COMPARATIVE ANALYSIS OF VARIOUS TYPES OF GENETIC ALGORITHMS TO RESOLVE TSP

Kulbhushan Verma¹, Ms. Manpreet Kaur², Ms. Palvee³

¹Electronics & Communication Deptt., International Institute of Telecom Technology, Punjab Technical University, Pojewal, Distt. Nawanshahr, Punjab, India.
²Electronics & Communication Deptt., International Institute of Telecom Technology, Punjab Technical University, Pojewal, Distt. Nawanshahr, Punjab, India.
³Electronics & Communication Deptt., International Institute of Telecom Technology, Punjab Technical University, Pojewal, Distt. Nawanshahr, Punjab, India.

ABSTRACT

Genetic algorithm includes some parameters that should be adjusting so that the algorithm can provide positive results. The crossover operators play very important role by constructing competitive Genetic Algorithms (GAs). In this paper, the basic conceptual features and specific characteristics of various crossover operators in the context of the Traveling Salesman Problem (TSP) are discussed. The results of experimental comparison of three different crossover operators for the TSP are presented. The results show that PMX operator enables to achieve a better solution than other operators tested.

Keywords: Crossover, Genetic Algorithms, Selection, Travelling Salesperson Problem.

1. INTRODUCTION

In the last few decades, the continuing advancement of modern technology has brought about a revolution in science and engineering. The revolution is the “Evolutionary Strategy”. The 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 observed 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 SURVEY

TSP is optimization problem which is used to find minimum path for salesperson. The actual use of TSP is routing in network. The 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 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]. 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. The 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.

2.1. The Evolutionary Algorithm

The advances in technology have made it possible for us to read our DNA and that of other creatures. What it has shown us is that we aren't as different from other creatures as we think. The 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. The 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. The 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 algorithm and evolution strategies.

2.2. Genetic Algorithm

Genetic algorithms are biologically inspired search methods, which are loosely based on molecular genetics and natural selection. The synthesis of the idea of Charles Darwin on evolution and natural selection, mendelian genetic and molecular biology is often called neo-Darwinism. The 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 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, Koza, 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 are NP-hard. The technique does not ensure an optimal solution. It usually give good approximations in a reasonable amount of time. This 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 consist of an evaluation of an individual’s, selection of individuals in which it will contribute to the next generation, recombination of the parents by means of crossover, mutation. The other operators are used 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 consist of the following steps:

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

3. NEW PROPOSED SCHEME

3.1. Purposed PMX crossover

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

In example 3.1, the offspring is created by first replacing the substring 236 in parent 2 by the substring 564. Hence, city 5 replace city 2, city 6 replace city 3 and city 4 replaces city 6 (step1). Since cities 4 and 5 are now duplicated in the offspring, the inverse replacement is applied outside of the cut points. Namely, city 2 replace city 5, and city 3 replace city 4 (step 2). In the latter case, city 6 first replace city 4, but since city 6 is already found in the offspring at position 4, city 3 finally replace city 6. Multiple replacements at a given position occur when a city is located between the two cut points on both parents.

Example 3.1

parent 1 : 1 2 5 6 4 | 3 8 7
parent 2 : 1 4 2 3 6 | 1 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 1 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. $PC = 1$.
For example, consider two parents

$$P1: 2 \ 1 \ 5 \ 4 \ 1 \ 7 \ 8 \ 9 \ 3 \ 1 \ 6 \ 10$$
$$P2: 1 \ 5 \ 4 \ 6 \ 1 \ 10 \ 2 \ 8 \ 7 \ 3 \ 9$$

Finally we have the off springs as follows:

$$O1: 9 \ 1 \ 5 \ 4 \ 10 \ 2 \ 8 \ 7 \ 6 \ 3$$
$$O2: 1 \ 5 \ 4 \ 6 \ 1 \ 7 \ 8 \ 9 \ 3 \ 1 \ 10 \ 2$$

(iv) If $X \% 10 = 0$
Apply the interchanging mutation to prevent the algorithm to trapped in local optima with mutation probability $PM = 0.1$.
(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

RESULTS

The Travelling Salesman Problem (TSP) is one the most famous problems in the field of operation research and optimization [1]. We use as a test of TSP problem in the city , which has 51,76,101 locations respectively in the city. The only optimization criterion is the distance to complete the journey. The optimal solution to this problem is known, it's 1500 iteration.

![Figure 1: The 51 locations in the city](image)
4. CONCLUSION

Table 1: Result Analysis of PMX, CX and OX

<table>
<thead>
<tr>
<th>No of cities</th>
<th>No of iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>1500</td>
</tr>
<tr>
<td>76</td>
<td>1500</td>
</tr>
<tr>
<td>101</td>
<td>1500</td>
</tr>
</tbody>
</table>

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.
5. FUTURE SCOPE

Knowledge can be augmented to other scientific as well as commercial domain such as IC fabrication, Railway, Airway reservation or defence sector. Knowledge augmentation is also depend upon the presentation of chromosome. Better the presentation will result better improvement in GA’s. The work can be extended in future by using some other crossover operators or can use different selection approaches. Different encoding schemes can be applied. We have used Symmetric TSP. The work can be extended for some other type of TSP.

6. REFERENCES


