

# Modified Order Crossover (OX) Operator

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**ABSTRACT:-** In this work Traveling salesperson problem is taken as Domain. TSP has long been known to be NP-complete and is a standard example of such problems. Genetic Algorithm (GA) is an approximate algorithm that doesn't always aim to find the shortest tour but to find a reasonably short tour quickly, which is a search procedure inspired by the mechanisms of biological evolution. In genetic algorithms, crossovers are used as a main search operator for TSP. Briefly speaking: the role of crossovers is to generate offspring that are better tours by preserving partial tours from the parents. There were a lot attempts to discover an appropriate crossover operator. This paper presents the strategy which used to find the nearly optimized solution to these type of problems. It is the order crossover operator (OX) which was proposed by Davis, which constructs an offspring by choosing a subsequence of one parent and preserving the relative order of cities of the other parent.

*Keywords: Genetic algorithm, Travelling salesman problem, Order Crossover.*

## I. INTRODUCTION

Genetic algorithms are one of the best ways to solve a problem for which little is known. They are a very general algorithm and so will work well in any search space. All you need to know is what you need the solution to be able to do well, and a genetic algorithm will be able to create a high quality solution. Genetic algorithms use the principles of selection and evolution to produce several solutions to a given problem.

### A. Problem specification

The Traveling Salesman Problem (TSP) is a classic combinatorial optimization problem, which is simple to state but very difficult to solve. The problem is to find the shortest possible tour through a set of  $N$  vertices so that each vertex is visited exactly once. This problem is known to be NP-hard, and cannot be solved exactly in polynomial time. Many exact and heuristic algorithms have been developed in the field of operations research (OR) to solve this problem. In the sections that follow, we briefly introduce the OR problem-solving approaches to the TSP. Then, the genetic algorithms are discussed.

### B. Exact algorithms

The exact algorithms are designed to find the optimal solution to the TSP, that is, the tour of minimal length. They are computationally expensive because they must (implicitly) consider all solutions in order to identify the optimum. These exact algorithms are typically derived from the integer linear programming (ILP) formulation of the TSP, Where  $N$  is the number of vertices,  $d_{ij}$  is the distance between vertices  $i$  and  $j$  and the  $x_{ij}$ 's are the decision variables:  $x_{ij}$  is set to 1 when arc  $(i,j)$  is included in the tour, and 0 otherwise.  $(x_{ij})_X$  denotes the set of subtour-breaking constraints

Min  $\sum_{i,j} d_{ij}x_{ij}$

Subject to:

$\sum_j x_{ij} = 1, i=1,\dots,N$

$\sum_i x_{ij} = 1, j=1,\dots,N$

$(x_{ij})_X$

$x_{ij} = 0$  or  $1$ ,

That restrict the feasible solutions to those consisting of a single tour. Although the subtour-breaking constraints can be formulated in many different ways Without the subtour breaking constraints, the TSP reduces to an assignment problem (AP), and a solution like the one shown in would then be feasible. Branch and bound algorithms are commonly used to find an optimal solution to the TSP, and the above AP-relaxation is useful to

generate good lower bounds on the optimal value. This is true in particular for asymmetric problems, where  $d_{ij}$  for some  $i, j$ .

## II. METHODOLOGY

### A. Order Crossover (OX) Davis (85), Oliver et al. (87)

The Path matrix considered in this is drawn under topic Figures. This crossover operator extends the modified crossover of Davis by allowing two cut points to be randomly chosen on the parent chromosomes. In order to create an offspring, the string between the two cut points in the first parent is first copied to the offspring. Then, the remaining positions are filled by considering the sequence of cities in the second parent, starting after the second cut point (when the end of the chromosome is reached, the sequence continues at position 1). In Figure shown in next section regarding Knowledge augmented PMX, the substring 564 in parent 1 is first copied to the offspring (step 1). Then, the remaining positions are filled one by one after the second cut point, by considering the corresponding sequence of cities in parent 2, namely 57814236 (step 2). Hence, city 5 is first considered to occupy position 6, but it is discarded because it is already included in the offspring. City 7 is the next city to be considered, and it is inserted at position 6. Then, city 8 is inserted at position 7, city 1 is inserted at position 8, city 4 is discarded, city 2 is inserted at position 1, city 3 is inserted at position 2, and city 6 is discarded.

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

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offspring

(step 1) : - - 5 6 4 - - -

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

**Figure** The order crossover.

Clearly, OX tries to preserve the relative order of the cities in parent 2, rather than their absolute position. In **Figure of PMX**, the offspring does not preserve the position of any city in parent 2. However, city 7 still appears before city 8, and city 2 before city 3 in the resulting offspring.

### B. Modified order crossover

In order to improve the efficiency of order crossover the minimum edge is detected from the second chromosome select first node of this edge as first crossover point and select 2<sup>nd</sup> crossover point after first randomly the minimum edge is selected as it has higher probability to participate in result.

parent 1 : 1 2 5 6 4 3 8 7  
 parent 2 : 1 4 2 3 6 5 7 8

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Step 1 detect shortest edge from second parent

e.g 3,6 from second parent

Step 2 select second crossover point randomly after first for e.g 5

crossover points are before 3 and after 5 in second chromosome

Step 3 apply order crossover

offspring

Step 3.1 : - - - 3 6 5 - -

Step 3.2 : 1 2 5 3 6 5 8 7

Step 3.3: 1 2 4 3 6 5 8 7

Fig Modified order crossover

## III. RESULTS

### A. Tables, Figures and Equations

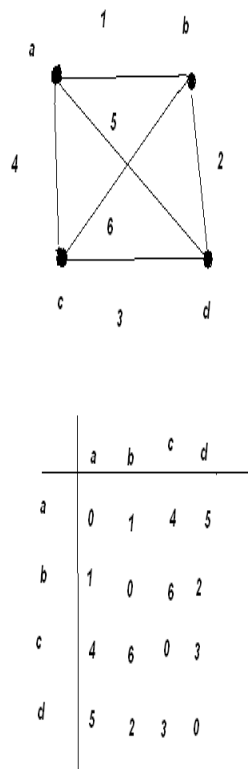


Figure 1- Path matrix

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

Step 1 find minimum edge from second parent using adjacency matrix  
 for e.g 3,6  
 then crossover point is shown in fig  
 1 4 2 | 3 6 5 7 8

Step 2 decide second crossover point randomly after first  
 for e.g  
 1 4 2 | 3 6 5 | 7 8

Step 3 apply crossover  
 (step 1) 1 2 **5 3 6 5** 8 7  
 (step 2) : 1 2 4 3 **6 5** 8 7

Figure 2- Knowledge augmented PMX

Table 1- Result of OX and My OX

Sample no.	ox, No. of iteration	Shortest path	Myox, No of iteration	Shortest path
1	1	86	1	87

2	1	348	3	339
3	1	1727	1	2225
4	1	605	2	610
5	2	2432	2	2388

**B. ABBREVIATIONS AND ACRONYMS**

TSP- Travelling Salesman Problem  
 GA- Genetic Algorithm  
 OX- Order Crossover  
 AP- Assignment Problem  
 OR- Operation Reserach  
 PMX- Partially mapped Crossover

**C. EQUATIONS**

$$F(x) = g(F(x)) \tag{1}$$

Where  $f$  -objective function ,  $g$  transforms the value of the objective function to a non-negative number and  $F$ -resulting relative fitness.

The most fit individuals and the fitness of the others is determined by the following rules:

- $MIN = 2.0 - MAX$
- $INC = 2.0 \times (MAX - 1.0) / n$
- $LOW = INC / 2.0$  (2)

The fitness of individuals in the population may be calculated directly as,

$$f(x_i) = \frac{2 - MAX + 2 (MAX - 1) x_i - 1}{n - 1} \tag{3}$$

Probability of each chromosomes selection is given by:

N

$$P_s(i) = \frac{f(i)}{\sum_{j=1}^N f(j)} \tag{3}$$

$P_s(i)$  and  $f(i)$  are the probability of selection and fitness value

**IV. CONCLUSION**

Gives the results of experiments comparing the proposed method with the conventional approach. In these experiments, the number of children generated by one crossover is limited because of calculation costs. Therefore, they tried generate better individuals within a limited number of children And again purposed a new crossover method that accelerates the local search efficiency. First, the children generated by the first parents are evaluated for their fitness. Then, some number of top children with an elite rate set beforehand is selected as the next parents.

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. 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 use of GA with knowledge augmentation. The objective is therefore to improve the performance of GA by using knowledge.

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 references, many models have been developed for TSP. From the experimental results the conclusion can be drawn that different methods might out perform the others in different situations.

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