ICMA 346 Project Formulation: The Tennessee Pterodactyls

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We have a yearly budget of \$50 million to sign free agents from the following table:

	Player	Position	Points	Rebounds	Assists	Minutes	Salary (\$M)
1	Mack Madonna	Back court	14.7	4.4	9.3	40.3	8.2
2	Darrell Boards	Front court	12.6	10.6	2.1	34.5	6.5
3	Silk Curry	Back court	13.5	8.7	1.7	29.3	5.2
4	Ramon Dion	Back court	27.1	7.1	4.5	42.5	16.4
5	Joe Eastcoast	Back court	18.1	7.5	5.1	41.0	14.3
6	Abdul Famous	Front court	22.8	9.5	2.4	38.5	23.5
7	Hiram Grant	Front court	9.3	12.2	3.5	31.5	4.7
8	Antoine Roadman	Front court	10.2	12.6	1.8	44.4	7.1
9	Fred Westcoast	Front court	16.9	2.5	11.4	42.7	15.8
10	Magic Jordan	Back court	28.5	6.5	1.3	38.1	26.4
11	Barry Bird	Front court	24.8	8.6	6.9	42.6	19.5
12	Grant Hall	Front court	11.3	12.5	3.2	39.5	8.6

The requirements are:

1. Sign exactly 5 players.
2. Total points per game ≥ 80.
3. Total rebounds per game ≥ 40.
4. Total assists per game ≥ 25.
5. Total minutes per game ≥ 190.
6. At most 2 front court and at most 3 back court players. As we must sign 5 players, we can simplify this to just require exactly 2 front court players.
7. Select the group that satisfies requirements 1-6 at minimum total salary cost.

Define a vector $\boldsymbol{x} \in \{0,1\}^{12}$, consisting of the following binary decision variables:

$$x_i = \begin{cases} 1, & \text{if player } i \text{ is signed,} \\ 0, & \text{otherwise,} \end{cases} \qquad i = 1, \dots, 12.$$

Let $\boldsymbol{s}, \boldsymbol{p}, \boldsymbol{r}, \boldsymbol{a}, \boldsymbol{m} \in \mathbb{R}_+^{12}$ be the salary, points, rebounds, assists, minutes vectors, and $\boldsymbol{f} \in \{0,1\}^{12}$ indicate front court (1) or back court (0).

We can now formulate the integer linear programming model:

$$\begin{aligned} \text{minimize} \quad & z = \boldsymbol{s}^\top \boldsymbol{x} \\ \text{subject to} \quad & \mathbf{1}^\top \boldsymbol{x} = 5, \\ & \boldsymbol{p}^\top \boldsymbol{x} \geq 80, \\ & \boldsymbol{r}^\top \boldsymbol{x} \geq 40, \\ & \boldsymbol{a}^\top \boldsymbol{x} \geq 25, \\ & \boldsymbol{m}^\top \boldsymbol{x} \geq 190, \\ & \boldsymbol{f}^\top \boldsymbol{x} = 2, \\ & \boldsymbol{x}, \boldsymbol{f} \in \{0,1\}^{12}, \\ & \boldsymbol{s}, \boldsymbol{p}, \boldsymbol{r}, \boldsymbol{a}, \boldsymbol{m} \in \mathbb{R}_+^{12}. \end{aligned}$$