Implementation of Genetic Algorithms for Optimization of Transportation Problem

Soobia Saeed[1]

(Received June 03, 2018; Revised November 24, 2018; Accepted December 11, 2018)

DOI: 10.33317/SSURJ.V8.I2.71

***Abstract*— Transportation problem is a model which is commonly used in data structure solving a problem (human problem solving due to the computational method) because all the humans are related to transportation in any type of manner. Normally, traditional mathematical procedures used for solving the problem which is quite lengthy, after the computational solving procedures it comes to the bit easier to solve it except traditional lengthy methods. The Genetic Algorithm (GA) is most powerful tool for solving transportation problem. It refines the better optimal solution, for enhancing the optimization of transportation problem, using genetic algorithms lots of the work already has been done. This paper discusses the impact of genetic algorithms on two different types of systems environments i.e., Single-Processor Environment Systems and Multi-Processor Environment Systems, for solving the transportation problem and found the best optimal solution time of both systems.**

***Index Terms*— Transportation Problem, Genetics Algorithm (GA), Single-Processor Systems, Multi-Processor Systems, Optimization.**

I. INTRODUCTION

A. Transportation Problem

The transportation means the movement of goods from one place to other places i.e., it can from one area to another area, one city to another city, one country to another country. These movements involve some cost or expenses. The emphasis should be given to minimize these expenses, this is what exactly the focus of transportation problems.

The transportation problem talks about the movement of a single item from a given set of supply points to a given set of destination points.

The Transportation Problem is a typical processes research problem where the objective is to conclude the program for transporting goods from source to destination in a way that decreases the shipping cost while satisfying supply and demand controls.

In this research paper a transportation problem is taken as an example, to compare via GA on single and distributed systems.

B. Algorithms

GAs are a great tool for taking gigantic pursuit spaces in exploring or searching for an ideal blend of arrangement of things, you may not generally discover in your lifetime i.e., it is not looking for the best solution it is looking for a good robust solution rated against fitness criteria, so it avoids for local optimal fitness and searches for global fitness. GAs relies on three bio-inspired operators such as:

- Selection: is the population improvement or survival for the fittest operator i.e., it duplicates structure with higher fitness and deletes structures with lower fitness
- Crossover: also called recombination, is a genetic operator used to combine the genetic information of two parents to generate new offspring. Crossover is a good component of the good structure combining two better structures i.e., crossover recombined elements of a good chromosome from different genomes.
- Transformation or Mutation: which makes new structures that are like current structures, with little pre indicated likelihood, change haphazardly all to be every part to each structure.

For Example, in the financial application that GA made its cover, that one variable part such as a cost to profit proportion is a better marker of future returns than another variable such is past returns for this situation the hereditary calculations would put more accentuation from the value income variable and less on the past return factors.

C. Problem Statement

Implementation of GA, for enhancing the optimization of transportation problem.

D. Background, Objectives, and Significance of the Study

The famous transportation problem is often called the Hitchcock problem. An American mathematician and physicist, Frank Lauren Hitchcock (1875-1957) was famous for Vector Analysis. He formulated the transportation problem in 1941. Genetic Algorithms were made to mirror a few of the procedures identified in normal development. Bunches of individuals, scientists tallied in, are astonished that life at the level of multifaceted nature that notice could have developed in the generally brief time, suggested by the fossil record. The thought with GA is to utilize this energy of advancement to tackle enhancement issues. The father of the first Genetic Algorithms was John Holland who created it in the mid-1970s.

The common objectives are to discover the arrangement of transportation issues, whichever minimize the cost of delivering ‘m’ units to ‘n’ goals or get the mostbenefit s out of transporting ‘m’ units to ‘ n’ goals i.e., find means to minimize the cost of the path between source and destination, deliver goods on time and in an easy way, as seen in Fig 1.

[1]Assistant Professor, Department of Software Engineering, Ilma University, Karachi, Pakistan. soobia_saeed123@hotmail.com

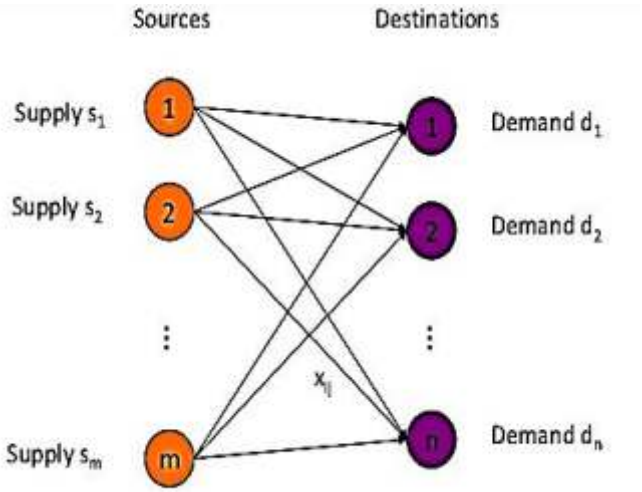

Fig. 1: Source and Destination Plan

This study will be of significance in several ways:

- First and foremost, it will help to find out that either the system is better for solving the problem of transportation by utilizing single-processor environment systems or multi-processor environment systems.
- Furthermore, the study will help an organization to acquire relevant skills, towards improving their services.

E. Hypotheses of the Study

This research will provide a basis, for choosing the best system (single or multi-processor systems), for finding the optimal solution of the transportation problem.

II. LITERATURE REVIEW

A. Transportation Problem

The purpose of solving the transportation problems is to find means to minimize the cost of the path between source and destination, deliver goods on time and in an easy way. The research took transportation problem as an example for showing the solution of the problem via GAs [1].

B. Genetic Algorithms

The GA is a classic example of machine learning, which originates its behavior from a demonstration of the procedures of development in nature. This is completed by the making within a machine, of a population of individuals denoted by chromosomes, in spirit a set of character strings that are similar to the base-4 chromosomes that look in our own DNA. The characters in the population then go through a process of evolution [2].

The genetic algorithms have three main types of rules for each stage i.e., creating the next generation from a current population:

- Selection Rules: Selecting people, guardians that contribute for the populace, for the people to come.
- Crossover Rules: blend of the guardians for making kids, for the people to come.
- Transformation Rules: applying haphazardly, alteration to the individual guardians, to initiating youngsters [3].

C. Search Space

The space for all possible arrangement is called a search space. Each point in the search space speaks to one attainable arrangement. Each possible arrangement can be "set apart" by its esteem or wellness for the issue arrangement that is one point in the search space.

D. Chromosome

A chromosome contains genes blocks of DNA, essentially it could be said that every gene encodes a characteristic, e.g., the color of the eye. Each gene has its position in the chromosome. This position is namedLocus . The entire set of hereditary material is named Genome. Genotype is the internally coded, inheritable information which is transported by all living microorganisms.

The transportation problem methods have the best for classical optimization. The common characteristics are to the 1940s and later on [4].

In the book, ‘Transportation Planning’, published by the National Commissariat of Transportation of the Soviet Union having an article called “Methods of Finding the minimal total kilometer age in cargo-transportation plans in space”, the author talks over the transportation problem and providing the solution for approaching the best ways [5].

A GA is an all-natural collection established marketing method. Four main changes can be found between GA-based methods and right problem-solving types of procedures:

- GAs works together with a coding of the parameter collection, not the variables themselves.
- GAs exploration for goals from a inhabitants of ideas, not really a one point.
- GAs use payoff (objective function) research, not other support knowledge such as without originality information found in calculus-based methods.
- GAs practice probabilistic progression guidelines, not deterministic suggestions. These four properties make GAs powerful, purposeful, and data-independent [6], [7].

A GA is a stochastic strategy with simple businesses, based on the idea of natural selection. The essential procedures are an assortment of population affiliates for the afterward group, ``mating" these people via crossover of ``chromosomes," and fulfillment modifications on the genes to reservation people diversity to be able to avoid convergence to local goals. To get rid of with, the suitability of every affiliate in the new group is set using an analysis ‘fitness’ function. This suitability influences the selection process of another group.

The GA operationsSelection, Crossover, and Mutation first and foremost contain unplanned amount group, copying, and partial string exchange. Thus, these are powerful tools which are modest to implement. Because it isbased on ordinary collections, which will allow a GA, to employ a ‘survival for the fittest'', strategy. The usage of a population of ideas helps the GA to avoid converging to false peaks ‘local optima’, in the search space [8].

In the year 2012 a group of three researchers found the best way to solve the transportation problem which is generally a mutual problem of merchandises control group and companies. GA's methods on operation cover techniques for chromosome and crossover and mutation these techniques help in finding the best fitness function for the successful mutation or crossover procedures [9], [10].

A large number of parameters can be a problem for copied based approaches, due to description of the gradient. In this type of situation, a not-terrible result via GA can be found and then increase on that with the derivative based method. The definition of "large" is growing all the time [11], [12].

The time of transportation might be a significant feature in numerous transportation problems. The effectiveness of any transportation has been presented as a collection of the time and the amount of goods on dynamic transport processes, the longest time on single active transport process, overall time on all energetic transport processes, and the total amount of goods with the lengthiest time of transport etc. The query ascends from thisis that, whether to achieve optimization at the same time for more purposes with ultimate importance for, each or to give single objective problems, which are of the great significance for a specific problem.

It is an easy way to produce simple algorithms that will give interesting results but, this paper,is discussing the result from GA, where all algorithms are failed to get the answer or best way, then at last GA provides a solution [12].

Transportation problem result finds with GA is better than the result of normal Volghen method. Its handled large data set, GA takesa shorter time to solve the problem in para llel of other solving matters. The good thing is that the transportation problem will be solved by a genetic algorithm and also it takes a large input of data.

The GA is a useful tool for finding the best optimization solution of transportation problem with a large amount of data [13].

Another research conducted in 2004 concluded that, GA has the capability to find the minimal cost of network optimization against the traditional math methods to solve it. Traditional math methods could also be used for solving the transportation problem. Also, the optimal solution result of GA by traditional mathematics methods have been checked [14].

Matrix-based GAs are proposed to solve the transportation problem for more optimal solutions, further GA, is used for solving more complicated and real-life transportation problems.

Finding the best answer to the transport problem which is matchless andin reality is a maximum solution. It has been applied for converting, complete developed transport problem into a linear coding problem and placed on the argument methods. The Dual Simplex (DS) strategy is most beneficial with a high view toVogel's Approximation Method (VAM) because DS strategy has least number of repetitions.

Transportation is playing a very important role in human's life as it is related to all other aspects like social and economic activities. The focus should be on finding better ways of solving it, to facilitate smooth working.

Transportation problem is related to linear programming problems. The aim of the solution for this problem is, transporting numerous quantities to their destinations with minimal cost effect. By using different algorithms cost minimization of transportation problem can be possible in contrast to typical mathematical solution methods [15].

The problem algorithms can solve the large search space transportation problems easily. It is proved that it is easy to solve a balanced transportation problem via North-West Corner, Least-Cost, Row/Column minimum methods [16].

The genetic algorithm developed for solving the incorporate inventory transportation problem. Appropriate genetic demonstration that focuses on the delivery schedule demonstrated in the form of a 2-dimensional matrix is intended for GA construction uses previously randomized version. GA is mainly based on two of its search phases Crossover and Mutation operations. Designing of Mutation operator is involved in a mechanism to help transport in a better manner through the customer [17].

III. RESEARCH METHODS

A. Method of Data Collection

This research is based on Quantitative Data Collection methods for collecting data. Experimental data is used as the primary source of data. Literature review, books and articles are used as a secondary source of data. Experimental treatment used for collecting data.

This work used C-Sharp programming language to improve the system and increased the efficiency of running the application on both environment systems on Single-Processor System and Multi-Processor System, after the implementation of a genetic algorithm.

B. Sampling Technique

The random quantitative sampling methods or techniques are used for collecting samples. Random sampling is easy to conduct and has a high possibility of a chieving a demonstrative sample and meets the assumption of many statistical techniques.

C. Sample size

The author used sample size for minimum 1000 destinations for sample and 1000 for supplies.

D. Research Model developed

The research model developed is based on:

- Implementation of transportation problem via a C-Sharp language based program.
- Finding a better optimal solution on the basis of genetic algorithms.
- Running the application on both environment systems on Single Processor System and Multi-Processor System.
- Analysis of the optimal point for both types of systems which are in the most competitive environment to solve the transportation problem.

E. Statistical Technique

The statistical techniques for transportation problem are given below:

- To analyze the results of both types of systems, and finding out which one provide better performance in minimal time, for solving transportation problem.
- Measuring the solution time of both types of systems for the transportation problem.

Below is the data set of a single transportation problem:
Total mill supply counts = 60
Total shops demands count = 80
It is a balanced transportation problem, for finding the optimal solution of the problem via the North West Corner Cell method.
Transportation problem runs 10000 times on single and multi-core systems, on multiple times for findings different times of result are written below:
The Northwest Corner (or upper left corner) method is a guideline that applies to a particular type of linear programming problem called the Transport Model, which ensures that a primary solution is possible (non-artificial). The other ways to obtain the initial primary solution are the lower method of Cell Costand the Vogel Rounding Model. In general, the Vogel Model produces the best primary and worst Northwest Corner solutions. However, the Northwest Corner method has the lowest number of calculations.
The Northwest Corner of the cell (the path) corresponds to the northeast corner or the upper left corner of the box (variable). The following describes the steps:

- Step 1: Set the maximum amount available for the selected cell and adjust the associated quantities of supply and demand by subtracting assigned amount.
- Step 2**:** Exit the row or column when the width or the order reaches zero, and then cross it to show that you cannot perform any other tasks for that row or column. If a row or column reaches zero at the same time, just cross one (row or column) and leave a width (zero) in a row (column) not to be deleted.
- Step 3: If there is one row or column that is not completely deleted, then stop, otherwise, move to the cell to the right if a column is deleted, or to the cell below if a line is deleted. Continue with step 1.

To illustrate how the North west Cornerapproach is applied, we will consider the followingB alanced Transport Model that takes into account 3 silo products that meet the needs of 4 mills (request).
The transport algorithm relies on the assumption that the model is balanced, i.e., the total demand is equal to the total supply (if the model is unbalanced, it can always be increased with an imaginary source or an imaginary return destination).
Balance the transport costs per unit are j represented in the upper right corner of each box. In addition, silos 1, 2 and 3 contain capacity and supply of 15, 25 and 10 units, respectively. On the other hand, Mills 1, 2, 3 and 4 have requirements or demands of 5, 15, 15 and 15 units, respectively. The model is balanced (total supply = total demand = 50 units), see Fig.2. When applying the Northwest Corner model to the previous example, the following results are obtained.

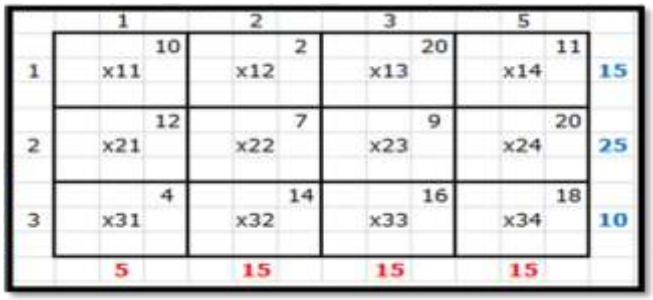

Fig. 2: Balanced Transport Model

With the further development of intelligent transport systems and artificial intelligence techniques, the relevant transportation method has also been deepened in the study. The author presented a model for improving the multi-object GA, including data from the Northwest Corner Cell Method, using the global search optimization algorithm to handle the multi-core optimization system and obtain the optimal solution for the linear transport model, see Fig 3.

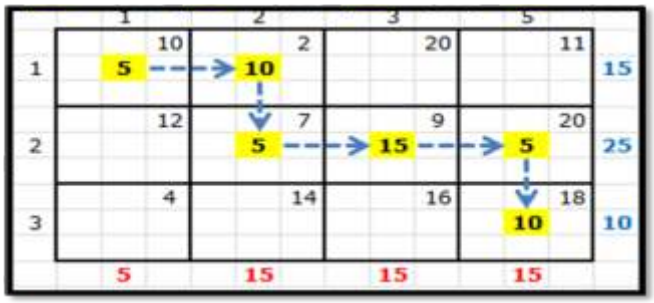

Fig. 3: Northwest Corner Model

IV. COMPARISON OF TP VIA NWCCM

Here are given below the transportation problem of the North West Corner Cell Method as shown in Table I:

Table I: Transportation Problem via North West Corner Cell Method

Runs	Time (Seconds)	
	Single Core	Double Core
First Time Run	46	28
Second Time Run	37	28
Third Time Run	35	27
Fourth Time Run	51	29
Fifth Time Run	32	33
Least Count Value	**40.2**	**29**

V. DISCUSSIONS

Here thecomparison of TP and NWCCM for transportation problem via North West Corner Cell Method can be seen. The first, second, third, fourth and minimum least value of runtime which shows the efficiency of the transportation problem. These measurements show that the examination of multi-core and single-core improvements and efficiencies and also the differences between these two types of systems are not much greater. This concludes that, according to our problem statement, the multi-core system is the best, to find the optimal solution to the problem of transport.

VI. CONCLUSION

The result shows that multi-core system environment is better in performance for calculation of Transportation Problem by utilizing North West Corner Cell Method. Differences between both types of systems are not much higher but as per the problem statement for finding the optimal solution of the transportation problem, the best system should be selected.

VII. POLICY IMPLICATIONS AND FUTURE RESEARCH

The findings of the research will encourage researchers to work on single and multi-core processors systems and to find the complete optimization solution of the ransportation problem on both types of systems. Many of the researchers have worked on optimization of transportation problem but none of them worked on optimization of both types systems to find which system environment is better as far as implementation is concerned.

REFERENCES

[1] Dharma, S., &Ahmed , A. M. B. (2005). *Optimization of Transportation Problem with Computer Aided Linear Programming Education*. Proceeding of the Postgraduate Annual Research Seminar Universiti Teknologi Malaysia, (140-144). Kuala Lumpur : Malaysia.

[2] Goldberg, D. E. (2008). *Genetic Algorithms in Search, Optimization, and Machine Learning.* London, UK : Dorling Kindersley Publisheing Inc.

[3] Brindha, G., Rohini, G., & Gnanakousalya, C. (2015). Genetic Algorithm based Optimization of Single Node in Reformed-Digital Micro Fluidic Biochip Education*Indian Journal of Science and Technology, 29(*8), 1-6.

[4] Man, K. F., Tang, K. S., & kwong, S. (2001). *Genetic Algorithms Concepts and Designs*, London, UK : Springer-Verlag London.

[5] Tolsto˘ı, A. N. (1930). *Russian Transportation Planning : Russian Methods of finding the minimal total kilometrage in cargotransportation planning in space (23-55)*, Moscow, USSR : TransPress of the National Commissariat of Transportation.

[6] Schrijver, A. (2002). On the history of transportation and maximum flow problems Education. *Journal of Mathematical Programming: Series A and B, 91*(3), 437-445.

[7] Gokhale, M. et al(1991). Building and Using Highly Parallel Programmable Logic Array Education. *Supercomputing Research Center, Daniel Lopresti Brown Universty, 24*(1), 81-89.

[8] Scott, S., Samal, A., &Seth , S. (1995). HGA: a hardware-based genetic algorithm Education. *Computer Based Learning Unit, University of Leeds*, 53-59.

[9] Winson, S.H., Chi-Kong C., Henry, C. B. (2012). Green Cargo Routing Using Genetic Algorithms Education. *Proceedings of The International MultiConference of Engineers and Computer Scientists.* Hong Kong : China.

[10] Carlos M. F., Peter J. F. (1993). *Genetic Algorithms for Multiobjective Optimization: Formulation, Discussion, and Generalization Education.* Proceedings of the 5th International Conference on Genetic Algorithms, (416-423). San Francisco, CA : Morgan Kaufmann Publishers Inc.

[11] Nikolic, I. (2007). Total Time Minimizing Transportation Problem Education. *Yugoslav Journal of Operations Research 1*(1), 125-133.

[12] Mitchell, M., (1998). An Introduction To Genetic Algorithms. Massachusetts Institute of Technology.

[13] Huyen, N. T., Luong, S. U., & Rosaly B. A. (2013). Genetic Algorithm for Solving Balanced Transportation Problem Education. *International Journal of Innovative Technology and Exploring Engineering*, 3(4), 182-190.

[14] Hai-Feng, C. et al. (2004). Solving Hitchcock's transportation problem by a genetic algorithm. *Education Journal of Chongqing University 3(*2), 54-57.

[15] Sharma, G., Abbas, S. H., & Gupta V. K.(2012). Solving Transportation Problem with The Various Method of Linear Programming Problem Education. *Asian Journal of Current Engineering and Maths 1(*1), 81-83.

[16] Ali, U. A., & Mustapha, A. M. (2013). Comparison of Transportation Algorithms Using Data from Katsina State Transport Authority, Katsina State, Nigeria Education*Nigerian Journal of Basic and Applied Science, 21*(3) 207-214.

[17] Abdelmaguid, T. F., & Dessouky M. M. (2006). A Genetic Algorithm Approach to The Integrated Inventory-Distribution Problem Education. *International Journal of Production Research, 44(*21), 4445-4464.