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Abstract

Keywords:

1. Introduction

: *task allocation* … *resource negotiation*.

… *task allocation* (B…, C…, & S…, 1992; … , 1994).

(B…, … , S…, & … , 2004).

(… & … , 2000).

… , 1997).

(. . C… , … , & D… , 1993; C… , 1983) … (. . … - C… & D… , 1990; S… , 1993; S… , 1980).

(C… … ., 1993).

* C… .T… .: +86 2165643235; … : +86 2165647894.

E-mail address: … @ … (… .-C. …).

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… :10.1016/ . … .2005.04.015

T;

,

C.

,

:

(1) $\rho_1 \subset A \times C$ $a_i \in A$, $c_j \in C$, $a_i \rho_1 c_j$
a_i c_j;
(2) $\rho_2 \subset A \times N$ $a_i \in A$, $n_j \in N$, $a_i \rho_2 n_j$
a_i n_j;
(3) $\rho_3 \subset T \times C$ $t_i \in T$, $c_j \in C$, $t_i \rho_3 c_j$
t_i c_j;
(4) $\rho_4 \subset T \times A$ $t_i \in T$, $a_j \in A$, $t_i \rho_4 a_j$
t_i a_j;

-

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.

C,

$a_i, a_j \in A$,

$C_{a_i}, C_{a_j} \subseteq C$

a_i a_j

.

$a_i, a_j \in A$, $C_{a_i} \cap C_{a_j} \neq \phi$.

$t_i \in T$

,

t_i

$C_{t_i} \subseteq C$,

C_{t_i} n.

$c_j \in C_{t_i} \subseteq C$,

.

$A_{t_i}^{c_j} \subseteq A$

c_j (c_j

t_i).

,

$j_i \neq j_2$,

$A_{t_i}^{c_{j_1}} \cap A_{t_i}^{c_{j_2}} \neq \phi$.

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( )

.

,

t_i

, $C_{t_i} = \{c_1, c_2, \ldots, c_n\}$

t_i, $A_{t_i}^{c_i}$

c_i (t_i), *agent task allocation for dynamic topology*

.

$A_r = \{a_r^1, a_r^2, \ldots, a_r^n\}$, n

C_{t_i}, $a_r^1 \in A_{t_i}^{c_1}$, $a_r^2 \in A_{t_i}^{c_2}$, $\ldots a_r^n \in A_{t_i}^{c_n}$,

$a_r^1, a_r^2, \ldots, a_r^n$

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(. .

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t

, $C_t = \{C_1, C_2, C_3, C_4\}$

c_1 : $A_t^{c_1} = \{a_1, a_2, a_3\}$;

c_2 : $A_t^{c_2} = \{a_1, a_4, a_6, a_7\}$;

c_3 : $A_t^{c_3} = \{a_5, a_6, a_9\}$;

c_4 :
$A_t^{c_4} = \{a_2, a_3, a_6, a_8\}$. A

.

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F . 1.

2.2. Task allocation algorithm

,

:

w w 2.1 w w .

Algorithm 1. (: t).

1. t TC, w $C = c_1, c_2, \ldots c_n$

2. F $c_j \in C$: A_j c_j AC, w : $A_j = \{a_j^1, a_j^2, \ldots, a_j^{k_j}\}$, w k_j k_j c_j.

4. $\overline{a_1}$ A_1, $\overline{a_2}$ $A_2, \ldots, \overline{a_n}$ A_n, (w) AN w N.

5. . w T $\{\overline{a_1}, \overline{a_2}, \ldots, \overline{a_n}\}$.

A 1, 4 , w w . *constraint satisfaction problem (CSP)* (. . , 1992; , , & , 2002), w w . X_i fi , $X_i = \{\overline{a_i^1}, \overline{a_i^2}, \ldots, \overline{a_i^n}\}$, X X_i, $X = A_1 \times A_2 \times \ldots \times A_n$ (A_j c_j). A , fi :

$$A = \{A_1, A_2, \ldots, A_n\}, \quad \forall j \in [1, n], \overline{a_i^j} \in A_j,$$

, w fi X_i, $\forall (X_j \in X, j \neq i)$, X_j X_i.

n , k_1 c_1, $A_1 = \{a_1^{i_1} | 1 \le i_1 \le k_1\}$; k_2 c_2, $A_2 = \{a_2^{i_2} | 1 \le i_2 \le k_2\}$; … k_n c_n, $A_n = \{a^{i_n} | 1 \le i_n \le k_n\}$. 4 A 1 A 2.

Algorithm 2. A

1 = ; - =

2 ($i_1 = 1$; $i_1 <= k_1$; i_1++)
($i_2 = 1$; $i_2 <= k_2$; i_2++)
⋮
($i_n = 1$; $i_n <=$; i_n++)
$(a_1^{i_1}, a_2^{i_2}, \ldots, a_n^{i_n})$ <
= $(a_1^{i_1}, a_2^{i_2}, \ldots, a_n^{i_n})$;
$= \{a_1^{i_1}, a_2^{i_2}, \ldots, a_n^{i_n}\}$

3 ( );

com_cost , w w A 3. A 3, an - AN, n w N.

Algorithm 3. (A).

/* n_1 A, n_2 w */

1 $= 0$; $= 0$; ξ-n_1 $= 0$

2 ($i = 1$; $i <= n_1$; $i++$)
($j = 1$; $j <=$ $_2$; $j++$)
$an_{ij} = 1$ $\xi(i) = j$; $++$

3 ($i = 1$; $i <=$; $i++$)
($j = 1$; $j <=$; $j++$)
$=$. $+ n_{\xi(i)\xi(j)}$;

4 (.);

F A 2, w , w $O(k_1 * k_2 *, \ldots, * k_n)$. , , , w . , w w , w A 4, w C , A C. A 4, w .

Algorithm 4.

1 =

2 F a_k A, $container_k = 0$;

3 F c_i C
F a_j $_i$,
$ac_{ji} = 1$, $container_j++$;

4 w , w $agent_r$.

5 $Cr =$ $agent_r$;
C = C-C ;
A = A- ;
$=$ $\cup$;

6 2 5, C ;

7 ( ).

3. Resource negoti tion for dyn mic topology networks

E , . w , w w :

$R_i = \{<r_{i1}, t_1>, <r_{i2}, t_2>, \ldots, <r_{ik}, \phi>\}$

w r_{i1} t_1, r_{i2} t_2, …, r_{ik} .

, w . D i w w r r_s , r_s w . T , i r w . w , i w w r j, fi , w , . S S 2.1, w :

(1) $\rho_5 \subset A \times R$ $a_i \in A$, $r_j \in R$, $a_i \rho_5 r_j$ a_i w r_j;
(2) $\rho_6 \subset A \times R$ $t_i \in T$, $r_j \in R$, $t_i \rho_7 r_j$ t_i r_j;

w w w .
\- .

Definition 6. A - : $AR = (ar_{ij})$, w $ar_{ij} = 1$ i j. T , w fi *task-resource mapping matrix.*

Definition 7. T - : $TR = (tr_{ij})$, w $tr_{ij} = 1$ i j. w w , w A 5. A 5, N w , w D fi 5; *TA* \- , w D fi 4.

Algorithm 5. A (i).

S 1 F *TA*, T_i i;
S 2 F *TR*, R_i T_i;
S 3 F *AR*, R_i' i ;
S 4 $R_i' \supseteq R_i$, S 5, ;
S 5 $\mathbb{R} = R_i - R_i'$;
S 6 F *AR*, *A* $\mathbb{R}$;
S 7 F *RN* *N*, A_r i i .
S 8 i w A_r.

S 9 4.

S 7 w :

(1) $A_r = \phi$; $R'' = \phi$;
(2) F A, a_n; a_n (R) a_i $A = A - \{a_n\}$; $A_r = A_r \cup \{a_n\}$; $R'' = R'' \cup R_l$;
(3) $R'' \supseteq R$ A_r; 2).

T , w a_n *Then,r4216t agent*

4.1. Knowledge representation of resource

A

linked list (F & , 1996)

rnodes,

F . 2, w *name* , *location*, *ownership* , *executing task* .

F , F . 3( ) a_1, F . 3( ) a_2.

a_1 r_1 w

w r_1. r_1 w a_3 t_5 w a_1, a_1 w r_1 a_3.

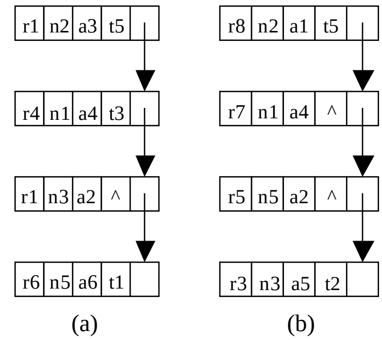
a_2 r_1 w fi

r_1

S 3, . .

```
Typedef struct node{
elementtype1 name;
elementtype2 location;
elementtype3 ownership;
elementtype4 executingtask;
struct node *next;
} rnode;
rnode resource[n];
```

F . 2. .



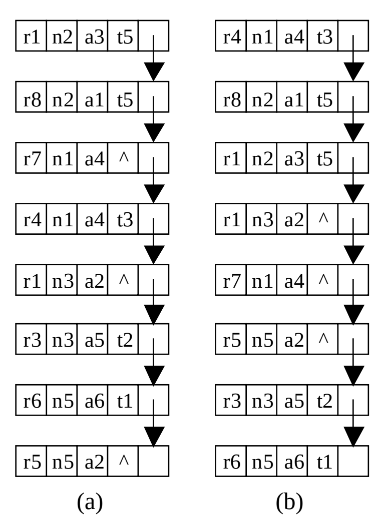
F . 3. A .

4.2. Integration of agent resource knowledge

A

. A ,

F . 4. F . 4( ) a_1, F . 4( ) a_2. F . 4( ) ( ), a_1 (a_2),



F . 4. .

w , w
inserting . T ,
$O(n)$.
E w ,
,
- .

5. C se studies nd perform nce n lyses

5.1. A case

T w , w
$M\times N$, w
. T
.
- ,
,
.
F . 5 . D
30×30 ,
. *d*.
A *d*. T
d , .

.

5.2. Task allocation

F F . 5, -
w (1):

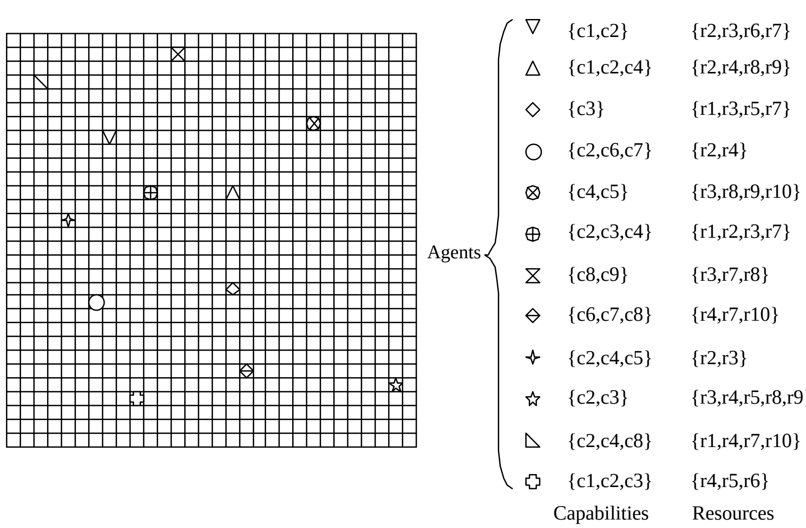
$$\begin{pmatrix} 1&1&0&0&0&0&0&0&0\\ 1&1&0&1&0&0&0&0&0\\ 0&0&1&0&0&0&0&0&0\\ 0&1&0&0&0&1&1&0&0\\ 0&0&0&1&1&0&0&0&0\\ 0&1&1&1&0&0&0&0&0\\ 0&0&0&0&0&0&0&1&1\\ 0&0&0&0&0&1&1&1&0\\ 0&1&0&1&1&0&0&0&0\\ 0&1&1&0&0&0&0&0&0\\ 0&1&0&1&0&0&0&1&0\\ 1&1&1&0&0&0&0&0&0 \end{pmatrix} \quad (1)$$

T - F . 5 , w 12×90,
w w w ,
, w
(2).

$$\begin{array}{llll} an_{7,43}=1 & an_{11,93}=1 & an_{5,203}=1 & an_{1,218}=1\\ an_{6,341}=1 & an_{2,347}=1 & an_{9,395}=1 & an_{3,557}=1\\ an_{4,577}=1 & an_{8,738}=1 & an_{10,779}=1 & an_{12,790}=1 \end{array} \quad (2)$$

T w $N=\{n_{ij}\}$,
i (m_1,n_1) ,
j (m_2,n_2)
, :

$$n_{ij}=|m_2-m_1|+|n_2-n_1|-1 \quad (3)$$



F . 5. A .

[illegible] w [illegible] 10 [illegible] [illegible] [illegible] , [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] , [illegible] [illegible] - [illegible] [illegible] [illegible] [illegible] w [illegible] (4).

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \tag{4}$$

[illegible] w w [illegible] [illegible] [illegible] [illegible] [illegible] t_5. A [illegible] (4), w [illegible] [illegible] t_5 [illegible] [illegible] [illegible] c_2,c_4,c_6,c_8} @ F (1), [illegible] [illegible] [illegible] [illegible] [illegible] c_2, c_4, c_6, c_8 [illegible] A_2, A_4,A_6,A_8.

$$A_2=\{a_1,a_2,a_4,a_6,a_9,a_{10},a_{11},a_{12}\} \quad A_4=\{a_2,a_5,a_6,a_9,a_{11}\}$$
$$A_6=\{a_4,a_8\} \quad A_8=\{a_7,a_8,a_{11}\} \tag{5}$$

[illegible] w w [illegible] A 2 [illegible] [illegible] [illegible] [illegible] , [illegible] [illegible] [illegible] [illegible] :

a_2,a_8} @ S (1)

w A 4 [illegible] [illegible] [illegible] [illegible] , [illegible] [illegible] [illegible] [illegible] :

a_{11},a_4} @ S (2)

w , w [illegible] [illegible] [illegible] [illegible] , w [illegible] 1. D [illegible] [illegible] [illegible] [illegible] , [illegible] w [illegible] [illegible] . [illegible] [illegible] [illegible] [illegible] [illegible] d.

A [illegible] (2) [illegible] (3), [illegible] [illegible] w a_6 [illegible] a_8 14, [illegible] S (1) 14d; [illegible] [illegible] w a_{11} [illegible] a_4 19, [illegible] S (2) [illegible] 19d.

[illegible] 1 [illegible] [illegible] [illegible] [illegible] S (1)

S	C	S	C
a_2,a_8} @	14[illegible]	a_6,a_8} @	19[illegible]
a_{11},a_4} @	19[illegible]	a_9,a_8} @	24[illegible]
a_1,a_2,a_4,a_7} @	87[illegible]	a_4,a_7,a_5} @	65[illegible]
a_2,a_5,a_8,a_7} @	106[illegible]	a_8,a_{11}} @	36[illegible]
a_2,a_5,a_8} @	45[illegible]	a_4,a_7,a_9} @	48[illegible]

[illegible] w, w [illegible] - [illegible] [illegible] [illegible] , [illegible] w

[illegible] 1. F [illegible] , [illegible] [illegible] a_2, a_5, a_8} @ $a_2 \leftrightarrow a_5$, $a_2 \leftrightarrow a_8$, $a_5 \leftrightarrow a_8$} @ [illegible] [illegible] w a_2 [illegible] a_5 10d, [illegible] w a_5 [illegible] a_8 13d, [illegible] [illegible] w a_2 [illegible] a_8 22d. [illegible] , [illegible] a_2, a_5, a_8} @ 45d.

F [illegible] 1, w [illegible] [illegible] [illegible] S (1), (2) [illegible] w [illegible] [illegible] .[illegible] , [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] .

5.3. Resource negotiation

[illegible] w w [illegible] [illegible] [illegible] [illegible] [illegible] . [illegible] [illegible] [illegible] [illegible] [illegible] S 5.2, . . . [illegible] 2, [illegible] 8} @ D [illegible] (6) [illegible] [illegible] - [illegible] [illegible] , [illegible] (7) [illegible] - [illegible] [illegible] .

$$\begin{pmatrix} 1 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} \tag{6}$$

$$\begin{pmatrix} 1 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 & 1 & 1 & 1 & 0 & 1 & 1 \\ 1 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 1 & 0 & 1 & 1 & 1 \end{pmatrix} \tag{7}$$

F (7), w [illegible] [illegible] [illegible] t_5 [illegible] r_1, r_2, r_3, r_5, r_6, r_7, r_8, r_9, r_{10}} @ w , (6), w [illegible] [illegible] [illegible] a_2 [illegible] a_8 [illegible] r_2, r_4, r_7, r_8, r_9,

r_{10} , w
w r_1, r_3, r_5, r_6
w w - w
(8), w
w : $t_1 \succ t_2 \succ t_3 \succ t_4 \succ t_5 \succ t_6 \succ t_7 \succ t_8 \succ t_9 \succ t_{10}$.

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} \tag{8}$$

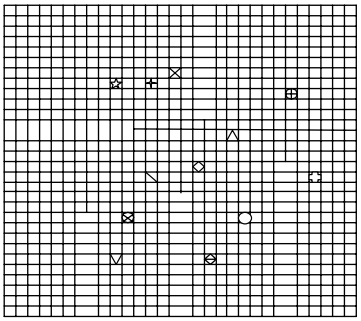
r_1, r_3, r_5, r_6
$a_1, a_3, a_5, a_6, a_7, a_9, a_{10}, a_{11}, a_{12}$ w Ä.
w w fi w a_j Ä, w (9).

$$d(\ddot{A}, a_j) = \min_{a_i \in \ddot{A}} [d(a_i, a_j)] \tag{9}$$

w $d(x_i,x_j)$ w x_i x_j.
A - Ä
w , Ä a_2, a_8 (
(9)), w $a_6, a_3, a_{12}, a_5, a_{10}, a_1, a_7, a_9, a_{11}$
A (8), a_6 w t_1, t_3, t_7.
t_1 t_5, , a_6
a_2 a_8.
a_3 w t_5

T 3
(3)

S	C	S	C
a_2,a_8	1	a_2,a_4,a_{11}	2
a_1,a_8	1	a_1,a_4,a_8	3
a_{12},a_8	2	a_1,a_4,a_7	6
a_2,a_4,a_8	3	a_1,a_4,a_{11}	4
a_2,a_4,a_7	5	a_{12},a_4,a_{11}	3



F . 8. ? w (4).

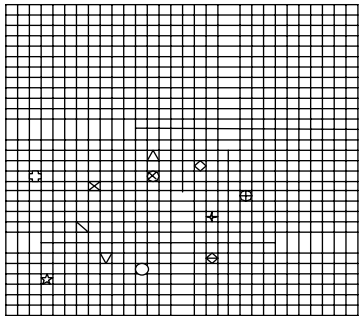
? w, w w , w F . 7. t_4 , A 2 S 2.2, a_2,a_8 A 4, a_1,a_8 ? w w w , w T 3.

? w, w w , w F . 8. t_{10} , A 2 S 2.2, a_2 A 4, a_2 ? w w w , w T 4.

? w, w w , w F . 9. t_1 , A 2 S 2.2, a_{12},a_7 A 4, a_1,a_7 ? w w w , w T 5.

T 4
(4)

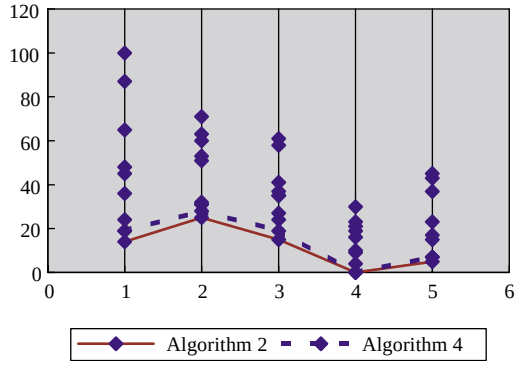
S	C	S	C
a_2	0	a_1,a_5	
a_1,a_6	3	a_1,a_9	1
a_1,a_{11}	1	a_{12},a_5	2
a_{12},a_6		a_{12},a_9	2
a_{12},a_{11}	1		



F . 9. ? w (5).

T 5
(5)

S	C	S	C
a_{12},a_7		a_2,a_8,a_7	3
a_1,a_7		a_2,a_{11},a_7	2
a_2,a_7		a_{12},a_8,a_7	4
a_1,a_8,a_7	4	a_{12},a_{11},a_7	1
a_1,a_{11},a_7	1		



F . 10. S .

? w w , w F . 10. F . 10, *Y*- *X*- . F F . 10, w . T , .

6. Conclusion

C w - . E , w w .

w . w , -
. , w , w
. , , 32 9.3( ).22-9.) w