Review of the Ph.D. thesis

Chaotic Attributes and Permutative Optimization

by **Donald Davendra**

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The author deals in his Ph.D. thesis with the class of problems of a combinatorial nature. These problems have quite simple formulations and they can be described by integer or mixed integer programming models. However, they belong to class of NP-hard or NP-complete problems, and therefore finding their exact solutions using methods such as dynamic programming and branch and bound method is restricted only to smaller instances. For large instances, the exact solution is not reachable in a reasonable amount of time and thus we must reduce the searching space of feasible solutions and only approximate it using heuristic or approximative methods.

The author his main attention paid to soft computing methods, especially evolutionary methods. Because of the fact that NP-hard problems cannot be solved by polynomial algorithms and no free lunch theorem this scientific area is still challenging and scientists try to find problem specific parameter settings, modifications of artificial intelligence methods, their combinations or propose quite new approaches. From this point of view is clear that topic of doctoral thesis is of high importance.

The Ph.D. thesis is logically structured into chapters and subchapters. It covers a wide class of problems, mainly from the area of scheduling of manufacturing processes (Permutative Flow Shop Scheduling, Flow Shop Scheduling with Limited Intermediate Storage, Flow Shop Scheduling with No Wait, Job Shop Scheduling) and several other well know combinatorial optimization problems (Quadratic Assignment Problem, Quadratic Assignment Problem).

The thesis has a theoretical and experimental part. The theoretical part is written in strictly mathematical style and summarises heuristics methods, parameters and their settings. In experiment part, the author uses for computations and tuning parameters of methods a large set of the Taillard benchmarks. I think that it would be useful also address benchmarks from the Operations Research Library, managed by John Beasley from Imperial College in London, because they are frequently used for comparing of quality of algorithms.

The Ph.D. thesis is written is very good English and from the presentation point of view (typography, graphs, mathematical style) is excellent. Misprints are not frequent (on page 14 instead of "Alrogithm ", "Algorithm" should be; page 52 - instead of "Each job has be pocessed", "Each job has to be processed" should be, page 59: "refered" – "referred", ...). However, the chapters are very brief, tables of experiment results immediately follow mathematical models and almost no applications are presented. The dissertation looks like a book of combinatorial optimization.

The author compares methods that he used (SOMA, differential evolution, genetic algorithms, ...), but I think that it would be nice to compare his results with published results of the other authors to prove that his approaches bring an improvement. As to JSSP, at least well known papers of E. Nowicki and C. Smutnicki (1996, tabu search) and E. Balas and A. Vazacopoulos (shifting bottleneck algorithm, 1998) should be mentioned in references.

I can say that the author has presented many original approaches and problem specific adaption of soft computing methods, and verified their efficiency on wide class of benchmarks. Very interesting and promising is his application of clustering techniques.

Questions

1. What is a difference between NP-hard and NP-complete problems?
2. Can you mention (more) practical applications of the studied combinatorial optimization problems?

Conclusion:

In my opinion, Donald Davendra has proved to be capable of solving difficult research problems.

The Ph.D. thesis satisfies conditions of the Czech Act 111/1998 and its Section 47, it has been solved in the framework of scientific projects, author's results have been published in books, prestigious scientific international conferences and journals and thus accepted by scientific community and therefore

I recommend,

Donald Davendra's Ph.D. thesis to be accepted by the Committee to be presented and defended in the Technical Cybernetics study branch.

Brno, 6th October 2009

Prof. RNDr. Ing. Miloš Šeda, Ph.D.
Institute of Automation and Computer Science
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PhD thesis review

Name of the thesis: **The Chaotic Attributes and Permutative Optimization**
Student: **Donald Davendra**

The student has chosen the stated topic, which is concerned to a novel approach of evolutionary algorithms with permutative varients. Work contains new evolutionary approaches for finding a suitable clustering in evolutionary algorithms (clustered population approach). Designed algorithms have been tested on a number of difficult tasks described in section from 5 to 10.

Five relatively ambitious aims are stated in the thesis. Designed modifications (varients) algorithms used evolutionary algorithms (SOMA, and DE). New algorithms ware generated on the principle of artificial intelligence. Complexity of stated aims were given also by choice of tested tasks.

Conclusion: PhD thesis has full-filed all stated aims, fits into the dissertation area and deals with very perspective problems of optimization algorithms.

Obtained results of PhD thesis contribute for solutions of very difficult problems because they improve classical evolutionary approach with permutative-based tools. Obtained results were published at research conferences and books. Special appreciation is attributed to the extensive amount of test computation in sections 5 - 10, which verify and validate the designed concept.

Conclusion: PhD thesis brings new knowledge in the area of improved evolutionary algorithms to solve difficult optimization problems. On the basis of list of author research activities and her oral presentations at the conferences is possible to state that Donald Davendra **has sufficient research erudition required to obtain the academic title.**

Other contributions of the work is, that it serves as a overview of current and designed optimization methods based on a combination of evolutionary algorithms with permutative-based combinatorial approaches. Thesis consists of several new approaches tested in sections 5 to 10. Reached results are contributing to area of knowlegde and there is great hope that this new approach to the design of improved algorithms especially in generally used algorithms even in exponentially amount of evolutionary algorithms in the area of Softcomputing.

Conclusion: Thesis is contributing to other development of science and technology, mainly in the area of optimization algorithms for solving complex permutative problems.

The thesis is elaborated, well-arranged, exemplary and it does not contain significant grammatical mistakes.

Remarks to the thesis:

In the introduction chapter is a very short description of current methods that are used for solving complex problems. There are only few small terminological errors in the text.

Questions to the defence:

1) Is it possible to use hierarchical and hybrid structures in the construction of parallel evolutionary algorithms with permutative-based combinatorial approaches?

With respect to facts listed in the thesis review (despite the listed insufficiencies), I recommend PhD thesis by **Donald Davendra** to defence. After successful tract and conclusion of the defence, I recommend further to give an academic title

„ Ph.D.“

to Donald Davendra according the law par. 47 odst.5 Zákona č. 111 about Universities.

In Brno 6.10.2009

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Prof.Ing.Pavel Ošmera, CSc.
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Review of PhD thesis.

Name of the postgraduate student: Donald David Davendra, M.Sc.

Ph.D. thesis title: Chaotic Attributes and Permutative Optimization

Reviewer: Prof. Ing. Petr Pivoňka, CSc., Department of Control and Instrumentation, Faculty of Electrical Engineering and Communication, Brno University of Technology, Czech Republic

Contents

The theme of this thesis is diversity in Evolutionary Algorithms and its application to permutative-based combinatorial optimization problems. This class of problem is very important in the field of manufacturing, scheduling, production planning and logistics.

The submitted dissertation thesis consists of 140 pages, 12 chapters, bibliography, publication list and curriculum vitae. It is written in English. Publication activity of the author comprises 1 book as co-author, 3 book chapters as co-authors, 2 papers in journal and 11 papers in international conferences.

The thesis is divided in two main parts, theoretical and experiment section. In theoretical section, Differential Evolution, permutative Self-Organizing Migration Algorithm SOMA and chaotic signature in population dynamics are described. The experiment section consists of testing of the flow shop scheduling, quadratic assignment problem, vehicle routing problem with analysis and conclusions.

Actuality of the Work

This thesis has examined the development and enhancement of Differential Evolution and SOMA optimization methods for the solving of permutative problems, and has developed the concept of stagnation in Evolutionary Algorithms. For this reason I consider this thesis theme as well chosen and it is a current research area in the present state of science.

Dissertation work consists of these main objectives:
- To expand and refine the application of DE to solve complex permutative problems.
- To develop permutative variant of SOMA.
- To develop static and dynamic inductive permutative versions of SOMA.
- To analyze the development of stagnation in Evolutionary Algorithms and develop a generic clustered population approach based on the principle of chaos.
- To perform detailed experimentation on a large number of different and complex combinatorial problems.

Conclusion

After studying the thesis and the student's publication activities, I have reached the conclusion that the student is a fully developed scientist and is able to do creative research. The student showed an excellent knowledge on the field Evolutionary Algorithms.

The thesis complies with the requirements on this type of work. I recommend the thesis for defense and I recommend awarding the candidate the title of doctor (Ph.D.) in case of a successful defense.

Brno, 23.9.2009

Prof. Ing. Petr Pivonka, CSc.