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Tabu Search Approach to Solve Routing Issues in Communication Networks

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***Abstract*—**Optimal routing in communication networks is a major issue to be solved. In this paper, the application of Tabu Search (TS) in the optimum routing problem where the aim is to minimize the computational time and improvement of quality of the solution in the communication have been addressed. The goal is to minimize the average delays in the communication. The effectiveness of Tabu Search method is shown by the results of simulation to solve the shortest path problem. Through this approach computational cost can be reduced.

***Keywords*—**Communication networks, optimum routing network, tabu search algorithm, shortest path.

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I. Introduction

In a communication networks, particularly, a packet switched communication network, routing is a major issue that has a significant impact on the system performance. The main objective of the routing optimization algorithm is to find the best path for data transmission within a short time to satisfy the demand. By optimizing the routing, we improve network throughput defined by the mean packet delay. This paper deals with shortest path computation in real time. In this context, shortest path is referred to the minimization of the propagation distance, number of nodes, link capacity, or congestion level of the link [1-2].

The routing problem is one of the important issues to be studied in communication networks. Several research interests in searching for solution have been studies.

In [3] a method of self-healing communication networks that allow re-routing of demands through switching processes at designated nodes is presented. In this paper, it is shown how network utilization, demand throughput and reliability of such networks can be studied simultaneously to achieve an optimal design. The use of linear programming approximation to the multi-commodity network flow formulation to solve the problem for medium and large network sizes in moderate computational times has been addressed.

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In [4] the problem of optimal routing in shortest-path data networks is addressed using open shortest path first (OSPF), routing information protocol (RIP), and other interior gateway protocols (IGPs). A proposed combinatorial algorithm for solving the optimal shortest-path routing problem consists of finding the link-distance metric assignment to all links in a network.

In [5], a description of the Hopfield/Tank model used for routing problem is shown.

In [6] a method that combines Hopfield networks (HN) and a genetic algorithm (GA) to solve the problem of optimal routing in computer networks is used.

In [13]-[14] neural network approach is applied to solve the shortest path problem.

In all methods, it has been reported that the performance has been improved. Limited global search, long computation time to solve large-scale problem, are the main problem of the most above listed algorithms. The application of Tabu Search to the routing problem has been motivated by the idea of taking advantages of being very successful in achieving near-optimal (and sometimes optimal) solutions to a variety of hard problems [7].

This paper is organized as follows: section I presents the introduction. Section II presents the details on the problem formulation. Tabu Search algorithm background is presented in section III. Section IV discusses the results obtained. Section V gives relevant conclusion.

II. Problem Formulation

Please A given directed graph $G = (V, E)$ and set of N nodes of graph $V(G) = \{n_i\}\ i = 1,2, \dots, N$, and that of edges connecting nodes in V is depicted in Fig. 1. Edge set of $E(G) = \{(i,j)|i,j \in V\}$ representing edges of a graph G. Corresponding to each edge there is a cost C_{ij} representing the cost from node n_i to node n_j.

In this problem, the total length is equal to the sum of all costs of links within the path. The conditions to be satisfied in this problem of finding the shortest path from the source to the destination are: each node is available only once in a path and one node at a time. We employ tabu search to solve the problem of finding the shortest path of a given communication network between a source and destination nodes.

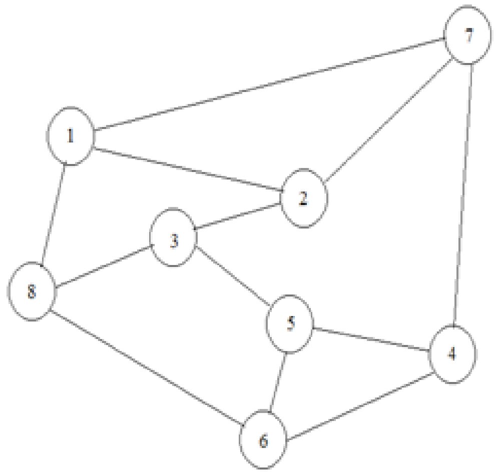

Fig. 1: Eight (8) node, Twelve (12) edge network model

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III. Tabu Search Algorithm

The Tabu Search metaheuristic has been defined in [8, 15, 16]. The basic idea behind tabu search is that, adding short-term memory to local search, improves its ability to locate optimal solutions. It is an is an iterative search that starts from some initial feasible solution and attempts to determine the best solution in the manner of a hill-climbing algorithm. The algorithm keeps historical local optima for leading to the near-global optimum fast and efficiently [8].

The idea is to make sure that there will be no same local optimum happening again in the process. Backtracking process starts from stepping back to some local optimum in tabu list and then searching a new optimum in different directions. Backtracking is performed when the backtracking criterion (BC) is encountered. In this paper, we address the use of tabu search for solving the routing problem. More details on tabu search can be found in [8-11]. In these publications, it is stated that the main two components of the tabu search algorithm are the tabu list restrictions and the aspiration criterion.

In applying the Tabu Search algorithm, to solve a shortest path routing problem, the basic idea is to choose a feasible solution at random and then obtain a neighbor to this solution. During these search procedures the best solution is always updated and stored aside until the stopping criterion is satisfied [12]. Fig. 2 shows the flow chart for the basic Tabu Search algorithm process, followed by its pseudo-code in Fig. 3.

IV. Results

The Tabu Search method has been used to perform an example of 5-node network shown in Fig. 3 used by [6, 13]. In [6], Hopfield-genetic approach was applied for the similar problem while in [13-14] neural network approach was used. Both methods converge to an optimal solution. Table 1 shows the 5-node, 8-links, network and their random costs. Table 2 shows the results of optimal paths from source node 1 and destinations node 4 and node 5. The optimal path for source node 1 and destination node 4 is: node 1-to- node 2 -to– node 4 (1-2-4). The optimal for source node 1 and destination node 5 is: node 1-to-node 2 –to-node 5 (1-2-5).

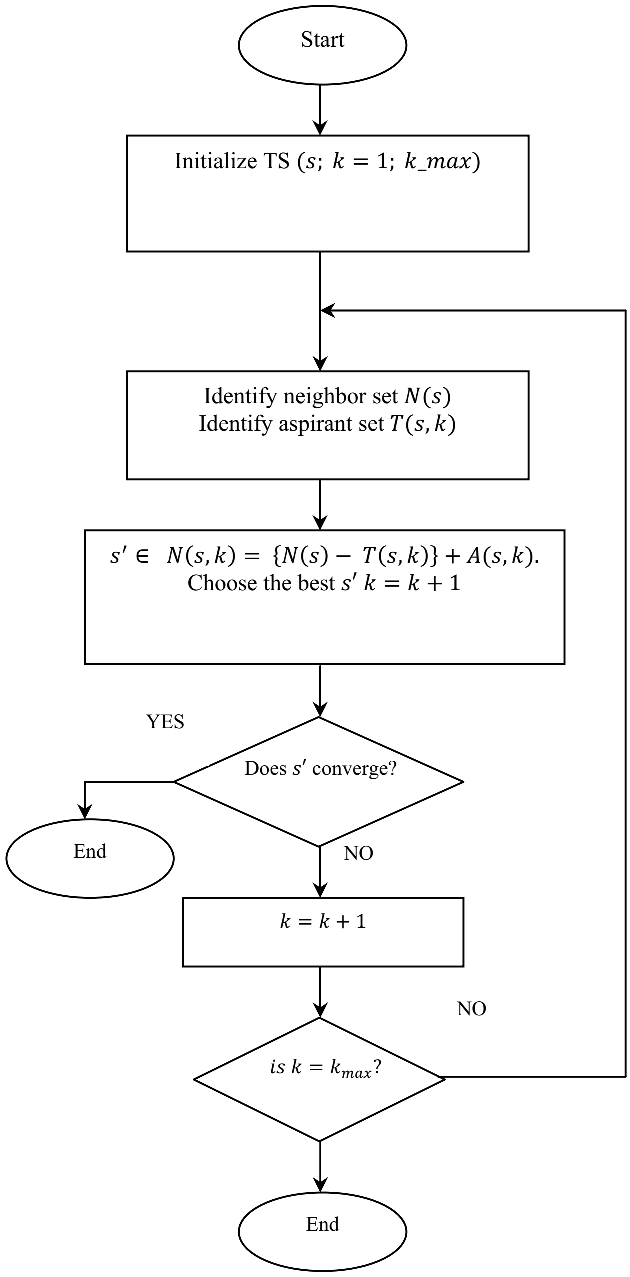

Fig. 2: Flow chart for the basic Tabu Search process [8].

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Initiate k = 1.
generate initial solution
WHILE the stopping condition is not met
DO
   Identify N(s). (Neighbourhood set)
   Identify T(s,k). (Tabu set)
   Identify A(s,k). (Aspirant set)
   Choose the best s'
   s' ∈ N(s,k) = {N(s) − T(s,k)} + A(s,k).
   s = s'.
   k = k + 1.
END WHILE
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Fig. 3: Tabu Search process pseudo-code.

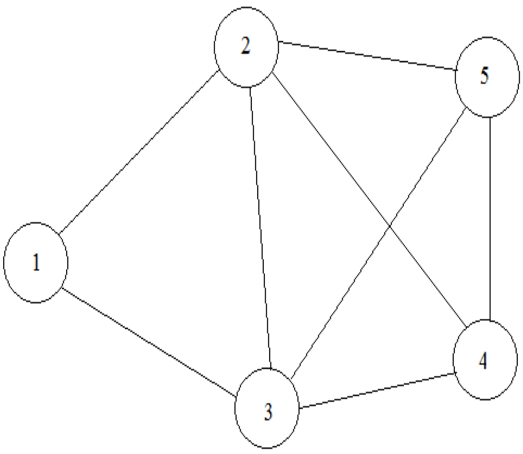

Fig. 3: A five (5)-node, eight (8)-links network

Table 1: The links and their random costs for five (5)-node, eight (8)-links network

Link	Cost
1-to-2	0.377483
1-to-3	0.76667686
2-to-3	0.03693263
2-to-4	0.415129
2-to-5	0.42212904
3-to-4	0.45564041
3-to-5	0.03693263
4-to-5	0.87610209

Table 2: The source destination optimal path for the five (5)-node, eight (8)-links network

Source	Destination	Optimal path	Cost
1	4	1-2-4	0.793612
1	5	1-2-5	0.799612

The similar approach was applied to an eight (8)-node, twelve (12)-links, network shown in Fig. 4 with link costs presented by Table 3.

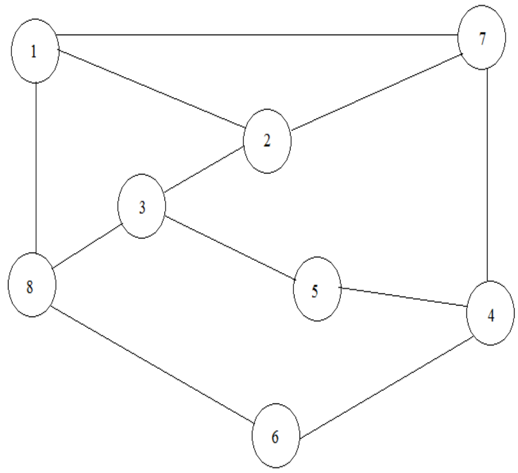

Fig.4: An eight (8)-node, twelve (12)-links network

Table 3: The links and their random costs for eight (8)-node, twelve (12) links network

Link	Cost
1-to-2	0.7919
1-to-7	0.9218
1-to-8	0.7382
2-to-3	0.1763
2-to-7	0.4057
3-to-5	0.9355
3-to-8	0.9169
4-to-5	0.4103
4-to-6	0.8936
4-to-7	0.0579
5-to-6	0.3529
6-to-8	0.8132

Table 4: The source destination optimal path for the eight (8)-node, twelve (12) links, and network

Source	Destination	Optimal path	Cost
1	4	1-7-4	0.9797
1	5	1-7-4-5	1.39
2	6	2-7-4-5-6	1.2268
3	7	3-2-7	0.582
6	7	6-5-4-7	0.8211

V. CONCLUSION

It has been observed that the performance of tabu search is robust and fast. In this paper a novel strategy for routing in computer networks has been presented. Results obtained for the test cases suggest that the simulated with Tabu Search algorithm allocation is a stout approach for this problem, and was always able to find good quality possible solutions.

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