620-362
Applied Operations Research

Xpress^{MP}:
Live Programming Problems

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1 Coach Night is trying to choose the starting lineup for the basketball team. The team consists of seven players who have been rated (on a scale of 1 = poor to 3 = excellent) according to their ball-handling, shooting, rebounding, and defensive abilities. The positions that each player is allowed to play and the player's abilities are listed in Table 9.

The five-player starting lineup must satisfy the following restrictions:

1 At least 4 members must be able to play guard, at least 2 members must be able to play forward, and at least 1 member must be able to play center.

2 The average ball-handling, shooting, and rebounding level of the starting lineup must be at least 2.

3 If player 3 starts, then player 6 cannot start.

4 If player 1 starts, then players 4 and 5 must both start.

TABLE 9

Player	Position	Ball-Handling	Shooting	Rebounding	Defense
1	G	3	3	1	3
2	C	2	1	3	2
3	G-F	2	3	2	2
4	F-C	1	3	3	1
5	G-F	1	3	1	2
6	F-C	3	1	2	3
7	G-F	3	2	2	1

5 Either player 2 or player 3 must start.

Given these constraints, Coach Night wants to maximize the total defensive ability of the starting team. Formulate an IP that will help him choose his starting team.

$B = \{1,\ldots,7\}$ = the set of all players

P_i = the set of all positions for player i

H_i = ball handling ability for player i

S_i = shooting ability for player i

R_i = rebounding ability for player i

D_i = defense ability for player i

$$x_i = \begin{cases} 1, & \text{if player } i \text{ chosen} \\ 0, & \text{otherwise} \end{cases}$$

$$\max \sum_{i \in B} D_i x_i$$

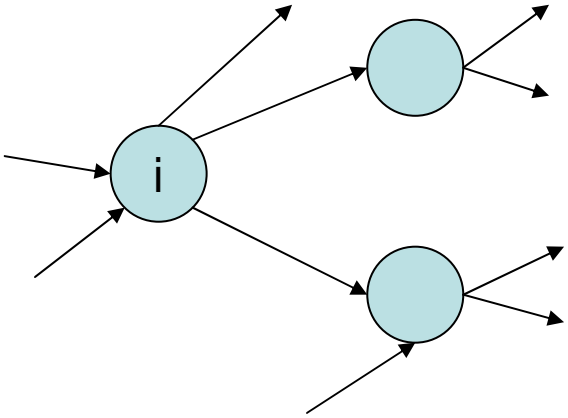
$$\sum_{i \in B} x_i = 5$$

$$\sum_{i \in B \text{ s.t. "G"} \in P_i} x_i \geq 4 \qquad \sum_{i \in B \text{ s.t. "F"} \in P_i} x_i \geq 2 \qquad \sum_{i \in B \text{ s.t. "C"} \in P_i} x_i \geq 1$$

$$\sum_{i \in B} B_i x_i \geq 10 \qquad \sum_{i \in B} S_i x_i \geq 10 \qquad \sum_{i \in B} R_i x_i \geq 10$$

$$x_3 + x_6 \leq 1 \qquad 2x_1 \leq x_4 + x_5 \qquad x_2 + x_3 \geq 1$$

Network loss problem



$N = \{0,1,2,3,4\} = \text{set of nodes}$

$N^{source} = \{0\} = \text{set of source nodes} \left(N^{source} \subseteq N\right)$

$A = \{(1,2),(1,3),(2,4),(3,4)\} = \text{set of arcs}$

$D_i = \text{demand at node } i \in N$

$S = \{1,2,3\} = \text{set of segments for loss function}$

$L_k = \text{loss rates at segment } k \in S$

$B = \{B_0, B_1, B_2, B_3\} = \{0,4,7,100\} = \text{set of breakpoints for loss function}$

$y_{ij} = \text{amount of flow on arc } (i,j) \in A$ $\qquad$ $z_i = \text{supply at node } i \in N^{source}$

$x_{ij}^k = \text{amount of flow on arc } (i,j) \in A \text{ represented by segment } k \in S$

$$\min \sum_{(i,j)\in A} l(y_{ij})$$

$$z_i + \sum_{(j,i)\in A} y_{ji} - \sum_{(j,i)\in A} l(y_{ji}) = \sum_{(i,j)\in A} y_{ij} + D_i, \quad \forall i \in N$$

$$l(y_{ij}) = \sum_{k\in S} L_k x_{ij}^k, \quad \forall (i,j) \in A \qquad\qquad y_{ij} = \sum_{k\in S} x_{ij}^k, \quad \forall (i,j) \in A$$

$$0 \le x_{ij}^k \le B_k - B_{k-1}, \quad \forall (i,j) \in A, k \in S$$