Suggestions on How to Improve the Medal Table Presented With Respect to Major International Sport Events

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Abstract

The common measure of national success with respect to major multiple-event sport competitions or championships are currently, we believe, not generally accepted as being fair and interesting.

In this text several suggested improvements to the current analyzing procedure are made. If implemented, they may and should lead to an increased level of public acceptance of such tables as being produced under the property of fairness of ranking. Moreover, the outcome may lead to a greater interest in this measure as a proper event in itself. In total this could easily further increase the public interest in already celebrated major sport happenings.

Contents

1 Introduction

Associated with major international sport events, where the joint event consists of several individual subevents,[1] most oftenly there is a so called *medal table*, where the represented nationalities are ranked according to their athletes's performances during the complete or joint event of interest. Usually, and which also functions as our starting point, one bases this ranking solely on eventwise top 3-results, i.e. the sets of gold, silver and bronze medals, observed with respect to the nationalities of the participating athletes.[2] These sets of medals constitute the available data set in this initial setting of our discussion.

The usual or standard way of analyzing this data set is by ranking or sorting the nations according to the following prioritized[3] ranking rules: (i) The number of gold medals. (ii) The number of silver medals. (iii) The number of bronze medals. Next, we give a very recent example of this analyzing procedure.

Example 1 (19^{th} **European Athletics Championship).** *This event took place in Gothenburg, Sweden, during August 2006. A total of 29 nationalities managed to get at least one medal (of any of the three kinds described above). In Table 1 we display only the top 10-nations found using the above mentioned standard analyzing procedure.*

Below, in the remainder of the main part of this text we will sequentially discuss: (*Section 2*) Why to change this analyzing system of measuring national performance or success. (*Section 3*) Several suggestions on how to improve the existing analyzing system. (*Section 4*) The derived ranks with respect to the above example, and their discrepancies, when using both the standard and the new suggested and adjusted procedures. (*Section 5*) Some

[1] The most well-known example should be the *Olympic Summer Games*.

[2] In each subevent, a *gold* medal corresponds to a 1^{st} place, a *silver* medal corresponds to a 2^{nd} place and a *bronze* medal corresponds to a 3^{rd} place respectively.

[3] Formally, let us assume that we want to rank a set of items (nations in our case). A *prioritized* ranking system goes as follows. Rank the items according to the highest-level (first or primary) ranking rule. If some items are equally ranked, look at the consecutive-level (second or secondary) ranking rule and try to rank these, and only these, items according to this rule. If some items still have equal rank, then consider the third rule. If the number of ranking rules available is a finite number n and some items still are equally ranked after the n^{th} ranking rule, one cannot ranking-wise separate these items and has to consider them as *ties* and give them an equal ranking.

generalizations to this initial setting, i.e. how to possibly extend the basis for deriving a basic data set of performance information. (*Section 6*) Some final thoughts and motivations.

Note 1. *Strictly speaking this discussion does not necessarily restrict oneself to the area of sport events. The restriction is rather based on the way one defines a data set and how one chooses to analyze these data. The discussion is applicable to all events consisting of a number of subevents each ending up with a final results in the form of ranked performances.*

2 Why Change Measure of National Success? A Motivating Example.

The two core questions related to this text may be formulated as follows: Why bother to change the measure of national success? Haven't we already found a sufficiently simple and interesting measure of success that commonly appeals to the public taste? Our answers to these questions are, in order, *it may increase the public interest in this measure* and *no we haven't.*

The common measure of success is not, according to our appreciation, generally accepted as being fair and is not even considered to be particularily

Rank	Nation	Gold	Silver	Bronze
1	Russia	12	12	10
2	Germany	4	4	2
3	Belarus	4	3	2
4	France	4	1	3
5	Spain	3	3	5
6	Sweden	3	1	2
7	Belgium	3	0	0
8	Portugal	2	1	1
9	Italy	2	0	1
10	Great Britain	1	5	5

Table 1: Top 10-nations using the standard analyzing medal table-procedure with respect to the 19^{th} *European Athletics Championship* (Gothenburg, Sweden, 2006).

interesting. The problem with lack of fairness is that it is now working only as a straightforward summary measure instead of being an interesting measure that stimulate the public to discussions and excitement through appealing to (harmless, i.e. non-violent and positive) nation-based competitive feelings and emotions. To prove our point we will later on, in Table 2 of Example 2, illustrate the claimed lack of fairness through a small example.

Note 2. *This interpretation of fairness relates to an intuitive feeling of the measure of being fair in the sense of measuring what it is supposed to measure.*[4] *Obviously, there is formally nothing wrong with the contemporary measure. According to the rules that defines itself it produces a formally correct and, in this sense, fair result.*

Example 2. *Let us now consider a small artificial example involving only three nations called A, B and C. In Table 2 these countries are ranked according to the standard medal table-analyzing procedure. If the intention is to create a fair measure of national performance with respect to the event of interest, which we believe is a necessary condition for true public interest and appreciation, this table speaks for itself. It is, by no means, a fair measure in this respect.*[5]

Rank	Nation	Gold	Silver	Bronze
1	A	2	0	0
2	B	1	5	2
3	C	0	22	15

Table 2: A motivating artificial example considering the ranking of 3 nations according to the standard approach to analyzing medal tables.

[4]This is to be interpreted as working on an abstract level of public attitudes and understanding.

[5]If we would dare to speculate about corresponding public attitudes, we would suggest that the ranking in fact should be reversed.

3 Suggestions on How to Improve the Measure of National Success

It is easy to complain or get bothered by states-of-the-world, but harder to reach out and contribute to it in any substantial way. So don't we have any suggestions on how to change this paradigm-of-calculation that bothers us? In fact, we certainly have. It is now time to introduce some suggestions on how to improve the described unsatisfactory measure of national success.

All procedures below are based on so called *numerical weighting* of medals. Basically this means that to each type of medal is attached a specific numerical value. Then, for each country, the sum of these values over all corresponding medals is computed. Finally all these nation-scores are sorted.

Definition 1. *Let us introduce the following notation. An analyzing procedure is primarily described by the* ***(a,b,c)-weighting****. Here* ***a****,* ***b*** *and* ***c*** *correspond to the numerical scores associated with a gold, silver and bronze medal respectively. Moreover, we adopt the order principle that we only accept weighting procedures where,*

$$a > b > c,$$

which means that we sort the nation-scores according to the principle of ranking a higher score over a lower score. Further, this implies that we demand a gold medal to be of greater worth than a silver medal, which in turn always is more valuable than a bronze medal. This assumption should be close to obviously understood and agreed on.

3.1 Suggestion 1

Our first suggestion is a *(3,2,1)-weighting*. This means that the numerical distances between all consecutive or neighbouring medal types are constant and equal to 1.[6] More explicitly, this implies that two bronze medals are performance-wise equal to one silver medal and, moreover, that three silver medals equal two gold medals.

Example 3. *Looking at Table 1 one may compute Sweden's national score as* $(3 \cdot 3 + 1 \cdot 2 + 2 \cdot 1) = 13$.

[6] Using the notation from Definition 1, this corresponds to considering the differences $a - b$ and $b - c$, where $(a - b)=(b - c)=1$.

3.2 Suggestion 2

Our second suggestion is a *(4,2,1)-weighting*. This means that the score ratios between consecutive medal-types are constant and equal to 2.[7] In other words, two bronze medals are performance-wise equal to one silver medal and two silver medals equal one gold medal.

Example 4. *Looking at Table 1 one may compute Sweden's national score as* $(3 \cdot 4 + 1 \cdot 2 + 2 \cdot 1) = 16$.

3.3 Suggestion 3

Our third suggestion is a *(9,3,1)-weighting*. This means that the score ratios between consecutive medal-types are constant and equal to 3. In analogy with the preceding suggestion, three bronze medals are performance-wise equal to one silver medal and three silver medals equal one gold medal.

Example 5. *Looking at Table 1 one may compute Sweden's national score as* $(3 \cdot 9 + 1 \cdot 3 + 2 \cdot 1) = 32$.

3.4 Generalization

Suggestions 2-3 are special cases of a more general family of analyzing procedures. Consider the $(n^2, n, 1)$-*weighting*, where n stands for a numerical value greater than one $(n > 1)$.[8] To ease interpretations one should perhaps further restrict n to being an integer $(n \in \mathbb{Z})$,[9] although this is not formally necessary. Here the score ratios between consecutive medal-types are constant and equal to n. In this case n bronze medals are performance-wise equal to one silver medal and n silver medals equal one gold medal.

Example 6. *Looking at Table 1 one may compute Sweden's national score as* $(3 \cdot n^2 + 1 \cdot n + 2 \cdot 1) = 3n^2 + n + 2$.

[7] Using the notation from Definition 1, this corresponds to considering the ratios a/b and b/c, where $(a/b)=(b/c)=2$.

[8] Otherwise the condition in Definition 1 is not fulfilled.

[9] The symbol $\mathbb{Z}$ denotes the set of integers, i.e. $\mathbb{Z} = \{\ldots, -2, -1, 0, 1, 2, \ldots\}$.

4 Results

We will examplify our suggestions by implementing all three of them with respect to the top 10-nations[10] in the 19^{th} *European Athletics Championship* (Gothenburg, Sweden, 2006), i.e. the data previously shown in Table 1. Further, the results of these calculations are presented in Table 3-5.

Example 7. *Firstly, we compute the nation-scores with respect to the data in Table 1 using the Suggestion 1-procedure. The results are displayed in Table 3.*

Rank	Nation	Gold	Silver	Bronze	Score
1	Russia	12	12	10	70
2	Germany	4	4	2	22
3	Belarus	4	3	2	20
4	Spain	3	3	5	20
5	Great Britain	1	5	5	18
6	France	4	1	3	17
7	Sweden	3	1	2	13
8	Belgium	3	0	0	9
9	Portugal	2	1	1	9
10	Italy	2	0	1	7

Table 3: Top 10-nations in the 19^{th} *European Athletics Championship* (Gothenburg, Sweden, 2006), if using the analyzing procedure referred to as 'Suggestion 1' and outlined in Section 3.1.

Example 8. *Secondly, we compute the nation-scores with respect to the data in Table 1 using the Suggestion 2-procedure. The results are displayed in Table 4.*

Example 9. *Thirdly, we compute the nation-scores with respect to the data in Table 1 using the Suggestion 3-procedure. The results are displayed in Table 5.*

[10] If calculated using the standard analyzing procedure, see Table 1.

Rank	Nation	Gold	Silver	Bronze	Score
1	Russia	12	12	10	82
2	Germany	4	4	2	26
3	Belarus	4	3	2	24
4	Spain	3	3	5	23
5	France	4	1	3	21
6	Great Britain	1	5	5	19
7	Sweden	3	1	2	16
8	Belgium	3	0	0	12
9	Portugal	2	1	1	11
10	Italy	2	0	1	9

Table 4: Top 10-nations in the 19^{th} *European Athletics Championship* (Gothenburg, Sweden, 2006), if using the analyzing procedure referred to as 'Suggestion 2' and outlined in Section 3.2.

Rank	Nation	Gold	Silver	Bronze	Score
1	Russia	12	12	10	154
2	Germany	4	4	2	50
3	Belarus	4	3	2	47
4	France	4	1	3	42
5	Spain	3	3	5	41
6	Sweden	3	1	2	32
7	Great Britain	1	5	5	29
8	Belgium	3	0	0	27
9	Portugal	2	1	1	22
10	Italy	2	0	1	19

Table 5: Top 10-nations in the 19^{th} *European Athletics Championship* (Gothenburg, Sweden, 2006), if using the analyzing procedure referred to as 'Suggestion 3' and outlined in Section 3.3.

Note 3. *We implemented the suggested procedures, i.e. computed the corresponding nation-scores, for these 10 nations only. The remaining 19 medal-nations of which some, according to certain analyzing procedures, otherwise possibly would enter the adjusted top 10s were not included in the calculations.*

The ranking data displayed in Table 1 and Table 3-5 may be merged into an overall table of national rankings corresponding to our working example. This is achieved in Table 6.

Nation	Old	S1	S2	S3
Russia	1	1	1	1
Germany	2	2	2	2
Belarus	3	3	3	3
France	4	6	5	4
Spain	5	4	4	5
Sweden	6	7	7	6
Belgium	7	8	8	8
Portugal	8	9	9	9
Italy	9	10	10	10
Great Britain	10	5	6	7

Table 6: The rankings of the official, and our initial, top 10-nations with respect to the performance in the 19^{th} *European Athletics Championship* (Gothenburg, Sweden, 2006) according to usage of the four distinct outlined medal table-analyzing procedures above (Comment: Old=standard procedure; Si=i^{th} suggested adjusted procedure).

Note 4. *Sometimes, using only the above primary ranking schedules, it is impossible to decide on which of two nations should have the higher rank, which logically then should lead to shared ranks. This situation arises when several nations end up with the same final scores. To try to avoid such ranking-ties one usually decide on a secondary ranking system as well.*

Reasonable approaches are: (i) Favour, if possible, a greater number of gold medals or, if not possible i.e. if these numbers are equal, a greater number of silver medals. This mimics the structure of the standard primary approach. (ii) Favour a higher number on the total number of medals. In Table 3 we faced two instances of ties which were taken care of using (i). If instead, in

this case, using the procedure of (ii) both pair of rankings should have been interchanged.

Finally, if two countries end up with both exactly the same number and values of medals there is no way, without incorporating external information, to ranking-wise separate them. In this case one has to give them the same, preferably the higher choice of, ranking.

Note 5. *If letting $n \to \infty$ in the generalized method of Section 3.4 the suggested procedure will, in the limit, approach the standard original procedure.*[11] *This behaviour may be observable even in a small-scale example as in Table 6.*

4.1 Recommendations

At this point one may pause, perhaps relax, and ask: What measure do we suggest? Of course, there is no simple and definite answer to such a question, since the experience of fairness probably is of a quite subjective nature.

In spite of this drawback, we would say or estimate that both 'Suggestion 2' and 'Suggestion 3', or any other measure located close to or inbetween these procedures, might be good choices consistent with the public appreciation and understanding of fairness.

Note 6. *Here it may be appropriate to point out that the weighting-schedules discussed above are not entirely unambiguous or unique. In fact, infinitely many schedules fulfilling the criteria of Definition 1 structurally correspond to the same procedure. For instance, the (3,2,1)-weighting and (6,4,2)-weighting are performance-wise equivalent. More generally, if multiplying all weights with the same positive constant*[12] *one does not structurally produce a new weighting procedure, but rather one moves to a different instance of the same procedure. To make the formulation of weighting schedules unambiguous one might, for instance, set $c = 1$ in Definition 1, i.e. restrict oneself to (a,b,1)-weightings.*

[11] This sentence includes usage of the mathematical notion of *limit*. Vaguely speaking, in this case, this means that if constantly increasing n the procedure using $(n^2, n, 1)$-weighting and the standard procedure will infinitely give increasingly similar results.

[12] For the present example, we have, $(6, 4, 2) = 2 \cdot (3, 2, 1)$.

5 Generalizations

A further generalization of the above procedures would be to produce a basic data set constituting of the top 6, or even top 8, results from each subevent. This approach has the following advantages:

More results matter Avoids the current fixation of top 3-results, i.e. traditional medals. The public appreciation of top 4-6 (or top 4-8) results may increase and public interest in this measure rise.

Enlarged data set The basic data set is enlarged, which creates a more exciting and unpredictable measure. The fairness of the measure will thus furtherly increase.

Globality factor More countries will be included in this extended medal table. This leads to more, so to speak, local competitions with respect to the medal table. During the joint championship several nations may fight for and care about, for instance, a 10^{th} place in the table.

5.1 Generalized Suggestions

All suggested methods above may be generalized in this way. Below we will state these generalizations through three examples.

Example 10. *The weighting procedure of 'Suggestion 1' above may be generalized to include top 6/top 8 results in the following way:*

$$\begin{cases} \textit{Top 6-based:} & (6,5,4,3,2,1)\textit{-weighting,} \\ \textit{Top 8-based:} & (8,7,6,5,4,3,2,1)\textit{-weighting.} \end{cases}$$

Example 11. *The weighting procedure of 'Suggestion 2' above may be generalized to include top 6/top 8 results in the following way:*

$$\begin{cases} \textit{Top 6-based:} & (32,16,8,4,2,1)\textit{-weighting,} \\ \textit{Top 8-based:} & (128,64,32,16,8,4,2,1)\textit{-weighting.} \end{cases}$$

Example 12. *The weighting procedure of 'Suggestion 3' above may be generalized to include top 6/top 8 results in the following way:*

$$\begin{cases} \textit{Top 6-based:} & (243,81,27,9,3,1)\textit{-weighting,} \\ \textit{Top 8-based:} & (2187,729,243,81,27,9,3,1)\textit{-weighting.} \end{cases}$$

6 Concluding Discussion

We believe that our above discussions and illustrations are consistently convincing in argueing for the following conclusion: It would be favourable, or even intellectually unacceptable not to, change the procedure of how the medal tables are produced.

One possible objection to our suggestions could be: Is it not to abstract or complicated to produce medal tables in this way? Our answer is simply *no it isn't*. Certainly not if you compare it to some other existing and widely accepted procedures within the sport community, for instance, see Example 13 below. Our appreciation is that a very substantial amount of the human population is interested in and thrilled by complicated things,[13] conditioned on that they are not unreasonably complicated. The complexity is connected to unpredictability and stimulate to, among other things, creative discussions and positive emotions. Most likely the society needs more complexity, not less. It is certainly time to fight ignorance and shallowness back. Complexity to the people. Now!

Example 13 (Generally Accepted Complex Sport Procedures). *Here complexity refers to calculations that are complex (at least) on the level of our suggested procedures above. Consider: (i) The ranking system in tennis. (ii) The full season-based world cup result-lists in, for instance, alpine and cross country skiing. (iii) The procedures of judging performances in e.g. ski jumping and diving.*

[13] Most certainly the vast majority of the subpopulation that shows any interest whatsoever in things as medal tables.

A Related Links

The link to the home page of the 19^{th} *European Athletics Championship*, that took place in Gothenburg (Sweden) during August 6-13 2006, is:

- **www.goteborg2006.com**.

An embracing list of standard medal tables is given at:

- **www.sports123.com/medals.html**.

A different and complementary view on medal table-production as a form of data analysis is given at:

- **www.b9tek.com/feature_olympics2004.htm**.

B Why not include external factors?

It is most certainly possible to weight the nation-scores with respect to (functions of) external factors as, for instance, the nation's *population*, *number of participating athletes* or *wealth*.[14] Such measures, according to our belief, might be interesting as complementary summarization, but is not appropriate for main official purposes. The reason is that it would be quite hard to tune the procedure-parameter, i.e. to choose weights in order to produce a measure that is robustly fair.[15]

A somewhat more realistic adjustment would be to, for such joint events that includes subevents of very different amount of competition or dignity, let the scores be weighted with respect to the observed subevent.

Example 14. *In the Olympic Games, such a situation might be when considering the type-of-sport factor. It may be argued that it is not fair that a success in a full team sport-tournament gives in total one score while, for instance, swimming and athletics could lead to a whole bunch of scores.*[16]

[14] Summarized using some relevant measure, i.e. the well-known *GNP*-parameter.

[15] In other words, that it is agreed on to give fair results for all, or at least most of the, nations of interest. The problem is obviously most severe for very small and low-crowded countries.

[16] In fact, in some cases it leads to multiple scores corresponding to a single individual!