

Effect of Crossover and Mutation Probabilities on Solving Traveling Salesman Problem (TSP) in Genetic Algorithm

تأثير احتمالية التزاوج واحتمالية الطفرة في حل مسألة البائع الجوال باستخدام الخوارزمية الجينية

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Abstract:

The aim of this paper is to explaining the effect of the probability of Crossover and mutation for solutions the Traveling Salesman Problem (TSP) in a Genetic Algorithm (GA). Order Crossover (OX) and exchange mutation operators have been used with experiment Law Crossover Probability ($P_c < 0.5$), and high Mutation Probability ($P_m > 0.5$).

الخلاصة:

يهدف البحث الى توضيح اثر احتمالية التزاوج والطفرة في حل مسألة البائع الجوال باستخدام الخوارزمية الجينية، تم استخدام التزاوج الترتيبي وطفرة الابدال مع احتمالية تزاوج واطئة واحتمالية طفرة عالية .

Introduction:

The genetic algorithm are an optimization technique based on natural evolution [1] Genetic Algorithm are a form randomized search, in that the way in which strings are chosen and combined is a stochastic process. This is a radically different approach to the problem solving methods used by more traditional algorithms, which tend to be more deterministic in nature. Genetic Algorithm include the survival of the fittest idea into a search algorithm which provides a method of searching which does not need to explore every possible solution in the feasible region to obtain a good result . Genetic Algorithm are based on the natural process of evolution in nature the fittest individuals are most likely to survive and mate ; therefore the next generation should be fitter and healthier because they were bred from healthy parents . [3] In section 2, we will explain the definition of Traveling Salesman Problem (TSP). In section 3 we will explain genetic algorithm in detail, including the representation operations; Finally evaluate the performance of this methods

Definition of Salesman Problem (TSP):

A salesman wants to visit (n) cities cyclically. He wants to visit each city once and return to the city where he starts. In which way should he visit the cities so that the distance traveled by him will be minimum ? Form Small Value of (n), one can easily find the solution by having a permutation of the cities which is the minimum distance tour .But for larger (n), it would be impracticable as there are (n-1)! ways to visit the cities. The Genetic Algorithm can produce reasonable Solution in short time[2]. The solutions to TPS are only valid when :

- 1.All N cities in the problem are present in the solution.
2. Use fixed-length chromosome to present our tours.
- 3 .All cities are represented once only in the solution
4. No cities are absent..

Genetic Algorithm:

The genetic algorithm are used for solving complex problem such as NP-hard problem.A typical example of such problem is the traveling salesman problem (TSP).The main advantage of the GA is that they can found a feasible solution for a very short time .

The steps of GA are[4]:

- 1- First create many random tours of cities .
- 2- Pick up two best fittest parents (tours) to make a new tour .
- 3- Crossover them and muted each according to some probability.
- 4- Replace some individuals of the old population according to replacement strategy in the hope the new tours will provide better solution .

Repeat until convergence .

The key function here is minimum distance of a tour which acts as fitness computed by the following equation [1] :

$$\text{Fitness} = \sum_{I=1}^{\text{no.cities}} D_i \dots\dots\dots (3.1)$$

Where D_i is the distance between two cities .

In this paper we have used the Roulette Wheel Selection , Order Crossover (OX) , exchange mutation , and the new offspring replaced in the population instead of individuals with law fattiness .

Results:

We evaluate the performance of the algorithm with 6 experiments, in all of them the population size was the duplicate of the number of cities in the problem.The three experiments involved low crossover probability and high mutation probability, and the other experiments involved crossover probabilities equal to (1) and low mutation probability, the result shown in the following figure:

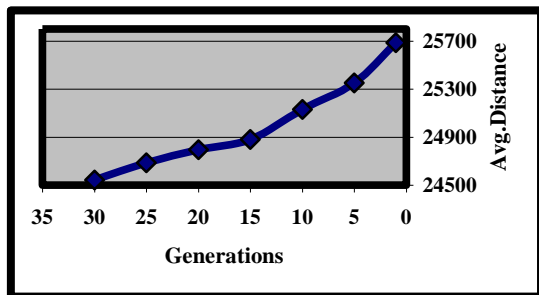


Figure (1) Best solutions with (10 cities , $P_c =1$, $P_m=0.1$)

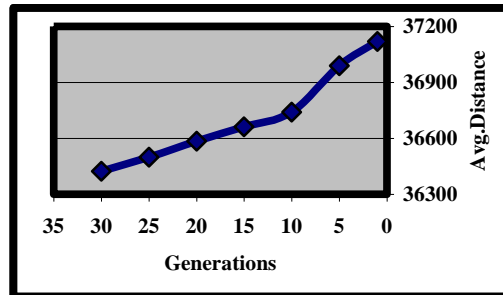


Figure (2) Best solutions with (10 cities , $P_c =0.1$, $P_m=0.9$)

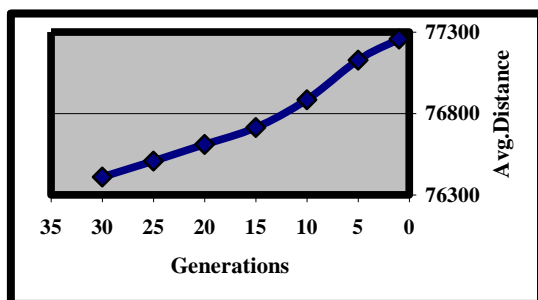


Figure (3) Best solutions with (30 cities , $P_c =1$, $P_m=0.1$)

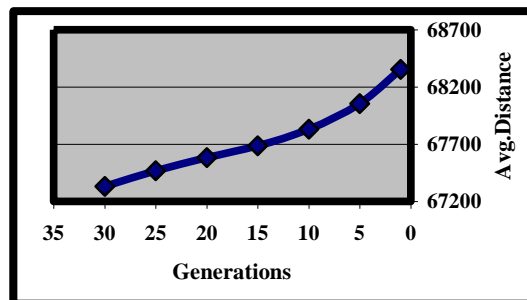


Figure (4) Best solutions with (30 cities , $P_c =0.1$, $P_m=0.9$)

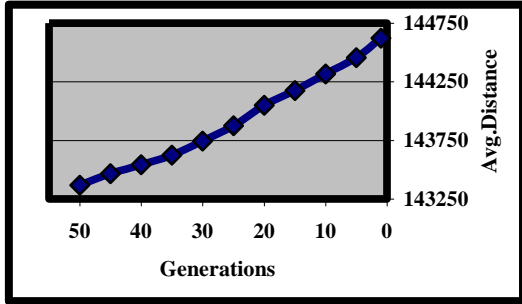


Figure (5) Best solutions with (50 cities , $P_c = 1$, $P_m = 0.1$)

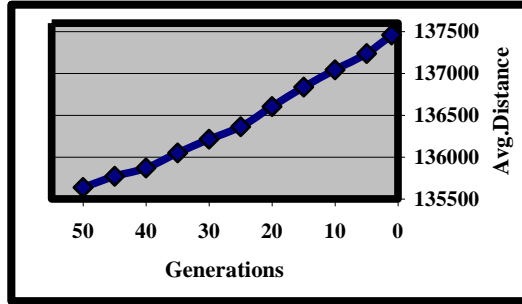


Figure (6) Best solutions with (50 cities , $P_c = 0.1$, $P_m = 0.9$)

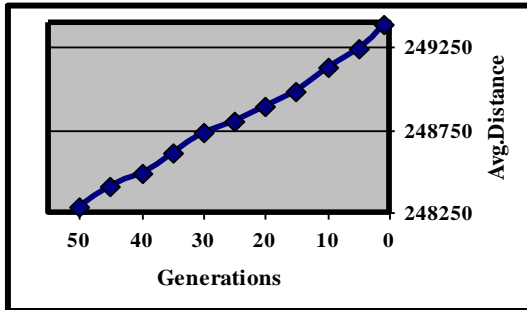


Figure (7) Best solutions with (100 cities , $P_c = 1$, $P_m = 0.1$)

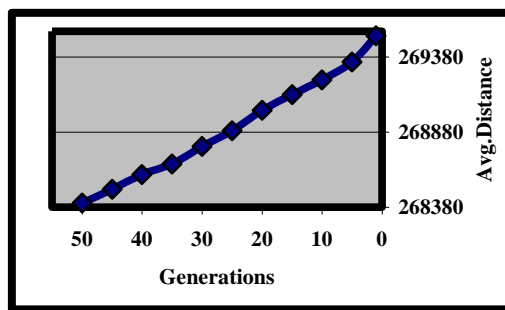


Figure (8) Best solutions with (100 cities , $P_c = 0.1$, $P_m = 0.9$)

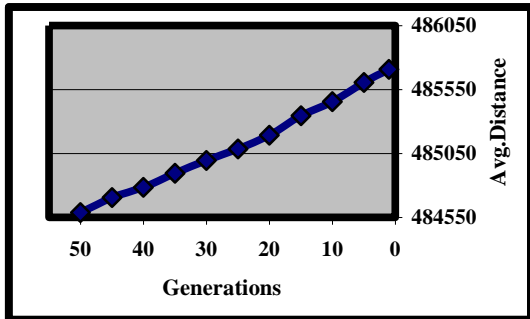


Figure (9) Best solutions with (200 cities , $P_c = 1$, $P_m = 0.1$)

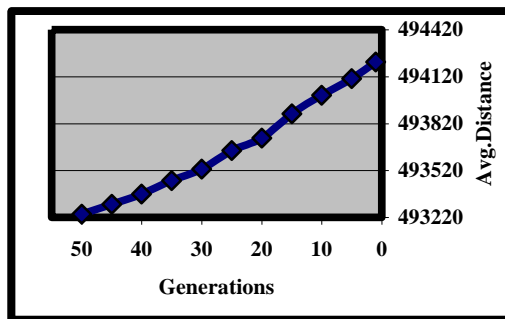


Figure (10) Best solutions with (200 cities , $P_c = 0.1$, $P_m = 0.9$)

Conclusion:

We show from figures above that the low crossover probability and high mutation Probability may be produce good solution (figure 4,6) when number of cities 30,50 , with small number of generation. In general ,the GA play a good role for solving TSP in practical way without high complexity .

Future Work:

We can use the selection(selection two parents for crossover) factor to evaluate the performance it on the GA .

References:

- [1] D.B.Fogel,An evolutionary Approach to the traveling salesman problem, Biological Cybernetics, 1988.
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- [3] I .M.Oliver,D.J.Smith and J.R.C.Holland , Study of permutation crossover operators on the TSP ,genetic algorithms and their applications: proceedings of the second international conference, 1987 .
- [4] M.Mitchell,An introduction to genetic algorithms, Cambridge USA,Landon UK: MIT Press, 1999.