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A Comparative analysis of Crossover operators in Shop Scheduling Problem

Anju Verma[1] , Archana Sandhu[2]

[1]P.M. College of Engineering, DCRURST, Murthal
Kami, Sonipat-131001, India
anju15.verma@gmail.com
[2]P.M. College of Engineering, DCRURST, Murthal
Kami, Sonipat-131001, India
asandhu43@gmail.com

Abstract: *A very famous best-known NP-hard problem is job shop scheduling problem. Variety of recent solutions is demanded by this downside so it will be resolved in touch of your time. Genetic formula is one in every of the most effective strategies which are used to solve varied NP-hard issues such as JSSP. Variety of crossover operators is projected for JSSP. This paper represents the comparative analysis of the PMX, CX and OX operators. Experimental results shows that the PMX crossover operator is best among the on top of 3 mentioned crossover operators because it notice the scheduled sequence that is best among the 3. The work proposed here intends to test the performance of different Crossover used in GA and compare the performance for each of them and compare to others. This research presents an investigation on comparison of PMX, OX, CX crossover operators to solve JSSP problem. The objective is therefore to improve the performance of GA by using these crossover operators.*

Keywords: *Genetic algorithms, Job Shop Scheduling Problem, Partially Matched Operator, Crossover Operator, Ordered Operator.*

1. INTRODUCTION

In the recent years many researchers have been observing a remarkable growth in the volume of applications, aiming to tackle an increasing number of problems, in a broader set of domains, such as Numerical and Combinatorial Optimization, Design, Computer Vision, Machine Learning, Telecommunications, Scheduling and Time-Tabling just to name a few [1]. Scheduling in many different areas falls into the category of 'NP-complete' problems; i.e. current algorithms require exponential time to reach a solution. These problems demand innovative solutions if they are to be solved within a reasonable amount of time. Further, scheduling problems come in many different forms, and so many human schedulers use various (manual) heuristic methods, learned only with hard won experience. The resulting schedules are often far from optimal, and yet have taken many hours to produce. The research will specifically try to find a genetic algorithm that makes automatic iterative scheduling practical for modern but relatively low cost computing equipment. This may be achieved by using an efficient encoding, and designing appropriate crossover and mutation operators for our problem [2]. Evolutionary algorithms are stochastic and adaptive population-based search methods based on the principles of natural evolution. They involve a population of individuals represented in a genotypic form (chromosomes/genotypes), each of which is a potential solution to the problem. Each individual has a fitness score associated with it, and individuals with better fitness scores are better solutions. Between one generation and the next, individuals are selected from which to create offspring by applying mutation and crossover operators.

2. LITERATURE REVIEW

- *JOB SHOP SCHEDULING PROBLEMS*

Scheduling could be a difficult analysis topic within the research and laptop Science domain. This thesis deals with programing issues within the producing area referred to as the job-shop programing issues (JSSPs). The JSSPs are well-known combinatorial improvement issues that contains a finite variety of jobs and machines.[3] Every job consists of a collection of operations that should be processed, on a collection of notable machines, and wherever every operation encompasses a notable interval. A schedule could be a complete set of operations, needed by employment, to be performed on different machines, in an exceedingly given order. additionally, the method may have to satisfy other constraints like (i) no over one operation of any job will be dead simultaneously and (ii) no machine will method over one operation at constant time. The objectives typically thought-about in JSSPs are the minimization of make span, the minimization of tardiness, and therefore the maximization of output. The whole time between the beginning of the primary operation and therefore the ending of the last operation, is termed as make span. In JSSPs, the scale of the solution space is a devotee of the quantity of machines, which makes it quite expensive to seek out the most effective make span for larger issues.

Genetic Algorithm (GA) is an approximate and optimizing algorithm which is based on the biological evolution process to find the shortest tour in short instant of time.[4] These are algorithms which are based on the principles of natural evolution, and they can be divided into four major types of algorithms: genetic algorithms (GA), genetic

programming, evolution strategies and evolutionary programming. All these types of algorithms are based on a population of individuals. Evolutionary algorithms have been applied to many problems in management, e.g., to location, inventory, production, scheduling, distribution or timetabling problems. Crossover operators are the backbone of a genetic algorithm. While using the Genetic Algorithms the problem of trapping into local optima is resolved. Crossover operators are used to produce the offspring from the existing parents by maintaining the partial tours. In genetic algorithms recombination in the form of using crossover operators plays a dominant role, evolution strategies mainly use mutation in the form of small changes of particular real variables.

Evolution strategies also use some type of recombination, often in the form of discrete recombination for generating the offspring (i.e., it is decided for each component the value of which of the two parents is used for the offspring) and intermediate recombination to determine the strategy parameters [5-6]. While in genetic algorithms often the parameters for applying specific genetic operators are constant, the strategy parameters in evolution strategies typically underlying an adaptation process. Genetic algorithms are particularly applied to combinatorial optimization problems so that in the following, we mainly focus on this class of evolutionary algorithms.

The basic steps of genetic algorithm used are given below:-

- Encoding
- Fitness Evaluation
- Selection
- Crossover
- Mutation
- Decoding

3. NEW PROPOSED SCHEME

In earlier works the genetic algorithms may converge slowly. The combination of a GA with other heuristics often improves the results. This can be a combination with other Meta heuristics. The computing time of the job shop scheduling problem using classical genetic algorithm is very large. [7-8]

The crossover operators are optimized using Travelling salesman problem (TSP). The TSP is used to find minimum path for salesperson. Minimum path will helps to reduce the overall receiving time and improves system performance. This process intends to test the performance of different Crossover used in GA and compare the performance for each of them and compare to others. This presents an investigation on comparison of PMX, OX, CX crossover operators to solve TSP problem. [9-10]

In Proposed work the performance of crossover operators are optimized by applying the GA on Shop scheduling problems. The objective is therefore to improve the performance of GA by using these crossover operators. An efficient implementation of genetic algorithm is required in shop scheduling problems. [11]

- **Partially Matched Crossover**: In partially matched crossover operator two crossover points are selected randomly from the parent's chromosomes to produce the offspring. The two crossover points give a matching selection which is used to affect a cross through position by position exchange operations. Partially Matched Crossover is a crossover for mating individuals consisting of enumerated type chromosomes in unique gene representation. Partially-Matched Crossover (PMX) is applied by choosing two random different crossing points in the strings and exchanging and swapping the segment contents from one individual to another. PMX is used to avoid duplicate allele values after crossover.[12-13]
- **Ordered Crossover:** In ordered crossover operator two cut points are randomly selected from parent's chromosomes. Here to produce the offspring O_1 the genes between the cut points are replaced by the genes in the second parent.[14-15]
- **Cyclic Crossover**: Cyclic crossover operator performs recombination under the constraint that each gene comes from the parent or other.

4. CONCLUSION AND FUTURE SCOPE

The experimental results show that the minimum length of the schedule are obtained from OX i.e. Ordered Crossover operator. This will provide the best optimal solution with less time and best sequence for operations to be performed on machines. The results show that the OX crossover outperforms the PMX and CX crossover operator. The best scheduled result will prove to produce best make span and less throughput from the desired population generated [16-17]. OX improves the GA's from premature convergence or time or both.

Table 1: Performance Comparison

No. of machines	No. of jobs	PMX	CX	OX
6	5	39	44	37
5	4	53	50	45
4	6	27	22	19
5	5	23	22	22
3	3	15	14	13

Table specifies the comparison among the performance of each of the three operators according to number of machines and number of jobs.

4.1 Suggestions for Future work

Knowledge can be augmented to other scientific as well as commercial domain such as IC fabrication, Railway or Airway reservation. Knowledge augmentation is also depending upon the presentation of chromosome. Better the presentation will result better improvement in GA's.

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REFERENCES

[1]. Naveen kumar, Karambir, Rajiv Kumar "A Comparative Analysis of PMX, CX and OX Crossover operators for solving Travelling Salesman Problem" Vol.1, Issue 2, July August 2012

[2]. Liang Sun, Xiaochun Cheng "Solving Job Shop Scheduling Problem Using Genetic Algorithm with Penalty Function " International Journal of Intelligent Information Processing Volume 1, Number 2, December 2010

[3]. ling He, Dejia Shi, Li Wang "An Adaptive Discrete Particle Swarm Optimization for TSP Problem" Asia-Pacific Conference on Computational Intelligence and Industrial Applications, pp:- 393-396, 2009

[4]. Fanchen Su, Fuxi Zhu, Zhiyi Yin, Haitao Yao, Qingping Wang, Wenyong Dong "New Crossover Operator of Genetic Algorithms for the TSP" International Joint Conference on Computational Sciences and Optimization, 2009

[5]. Jie Gao, Linyan Sun, Mitsuo Gen "A hybrid genetic and variable neighborhood descent algorithm for flexible job shop scheduling problems" Computers & Operations Research, pp:- 2892 – 2907, 2008

[6]. Jorge José de Magalhães Mendes "A Hybrid Genetic Algorithm for the Job Shop Scheduling Problem" AT&T Labs Research Technical Report TD-5EAL6J, September 2002.

[7]. Ferdinando Pezzella, Emanuela Merelli "A tabu search method guided by shifting bottleneck for the job shop scheduling problem" European Journal of Operational Research pp:- 297-310, 2000

[8]. Runwei Cheng "A tutorial survey of job-shop scheduling problems using genetic algorithms, part II: hybrid genetic search strategies" Volume 36, Issue 2, April 1999.

[9]. Ching-Fang Liaw, "A hybrid genetic algorithm for the open shop scheduling problem" Received 1 September 1998; accepted 1 February 1999.

[10]. Otto-von-Guericke "Genetic Algorithms For Shop Scheduling Problems: A Survey"

[11]. E. Falkenauer and S. Bouffouix "A Genetic Algorithm for Job Shop"

[12]. Takeshi Yamada and Ryohei Nakano "Job-shop scheduling" The Institution of Electrical Engineers, ISBN

[13]. F. Pezzellaa,, G. Morgantia, , G. Ciaschetti "A genetic algorithm for the Flexible Job-shop Scheduling Problem".

[14]. Christian Bierwirth, Dirk C. Mattfeld and Herbert Kopfer "On Permutation Representations for Scheduling Problems".

[15]. Sushil J., Louis Zhijie Xu "Genetic Algorithms for Open Shop Scheduling and Re-Scheduling"

[16]. V. M. Kureichick, A. N. Melikhov, V. V. Miagkikh, O. V. Savelev and A. P. Topchy "Some New Features In Genetic Solution Of The Traveling Salesman Problem." ACEDC.

[17]. Ole J. Mengshoel and David E. Goldberg "The Crowding Approach to Niching in Genetic Algorithms".