

Shifting Bottleneck Heuristic

Algorithm

1. Initialization

- $M_0 = \emptyset$ (scheduled machines)
- $G =$ only conjunctive arcs
- $C_{\max} =$ critical path in G .

2. (Choice of machine.) For each $M_i \in M - M_0$,

- generate the $1|r_j|L_{\max}$ schedule
- compute $L_{|max}(i)$.

3. Scheduling the bottleneck machine

- Let k be the machine that maximizes $L_{\max}(i)$
- Schedule k by the $1|r_j|L_{\max}$ solution
- Update G
- $M_0 = M_0 \cup \{k\}$.

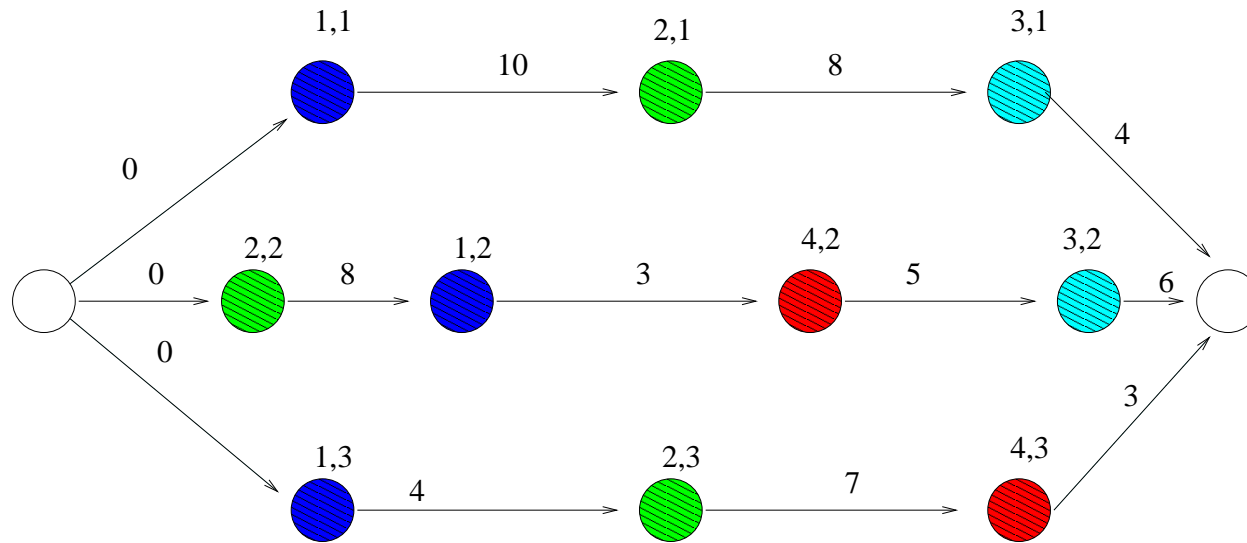
4. (Resequence already scheduled machines.) For each $M_i \in M_0 - \{k\}$

- Delete disjunctive arcs for M_i from G
- Form the $1|r_j|L_{\max}$
- Reschedule M_i according to this schedule

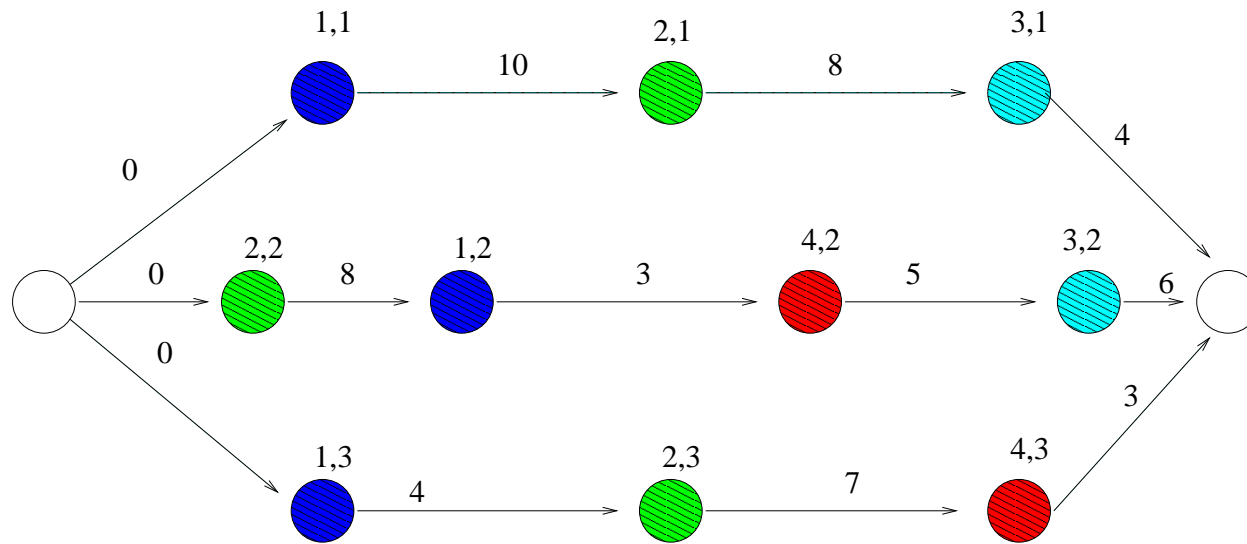
5. If $M = M_0$ stop, else go to 2

Example

jobs	machine sequence	processing times
1	1,2,3	$p_{11} = 10, p_{21} = 8, p_{31} = 4$
2	2,1,4,3	$p_{22} = 8, p_{12} = 3, p_{42} = 5, p_{32} = 6$
3	1,2,4	$p_{13} = 4, p_{23} = 7, p_{43} = 3$



Iteration 1



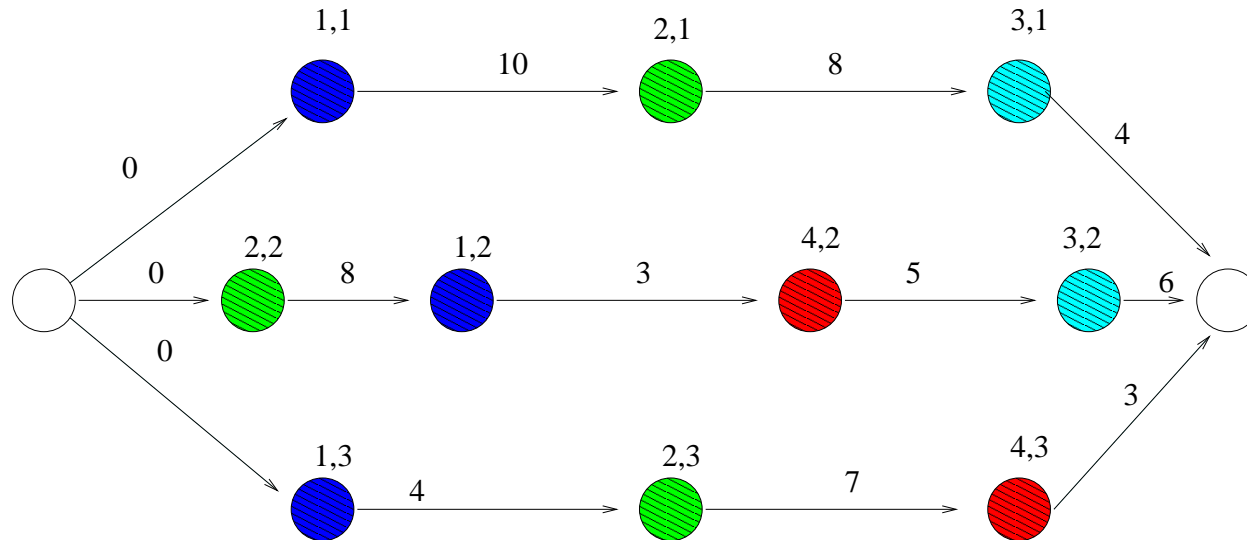
Form the $1|r_j|l_{\max}$ problems (Recall $d_j = LB - (CP - p_j)$)

Machine 1

job	1	2	3
r_j	0	8	0
p_j	10	3	4
d_j	10	11	12

Optimal schedule 1,2,3, $L_{\max}(1) = 5$

Iteration 1 (cont)



Form the $1|r_j|l_{\max}$ problems

Machine 2

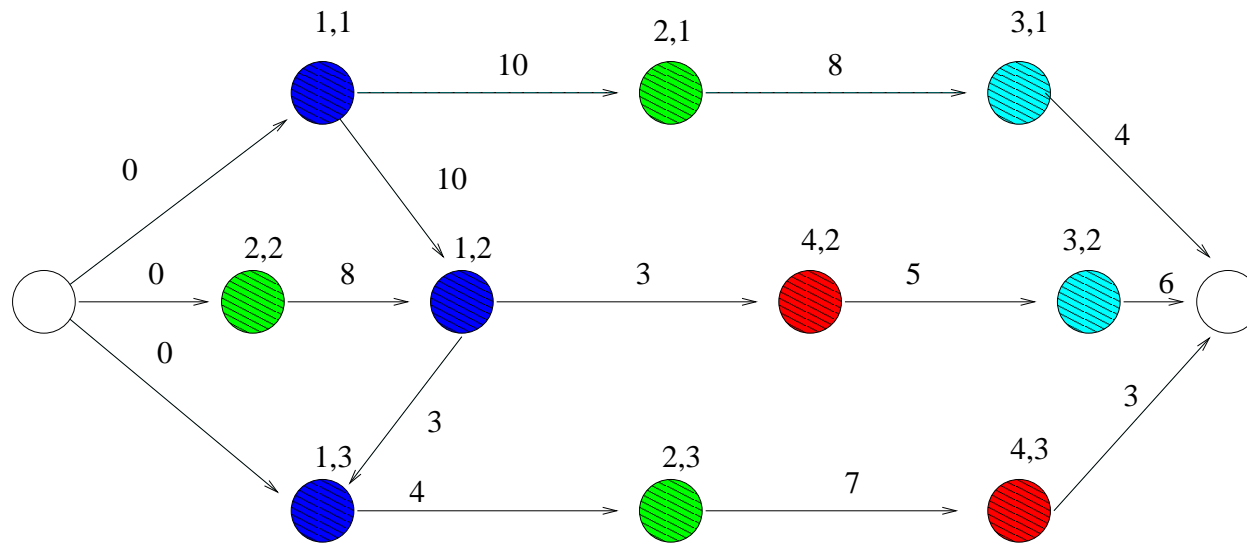
job	1	2	3
r_j	10	0	4
p_j	8	8	7
d_j	18	8	19

Optimal schedule 2,3,1 $L_{\max}(2) = 5$

Similarly $L_{\max}(3) = 4$. $L_{\max}(4) = 0$.

Schedule M_1 in the order 1,2,3.

Iteration 2



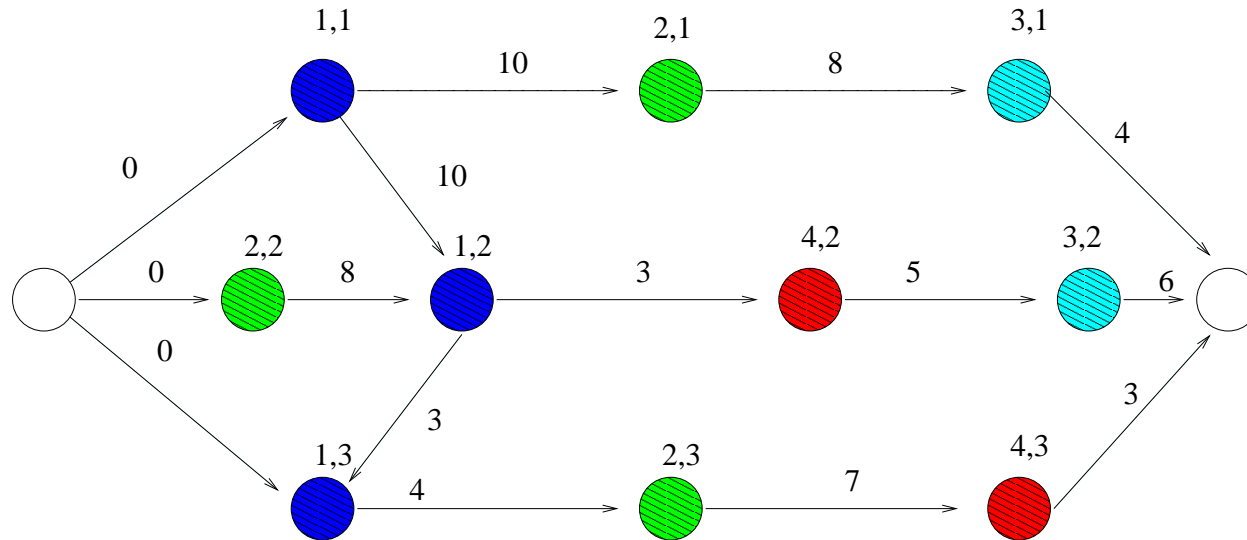
Form the $1|r_j|l_{\max}$ problems

Machine 2

job	1	2	3
r_j	10	0	17
p_j	8	8	7
d_j	23	10	14 24

Optimal schedule 2,1,3, $L_{\max}(2) = 1$

Iteration 2 (cont)



Form the $1|r_j|L_{\max}$ problems

Machine 3

job	1	2
r_j	18	18
p_j	4	6
d_j	27	27

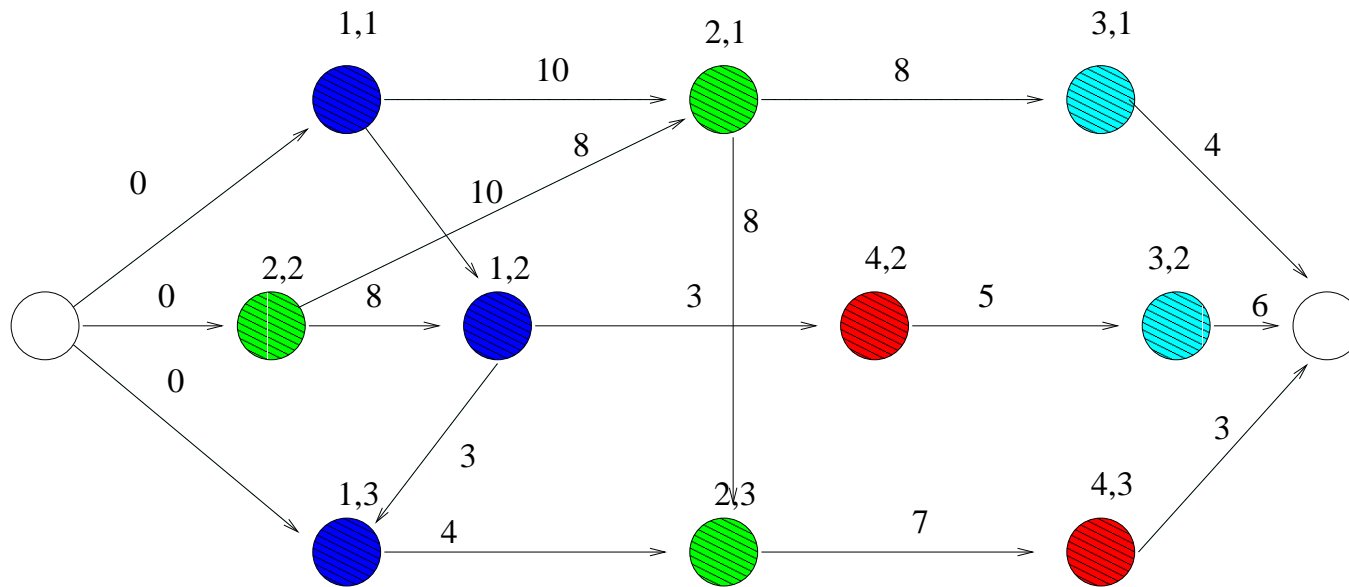
Optimal schedule (either), $L_{\max}(3) = 1$

Similarly $L_{\max}(4) = 0$.

Schedule M_2 in the order 2,1,3.

Resequence Trying to resequence machine 1 does not help.

Iteration 3

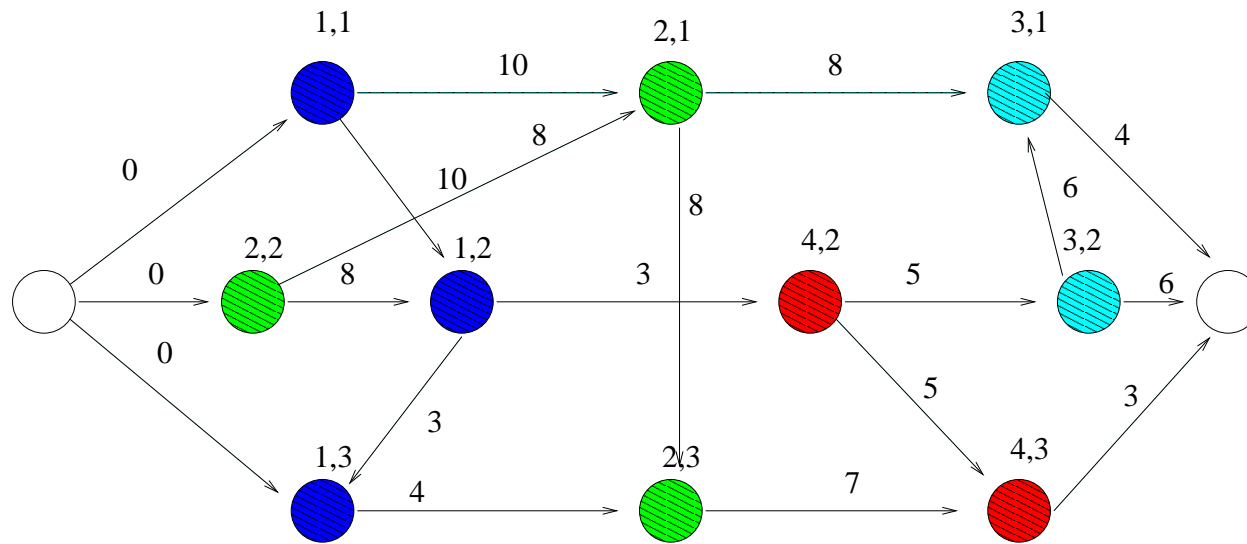


Form the $1|r_j|L_{\max}$ problems

Machine 3 and Machine 4 both have $L_{\max}() = 0$.

Resequencing does not help.

Final schedule



Critical path length is 28. (Colors between pictures do not correspond)

