# Shark Smell Optimization

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**Abstract.** In this paper a pseudocode is presented for the Shark Smell Optimization algorithm.

## 1 Introduction

In this paper we introduced and explained the pseudocode (as seen in 3) for a new optimization algorithm based on the hunting method of sharks. The algorithm was originally introduced here [1].

## 2 Algorithm Description

This algorithm uses a ”shark”, an individual, to find a ”wounded fish”, the maximal value of the objective function, by following the ”blood particles”, the gradient of the objective function, and performing ”circular searches”, local searches around the individual's position at each stage. This is repeated for each individual until stage $k_{max}$ is reached. The number of individuals and stages can be decided by the user. A single iteration of the algorithm will first contain the calculation of the movement of the individuals in each dimension of the search space. Then a new position is calculated for every position. From this position a random local search will be done, where the best point from this search will be compared with the position from the the first search. The best one of these will be the new starting position for this individual for the next iteration.

### 2.1 Comparison with standard algorithms

### 2.2 (Optional) Usage of algorithms

## 3 Pseudo-code

We followed the following notation convention. All user assigned variables are mentioned in Appendix A.

- $N$: The number of individuals in the set/array.
- $M$: The dimensionality of the search space.
- $k_{max}$: Maximal amount of stages.
- $O$: Number of rotational candidate solutions.
- $n$, $m$, $k$ and $o$: Administrative array counters for $N$, $M$, $k_{max}$ and $O$ respectively.
- $X_n^k$: The solution candidate $\mathbb{R}^n$ of an individual at a stage.
- $V_n^k$: The calculated movement in $\mathbb{R}^n$ for an individual at a stage.
- $v_{n,m}^k$: The calculated movement in a direction for an individual at a stage.
- $Y_n^k$: The provisional solution candidate in $\mathbb{R}^n$ after movement of an individual at a stage.
- $Z_n^k$: Set of O provisional solution candidates in $\mathbb{R}^n$ of an individual at a stage after local search.
- $x_m$: A variable in the search space.
- $x_m^{\min}$, $x_m^{\max}$: The minimal and maximal values in the search space for a variable.
- $f(\mathbf{x})$: Objective function value of $\mathbf{x}$ $(f : \mathbb{R}^n \to \mathbb{R})$.
- $\leftarrow$: Assignment operator.
- $\boldsymbol{\alpha}$: User assigned vector in $\mathbb{R}^k_{max}$ between 0 and 1. Represents the inertia coefficient for each stage.
- $\boldsymbol{\beta}$: User assigned vector in $\mathbb{R}^k_{max}$ between 0 and 1. Represents the velocity limiter ratio for each stage.
- $\boldsymbol{\eta}$: User assigned vector in $\mathbb{R}^k_{max}$ between 0 and 1. Limits the gradient of the objective function for each stage.
- $R1$ and $R2$: Random uniform value between $0$ and $1$ to give the algorithm more stochastic search value.
- $R3$: Random uniform value between $-1$ and $1$ to give the algorithm more stochastic search value.
- max(): Takes the the maximum value of the values between brackets. If there is one value between the brackets, it takes the maximum value of all values produced in the for loop, used in line 32.
- Further notation convention is based on mathematics.

**Algorithm 1** Shark Smell Optimization

$M \leftarrow User \quad assigned$ ▷ Initialize
$k_{max} \leftarrow User \quad assigned$
$k \leftarrow 1$
$O \leftarrow User \quad assigned$
$\boldsymbol{\alpha} \leftarrow User \quad assigned$
$\boldsymbol{\beta} \leftarrow User \quad assigned$
$\boldsymbol{\eta} \leftarrow User \quad assigned$
**for** $n = 1 \rightarrow n$ **do**
  **for** $m = 1 \rightarrow m$ **do**
    $x^1_{n,m} \leftarrow \boldsymbol{\mathcal{U}}(x^{\min}_m, x^{\max}_m)$
  **end for**
**end for**
**while** $k < k_{max}$ **do**
  **for** $n = 1 \rightarrow N$ **do** ▷ Calculation of movement per individual
    **for** $m = 1 \rightarrow M$ **do**
      $v^k_{n,m} \leftarrow \eta_k \cdot R1 \cdot \frac{\partial f(x)}{\partial x_m}\Big|_{X^k_n} + \alpha_k \cdot R2 \cdot v^{k-1}_{n,m}$
      **if** $\left|v^k_{n,m}\right| > \left|\beta_k \cdot v^{k-1}_{n,m}\right|$ **then**
        $\left|v^k_{n,m}\right| \leftarrow \left|\beta_k \cdot v^{k-1}_{n,m}\right|$
      **end if**
    **end for**
  **end for**
  **for** $n = 1 \rightarrow N$ **do** ▷ Provisional assignment of new position per individual
    $Y^{k+1}_n \leftarrow X^k_n + V^k_n$
  **end for**
  **for** $n = 1 \rightarrow N$ **do** ▷ Random local search from provisional position per individual
    **for** $o = 1 \rightarrow O$ **do**
      $Z^{k+1,o}_n \leftarrow Y^{k+1}_n + R3 \cdot V^k_n$ ▷ Deviation
    **end for**
  **end for**
  **for** $n = 1 \rightarrow N$ **do** ▷ Definitive assignment of new position chosen from provisional position and random local searches per individual
    **for** $o = 1 \rightarrow O$ **do**
      $X^{k+1}_n \leftarrow \max(f(Z^{k+1,o}_n))$
    **end for**
    $X^{k+1}_n \leftarrow \max(f(X^{k+1}_n), f(Y^{k+1}_n))$
  **end for**
  $k \leftarrow k + 1$ ▷ Administration
**end while**

### 3.1 Assumptions

With this algorithm we have done the assumed that the objective function should be maximized. In our pseudocode, on line 27, we deviated from the original paper. In the original paper this line was:
$Z_i^{k+1,m} \leftarrow Y_i^{k+1} + R3 \cdot Y_i^{k+1}$
We changed the second $Y$ to a V, as we think that the searchspace for the rotational movement should be related to the velocity, and not to the current location.

## 4 Experiments

### 4.1 Original experiments

## 5 Results

## 6 Conclusion

## Appendix A

| Variable | Minimum value | Maximum value |
|---|---|---|
| $M$ | 1 | undefined |
| $k_{max}$ | 1 | undefined |
| $O$ | 0 | undefined |
| $\alpha_k$ | 0 | 1 |
| $\beta_k$ | 0 | 1 |
| $\eta_k$ | 0 | 1 |

## References

1. Abedinia, Oveis, A.N., Ghasemi, A.: A new metaheuristic algorithm based on shark smell optimization. In: Wiley Periodicals. vol. 21, No. 5, pp. 97–116 (2014)

## A Supplementary materials

Next to the report, you are also required to submit the following materials:

– The C++ code of your algorithm. Use sufficient comments, modular coding style and clear variable names. This should only be one file which can directly be plugged into the IOHexperimenter (name the file *GroupXX.cpp*). Make sure this file compiles and runs without errors on linux (the machines in rooms 302-306).
*Tip: You can sse https://git.liacs.nl to host and share code with your teammates. You can log in using your ULCN username and password.*

– The runtime data generated by your code. This should be a single zip-file, containing only the data from your algorithm (set algorithm name property to *GroupXX-Animal-Name*).

– Per team member: In an email (to `d.l.vermetten@liacs.leidenuniv.nl`, subject line should include "[NaCo Assignment Review]" + your group number): a grade for your teammates based on their contribution, with some motivation.

– This report in pdf format + the files used to generate it (tex, bib, figures).