



Modelling a Novel Multi-Objective Open-Shop Scheduling Problem and Solving by a Scatter Search Method

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Keywords

Open shop scheduling problems,
Tardiness and earliness time,
Makespan, Setup cost, NSGA-II,
Multi-objective scatter search

ABSTRACT

This paper proposes a novel, multi-objective integer programming model for an open-shop scheduling problem (OSSP). Three objectives are to minimize the makespan, total job tardiness and earliness, and total jobs setup cost. Due the complexity to solve such a hard problem, we develop a meta-heuristic algorithm based on multi-objective scatter search (MOSS), and a number of test problems are solved by this proposed algorithm. Finally, to prove its efficiency, the related results are compared with the results obtained by the well-known multi-objective evolutionary algorithm, called NSGA-II. The results confirm the efficiency and the effectiveness of our proposed MOSS to provide good solutions, especially for medium and large-sized problems.

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NP-hard

NSGA-II

NSGA-II

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771

772

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$$\begin{aligned}
\text{Min } Z_1 & \quad () & \bullet \\
\text{Min } Z_2 & \quad () & \\
\text{Min } Z_3 & \quad () & \bullet \\
\text{s. t.} & & \bullet \\
Z_1 \geq c(t, k) & \quad \forall t, k & () & \bullet \\
t(i, k) - c(t, k) + M(1 - a_{ik})c(t, l) & \quad \forall i, k, l & () & \bullet \\
c(j, k) - t(j, k) + M(1 - x_{ijk}) \geq c(t, k) & \quad \forall i, j, k & () & \bullet \\
a_{ilk} + a_{ikl} = 1 & \quad \forall i, k, l & () & \\
x_{ijk} + x_{jik} = 1 & \quad \forall i, j, k & () & \\
c(t, k) - t(t, k) \geq 0 & \quad \forall t, k & () & \quad i = \{1, \dots, n\} \quad : j \quad i \\
mc(t) = \max\{c(t, k)\} & \quad \forall t, k & () & \quad m \quad j = \{1, \dots, m\} \quad : k \\
Z_2 = \sum_{i=1}^n \max\{mc(i) - d(i)\} & \quad () & \\
Z_3 = \sum_{k=1}^m \sum_{j=1}^n \sum_{i=1}^n s_i(j, k) x_{ijk} & \quad () & \\
& \quad () \quad () & \\
& \quad () & \\
& \quad \text{Max} & \quad k \quad i & : T_{ik} \\
& \quad Z_1 \quad Z_1 & \quad i & : d_i \\
& \quad () \quad () & \quad k \quad i & : O_{ik} \\
& \quad \text{Max} & \quad j \quad k & : S_i(j, k) \\
& \quad () & \quad i \quad k & \\
& \quad () & \quad k \quad i & : C_{ik} \\
& \quad () & \quad i & : mc_i \\
& \quad () & \quad \left. \begin{array}{l} 1 \text{ کار روی ماشین } k \text{ در صورتی که ماشین } i \text{ باشد} \\ 0 \text{ در غیر این صورت} \end{array} \right\} a_{ik} \\
& \quad () & \quad \left. \begin{array}{l} 1 \text{ کار روی ماشین } k \text{ در صورتی که کار } i \text{ روی ماشین } k \text{ باشد} \\ 0 \text{ در غیر این صورت} \end{array} \right\} x_{ijk} \\
& \quad () & \\
& \quad () & \\
& \quad () & \\
& \quad () & \\
& \quad () &
\end{aligned}$$



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b [] *p*-medium []

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b
(3b-7)/2

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n m $m \times n$

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k i

1	2			$n \times m$
O_{12}	O_{24}	O_{ik}

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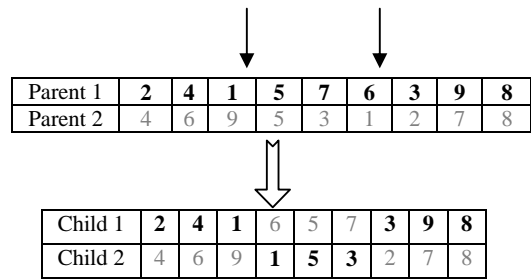
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N

i

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N:

2	5	3	6	4	1
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i

4	2	6	3	1	5
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$n \times m$

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()

4	2	6	3	1	5
1	2	6	3	4	5
5	2	6	3	4	1
2	5	6	3	4	1
2	5	3	6	4	1

(S₁,S₂,S₃)

Refset1 : S₁

|b₁-1|

Refset2 : S₂

|b₂-1|

N

Refset1 :S₃

[]

Refset2

Refset1

Refset2

b₁

OX

[]

XP

i

IP

j

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Original trial solution 1 : 1 4 7 | 2 3 5 | 9 8 6
 Original trial solution 2 : 3 9 5 | 2 4 6 | 1 7 8

() Refset2 () Refset1

Refset1 = b <= b₁ + b₂

b₂ b₁

Refset1

b₁

New trial solution 1 : 9 8 6 | 1 4 7 | 2 3 5
 New trial solution 2 : 1 7 8 | 3 9 5 | 2 4 6

Refset1

b₁

b₂ Refset2

Refset1

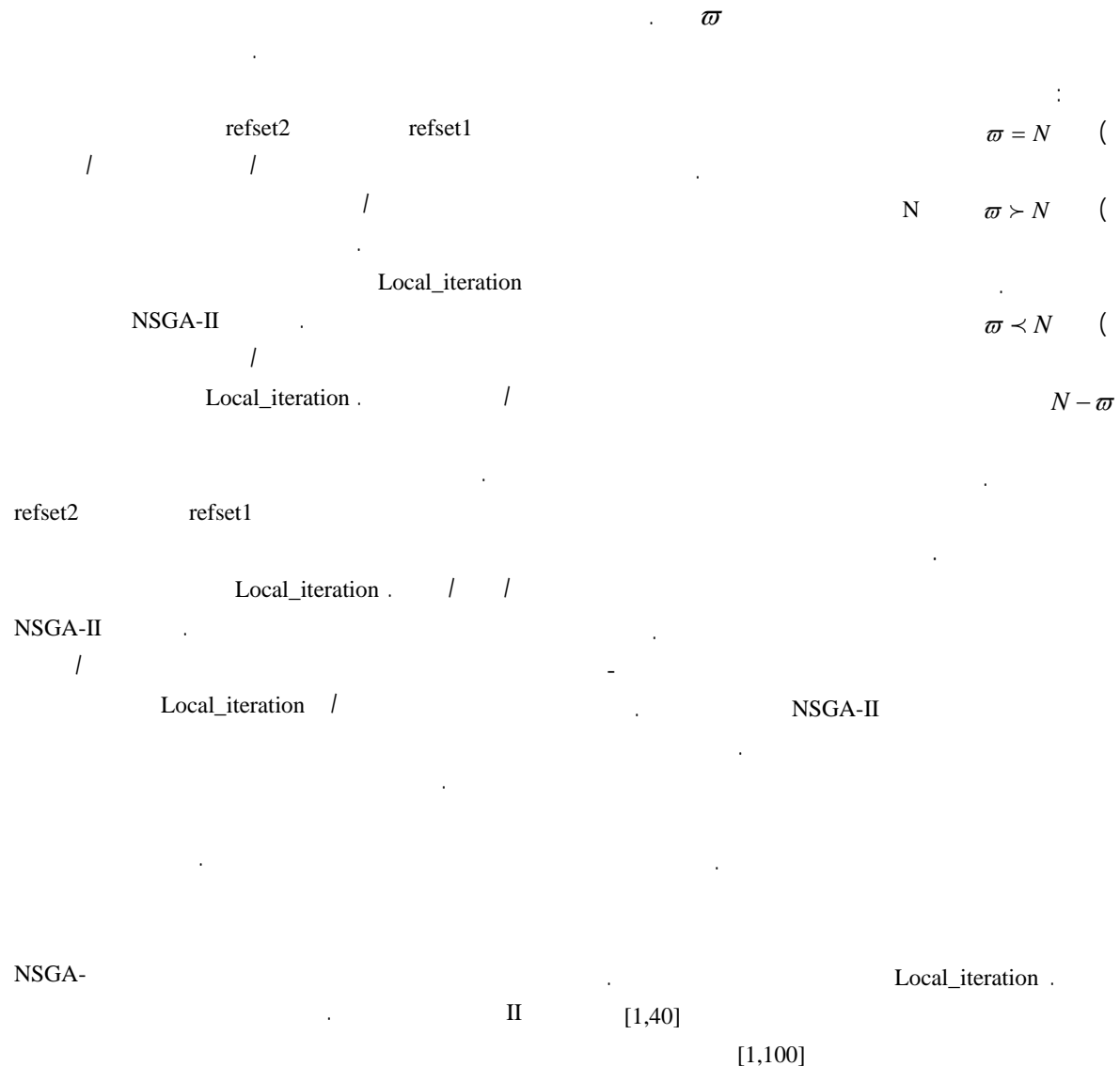
New trial solution 1 : 9 8 1 7 3 5
 New trial solution 2 : 1 7 8 9 4 6

Refset2

Refset1

$[0.2p_{mean}, 0.3p_{mean}]$
 $[p(1-t-r/2), p(1+t+r/2)]$
 $p_{mean} \quad p=p_{mean}(n+m-1)$
 $t \quad r$
 $t=0.4 \quad r=\{0.2, 0.6\}$

Final trial solution 1 : 9 8 1 2 4 6 7 3 5
 Final trial solution 2 : 1 7 8 2 3 5 9 4 6



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