# Cumulative Constraints

Sabbir

October 28, 2015

## 1

Lets denote multiple Active applications ($1 \leq i \leq n$), which run all the time.

Table 1: Energy consumption for Active applications

| | Mode 1 | Mode 2 | Mode 3 |
|---|---|---|---|
| $A_1$ | 50 | 60 | 70 |
| $A_2$ | 40 | 45 | 55 |

Table 2: Profit for Active applications

| | Mode 1 | Mode 2 | Mode 3 |
|---|---|---|---|
| $A_1$ | 100 | 110 | 120 |
| $A_2$ | 90 | 100 | 110 |

If $M$, $E$, $P$ denotes Mode of the application, Energy consumption and Profit for Application, then

- $M_{ij} \in [1, 3]$ *where* j$\in [1, 24]$
- $E_{ij} \in [0, 1000]$
- $P_{ij} \in [0, 1000]$
  Now for $\forall i \in [1, n], \forall j \in [1, 24]$

- element ($M_{ij}$, $Row_i^{Energy}$, $E_{ij}$) % $\quad E_i{=}Row_i^{Energy}[M_i]$
- element ($M_{ij}$, $Row_i^{Profit}$, $P_{ij}$) % $\quad P_i{=}Row_i^{Profit}[M_i]$

For, Batch jobs ($1 \leq i \leq m$), it arrives with duration and deadline. The provider can earn profit only the job is finished before or at deadline, but not for accomplishing in each slots or duration. So, $Duration_i{=}fixed$, $Deadline_i{=}fixed$, $ConsumptionPerHour_i{=}fixed$.

Table 3: Energy consumption for Batch Application

| | On | Off |
|---|---|---|
| $B_1$ | 60 | 0 |

Profit for Batch jobs and Penalty is $Q_i \in [0, 1000]$ *and* $\text{Pen}_i \in [0, 1000]$ *respectively.* $S_{Bi1} < S_{Bi2} \ldots\ldots < S_{BiDuration_i} \in [1, 24]$, $E_i \in [0, 1000]$

- element ($S_{BiDuration_i}$, $[\ldots\ldots\ldots Profit_i,\ Penalty_i, \ldots.]$, $Q_i$)

1 2 deadline

Total Profit

- $\text{P} = \sum_{i=1}^{n} P_{ij} + \sum_{i=1}^{m} Q_i$
- Objective Function

$$\text{maximize} \quad P$$

## 2 Example

Lets recall Table 1 where we have 2 Active jobs, such as $A_1$ and $A_2$. For modelling the problem as cumulative constraints, we need to define $Start(S)$, $Duration(D)$ and $Height(H)$. As we can not change the Global Height, we introduce a fake active job for each slot/duration if the height of available energy changes in every slot/duration. Lets, assume there are 6 slots. So, there will be 6 fake Active jobs as $C_1$, $C_2$, $C_3$, $C_4$, $C_5$, and $C_6$, which have same $Start(S)$ and $Duration(D)$ value of Active jobs, but different $Height(H)$. and 1 Batch job that needs 3 duration for completion and it should accomplish before slot 5.

- $S_{A_1} \in [1,2,3,4,5,6]$, $\mathrm{D}_{A_1} \in [1]$, $\mathrm{H}_{A_1} \in [50,60,70]$

- $S_{A_2} \in [1,2,3,4,5,6]$, $\mathrm{D}_{A_2} \in [1]$, $\mathrm{H}_{A_2} \in [40,45,55]$

- $S_{B_1} \in [1,2,3,4,5,6]$, $\mathrm{D}_{B_1} \in [3]$, $\mathrm{H}_{B_1} \in [60]$, *where* $\mathrm{S}_{B_1} + D_{B_1} \leq Deadline$
- $S_{C_1} \in [1]$, $\mathrm{D}_{C_1} \in [1]$, $\mathrm{H}_{C_1} = [\mathit{GlobalHeight}$ - $\mathit{AvailableEnergy}_1$ (slot 1)]

- $S_{C_2} \in [2]$, $\mathrm{D}_{C_2} \in [1]$, $\mathrm{H}_{C_2} = [\mathit{GlobalHeight}$ - $\mathit{AvailableEnergy}_2$ (slot 2)]

- $S_{C_3} \in [3]$, $\mathrm{D}_{C_3} \in [1]$, $\mathrm{H}_{C_3} = [\mathit{GlobalHeight}$ - $\mathit{AvailableEnergy}_3$ (slot 3)]

- $S_{C_4} \in [4]$, $\mathrm{D}_{C_4} \in [1]$, $\mathrm{H}_{C_4} = [\mathit{GlobalHeight}$ - $\mathit{AvailableEnergy}_4$ (slot 4)]

- $S_{C_5} \in [5]$, $\mathrm{D}_{C_5} \in [1]$, $\mathrm{H}_{C_5} = [\mathit{GlobalHeight}$ - $\mathit{AvailableEnergy}_5$ (slot 5)]

- $S_{C_6} \in [6]$, $\mathrm{D}_{C_6} \in [1]$, $\mathrm{H}_{C_6} = [\mathit{GlobalHeight}$ - $\mathit{AvailableEnergy}_6$ (slot 6)]

cumulative (< >, 175)