Shifting Bottleneck Heuristic

1. Start with $M_0 = \emptyset$. $G[M_0]$ ≡ fixed arcs + disjarcs for M_0

2. For each machine $i \in M - M_0$, check the effect of adding i's disjunctive edges on $C_{max}\{M_0\}$ as follows.

   - Calculate r_j for each j as s longest path from to (i,j)
   - Calculate d_j for each j as ~~longest path from~~

     $C_{max}(M_0)$ − (longest path from (i,j) to t) + p_{ij}

   - Solve $(1|r_j|L_{max})$ with this data. Let L_{max} be $L(i)$ and schedule be $(j_1, j_2, \ldots, j_n)$

   - Add machine i with largest $L(i)$ to M_0
     Add arcs $(ij_1 \to ij_2)$, $(ij_2 \to ij_3)$ ... $(ij_{n-1} \to ij_n)$ for machine i

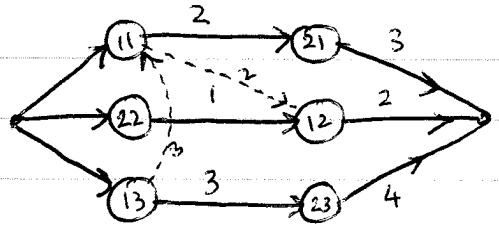
(*) 3. For every "old" machine, $i' \in M_0 - i$, re-evaluate ~~recalculate~~ their ~~order~~ orientation of their disjunctive arcs by solving another $(1|r_j|L_{max})$ problem.

4. End when $M_0 = M$.

Shifting Bottleneck heuristic

- Decides ~~which~~ the orientation one machine at a time.

- Start with $M_0 = \emptyset$



$C_{max}(M_0)$ ≡ Longest path from s-t where ~~one~~ disj edges corr. to M_0 have been added

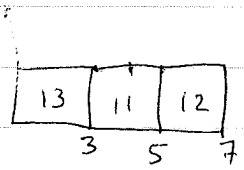
$C_{max}\{\emptyset\} = 7$

- If m/c 1 ~~were~~ disj edges were to be added, how much would it affect Cmax.

Think of a single m/c problem
M/C = M/C 1
Jobs: (11, 12, 13)

$r_{11} = 0$, $r_{13} = 0$, $r_{12} = 1$
$d_{11} = 4$ $d_{13} = 3$ $d_{12} = 7$
$p_{11} = 2$ $p_{13} = 3$ $p_{12} = 2$

$d_{ij} \equiv C_{max} - (\text{long path from } (ij) \text{ to } t) + p_{ij}$



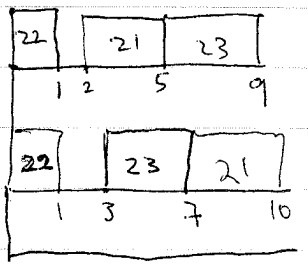
~~13~~ 13, 11, 12

$L_{max} = 1$

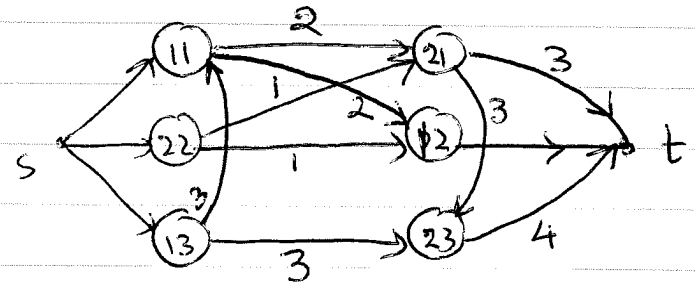
$C_{max}\{m1\} = 7 + 1 = 8$

- If m/c 2's disj edges were to be added, how much would it affect Cmax

$r_{21} = 2$ $r_{22} = 0$ $r_{23} = 3$
$d_{21} = 7$ $d_{22} = 5$ $d_{23} = 7$
$p_{21} = 3$ $p_{22} = 1$ $p_{23} = 4$

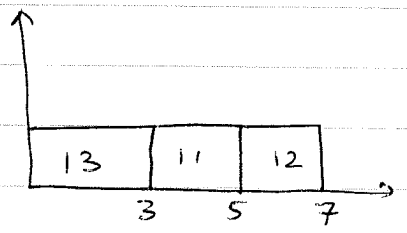


Add m/c 2 to M_0



$C_{max}\{2\} = 9$

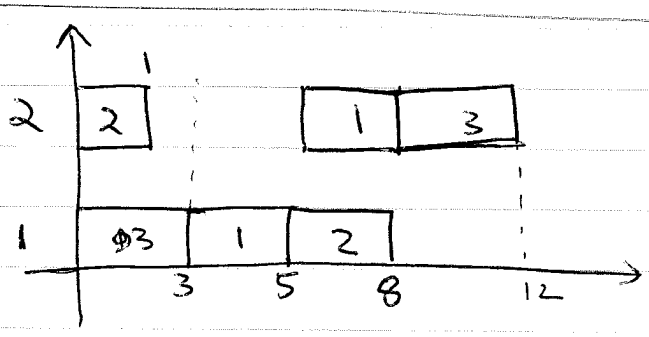
$r_{11} = 0$	$r_{12} = 1$	$r_{13} = 0$
$d_{11} = 6$	$d_{12} = 9$	$d_{13} = 5$
$p_{11} = 2$	$p_{12} = 2$	$p_{13} = 3$



13, 11, 12

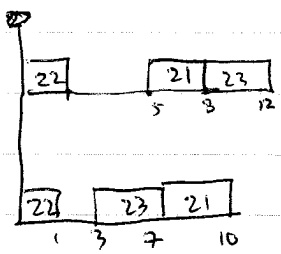
$L_{max} = 0$

$t_{13} = 0$
$t_{22} = 0$
$t_{11} = 3$
$t_{12} = 5$

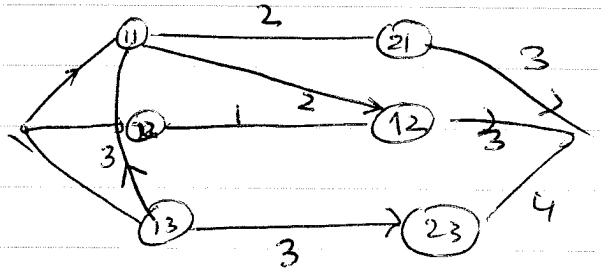


$t_{21} = 5$
$t_{23} =$ ~~12~~ 8

Re-evaluation step :-



$r_{21} = 5$	$r_{22} = 0$	$r_{23} = 3$
$d_{21} = 8$	$d_{22} = 5$	$d_{23} = 8$
$p_{21} = 3$	$p_{22} = 1$	$p_{23} = 4$



$C_{max} = 9$