

SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: 15140

STSM title: Robust and understandable evolutionary algorithms

STSM start and end date: 06/11/2018 to 14/11/2018

Grantee name: Adam Viktorin

PURPOSE OF THE STSM:

The purpose of this STSM under the ImAppNIO COST action was to discuss the ongoing research in Artificial Intelligence Laboratory – A.I.Lab (<https://ailab.fai.utb.cz/>) connected to PhD thesis of grantee Adam Viktorin and the development of more robust but understandable evolutionary algorithms for global optimization. In the past, the grantee has already worked with host Assist. Prof. Dr. Ales Zamuda (COST ImAppNIO WG3: Benchmarking vice-chair).

The main goal was to finalize a joint publication for Swarm and Evolutionary Computation Journal dealing with a new adaptive scheme for control parameter values in Success-History based Adaptive Differential Evolution (SHADE)-based algorithms (<https://doi.org/10.1016/j.swevo.2018.10.013>). This paper also proposes a novel algorithm for continuous single objective optimization titled DISH, co-authored by grantee and host:

Distance based parameter adaptation for Success-History based Differential Evolution
Adam Viktorin, Roman Senkerik, Michal Pluhacek, Tomas Kadavy, Aleš Zamuda
<https://doi.org/10.1016/j.swevo.2018.10.013>

Abstract

This paper proposes a simple, yet effective, modification to scaling factor and crossover rate adaptation in Success-History based Adaptive Differential Evolution (SHADE), which can be used as a framework to all SHADE-based algorithms. The performance impact of the proposed method is shown on the real-parameter single objective optimization (CEC2015 and CEC2017) benchmark sets in 10, 30, 50, and 100 dimensions for all SHADE, L-SHADE (SHADE with linear decrease of population size), and jSO algorithms. The proposed distance based parameter adaptation is designed to address the premature convergence of SHADE-based algorithms in higher dimensional search spaces to maintain a longer exploration phase. This design effectiveness is supported by presenting a population clustering analysis, along with a population diversity measure. Also, the new distance based algorithm versions (Db_SHADE, DbL_SHADE, and DISH) have obtained significantly better optimization results than their canonical counterparts (SHADE, L_SHADE, and jSO) in 30, 50, and 100 dimensional functions.

Other goals comprised of evaluating experiment results for other topic related to Differential Evolution and an open discussion about the meaning of these results. Another part of the STSM was to discuss possible future research directions of improving DISH algorithm regarding its robustness and performance.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSM

Daily meetings were carried out during this STSM between STSM grantee (Adam Viktorin) and host (Assist. Prof. Dr. Aleš Zamuda). During these meetings discussions regarding following topics took place:

- Finalization of the SWEVO paper processing (Distance based parameter adaptation for Success-History based Adaptive Differential evolution - <https://doi.org/10.1016/j.swevo.2018.10.013>). Post-acceptance discussion about the last revision and respond to reviewers comments.

- The future direction of possible research on the DISH algorithm proposed in the above-mentioned paper regarding improvement and possible implementation in other optimization fields.
- Discussions and collaboration on writing of a future joint paper in the context of Differential Evolution Case Study.
- A quick overview of the research carried out at the hosting laboratory.

Apart from the discussions a series of tests and result evaluations took place as well:

- Testing of a novel method implemented into the DISH algorithm.
- Statistical evaluation of the results regarding the second above mentioned Differential Evolution collaboration.
- Preparation of tables and figures for the manuscript.
- Rewriting of the current version of the manuscript.

Social network activities:

- The results of this STSM were also advertised on Twitter and Facebook:
<https://twitter.com/aleszamuda/status/1062301837410422785>
https://twitter.com/A_I_Lab/status/1062293702356451328
<https://www.facebook.com/ailab.fai.utb.cz/posts/1584603401641640>

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The main results obtained during this STSM could be described by the following points:

- The final version of a joint publication *Distance based parameter adaptation for Success-History based Adaptive Differential Evolution* for SWEVO journal was discussed during the STSM and got listed as accepted in the Articles in press page of SWEVO journal. The publication is now available at <https://doi.org/10.1016/j.swevo.2018.10.013>. The article was made available on 12th November 2018.
- For the other manuscript, statistical evaluation of the results was done, which produced three types of tables based on three hypotheses. There are currently 135 new tables connected to the first hypothesis, 45 new tables connected to the second hypothesis and 27 new tables connected to the third hypothesis. For a more clear overview of the results, 3 aggregating tables (one for each hypothesis) were produced as well and further aggregated into the final table comprising only of the hypotheses and their acceptance rate. Also, 27 boxplot figures describing basic statistical properties were produced and put into the manuscript. Furthermore, 30 comparison figures were produced in order to compare two different approaches to a given problem.
- The experiment regarding a new method implemented into DISH was designed and is run.

FUTURE COLLABORATIONS

The discussion on the form of a future collaboration was part of the STSM. STSM applicant Adam Viktorin and Assist. Prof. Aleš Zamuda are currently working on another joint publication concerning Differential Evolution. Also, during the STSM a number of possible future directions regarding DISH algorithm and its benchmarking was raised, which will be another form of collaboration between both laboratories.