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Comparative Analysis of Crossover Operator through Genetic Algorithm

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Abstract: *Genetic algorithms are one of appropriate way of finding a solution although a very less knowledge is there. We are having very general algorithms for state space search. That means you only need to be able to find out the solution whereas genetic algorithm provides us with some quality solution. Genetic algorithms tend to thrive in an environment in which there is a very large set of candidate solutions and in which the search space is uneven and has many hills and valleys. As genetic algorithms can perform better in any environment but they will be greatly outclassed by more situation specific algorithms in the simpler search spaces. Therefore, this thing must be keep in mind that genetic algorithms are feasible not optimal one. Sometimes they can take quite a while to run and are therefore not always feasible for real time use*

Keywords: *genetic algorithms, travelling salesperson problem, crossover, selection.*

1. INTRODUCTION

In the last few decades, the continuing advancement of modern technology has brought about a revolution in science and engineering. One such revolution is the "Evolutionary Strategy". Evolution is now producing practical benefits in a very different field. This field is computer science, and the benefits come from a programming strategy called *genetic algorithms*. 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[1]-Tabling just to name a few [6]. 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. LITERATURE REVIEW

TSP is optimization problem which is used to find minimum path for salesperson. The Actual use of TSP is routing in network. Minimum path will helps to reduce the overall receiving time and improves system performance [4]. 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 thesis presents an investigation on comparison of PMX, OX, CX crossover operators to solve TSP problem. The objective is therefore to improve the performance of GA by using these crossover operators [2-3].

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Since there are other methods traditionally adopted to obtain the optimum distance for TSP. This work aims at establishing the superiority of Genetic Algorithms in optimizing TSP. One of the objectives of this research work is to find a way to converge fast. Since precise minimum path remains a great challenge, the objective of this work is to develop some new and practical model with computational intelligence algorithms. As can be seen from the bibliography, many models have been developed for TSP. From the experimental results the conclusion can be drawn that different methods might outperform the others in different situations.

The Evolutionary Algorithm

Advances in technology have made it possible for us to read our DNA and that of other creatures, and what it has shown us is that we aren't as different from other creatures as we think. Over time, creatures change to adapt to their environment to survive and thrive.

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. Generally selection is biased towards fitter individuals, and unpromising areas of the search space are abandoned with the loss of poorer performing individuals from the population over time. Evolutionary algorithms encompass genetic algorithms, evolutionary programming and evolution strategies.

Genetic Algorithm

Genetic algorithms are biologically inspired search methods, which are loosely based on molecular genetics and natural selection. The synthesis of the ideas of Charles Darwin on evolution and natural selection, Mendelian genetics and molecular biology is often called neo-Darwinism. Darwin pointed out in *The Origin of Species* that the natural consequence of the rule that like produces like (and that like is not identical) combined with the tendency of some progeny themselves to reproduce more successfully, is that a population over a period of time may change. In doing so then it would, on average, change such that members of future generations in *the milieu of prior generations* would naturally have a higher reproductive success rate. He did not define the mechanisms by which the change is coded [9],[10]. The basic principles of genetic algorithms were stated by John Holland They have since been reviewed by a number of people viz. Goldberg, **K**oza, Michalewicz and Beasley **"**Potvin ‚Jean-Yves(n.d)**"**.They discovered that genetic algorithms are a relatively new optimization technique which can be applied to various problems, including those that are NP-hard. The technique does not ensure an optimal solution, however it usually gives good approximations in a reasonable amount of time. This, therefore, would be a good algorithm to try on the TSP problem, one of the most famous NP-complete problems. The algorithm requires a population of individuals. Each individual is an encoded version of a proposed solution. The algorithm consists of the *evaluation* of individuals, *selection* of individuals, which will contribute to the next generation, *recombination* of the parents by means of *crossover, mutation* and other operators to produce a new generation. In this process, selection has the role of guiding the population towards some optimal solution, crossover the role of producing new combinations of partial solutions, and mutation the production of novel partial solutions [5]. The genetic algorithm process consists of the following steps:

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

3. NEW PROPOSED SCHEME

Purposed PMX crossover

Available Partially-Mapped crossover (PMX) Goldberg and Lingle (85). This operator first randomly selects two cut points on both parents. In order to create an offspring, the substring between the two cut points in the first parent replaces the corresponding substring in the second parent[6]. Then, the inverse replacement is applied outside of the cut points, in order to eliminate duplicates and recover all cities.

In Figure 3.3, the offspring is created by first replacing the substring 236 in parent 2 by the substring 564. Hence, city 5 replaces city 2, city 6 replaces city 3, and city 4 replaces city 6 (step1). Since cities 4 and 5 are

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now duplicated in the offspring, the inverse replacement is applied outside of the cut points. Namely, city 2 replaces city 5, and city 3 replaces city 4 (step 2). In the latter case, city 6 first replaces city 4, but since city 6 is already found in the offspring at position 4, city 3 finally replaces city 6. Multiple replacements at a given position occur when a city is located between the two cut points on both parents, like city 6 in this
Example.

parent 1 : **1 2 | 5 6 4 | 3 8 7**
parent 2 : 1 4 | 2 3 6 | 5 7 8
____

offspring
(step 1) : 1 4 **5 6 4** 5 7 8
(step 2) : 1 3 **5 6 4** 2 7 8

Figure 3.5 The partially-mapped crossover.

The Pseudo code for PMX Genetic algorithm under TSP problem

1. Start
2. Generate the random population by using randperm function.
3. X=1
4. Repeat step i to vi while (X!=100)

(i) Evaluate the fitness of each single chromosome using fitness function in which the weight between each individual city is summed up.

(ii) Individual with largest fitness value is selected by using the Roulette wheel selection procedure.

(iii) Apply the PMX crossover for producing the off springs with crossover probability i.e. P_C =1.

For example, consider two parents

P_1: 2 1 5 4 | 7 8 9 3 | 6 10

P_2: 1 5 4 6 | 10 2 8 7 | 3 9

Finally we have the off springs as follows:

O_1: 9 1 5 4 |10 2 8 7| 6 3

O_2: 1 5 4 6 | 7 8 9 3 | 10 2

(iv) If X%10 = =0

Apply the interchanging mutation to prevent the algorithm to trapped in local optima with mutation probability P_M = 0.1.

(v) The weak chromosomes are replaced by using weak replacement function.

(vi) X=X+1;

5. After 1000 iterations the algorithm will terminate.
6. End

4. CONCLUSION AND FUTURE SCOPE

Table1: Result Analysis of PMX, CX and OX

No of cities	Pc Crossover Probability	P_M Mutation Probability	Average Distance by PMX	Average Distance by CX	Average Distance by OX
25	1	0.1	428	483	503
30	1	0.1	436	461	493

The experimental results show that the distance measured by partially matched crossover operator is minimum as compared to distance measured by cyclic crossover operator. And distance measured by cyclic crossover operator is less than the distance measured by ordered crossover. The results show that the PMX crossover outperforms the CX and OX crossover operator [7-8]. PMX improves the GA's from premature convergence or speed or both

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 depend upon the presentation of chromosome. Better the presentation will result better improvement in GA's.

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