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Research paper

The Multi-Depot Travelling Salesman Problem using MATLAB Coding with Genetic Algorithm:A Case Study of Domino's Pizza Centers

Ms.Nilofer[1], ,Dr.Mohd.Rizwanullah[2]

Department of Mathematics & Statistics
Manipal University Jaipur ,Rajasthan, India
**Corresponding author E-mail: nilofariqbalansari1987@gmail.com*

Abstract

*D*ominos is the best pizza delivery company in the world. In current phase of business it is also having the high demand of internal consumption. The delivery boy need to cover the 12 centers which are located at different place in Jaipur. In this paper an attempt has been made to improve delivering of pizzas at twelve randomly Centers in the city. The problem is modeled as Travelling Salesman Problem. In this problem, our objective is to find the lowest tour cost of the pizzas centers, which are connected. Different paths cost is given (TSP) and it is very similar to the Assignment Problem (AP) apart from there is an further constraint i.e. $C_{ij}=\infty$, if i = j. The salesman has to visit n cities. The objective in this paper is to select the method in which the cities are visit in such a way and that total travelling time is to be minimized; sometimes AP does not fulfill the further restriction, In this article we present modified one's algorithm with MATLAB Coding with genetic algorithm for the solution of the TSP problem.

Keywords*: *Fittest, GA, MATLAB Code, Mutation, TSP

1. Introduction

1.1 Travelling Salesman Problem

The traveling salesman problem is an optimization problem where there are a finite number of cities or centers and the cost of traveling between each city is known. The main objective is to find an ordered set of all the cities for the salesman to visit such that the cost of travelling can be minimized. We required a list of pizza center's location and distances and cost to solve for the traveling salesman problem. We take a set of domino's pizza centers in Jaipur city in INDIA and distance between each centres. The problem is to find the minimum probable routes that visit every city correctly once and return to the starting point.

1.2 Genetic Algorithm

We know that genetic is a biological terms. It is search based optimization algorithm. Which is based on natural selection and genetics? This selection is bio inspired operators and such as pairing crossover and mutation. And then the populations have produced children and a particular fitness value. Now genetic algorithm has been used to find optimal or near optimal solution to difficult problems.

1.3 Steps of Algorithms

i. We generate the primary population of independent strings of the given TSP problem and make a matrix depiction of each casually, which satisfy the two simple situations as stated earlier.

ii. We give a fitness task to each separate in the population using fitness conditions measure,
F(t) = **assignment value of the given problem/ string value**
The range of measure rest on the strings value if it is close to 1.

iii. We generate several new off-spring strings of populations from the two surviving strings in the parent population by put on crossover operation.
iv. Modify the resulting off-springs if compulsory.
v. Request the different off-springs as parent population and stepscontinued (iii) and (iv) up to we become a only value. Offspring that will be an optimum or near optimum clarification to the problem.

1.2 Optimization algorithm

Optimization is the process of **making something better**.



Fig 1: Algorithm Optimisation Process

1.3 Terminology of Genetic Algorithm

- Population
- Chromosomes
- Gens

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1.4 Operators of Genetic Algorithm

- Selection
- Crossover
- Mutation

1.5 Concept of Genetic Algorithm

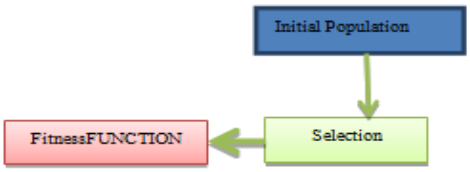


Fig. 2: Concept of Genetic Algorithm

2. Methodology

Genetic Algorithm is very simple algorithm and informally producing the first population of strings, and gene pool are referred by and then applying operators to produce others, and the best population as following generations. This operator is the first Imitation, which copied to the strings and following generation next by selected possibility created on their independent gathering value. The second operator is crossover. Crossover operator is applying some sets of strings and creates new strings. The third operator is mutation. This operator is the erratic random adjustment of the value at the position of string. Genetic algorithm is the most powerful process and search by imitation with crossover operator. Mutation separates the search space and keeps from cost of genetic measurable and it can be created by imitation and crossover. So, in the probability mutation, the put on the mutation in possibility of set is very low, and setoff crossover is very high in probability.

Initial population is
A-B-C-D-F-E-G-I-H-J-K-L-A = 35.3
A-C-D-E-G-F-I-H-J-K-L-B-A = 36.3
A-D-F-E-C-H-G-I-J-K-L-B-A = 54.2
A-E-D-F-C-G-B-H-I-J-K-L-A = 61.5
A-F-G-E-C-D-I-J-H-K-L-B-A =52.7
A-G-D-E-F-H-I-J-K-L-B-C-A =39.4
A-H-J-I-K-E-D-C-B-F-L-G-A =68
A-I-J-H-G-F-E-D-C-B-K-L-A=61.1
A-J-K-H-I-L-G-D-E-F-C-B-A=60.8
A-K-H-J-G-E-F-L-D-E-I-B-A = 57.7
A-L-J-K-B-C-D-F-E-I-G-H-A =66.2
by fitness criteria, we choosing the tour of Centre's which is having values,

3. Path Representation.

We can say that to present the legal tour path representation is the best way. Example for, a path A→B→C→D→F→E→G→H→J→K→L is simply as (ABCDFEGHJKL).
This combinatory issue is a TSPs issue correspond by a route and usually crossover operators for instance one & two point and This crossover are not suitable, then route presented by only mapped, order and cycle crossover operators and this operators we can used in literature. And paralleled by our proposed crossover operator by the operators.

3.1. PMX.

In partially mapped crossover operator(PMX), We choose only `two non children which is cut points on parents to form offspring, the bit among cut points, one parent's string is mapped onto the other parent's string and the rest information is interchanged. We reckon the two parents path with indiscriminately one cut point in both C and D bits and other cut point in both F and Gth bits are shown below

$P1$ = (C D H K| B G A L| E J F I),
$P2$ = (D B E C | A G J F| L H I K). (1)

the cut points to be in mapping section . in this instance, the mapping systems are b↔a, k↔j, and a↔l. now two mapping sections are taken with each other to make off spring as shown below

$O1$ = (× × × × |B G A L| × × × ×),

$O2$ = (× × × × |A G J F| × × × ×). (2)
Then we can fill addedbits
$O1$ = (C D × × | B G A L| × × × I),

$O2$ = (D × × C | A G J F| L× × ×). (3)

Hence, first crossover comes from L which is generated by first parent but L is already existing this offspring, so let us analyze mapping A↔L and see again A existing in this offspring, again check mapping B↔A, so B takes the position at first ×.Second × is generated by offspring J which is originated by first parent but J has its position already in this offspring; we check mapping K↔J aswell,so7occupiesatsecond×.Thustheoffspring A is
$O1$ = (C D H K | B G A L| E F G I). (4)
Irrationally, we proceed further for
$O2$ = (D H K C | A G J F| L B E I). (5)
Order of Crossover Operator. Let consider a offspring for choosing a sub tour of a parent and securing the virtual command of bits of the other parent. For example, following two parents tour are
$P1$ = (C D H K| B G A L| E J F I),

$P2$ = (D B E C | A G J F| L H I K). (6)

$O1$ = (× × × × |B G A L| × × × ×),

$O2$ = (× × × × |A G J F| × × × ×). (7)

We start from the second cut point of one parent, and bits from the new parent are taken in an alike order eliminating remaining bits. The second parent bits order from the second cut point is "D→E→G→F→I→H→J→K→L→B→A→C.". We remove the bits B, G A and L, new sequence of the first off spring is"D→E→F→I→H J→K→C." The placed value in order and the first offspring starting from the second cut point:

$O1$ = (E FJ B |B G A L| C D H I). (8)

Similarly, we follow the process further

$O2$ = (D B G I| A G J F| E C H L) (9)

3.2 Cycle Crossover Operator.

Firstly POLI et al. [8] proposed by we create the cycle cross over operator offspring in this techniques such a way that each bit with its position comes from one of the parents. Instantaneously, we assume that the path of the two parents as the tours of two parents:

$P1$ = (ABCDEFGHIJKL),

$P2$ = (IEBACFDGHJKL). (10)

We select the first bit for the offspring to be both since the second parents we choose A:

$O1$ = (A × × × × × × × × × × ×) (11)

$O1$ = (A × × × × × × × × × × L) (12)

The suggested bit k, the second parent of bit objective under the selected bit at k^{th} position in the first parent. Thus

$O1$ = (A × × × × ×× × × × K L) (13)

Next, set D at D^{th}point as

$O1$ = (A × × D × × × × × × K L) (14)

A is now in the list; so a cycle and filling are completely the lasting total locations with the bits and bits are in second parents.

$O1$ = (IEBACFDGHJKL) (15)

Similarly the second offspring is

$O2$ = (ABCDEFGHIJKL) (16)

But there are a problem that comes during creating different off springs let us consider following two parents:

$P1$ = (AEDFCGBHIJKL)
$P2$ = (DEFALKHIGCB) (17)

After applying CX technique, the result obtained is as follows:

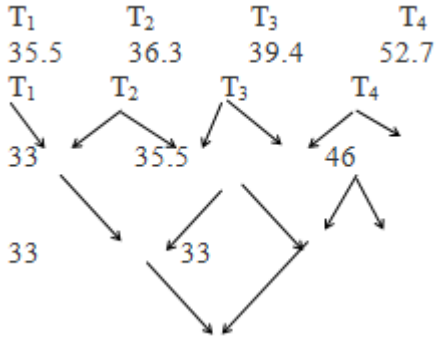
$O1$ = (EGFCBADHKJLI),
$O2$= (FCBAGHJLKDEI), (18)
Which parents are exactly same?

Table 1: Transition Distance between Cities

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)
((A)	0	0.2	0.3	5	7	8	8	10	12	12	14	18
(B)	0.2	0	0.1	5.1	7	8	8	10	12	12	14	17
(C)	0.3	0.1	0	5	7	8	8	10	11	11	14	18
(D)	5	5.1	5	0	3	2	2	3	5	5	7	11
(E)	7	7	7	3	0	1.5	1	2	4	4	6	10
(F)	8	8	8	2	1.5	0	1	2	4	4	6	12
(G)	8	8	8	2	1	1	0	2	4	4	10	10
(H)	10	10	10	3	2	2	2	0	2	1	4	8
(I)	12	12	11	5	4	4	4	2	0	1	2	6
(J)	12	12	11	5	4	4	4	1	1	0	2	4
(K)	14	14	14	7	6	6	10	4	2	2	0	2.5
(L)	18	17	18	11	10	12	10	8	6	4	2.5	0

Table2: Comparison between crossovers

Crossover	Opti.	Avg. val.	Best Value	Worst Value
PMX	17/18	159.7	35.3	175
OX	14/18	160.3	35.3	153



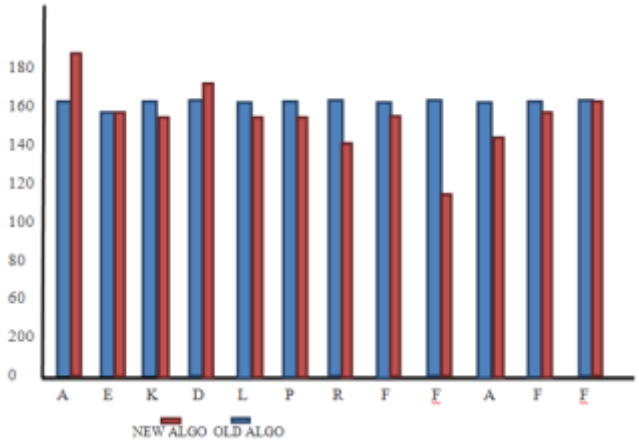


Fig. 3: Comparison between New and Old Algorithm

5. Computational Result and Discussion

To compare the given crossover operator we operate MATLAB with few number of outmoded routes sign crossover operators in genetic algorithm. In our 12 domino's pizza Centre's we have to do practice to cover up the minimum distance among the same in the city in table 2. We have solved the problem by genetic algorithm. The parameters in genetics are as

Population size, M = 18; maximum generation, G = 12; probability of crossover, Pc =0.8; probability of mutation, =0.2. , the best path and value are A-B-C-D-F-E-G-I-H-J-K-L-A = 35.3and 159, respectively. In Table 3 the results and shows that the presentation of PMX and OX is much better than the two prevailing crossover operators with 18 runs.

6. Conclusion

In this paper, Genetic Algorithm has been presented for TSP with different crossover operators for the optimization of different Pizza delivery centers. Three different operators have been used and we get a real value of TSP using genetic algorithm. The fittest criteria, is provided by the suggested algorithm is for symmetric as well as asymmetric TSP.

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