



Optimal Darts Cricket Strategy

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What is the optimal cricket strategy?

- ▶ This is a very tough mathematical problem. A closed form solution is out of the question so we have to use simulation.
- ▶ Luckily.... I was able to teach my computer to play cricket against itself and was able to program the 17 different strategy personalities described on the next page.
- ▶ These personalities were equivalent in skill and only differed by strategy.
- ▶ I had the computer play itself round robin style a few million times and recorded the results of each personality against each other.
- ▶ I then duplicated the simulation with opponents of different skill levels.
- ▶ With these results I am convinced I have identified/confirmed the optimal cricket strategy:
 - ▶ **Establish a point lead and then cover numbers.**
 - ▶ **Increase point cushion if you suspect opponent is focusing on blocking.**
 - ▶ **Point with “extra darts” if you suspect you are more skilled than your opponent.**
 - ▶ **Never chase! Ever.**

The 17 Strategy Personalities

- ▶ **1)** Simple strategy of covering all the numbers in order from 20 to Bull and only after all the numbers have been covered does the strategy focus on accumulating the necessary points to win.
- ▶ **2-5)** The strategy here is to establish a certain point lead and then once that point lead is reached, cover the remaining numbers in order.
 - 2) Lead by any amount
 - 3) Lead by 3 times the highest number unblocked to opponent.
 - 4) Lead by 6 times the highest number unblocked to opponent.
 - 5) Lead by 9 times the highest number unblocked to opponent.
- ▶ **6-9)** Identical strategy to 2-5 with the exception that if at any point the next open number can not be completely covered assuming single hits with darts remaining in hand, the strategy aims these “**extra darts**” at the highest number the strategy has closed and can point on. If no targets are currently closed and pointable, the strategy works on closing/pointing on the highest number not closed by the opponent.
- ▶ **10-17)** Identical strategy to 2-9 with the exception that the strategy first “**chases**” to complete any number that the opposing strategy has covered and can currently point on.

Results of Simulation

- ▶ The below matrix shows the win percentage of the strategy on the top row vs. the strategy on the far left column.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	50%	63%	85%	86%	85%	72%	86%	86%	86%	45%	49%	56%	57%	57%	57%	56%	57%
2	37%	50%	42%	35%	29%	48%	41%	33%	27%	26%	38%	41%	42%	41%	42%	41%	41%
3	15%	58%	50%	43%	37%	58%	49%	41%	36%	26%	50%	52%	52%	52%	52%	52%	52%
4	14%	66%	57%	50%	45%	65%	55%	49%	44%	33%	57%	60%	61%	60%	60%	59%	59%
5	15%	71%	63%	55%	50%	69%	60%	54%	49%	37%	61%	63%	63%	63%	63%	63%	64%
6	28%	52%	42%	35%	31%	50%	41%	35%	30%	25%	41%	44%	43%	43%	43%	43%	43%
7	14%	59%	51%	45%	40%	59%	50%	43%	39%	26%	51%	53%	53%	53%	53%	53%	53%
8	14%	67%	59%	51%	46%	65%	57%	50%	45%	34%	58%	60%	61%	60%	60%	60%	60%
9	14%	73%	64%	56%	51%	70%	61%	55%	50%	37%	61%	63%	63%	64%	64%	63%	63%
10	55%	74%	74%	67%	63%	75%	74%	66%	63%	50%	49%	56%	56%	56%	57%	56%	57%
11	51%	62%	50%	43%	39%	59%	49%	42%	39%	51%	50%	47%	47%	47%	47%	47%	47%
12	44%	59%	48%	40%	37%	56%	47%	40%	37%	44%	53%	50%	48%	48%	49%	48%	48%
13	43%	58%	48%	39%	37%	57%	47%	39%	37%	44%	53%	52%	50%	49%	49%	49%	49%
14	43%	59%	48%	40%	37%	57%	47%	40%	36%	44%	53%	52%	51%	50%	49%	48%	49%
15	43%	58%	48%	40%	37%	57%	47%	40%	36%	43%	53%	51%	51%	51%	50%	49%	49%
16	44%	59%	48%	41%	37%	57%	47%	40%	37%	44%	53%	52%	51%	52%	51%	50%	49%
17	43%	59%	48%	41%	36%	57%	47%	40%	37%	43%	53%	52%	51%	51%	51%	51%	50%
AVG.	33%	62%	54%	47%	43%	61%	53%	47%	43%	38%	52%	53%	53%	53%	53%	52%	52%

Note: Sample size in each cell is 20,000 games. So the sample estimate of the real population theoretical win proportion will have a standard deviation of no more than $.5/\sqrt{20,000}=.354\%$. So a 99% confidence interval around each estimate will be +/- .911%. So we can have very high confidence that the true theoretical proportion in each cell is no more than 1% off from the estimated number presented on this page.

Analysis of Results (Equally Skilled Opponents)

- ▶ The optimal strategy is strategy 2 - **Lead by any point amount and then cover the numbers!**
- ▶ In almost every scenario, against almost every strategy, strategy 2 yields the highest win percentage.
- ▶ The only time strategy 2 is not universally optimal is in the situation where the opponent is employing strategy 1. In this scenario, you want to get a few dart lead in points before continuing as in Strategies 3-5 and 7-9. Makes sense **if your opponent's focus is to block all scoring opportunities first...then you will want to build up a point cushion** in this scenario when you can. Even still, if you stick with strategy 2 in this scenario you will still win 2/3rds of the time against an equally skilled shooter.
- ▶ **Chasing should never happen.** Every flavor of chasing I modeled is dominated by strategy 2 in every scenario.
- ▶ Strategy 6 is a very close second although suboptimal strategy - **Taking any lead and also pointing with "Extra darts"**. This is a very good strategy but statistically not the best strategy with equally matched players.
- ▶ Strategy 2 is statistically significantly better than Strategy 6 against most strategies(13 out of 17 strategies)
- ▶ Strategy 6 is statistically significantly better against Strategies 1 & 10.
- ▶ Strategy 2 & 6 are statistically equivalent against Strategies 3 & 7.
- ▶ However, the most convincing and statistically significant argument of which strategy is better is to look directly at the cell for Strategy 2 vs Strategy 6.
- ▶ In this sample of 20,000 games I have strategy 2 winning 51.9% of the games against strategy 6. The probability that strategy 6 is actually better or equivalent to strategy 2 and we just happened to pick a bad sample of 20,000 games during this experiment is one in 28,000,000. So it's safe to say this result wasn't an accident and that you should **stick with Strategy 2 when playing an evenly matched opponent.**

What if one opponent is relatively more skilled?

- ▶ It's been argued to me that the optimal strategy to use might depend on how skilled the players are relative to each other. To test this argument, I reran the simulation with one player 95% as accurate at hitting targets as their opponent.
- ▶ I originally tried this experiment against an opponent 90% as skilled at hitting targets but the results were heavily skewed toward them losing a large majority of games and I decided that **at a certain point strategy universally losses out to better darts.**
- ▶ You'll notice that on the main diagonal in the prior results matrix the win percentage is 50% across the board. This is what you would expect with equal skill and equal strategy for each cell because neither player has an advantage.
- ▶ Also, the average of all cells in the earlier matrix = 50%. This is what you would expect because opponents have equivalent skill and have played each strategy an equal amount of times. Individual cells may have the strategy influence but the entire grid as a whole should average out this bias.
- ▶ Lastly, you'll notice that each cell is paired with an entry across the reflection of the main diagonal to sum to one. For example, the win percentage of 3 vs 1 = 85% and the win percentage of 1 vs 3 = 15%. This is because these reflected cells represent the same game.....1 vs. 3 of equal skill. However, these reflections do not represent the same game in the next simulation, where the higher skilled player uses strategy 1 in one game and strategy 3 in the other.
- ▶ In other words, the reflection property won't exist on the results matrix for players of unequal skill because we can reasonably expect the better player to have a higher win percentage on average.

Results of Simulation

- The below matrix shows the win percentage of the strategy on the top row vs the strategy on the far left column. The strategy on top is the strategy used by the higher skilled player.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	51%	68%	88%	89%	89%	77%	88%	88%	89%	51%	55%	63%	63%	62%	63%	63%	62%
2	32%	51%	52%	46%	41%	57%	52%	45%	40%	32%	45%	50%	49%	49%	50%	49%	49%
3	32%	65%	62%	56%	51%	69%	61%	55%	51%	32%	58%	61%	61%	61%	60%	60%	60%
4	41%	73%	69%	65%	61%	74%	69%	64%	59%	41%	66%	68%	68%	68%	67%	69%	69%
5	45%	78%	76%	71%	68%	81%	74%	70%	66%	45%	68%	71%	72%	71%	72%	71%	71%
6	32%	56%	54%	48%	44%	61%	53%	46%	42%	32%	49%	52%	52%	52%	52%	52%	52%
7	34%	67%	65%	59%	55%	70%	63%	58%	54%	34%	60%	62%	62%	62%	63%	63%	63%
8	42%	75%	72%	67%	63%	76%	70%	66%	62%	42%	66%	69%	69%	68%	68%	69%	69%
9	44%	80%	76%	72%	69%	81%	75%	71%	68%	45%	69%	72%	72%	72%	72%	72%	72%
10	50%	69%	88%	89%	89%	78%	89%	89%	89%	50%	55%	63%	63%	62%	62%	62%	63%
11	47%	57%	58%	52%	49%	61%	57%	52%	49%	47%	50%	55%	54%	54%	54%	54%	54%
12	46%	60%	57%	49%	46%	63%	55%	49%	46%	45%	54%	57%	55%	56%	56%	55%	56%
13	45%	61%	57%	50%	46%	64%	56%	48%	46%	45%	54%	57%	57%	57%	57%	57%	57%
14	45%	61%	57%	49%	45%	64%	56%	49%	47%	45%	55%	58%	57%	57%	57%	57%	56%
15	45%	61%	56%	50%	46%	63%	55%	50%	47%	45%	55%	57%	57%	57%	56%	57%	57%
16	46%	60%	57%	49%	46%	63%	57%	49%	46%	45%	54%	58%	57%	57%	57%	57%	57%
17	45%	60%	56%	49%	45%	64%	56%	49%	46%	45%	56%	58%	57%	57%	57%	57%	57%
AVG.	42%	65%	65%	59%	56%	69%	64%	59%	56%	42%	57%	61%	60%	60%	60%	60%	60%

Average winning percentage is 59%. This is because of the difference in opponent skill.

Analysis of Results (More Skilled Player Perspective)

- ▶ The **optimal strategy is strategy 6 - Lead by any point amount and point with “extra darts”**.
- ▶ In almost every scenario, against almost every strategy, strategy 6 yields the highest win percentage.
- ▶ Strategy 6 is statistically significantly the most optimal strategy against 15 of 17 strategies.
- ▶ Strategy 2 is a close second.
- ▶ The only time strategy 6 is not universally optimal is in the situation where the opponent is employing strategy 1 or 10. In this scenario, you want to get a few dart lead in points before continuing as in Strategies 3-5 and 7-9. Makes sense **if your opponent's focus is to block scoring opportunities....then you will want to build up a point cushion** in this scenario when you can. Even still, strategy 6 in this scenario won 76% of the time. (Better than the 59% average win rate across all strategies)
- ▶ Strategy 1 & 10 may be employed by weaker players to keep the game short. This increases their chance of pulling out a win. By pointing in strategies 3-5 & 7-9, the better player lengthens the game and increases the probability that their higher skill will guarantee a win over time. We see that in the win percentage spike to the 90% range when pointing against strategies 1 & 10.
- ▶ **Chasing should never happen.** Chasing is never the optimal strategy for the relatively more skilled player.

Analysis of Results (Weaker Player Perspective)

- ▶ The weaker player wants to minimize the stronger players win percentage.
- ▶ From experience and this analysis, it is fair to assume that the stronger player will employ strategy 2 or 6. Nevertheless, the conclusion to be drawn for the weaker player works regardless of the strategy employed by the more skilled player.
- ▶ The **weaker player's best strategy to minimize the stronger player's win percentage is strategy 2 with strategy 6 being a close second.** Look how pink (low) the win percentage is for the stronger player on the horizontal representing the weaker player's response to play strategy 2 or strategy 6. Both of these horizontal rows show relatively low win percentages for the opponent regardless of their actual strategy.
- ▶ **The weaker player will employ strategy 2 and hope the stronger player does so as well.**
- ▶ **Chasing is never an optimal solution.....even for the weaker player.**

Summary

- ▶ Best strategy for evenly matched players is to play with Strategy 2. **Take any lead and then cover numbers.**
- ▶ However, if you know you are the more skilled player, you can opt to extend the game and increase your chances of winning marginally by employing Strategy 6, **Take any lead, cover numbers, and point with “extra darts”.**
- ▶ **Strategy 2 outperforms Strategy 6 with evenly matched players.**
- ▶ If you suspect your opponent is trying to shorten the game by focusing on strategy 1 or 10 and blocking scoring opportunities, you can **increase your win percentage marginally by establishing a point cushion and extending the game** as in Strategies 3-5 and 7-9.
- ▶ **Never Chase!** This is a suboptimal strategy in any scenario at any skill level.
- ▶ Notice that when debating between Strategy 2 & 6, if either opponent chooses strategy 6 the game is lengthened and the more skilled player is more likely to win. **Weaker player should play Strategy 2 and hope opponent does so as well.**
- ▶ This all goes back to classic dart strategy.....**better players want a long game and weaker players want a short game.**