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IMPLEMENTATION OF OPTIMIZATION APPROACHES AND MATHEMATICAL MODEL OF THE KOMMIVOYAJOR ISSUE IN TOURISM FIRMS

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Annotation: the Commivoyager issue (TSP) is one of the most common and studied issues in mathematical optimization and computer science. The goal of the matter is to find the shortest route by which one kom-mivoyajor goes to the designated cities, visiting each city only once, and eventually returning to his starting point.TSP is known for its complete combinatorial properties and high level of complexity. This issue is considered an NP-complete issue, meaning that finding an exact solution is greatly complicated as the number of issues increases. A variety of algorithms have been developed to find solutions through computers, including network search algorithms, genetic algorithms, and simulated annealing techniques.The kommivoyajor issue is used in practice in many areas, such as logistics, transport, robotics and various resource management systems. He also optimizes issues and increases efficiency

Annotation: The Traveling Salesman Problem (TSP) is one of the most well-known and studied problems in mathematical optimization and computer science. The objective of the problem is to find the shortest possible route that allows a traveling salesman to visit a set of specified cities, visiting each city only once, and ultimately returning to the starting point. TSP is famous for its fully combinatorial nature and high complexity. It is classified as an NP-complete problem, meaning that finding an exact solution becomes increasingly difficult as the number of cities grows. Various algorithms have been developed to find solutions using computers, including network search algorithms, genetic algorithms, and simulated annealing methods. The Traveling Salesman Problem is applied in many practical fields, such as logistics, transportation, robotics, and various resource management systems. It is also of great theoretical importance as a tool used for optimization and improving efficiency.

Аннотация: Задача коммивояжера (TSP) — одна из самых известных и изученных задач в математической оптимизации и информатике. Цель задачи — найти кратчайший маршрут, позволяющий коммивояжеру посетить заданные города, посетив каждый город только один раз, и в конце концов вернуться в исходную точку. TSP известна своими полностью комбинаторными свойствами и высокой сложностью. Эта задача является NP-полной, что означает, что нахождение точного решения становится всё сложнее по мере увеличения числа городов. Для нахождения решений с помощью компьютеров разработаны различные алгоритмы, включая алгоритмы поиска в сети, генетические алгоритмы и методы симулированного отжига. Задача коммивояжера

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применяется в различных областях, таких как логистика, транспорт, робототехника и системы управления ресурсами. Она также имеет большое теоретическое значение как инструмент для оптимизации и повышения эффективности.

Keywords: Commivoyajor issue (TSP), optimization, combinatorics, NP-complete issue, shortest path, algorithms, logistics, transport, robotics, resource management, simulated annealing, genetic algorithms, network search algorithms, solution topping.

Keywords: Traveling Salesman Problem (TSP), optimization, combinatorics, NP-complete problem, shortest path, algorithms, logistics, transportation, robotics, resource management, simulated annealing, genetic algorithms, network search algorithms, solution finding.

Ключевые слова: Задача коммивояжера (TSP), оптимизация, комбинаторика, NP-полная задача, кратчайший путь, алгоритмы, логистика, транспорт, робототехника, управление ресурсами, симулированный отжиг, генетические алгоритмы, алгоритмы поиска в сети, нахождение решения.

Introduction. The kommivoyajor issue is one of the most important issues in the field of combinatorial optimization, the purpose of which is to visit several cities and find the shortest route back to the starting point with a minimum path length. This issue is used in areas such as transport logistics, optimization of production processes and the design of electronic circuits

Solving methods: Bruteforce (full review),Dynamic Programming (Held-Karp algorithm),greedy algorithm (Greedy Algorithm),genetic algorithm, simulated annealing (Simulated Annealing), linear programming, and chess be (Branch and Bound

Purpose: the purpose of the Kommivoyajor issue is to find the shortest and most effective way of Kom – mivoyajor to visit the given cities. In this case, each city should be visited only once, and in the end the kom-mivoyajyor should return to the starting city. The main goal of the issue is to keep the distance from visiting cities to a minimum and thus reduce time and costs. In solving tsp, by optimizing the goal, it is to increase efficiency in real-world areas such as transport, logistics and resource management. Also, algorithms and methods developed to solve TSP can be extended to many other optimization issues.

With only one visit to each of the n cities given, a tour for the shortest time(road, cost) can be found in sik li. Where the number of cycles is at most ta. This issue has been linked to the question of finding the minimum length Hamilton cycle. The "networks and boundaries"method can be used to solve the commivoyajor issue. This method is performed using a cycle-free and surface graph to which you are connected, as well as drawing up tables.

Sample option. We introduce the concept of quoting a table. To do this, the table rows are first quoted, that is, the smaller of that row is subtracted from each row element of the table accordingly. After that, the same action is performed with respect to the table columns and the table columns are brought. A table in which all lines and columns are listed is called quoted. The sum of the smallest elements of the rows and columns of the table is determined by h, which is called the quotient of the table. As an example, let's see the following train travel schedule throughout Uzbekistan:

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We enter the marks.

1.Paris-Berlin – 1050

Paris -Rome – 1420

Paris - Madrid – 1260

Paris -Amsterdam – 510

Paris -Vienna – 1230

Paris -Prague – 1030

Paris -Zurich – 615

2.Berlin-Paris – 1050

Berlin -Rome – 1180

Berlin - Madrid – 1860

Berlin - Amsterdam – 650

Berlin - Vienna – 680

Berlin - Prague – 350

Berlin - Zurich – 820

3.Rome-Paris – 1420

Rome - Berlin – 1180

Rome - Madrid – 1360

Rome - Amsterdam – 1530

Rome - Vienna – 760

Rome - Prague – 850

Rome - Zurich – 550

4. Madrid - Paris – 1260

Madrid - Berlin – 1860

Madrid - Rome – 1360

Madrid - Amsterdam – 1480

Madrid - Vienna – 1730

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Madrid - Prague –1820

Madrid - Zurich - 1320

5. Amsterdam - Paris – 510

Amsterdam - Berlin – 650

Amsterdam - Rome – 1530

Amsterdam - Madrid – 1480

Amsterdam - Vienna – 1150

Amsterdam - Prague – 780

Amsterdam - Zurich – 760

6. Vienna - Paris – 1230

Vienna - Berlin – 680

Vienna - Rome – 760

Vienna - Madrid – 1730

Vienna - Amsterdam – 1150

Vienna - Zurich – 590

Vienna - Prague – 330

7. Prague - Paris – 1030

Prague - Berlin – 350

Prague - Rome – 920

Prague - Madrid – 1820

Prague - Amsterdam – 780

Prague - Vienna – 330

Prague - Zurich – 590

8. Zurich - Paris – 615

Zurich - Berlin – 820

Zurich - Rome – 850

Zurich - Madrid – 1320

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Zurich - Amsterdam – 760

Zurich - Vienna – 670

Zurich - Prague – 590

B/S	1	2	3	4	5	6	7	8	Satr bo'yicha eng kichik
1		1050	1420	1260	510	1230	1030	615	510
2	1050		1180	1860	650	680	350	820	350
3	1420	1180		1360	1530	760	850	550	550
4	1260	1860	1265		1480	1730	1820	1320	1260
5	510	650	1530	1480		1150	780	760	510
6	1230	680	760	1730	1150		330	590	330
7	1030	350	920	1820	780	330		590	330
8	615	820	850	600	760	670	590		590

Table 1

To cite the lines of Table 1, let's write down the smallest element of the line corresponding to

B/S	1	2	3	4	5	6	7	8
1		540	910	750	0	720	520	105
2	700		830	1510	300	330	0	470
3	870	630		810	980	210	300	0
4	0	600	5		220	470	560	60
5	0	140	1020	970		640	270	250
6	900	350	430	1400	820		0	260
7	700	20	590	1490	450	0		260
8	25	230	260	10	170	80	0	
ustun bo'yicha eng kichik element	0	20	5	10	0	0	0	0

its right, and subtract it from the elements of the line to get to Table 2 below.

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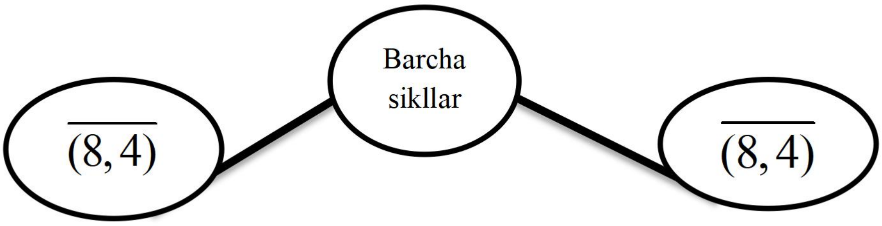
Table 2

In order to cite the columns of the resulting Table 2, the smallest element of the corresponding column is written under the table and subtracted from the column elements, resulting in the following table 3.

B/S	1	2	3	4	5	6	7	8
1		520	905	740	$0^{(275)}$	720	520	105
2	700		825	1500	300	330	$0^{(300)}$	470
3	870	610		800	980	210	300	$0^{(270)}$
4	$0^{(0)}$	680	$0^{(255)}$		220	470	560	60
5	$0^{(120)}$	120	1015	960		640	270	250
6	900	330	425	1390	820		$0^{(260)}$	260
7	700	0	585	1480	450	$0^{(80)}$		260
8	25	210	255	$0^{(740)}$	170	80	$0^{(0)}$	

Table 3



1-rasm.

Table 3 is listed, with at least one zero element in each row and column. The quotient of the table under consideration H is equal to the following number

$$h_1 = 510 + 350 + 550 + 1260 + 510 + 330 + 330 + 590 + 0 + 20 + 5 + 10 + 0 + 0 + 0 + 0 = 4465$$

$$h_1' = h_1 + 740 = 5205$$

In general, the method of networks and boundaries consists of two important stages:
1) branching;
2) determination of lower boundaries.

During the solution of the issue, both stages are carried out in parallel. To carry out these stages, it is necessary to carry out the following work in a row. A) to cite the starting Table; B) to determine the quotient h; C) to determine the degree of zero elements of the cited Table; D) to carry out the branching based on these levels; E) to determine the lower

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limits of the cycles that make up the branching results; F) to reduce the size of the table by one; G) to avoid continue networking.

During the use of this method, all calculations are carried out using a given table, the results of which are shown in a separately compiled graph. At the end of this process, a perfect(minimum cost) cycle is determined.

A graph consists of a set of interconnected circles, each of which determines a set of cycles with a certain property. The limit-numbers written next to these circles denote the lower limit of the costs corresponding to the cycles belonging to that circle. The initial part of the graph will be in the form of Figure 1. In this, the first initial circle defines a set containing all the cycles and states that the cost per arbitrary cycle will not be less than the number H. In the example seen above, h=4465, which means that there is no cycle with a cost less than 4465.

The rows and columns in which the Zero is located, the level of which is the largest, are found and branched on. Location, when there are several large-level zeros, an optional one is selected. In this case, the right-hand circle denotes and is marked by the set of all cycles that involve the transition from city I to city j, while the left-hand circle, on the contrary, denotes and is marked by the set of routes that do not involve the transition from city I to city J.

The degree is the zero element of which the most kata is 740, which means that the branching graph is in Figure 1.The minimum cost factor for the chapdoirachayoni is written to h=4465, the number 5205, which is formed by adding the largest level of zero 740. To determine the lower limit of costs corresponding to the right-hand Circle, Line 8 and Column 4 of Table 3 are discarded(deleted) (which means that the size of the table is reduced by one). In this case, it should be noted that the ordinal numbers of the cities will definitely remain(written), while other, will turn out to be. After that,the formation of all incomplete cycles is prohibited, the issue is lost) denotes the transition from belgii-city to City-City, for which the element is replaced and written on the sign, $c_{48} =$).

We will continue our work by making tables again.

B/S	1	2	3	5	6	7	8	
1		520	905	$0^{(325)}$	720	520	105	0
2	700		825	300	330	$0^{(300)}$	470	0
3	870	610		980	210	300	$0^{(315)}$	0
4	$0^{(315)}$	680	$0^{(425)}$	220	470	560		0
5	$0^{(120)}$	120	1015		640	270	250	0
6	900	330	425	820		$0^{(260)}$	260	0
7	700	$0^{(340)}$	585	450	$0^{(210)}$		260	0
	0	0	0	0	0	0	0	

Table 4

$h_2 = 4465+0=4465 \quad h_2' = h_2 +425=4885$

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$c_{43} = 0^{(425)}$

$c_{34} =$

B/S	1	2	5	6	7	8	
1		520	$0^{(405)}$	720	520	$0^{(145)}$	0
2	700		300	330	$0^{(300)}$	365	0
3	870	610	980	210	300		0
5	$0^{(730)}$	120		640	270	145	0
6	900	330	820		$0^{(260)}$	155	0
7	700	$0^{(120)}$	450	$0^{(210)}$		155	0
	0	0	0	0	0	0	

Table 5

$h_3 = 4465 \qquad h_3^{'} = 4465 + 700 = 5165$

$c_{51} = 0^{(700)}$

B/S	2	5	6	7	8	
1	520		720	520	$0^{(675)}$	0
2		$0^{(150)}$	330	$0^{(0)}$	365	0
3	400	470	$0^{(90)}$	90		0
6	330	520		$0^{(155)}$	155	0
7	$0^{(330)}$	150	$0^{(0)}$		155	0
	0	0	0	0	0	

Table 7

$h_4 = 4465 + 210 + 300 = 4975 \qquad h_4^{'} = 5650$

$c_{18} = 0^{(675)}$

B/S	2	5	6	7	
2		$0^{(150)}$	330	$0^{(0)}$	0
3	400		$0^{(90)}$	90	0
6	330	520		$0^{(330)}$	0

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7	$0^{(330)}$	150	$0^{(0)}$		0
	0	0	0	0	

Table 8

$h_5 = 4975 \qquad h_5^{'} = 4975 + 330 = 5305$

$c_{67} = 0^{(330)}$

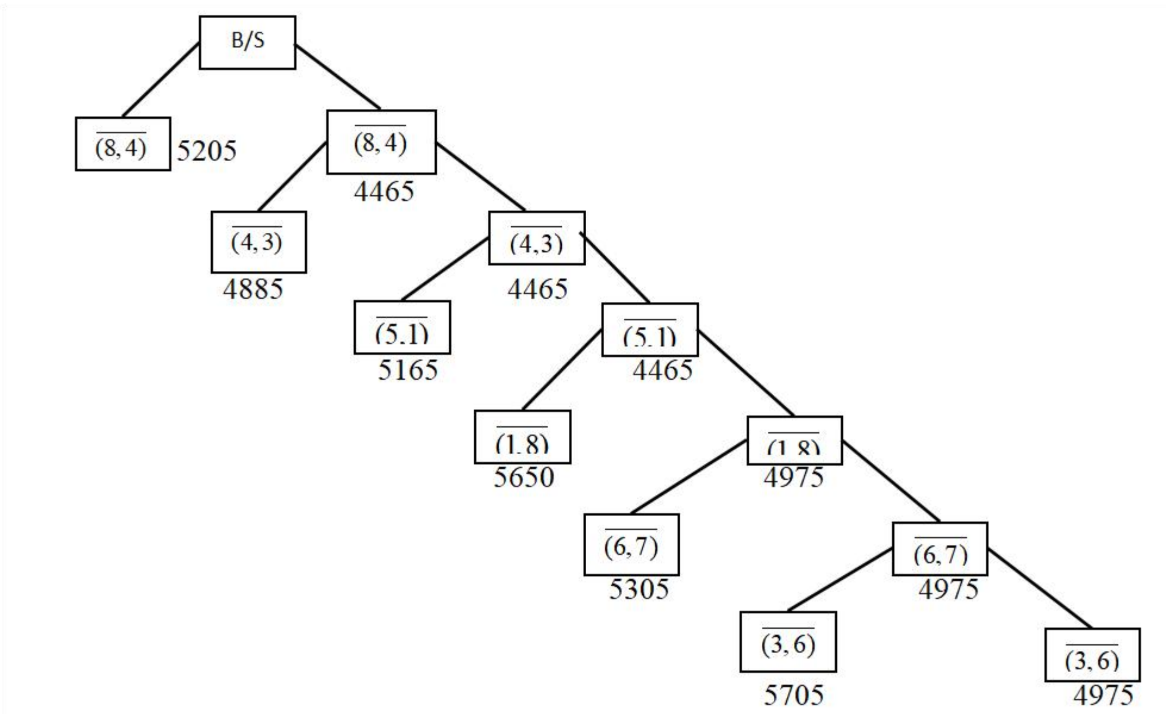
B/S	2	5	6	
2		$0^{(480)}$	330	0
3	400		$0^{(730)}$	0
7	$0^{(550)}$	150		0
	0	0	0	

Table 9.

$h_6 = 4975 \qquad h_6^{'} = 4975 + 730 = 5705$

$c_{36} = 0^{(730)}$

B/S	2	5
2		0
7	0	



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5705	4975

Shortest route (optimal route):

$5 \to 2 \to 1 \to 6 \to 8 \to 3 \to 4 \to 1 \to 5$
Minimum distance: 4975 units.

Conclusion. The commivoyager problem is a classical mathematical problem used to model and optimize many real-life problems. Due to the computational complexity of finding an Optimal solution, approximation algorithms or heuristic approaches are used in most cases.

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