Best of the Best

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Background

By the very definition of the word, an athlete possesses skills in "exercises, sports, or games" that put their physical ability to the test.[1] These sports and games, however, may present several challenges which have little to nothing to do with the pure physical ability of their players. To design a collection of useful metrics to determine the best athlete, one must consider the vast range of characteristics that contribute to an athlete's success in their context. One way to do this would be to focus on one or a few closely related sports or games and simply ignore the rest. Since the goal of the metrics developed below is to determine the "best athlete" without restricting the definition of the word, the approach taken below is instead to focus on four categories of characteristics. These are:

- Physical Strength, Endurance and Aerobic Performance

- Physical Flexibility

- Teamwork

- Strategic Ability and Decision Making

Excellence in any one exercise, sport, or game may require one, some, or all of these categories of characteristics. Therefore, four metrics are developed below for each, with a fifth metric for combination of these categories.

Since the goal of each metric is to rank athletes relative to each other, scoring for some categories is based on percentiles and ranking of data collected. It is therefore assumed that this data can be obtained for the athletes being compared.

Metric 1: Let's Get Physical (P)

Likely the most obvious characteristic group of an athlete is their physical strength and aerobic performance. Skills in exercise alone is enough to righfully consider one an athlete.[1] To rank athletes within this category, 4 data points are to be obtained for each athlete:

Event	Notation	Measures
1 Mile Running Time	e_1	Aerobic Performance
400m Swim Time	e_2	Aerobic Performance
Push-ups "to fail"	e_3	Strength and Endurance
Pull-ups "to fail"	e_4	Strength and Endurance

Here, "to fail" indicates that these data are the maximum number of Push-ups and Pull-ups an athlete can do consecutively.

Once these raw values are obtained, each datum is converted to the value of its percentile within its event among all athletes. The percentiles e_1, e_2, e_3, and e_4 lie at within their event (represented between 0 and 1) will be denoted p_1, p_2, p_3, and p_4 respectively.

Resulting Metric

These p_i values for any one athlete are then combined as a linear combination to form their score for this metric, P, from 0 to 100.

$$P = 25(p_1 + p_2 + p_3 + p_4)$$

By this metric, the athlete with P closest to 100 is the best athlete.

Metric 2: Quite a Stretch (F)

Many competitive events require exceptional flexibility in an athlete. This category will be gauged across athletes using the scores of two tests: the Sit and Reach to measure their lower body and back flexibility (L), and the Shoulder-Neck Mobility Test to score their upper body flexibility (U). Each are described by author Robert Wood online on *Topend Sports Website.*

> The Sit and Reach "involves sitting on the floor with legs stretched out straight ahead... The soles of the feet are placed flat against [a] box. Both knees should be locked and pressed flat to the floor... With the palms facing downwards, and the hands on top of each other or side by side, the subject reaches forward along the measuring line as far as possible. Ensure that the hands remain at the same level... After some practice reaches, the subject reaches out and holds that position for at one-two seconds while the distance is recorded."[2]

> In the Should-Neck Mobility Test, "[t]he subject stands with their back against the wall, with the feet 1½ foot away from the wall. The buttocks, back and shoulder plates should rest against the wall. The subject raises their hands with thumbs ahead, to above the head as far as they can while keeping your arms straight and shoulder-width apart. When hands are above the head, they attempt to turn the hands and place backs of the hands against the wall. Elbows and wrists need to be kept straight. Only one attempt is allowed."[3]

The Sit and Reach score L is the measured distance and the Shoulder-Next Mobility Test score U is either 1, 3, or 5 points, with 1 indicating no wall-hand contact, 3 indicating finger-wall contact, and 5 indicating full hand contact.

As in the previous metric, L is to be converted to L_p, the percentile an athlete's score falls at within the range of L for all athletes compared.

Resulting Metric

The linear combination of these two scores, weighted to have equal influence and to range from 0 to 100 yields the metric F:

$$F = 50L_p + 10U$$

By this metric, the athlete with F closest to 100 is the best athlete.

Metric 3: A Real Team Player (T)

Many sports and games are team events. These require an athlete to not only be physically capable, but socially capable as well. Developing a metric to measure just how "sociable" an athlete is presents a challenge. What may be considered "socialable" and ultimately helpful in one sport or game may prove detrimental in another.

One solution is not to measure the characteristics of an athlete *directly*, but rather by where it matters the most: their team. This could be done a number of ways. One method would be to survey teammates of the athletes being compared with the following prompts:

1. Rank the members of your team in order from least to most critical to the success of the team overall.

2. Rate each member of your team between 0 and 10, 0 being the least critical and 10 being the most critical to the success of the team overall.

The ranking of the first question will allow each member to have a percentile *within their team* t_p (represented between 0 and 1). The trouble with this alone is that, when comparing many athletes across different teams of the same sport, all of these teams will have the same number of players, resulting in many ties of this score. This is the use of the average of all of the ratings a single player receives t_r.

Resulting Metric

The product of these two scores, scaled to range from 0 to 100 yields the metric T:

$$T = 10 t_p t_r$$

By this metric, the athlete with T closest to 100 is the best athlete.

Metric 4: Head in the Game (S)

Researchers in Italy recently published a collection of 10 games as a way of measuring a suggested "Strategic Quotient" that measures the rationality and mentalization skills of an individual.[4] These games were specifically designed to attempt to score an individual's strategic reasoning ability in the context of situations with multiple other decision-makers involved. For this metric, a test of games similar to this could be given to the athletes, with more games to be more thorough.

Resulting Metric

S = The percentile an athlete falls at within all of the scores of all athletes compared on this test, represented between 0 and 100.

By this metric, the athlete with $S = 100$ is the best athlete.

Metric 5: Best of the Best (B)

Many Olympic games require many or all of these categories and their characteristics. Every major sport - Baseball, Football, Soccer, etc. - requires strength, aerobic performance, endurance, upper and lower body flexibility, teamwork, reasoning and mentalization. This last metric, therefore, simply (but reasonably) combines all of the four previous metrics into one.

Resulting Metric

$$B = \frac{P + F + T + S}{4}$$

By this metric, the athlete with a B closest to 100 is the best athlete.

Conclusion

As mentioned above, many sports and games require all of these groups of characteristics. No list of characteristics could ever describe all of the traits that are required for an athlete to succeed in *all* exercises, sports and games without including traits that are non-applicable to some. By developing a metric for each category of characteristics, one who wishes to determine the best athlete within a certain context can pick and

choose which metrics are applicable, include them in a linear combination similar to B, and exclude the rest. These models are more than just reflective. Since all but the teamwork metric are linear, given an athlete who wished to improve their ranking with given resources to do so, any combination without teamwork could be optimized with linear programming (or nonlinear/quadratic programming if teamwork were included). This would allow any athlete to make better decisions to allocate the limited resources available to them, such as their time, money, and attention, to improve their athleticism.

References

1. "Definition of Athlete." *Merriam-Webster*, www.merriam-webster.com/dictionary/athlete. Accessed 27 January 2019.

2. Wood, Robert. "Sit and Reach Test." *Topend Sports Website*, 2008, https://www.topendsports.com/testing/tests/sit-and-reach.htm, Accessed 27 January 2019.

3. Wood, Robert. "Shoulder-Neck Mobility Test." *Topend Sports Website*, January 2018, https://www.topendsports.com/testing/tests/shoulder-neck-mobility.htm, Accessed 27 January 2019.

4. Bilancini, Ennio, et al. "Assessing Actual Strategic Behavior to Construct a Measure of Strategic Ability." *Frontiers*, 20 Dec. 2018, www.frontiersin.org/articles/10.3389/fpsyg.2018.02750/full#supplementary-material. Accessed 27 January 2019.