## Preparing for the Rio 2016 Olympics

Suppose you have a few matching sets of Easton X10's (30 arrows in total). They are all cut to length, new points installed and freshly fletched. And suppose you are in the final preparation

week for the Rio 2016 Olympic Games. All your arrows are prepared and shoot fine, but which ones are the ones you are going to use in competition? And does it matter? Can you simply pick a random set of 6 arrows from the 30 in your quiver or should you be more specific? Question; which 6 arrows should you use in the Rio 2016 ranking round?
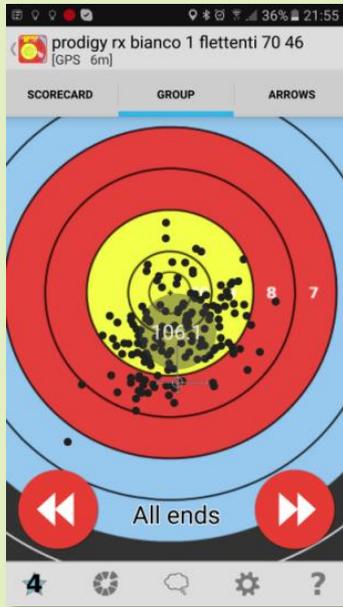
In the months before the Olympics, Italy's head coach Wietse van Alten and top-international archer David Pasqualucci participated in developing and testing an experimental feature of Artemis; how to select the best grouping arrows from a set of 30 arrows?


To start with, they created a match consisting of 7 ends of 30 arrows, making sure that every single arrow of the 30 arrows was shot each 'end'. This match was shot in an indoor 70m range without sight adjustments and plotted including arrow

identification number. The resulting group can be seen in the top left screenshot[1]
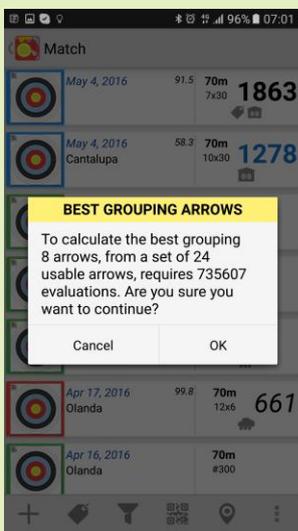
(T*he group is low because the sight was not adjusted during shooting. It needs to stay the same throughout this procedure!*).

Artemis' new feature can computes which 8 arrows are the best grouping set of arrows from a complete set of arrows.

(Artemis' default is to choose 8 arrows instead of 6 to account for arrow loss during competition, so 6 plus 2 spare. This can be changed in the advanced Analysis & Advice Options).

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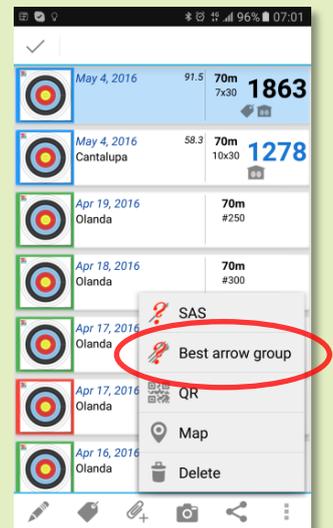
[1] In fact, the screenshot does not show the result of all 30 different arrows. The screenshots for this example were made after the Olympics with Artemis version 3.9. The actual data from Pasqualucci's tests is used, but only for 24 arrows (instead of all 30). The data is from an experimental test-run performed in May 2016 and not from the final week before the Olympics, when the actual selection of arrows took place. The experimental version was likely to overflow and/or needed extreme computational power for such large arrowsets (30 arrows). For example, the number of combinations to evaluate when selecting 15 arrows from a set of 30 is 155.117.520!

This is the reason that Artemis version 3.9 can only be used for a maximum of 24 arrows.

How does the algorithm work? From the results, Artemis first selects arrows numbered 1, 2, 3, 4, 5, 6, 7 and 8 and evaluates their grouping pattern. In this example, it evaluates a group of 56 shots; i.e. the 8 selected arrows which have all been shot 7 times. The group performance is determined by calculating the ASL (a measure of group size) of the group *independent* of where the group is on the target face. The algorithm doesn't care where the center of the group was on the target face, just how small it was. Then it does the same for arrows numbered 1, 2, 3, 4, 5, 6, 7 and 9. It computes the group size again and compares it with the previous set's group size.

Artemis iterates over *all* possible combinations of (in this case) 8 arrows out of 24 arrows, to find the best group. This means it has to evaluate **735.471** different combinations! So it takes a few minutes to compute.

When finished, a dialog shows the results; the 8 arrows that performed best (have the best/smallest group). It is this set of arrows which is best to use in competition!
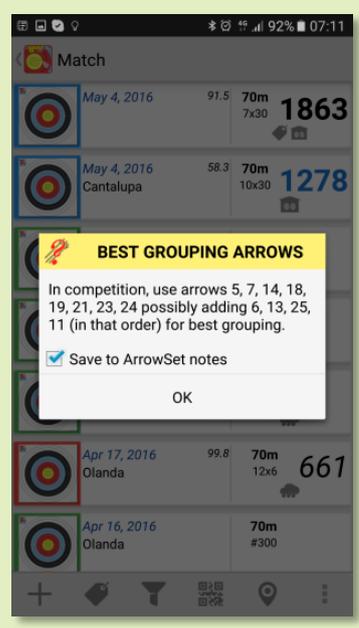
The result is also saved to the notes-section of the quiver/arrow-set for later reference.

What is interesting is to estimate the difference, expressed in points gained, between the 'best' 8 arrows compared to a randomly picked set of 8 arrows from the test data. Although this particular set of data is relatively small, we can still use Artemis to get a rough impression.

Using Artemis' Analysis, the *group* (not the score!) of the 8 best-grouping arrows is compared with a group of 8 randomly picked arrows from the same arrow-set and plot on two different targets. See the screenshot on the left.

The 8 randomly picked arrows grouped with an ASL of 104.8 which is *equivalent* to a 70m round score of 672. However, the 8 best grouping arrows had an ASL of 113.8 which is *equivalent* to a 70m round score of 690.

Again, a small dataset, so perhaps not statistically relevant, but still reason enough to put some effort in selecting your best grouping arrows, a few days before any important competition.

David Pasqualucci shot the 3rd highest score in the Rio 2016 ranking round, a score of 685, which is pretty close to the predicted score of 690 ☺

Steps to use this new feature in Artemis

There are several different ways to use this new feature, but suppose you have (as most of us) a set of 'only' 12 arrows and it is a couple of days before a 70m (720 round) competition. It is nice weather (no wind) and you have already warmed-up, and your sight is more or less correct. The following procedure will result in a 'best grouping arrowset' selection.

1. Create a Match (Type: plot, tuning, 70m, 122cm target face) of 16 ends of 6 arrows.
2. Fill your quiver with 6 arrows in the upper tube and 6 arrows in the bottom tube.
3. Before you start the match, set the options
   a. 'Default shot rating' to 5 stars
   b. Check 'Rate your shot'
   c. Check 'Identify arrow'
4. Start the match and make sure the star-rating symbol in the menu indicates '3'. So only plots rated 3 and above will be shown. And since you set the default to '5', all shots will be shown. The star-rating is used by the 'best arrow group'-computation, for it will only take shots into account that have a rating equal or higher than set.
5. Now shoot the match and plot each arrow by number. Shoot your upper tube of arrows in all even ends and the bottom tube of arrows in all uneven ends. This way you shoot all 12 arrows 8 times. Do **not** change your sight during the 16 ends. If you have an arrow which was really badly executed, then this arrow will influence the result for the wrong reasons, so mark that specific shot with a single star (1 star). All normal executed shots remain 5 stars.
6. When the match is finished, long-select the match from the matchlist and select the 'best grouping arrow set'-function. The algorithm will take into account all shots of all arrows that;
   a. Have been shot more than 3 times (in this case they should all been shot and plotted 8 times),
   b. with a shot rating higher than the indicated shot rating.
7. Computation of best groups of 8 arrows from a set of 12 will be almost instant (only 495 different combinations possible).
8. Use the advised set of arrows for your upcoming competition.