

Tigermetrics

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The PGA Tour collects data on every stroke of (almost) every golf tournament, with the location of the ball determined to the inch. These data open up exciting possibilities for the analysis of golf statistics. In this paper, we present several statistics, examining various aspects of the game. Certain putting statistics indicate that professional golfers perform with greater proficiency when putting for par than when putting for birdie. A general framework for evaluating golfers at different skills is presented. Special attention is paid to Tiger Woods and his remarkable career.

Viewed one way, this article is a brief report on the most enjoyable data mining project that I can imagine. A more global, though possibly overstated, view is that this is an announcement that golf statistics are about to change dramatically. Data sets exist to do for golf what sabermetrics has done for baseball.

The data come from the PGA Tour's ShotLink system. ShotLink is a system of lasers and volunteers who record the location of every shot, including qualitative information such as lie (rough or not, uphill or not, and so on) and quantitative information such as distance to the hole (measured to the inch). We can thus answer detailed questions about the performance of (male) PGA golfers. The PGA Tour is very generous in making the data available to educators.



There is one major drawback to the data at this point. Although it includes essentially every shot taken in PGA Tour events from 2004 to 2008, the PGA Tour does not run any of the four "major" tournaments (Masters, U.S. Open, British Open, PGA Championship). The public's perception of golfers' abilities is influenced by their performances in the majors, but the majors do not contribute at all to the statistics cited here.

So, what can be learned from the data? Since approximately 1.2 million shots per year are detailed, the better question is, what do you want to know? A sample of facts follows. A more comprehensive exploration will appear in [1].

How many putts do the pros make? In 2007, PGA golfers made 99.2% of their putts of length three feet or less. That is a high percentage, but it means that of the 168389 putts attempted from three feet or less in 2007, 1536 were missed. None of the regular tour players escaped the season without missing at least one short putt. From distances greater than three feet and less than or equal to four feet, the percentage drops to 91.5%.

Figure 1 shows the success rate at distances from 3 to 25 feet in 2008. The percentages in other years from 2004 to 2007 have been nearly identical.

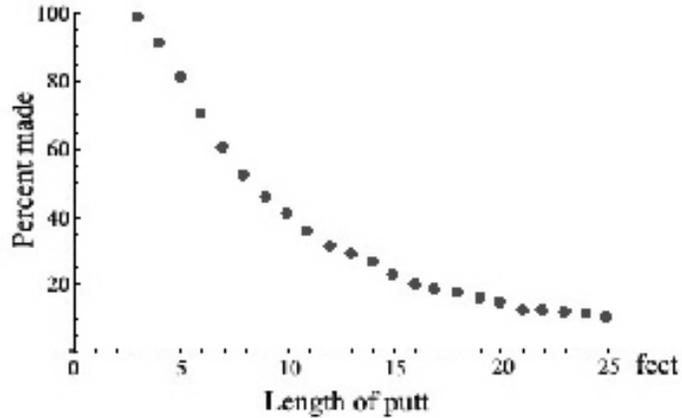


Figure 1: Percent of putts made from 3 to 25 feet in 2008

The question that most often arises is about the "break-even" point: at what distance does the percentage of putts made drop below 50%? The answer is 8 feet. That is:

**At every distance greater than 8 feet,
the pros make less than half of their putts.**

For most casual golfers, that seems like a surprisingly short distance. Of course, the pros putt on different greens than we do, they are under much more pressure, they never take mulligans and they have the PGA Tour recording every stroke, even on bad days.

Is Tiger Woods the best putter on tour? In some ways, Tiger does not rate as a great putter. For example, in 2007 Tiger ranked 181st in percentage of putts made between 7 and 8 feet. He was 187th in putts made between 6 and 7 feet and 74th in putts made between 5 and 6 feet.

This surprises many golf fans. We are accustomed to watching Tiger make every putt down the stretch on his way to another tournament win. In particular, he seems to make every critical par putt. Maybe the word "par" in that statement is key. Does he make a higher percentage of par putts than birdie

putts? The answer is "yes" from most distances in 2007, as seen in Figure 2.

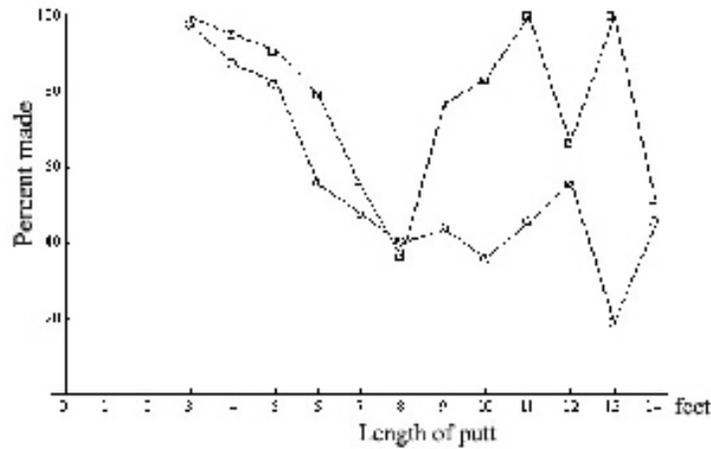


Figure 2: Percentages of putts made by Tiger Woods in 2007 from 3 to 14 feet, putting for par (□) or birdie (○)

This turned out to be a good question to ask in general. The answer is:

At every distance, the pros make a higher percentage of putts for par than they do for birdie.

The percentage is even higher for bogey than it is for par. The tour-wide statistics for 2008 are shown in Figure 3. (The percentages are similar in other years.)

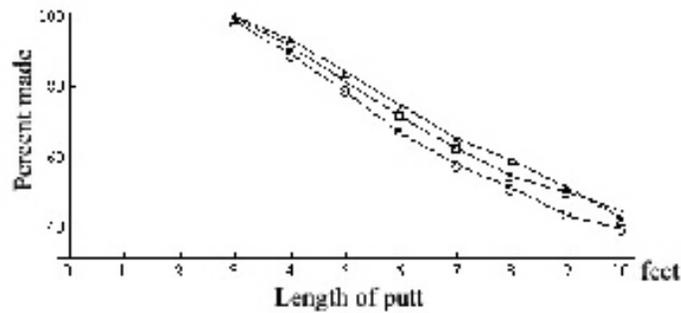


Figure 3: Percentages of putts made by PGA Tour in 2008 from 3 to 10 feet putting for bogey (△), par (□) or birdie (○)

To return to Tiger, his best putting statistically is at the longer distances. In 2007, he ranked 8th in percentage of putts made from 10 to 15 feet and 5th

in putts made from 15 to 20 feet. This does not answer the original question. Is Tiger the best putter on tour? To make progress on that, we need to answer a more important question.

What is a reasonable system for ranking putters? There are many ways to answer this. My system starts with a compilation of tour putting averages at every distance from 3 to 100 feet. However, the averages compiled are not of the percentages of putts made. Instead, I look at the average number of putts taken when the first putt is of that distance. For example, from 35 feet the percentage of putts made is important, but so is the percentage of 3-putts. The average number of putts taken from 35 feet accounts for all results, both good and bad. In 2008, it turned out that the pros averaged 2.02 putts from 35 feet. In fact,

**At every distance greater than 32 feet in 2008,
the pros averaged more than 2 putts per hole.**

Now we can rate the putting effectiveness of a particular player. Suppose that on his first hole of the year, he starts 35 feet away and takes 2 putts. That performance is 0.02 strokes better than average. On the second hole, he starts 22 feet away and takes 2 putts. Compared to the tour average of 1.90 putts from 22 feet, that performance is 0.10 strokes worse than average. For the two holes, our pro is a net 0.08 strokes below average as a putter, or 0.04 strokes per hole worse than average. Now, do the corresponding calculations for every remaining hole that the golfer played for the year and compute that player's average performance.

In 2008, Corey Pavin's putting performance averaged 0.0547 strokes per hole or, multiplying by 18, about 0.98 strokes per round better than average. For a round, Pavin averaged almost one putt less than an average tour putter would have required putting from the same distances. Pavin's average was the best average on the tour. Tiger Woods ranked fourth at 0.84 strokes per round better than average.

By this measure, Tiger is the most consistently effective putter on tour, ranking 3rd in 2007, 17th in 2006, 8th in 2005 and 2nd in 2004. Earlier, it was noted that Tiger's "best" distances are in the 10- to 20-foot range. Since he hits a high percentage of greens in regulation, these are common putting distances for him, so his putting results from this distance are weighted heavily. The ranking system accounts for the actual distances from which each player putted during the year.

Who is the best at hitting irons from the fairway? The ShotLink data do not include the player's club selection, so no ranking can be made of players' abilities with, for example, an 8-iron. In any case, our high-tech era of specialty clubs and hybrids minimizes the significance that can be attached to the number or symbol stamped on the bottom of the club. However, we can compile averages of how close to the hole players hit from different distances. They make it clear that Tiger is the best iron player on tour.

Since distances are measured to the inch, there is again a choice of how to split them up. I followed the PGA Tour convention of using 25-yard intervals.

For example, in 2007 Tiger hit 56 shots from the fairway at distances between 100 and 125 yards from the hole. They finished a total of 11328 inches from the hole, or an average of 16.8 feet, the third best average on tour. In 2007, Tiger averaged 23.2 feet from the hole when hitting from the fairway at distances between 150 and 175 yards, the best average on tour. From distances of 175 to 200 yards, Tiger's average approach distance of 26.8 feet was also the best on tour. As the table shows, Tiger has dominated at this level for years.

Distance (yards)	2004	2005	2006	2007	2008
100-125	1	1	3	3	1
125-150	52	1	44	7	100
150-175	11	51	1	1	1
175-200	6	3	1	1	1

Figure 4: Tiger Woods's ranks hitting approach shots from the fairway from different distance ranges between 100 and 200 yards

As reader Dick Green pointed out, there is a flaw in the use of average distances to rate players. Two approach shots 30 feet from the hole average the same as one approach shot 4 feet away and one 56 feet away. The second combination is likely to produce a better score. An improved rating system is given in [1].

Is there a hidden flaw in Tiger's game? The short answer is "no!" but there *is* an interesting blip in Tiger's approach shot rankings. The distance range 125-150 yards showed some relatively large ranks in Figure 4. We can discount 2008 because of the small number of shots (19) he hit from that distance range in his injury-shortened year. (That did not stop him from dominating every other distance category.) The one year (2005) in which Tiger led the tour at the 125-150 yard distance is also the year that his 150-175 yard ranking fell significantly. So, it seems that (by his standards) there is often one distance range from which Tiger struggles.

Who is the best golfer overall? In most sports, the ultimate product of a statistical analysis of athletes is an answer to the question of who is the best. There is little doubt in golf. Nevertheless, I have a system for rating golfers. A brief description follows. (Yes, Tiger Woods ranks number one in every year from 2004 to 2008.)

The putting rating system is described above. It gives a number of strokes better or worse than average for each golfer. The concept behind the putting system and the same measurement unit (strokes) can be extended to other types of shots.

For example, suppose that Tiger is in the fairway 122 yards from the hole, and hits his shot a mere 4 feet from the hole. The tour average from this distance (in 2008) was 22.4 feet from the hole. Both approach distances get converted to strokes. From 4 feet, the tour averaged 1.142 putts, while from 22 feet the tour averaged 1.548 putts. The conclusion is that Tiger's shot is 0.406 strokes better than average.

My system averages the player's performance (in strokes, not distance) for different types of shots. My categories include pitches (4-50 yards) from the fairway, pitches from the rough, irons (50-200 yards) from the fairway, irons from the rough, long irons (200-250 yards) from the fairway, sand shots, par-3 tee shots, par-4 tee shots and par-5 tee shots. They combine to give a grand total of strokes per round above or below average. (Details are in [1].)

For 2008, the top 5 were

Rank	Name	Rating
1.	Tiger Woods	2.65
2.	Padraig Harrington	1.25
3.	Vijay Singh	1.24
4.	Anthony Kim	1.22
5.	K.J. Choi	1.21

Figure 5: The top five rated PGA golfers in 2008, measured in strokes per round better than average

In Tiger's absence, Harrington won the final two majors so his ranking as #2 is not surprising, until you remember that the rankings are based on data that exclude the majors. Harrington was obviously playing well before the majors.

Tiger's score of 2.65 means that if you add up his ratings for 2008 in the different categories, weighted by average usage (e.g., there are usually eleven par 4's on a course, so the par-4 tee shot rating is multiplied by 11), Tiger computes to being 2.65 strokes per round better than the average PGA Tour player. He also rates 1.4 strokes per round better than anyone else on tour. Over four rounds of a tournament, this predicts that Tiger wins by at least 5.6 strokes.

What else can be learned? The possibilities are limitless. There are many questions waiting impatiently on my to-do list. For example, when a pro has a bad tournament, is it more often a result of his strengths (e.g., great putting) dropping to below average or his weaknesses (e.g., mediocre driving) becoming worse? So many questions, so little time, but we now have the data with which to find answers.

Others, including statisticians at the PGA Tour, are answering questions that would have been on my list if I had been inspired enough to think of them. This is why I suggest that there is about to be an explosion in golf statistics. The details have been recorded in the ShotLink data. All that is required is a critical mass of explorers asking good questions. I anticipate having great fun reading about all of the new discoveries in the near future.

Acknowledgements

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Reference.

1. Roland Minton, *Golf by the Numbers*, Johns Hopkins Press, to appear.

Biography.

ROLAND MINTON received his Ph.D. in 1982 from Clemson University, home of the 2003 NCAA golf national champions. He has taught at Roanoke College since 1986. He has co-authored with Bob Smith a series of calculus textbooks, and explored a number of fun mathematics applications ranging from sports of all kinds to chaos theory to Elvis, the calculus dog. His wife Jan also teaches at Roanoke College, his daughter Kelly teaches science in Kyle, Texas, and his son Greg is a graduate student at MIT. Roanoke College, Salem, Virginia. Email: minton@roanoke.edu.