Improving darts players' performance by experiment and modeling - Progress Report

Project Aims

Core to the completion of this project is the ability to record a set of dart throws for statistical analysis. A brief look at published research in this field suggests this has traditionally been done 'by hand', with rulers and tape, without the use of computers to aid in recording data accurately and at speed. Some custom software to speed up this process would allow for data to be taken at a faster rate, but this must not come at the cost of accuracy.

With data collected, we must make assumptions about the distribution that best fits this data. Treating the distribution as Gaussian initially, we can begin to draw conclusions from individual data sets. Later on in the project we may investigate other more exotic distributions with a view to concluding, either quantitatively or merely qualitatively, whether they offer a better fit that a 2D Gaussian.

From these conclusions we will be able to advise the player on the best part of the board to aim for during the scoring phase of a darts match (ie. when the sole objective is to score the most points). This advice will hopefully agree with the consensus of previous reports on the same topic.

Lastly, the same conclusion will hopefully inform a player of their chance of hitting each double given their particular throw distribution. This area is much less explored by existing literature.

Stretch Goal

If the project progresses well, we hope to also be able to advise the player on the optimum point in a match to switch from the scoring phase to the checkout phase given their darts ability. With a little thought, it seems obvious that a player with more skill will switch from scoring to checking out later in the game than someone with less ability. Quantifying that exact point presents a tricky but interesting mathematical challenge.

Equipment

Naturally the project demands a mounted dartboard and darts (in accordance with competition regulations). The data collection apparatus will comprise a tripod mounted web cam feeding into our custom data collection software (built as a web application with a suitable mathematics library) which will provide an HTML5 based user interface to both collect and review data from. (A demo is available at http://dartstats.herokuapp.com)

Achievements so Far

So far we can record an arbitrary number of darts throws. The errors in these readings have yet to be fully treated, but are currently estimated to be +/- 5mm. By assuming only unskewed, 2D Gaussian distributions we can generate heatmaps showing the statistically optimal places of a dartboard to aim for in the scoring phase of a darts game. This is generated by asking a player to throw a number of darts (typically 75), recording each throw's x and y coordinate (in our coordinate system the centre of the bullseye is (0,0)). By assuming a radial Gaussian distribution, the sample standard deviation in x and y are calculated as well as a standard deviation in R (straight line distance from the origin). It is the standard deviation in R that informs the Guassian function which is convoluted with a dartboard function to produce a heatmap.

We can also integrate a player's radial Gaussian distribution over the shape of each bed to give the percentage chance of hitting that bed when aiming for it. This constitutes the early stages of investigating the tactics of checking out and when to switch away from the scoring phase in a darts match.

Results so Far

All results thus far are based on observations of our own darts ability. Neither myself or Jack are particularly good at darts.

We have noted that our standard deviations in x and y differ greatly (standard deviation in x is much less than standard deviation in y). We believe this to be fairly typical of most (amateur) players and indicated that it is much easier to control ones lateral deviation than ones vertical.

Based on the current assumptions and limited data taken, for amateur players, towards the top left corner of treble 19 is the optimal place to aim for the scoring phase of the game. This makes a great deal of sense: 19 is bordered by 7 above and 3 below, whereas 20's neighbours are 5 and 1.

Preliminary investigations into doubles with non radial Gaussians indicate d6 and d11 are easier to hit than d20 and d3, supporting the conclusion that amatuer players have greater lateral control.

Curiously, it appears the Guassian spread is smaller when a player aims for a double bed (when checking out) compared with aiming for the bullseye (ie when taking data). This observation is purely qualitative, but very interesting nonetheless. This could suggest a psychological element to a players ability, with a subconscious tendency to greater focus and/or accuracy when they are close to the end of a game.

Plans for Remainder of Project

The error in dart position needs quantifying and minimising before we can claim to be able to fully quantify a player's ability. We also need to demarcate the most optimal place to aim for each heatmap (effectively differentiation of the heatmaps) and compare this with previously published results. Finally, we need to produce heatmaps with non-radial Gaussians not centred about (0,0) in line with the data coming from people's throws at the bullseye.

Any Problems Encountered

We found difficulty taking data from a web cam and interpreting/recording distances accurately, but the majority of problems have been overcome and we fully understand what needs to be done to further iron out the last of the inaccuracies. All of our code has been written in JavaScript. This has been beneficial in building a convenient user interface to work with our data, but JavaScript can be problematic when dealing with floating point numbers. We are in the process of introducing a library to ensure complete numerical accuracy throughout the model.

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