GPS Analysis Methods

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Analysing GPS data can range from simple to very complex, with the best analysis often dictated by the situation.
There are 3 main types of analyses: Absolute speed, relative speed (where the absolute speed is expressed as a percentage of that athlete's maximum speed) and change in velocity (or acceleration).

Absolute speed

Often, simple absolute values like total distance and average speed will tell you all you need to know about how hard an athlete worked during a training session or game. There are many ways to express summary values for absolute speed which all essentially mean the same thing, they are just expressed differently. For example, average speed can be measured in different units (m/s or km/h) and is often expressed as metres run per minute.
In addition to the total average values, you need to know if the distribution of effort across the speed zones is the same. Otherwise there is no way to tell if sessions you are analysing were completed in the same way. To do this, absolute speed is broken down into time spent and distance run in different speed zones (i.e. time spent running between 15km/h and 20km/h). Total distance and time spent in these zones provides an excellent snapshot of the intensity of effort during the session. Also, expressing these values as a percentage of the total time or distance allows for a quick comparison across sessions.
Continuous time spent over a threshold speed can be used to examine how many 'steady state' efforts took place. This value could be expressed as number of continuous efforts in a zone over a certain time threshold (i.e. number of times an athlete runs at over 10km/h for at least 10 seconds), or the longest continuous time over a threshold speed. These values will give you information on longer efforts of continuous running which would occur in situations like running the length of the field during a game. This is very important information that can be used in planning training sessions to replicate games. For instance, if you find that an athlete is doing more long and continuous runs during a game then those sort of efforts should be incorporated into training so that game activities are replicated in training. It is very possible that some positions in a game will have more long efforts than others (a midfielder compared to a forward, for instance). This information will help you to tailor your training to not just the overall game demands but the physical demands of each position on the field as well.

Example 1: An athlete seems to be running out of energy part way through the game, but when you look at their average speed there is no difference from first half to second half. However, when you break down the speed during each half and look at the speed distribution, the second half has less time spent in the higher speed zones and more time running at a constant pace in the lower speed zones. This is demonstrated with real data in the graph below. In this example, there is virtually no difference in the average speed (the athlete ran an extra metre per minute in the first half), but there is a large difference in the distribution of the percentage of time spent in the speed zones, with the main difference coming in the time spent in zone 2 (about jogging pace). This athlete spent much more time at jogging pace and less time at a fast run pace during the second half. In addition, there were over double the number of acceleration efforts during the first half. Altering training to concentrate more on repeated efforts at the higher speed zones to make the athlete more resilient to those types of

efforts should help them to be more effective in the second half of the game.

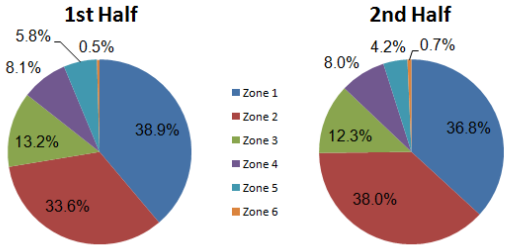

Figure 1: *Time in speed zones, expressed as a percentage of total time. The athlete had an almost identical average speed, but the analysis of time spent in speed zones shows a difference in the way that speed was achieved.*

Example 2: You are using total distance to track work rate during a game, and you notice a slight drop-off two weeks in a row. This could be due to a number of factors, including the tactics used during the game. A good indicator of whether or not there were different game considerations is to go back and check the speed distribution to look for any differences in how the athlete achieved their average speed. If there is no difference, then other factors such as injury, recovery and motivation should be examined. Either way, using the simple measure of total distance during a game as an indicator of effort has effectively identified a change in the normal game performance.

Relative Speed

Comparing match and training performance across a group of athletes becomes difficult if you have a diverse group. To accurately compare across such a group, you may not only need to know their absolute performance, but you also need to know how close that performance was to the maximum performance they are capable of. This is where relative measures can be used. By converting the absolute measures to a percentage of an athlete's maximum performance you can easily compare how hard physically a group of athletes have worked.

The analysis of relative speed measures can be done in the same way as for absolute speed measures. Simple measures like average percentage effort will give a very good overview of the relative speed during the session. Splitting the values into zones will provide more in depth information about the distribution of intensity during the session, and continuous time in zones will provide useful information on steady state running.

Example 3: Two athletes ran the same distance in a training session. How much recovery will athlete A need compared to athlete B?

To answer this question, their relative speed must be examined. If they have significantly different maximum speeds, they have probably worked at different intensities. Using relative speed to look at each athlete's intensity of effort will give you a much better idea of the actual physical load placed on an athlete during the session, and therefore how much recovery they should need before the next session.

Example 4: You feel that one of your physically talented athletes isn't quite reaching their potential during games. By looking at their relative speed, you can compare how hard they worked compared to the rest of the group. If, for instance, they ran at an average speed of 20km/h and their maximum speed is 35km/h, they probably were not pushing themselves as hard as another athlete who ran at an average speed of 18km/h but their maximum speed is 25km/h. The more talented athlete achieved a better absolute result (20km/h compared to 18km/h), but their actual physical effort was not as much as the slower athlete. This could be due to a number of factors like tactics, game situation, distributions of effort across the speed zones and number of sprints. However, the relative measure of performance has allowed you to directly compare two athletes of different maximum physical capabilities.

Acceleration

The third form of analysis and probably the least understood is change in speed or acceleration. Running at a constant pace takes much less effort than accelerating and decelerating. If two athletes have averaged the same speed during a training session, the one who has *varied their speed the most* will have spent the most energy.

Unfortunately, acceleration is not an easy measure to calculate. You cannot use a constant threshold amount as a cut-off to define when a change in speed can be deemed 'sig-

nificant' because it is easier to accelerate from slow speeds than it is from higher starting speeds. For instance, two athletes (athletes 'A' and 'B') could be using the same amount of energy to accelerate, but athlete 'A' has a much lower starting speed for their accelerations than the other. Athlete 'A' will have more change in speed than athlete 'B', so if you use a constant threshold you would assume that athlete 'A' has accelerated more and therefore spent more energy.

To avoid errors like this, you need to scale the amount of acceleration for the starting speed of the effort.

Even though it is difficult to determine, the number and type of accelerations is a very important value. It is really the best measure of sprinting available, much better than using an absolute threshold to determine when a sprint starts and finishes. This is because if you use a threshold value to determine a sprint start, you have ignored the initial part of the sprint that accelerated the athlete up to that threshold value. Of course in many sports, sprint efforts can be very short; demanding high acceleration and physically effort, but perhaps never reaching a high absolute speed. By using acceleration to identify sprints, then the starting speed, duration and even maximum speed do not affect the identification of a sprint.

Looking at the time between accelerations has been found to be a very reliable indicator of fitness and performance in team sports. Often called 'Repeat Sprints' (or 'Repeat High Intensity Efforts'), this value looks at the number of times sprints (or accelerations) are done with limited rest between efforts. Doing multiple accelerations over a short period of time (i.e. when the ball is in the same area as the athlete) takes a lot of energy, and is a very good indicator of an athlete's fitness (a fitter athlete will have more repeat sprints than a less fit athlete). Its particularly relevant to team and ball sports where the ball may stay in a particular area of the pitch for some time, and the best athletes are able to make repeated efforts to influence play.

Repeat sprints can also be broken down for a more detailed analysis. For instance, you can look at the amount of rest between sprints, or the length of the sprints, or the number of sprints that an athlete can cluster together during a game. It is a very important measure in the analysis of team sports.

Example 5: Two athletes have the same average speed and similar distribution of speed across zones. However, one of the athletes has a lot more accelerations and is therefore more variable in their speed. Higher variability of speed means higher energy cost, so the athlete with more accelerations has worked harder during the session. As with all physiological values, the higher energy cost does not necessarily mean better game performance since less variability in speed might mean reading the play more effectively. However, there are implications for physical training and recovery which can be taken from these results.

Example 6: Two athletes have the same number of sprints, but one athlete has clustered their sprints together (i.e. has more 'repeat sprints'). If the game situations are the same, these results suggest that the athlete with less repeat sprint efforts is struggling to recover from their initial sprint. A repeat sprint example can be seen in the graph below, which shows speed vs time during an AFL (Australian Rules Football) game. In the highlighted section, the athlete has been able to sprint three times with little rest between efforts. He has been able to recover from his initial effort sufficiently to influence the play twice more in a short period of time. Research suggests that all players will be able to produce one sprint, some will be able to do two, but only the best are able to consistently sprint three times with little rest between efforts. Specific training that concentrates on accelerating with minimal recovery should help the athlete to recover faster from the initial sprint and produce more repeat sprint efforts.

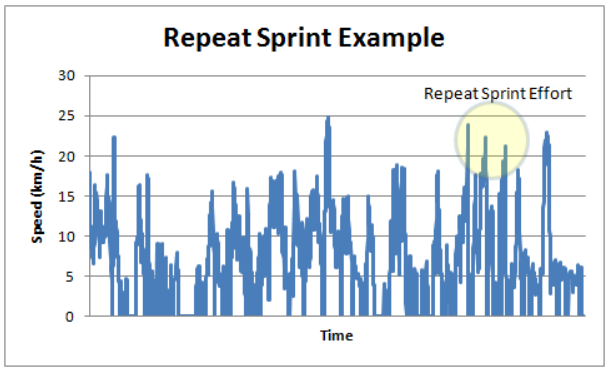

Figure 2: Speed vs time graph for a portion of an AFL game, with a section containing a repeat sprint effort highlighted.

Summary:

GPS analysis can range from a simple overview to a complex and in depth analysis. But for all analyses there are three main areas that need to be examined; How far an athlete has gone and the time taken to get there (absolute speed), how hard they have worked in relation to their own capabilities (relative speed), and how variable their effort was (acceleration). More information will always become available with more complex analysis. However, a few simple measures for absolute speed, relative speed and acceleration will often tell you all you need to know about how an athlete performed during the game or training session.