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A SURVEY ON NON DOMINATED SORTING GENETIC ALGORITHM II AND ITS APPLICATIONS

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Abstract: - In this paper, we discuss about various applications of Non-dominated Sorting Genetic Algorithm. Six papers are taken for survey. Its advantages and disadvantages are discussed.

I. INTRODUCTION

The use of technology has increased rapidly over the past years and so has enlarged the usage of software. This makes it important to sustain the quality of the software. Software testing is the most significant critical quality assurance measure consuming at least 50% of software development cost [2]. The automation process of test data generation is a way that will reduce the time taken up by this task. Genetic Algorithm (GA) is used for this purpose. A number of multi-objective evolutionary algorithms have been suggested earlier. Non-Dominated Sorting Genetic Algorithm (NSGA-II) is an algorithm given to solve the Multi-Objective Optimization (MOO) problems. It was proposed by Deb et.al in 2002 [3], advancing on the concept given by Goldberg 1989 [1]. NSGA-II is one of the most widely used algorithms for solving MOO problems. Rest of the paper is organized as follows: NSGA-II in second section, Succinct Survey in third section and conclusion in fourth section.

II. NSGA II

The Non-dominated Sorting Genetic Algorithm is a Multiple Objective Optimization (MOO) algorithm and is an instance of an Evolutionary Algorithm from the field of Evolutionary Computation. The objective of the NSGA algorithm is to improve the adaptive fit of a population of candidate solutions to a Pareto front constrained by a set of objective functions. The algorithm uses an evolutionary process with surrogates for evolutionary operators

including selection, genetic crossover, and genetic mutation. The population is sorted into a hierarchy of sub-populations based on the ordering of Pareto dominance. Similarity between members of each sub-group is evaluated on the Pareto front, and the resulting groups and similarity measures are used to promote a diverse front of non-dominated solutions.

III. LITERATURE SURVEY

A. Multi objective optimization of induction machines including mixed variables and noise minimization.

In 2007 [6], Le Besnerais et al described a fast analytical model of a variable-speed induction machine which calculated both motor performances and sound power level of electromagnetic origin. This model was then coupled to Non-dominating Sorting Genetic Algorithm (NSGA-II) in order to perform global constrained optimizations with respect to several objectives (e.g. noise level, efficiency and material cost). As induction machine design involves both continuous and discrete variables, a modified NSGAII algorithm handling mixed variables was detailed. Finally, some optimization results were presented and analyzed by the aid of several visualization tools. These new designs improved electromagnetic noise level by acting on both electromagnetic exciting forces characterization (orders and frequencies) and excited structure characterization (natural frequencies, radiation efficiency).

B. Evolutionary Many objective Optimization by MO-NSGA-II with Enhanced Mating Selection.

In 2007 [7], Shao-Wen Chen et al stated that MO-NSGA-II strengthens the dominance-based predecessor, NSGA-II, by guiding the search process with reference points. In the paper, they further improve MO-NSGA-II by enhancing its mating selection mechanism with a hierarchical selection and a neighborhood concept based on the reference points. Experimental results confirmed that the proposed ideas led to a better solution quality.

C. Substitute Distance Assignments in NSGA-II for Handling Many-Objective Optimization Problems.

In 2007 [8], Mario et al studied the performance of the Fast Elitist Non-dominated Sorting Genetic Algorithm (NSGAII) for handling such many-objective optimization problems is presented. In its basic form, the algorithm is not well suited for the handling of a larger number of objectives. To overcome this problem, substitute distance assignment schemes are proposed that can replace the crowding distance assignment, which is normally used in NSGA-II. For a number of many-objective test problems, all proposed substitute distance assignments resulted into a strongly improved performance of the NSGA-II.

D. Effectiveness of Scalability Improvement Attempts on the Performance of NSGA-II for Many-Objective Problems.

In 2008 [9], Hisao et al examined the effectiveness of scalability of evolutionary multi objective optimization (EMO) algorithms to many-objective problems through computational experiments on multi objective knapsack problems with two, four, six, and eight objectives. They explained and various scalability improvements approaches and examined their effects on the performance of NSGA-II through computational experiments. Experimental results clearly show that the diversity of solutions is decreased by most scalability improvement approaches while the convergence of solutions to the Pareto front is improved.

E. NSGA-II algorithm for multi objective generation expansion planning problem.

In 2009 [10], Murugana et al presents an application of Elitist Non-dominated Sorting Genetic Algorithm version II (NSGAI), to multi-objective generation expansion planning (GEP) problem. The GEP problem is considered as a two-objective problem. The first objective is the minimization of investment cost and the second objective is the minimization of outage cost (or maximization of reliability). To improve the performance of NSGA-II, two modifications are proposed. One modification is incorporation of Virtual Mapping Procedure (VMP), and the other is introduction of controlled elitism in NSGA-II. A synthetic test system having 5 types of candidate units is considered here for GEP for a 6-year planning horizon. The effectiveness of the proposed modifications is illustrated in detail.

F. Multi objective Optimization Problems with Complicated Pareto Sets, MOEA/D and NSGA-II.

In 2009 [11], Hui Li and Qingfu Zhang introduced a general class of continuous multi-objective optimization test instances with arbitrary prescribed PS shapes, which could be used for studying the ability of multi objective evolutionary algorithms for dealing with complicated PS shapes. It also proposed a new version of MOEA/D based on differential evolution (DE), i.e., MOEA/D-DE, and compares the proposed algorithm with NSGA-II with the same reproduction operators on the test instances introduced in this paper. The experimental results indicate that MOEA/D could significantly outperform NSGA-II on these test instances. It suggests that decomposition based multi objective evolutionary algorithms are very promising in dealing with complicated PS shapes.

G. Analysis of NSGA-II and NSGA-II with CDAS, and Proposal of an Enhanced CDAS Mechanism.

In 2009 [12], Tanaka et al analyzed the functionality transition in the evolution process of NSGA-II and an enhanced NSGA-II with the method of controlling dominance area of solutions (CDAS) from the viewpoint of front distribution. They examine the relationship between the population of the first front consisting of non-dominated solutions and the values of two metrics, NORM and ANGLE, which measure convergence and diversity of Pareto-optimal solutions (POS), respectively. They also suggest potentials to further improve the search performance of the enhanced NSGA-II with CDAS by emphasizing the parameter S, which controls the degree of dominance by contracting or expanding the dominance area of solutions, before and after the boundary generation of functionality transition. Furthermore, they analyze the behavior of the evolution of the enhanced NSGA-II with CDAS using the best parameters combination and compare its performance with two other algorithms that enhance selection of NSGA-II.

H. Modified NSGA-II for a Bi-Objective Job Sequencing Problem.

In 2012 [13], Susmita Bandyopadhyay proposed a better modified version of a well-known Multi-Objective Evolutionary Algorithm (MOEA) known as Non-dominated Sorting Genetic Algorithm-II (NSGA-II). The proposed algorithm included a new mutation algorithm and was been applied on a bi-objective job sequencing problem. The objectives were the minimization of total weighted tardiness and the minimization of the deterioration cost. The results of the proposed algorithm were compared with those of original NSGA-II. The comparison of the results shows that the modified NSGA-II performs better than the original NSGAI.

I. Optimization of ECM Process Parameters Using NSGA-II.

In 2012 [14], Chinnamuthu et al attempted to establish a comprehensive mathematical model for correlating the interactive and higher-order influences of various machining parameters on the predominant machining criteria, i.e. metal removal rate and surface roughness through response surface methodology (RSM). The adequacy of the developed mathematical models was also been tested by the analysis of variance (ANOVA) test. The process parameters were optimized through Non dominated Sorting Genetic Algorithm-II (NSGA-II) approach

to maximize metal removal rate and minimize surface roughness. A non-dominated solution set was obtained and reported.

J. Optimal Combined Economic and Emission Load Dispatch using Modified NSGA-II with Adaptive Crowding Distance.

In 2012 [15], Biswajit Purkayastha and Nidul Sinha presented an algorithm based on modified non-dominated sorting genetic algorithm (NSGAI) with adaptive crowding distance for solving optimal economic emission dispatch (EED) problems in electric power system. Economic emission load dispatch problems are multi objective optimization problems and are the right field for testing and application of NSGA-II algorithms. NSGA-II is reported to have performed excellently on many bench mark test cases of multi objective optimization problems. However, modification of NSGA-II with adaptive crowding distance improved further the performance of the algorithm as the modified crowing distance enhances the capability of creating more potential and diverse solutions. The performance of the algorithm was tested on a test case of EED problem. The results were impressive and encouraging.

K. Voltage Stability Constrained Optimal Power Flow Using NSGA-II.

In 2013 [16], Sandeep et al works included multi-objective evolutionary algorithm techniques such as Genetic Algorithm (GA) and Non-dominated Sorting Genetic Algorithm II (NSGA-II) approach for solving Voltage Stability Constrained-Optimal Power Flow (VSC-OPF). Multi-Objective OPF, formulated as a multi-objective mixed integer nonlinear optimization problem, minimizes fuel cost and minimizes emission of gases, as well as improvement of voltage profile in the system. The above method were tested on standard IEEE 30-bus test system and simulation results were done for base case and the two severe contingency cases and also on loaded conditions. This simulation results were carried out using NSGA-II and are found that voltage stability is improved in NSGA-II than multi-objective GA of the proposed algorithm than the other approaches.

IV. CONCLUSION

The NSGA-II has been used for a wide variety of applications in a number of different fields. For some applications the NSGA-II has been used in its basic form where as for some applications it has been modified in different ways. The above paper gives a succinct overview of all the applications and modifications.

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