two decades we have been witnessing a new trend by which dozens of metaphor-based metaheuristics based on the most diverse possible set of natural, artificial, social, and sometimes even supernatural phenomena and behaviors are proposed, without a clear motivation beyond the desire of their authors to publish their papers.

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Despite several attempts (Sörensen 2015; Sörensen et al. 2019; Weyland 2010; Piotrowski et al. 2014; Fong et al. 2016; Camacho Villalón et al. 2019; Camacho Villalón et al. 2020; Swan et al. 2015; Lones 2020; Tzanetos and Dounias 2020) to put an end to the flood of increasingly outlandish, "novel" metaphor-centered metaheuristics, there is still a steady inflow of such papers submitted, and often accepted for publication. For many reasons, we believe this is detrimental to the field of metaheuristics. This letter describes some of the negative effects of publishing such papers in the literature and proposes a necessary action to try to put a limit to this highly undesirable phenomenon.

Useless metaphors The usefulness of the metaphors that inspired the myriad of metaheuristics already published somewhere in the literature is arguably the most questionable aspect of these methods. As demonstrated by the long list of "novel" algorithms gathered by Campelo and Aranha (2021), inventing a metaheuristic that loosely mimics a real-world process is a trivial exercise that does not in itself justify inclusion in the scientific body of literature. Also, it is often the case that the mathematical models derived from the metaphors are modified or omitted in the implementation of the metaheuristics because they result in poorly performing implementations (Melvin et al. 2012; Piotrowski et al. 2014). Indeed, it is not only the fact that using these new metaphors lacks any sound, scientific motivation; but also that, in most cases, the metaphors themselves are not well represented by the resulting computational algorithm (i.e., the metaphor is invariably oversimplified or modified to look like an optimization process even when it is not). Very alarming is the fact that there are numerous examples of metaphor-based metaheuristics in which the metaphor, the mathematical model derived from the metaphor and the implementation of the algorithm are three (almost completely) different things (Camacho Villalón et al. 2020; Camacho Villalón et al. 2021).

Lack of novelty One argument often used to justify introducing a new metaphor-based metaheuristic is that there are novel concepts in the behavior inspiring the algorithm that can be used to solve optimization problems. Unfortunately, there is plenty of evidence that this is rarely the case. In fact, it has become increasingly common to discover, sometimes a few years after publication, that the exact same concepts proposed in the "novel" metaheuristic were proposed before in previously published works (Weyland 2010; Simon et al. 2011; Piotrowski et al. 2014; Camacho Villalón et al. 2019; Camacho Villalón et al. 2020; Tzanetos and Dounias 2020; Camacho Villalón et al. 2021). However, what is invariably new is the non-standard terminology used to present the "novel" metaheuristics. Publishing papers that do not propose anything more than a new terminology to refer to already well-known concepts has pernicious effects, such as (i) creating confusion in the literature, (ii) hindering our understanding of the existing metaphor-based metaheuristics, and (iii) making extremely difficult to compare metaheuristics both theoretically and experimentally.

Poor experimental validation and comparison Biased computational experimentation, the so-called apples to oranges comparison, often comparing "novel" metaphor-based metaheuristics run on recent computers against methods run on older computers, and/or limited experimentation often show a false picture of the performance of a "novel" method (Sörensen 2015; Weyland 2010). In addition to this, rather than testing the "novel" metaheuristic against the best performing algorithms for the considered problem, the comparison is often made with other versions of the very same metaheuristic that is being evaluated or with old algorithms whose performance is far from the state-of-the-art (García-Martínez et al. 2017).

It is important to stress that, even in those cases in which a metaphor-based metaheuristic can be shown to have a very good performance on some optimization problems,

expressing an optimization method in the non-standard, metaphor-based vocabulary only serves to obfuscate its functioning, making it close to impossible to position the "novel" method in the literature and to discern how it relates to existing methods.

Metaphor-based optimization in application-oriented journals Because of the measures that the field of optimization has been increasingly taking against papers whose only contribution to the literature is a new metaphor upon which an otherwise trivial optimization algorithm is based (see below), authors of such papers are resorting to different outlets, such as journals that publish papers on the topic of the metaphor. For instance, if the metaphor is the mating behaviour of bats, authors will attempt to publish it in specialised journals on bats, or on animal mating behaviour; metaheuristics inspired on improvising musicians will go for journals on music. If the metaphor is the spread of a virus, they will turn to journals on biomedical informatics. The additional advantage of submitting a manuscript to what can only be considered an off-topic journal is that editors and reviewers might not be sufficiently knowledgeable in the specific field of optimization to evaluate the true merits of the paper. Fortunately, this strategy usually does not work and the editors and reviewers quickly realize that the paper is out of scope for their journal. In some cases, regrettably, a paper manages to slip through the net of peer review and gets published. This may happen, e.g., when reviewers are selected from the authors' bubble (based on the list of references or, in some cases, on recommendations of the authors themselves); or when reviewers become blindsided by the metaphor and fail to recognize that the manuscript lacks any meaningful contribution to the state-of-the-art.

The appearance of papers proposing algorithms inspired by often ludicrous processes that do not—by any stretch of the imagination—optimize anything indicates poor scientific housekeeping and, consequently, radiates badly on the research community on metaheuristics. We strongly feel that it is in the best interest of this community that scientific standards in the field are improved, and that papers whose only claim to scientific contribution is having found a new source of inspiration are no longer published. For this reason, we call upon all editors-in-chief in the field to adapt their editorial policies—like several journals such as the Journal of Heuristics (Journal of Heuristics 2015), Swarm Intelligence (Dorigo 2016), and the ACM Transactions on Evolutionary Learning and Optimization (ACM 2021) have already done—and add a statement to the following effect to their submission guidelines:

> This journal will not publish papers that propose "novel" metaphor-based metaheuristics, unless the authors (i) present their method using the normal, standard optimization terminology; (ii) show that the new method brings useful and novel concepts to the field; (iii) motivate the use of the metaphor on a sound, scientific basis; and (iv) present a fair comparison with other state-of-the-art methods using state-of-the-art practices for benchmarking algorithms.

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