1. INTRODUCTION
   1. **Overview**

The goal of this article is to find a potential NBA champion team with the lowest budget. The team is filled with thirteen to fifteen players, and they must combine to produce statistics higher than the previous champions while minimizing the salaries of all the chosen players. We also study how the effect of allowing a penalty cost would do to the combination of the team.

* 1. **Motivation**

Since sports is becoming a multi- million-dollar industry, there are competitions everywhere. Our primary interest is in the NBA industry. We, as sports managers, want to save as much spending as possible while having the ability to achieve our long-term goal, which is to become the champion.

* 1. **Specific Questions in this Line of Research**

Straight from the report

1. MODELS
   1. **Basic Model**

The simplest model of creating a NBA team is formulated as an Integer Linear Program (ILP), or more precise a bin packing model. The basic setup is that we have n total players and m possible required constraints for setting up the team. Each player has his own skillset, as well as individual salary. Here, player i’s j skillset is given as $$a\_ij$$, and the corresponding requirement is given as $$b\_j$$. We introduce a decision variable, denoted by $$x\_i$$, as player i. This is also a binary variable, given as

$$x\_i = $$

A constraint is implemented on how many players we can have on a team. The roster size needs to be between thirteen to fifteen. This is shown as below:

$$ 13 \leq \sum\_{i=1}^{n}x\_i \leq 15$$

Multiplying the players with their respective annual salaries, denoted by $$c\_i$$, in million dollars, the objective function would be:

$$\sum\_{i=1}^{n} c\_i x\_i$$

We are implementing a penalty cost parameter, denoted by $$\alpha = \{\alpha \in \R, \alpha > 0\}$$. The unit for this parameter would be in millions of dollars. $$\alpha$$ enables the ILP to accept a set of players that do not meet the certain constraint requirement. The difference between the constraint requirement and the sum of the chosen players’ statistics equals the units penalized. This difference is given as

$$ \alpha \space

(b\_k \space - min (b\_k, a\_{k1}x\_1 + a\_{k2}x\_2 + a\_{k3}x\_3 + ...+ a\_{{k(n-1)}}x\_{n-1} + a\_{kn}x\_n)) $$

where $$0< k < m$$

Since we want to minimize the cost, the object function will now become

$$min \sum\_{i=1}^ {n} \space c\_i x\_i \space + \alpha \space

(b\_k \space - min (b\_k, a\_{k1}x\_1 + a\_{k2}x\_2 + ...+ a\_{{k(n-1)}}x\_{n-1} + a\_{kn}x\_n))^2$$

Also, all the constraints are written in the form of

$$ \sum\_{i=1}^{n} \sum\_{j=1}^{m} a\_{ij}x\_i \geq b\_j \space ,

where \space a\_{ij} \space is \space the \space

d \space stats \space for \space player \space i \space and \space

b\_j\space is \space the \space j \space standard$$

For example,

$$a\_{11} x\_1 + a\_{12}x\_2 + ... + a\_{1(n-1)}x\_{n-1} + a\_{1n}x\_n > b\_1$$

$$a\_{21} x\_1 + a\_{22}x\_2 + ... + a\_{2(n-1)}x\_{n-1} + a\_{2n}x\_n > b\_2$$

$$\vdots \space \space \space \space \space \space \space\space \space \space\space \space \space\space \space \space\space \space \space\space \space \space \space \space \space \space \space \dots \space \space \space\space \space \space\space \space \space\space \space \space\space \space \space\space \space \space\space\space \space \space\space \space \space\space \space \space \space \space \vdots $$

$$a\_{j1} x\_1 + a\_{j2}x\_2 + ... + a\_{j(n-1)}x\_{n-1} + a\_{jn}x\_n > b\_j$$

$$\vdots \space \space \space \space \space \space \space\space \space \space\space \space \space\space \space \space\space \space \space\space \space \space \space \space \space \space \space \dots \space \space \space\space \space \space\space \space \space\space \space \space\space \space \space\space \space \space\space\space \space \space\space \space \space\space \space \space \space \space \vdots $$

$$a\_{(m-1)1} x\_1 + a\_{(m-1)2}x\_2 + ... + a\_{(m-1)(n-1)}x\_{n-1} + a\_{(m-1)n}x\_n > b\_{m-1}$$

$$a\_{m1} x\_1 + a\_{m2}x\_2 + ... + a\_{m(n-1)}x\_{n-1} + a\_{mn}x\_n > b\_m$$

* 1. **Advanced Model**

Straight from the progress report

The difference is now becoming

$$ \alpha \space

(b\_k \space - min (b\_k, a\_{k1}x\_1 + a\_{k2}x\_2 + a\_{k3}x\_3 + ...+ a\_{{k(n-1)}}x\_{n-1} + a\_{kn}x\_n))^2 $$

The objective function would then be

$$min \sum\_{i=1}^ {n} \space c\_i x\_i \space + \alpha \space

(b\_k \space - min (b\_k, a\_{k1}x\_1 + a\_{k2}x\_2 + ...+ a\_{{k(n-1)}}x\_{n-1} + a\_{kn}x\_n))^2$$

* 1. **Complex Model**

Straight from the progress report

The objective function would then be

$$min \sum\_{i=1}^ {n} \space c\_i x\_i \space + \alpha \space

(b\_k \space - min (b\_k, a\_{k1}x\_1 + a\_{k2}x\_2 + ...+ a\_{{k(n-1)}}x\_{n-1} + a\_{kn}x\_n))^2$$

$$

+ \alpha\_1 \space

(b\_{k+1} \space - min (b\_{k+1}, a\_{(k+1)1}x\_1 + a\_{(k+1)2}x\_2 + ...+

a\_{(k+1)(n-1)}x\_{n-1} + a\_{(k+1)n}x\_n))^2 $$

$$

+

\alpha\_2 \space

(b\_{k-1} \space - min (b\_{k-1}, a\_{(k-1)1}x\_1 + a\_{(k-1)2}x\_2 + ...+ a\_{(k-1)(n-1)}x\_{n-1} + a\_{(k-1)n}x\_n))^2 $$

REST straight from the progress report

1. **DATA**
2. **ALGORTHMS (need to provide a toy data and show how our models works in them)**
3. **CURRENT RESULTS**
4. **OBSTACLES ENCOUNTERED**
5. **QUESTIONS FOR FUTURE RESEARCH** (other than whats in the progress report, do you guys think we should consider another similar model, and compare this and our original models, if yes, I have another model already. Just thought we could put it here for a strong finish.)