
Algorithm 1 Improved K-Means algorithm

Input: N orders in a batch; the number of picking stations S

Output: Picking order of each picking station

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1 Step 1: Compute the association matrix;//计算订单组的耦合矩阵
2 for ( $i = 1; i \leq N; i++$ ) do
3   for ( $j = 1; j \leq N; j++$ ) do
4     if ( $i == j$ ) then
5        $L_{ij} \leftarrow 0;$ 
6     else
7        $L_{ij} \leftarrow \sum_{m=1}^N x_{im}x_{jm};$ 
8     end
9   end
10 end
11 Step 2: Distribute initial orders to picking stations;//为所有拣选台分配初始订单组
12 for ( $i = 1; i \leq S; i++$ ) do
13   Find the maximum  $L_{kj}$  in the order association matrix, and order  $k$  and order  $j$  are not
    distributed to any picking station;
14   Add order  $k$  and order  $j$  to picking station  $i$ ;
15   Order number of picking station  $i$  plus 2;
16 end
```

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Step 3: Distribute the rest of orders to picking stations;//分配剩余的订单组

for ($i = 1; i \leq S; i++$) **do**

while (*order number of picking station $i < Q_i$*) **do**

$MaxAssociation \leftarrow 0$;//最大的耦合因子

$p \leftarrow 0$;//待分配的订单

$u \leftarrow$ the last order of picking station i ;//拣选台 i 的最后一个订单组 u

$k \leftarrow$ order number of picking station i ;// k 为拣选台中间变量

for ($l = 1; l \leq N; l++$) **do**

if ($i == 1$) **then**

if ($L_{kl} \geq MaxAssociation$) \wedge (*order l is not distributed*) **then**

$MaxAssociation \leftarrow L_{ul}; p \leftarrow l;$

end

else

$m \leftarrow \varepsilon N_k^i(l) + 2L_{ul};$

if ($m \geq MaxAssociation$) \wedge (*order l is not distributed*) **then**

$MaxAssociation \leftarrow L_{ul};$

$p \leftarrow l;$

end

end

 Add order p to picking station i ;

 Order number of picking station i plus 1;

end

end

end

return result;//返回结果
