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MSPP . NP-Hard (MSPP)

(GA)

MSPP (GIS)

MSPP

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MSPP .

[ ]

Chakhar .

[ ] Martel

NP-Hard

MSPP

[ ]

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"

SPP

(SPP)

SPP

(MSPP)

[ ]

) MSPP

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[ ] Martins (GA)  
dos Santos Martins [ ]  
[ ]  
Hallam MSPP GIS  
) [ ]  
(A\* MSPP SPP  
[ ] Park Nepal MSPP  
exhaustive  
Roy [ ]  
MSPP MSPP  
(QoS) MSPP  
QoS MSPP  
QoS Perez Mandow [ ] Fernandez  
[ ] de la Cruz  
“lexicographical goal satisfaction”  
GIS  
[ ] GIS Anderson Skriver [ ]  
G(V,E)  
 $\forall e \in E : e \rightarrow c(c_1, c_2, \dots, c_D)$  ( )

---

**MSPP**

$e \in G$

$D$  MSPP

$c$

$D$  (e)

MSPP

$Y = \{y_0, \dots, y_{D-1}\}$

$X = \{x_0, \dots, x_{D-1}\}$

$Y = \{y_0, \dots, y_{D-1}\}$   $X = \{x_0, \dots, x_{D-1}\}$

iff  $\forall i \rightarrow x_i \leq y_i$  and  $\exists j: x_j < y_j$  ( )

MSPP

$P_{true}$

$P_{true}$

$P_{true}$

[ ] ( Np-Hard

[ ]

$P_{true}$

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$\mathcal{G}$

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$P_{approx}^g$

$P_{approx}$

( )

$D =$  MSPP

$P_{true}$

$P_{A2}$

$P_{A1}$

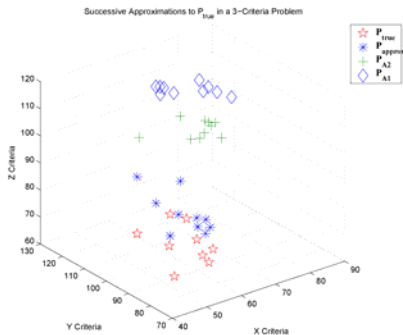
$k$

$P_{s,t} = \{p_0=s, p_1, \dots, p_{k-1}=t\}$

$P_{true}$

$P_{approx}$

$P_{s,t}$



شکل ۱: نمایشی از تکامل  $P_{approx}^g$  متوالی و  $P_{true}$ .

$\forall e \in E : e \rightarrow c(c_{length}, c_{time})$  and  $D = 2$  ( )

$pdv P_{s,t}$

$pdv i$

$D$  (c)

$t s P_{s,t}$

$i \in$

MSPP ( )

$s, t \in V$

[ ]  $P_{s,t}$

$P_{s,t} \forall P_{s,t} \in pdv(q_1, q_2, \dots, q_D)$  ( )

$$\sum_{(i,j) \in P} X_{i,j} - \sum_{(i,j) \in P} X_{j,i} = \begin{cases} 1, & i=s \\ 0, & \text{for } i \in V - \{s, t\} \\ -1, & \text{for } i=t \end{cases} \quad ( )$$

$$X_{i,j} = \begin{cases} 1, & \text{if edge } (i,j) \text{ is on the path } P_{s,t} \forall \text{ edges } (i,j) \in E \\ 0, & \text{otherwise} \end{cases} \quad ( )$$

$$\begin{cases} q_1 = \sum_{(i,j) \in P_{s,t}} c_{i,j}^1 \in (X_{i,j}) \\ q_2 = \sum_{(i,j) \in P_{s,t}} c_{i,j}^2 \in (X_{i,j}) \\ \dots \\ q_D = \sum_{(i,j) \in P_{s,t}} c_{i,j}^D \in (X_{i,j}) \end{cases} \quad ( )$$

$P_{s,t}$

$G(V,E)$

[ - ] "forward and backward-star"

$G(V,E)$

$G(V,E)$

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[ ] "Pareto ranking"

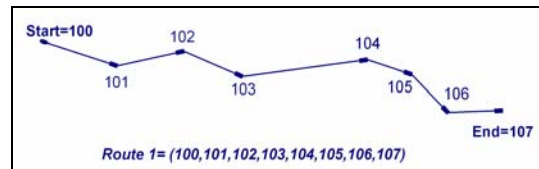
Pareto

$G(V,E)$

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شکل ۲: نمایشی از یک کروموزوم (مسیر).

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(noise)

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s.

"forward and backward-

$G(V,E)$

۱۴

s.

[ ] star"

s

$G(V,E)$

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( )

d=2 d-Heap's

[ - ]

( )

[ - ] d=2 d-Heap's

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(n)

$R_1 = (100, 101, 102, \underline{103}, 104, \underline{105}, 106, 107)$  ( )

$R_2 = (100, 108, \underline{103}, 109, 110, \underline{105}, 107)$  ( )

$R_{old} = (100, 108, \underline{103}, 109, 110, 111, \underline{103}, 105, 107)$  ( )

) n=2

$(105 \ 103 \ \dots \ R_2 \ R_1)$

$R_3 = (100, 101, 102, 103, 109, 110, 105, 106, 107)$  ( )

$R_4 = (100, 108, 103, 104, 105, 107)$  ( )

(  $R_{old}$  )

( )

)

(

$R_{new} = (100, 108, 103, 104, 105, 107)$  ( )

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MSPP

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Esri ArcGIS 8.3 (ArcInfo)

Visual COM

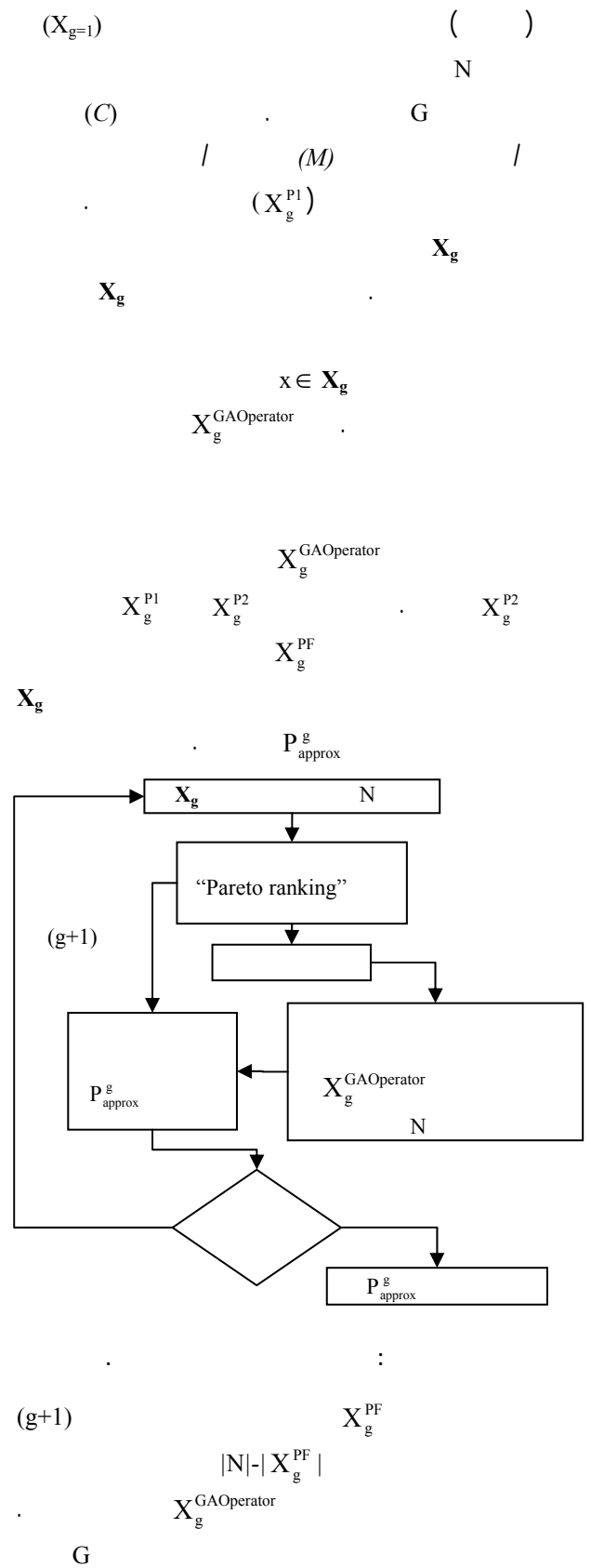
512Mb 2.26GHz Pentium 4

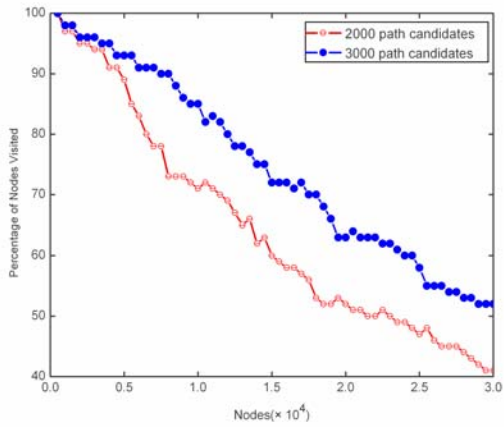
XP

[ ] Zitzler

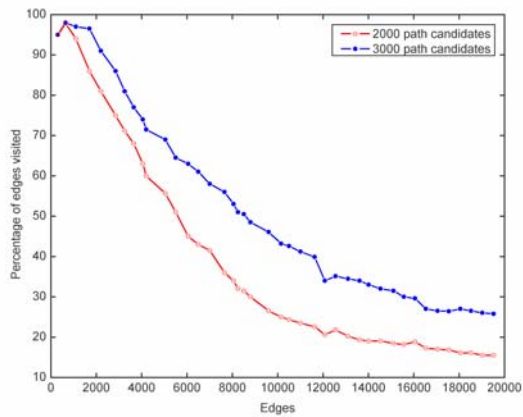
D

(Random walking)





شکل ۴: درصد گره‌های مشاهده شده از طریق GA.



شکل ۵: درصد یال‌های مشاهده شده از طریق GA.

[ - ]

“random walking”

(s,t)

“random walking”

$P_{s,t}$

“random walking”

$P_{approx}$

(D= )

( )

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%

[ ]

%

( )

"  $\alpha$   $P_{approx}$  "

%

( )

MSPP

%

$P_{approx}$

$P_{approx}$

)

MSPP1

CD( $P_{approx}$ )

(

CD( $P_{approx}$ )  $P_{approx}$

[ ]

Xiao

CD( $P_{approx}$ )

MSPP1

CD( $P_{approx}$ ) MSPP2

$$P_{approx}^{cut\_off} = P_{approx}^G \quad CD(P_{approx}) \quad P_{approx}$$

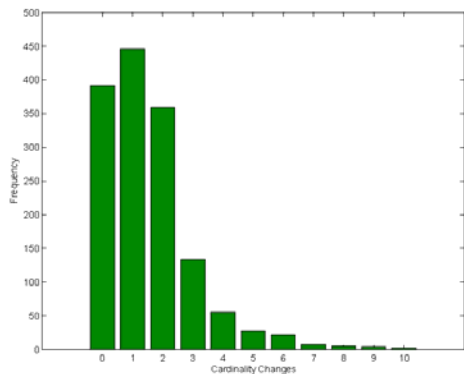
( )

$\alpha$

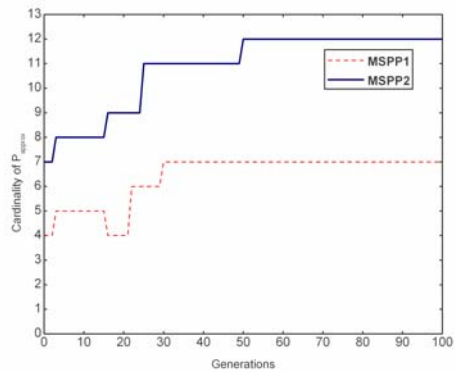
$$P_{approx}^{cut\_off} = P_{approx}^G$$

(G % )  $\alpha$

(G % )



شکل ۸: تغییر کاردینالیتی با  $\alpha = 0.25$  (شبکه متراکم).



شکل ۶: تغییر کاردینالیتی برای دو MSPP مجزا.

( ) ( )

MSPP: D=

y

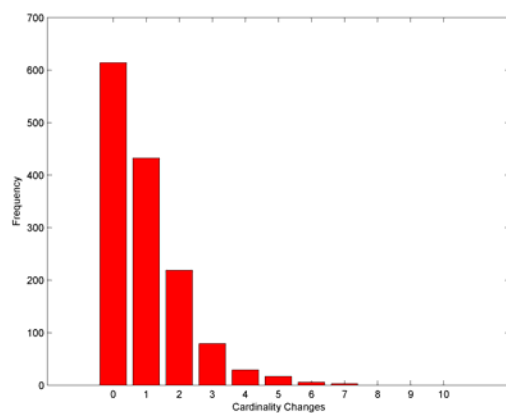
GIS  $P_{approx}$   $P_{approx}$

cut\_off < G  $P_{approx}^G$   $P_{approx}^{cut\_off}$

( )

MSPP

[ ] Zitzler  $P_{approx}$



شکل ۷: تغییر کاردینالیتی با  $\alpha = 0.25$  (شبکه نامتراکم).

% ( )



$P_{approx} = P_{true}$   $P_{true}$   
 [ ] Np-Hard  $P_{true}$  ( )  
 $P_{true}$  MSPP  $P_{true}$   
 [ ]  
 (s,t)  $P_{true}$  [ - ]  $P_{true}$   
 ) D  
 [ ] BFS ( [ - ]  
 MSPP  
 :  
 $P_{true}$  :  
 $P_{true}$   
 $P_{approx}$  : MSPP  
 D= D= Van Veldhuizen  $P_{true}$   
 D= [ ] Lamont  
 -  
 (s,t)  
 D( $P_{ap}, P_T$ ) :  
 $P_{true}$   $P_{approx}$   $P_{approx}$   
 D( $P_{ap}, P_T$ )=0  $P_{approx}$   
 $P_{approx} = P_{true}$   $P_{approx}$  [ ] Lamont Van Veldhuizen  
 $n \geq 1$  D( $P_{ap}, P_T$ )=n  
 $P_{true}$  n  $P_{approx}$   
 % (  $\leq D \leq$  ) MSPP  
 $P_{approx} = P_{true}$  [ ] Zitzler :  
 $P_{true}$  D( $P_{ap}, P_T$ )=1  
 $P_{approx}$   $P_{approx}$   
 [ ] Mattson Messac " MSPP  
 "  
 [ ] Anderson Skriver  $P_{true}$

( ) ( ) ( )

$P_{true}$

$P_{true}$

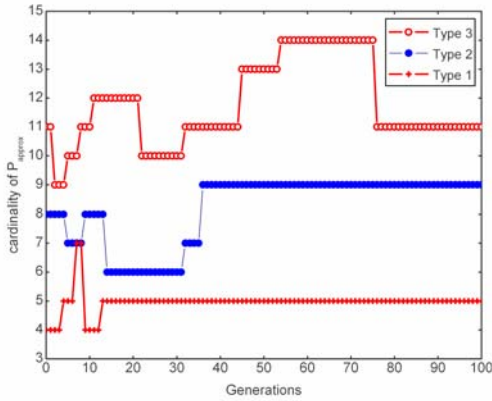
(  $D \geq$  )  $D$

$D(P_{app}, P_T) = 1$

MSPP

$P_{true}$

$P_{approx}$



شکل ۹: حالت‌های مشاهده شده از رفتار GA.

جدول ۱: نتایج تست کیفیت GA با در نظرگیری دو معیار مستقل ( $D=2$ ) متناسب به هر یال، تولید شده بصورت تصادفی با توزیع یکنواخت.

$G=(V,E)$	#Tests	$D(P_{app}, P_T) = 0$	$D(P_{app}, P_T) = 1$	$D(P_{app}, P_T) \geq 2$
(100,300)	50	50	0	0
(200,400)	50	49	1	0
(300,600)	50	49	1	0
(500,1500)	50	48	1	1
(800,2000)	50	47	2	1
(1000,2500)	50	47	2	1
(1000,3000)	50	47	2	1
(2000,5000)	50	45	3	2
(2000,6000)	50	44	3	3
(2500,8000)	50	44	3	3
(3000,9500)	50	43	4	3
(3000,10000)	50	43	4	3

جدول ۲: نتایج تست کیفیت GA با در نظرگیری سه معیار مستقل ( $D=3$ ) متناسب به هر یال، تولید شده بصورت تصادفی با توزیع یکنواخت.

$G=(V,E)$	#Tests	$D(P_{app}, P_T) = 0$	$D(P_{app}, P_T) = 1$	$D(P_{app}, P_T) \geq 2$
(100,300)	50	50	0	0
(200,400)	50	50	0	0
(300,600)	50	48	1	1
(500,1500)	50	48	1	1
(800,2000)	50	47	2	1
(1000,2600)	50	47	2	1
(1000,3000)	50	46	2	2
(2000,5000)	50	45	3	2
(2000,6000)	50	46	2	2
(2500,8000)	50	46	2	2
(3000,9500)	50	45	3	2
(3000,10000)	50	43	4	3

جدول ۳: نتایج تست کیفیت GA با در نظرگیری چهار معیار مستقل ( $D=4$ ) متناسب به هر یال، تولید شده بصورت تصادفی با توزیع یکنواخت.

$G=(V,E)$	#Tests	$D(P_{app}, P_T) = 0$	$D(P_{app}, P_T) = 1$	$D(P_{app}, P_T) \geq 2$
(100,300)	50	50	0	0
(200,400)	50	50	0	0
(300,600)	50	47	2	1
(500,1500)	50	46	2	2
(800,2000)	50	45	3	2
(1000,2500)	50	44	4	2
(1000,3000)	50	43	4	3
(2000,5000)	50	42	5	3
(2000,6000)	50	42	5	3
(2500,8000)	50	41	5	4
(3000,9500)	50	40	6	4
(3000,10000)	50	40	6	4

MSPP

MSPP

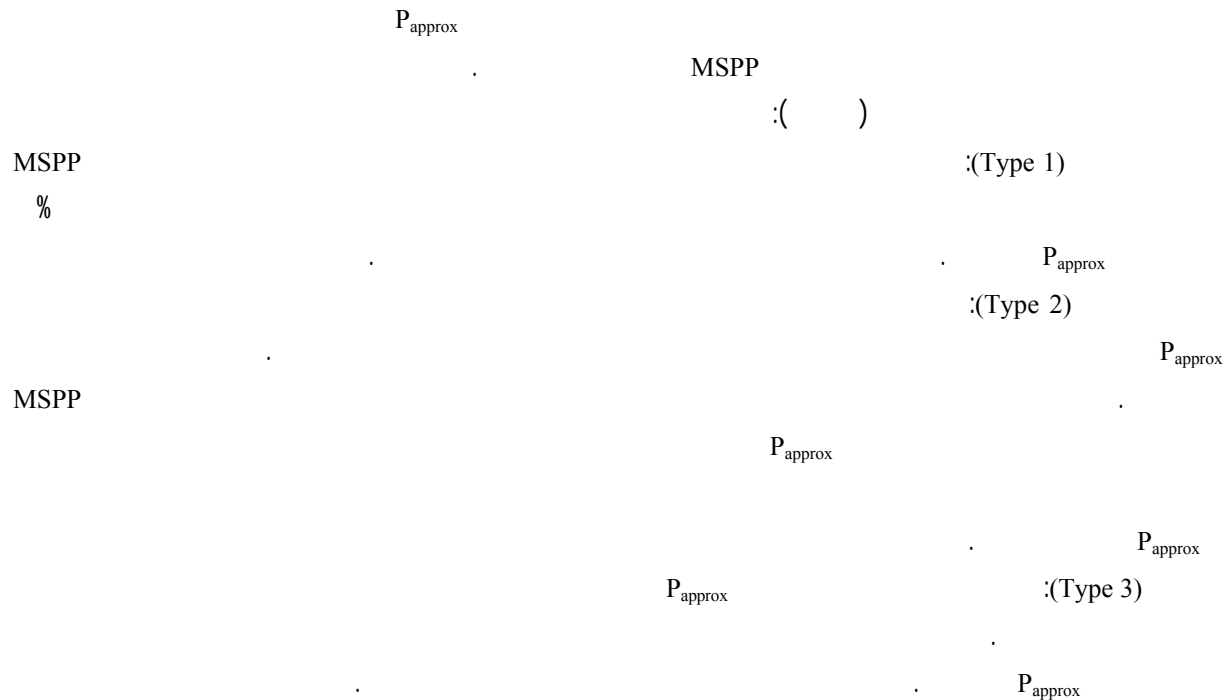
[ ]

MSPP

MSPP

$P_{approx}$

[ ]



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|---|--|
| 1- Multi-Criteria Shortest Path Problems  | 11- Modified Dijkstra algorithm              |
| 2- Genetic Algorithm                      | 12- Ranking                                  |
| 3- Geo-spatial Information System         | 13- Tournament Selection without replacement |
| 4- Shortest Path Problem                  | 14- Selection pressure                       |
| 5- Weighted linear combination            | 15- Crossover                                |
| 6- Pareto                                 | 16- Multi point crossover                    |
| 7- Quality of Service                     | 17- Mutation                                 |
| 8- Path description vector ( <i>pdv</i> ) | 18- Component Object Mode                    |
| 9- Pareto optimal                         | 19- Breath First Search                      |
| 10- Early termination                     |  |
-

