Journal of Computer-Generated Mathematics

The use of the brute-force method for solving the traveling salesman problem

Deko Dekov

Abstract. In this paper we propose the brute-force method as a suitable method for solving the traveling salesman problem in high schools and colleges.

Keywords: brute-force method, traveling salesman problem

Given n cities, denoted by City #1, City #2,…, City #n, and for each i,j = 1,2,…,n, the distance from City #i to City #j, denoted by $c(i,j)$.If $(i_1,i_2,...,i_{n-1})$ is a permutation of {2,3,…,n}, we call the sequence $1,i_1,i_2,...,i_{n-1},1$ a *path*, and we call the sum

$$c(1,i_1)+c(i_1,i_2)+c(i_2,i_3)+...+c(i_{n-2},i_{n-1})+c(i_{n-1},1)$$

the *length* of the path. The traveling salesman problem is as follows. Find all paths with minimal length. If we have to find all paths sorted by length, we call the problem the *extended* traveling salesman problem.

The brute-force solution of the traveling salesman problem is as follows. We calculate the lengths of all paths, and then we sort the paths by length.

Since the brute-force method is simple, it allows simple implementation. I have created a simple computer program by using the programming language PHP. The computer program is used in examples given below.

If the traveling salesman problem is defined for n cities, where n $\leq$ 8, the computer program displays the answer without any delay, that is for less than 1 second. Hence, we could use the brute-force method as a suitable method for solving the traveling salesman problem in high schools and colleges. Also, for the extended traveling salesman problem we obtain the answer without delay. The university students have to study more fast and sophisticated methods, but in the high schools and colleges, we could prefer the brute-force method, since it is simple and the students could easily understand and use it.

Example 1. Solve the extended traveling salesman problem given by the following table:

	To #1	To #2	To #3	To #4	To #5
From #1	0	16	20	24	21
From #2	4	0	21	14	15
From #3	23	6	0	13	15
From #4	9	24	15	0	19
From #5	17	8	2	8	0

Solution. The record of the output of the computer program is available for download as supplementary material.

Example 2. Solve the extended traveling salesman problem given by the following table.

	To #1	To #2	To #3	To #4	To #5	To #6
From #1	0	16	20	24	21	12
From #2	4	0	21	14	15	8
From #3	23	6	0	13	15	8
From #4	9	24	15	0	19	20
From #5	17	8	2	8	0	13
From #6	21	24	4	2	10	0

Solution. The record of the output of the computer program is available for download as supplementary material.

Example 3. Solve the extended traveling salesman problem given by the following table.

	To #1	To #2	To #3	To #4	To #5	To #6	To #7
From #1	0	16	20	24	21	12	17
From #2	4	0	21	14	15	8	14
From #3	23	6	0	13	15	8	13
From #4	9	24	15	0	19	20	22
From #5	17	8	2	8	0	13	11
From #6	21	24	4	2	10	0	5
From #7	2	19	19	5	22	3	0

Solution. The record of the output of the computer program is available for download as supplementary material.

Example 4. Solve the extended traveling salesman problem given by the following table.

	To #1	To #2	To #3	To #4	To #5	To #6	To #7	To #8
From #1	0	16	20	24	21	12	17	10
From #2	4	0	21	14	15	8	14	8
From #3	23	6	0	13	15	8	13	9
From #4	9	24	15	0	19	20	22	21
From #5	17	8	2	8	0	13	11	17
From #6	21	24	4	2	10	0	5	19
From #7	2	19	19	5	22	3	0	10
From #8	2	10	16	9	4	2	11	0

Solution. The record of the output of the computer program is available for download as supplementary material.

Example 5. Solve the extended traveling salesman problem given by the following table.

	To #1	To #2	To #3	To #4	To #5	To #6	To #7	To #8	To #9
From #1	0	16	20	24	21	12	17	10	19
From #2	4	0	21	14	15	8	14	8	3
From #3	23	6	0	13	15	8	13	9	18
From #4	9	24	15	0	19	20	22	21	13
From #5	17	8	2	8	0	13	11	17	17
From #6	21	24	4	2	10	0	5	19	25
From #7	2	19	19	5	22	3	0	10	11
From #8	2	10	16	9	4	2	11	0	23
From #9	3	11	25	19	14	3	4	7	0

Solution. The record of the output of the computer program is available for download as supplementary material.

Dr.Deko Dekov
Zahari Knjazeski 81
6000 Stara Zagora
Bulgaria
Submitted on 1 October 2011
Publication date: 15 February 2012