How to use analytics to play darts like a pro

Written by

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For the first time, new research from Imperial Business School demonstrates how to calculate the optimal darts strategy.

From expected goals in football to biomechanics in cricket, sport is undergoing an analytics revolution. No discipline is untouched by a newfound focus on statistics, and this includes darts – a game which has undergone a rapid journey from pub activity to global primetime.

In darts, two players alternate taking turns of three successive throws. The goal is to get from 501 points to zero before your opponent, with the final throw hitting a double. To date, however, analysis of darts has focused on the individual getting from 501 to zero in as few turns as possible, which isn't quite the same thing. **Our research is the first to account for this subtle difference** by modelling darts as a dynamic zero-sum game.

Strategic play

In other words, when computing a player’s optimal strategy we ought to take the opponent’s score into account. This is particularly important towards the end of a game, when a player could choose to aim for the double bullseye – a region worth 50 points that counts as a double, but is considerably more difficult to hit than other doubles.

Whether choosing this high-risk, high-reward option is optimal depends on the opponent’s score. If the opponent is likely to win next turn, it’s more likely to be worthwhile. Conversely, if the opponent has a high score remaining and is unlikely to win next turn, **it might be better to take a safer option** and aim for an easier double on the next turn.

By analysing data from professional players, we were able to develop a model to calculate a player’s optimal strategy for this type of situation. To illustrate this, we compared two hypothetical situations. In both situations Player A is on a score of 50 with one throw left in their turn. In the first situation Player B is also on 50 and in the second Player B is on 150.

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We can calculate Player A’s win-probability as a function of where on the dartboard they target the final dart in their turn. In one situation we assessed, for example, it is **much more advantageous for Player A to be aggressive and aim for the bullseye**, as it gives a win probability of 46.8 per cent compared with much smaller win probabilities for any other region of the board.

In the second situation we looked at, however, **a defensive approach offers a superior win percentage** of 78.6 per cent if Player A aims for single 10, as this leaves them with three throws at the easier-to-hit double 20 on the next turn. This is because Player B is far less likely to win on their next turn, so Player A is likely to have another turn and therefore another chance to win.

We found that playing strategically in this way gives the typical professional player an increased chance of victory of between 0.2 per cent and 0.6 per cent in a single game (also known as a "leg"), compared to using a strategy that ignores the opponent’s score. Over a longer match (e.g. best of 35 legs), however, this can be as high as two to three per cent – a significant edge for professional players.

Skill factor

However, this does not take into account variations in skill between different players. In practice, skill levels vary with the target region (e.g. players practise targeting triple 20 more, so can hit it more easily than other triples) and the individual player (e.g. one player might be better at hitting certain regions than others).

As we did not have data for every player–target combination, we applied empirical Bayesian methods to fill the gaps, allowing us to fit a skill model for each player. We then used this to analyse real-world situations.

For example, in a 2018 match between Gerwyn Price and Peter Wright, Wright was on 18 and Price was on 20. It was the beginning of Wright's turn and the most obvious strategy was to aim for double nine to win the leg. Instead, he aimed (successfully) at single two, then needed to hit double eight with one of his next two throws. He missed both of those, and Price then won the leg.

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Commentators questioned Wright's decision not to use all three throws to aim at double nine. However, according to our skill model, what he did was indeed **the optimal strategy for him**, with a win percentage of 71.4 per cent when targeting single two with his first dart versus 70.5 per cent if he targeted double nine.

Interestingly, when we applied the same situation to a different player – Michael Smith – our model recommended the double nine approach, with a win percentage of 77.8 per cent compared to 70.3 per cent. This is because Smith is more adept at hitting double nine than double eight, while the opposite is the case for Wright.

This suggests experienced players are well aware of their own relative strengths and weaknesses. **Our skill model effectively makes this instinctive knowledge visible**, unlocking one of the key mysteries of the game – how and why the top players play the way they do.

This article draws on findings from "Play Like the Pros? Solving the Game of Darts as a Dynamic Zero-Sum Game and An Empirical Bayes Approach for Estimating Skill Models for Professional Darts Players" by Martin B. Haugh (Imperial College London)

and Chun Wang (Tsinghua University).

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Martin joined Imperial Business School in 2017, having spent more than a decade at Columbia University. He also spent four years working in hedge funds in New York and London. His main research interests are: computational finance and risk management; Markov decision processes and suboptimal control; and machine learning, business analytics and big data.

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