

Wydział Informatyki, Elektroniki i Telekomunikacji

KATEDRA INFORMATYKI

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Szanowny Panie Dziekanie,

w załączeniu przesyłam recenzję poprawionej wersji rozprawy doktorskiej Pana mgra Radhwana Yousif Sedik Al-Jawadiego nt. „New Evolutionary Optimization Algorithms Using Similarities and Dissimilarities in Binary Strings”.

Z wyrazami szacunku



Kraków, October 20, 2018

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w Krakowie

Evaluation report of the PhD dissertation

The subject of this review is the evaluation of the corrected version of the dissertation entitled “New Evolutionary Optimization Algorithms Using Similarities and Dissimilarities in Binary Strings” prepared by Radhwan Yousif Sedik Al-Jawadi and supervised by prof. dr. hab. Marcin Studniarski. The review was prepared at the request of the Dean of Faculty of Mathematics, Informatics, and Mechanics, University of Warsaw.

Both the problem area and the importance of the subject matter were discussed when evaluating the original version of the dissertation and the conclusions remain up-to-date with the corrected version. The essence of my opinion is that: 1. building and analyzing effective and efficient algorithms for computationally difficult problems is extremely important and widely discussed topic in the contemporary literature; 2. the results reported by the Author in the dissertation show good performance of the proposed techniques considering the selected (extended) set of benchmark problems. I also stick to my final statement that the ideas presented in the dissertation may constitute an interesting step towards the construction of efficient algorithms for the considered class of optimization problems.

The structure and contents of the dissertation

The dissertation contains 201 pages (previously 156 pages) and is written in English. It is comprised of 8 chapters, including Introduction and Conclusions. It includes a Polish and English abstract, lists of abbreviations, contents, tables, drawings and a bibliography. A general structure and contents of the thesis has not changed much, yet the new version improves the readability and technical quality of the text.

The introduction gives a general background for search and optimization techniques, and contains updated thesis aims, which in particular reflect the new experimental results regarding the comparison with state-of-the-art algorithms.

The second chapter now presents a much more detailed review of research in the field of evolutionary algorithms, and – what is especially important – provides some background of the latter-proposed techniques.

In the next three chapters the Author introduces new evolutionary techniques for single objective continuous optimization problems, which are based on the similarity and dissimilarity operators. The experimental part of each chapter was extended to show the effectiveness comparison with algorithms more suitable for continuous optimization, as well as to provide more information on their performance.

The new Chapter 7 collects the experimental results comparing all proposed algorithms based on an extended set of benchmark problems.

Discussion of the Author's contributions

As mentioned earlier, the extensions and corrections introduced in the new version of the dissertation make the work read better and the discourse more convincing. The most important is the complementary experimental material provided to show the performance of the proposed algorithms, especially to compare them with selected state-of-the-art evolutionary approaches. In other words, the technical quality of the work has been improved.

Nevertheless, my overall assessment of the Author's contributions remains similar as before. I consider that the proposition and experimental evaluation of new algorithms is the main achievement of the thesis. The introduced solutions make use of different techniques to maintain the diversity of the population, which is one of the most important practical aspects of applying evolutionary algorithms. Thus, both the direction of research and the methodology based on empirical research fits well with trends in the field of computational intelligence. The proposed combinations of operators give interesting results and thus can be the basis for further research and development. I would also stress an important element of the work, which is the convergence analysis of one of the proposed algorithms, giving a theoretical background to the presented algorithmic solutions.

Despite the extensions and corrections introduced, the dissertation still contains issues of problematic or at least debatable nature. I should stress the following:

1. In the corrected version of the dissertation the formulation of the main goal remains at the same level of generality and concerns the introduction of new algorithms to effectively solve continuous optimization problems. Even though the experimental evaluation of these new algorithms, which seems to be the most

important Author's contribution, was extended to cover a wider spectrum of benchmark problems and competing algorithms, I consider it still too narrow for such a general statement. Anyway, I appreciate the number and variety of experiments reported.

2. Even though the range of competing algorithms was significantly increased (from only classical Genetic Algorithm in the original version to Differential Evolution and Covariance Matrix Evolutionary Strategy), these are surely not the best existing algorithms for solving such multimodal optimization problems as most of the benchmarks used. Solving computationally difficult optimization problems (in terms of both fitness landscape shape and dimensionality) with the use of evolutionary algorithms often requires applying some dedicated apparatus. Considering the multimodality, a typical example would be a speciation mechanism, such as in structured population approaches, which realize the idea of allopatric speciation. Notwithstanding these remarks I appreciate the experimental comparison with more state-of-the-art algorithms provided by the Author.
3. In experiments with 100-dimensional benchmarks the Author applied a "hack" as described on page 145. I understand that it was because of weak results achieved in this case by the examined algorithms (?). I would like to stress that it seems this should work only for symmetric functions with a global optimum in $(0, \dots, 0)$. It could be treated as a "dedicated apparatus" as described above, but first of all it uses low level information about the optimization problem, and as such, lacks generality. Even if we look at it as a dedicated "informed" mechanism, it makes the comparison unfair because the competitors are unaware of the particular problem being solved. Despite this, the classical Genetic Algorithm finds the solution faster, which is not commented by the Author at all.
4. A discussion of the experimental results and conclusions drawn are invariably scarce. The description of experiments lacks interpretation and deeper analysis of the results obtained. The Author comments on what was observed but does not try to answer the question why it happened. Reading provided descriptions one may have an impression that the Author does not understand the behavior and features of the proposed mechanisms. What is also important, the computational complexity of different algorithms is completely neglected in the reports and conclusions from the experiments.
5. The structure of the dissertation still looks like a compilation of independent publications. Even though the state of the art in Chapter 2 has been significantly expanded, the discourse in many places is inconsistent because of very few references between particular chapters, especially new sections of Chapter 2.

Final evaluation

The corrected version of the dissertation is better structured and contains new results, which improve its overall technical quality. I maintain that the Author presented the original solution to an important research problem in the field of computer science and the results prove the ability to conduct scientific work on his own. The aforementioned shortcomings are of a debatable nature and do not significantly affect the merits of the presented issues.

In my opinion, the dissertation prepared by Radhwan Yousif Sedik Al-Jawadi entitled "New Evolutionary Optimization Algorithms Using Similarities and Dissimilarities in Binary Strings" **meets the minimum requirements set for doctoral dissertations by the relevant law.** I, therefore, propose to **accept this dissertation and allow the Author to defend it publicly.**

A handwritten signature in blue ink, appearing to read "Radhwan Yousif Sedik Al-Jawadi". The signature is fluid and cursive, with a long, sweeping underline that extends to the left.