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An Algorithm of Searching for the Shortest Path

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***Abstract*—In recent years, residents in various regions transfer their jobs increasingly frequently, job transfer involving migrating between cities is no longer novelty. Job transfer involving migrating between cities might bring economic problems, especially when those who have estate implement job transfer. How to relieve negative impact with which job transfer involving migrating between cities brings economic is non-ignorable problem. This paper points out that this problem is mainly inflation and proposes a solution containing seeking for the shortest path. The essence of the shortest path is that inflation caused by job transfer involving migrating between cities is overcome with the biggest reliability.**

Keywords- job transfer, inflation, shortest path.

I. INTRODUCTION

Nowadays, data in information system grows exponentially, how to exploit data resource has become a worldwide problem. In general, that data resource seems to be abandoned stem from the fact that people do not know when to have resorts to data resource. If one clearly knows that data resource is helpful to his or her work, data resource will be made use of to solve practical problem.

For the moment, job transfer is a universal phenomenon, which usually involves real estate business. Real estate business undoubtedly exerts its influence on fluctuation of price, which should be controlled within reasonable range. At this time, exploiting data resource is a choice which people are able to think of. Seeking for the shortest path upon directed graph is one of the methods by which data resource is exploited since much information can be represented by directed graph.

II. RELATED RESEARCH

Stéphane Chrétiena, et al. studies the expectation of the inspection time in complex aging systems, i.e. the length of the shortest path in a Directed Acyclic Graph, with random costs on edges [1]. Jianqiang Cheng et al. consider a stochastic version of the shortest path problem, namely the Distributionally Ro-bust Stochastic Shortest Path Problem (DRSSPP) on directed graphs. In order to solve NP-hard problem in the model, they propose new reformulations and approximations using a sequence of semidefinite programming problems which provide tight lower bounds[2]. Li Wang et al. investigates the constrained shortest path problem in a transportation network where the link travel times are assumed to be random variables defined on the basis of joint probability mass functions. An algorithmic framework, integrating the sub-gradient algorithm, label-correcting algorithm and K –shortest path algorithm, is designed to minimize the gap between the upper and lower bounds to find near-optimal solutions. The proposed algorithm is proved to be able to quickly find the high-quality solutions with small relative gaps, demonstrating the effectiveness of the proposed approaches [3].Daniele Ferone et al. study the constrained shortest path tour problem. Given a directed graph with non-negative arc lengths, the aim is to find a single-origin single-destination shortest path, which needs to cross a sequence of node subsets that are given in a fixed order. The subsets are disjoint and may be of different size. In addition, it is required that the path does not include repeated arcs. To exactly solve it, a Branch & Bound method is proposed. Given the problem hardness, a Greedy Randomized Adaptive Search Procedure is used, which is effective in finding optimal or near optimal solutions in very limited computational time. It is also developed to find near-optimal solutions for medium to large scale instances [4]. Mohammad Hajian et al. consider the problem of finding the fire traversal time across a landscape considering wind speed as an unpredictable phenomenon. The landscape is represented as a graph network and fire propagation time is modeled as the Stochastic Shortest Path problem. Monte-Carlo simulation is utilized to determine the fire travel-time distribution. The algorithm with less simulation time and higher prediction accuracy can serve as a fast and reliable tool for fire prediction [5]. Markó Horváth et al. investigate LP-based branch-and-bound methods and introduce new cutting planes, separation procedures, variable fixing, and primal heuristic methods for solving RCSPP, in which there is a directed graph along with a source node and a destination node, and each arc has a cost and a vector of weights specifying its requirements from a set of resource types with finite capacities, to optimality [6]. Rafael Castro de Andrade considers a directed graph G=(V, A) with a set of nodes V and a set of arcs A , and let c u v denote the length of an arc uv ∈ A . Given two nodes s and t of V , we are interested in the problem of determining a shortest-path from s to t in G that must visit only once all nodes of a given set P⊆V-{ s, t} . This problem is NP-hard for P=V-{ s, t} . Three new compact formulations, among which ,a primal-dual mixed integer model presenting a small number of variables and constraints allows the efficient solution of randomly generated and benchmark (from the TSPLIB) instances of the problem with hundreds of nodes, are developed for this problem[7]. Leonardo Taccari compares several integer programming formulations for the ESPP, which consists of finding a minimum-cost path between two nodes s and t such that each node of G is visited at most once, if given a directed graph G = (V, A) with arbitrary arc costs[8]. Yi Shen et al. propose a biased-shortest path method with minimal congestion. Their method has the advantage of low computation cost because the optimal paths are dynamically self-organized by nodes in the delivering process of packets with local traffic information [9]. Stasys Jukna et al. prove a general lower bound on the size of switching-and-rectifier networks over any semiring of zero characteristic, including the (min, +) semiring. Using it, they show that the classical dynamic programming algorithm of Bellman, Ford and Moore for the shortest s-t path problem is optimal, if only Min and Sum operations are allowed [10].

Generally, above researches focus on how to find the shortest path better in terms of computational time, complying with given regular of visiting node in graph. But they stop explanation of the shortest path over literal level, in terms of which our research is different from theirs.

III. METHOD

A. Problem

It is supposed that there is one person who has decided to give up his work in city A so as to take up new work in city B. If he or she has purchased estate in city A, then his or her behavior of changing work might aggravate inflation, especially when there is no person who is willing to exchange his or her estate in city B for the estate in city A. The reason why changing work might aggravate inflation is that if one, who originally works in city A and wants to work in city B, cannot find another one who is willing to exchange his or her estate in city B for the estate in city A, he or she must sell his or her estate in city A and wait an appropriate chance by which he or she purchase another estate in city B, which means that he or she hold enough money for a period of time. That he or she holds enough money for a period of time undoubtedly aggravates inflation.

How to overcome the problem, which is typically inflation, brought by that everyone with estate give up current work and find new work in another city? If we record “A->B” representing that one transfer work from city A to city B, then for the sake of overcoming inflation, meanwhile, we hope that there is another one who wants to transfer work from city B to city A , which can be recorded as “B->A”. As alternative, “B->……->A”, where “B->……->A” contains finite letter like ‘A’ or ‘B’, is also expected. The difference between “B->A” and “B->……->A” is that the former is more reliable than the latter.

The following is the reason why “B->A” is more reliable than “B->……->A”.

The definition of “B->A” is that there exists at least one person who is willing to give up current work in city B and seek for new work in city A. In other words, “B->A” represents the person’s willing of transferring work from city B to city A. However, whether the person really do so depends on many objective conditions. It is assumed that the person’s wish come true according to probability of p, then “B->C->A” will come true according to probability of p^2, “B->C->D->A” will come true according to probability of p^3, and so on. Obviously, given that n is an integer no smaller than 1, p is no smaller than p^n since p is a number no bigger than 1. That p is no smaller p^n means that “B->A” is more reliable than “B->……->A”. In other words, the probability of that “B->A” comes true is bigger than that of that “B->……->A” comes true. So, if there exist many paths from B to A, the shortest path from B to A is what we should seek for.

Facing a tremendous amount of data, how can we find the shortest path between given node B and another given node A, where node B and node A represent city B and city A, respectively? This problem is the key point we will discuss in the following.

B. Solution

If there is one person who will transfer his or her work from city A to city B according to probability 1, which means that “A->B” is recorded in information system, it is expected that some information like “B->……->A” exist in information system so that people needn’t worry about inflation. The following figure is fictitious information that stored in information system which we will make a detailed analysis of to find the shortest path between B and A.

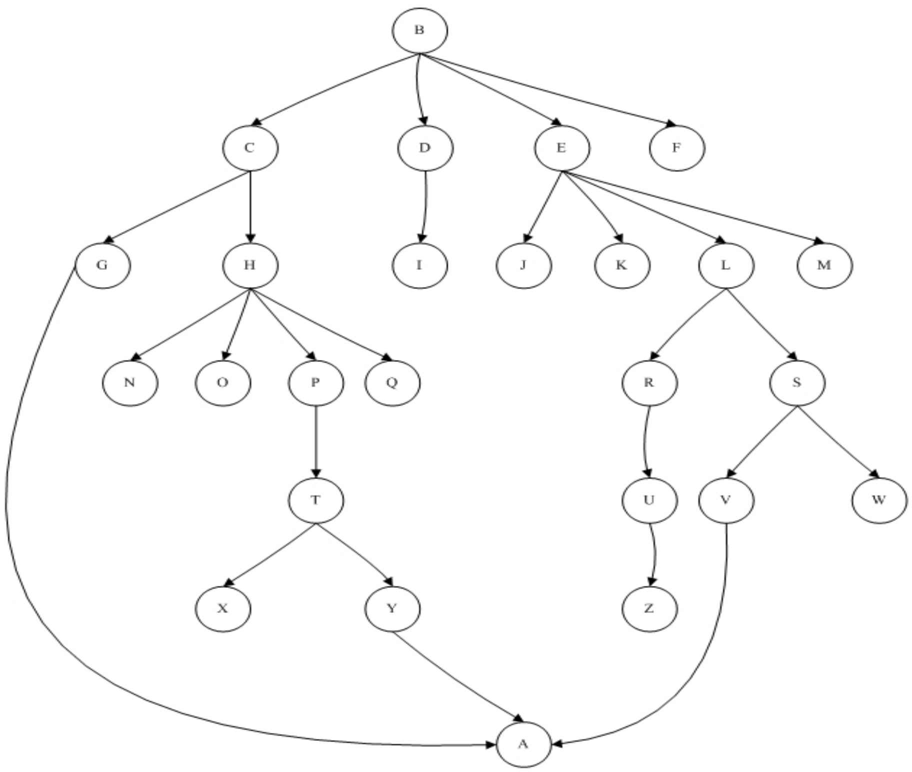

Figure 1. Fictitious information stored in information system.

The above figure (Fig. 1) can be called directed graph. In order to find the shortest path between B and A, what should be firstly done is to store information represented by above directed graph in to computer. The directed graph can be represented in computer in the form shown in Fig. 2.

Node	Parent	Node	Parent	Node	Parent
B	NULL	K	E	T	P
C	B	L	E	U	R
D	B	M	E	V	S
E	B	N	H	W	S
F	B	O	H	X	T
G	C	P	H	Y	T
H	C	Q	H	Z	U
I	D	R	L	A	G,Y,V
J	E	S	L		

Figure 2. The representation of directed graph in computer.

Where the first element of every tuple represents child, and the second element of every tuple represents the parent of the child. For instance, tuple <C,B> means that B is the parent of C and C is one of the children of B. There is some elements as first element of a tuple, who have more than one parents. The representation of this kind of tuple is different from that of other tuples, which can be seen from Fig. 2. For example, A has 3 parents, they are G, Y,V, respectively.

When meeting the circumstance in which there exists element like A, who has more than one parent, the representation of directed graph in computer need to be changed. Take Fig. 2 for example, the table in Fig.2 should be divided into 3 tables since A has 3 parents. The parts of 3 tables are in Fig.3 , Fig. 4, Fig. 5, respectively.

Node	Parent
T	P
U	R
V	S
W	S
X	T
Y	T
Z	U
A	G

Figure 3. A part of the 1^{st} fragmentation of representation of directed graph in computer of directed graph in computer.

Node	Parent
T	P
U	R
V	S
W	S
X	T
Y	T
Z	U
A	Y

Figure 4. A part of the 2 nd fragmentation of representation of directed graph in computer of directed graph in computer.

Node	Parent
T	P
U	R
V	S
W	S
X	T
Y	T
Z	U
A	V

Figure 5. A part of the 3 rd fragmentation of representation of directed graph in computer of directed graph in computer.

What follows should be that finding path between B and A based on each fragmentation of representation of directed graph in computer, and comparing each path between B and A in order to confirm the shortest path between B and A. Among above steps, finding path between B and A based on each fragmentation should be most time-consuming. The following pseudocode describe the algorithm which is used to find path between B and A based on each fragmentation:

```
INT I=0;
INT NUM=9999;
FINDPATH(B,A)
{
     OUTPUT(A);
     I=I+1;
     IF(I>NUM)
        QUIT(1);
     P=GETPARENT(A);
     IF NOT(P==NULL)
        FINDPATH(B,P);
     ELSE
        QUIT(2);
}
```

Where NUM is used to end the procedure in the circumstance that there is no path between B and A and there exists at least one circle in directed graph.

Using above algorithm to analyze Fig. 3, Fig. 4 and Fig. 5 results in 3 paths, they are “AGCB”, “AYTPHCB”, “AVSLEB”, respectively. Comparing these paths with each other, the shortest path can be found. It is “AGCB”.

IV. Conclusion and Future Research

Seeking for the shortest path can be used to supporting solving economic problem such as inflation triggered by job transfer involving migrating between cities since to some extent, the shortest path represents the biggest reliability of facilitating job transfer between cities without involving currency. In this paper, information stored in information system, which reflects circumstance of job transfer, is too simple to really reflect reality. For the future, undirected graph and weighted graph will be considered.

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