The classical formulation for **resource constrained project scheduling problem with discounted cash flow** that aims to **maximize the net present value (NPV)** is:

$$\text{Max}, Z = \sum_{i=1}^{n} C_i \, e^{-\alpha f_i} \tag{1}$$

Subject to

$$f_i \le f_j - d_i, \forall(i,j) \in precedence \tag{2}$$

$$\sum_{i \in S(t)} r_{ik} \le a_k, \quad k = 1, \dots, R; t = 1, \dots, D \tag{3}$$

$$f_1 = 0 \tag{4}$$

$$f_i \le D, i = 1, \dots, n \tag{5}$$

$$f_i \; integer, \forall_i \in N \tag{6}$$

Where,

i = activity, $i = 1,\dots,n$

prcedence = precedence between activity i and j

k = number of non-renewable resource, $k = 1,\dots,k$

activity $i = 1$ and $i = n$, that means first and last activity are dummy

C_i is the net cash flow at a discount rate α for the activity i

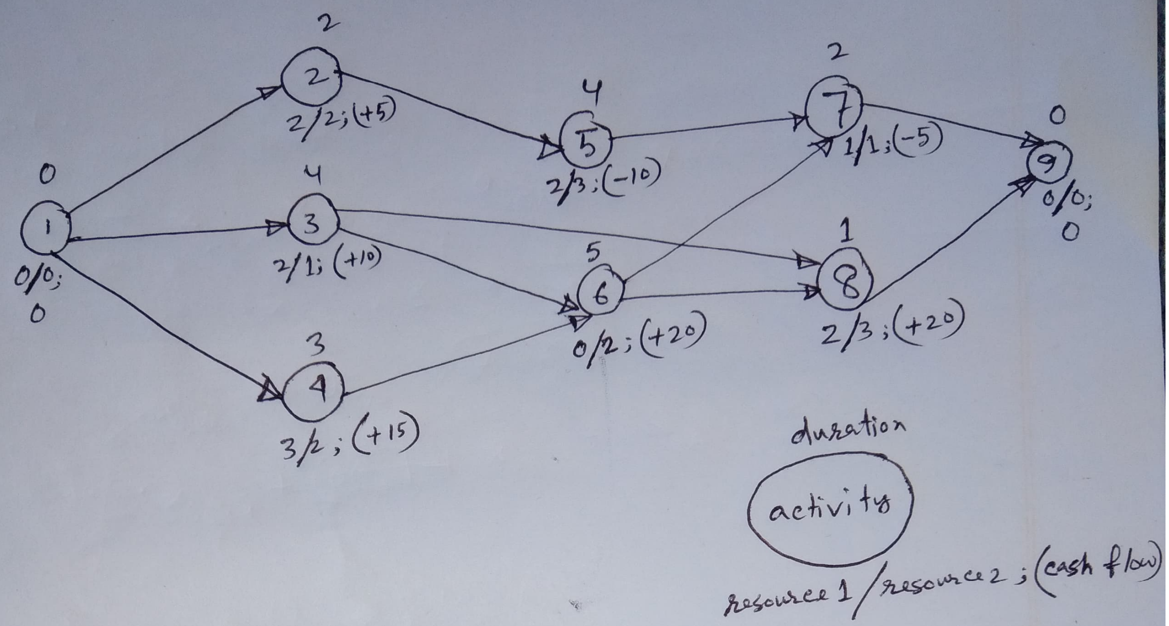
The decision variable f_i is the finish time for each activity i.

Each activity has a duration d_i, and renewable resource demand r_{ik}.

Each renewable resource k has a limited constant availability of a_k.

The objective function aims to maximize the NPV (Eq. 1), whereas the constraints (2) ensure precedence feasibility. Inequality (3) indicates that the demand of the renewable resources (r_{ik}) must satisfy its availability (a_k); i.e., the resource constraints. It is assumed that the first activity (dummy) starts at time zero (Eq. 4). Inequality constraint (5) implies that, each activity will be finished on or before the deadline of the project's deadline (D). Constraint (6) indicates that the activity finished time, that is the decision variable, will be non-negative integer value.

Example Problem



activity	duration	resource 1	resource 2	cash flow	Precedence
1	0	∅	∅	0	2, 3, 4
2	2	2	2	+5	5
3	4	2	1	+10	6, 8
4	3	3	2	+15	6
5	4	2	3	−10	7
6	5	0	2	+20	7, 8
7	2	1	1	−5	9
8	1	2	3	+20	9
9	0	0	0	0	

Maximum resource availability (a_k) : $[a_1, a_2] = [4, 4]$ over the whole project.