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Erratum

A note on “Opposition versus randomness in soft computing techniques” [Appl. Soft Comput. 8 (2) (2008) 906–918]

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ABSTRACT

In this note we clarify some issues with respect to the *central opposition theorem* as formulated in [1]. We slightly reformulate the theorem to more plausibly highlight its proof. As well, we provide some general remarks to better understand the scope of that theorem.

1. Central Opposition Theorem

The Central Opposition Theorem as stated in [1] is:

Theorem 1.1. *Assume that* (a) $y = f(x)$, $(x \in [a, b])$ *is an unknown function with at least one solution* $x_s \in [a, b]$ *for* $f(x_s) = \alpha$; *the solution can be anywhere in our search space* (i.e. *a black-box optimization prolem*), (b) x *is the first uniform random guess and* x_r *is a second uniform random guess in* $[a, b]$; *candidate solutions should be uniform random numbers because all points have the same chance to be the solution,* (c) *Opposite of* $x \in [a, b]$ *is defined as* $\breve{x} = a + b - x$, *then* $Pr(|\breve{x} - x_s| < |x_r - x_s|) > Pr(|x_r - x_s| < |\breve{x} - x_s|)$. *In other words, the probability that the opposite point is closer to the solution is higher than the probability of a second random guess.*

The statement (c) of this theorem is not precisely formulated. The miswording which does not accurately represent the main statement of the theorem is the sentence “the probability that the opposite point is closer to the solution is higher than the probability of a second random guess”.

The presented proof (for 1-*D*) actually proves the following probabilities:

- $Pr(|x - x_s| < \min\{|x_r - x_s|, |\breve{x} - x_s|\}) = 0.3613$
- $Pr(|\breve{x} - x_s| < \min\{|x_r - x_s|, |x - x_s|\}) = 0.3613$
- $Pr(|x_r - x_s| < \min\{|x - x_s|, |\breve{x} - x_s|\}) = 0.2773$

Therefore, assuming case (1) does not occur (i.e. $|x - x_s|$ is the closest) there is a difference of $0.3613 - 0.2773 = 0.084$ favoring the opposite guess. To correctly show this the revised wording of this theorem should read:

Theorem 1.2. *Assume that* (a) $y = f(x)$, $(x \in [a, b])$ *is an unknown function with at least one solution* $x_s \in [a, b]$ *for* $f(x_s) = \alpha$; *the solution can be anywhere in our search space* (i.e. *a black-box optimization prolem*), (b) x *is the first uniform random guess and* x_r *is a second uniform random guess in* $[a, b]$; *candidate solutions should be uniform random numbers because all points have the same chance to be the solution,* (c) *Opposite of* $x \in [a, b]$ *is defined as* $\breve{x} = a + b - x$. *Then,* $Pr(|\breve{x} - x_s| < \min\{|x_r - x_s|, |x - x_s|\}) > Pr(|x_r - x_s| < \min\{|x - x_s|, |\breve{x} - x_s|\})$. *In other words, the probability that the opposite point is closer to the solution is higher than a second random guess, assuming the original guess is not closer* (i.e. $|x - x_s| > \min(|\breve{x} - x_s|, |x_r - x_s|)$).

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The n-dimensional case then follows as described in [1], with a similar rewording as above.

In addition we should reinforce the following knowledge:

- x and x_r are independent random variables
- x and $\breve{x}$ are not independent since $\breve{x} = a + b - x$, hence, $\breve{x}$ is not an independent random variable and may be regarded, at most, as a quasi-random number
- x and $\breve{x}$ are always considered as a pair ($\breve{x}$ does not exist without x)
- $\breve{x}$ and x_r cannot be compared to each other in any respect by neglecting x, only the pair $(x, \breve{x})$ can be compared to x_r as demonstrated in Theorem 3 in [1]

The interested reader may find more insight in [2].

References

[1] S. Rahnamayan, H.R. Tizhoosh, M.M.A. Salama, Opposition versus randomness in soft computing techniques, Applied Soft Computing 8 (2) (2008) 906–918.
[2] M. Ventresca, Oppositional Concepts in Computational Intelligence. Springer Series: Studies in Computational Intelligence, vol. 155, Springer, 2008.