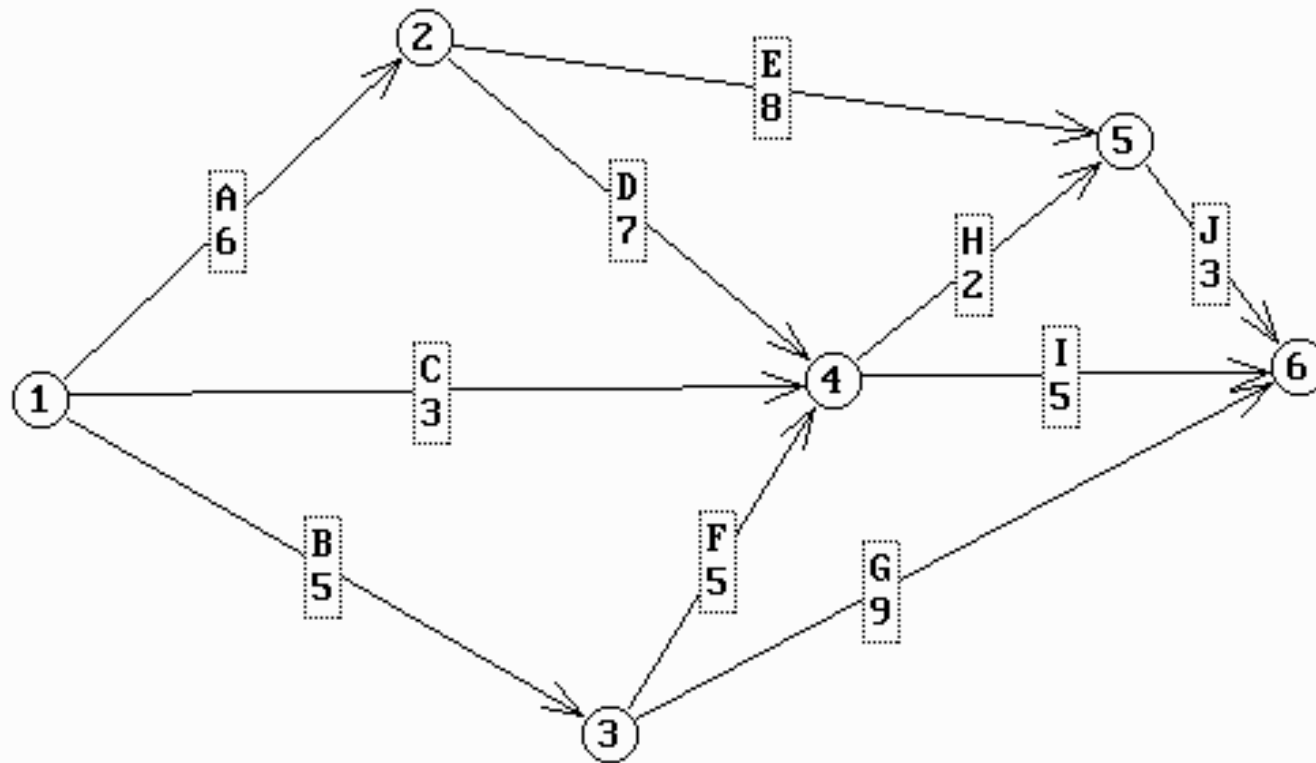


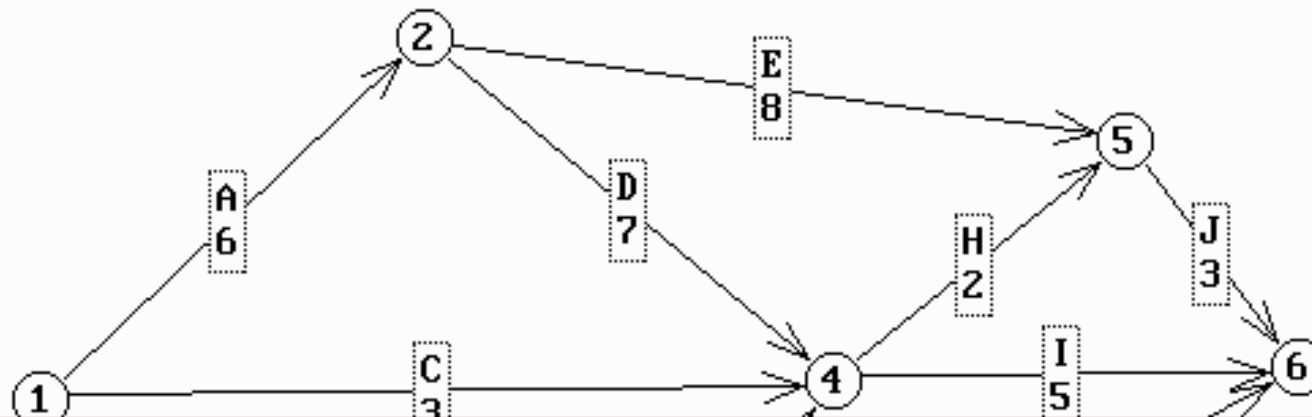
Программа СРМ1.EXE

Исследование операций
с применением компьютера
Версия 2.00a (2007)

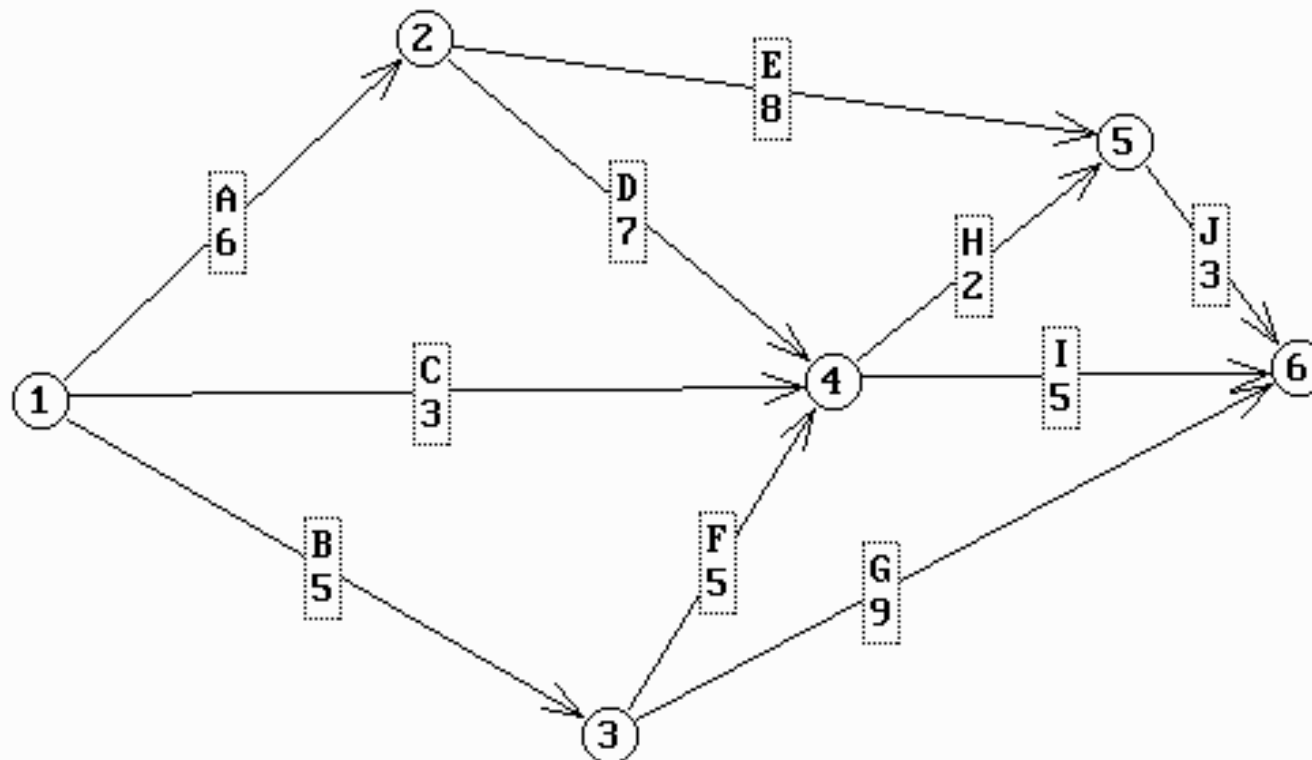


CRITICAL PATH METHOD
Reading problem from a file

CPM1 /3

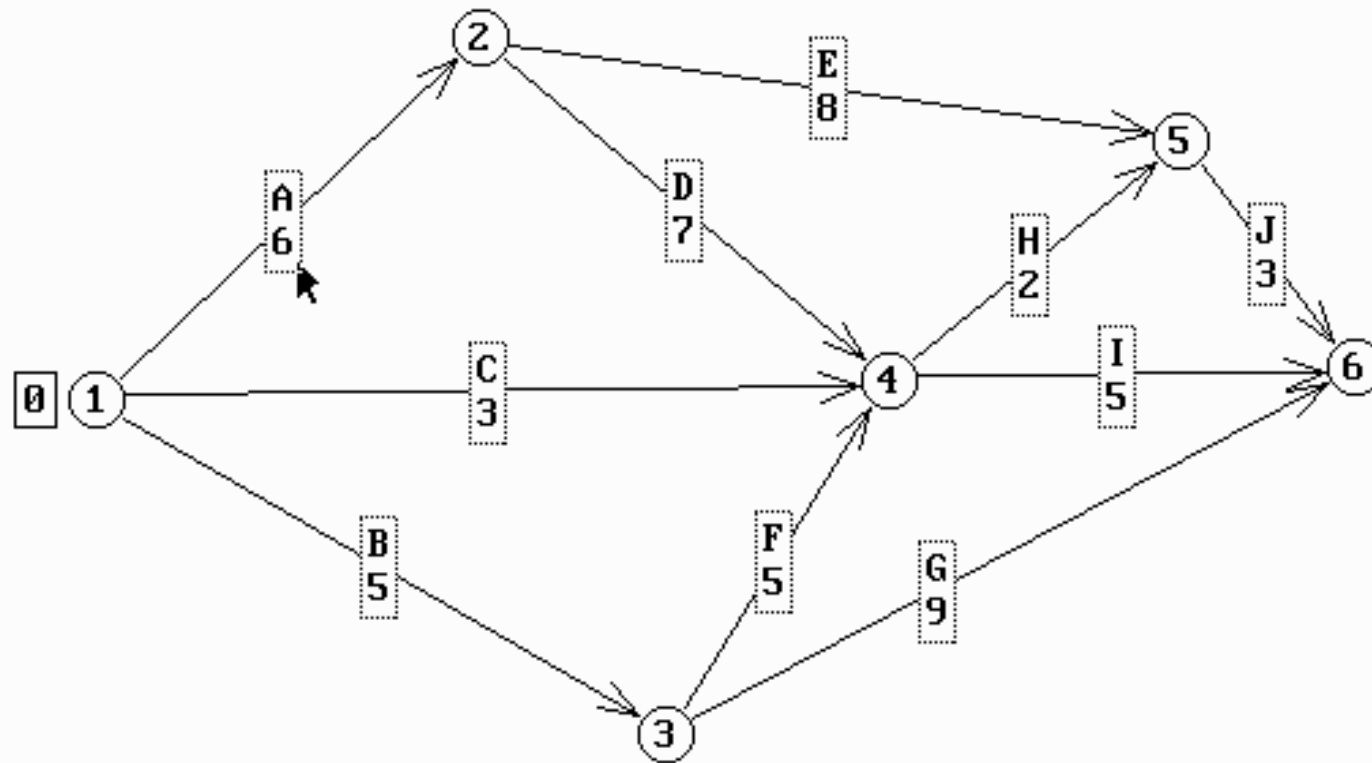


Activity	Initial event	Final event	Normal time	Crash time	Total normal cost	Total crash cost	Maximum reduction in time	Cost per unit
A	1	2	6	3	12	18	3	2.0
B	1	3	5	3	6	9	2	1.5
C	1	4	3	2	8	10	1	2.0
D	2	4	7	5	9	11	2	1.0
E	2	5	8	6	4	9	2	2.5
F	3	4	5	4	8	9	1	1.0
G	3	6	9	7	12	14	2	1.0
H	4	5	2	1	7	11	1	4.0
I	4	6	5	2	10	14	3	1.3
J	5	6	3	1	6	9	2	1.5



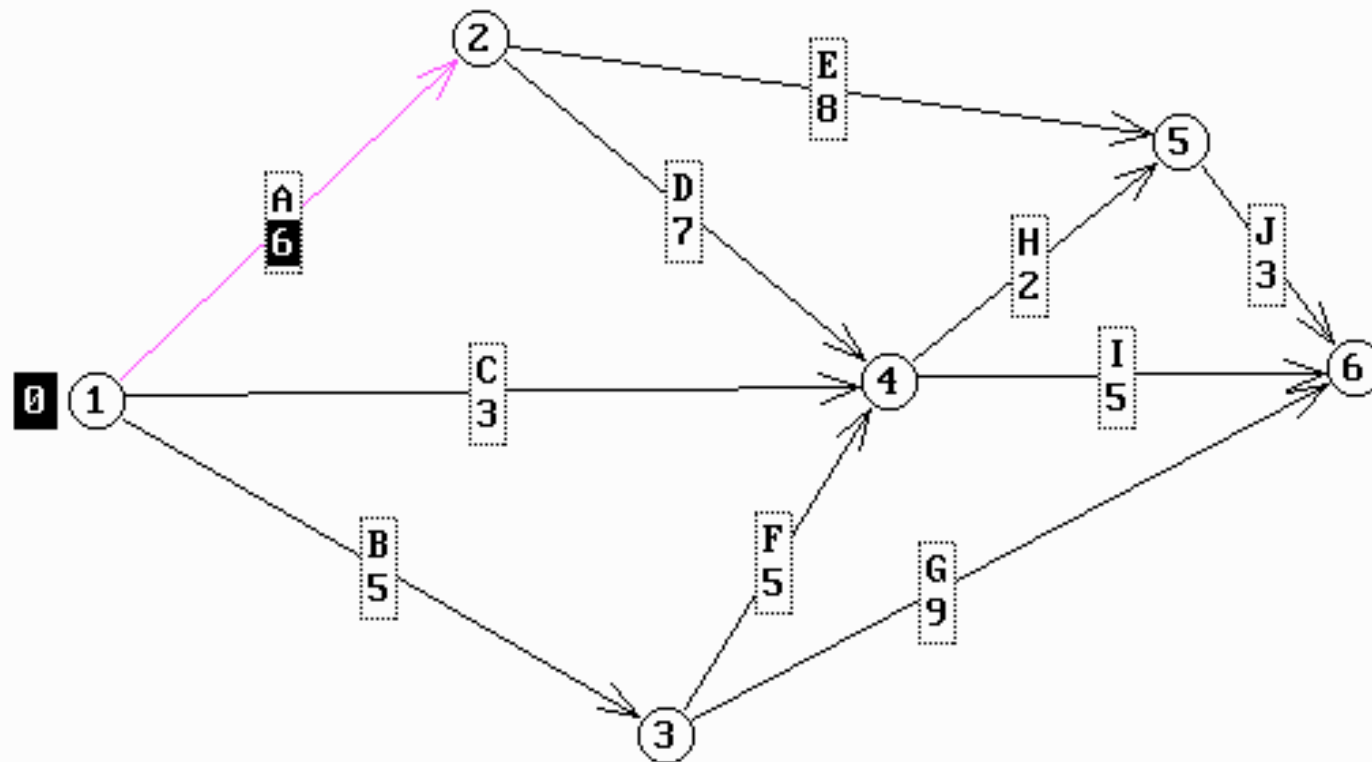
1. Critical path method
2. Minimization of the total completion time
3. Minimization of the total crash cost
4. Exit

Forward pass



Select the activity

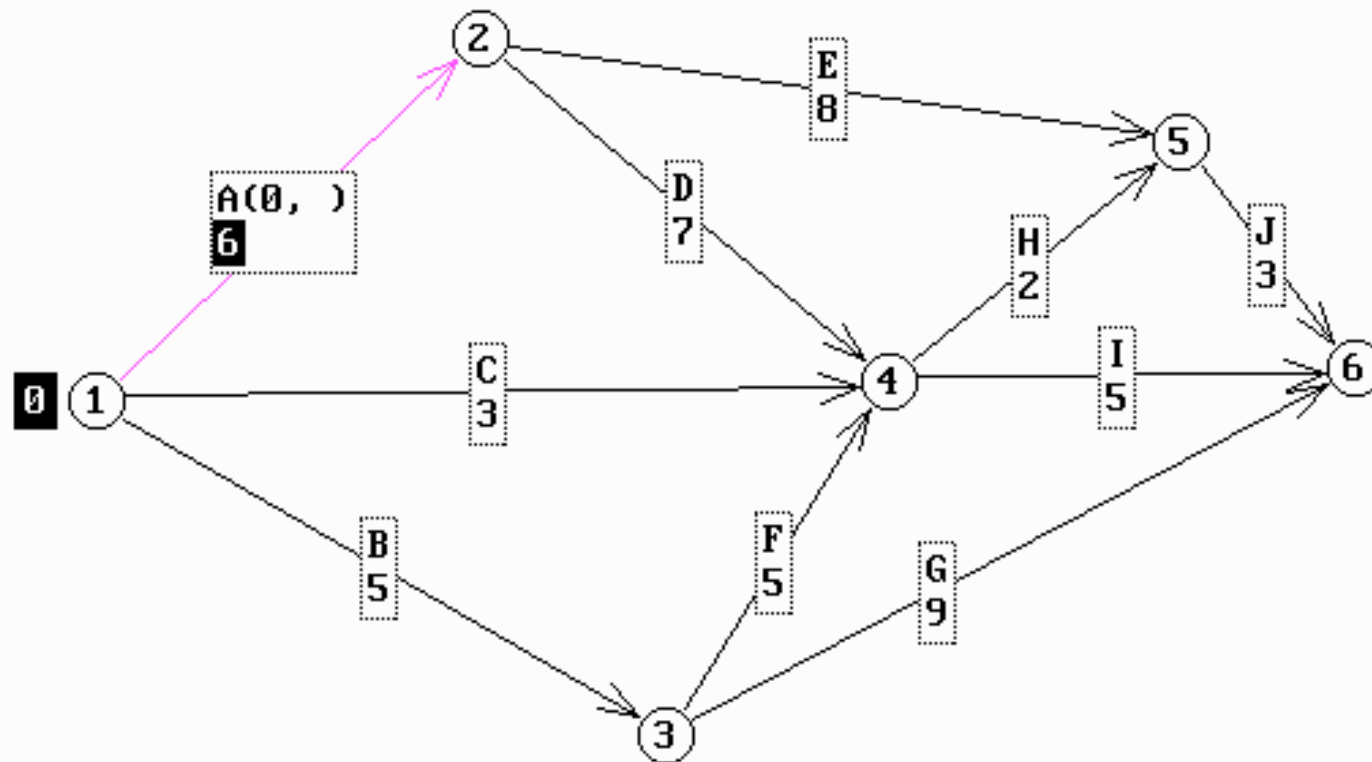
Forward pass



Enter earliest start time



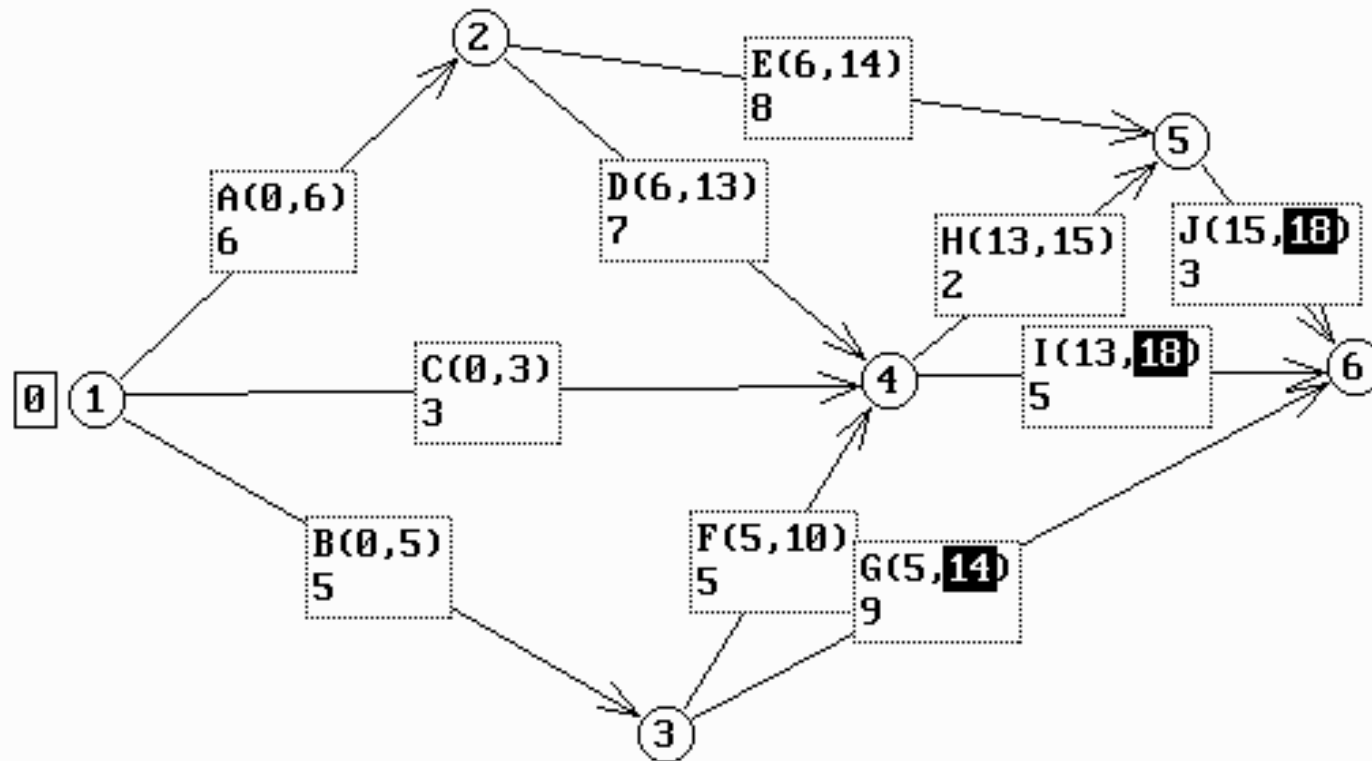
Forward pass



Enter earliest finish time

1	2	3	4
5	6	7	8
9	0	.	←

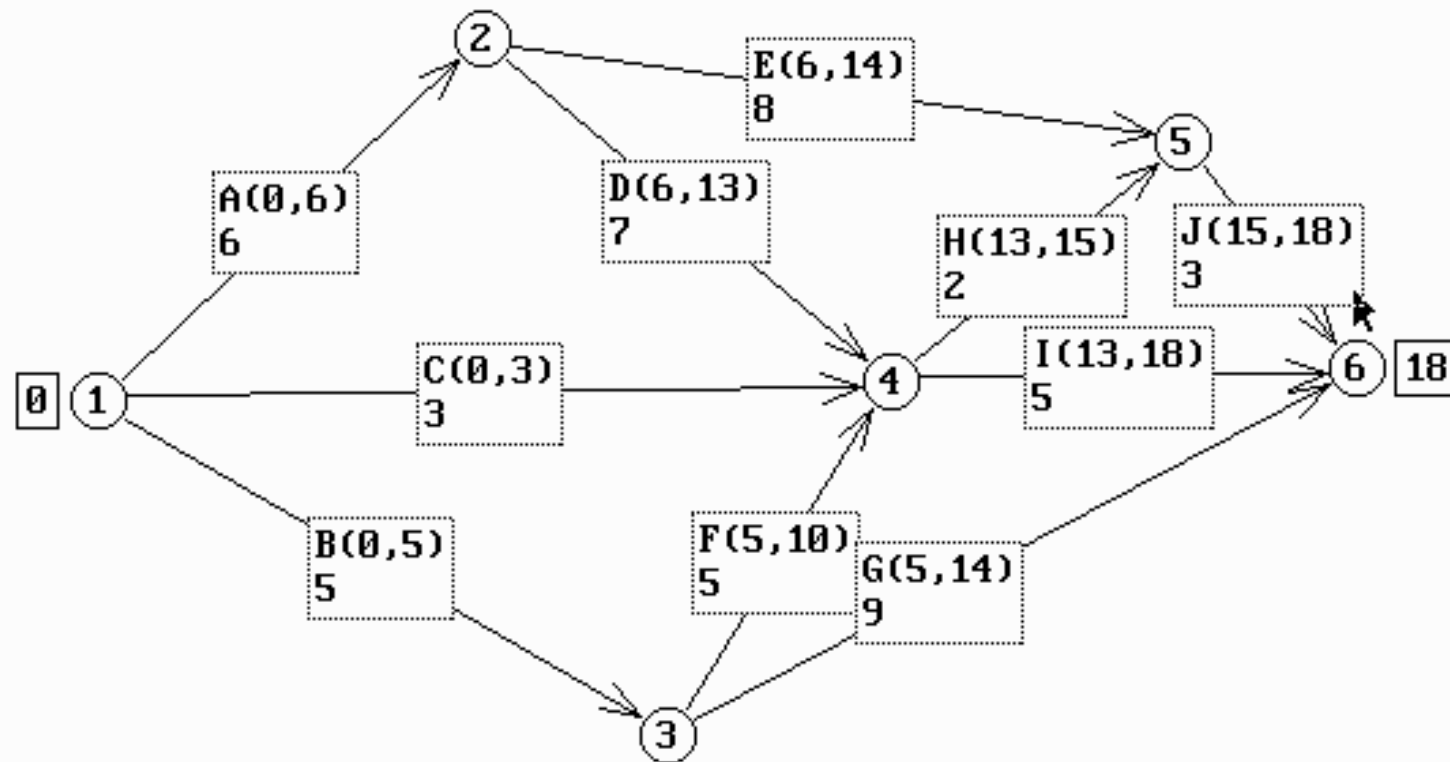
Forward pass



Enter project completion time



Backward pass

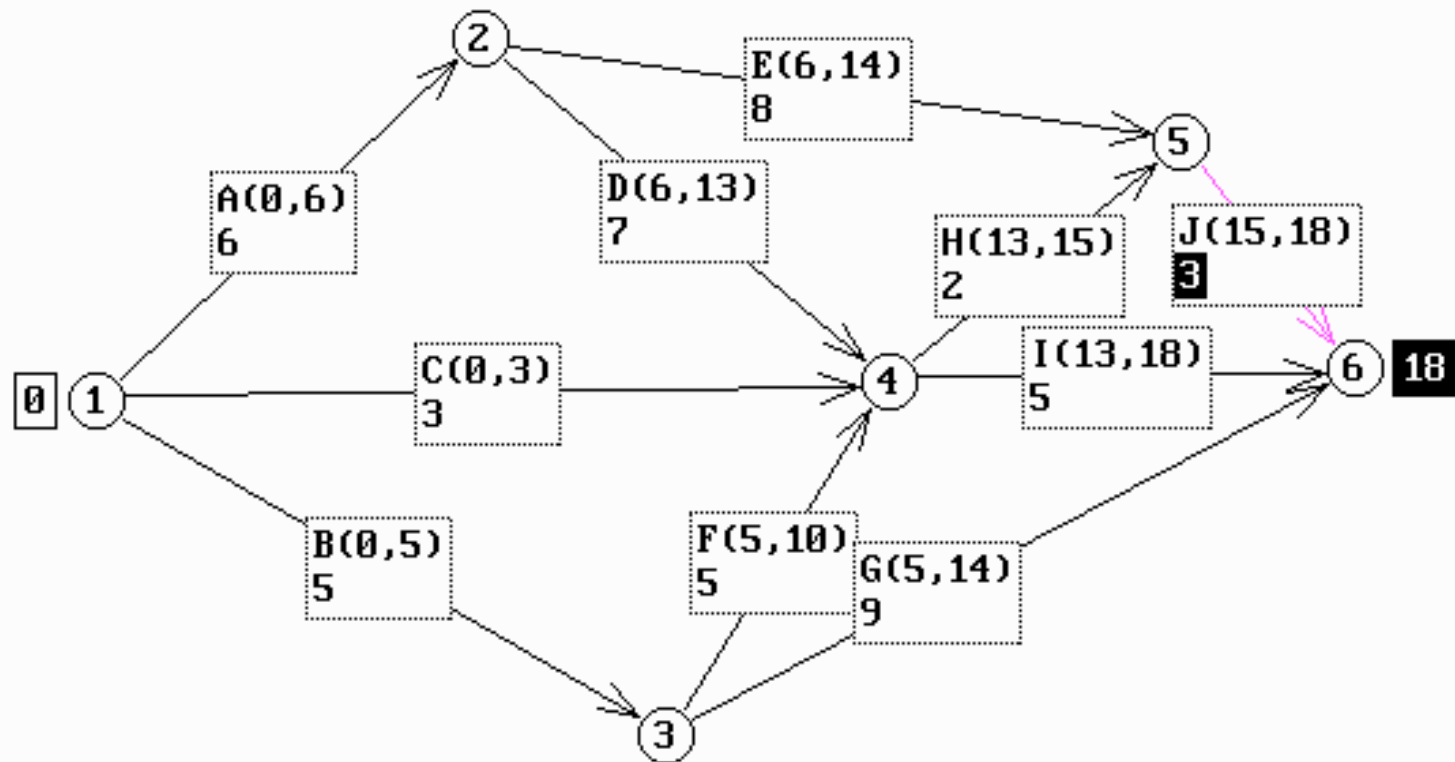


Select the activity

CRITICAL PATH METHOD
Solving the problem

CPM1/10

Backward pass



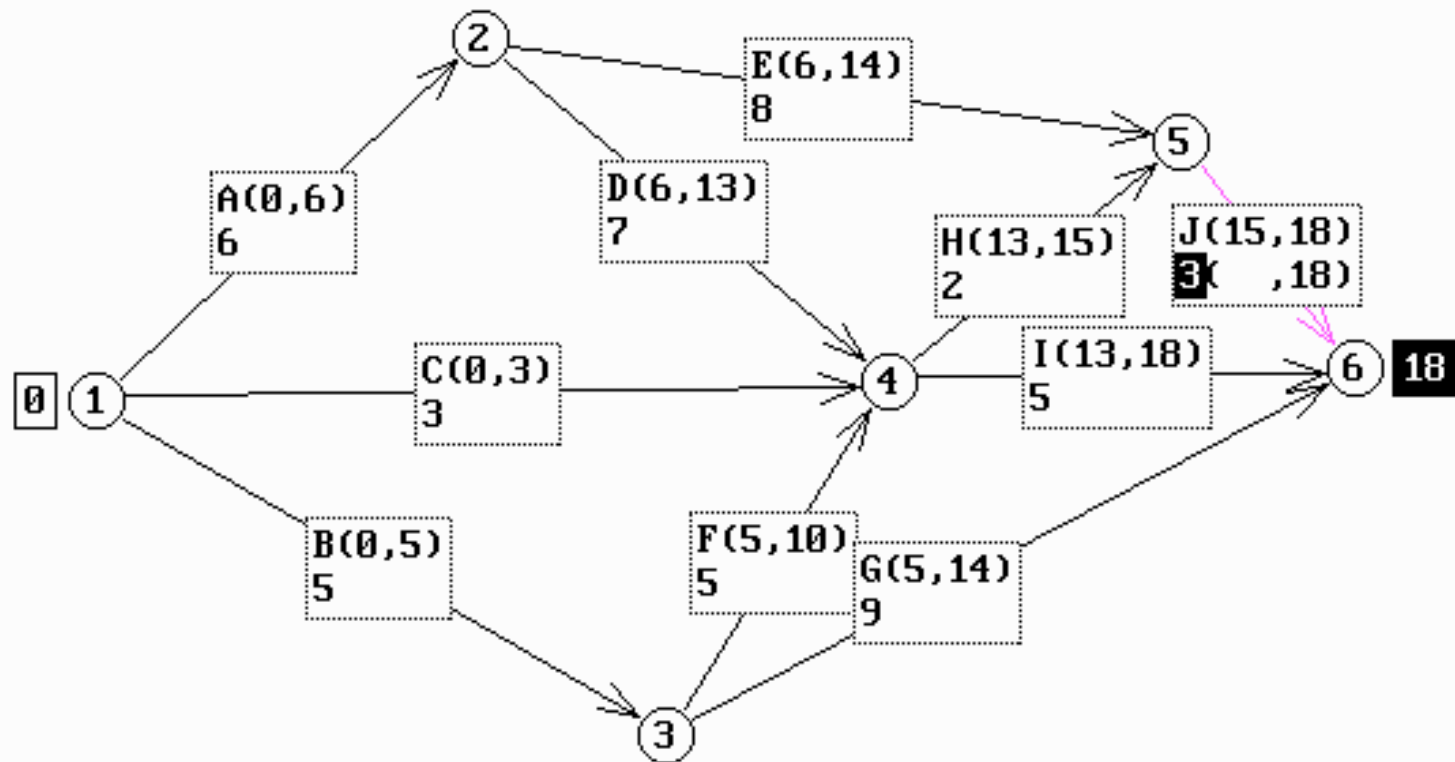
Enter latest finish time 18



CRITICAL PATH METHOD
Solving the problem

CPM1/11

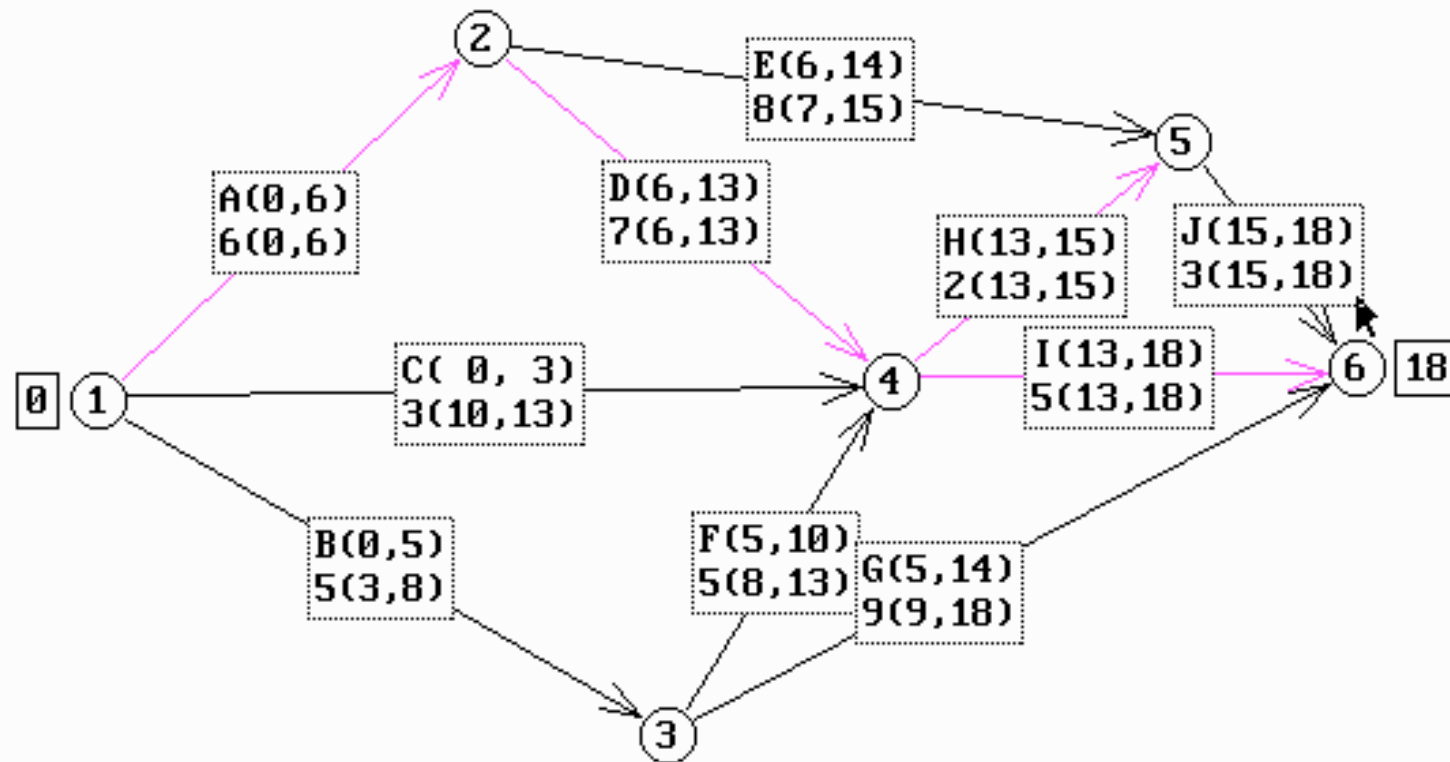
Backward pass



Enter latest start time 15

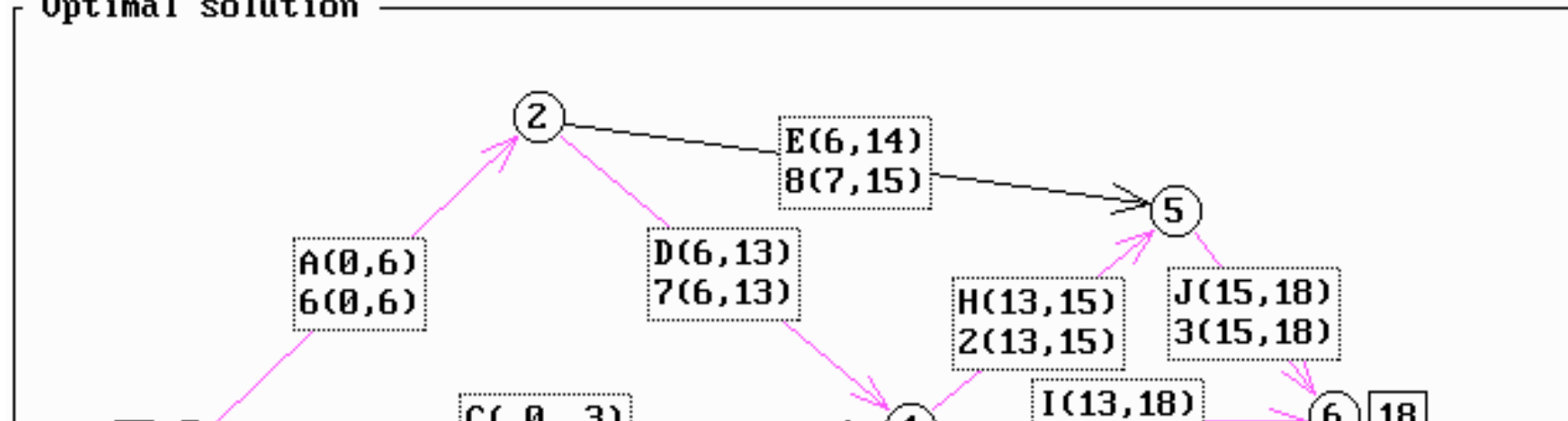


Critical path



Select critical activities

Optimal solution



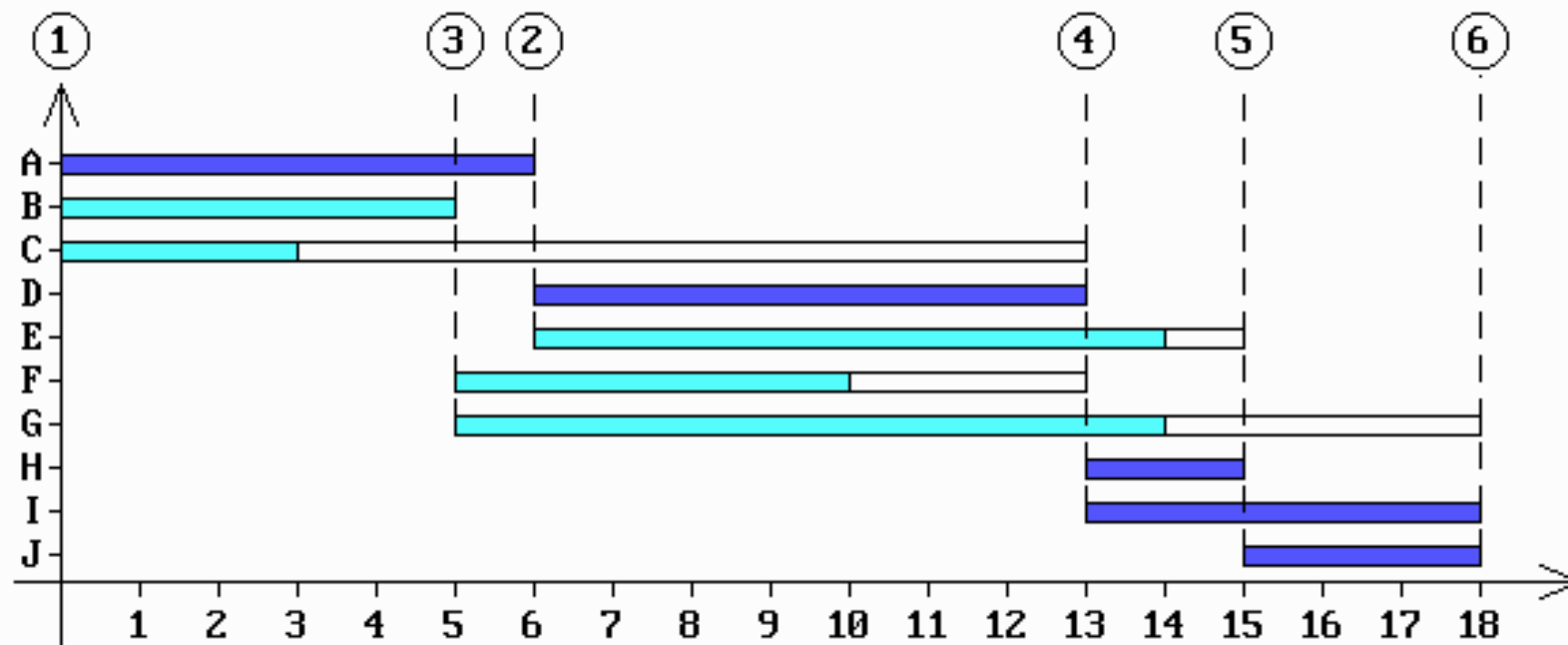
Activity	Completion time	Earliest start	Earliest finish	Latest start	Latest finish	Slack	Crit. path
A	6	0	6	0	6	0	Yes
B	5	0	5	3	8	3	No
C	3	0	3	10	13	10	No
D	7	6	13	6	13	0	Yes
E	8	6	14	7	15	1	No
F	5	5	10	8	13	3	No
G	9	5	14	9	18	4	No
H	2	13	15	13	15	0	Yes
I	5	13	18	13	18	0	Yes
J	3	15	18	15	18	0	Yes

Project completion time: 18

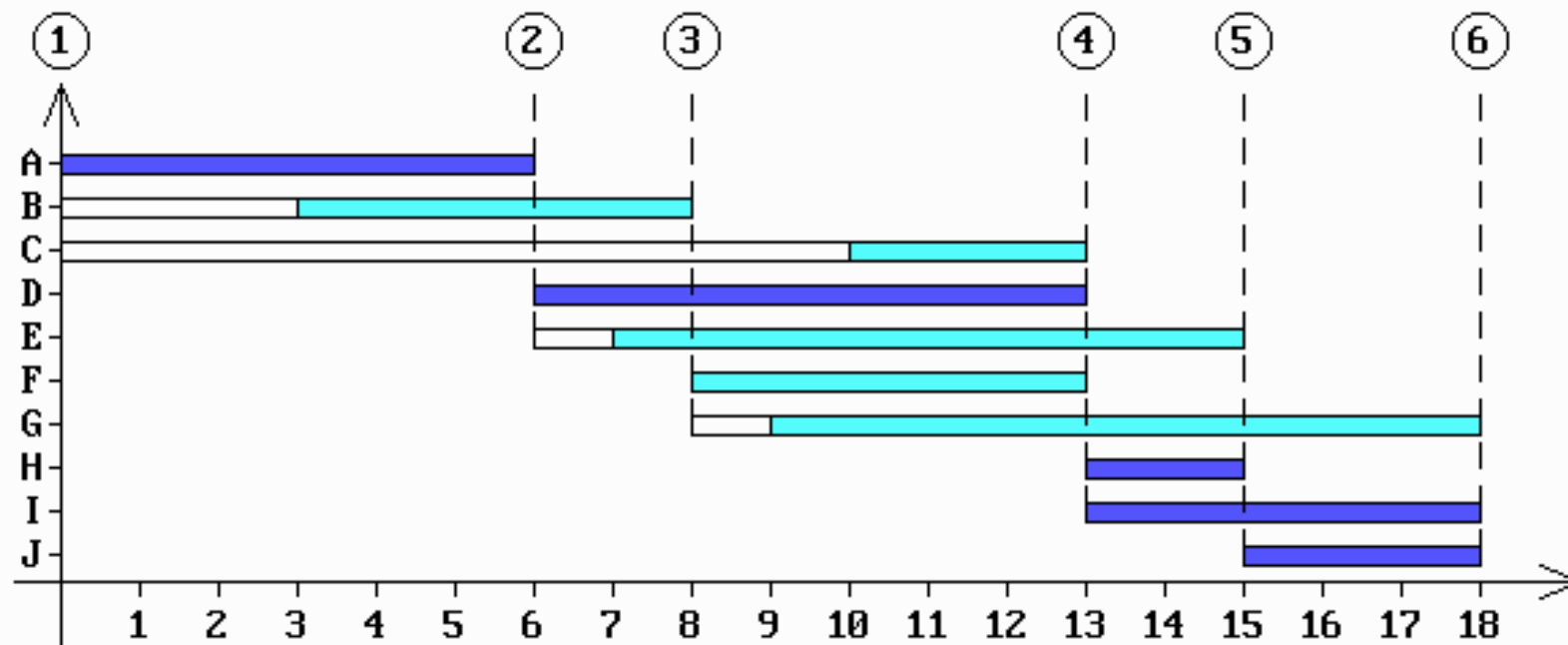
CRITICAL PATH METHOD
Solving the problem

CPM1/14

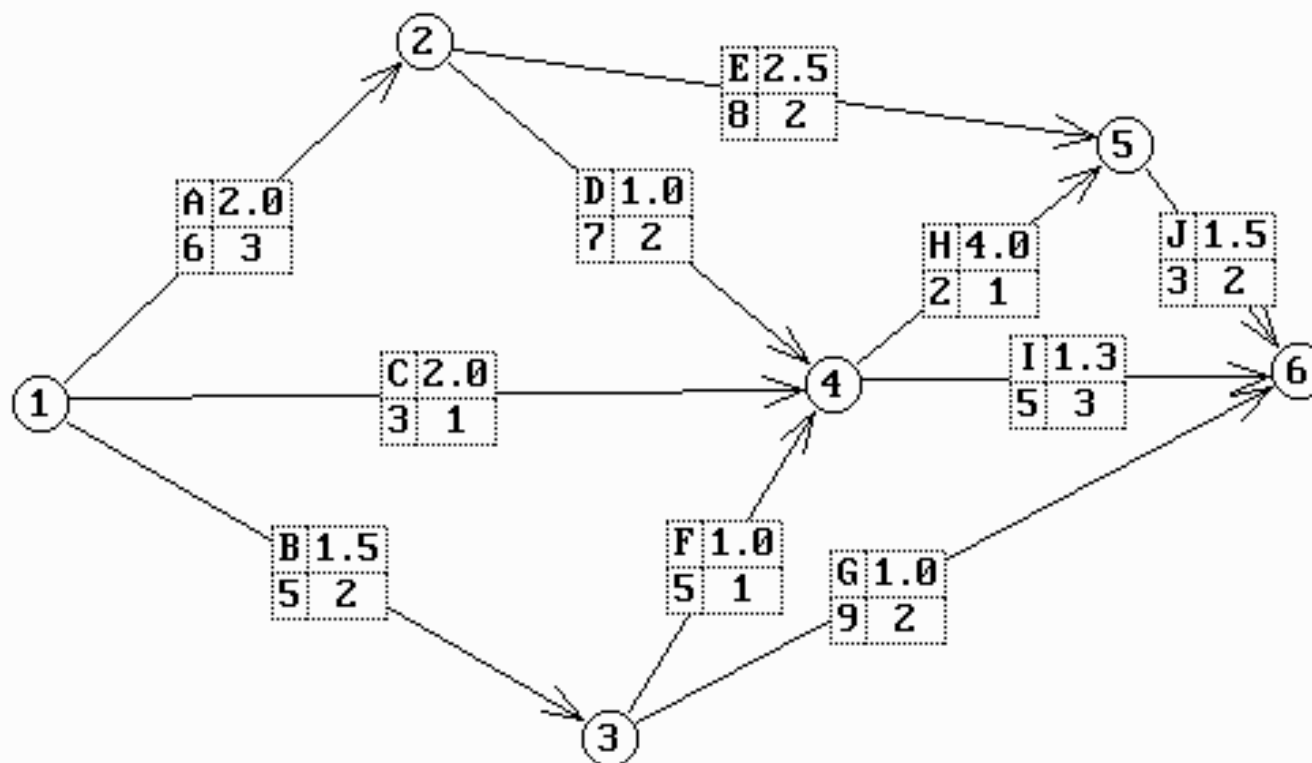
Starting all activities at earliest starting times



Starting all activities at latest starting times

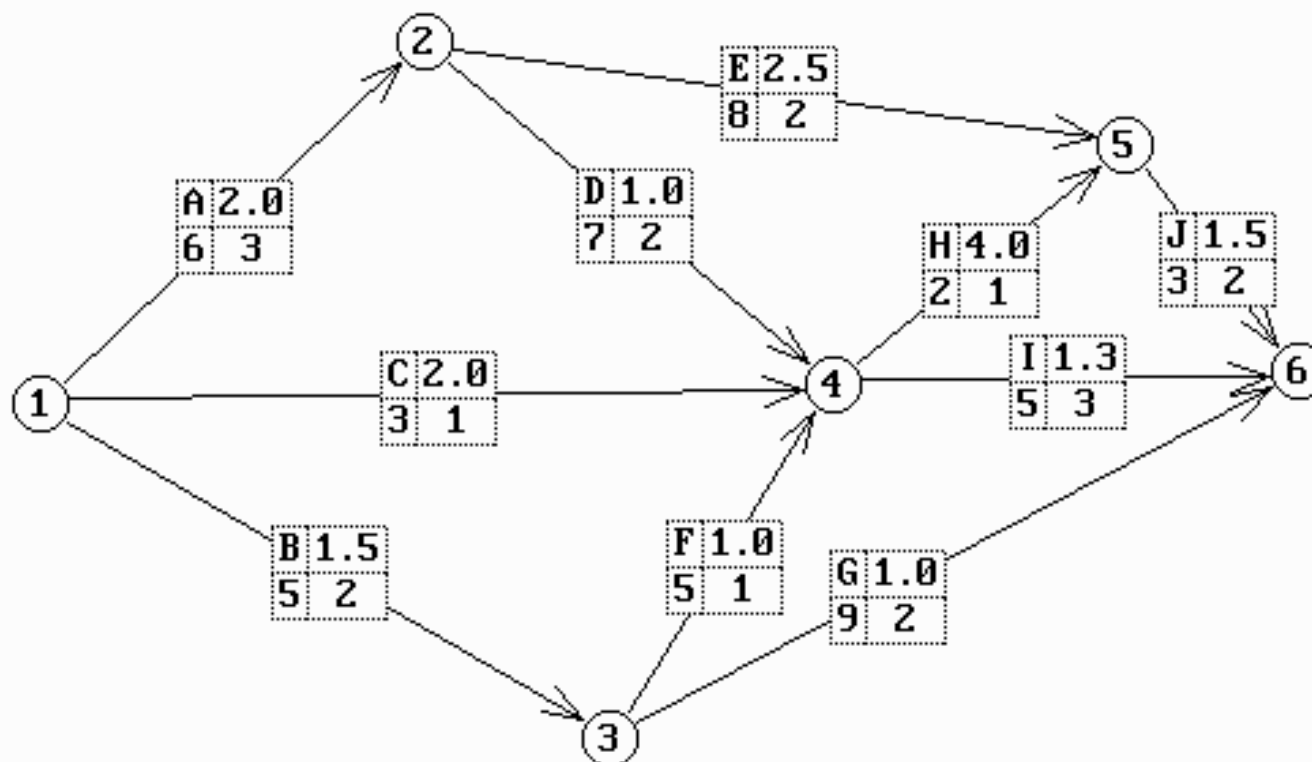


Minimization of the total completion time



Enter objective function:
 $x(6) \rightarrow \min$

Minimization of the total completion time



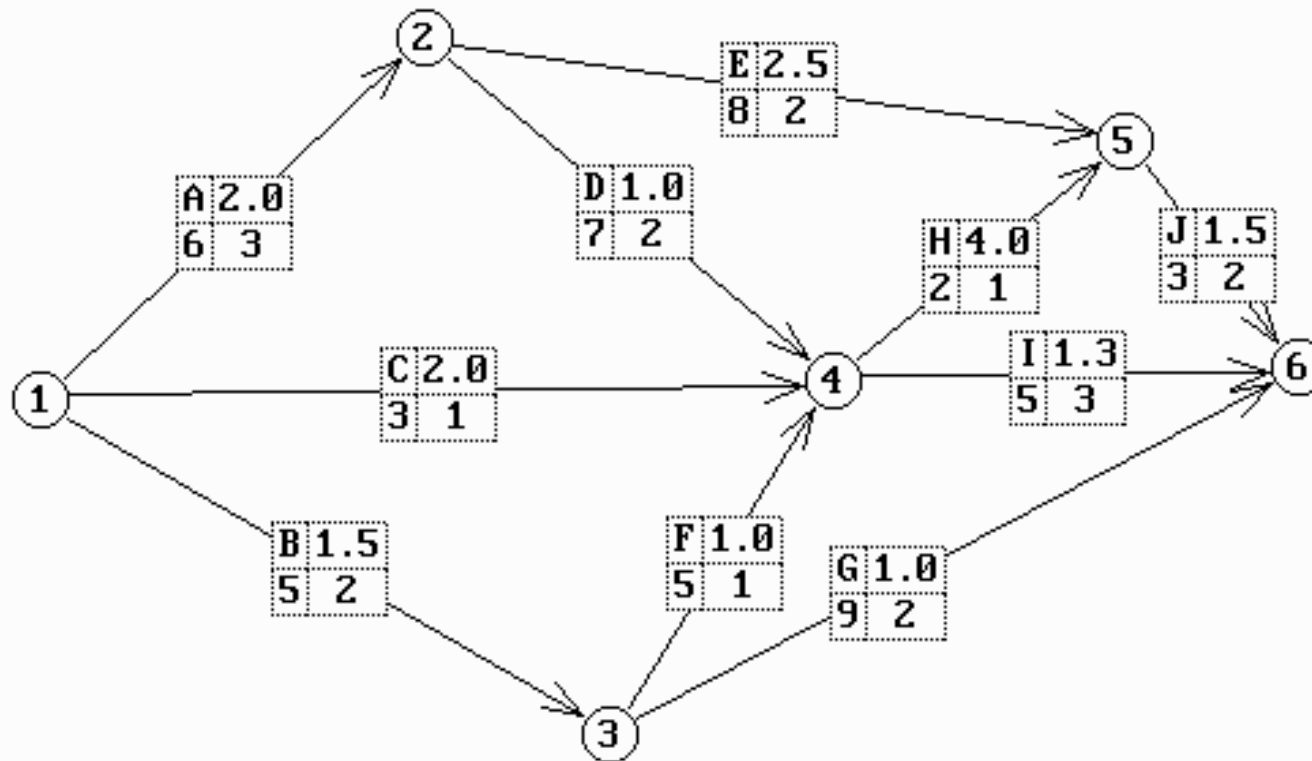
Enter constraints for activity A:

- $x(2) \geq x(1) + 6 - y(A)$
- $0 \leq y(A) \leq 3$

CRITICAL PATH METHOD
Solving the problem

CPM1/18

Minimization of the total completion time

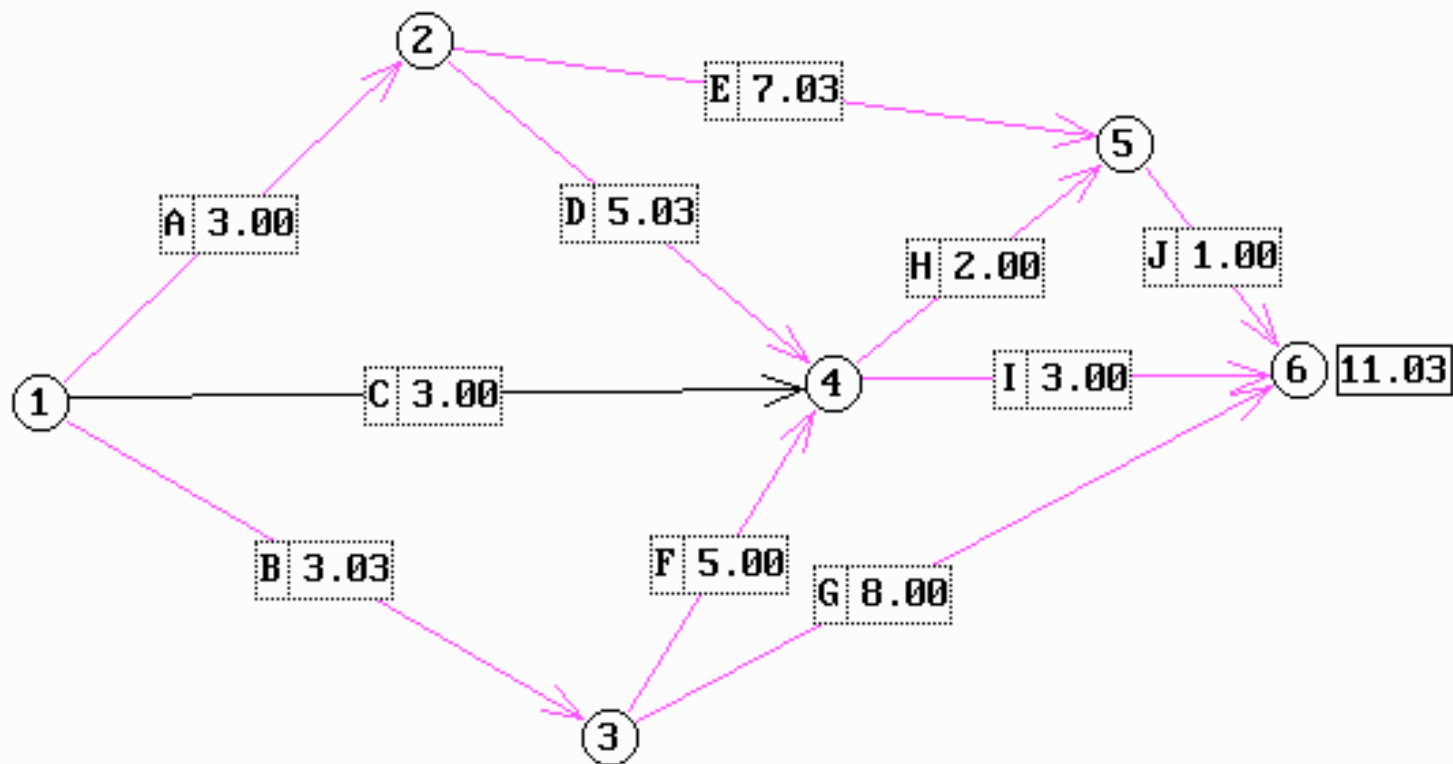


Enter total crash cost constraint:

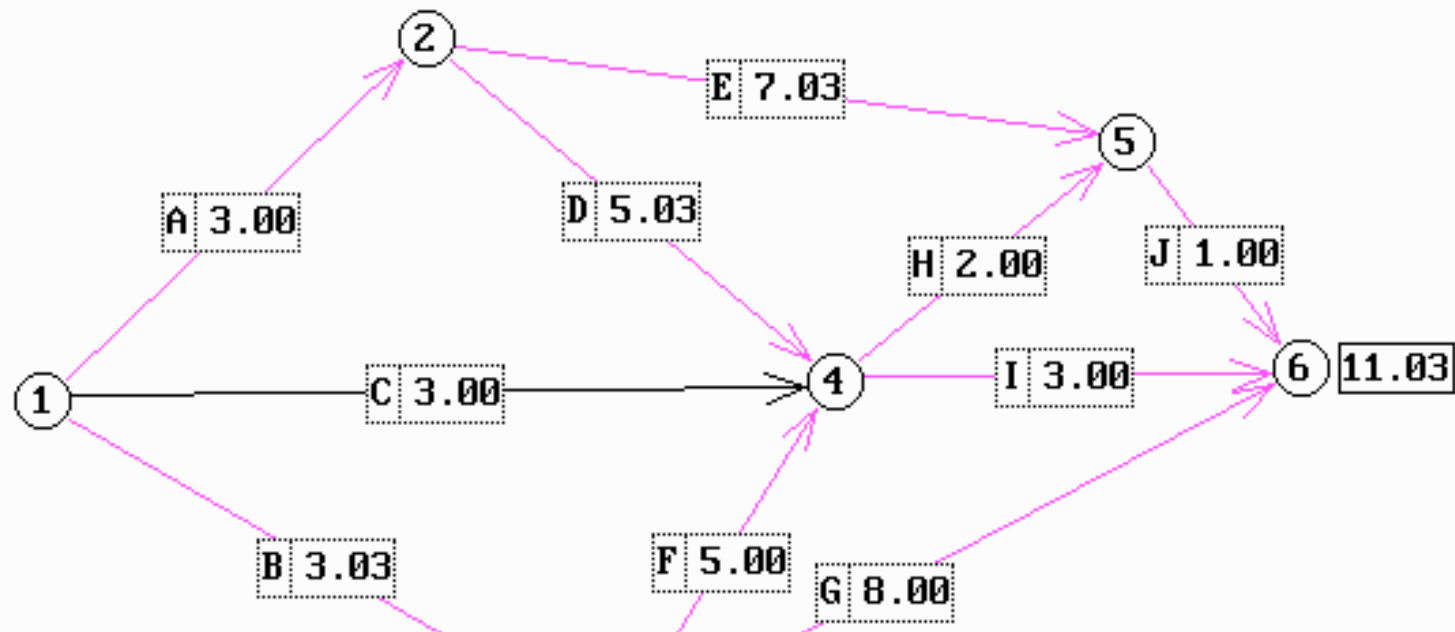
$$\begin{aligned}
 & 2.0 * y(A) + 1.5 * y(B) + 2.0 * y(C) + 1.0 * y(D) + \\
 & 2.5 * y(E) + 1.0 * y(F) + 1.0 * y(G) + 4.0 * y(H) + \\
 & 1.3 * y(I) + 1.5 * y(J) \leq 20
 \end{aligned}$$

1	2	3	4
5	6	7	8
9	0	.	←

Optimal solution ————— ime



Optimal solution time



Solution of the linear programming problem

Times of earliest occurrences of events

$x(1) = 0.0$ $x(2) = 3.0$ $x(3) = 3.0$ $x(4) = 8.0$ $x(5) = 10.0$
 $x(6) = 11.0$

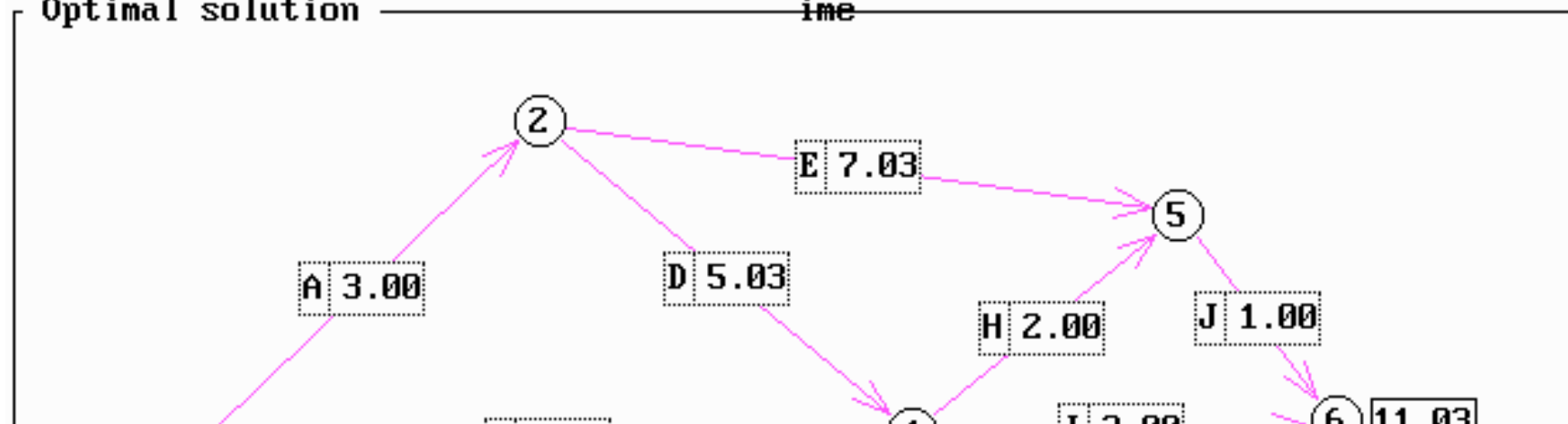
Amount of time the activity is crashed

$y(A) = 3.0$ $y(B) = 2.0$ $y(C) = 0.0$ $y(D) = 2.0$ $y(E) = 1.0$
 $y(F) = 0.0$ $y(G) = 1.0$ $y(H) = 0.0$ $y(I) = 2.0$ $y(J) = 2.0$

CRITICAL PATH METHOD
Solving the problem

CPM1/21

Optimal solution time

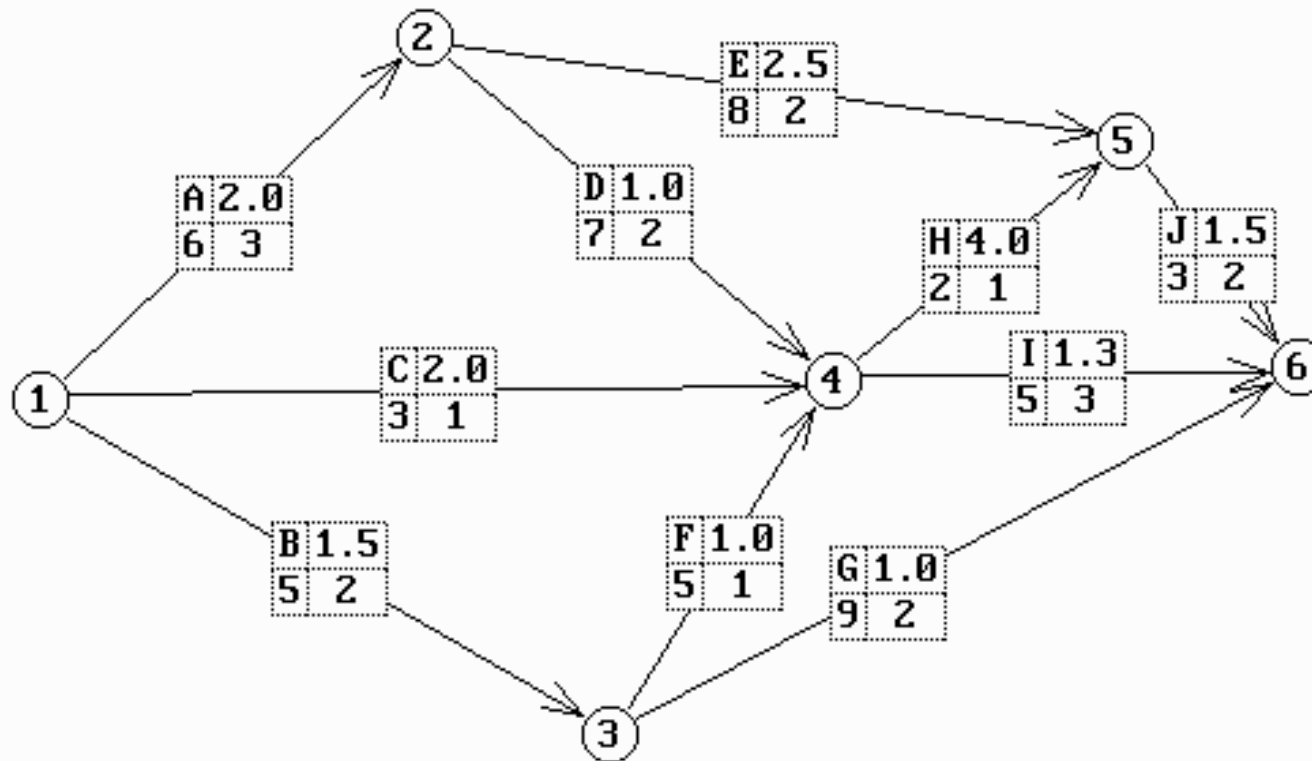


Activity	Completion time	Earliest start	Earliest finish	Latest start	Latest finish	Slack	Crit. path
A	3.000	0.000	3.000	0.000	3.000	0.000	Yes
B	3.033	0.000	3.033	0.000	3.033	0.000	Yes
C	3.000	0.000	3.000	5.033	8.033	5.033	No
D	5.033	3.000	8.033	3.000	8.033	0.000	Yes
E	7.033	3.000	10.033	3.000	10.033	0.000	Yes
F	5.000	3.033	8.033	3.033	8.033	0.000	Yes
G	8.000	3.033	11.033	3.033	11.033	0.000	Yes
H	2.000	8.033	10.033	8.033	10.033	0.000	Yes
I	3.000	8.033	11.033	8.033	11.033	0.000	Yes
J	1.000	10.033	11.033	10.033	11.033	0.000	Yes

Project completion time: 11.03

Total crashing cost: 20.000

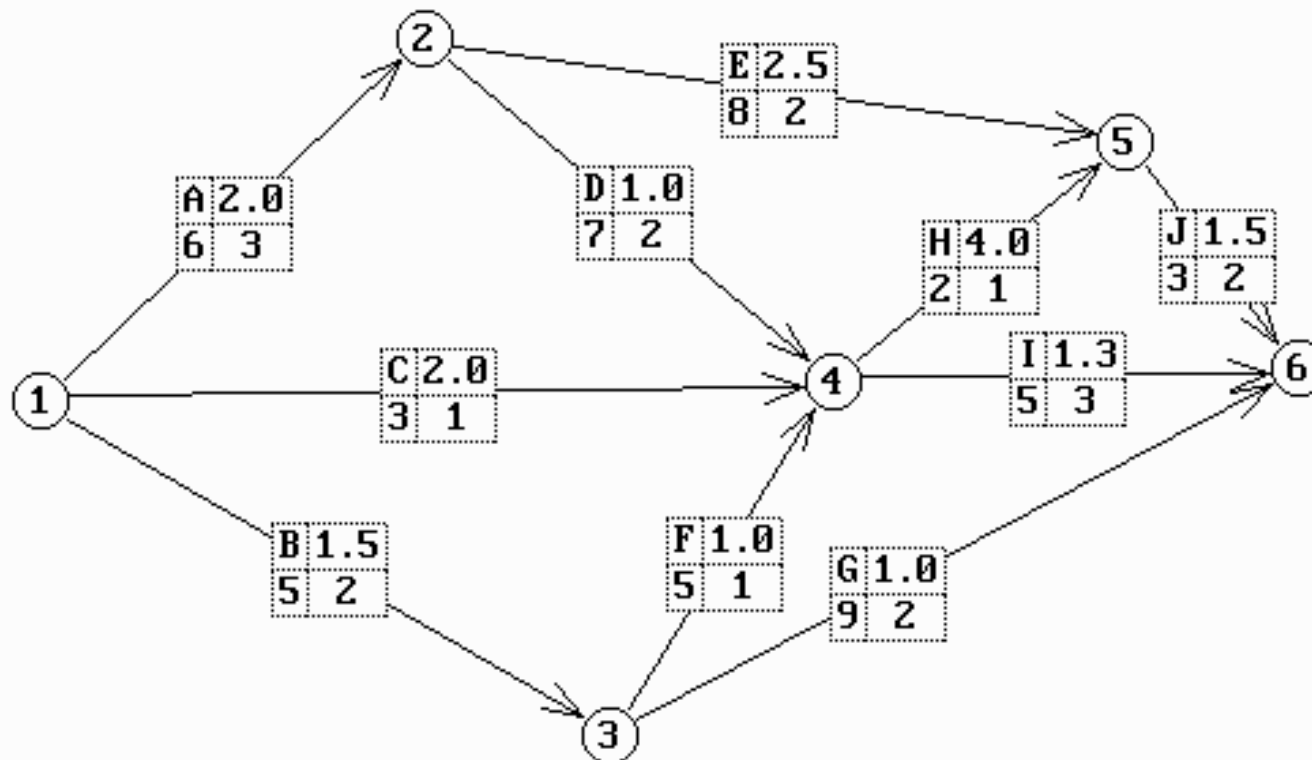
Minimization of the total crash cost



Enter objective function:

$$\begin{aligned}
 & 2.0 * y(A) + 1.5 * y(B) + 2.0 * y(C) + 1.0 * y(D) + \\
 & 2.5 * y(E) + 1.0 * y(F) + 1.0 * y(G) + 4.0 * y(H) + \\
 & 1.3 * y(I) + 1.5 * y(J) \quad \rightarrow \min
 \end{aligned}$$

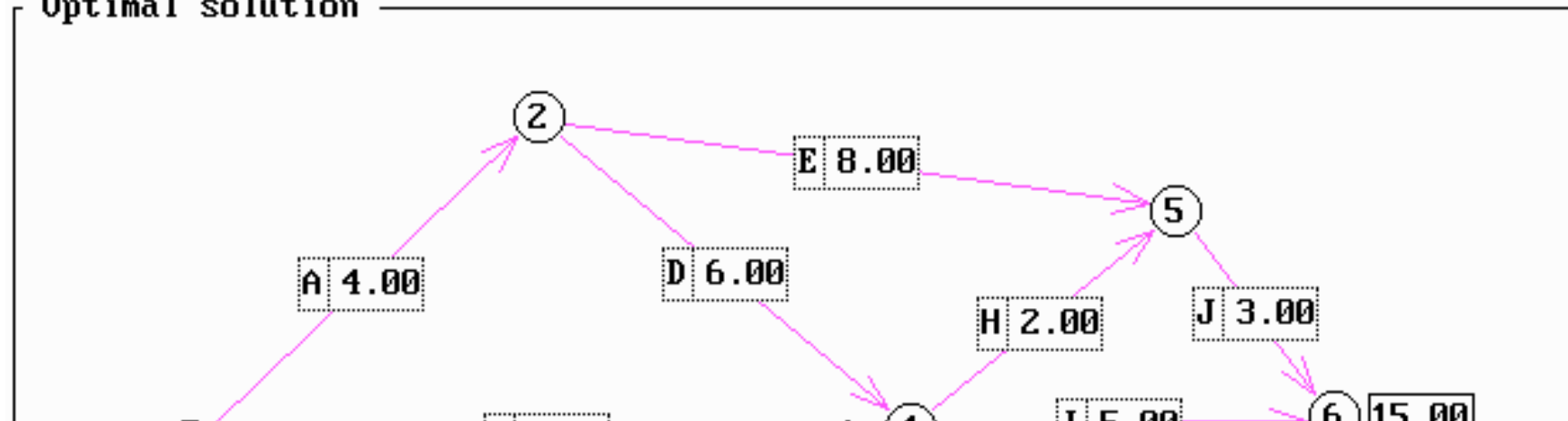
Minimization of the total crash cost



Enter total completion time constraint:
 $x(6) \leq 15$



Optimal solution



Activity	Completion time	Earliest start	Earliest finish	Latest start	Latest finish	Slack	Crit. path
A	4.000	0.000	4.000	0.000	4.000	0.000	Yes
B	5.000	0.000	5.000	0.000	5.000	0.000	Yes
C	3.000	0.000	3.000	7.000	10.000	7.000	No
D	6.000	4.000	10.000	4.000	10.000	0.000	Yes
E	8.000	4.000	12.000	4.000	12.000	0.000	Yes
F	5.000	5.000	10.000	5.000	10.000	0.000	Yes
G	9.000	5.000	14.000	6.000	15.000	1.000	No
H	2.000	10.000	12.000	10.000	12.000	0.000	Yes
I	5.000	10.000	15.000	10.000	15.000	0.000	Yes
J	3.000	12.000	15.000	12.000	15.000	0.000	Yes

Project completion time: 15.00 Total crashing cost: 5.000