Research Journal of Applied Sciences, Engineering and Technology 5(16): 4235-4239, 2013
DOI:10.19026/rjaset.5.4654
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: December 31, 2012 Accepted: January 17, 2013 Published: April 30, 2013

Research Article

The Best Lineup of Regiment Gymnastics Team 0-1 Programming Model Research and Application

Lu Liu and Feng Li

Institute of Physical Education, Huanggang Normal University, Huangzhou 438000, China

Abstract: Through the women's gymnastics team competition schedule regulation and known data analysis, reasonable lists the objective function and the constraint condition, in each of the player each individual score according to the most pessimistic and each individual score according to the mean value estimation of two cases, with the team total maximum as the goal, with constraint conditions, established to 0-1 integer planning as the core of the mathematical model, at last gives a very good under different circumstances of the line-up the best solution and to win, scoring foreground undertook comprehensive estimation. The model not only can well solve the optimal lineup problem of arrangement of athletes, but also extended to the lives of many aspects, has certain promotion value.

Keywords: Best Lineup, 0-1 plan model, regiment gymnastics

INTRODUCTION

On 2004 years in Athens, with his seven gold medals to China gymnastics team has become one of the most unsuccessful team. After returning China, the Chinese gymnastics team from the beginning of zero, Arouse one's all efforts to make the country prosperous. Work from the intravenous drip, small to each action and the details of life, to coach the adjustment of division of labor, as well as the analysis of each player's battlefield play situation, a comprehensive layout adjustment team lineup. Until 2006 October in Denmark Aarhus (Serpa, 2008), starting zero of Chinese Gymnastics got eight gold medals finally shocked the world. In two years, Chinese Gymnastics from "zero" to" eight" victory, with the strength to prove that Chinese gymnastics team is an excellent combat group. This is not accidental, but if not consider the situation, no arrangements for the lineup, the gymnastics team to play and win will be greatly affected, therefore, mastery of each player's score information, from reasonable lineup on team success crucial. For the optimal lineup problem research, many scholars at home and abroad in soccer, basketball and other sports items in the game strategy to conduct research, for gymnastics class project study is blank. This study through the survey group gymnastics competition background information, the Olympic and world gymnastics competition analysis, combined with the constraint conditions, the establishment of a 0-1 integer planning as the core of the mathematical model, at last gives a very good under different circumstances of the line-up the best solution and to win, scoring foreground undertook comprehensive estimation (Harwood, 2008).

THE BACKGROUND AND ASSUMPTIONS OF MODEL

Regiment gymnastics competition is composed of four items (Uneven Bars, balance beam, Vault, floor exercise) composition, schedule: each team allowed ten athletes, each item can have 6 players in. Each player entry results score from high to low: 10; 9.9; 9.8; ... 0.1 0. Each team's score is the total score and the player, most of the team as the winner. In addition, also are provided for each player can only participate in the triathlon (four participants) and single game which is one of two categories in the individual competition, each athlete not only participates in three individual. Each team should have four people take part in the triathlon; the remaining players participate in the individual competition. Now a team coach to have led the ten athletes to participate in various projects of the results of a large number of tests, the coach discovers each athlete in each event results was stable in four score (Table 1), they get the corresponding results probability also by statistics (Table 2). Try to answer the following questions:

- Each player each individual score according to the most pessimistic estimates, based on this premise, requests for the team from a lineup, the team scores as high as possible; each player each individual

Corresponding Author: Lu Liu, Institute of Physical Education, Huanggang Normal University, Huangzhou 438000, China

Table 1: The individual score each contestant most pessimistic results table

Athlete	1	2	3	4	5	6	7	8	9	10
Uneven bars 1	8.4	9.3	8.4	8.1	8.4	9.4	9.5	8.4	8.4	9
balance beam 2	8.4	8.4	8.1	8.7	9	8.7	8.4	8.8	8.4	8.1
Vault 3	9.1	8.4	8.4	9	8.3	8.5	8.3	8.7	8.4	8.2
floor exercise 4	8.7	8.9	9.5	8.4	9.4	8.4	8.4	8.2	9.3	9.1

Table 2: The individual scores for each contestant to mean estimation result table

Athlete	1	2	3	4	5	6	7	8	9	10
Uneven bars 1	9	9.6	9	9.1	9	9.7	9.8	9	9	9.4
Balance beam2	9	9	9.1	9.1	9.4	9.1	9	9.8	9.2	9.1
Vault 3	9.5	9	9	9.5	8.9	8.9	8.9	9.1	9	9.2
Floor exercise 4	9.1	9.3	9.8	9	9.7	9	9.2	9.3	9.7	9.5

score according to the mean imputation, under this premise, requests for the team from a play the lineup, the team scores as high as possible (Hardy and Gaynor, 1991).

- If the previous data and recent information obtained through analyzing: the championship team scores estimated to be not less than 236.2 points, the team in order to win to be discharged to lineup; how the score(expected value)foreground.

Hypothetical problem:

- All the contestants of the team to participate in at least one project
- All players in this game can play a normal level
- The team all the players, one player before and after two matches are grade without mutual interference
- Each player in different projects scoring obeys normal distribution

PROBLEM ANALYSIS

A team ten players has one and only four people took part in the triathlon, the remaining six participants assigned to each individual and this six people each to participate in individual cannot exceed three. Each project can not exceed a maximum of six people.

Aiming at the problem one, each player each individual score according to the most pessimistic about the situation, which is selected for each player in each item of the worst score as the game results and each player each individual score according to the mean value estimation of the two kinds of situations, which has given in each player project results entries, establishing the 0-1 programming model and how to arrange the game can make the whole team score the best (Karel, 1984).

Aiming at the problem two, in the women's gymnastics team competition, each player can only be in the prediction of the four results among them a kind of participate in the competition, the problem is transformed into how to select each player results as a squad, requirements of the lineup total score is greater than 236.2 and obtain all the overall scores higher than 236.2 points all the lineup and through the corresponding probability calculate the team in this match win probability much. In the competition each player in different results projects is the normal distribution assumption, in this case, use probability theory knowledge into solving the 0-1 programming model.

MODEL STABLISHMENT AND THE SOLUTION

Model establishment and solution for the problem one: According to each individual score at the most pessimistic estimate a model. In the all-around competition team has only four people, is $\sum_{i=1}^{10} X_i = 4$; each item can have up to six players, is:

$0 \le \sum_{i=1}^{10} X_{ij} \le 6$; in the individual competition not only in three individual, is: $0 \le \sum_{j}^{4} X_{ij} - 4b_i \le 3$;

With each player in each individual score according to the most pessimistic scenario (Table 1), the whole the team's total score:

$$S_1 = \sum_{i=1}^{10} \sum_{j=1}^{4} a_{ij} * X_{ij}$$

To sum up, the nonlinear model is as follows:
Object function max:

$$S_1 = \sum_{i=1}^{10} \sum_{j=1}^{4} a_{ij} * X_{ij} \tag{1}$$

$$s.t \begin{cases} \sum_{i=1}^{10} X_i = 4 \\ 0 \le \sum_{i=1}^{10} X_{ij} \le 6 \\ 0 \le \sum_{j=1}^{4} X_{ij} - 4b_i \le 3 \\ X_{ij} = 0 \ or \ 1 \\ b_i = 0 \ or \ 1 \end{cases}$$

i = 1, 2, 3, …, 10; j = 1, 2, 3 and 4

Each player's individual score according to the mean value estimation model is built below the circumstance. Each player's individual score according to the mean imputation, is selected for each contestant of all possible scenarios weighted mean as each contestant game scores (Table 2), design a lineup, the

Table 3: Different squad list

Each individual score according to the most pessimistic lineup						
Project	Uneven bars 1	Balance beam 2	Vault 3	Floor exercise 4	Triathlon	Optimal results
Athlete	7 10	4 8	1 4	3 10	2 5 6 9	212.3
Each individual score according to the mean time squad						
Project	Uneven bars 1	Balance beam 2	Vault 3	Floor exercise 4	Triathlon	Optimal results
Athlete	6 7	3 5	1 4	3 5	2 8 9 10	224.7

team parted to a maximum total. The constraint conditions and model (1) is the same, the nonlinear model is as follows:

Object function max:

$$S_2 = \sum_{i=1}^{10}\sum_{j-1}^{4} b_{ij} * x_{ij} \tag{2}$$

$$s.t \begin{cases} \sum_{i=1}^{10} b_i = 4 \\ 0 \le \sum_{i=1}^{10} X_{ij} \le 6 \\ 0 \le \sum_{j=1}^{4} X_{ij} - 4X_i \le 3 \\ X_{ij} = 0\ or\ 1 \\ b_i = 0 \text{ or } 1 \end{cases}$$

i = 1, 2, 3,…,10; j = 1, 2, 3 and 4

The mode of problem one's solution use the EXCEL table to the model (1) and (2) model solution, the obtained results in Table 3.

From Table 3, we can draw that each player in each individual score according to the most pessimistic scenario, 2, 5, 6, 9 players participated in the competition, 7, 10 players participated in the uneven bars, 4, 8 players participated in the balance beam, 1, 4 players participated in the vault, 3, 10 contestants participated in free gymnastics. With the lineup for the game, the team the best score of 212.3 points. Each player's individual score according to the mean estimates, 2, 8, 9, 10 runners participated in the competition, 6, 7 runners participated in the uneven bars, 3, 5 runners participated in the balance beam, 1, 4 contestants participated in horse vaulting, 3, 5 contestants participated in free gymnastics item mesh. With the line-up for the game, the team the best score of 224.7 points.

Model establishment and solution for the problem two: Build can make the team win model. According to the previous data and recent information obtained through analyzing: the championship team scores are estimated to be less than 236.2 min. For this competition can win the championship, the team in the match score not less than 236.2, establish the model of an all winners squad and forecast to the line-up for the match probability how big. In the known constraints, from different players in different projects four prediction results to select and can only choose a part of a team, make the competition overall score less than 236.2 points. Because each player four prediction results of different project selection and can only choose a situation, it has constraints as follow:

$$0 \le \sum_{i=1}^{4} A_i(k,j) \le 1,\ k=1,2,3,4\ \ i=1,2,3,\ \ldots,10$$

Each player in the individual can not exceed three, is:

$$0 \le \sum_{j=1}^{4}\sum_{k=1}^{4} A_i(k,j) - 4*b_i \le 3 \quad i=1,2,3,\ldots,10$$

With each team no more than 6 persons participated in the same project, is:

$$\sum_{i=1}^{10}\sum_{k=1}^{4} A_i(k,j) \le 6 j = 1,2,3,4$$

With each team participate in the competition; the number is four, there is: $\sum_{i=1}^{10} b_i = 4$; then the I player participants in the k score in the j project result for different players, the score is: $C_i(i, j) * A_i(i, j)$ different project four score and score probability (see Schedule) model as follows:

Object function Max:

$$W = \sum_{i=1}^{10}\left(\sum_{k=1}^{4}\sum_{j=4}^{4}\left\{C_i(k,j)*A_i(k,j)\right\}\right) \tag{3}$$

$$s.t \begin{cases} 0 \le \sum_{k=1}^{4} A_i(k,j) \le 1 \\ 0 \le \sum_{k=1}^{4}\sum_{j=1}^{4} A_i(k,j) - 4*b_i \le 3 \\ 0 \le \sum_{i=1}^{10}\sum_{k=1}^{4} A_i(k,j) \le 6 \\ \sum_{i=1}^{10} b_i = 4 \\ A_i(k,j) = 0 or 1 \\ b_i = 0 or 1 \end{cases}$$

k, j = 1, 2, 3, 4 i = 1, 2, 3, …, 10

Establish the model for 90% beat level. Because each player in the different project scores Yij obey normal distribution, according to the different players and the same players from different project match results are independent of each other, using the additive of, normal distribution get in the game the team's overall score:

$$W = \sum_{i=1}^{10}\sum_{k=1}^{4}\sum_{j=1}^{4}\left\{C_i(k,j) * A_i(k,j)\right\} = \sum_{i=1}^{10}\sum_{j=1}^{4} X_{ij} * Y_{ij}$$

Because, $\mu_{ij} = E(Y_{ij})$, so that in this competition the team scoring expectation value is:

$$E(W) = E\left(\sum_{i=1}^{10}\sum_{j=1}^{4} X_{ij} * Y_{ij}\right) = \sum_{i=1}^{10}\sum_{j=1}^{4} X_{ij} * \mu_{ij}$$

Standard deviation is:

$$S(W) = \sum_{i=1}^{10}\sum_{j=1}^{4} X_{ij} * S_{ij}$$

The use of probabilistic knowledge, using the sample variance $S(W) * S(W)$estimate the overall variance $Var(W)$, there is:

$$Var(W) = S(W) * S(W)$$

So that the entire team in this game is scored with a mean $E(W)$, variance $Var(W)$ of normal distribution. u for the team in this game is 90% sure defeat level opponent, there is:

$$P\{W > U\} \geq 0.9$$

Standardization of the equation is:

$$P\left\{\frac{W - E(W)}{S(W)} > \frac{u - E(W)}{S(W)}\right\} \geq 0.9$$

By the nature of normal distribution by 1 - ∅ (u – E (W)/S(W)) ≥ 0.9, we can got that, ∅ (u – E (W)-u/S(W)) ≥ 0.9,checking the normal distribution table shows, ∅ (1.28) $_{= 0.9}$. So

$$\frac{E(W) - u}{S(W)} \geq 1.28$$,

That is u≤E(W) – 1.28 * S(W), now set to maximum value as the goal of the 0-1 programming model as follow:
Object function max:

$$E(W) - 1.28 * S(W) = \sum_{i=1}^{10}\sum_{j=1}^{4} X_{ij} * \mu_{ij} - 1.28 * \sum_{i=1}^{10}\sum_{j=1}^{4} X_{ij} * S_{ij} \quad (4)$$

$$s.t\begin{cases} \sum_{i=1}^{10} X_i = 4 \\ 0 \leq \sum_{i=1}^{10} X_{ij} \leq 6 \\ 0 \leq \sum_{j=1}^{4} X_{ij} - 4b_i \leq 3 \\ X_{ij} = 0 \text{ or } 1 \\ b_i = 0 \text{ or } 1 \end{cases}$$

The solution of problem two's model, aiming at the solution of the model can make the team won the model, from the EXCEL table to calculate model (3) of the results (Table 3) can be known, each contestant's performance are selected in the prediction results in the maximum results, of which 1, 4, 8, 9 runners participated in the decathlon, 3, 7 runners participated in the uneven bars, 6, 7 runners participated in the balance beam, 2, 10 contestants participated in horse vaulting, 3, 5 contestants participated in free gymnastics. With the line-up for the game, the team gets the optimal result is 236.4 points, if the game can get the scores, then have the opportunity to win the championship. From the known conditions, each players score. The order from high to low: 10, 9.9, 9.8, ... , 0.1, the difference is 0.1, the team has a total of 3 to 236.4236.3236.2 score won the championship. In order

Table 4: The team lineup of the score was 136.4

Event	Uneven bars 1	Balance beam 2	Vault 3	Floor exercise 4	Triathlon	Optimal results
Athlete	3 7	6 7	2 10	3 5	1 4 8 9	236.4

Table 5: The team score was 136.4 lineups of results and probability table

Uneven Bars 1		balance beam 2		Vault 3		Floor exercise 4	
Results	Probability	Results	Probability	Results	Probability	Results	Probability
9.4	0.1	10	0.1	9.8	0.2	9.9	0.1
--	--	--	--	10	0.1	--	--
10	0.1	--	--	--	--	10	0.2
9.5	0.1	9.9	0.1	9.7	0.3	10	0.1
--	--	--	--	--	--	9.9	0.2
--	--	9.9	0.1	--	--	--	--
10	0.2	10	0.1	--	--	--	--
10	0.1	10	0.4	9.9	0.1	9.8	0.1
9.4	0.1	9.8	0.2	10	0.1	9.9	0.3
--	--	--	--	9.6	0.1	--	--

"- " indicates no data

Table 6: Different player event mean value table

Uneven Bars	0.56	0.14	2.6	1.2	0.56	0.14	0.14	1.4	0.56	0.29
balance beam	1.4	0.56	1.2	0.84	0.29	0.84	1.4	1.4	1.16	1.2
Vault	0.29	1.4	0.56	0.3	0.56	0.24	0.56	0.84	1.4	1.2
Floor exercise	0.84	0.29	0.14	1.4	0.14	0.56	1.16	1.5	0.24	0.29

Table 7: Different player event variance

Athlete	Uneven bars 1	Balance beam 2	Vault 3	Floor exercise 4
1	0.1400	0.3500	0.0725	0.2100
2	0.0350	0.1400	0.3500	0.0725
3	0.6500	0.3000	0.1400	0.0350
4	0.3000	0.2100	0.0750	0.3500
5	0.1400	0.0725	0.1400	0.0350
6	0.0350	0.2100	0.0600	0.1400
7	0.0350	0.3500	0.1400	0.2900
8	0.3500	0.3500	0.2100	0.3750
9	0.1400	0.2900	0.3500	0.0600
10	0.0725	0.3000	0.3000	0.0725

to find out the three score lineup, as long as the model (3) constraints on a constant basis, the objective function is modified Y = 263.2 and Y = 263.2 then conducted operations, operations were no solution. Therefore, in order to win the championship, the team in the competition with 236.4 points in only this kind of situation can win the championship. But in this lineup played has very little to crown probability, the probability for2.88×10^{-36}. In 236.4 won the lineup in Table 4, achievement and probability in Table 5.

Aiming at solving the 90% beat level model, using the model (4), with mean Table 6 and 7 and 90% of the can beat a level of 219.9 points.

CONCLUSION

Advantages: The model of the complex squad selection problem, using 0-1 integer programming model, simplify the problem into optimization problem. At the same time using probability on the estimation problem and optimization model to combine, calculation is simple, clear, easily to understand.

Defect: Each player in different projects in the results obeys normal distribution is based on the reality of bold hypothesis, without using computer simulation and determine whether the normal distribution test. The four models is the use of 0-1 programming model, although simple, but relatively monotonous.

The promotion of the model: The model not only can well solve the optimal lineup problem of athletes, but also extended to life many aspects. For example production personnel arrangement, securities, stock investment, the model can easily solve many of life for the selection problem of permutation and combination. In real life are required for optimal arrangement is not limited to the ten, the ten becomes n people; the model can also be used.

SIGN AGREEMENT

- i, j, k : i respect player, j respect event , k respect the same player with a different scoring in the same project
- x_{ij} : {1, the I player participated in the j project{0.the t plaer don,t participated in the j project
- b_i : {1.the I player take part in the all-around competition {0.the t plaer don,t participated in the all- competition
- a_{ij} : Players at the most pessimistic estimates of the individual scores, the i players to participate in the j project result
- S_1 : Players at the most pessimistic estimates of the individual scores, the team's best score
- b_{ij} : Player individual score according to estimates, the i players to participate in the j project result
- S_2 : Player individual score according to estimates, the team's best score
- $A_i(k, j)$: {1, the I player participated in the j project{0.the t plaer don,t participated in the j project
- $P_i(k,j)$: The i player with k score in j project probability
- $C_i(k,j)$: The i player with k score in j project's score
- Y_{ij} : The i player with k score in j project of random variables
- W : The team, score of the tournament
- μ_{ij} : The i player with k score in j project expectations
- S_{ij} : The i player with k score in j project standard deviation
- u : The tournament in 90% defeating an opponent scoring

REFERENCES

Hardy, L. and P. Gaynor, 1991. Catastrophe model of anxiety conceptual andperformance. British J. Psychl., 28(2): 129-256.

Harwood, C.G., 2008. Developmental consulting in a professional football academy: The 5C's coaching efficacy program. Sports Psychol., 22(1): 109-133.

Karel, V., 1984. The International Dimensions of Human Rights. Greenwood Press, Westport, Conn, pp: 755, ISBN: 0313233942.

Serpa, S., 2008. Olympic Games and Sport Psychology. Fitness Information Technology, Retrieved from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2267321/.