

A new Algorithm for Large-Scale Traveling Salesman Problems

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Abstract

The classic traveling – salesman problem is to determine a tour that will minimize the total distance or cost involved in visiting several cities and returning to the starting point. This paper describes a new algorithm for accelerating the computational performances of branch exchange heuristics for symmetric traveling salesman problem. The improvement in performance is obtained by considering only exchanges that have a good chance of producing a better solution. This algorithm is faster than other heuristics' algorithms and computation times increase much less rapidly with problem size. The new algorithm makes it possible to solve large-scale traveling salesman problems.

Key words: Traveling salesman problem, Heuristic algorithm.

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	:	
(EXACT)	-	$(C_{ij} = C_{ji} \quad \forall i,j)$
		(SYMMETRIC)
[]		(ASYMMETRIC)
	:	(n) n
(Dynamic Programming)	-	(n-1) ! (n-1) ! /2
(Integer Programming)	-)
(Branch and Bound)		(Combinatorial Optimization Problem
(HEURISTIC)	-	

[] " (EXACT)
 [] (HEURISTIC)

S.Ellon 3-opt 2-opt
 [] N.Christofides
 r-opt

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2-opt r-opt

3-opt 5-opt

B.W.Kernighan , S.Lin
 K []

n^2 n
T.Doyle, L.Bodin,
[] W.stewart.JR B.Golden

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(

[] [] []

(n)

) 2-opt

() 3-opt (

(MST)

[]

(Arbitrary Insertion)

[] W.R.Stewart, Jr

(Average

of Arcs)

(Minimal Spanning trees)

n-1

n

3-opt

n-1

n

n-1

I

$O(n^2)$ $O(n^3)$

n-1

%

($\frac{n}{1.}$)

$$C' = \begin{bmatrix} - & - & 40 & 38 & 20 & - & - & - & 7 & 5 \\ - & - & - & 30 & 52 & 16 & 9 & - & - & - \\ 40 & - & - & - & 37 & - & - & 6 & 52 & - \\ 38 & 30 & - & - & - & 40 & 25 & - & - & 55 \\ 20 & 52 & 37 & - & - & - & - & - & - & 8 \\ - & 16 & - & 40 & - & - & - & 41 & 22 & 7 \\ - & 9 & - & 25 & - & - & - & - & 27 & 36 \\ - & - & 6 & - & - & 41 & - & - & 52 & 56 \\ 7 & - & 52 & - & - & 22 & 27 & 52 & - & - \\ 5 & - & - & 55 & 8 & 7 & 36 & 56 & - & - \end{bmatrix}$$

$C : n \times n$
 $C' : n \times n$
 $C = (C_{ij})$
 $C' = (C'_{ij})$
 $C_{ij} = C_{ji}$
 $C'_{ij} = C'_{ji}$
 $C_{ij} \leq b_i$
 $C'_{ij} \leq b_i$

3-opt 2-opt

$$\sum_{j=1}^n C_{ij}$$

$$b_i = \frac{\sum_{j \neq i} C_{ij}}{(n-1)} \times 2p$$

$$C'_{ij} = C_{ij} \quad C'_{ij} \leq b_i (\forall j)$$

$$C'_{ji} = C_{ij}$$

2-OPT
3-OPT

(n=10)

MST

n

$$C = \begin{bmatrix} - & 75 & 40 & 38 & 20 & 77 & 91 & 84 & 7 & 5 \\ 75 & - & 62 & 30 & 52 & 16 & 9 & 80 & 66 & 49 \\ 40 & 62 & - & 99 & 37 & 76 & 85 & 6 & 52 & 71 \\ 38 & 30 & 99 & - & 82 & 40 & 25 & 85 & 80 & 55 \\ 20 & 52 & 37 & 82 & - & 80 & 75 & 91 & 93 & 8 \\ 77 & 16 & 76 & 40 & 80 & - & 78 & 41 & 22 & 7 \\ 91 & 9 & 85 & 25 & 75 & 78 & - & 81 & 27 & 36 \\ 84 & 80 & 6 & 85 & 91 & 41 & 81 & - & 52 & 56 \\ 7 & 66 & 52 & 80 & 93 & 22 & 27 & 52 & - & 51 \\ 5 & 49 & 71 & 55 & 8 & 7 & 36 & 56 & 51 & - \end{bmatrix}$$

2-opt

MST

3-opt

P=0.5

AI

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(s)	AI 2-opt 3-opt	(n/10)MST AI 2-opt 3-opt	AV(p=0.5) AI 2-opt 3-opt	AV(p=0.25) AI 2-opt 3-opt	AV(p=0.17) AI 2-opt 3-opt	AV(p=0.125) AI 2-opt 3-opt	AV(p=0.1) AI 2-opt 3-opt
n							
n =	/	/	/	/	/	/	/
n =	/	/	/	/	/	/	/
n =	/	/	/	/	/	/	/
n =	/	/	/	/	/	/	/

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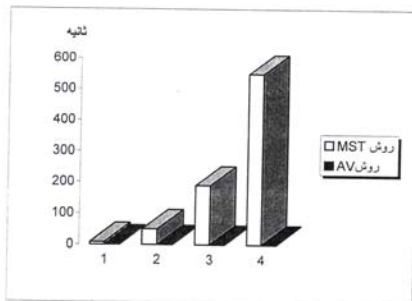
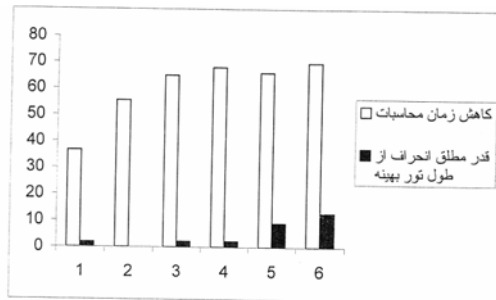
AV MST

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AV,MST

(n/10)MST	% /	% /
AV(p=0.5)	% /	%
AV(p=0.25)	%	% /
AV(p=0.17)	%	% /
AV(p=0.125)	%	% /
AV(p=0.1)	% /	% /

n	(n/10) MST	AV(p=0.5, 0.25,0.17,0.125,0.1)
	/	/
	/	/
	/	/
	/	/



(N/10)MST	1
AV(P=0.5)	2
AV(P=0.25)	3
AV(P=0.17)	4
AV(P=0.125)	5
AV(P=0.1)	6

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AV,MST

n= KMST

/ MST

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(Average of Arcs)

$$\frac{1}{3}$$

(MST)