# Scheduling Program of the Track and Field Sports Competition Based on R_Timetable Algorithm

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***Abstract*—The characteristics and several common open questions of the scheduling program in the track and field sports competition are analyzed in this paper, and then an automation method based on R-timetable algorithm, which is achieved effectively through the C++ program design, is provided to solve the corresponding problems. It has been found that the method in this paper immensely optimizes the organization, and perfectly improves the efficiency of arrangement of the sports competition.**

***Index Terms*—R-timetable, Track and Field Sports Competition, Scheduling program, Algorithm.**

## I. Introduction

Competition schedule is very important. It determines whether the whole competition can carry out smoothly, since it shows all the arrangements for all of the athletes to compete in a contest, also for the judges to work and for the audiences to watch. Thus arranging the agenda is definitely complicated and difficult, The reasons lists showing as following.

Firstly arranging the competition schedule is a sort of problems which belongs to the time planning program or belongs to kind of NP problems, and the deterministic algorithm for solving this kind of problems has not yet been achieved till now.

Secondly the principally key part of arranging the competition schedule is to ascertain the best permutation, and it's generally a huge number of permutation for all of the items. Taking 10 items for example, the number of permutation is 3,628,800.

Lastly due to the influence of a number of factors, which are related to each other and meanwhile restricted or impacted mutually, for instance, javelin item and shot item cannot be arranged at the same period, 3,000-meter item and 5,000-meter item cannot be conducted on the same day, etc. We are still looking forward to finding out one of the best way to arrange the competition schedule.

At present, there are still a series of typical problems against the arrangement of sports competition schedule, mainly showing as follow.

Firstly the schedule of the school sports competition is usually worked out just by simple hand working, so it's common to make mistakes with inefficiency.

Secondly the arrangement of competition schedule mostly bases on the past experiences, instead of carrying out according to the logical scientific theory.

Lastly there are only a few methods up to now, such as cut-and-try method, genetic algorithm[1], search method[2] etc, which are studied and applied to arrange the sports competition schedule. Although all these methods can speed the arrangements effectively, it's hard to ensure the approving results as well.

In view of the above-mentioned facts, an automation method based on R-timetable algorithm is given to optimize the organization and improve the efficiency of arrangement of the sports competition in this paper.

## II. Focused Background

There are a series of particular characteristics of the track and field sports competition holding in the colleges or universities compared with other significant official sports competitions[3-7],showing as following.

Firstly, at present for many contemporary colleges and universities, there are usually at least two playgrounds can be used for athletic fields, thus track competition and field competition can be arranged at the same periods but

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the different sports grounds. Consequently arrangements for sports competition can be carried out easily just by considering the conflicts of concurrently items.

Secondly, there are just three days by a definite date of the school sports competition, and the concurrently items are seldom regular ways since all of the athletes are students or teachers but not the professional athletes, thus they join the different items just according their hobbies.

Thirdly, school sports competitions commonly include many different kinds of groups, such as man and women items groups of students, man and women items groups of young teachers, men and women items groups of middle age teachers, men and women items groups of senior age teachers.

Lastly, it's flexible for arranging the agenda of school sports competition compared with the professional sports competitions. According to the actually special situation, there are some recreational items for senior age teachers arranged during the common items, such as the games of upland fishing, carrying things run.

Therefore, the principle of arrangement for the school sports competition is trying to avoid the clashes of the concurrently items since it's really complicated because of much more different groups and special items. By considering the R-timetable algorithm method is one of the most effective way to solve time planning problems, the agenda arrangement is carried out by the R-timetable automation algorithm in this paper.

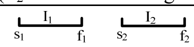
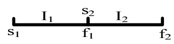
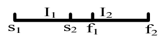
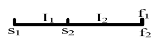
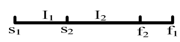
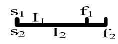
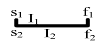
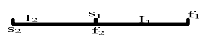
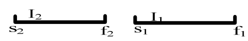
## III. R_TIMETABLE ALGORITHM

### A. Temporal Matrix of Relation

For a random event, let the starting time be si, and the finishing time be fi ($s_i$<$f_i$), define the time interval of the event as [$s_i$, $f_i$], denoted by $I_i$. Then the relations between any two random events can be shown by corresponding time intervals of each other.

For the random event $I_1$ and another random event $I_2$, the two time intervals of these two random events should be denoted as $I_1(s_1,f_1)$ and $I_2(s_2,f_2)$ respectively, then there are 13 different time intervals for all of possible relations between these two events $I_1$ and $I_2$ , showing as the following table 1.

TABLE 1:
THE 13 DIFFERENT TIME INTERVALS FOR ALL POSSIBILITIES BETWEEN THE TWO EVENTS $I_1$ AND $I_2$

| The relation between $I_1$ and $I_2$ | number | Symbolic representation | The relation between $s_i$ and $f_i$ (for i=1,2) | sketch map of the time intervals ( $I_2$ remains unchanged) |
|---|---|---|---|---|
| before | 1 | < | $s_1<f_1<s_2<f_2$ |  |
| meet | 2 | *m* | $s_1<f_1=s_2<f_2$ |  |
| overlap | 3 | *o* | $s_1< s_2< f_1<f_2$ |  |
| finished by | 4 | fi | $s_1< s_2< f_1=f_2$ |  |
| contains | 5 | di | $s_1< s_2< f_2<f_1$ |  |
| started by | 6 | si | $s_1= s_2< f_2<f_1$ |  |
| start | 7 | s | $s_1= s_2< f_1 < f_2$ |  |
| equal | 8 | = | $s_1= s_2< f_1 =f_2$ |  |
| during | 9 | d | $s_2<s_1< f_1<f_2$ |  |
| finish | 10 | f | $s_2<s_1< f_1=f_2$ |  |
| overlaped by | 11 | oi | $s_2<s_1< f_2<f_1$ |  |
| meet by | 12 | mi | $s_2< f_2=s_1< f_1$ |  |
| after | 13 | > | $s_2< f_2<s_1< f_1$ |  |

In the rectangular coordinate system, the ordered pair, such as ($s_i$, $f_i$), can be denoted by a point. Then the time intervals of the events including all possibilities can be represented by coordinate points in the plane. There are 5 cases among $s_1$and $I_2$, which are $s_1<s_2$, $s_1=s_2$, $s_2<s_1<f_2$, $s_1=f_2$, $s_1>f_2$. Similarly, there are 5 cases among $f_1$ and $I_2$.which are $f_1<s_2$, $f_1=s_2$, $s_2<f_1<f_2$, $f_1=f_2$, $f_1>f_2$. Number 1, 2, 3, 4, 5 represent the corresponding intervals or points (-∞, $s_2$), [$s_2$], ($s_2$, $f_2$), [$f_2$], ($f_2$, +∞) respectively, thus the figural relations between $I_1$ and $I_2$ show as figure 1.

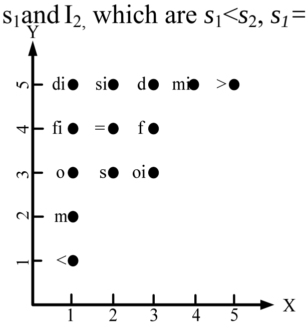



Figure 1. Figural relations between $I_1$ and $I_2$

Moving forward to follow the same method, assume that $X_1$={-1,0,1} and number -1, 0, 1 represent intervals or points of (-∞, $s_2$), [$s_2$], ($s_2$, +∞) respectively.

Similarly, let $X_2$={-1,0,1} and number -1,0,1 represent the intervals or points of (-∞, $f_2$), [$f_2$],($f_2$,+ ∞) respectively, Using number 1, 2, 3, 4, 5 to represent the subsets of the product space among $X_1$ and $X_2$, then $X$ can be expressed as the subset of the space domain $X_1 \times X_2$, showing as the following figure 2.

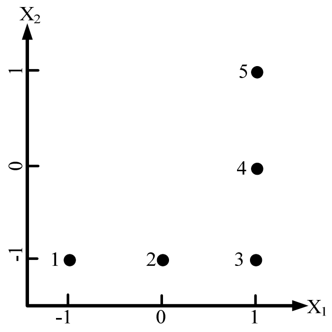



Figure 2. Subset of the product space $X_1 \times X_2$

In the same way, let $Y_1$={-1, 0, 1} and the number -1, 0, 1 represent the intervals or points of $(-\infty, s_2)$, $[s_2]$, $(s_2, +\infty)$ respectively; Similarly, let $Y_2$={-1, 0, 1} and the number -1,0,1 represent the intervals or points $(-\infty, f_2)$, $[f_2]$, $(f_2, +\infty)$ respectively, then *Y* can be expressed as the subset of the space domain $Y_1 \times Y_2$.

Supposing that if *R*(1, 2) is the simple-ingredient time relational constraints [8] between $I_1$ and $I_2$, then *R*(1, 2) can also be denoted by using a 2×2 matrix. For example, if $R(1,2)=\{<\}=(1)\times(1)=((-1)\times(-1))\times((-1)\times(-1))$,then it can be expressed as a matrix

$$\begin{pmatrix} -1 & -1 \\ -1 & -1 \end{pmatrix}.$$

In general, supposing that if the set of events is$\{(i, I_i), i=1, 2, 3, \ldots, n\}$ and the time interval $I_i$ is $(s_i, f_i)$ for any random event *i*(*i*=1, 2, 3, … n),then for any two random events $I_i$ and $I_j$, the time interval relational constraints between them should be

$$R(i,j)=(A_1(i,j) \times A_2(i,j)) \times (B_1(i,j) \times B_2(i,j)),$$

since $A_1$、$A_2$、$B_1$、$B_2$ are the subsets of the set{-1, 0, 1}, the corresponding matrix should be

$$M(i,j)=\begin{pmatrix} A_1(i,j) & A_2(i,j) \\ B_1(i,j) & B_2(i,j) \end{pmatrix}, \quad i \neq j,$$

especially when *i=j* we get

$$M(i, i)=\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}.$$

The matrix

$$M=\begin{pmatrix} M(1,1) & M(1,2) & \cdots & M(1,n) \\ M(2,1) & M(2,2) & \cdots & M(2,n) \\ \vdots & \vdots & \vdots & \vdots \\ M(n,1) & M(n,2) & \cdots & M(n,n) \end{pmatrix}$$

is called the corresponding relational matrix of {*R*(*i, j*)}, or time matrix of relation for short, and $M(j, i)=-M(i, j)^T$. It contains $n^2$ 2×2 matrices, in other words, it's a matrix of $2n \times 2n$ and any element can be written in the form of M (i, j) $i,j=1,2,\ldots,2n$.

### *B. Description of the Algorithm*

*a. Data structure*

The main data structure in the R-timetable algorithm includes structure types, set types and array types. All of the specific details show as following.

The 1-dimension structure types data for saving the time intervals *p*[*i*] and $x_1$ and $x_2$, the relations between them showing in the figure 1 and figure 2, and the data of storage listing in the following table 2 and table 3.

TABLE 2:
THE ELEMENTS OF ARRAY *p*

| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| p[i].x | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 5 |
| p[i].y | 1 | 2 | 3 | 4 | 5 | 5 | 3 | 4 | 3 | 4 | 5 | 5 | 5 |

TABLE 3:
THE ELEMENTS OF ARRAY $X_1$ AND $X_2$

| i | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| x1x2[i].x | −1 | 0 | 1 | 1 | 1 |
| x1x2[i].y | −1 | −1 | −1 | 0 | 1 |

*R* is the 2-dimension integral types array for storing the data of time intervals. For the specific event sets *E*, pick up any random element event *i* and another element event $j(j \in E-\{i\})$, the relation of the event *i* and *j* are stored in the 2-dimension integral types array *R*(*i, j*), which should be denoted as

$R(i, j) \subset \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13\}$.

Substitute the corresponding value for example, it can be $R(1, 2)=\{1, 2\}$, $R(1, 3)=\{1\}$, $R(2, 3)=\{13\}$.

*M* is the 2-dimension integral array for storing the data of time matrix of relation.

*HJ* is the set of the corresponding line numbers related to the temporal matrix of relation M.

*e* is the line number of the corresponding non-positive row vector.

*S* keeps the records of consistent subsets of *e* in the 1-demension integral array.

*b. Design of the algorithm*

Assume that there are *n* random events, then the steps of the algorithm show as following.

Step 1, Input temporal matrix of relation M and the set of the corresponding line numbers *HJ*(M).

Step 2, Let S=Φ.

Step 3, If *HJ* (M)=Φ, then output *S*, since *S* is the permutation number of the events, which can meet the conditions of time relational constraints, the program ends. If not, move on to the step 4.

Step 4, If M has non-positive row vectors, then $e_i$ (starting from *i*=1) represents the set of the line numbers for these row vectors, and move on to step 5. If not, the program ends.

Step 5, Work out the compatible subset of $e_i$, denoted by $d_i$, move on to step 6. If not, the program ends.

Step 5-1, Let $e_i=\{x_1, x_2, \ldots, x_m\}$, $j=1$;

Step 5-2, If $j \geq m+1$, the program ends. Otherwise, let $L_0=\{x_j\}$, $L_1=\{y \mid m(x_j, y)=\{0,1\} \text{ or } =\{0\}, y \in HJ(M)\}$,

Generally,

$L_{k+1}=\{y|\exists\, x\in L_k, m(x,y)=\{0,1\} \text{or} =\{0\}, y\in HJ(M)\}$.

Step 5-3,

$L(x_j)=\bigcup_k L_k$ .For $\forall z\in HJ(M)$,

$$\bigcap_{y\in L(x_j)} m(y,z)\neq\Phi \text{ and } \neq\{1\}.$$

Then let $d_i=L(x_j)$, and $d_i$ is the compatible subset of $e_i$ including $x_j$, if it's done, move on to step 6. If not, move back to step 5-1 for *j*++.

Step 6, Delete all of the row elements and the column elements related to $d_i$ from the matrix M, then we'll get the corresponding sub matrix $M_i$.

Step 7, Adding all of the elements of $d_i$ to *S*, giving M the value again with $M_i$ for *i*++, move back to step 3.

Note: Non-positive row vectors, which are denoted by $(a_{i1},a_{i2},\ldots,a_{i2n})$, for $a_{ij}=\min\{t|t\in m(i,j)\}(j=1,2,\ldots,2n)$, and $a_{ij}\leq 0$.

## IV. CASE STUDY OF ARRANGING THE COMPETITION SCHEDULE

### A. Set Up Temporal Matrix of Relation

*a. Elementary principles for arranging the schedule*

1) Short distance sport items first, and then the long distance ones.

2) Preliminary contest first, and then finals.

3) Track first, and then the field events.

4) Spacing interval during the same sport events should be reasonable to make sure athletes have enough time to rest or get ready for next item[9-10].

5) Try to arrange attractive or interesting items and the others alternately.

6) Minimize the clashes in a possible way according to the situation of the multiple occupied athletes, and try to prolong the time span among any items if simultaneous entries happen.

One of the effective way to minimize the clashes of the multiple occupations is to interlude items and hold the concurrently item in the different time spans, which is the precedence essentially related to each of the time interval of sport events.

According to the statistical data of the entry form list, for the items of Men's 100-meter and Men's 400-meter, Women's 100-meter and Women's 200-meter, athletes usually take part in the items at the same time. In order to leave enough time for the multiple occupied athletes to rest, the schedule can be arranged as following way

Men's 100-meter→Women's 100-meter→Men's 400-meter→Women's 200-meter.

The contradistinctive nexus among the four items can be shown as the following table 4.

TABLE 4.
THE TIME INTERVALS OF CONCURRENTLY ITEMS

| | Men's 100-meter | Men's 400-meter | Women's 100-meter | Women's 200-meter |
|---|---|---|---|---|
| Men's 100-meter | = | < | < | < |
| Men's 400-meter | | = | > | < |
| Women's 100-meter | | | = | < |
| Women's 200-meter | | | | = |

From the above table, we know that Men's 100-meter < Men's 400-meter, which means that the item of Men's 100-meter is arranged prior to Men's 400-meter. In the same way, Men's 400-meter > Women's 100-meter means that the item of Men's 400-meter is arranged behind the item of Women's 100-meter. Consequently, the clash of concurrent items is removed in a perfect way by putting the item Women's 100-meter in the item Men's 100-meter and Men's 400-meter.

*b. Case study of the competition schedule*

Taking the agenda of the 17th track and field sports competition of Nanyang Institute of Technology for the example, we worked out one of the best scheme of the competition schedule. Preliminary contests and finals of the typical items in the track items and field items were principally researched in what follows.

Typical items mentioned above include Men's 100 meter , Men's 400-meter , Men's 3000-meter ,Women's 100-meter , Women's 400-meter , Women's 3000-meter , Men's shot-put , Women's shot-put , Men's long jump, Women's long jump. Now regard all of these items as individual events and put them in order, the opening and closing ceremony both are ordered in the serial number. There are 18 events in total, showing as follow table 5.

TABLE 5.
SPORTS EVENT AND SERIAL NUMBER

| Serial number | Sports event |
|---|---|
| 1 | Men's 100-meter preliminary |
| 2 | Women's 100-meter preliminary |
| 3 | Men's 400-meter preliminary |
| 4 | Women's 400-meter preliminary |
| 5 | Men's 3000-meter final |
| 6 | Women's 3000-meter final |
| 7 | Men's 100-meter final |
| 8 | Women's 100-meter final |
| 9 | Men's 400-meter final |
| 10 | Women's 400-meter final |
| 11 | Men's shot-put qualifying round |
| 12 | Women's shot-put qualifying round |
| 13 | Men's long jump qualifying round |
| 14 | Women's long jump qualifying round |
| 15 | Men's long jump final |
| 16 | Women's long jump final |
| 17 | Opening ceremony |

According to the principle of the arrangement for the school competition schedule, all of the time intervals co-relations of eighteen events mentioned above show as following table 6.

TABLE 6.

CO-RELATIONS OF 18 EVENTS' TIME INTERVAL

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | = | m | < | < | < | < | < | < | < | < | s | < | < | < | < | < | > | < |
| 2 | | = | < | < | < | < | < | < | < | < | d | < | < | < | < | < | > | < |
| 3 | | | = | m | < | < | < | < | < | < | > | < | s | < | < | < | > | < |
| 4 | | | | = | < | < | < | < | < | < | > | < | d | < | < | < | > | < |
| 5 | | | | | = | m | > | > | < | < | > | > | > | s | < | < | > | < |
| 6 | | | | | | = | > | > | < | < | > | > | > | > | s | < | > | < |
| 7 | | | | | | | = | m | < | < | > | s | > | < | < | < | > | < |
| 8 | | | | | | | | = | < | < | > | d | > | < | < | < | > | < |
| 9 | | | | | | | | | = | m | > | > | > | > | s | < | > | < |
| 10 | | | | | | | | | | = | > | > | > | > | > | < | > | < |
| 11 | | | | | | | | | | | = | < | < | < | < | < | > | < |
| 12 | | | | | | | | | | | | = | > | < | < | < | > | < |
| 13 | | | | | | | | | | | | | = | < | < | < | > | < |
| 14 | | | | | | | | | | | | | | = | < | < | > | < |
| 15 | | | | | | | | | | | | | | | = | < | > | < |
| 16 | | | | | | | | | | | | | | | | = | > | < |
| 17 | | | | | | | | | | | | | | | | | = | < |
| 18 | | | | | | | | | | | | | | | | | | = |

Obtain the temporal matrix of relation according to the time interval co-relations of 18 events as following figure 3.

```
0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1
1, 0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1
1, 1, 0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1
1, 1, 1, 0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1
1, 1, 1, 1, 0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1, 0,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1
1, 1, 1, 1, 1, 0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1, 1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1
1, 1, 1, 1, 1, 1, 0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1, 1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1
1, 1, 1, 1, 1, 1, 1, 0,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1, 1,-1,-1,-1,-1,-1,-1,-1, 1, 1,-1,-1
1, 1, 1, 1, 1, 1, 1, 1, 0,-1,-1,-1, 1, 1, 1, 1,-1,-1,-1,-1, 1, 1, 1, 1, 1, 1, 0,-1,-1,-1,-1,-1, 1, 1,-1,-1
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1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,-1, 1, 1, 1, 1,-1,-1,-1,-1, 1, 1, 1, 1, 1, 1, 1, 1, 0,-1,-1,-1, 1, 1,-1,-1
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Figure 3 ： Temporal matrix of relation of case study

## *B. Consequence and Analysis of the Case Study Arrangement*

*a. Consequence of case study*

According to the temporal matrix of relation, run the program based on R_time table algorithm, we can obtain the data as following:

$e_1=\{33\},d_1=\{33\},e_2=\{34\},d_2=\{34\},e_3=\{1,21\},$ $d_3=\{1,21\},e_4=\{2\},d_4=\{2\},e_5=\{3\},d_5=\{3\},e_6=\{4\},d_6=\{4\},e_7=\{22\},d_7=\{22\},e_8=\{5,25\},d_8=\{5,25\},e_9=\{6\},d_9=\{6\},e_{10}=\{7\},d_{10}=\{7\},e_{11}=\{8\},d_{11}=\{8\},e_{12}=\{26\},d_{12}=\{26\},e_{13}=\{13,23\},d_{13}=\{13,23\},$
$e_{14}=\{14\},d_{14}=\{14\},e_{15}=\{15\},d_{15}=\{15\},e_{16}=\{16\},$

$d_{16}=\{16\},e_{17}=\{24\},d_{17}=\{24\},e_{18}=\{9,27\},d_{18}=\{9,27\},e_{19}=\{10\},d_{19}=\{10\},e_{20}=\{28\},d_{20}=\{28\},e_{21}=\{11,29\},d_{21}=\{11,29\},e_{22}=\{12\},d_{22}=\{12\},e_{23}=\{17\},d_{23}=\{17\},e_{24}=\{18\},d_{24}=\{18\},e_{25}=\{30\},d_{25}=\{30\},e_{26}=\{19\},d_{26}=\{19\},e_{27}=\{20\},d_{27}=\{20\},e_{28}=\{31\},d_{28}=\{31\},e_{29}=\{32\},d_{29}=\{32\},e_{30}=\{35\},d_{30}=\{35\},e_{31}=\{36\},d_{31}=\{36\}$

Then the corresponding R_time table should be:

(33,34,(1,21),2,3,4,22,(5,25),6,7,8,26,(13,23),14,15,16,24,(9,27),10,28,(11,29),12,17,18,30,19,20,31,32,35,36)

and the marshalling sequence of all these events shows as figure 4.

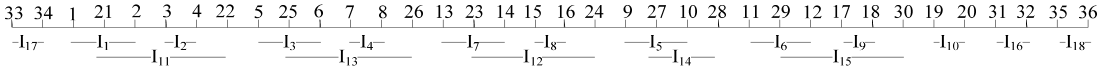


Figure 4：The marshalling sequence of the case study events

*b. Analysis of case study resolution*

According to the above conclusion data, the whole procedure should be: Opening ceremony first.

For track items, the sequence should be:

Men's 100-meter preliminary→Women's 100-meter preliminary→Men's 400-meter preliminary→Women's 400-meter preliminary item →Men's 100-meter final item→ Women's 100-meter final→Men's 3000-meter final→ Women's 3000-meter final→Men's 400-meter final→Women's 400-meter final;

For field events, the sequence should be:

Men's shot-put qualifying round→Men's long jump qualifying round item →Women's shot-put qualifying round→Women's long jump qualifying round→Men's long jump final→Women's long jump final.

For interlude items, the sequence should be:

Men's shot-put qualifying round item should start while Men's 100-meter preliminary item is being in play, Men's long jump qualifying round item should start while Men's 400-meter preliminary item is being in play, Women's shot-put qualifying round item should start while Men's 100-meter final item is being in play, Men's long jump qualifying round item should start while Men's 3000-meter final item is being in play, Men's long jump final item should start while Women's 3000-meter final item is being in play, Women's long jump final item should start after Women's 3000-meter final item ends.

This agenda is highly logical and rigorously scientific by following almost all of the elementary principles of arrangement and taking account of the other factors, such as, consider to collocate the short distance items and the long distance ones, combine the preliminary contests and the finals, intersect the track and the field events, of course leave the reasonable spacing interval during the same sport events so that athletes have enough time to rest or get ready for next item, and also arrange attractive or interesting items and the others alternately, etc.

## V. CONCLUSION

This paper provides an automation method based on R-timetable algorithm, which is achieved effectively through the C++ program design, since it's proved to be logically feasible, according to the characteristics and several common questions of the scheduling program in the track and field sports competition.

The data of experimental results indicate that the method contributes many merits and advantages with respect to many common and typical problems, mainly show as follows:

First, the method optimizes the assembly of programs perfectly, including less clashes of merged programs, reasonable interludes of attractive programs, etc.

Second, it also remarkably increases the efficiency, makes the arrangement easier and more concise than before.

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