Ranking Putters on the PGA Tour Using Green Contours

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- **Analytics and strategy**

Purpose: For decades putting was measured by putts per round, a simple 'counting' stat that could be implemented before the widespread availability of personal computers. This measure is flawed because it conflates putting with other golf skills. For example, one player could miss a green, chip to three feet and sink the putt while another hits the green 30 feet from the hole and also holes the putt. Both putting performances are rated equally in the putts per round metric, even though sinking the 30-footer represents a better putting performance than sinking a three-footer. Broadie (2008) proposed a strokes gained method for measuring golf performance which compares the player's strokes to hole out relative to the average strokes to hole out across all players starting from a given position. A one-putt from three feet would have a strokes gained of 0.04, because the average strokes to hole out is 1.04. A one-putt from 30 feet would have a strokes gained of 0.98, because the average strokes to hole out is 1.98. In 2009 on the PGA Tour, Tiger Woods was ranked tied for 22 in putts per round, even though he was widely regarded as one of the best putters. Using the strokes gained measure, Tiger Woods was ranked second in strokes gained putting in 2009, a result that is much more aligned with the opinion of golf experts. This implementation of the strokes gained concept uses putt distance as the only factor in the determination of the average putts to hole out. Even though distance is the primary determinant of putt difficulty, other factors

including wind, green smoothness, green speed, green contours and slopes also affect difficulty. The purpose of this study is to add green contour information in order to more accurately measure putt difficulty and to determine the impact on the ranking of putters.

Methods: The PGA Tour's ShotLink database contains location (x,y,z) information for the starting and ending points of shots. This data was used to infer green contours for each green played. The physics model of Penner (2002) was used to infer putt trajectories based on the green contour and the starting and ending locations of putts. Together this information allowed us to measure the net slope between the ball and the hole, the break amount, break direction, and other variables of interest. Figures 1 and 2 provide illustrations of how the inferred variables correspond to actual outcomes.
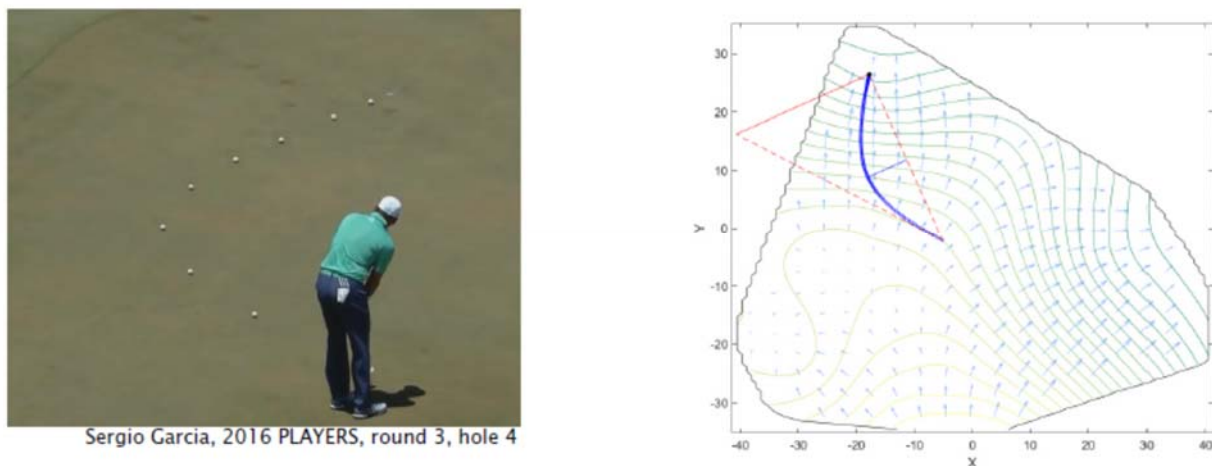

Figure 1. *The left panel shows a putt of Sergio Garcia in the 2016 PLAYERS Championship on the TPC Sawgrass course in round 3 on hole 4. The right panel shows the green contour, estimated putt trajectory (blue solid line) and the estimated break amount (red solid line). The putt distance was 31 feet, with a net slope of -2.1 degrees (i.e., downhill from the ball to the hole), a launch direction of 33 degrees, a break amount of 21 feet, and a left-to-right break direction.*
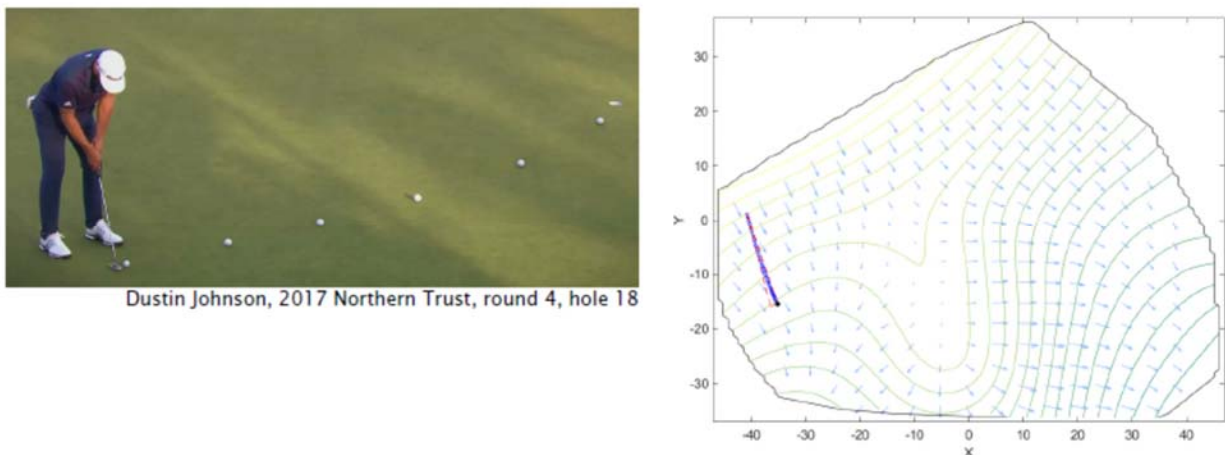
Figure 2. *The left panel shows a putt of Dustin Johnson in the 2017 Northern Trust in round 3 on hole 18. The right panel shows the green contour, estimated putt trajectory (blue solid line, with the putt starting at the top left) and the estimated break amount (red solid line). The putt distance was 18 feet, with a net slope of -2.0 degrees (i.e., downhill from the ball to the hole), a launch direction of 5 degrees, a break amount of 1.4 feet, and a right-to-left break direction.*

The average putts to hole out was estimated via regression using the variables log(dis), log(dis)^2, log(dis)^3, first-putt indicator, launch direction, net slope, net slope^2, slope at the hole, double-beak indicator, and interaction terms (e.g., net slope times launch direction). A standard cross-validation procedure was used to avoid overfitting.

Results: Figure 3 provides sample results of the regression model for estimating the average putts to hole out as a function of green contour variables. Table 1 shows strokes gained putting results from the 'distance-only' strokes gained putting model used by the PGA Tour and the 'green contour' strokes gained putting model developed in this paper. Over an entire season, players are ranked similarly by the two methods.
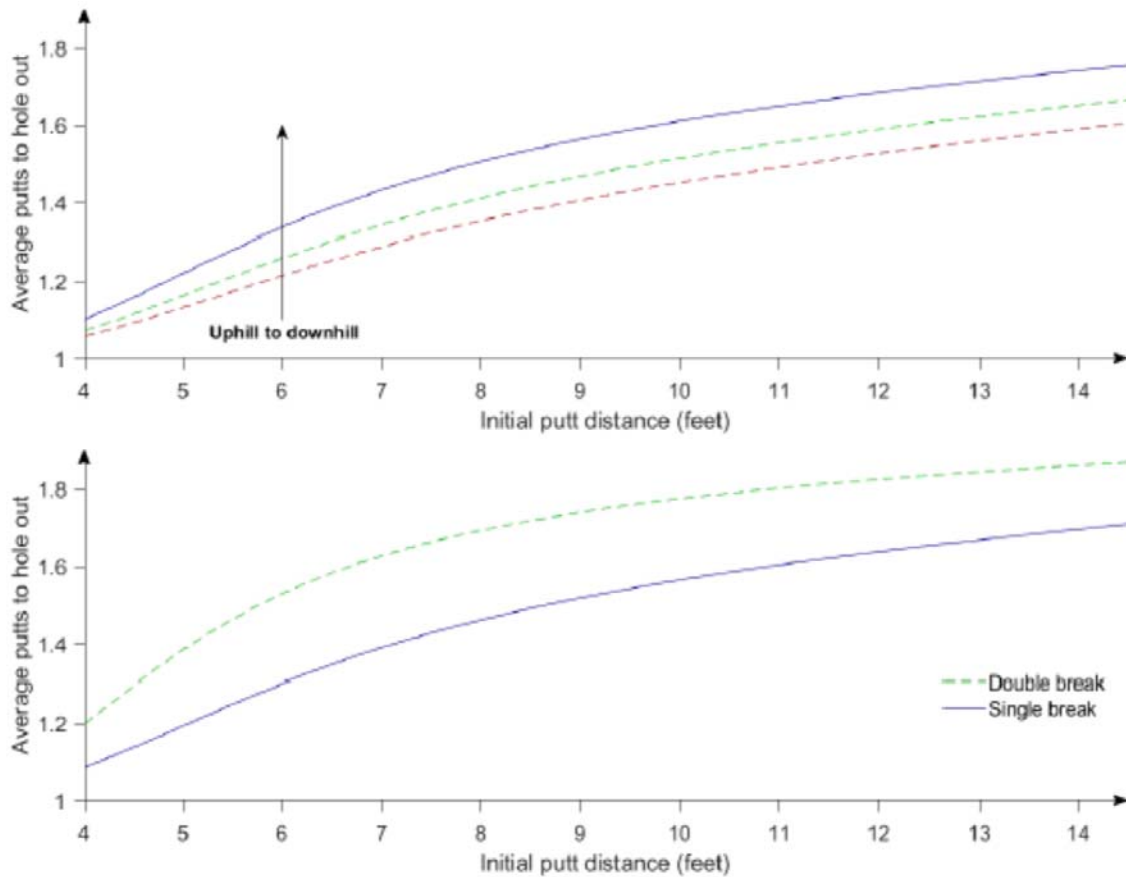
Figure 3. *The top chart shows how the average putts to hole out varies with the initial putt distance and net slope of the putt and illustrates that, all other factors equal, uphill putts are easier than downhill putts. The bottom chart illustrates that, all other factors equal, double-breaking putts are much more difficult than putts with a single break.*

Rank	Player	SGP dis-only		Rank	Player	SGP contour
1	Rickie Fowler	0.88		1	Michael Thompson	0.88
2	Michael Thompson	0.87		2	Rickie Fowler	0.86
3	Luke Donald	0.72		3	Luke Donald	0.72
4	Graeme McDowell	0.63		4	Graeme McDowell	0.68
5	Brian Harman	0.60		5	Jonas Blixt	0.57
6	Rafa Cabrera Bello	0.58		6	Kevin Kisner	0.54
7	Patrick Reed	0.57		7	Patrick Reed	0.54
8	Brooks Koepka	0.55		8	Adam Hadwin	0.53
9	Jonas Blixt	0.54		9	Mackenzie Hughes	0.52
10	Mackenzie Hughes	0.54		10	Brian Harman	0.52
12	Kevin Kisner	0.52		11	Rafa Cabrera Bello	0.51
13	Adam Hadwin	0.52		13	Brooks Koepka	0.49
18	Steve Wheatcroft	0.44		30	Steve Wheatcroft	0.38

Table 1. *Results from the 2017 PGA Tour season. The left panel shows the ranking of PGA Tour putters using the 'distance-only' strokes gained putting model. The right panel shows the ranking of PGA Tour putters using the 'green contour' strokes gained putting model developed in this paper. Eight of the top ten players are common to both rankings. Players omitted from the top ten of one ranking are within the top 13 in the other ranking. Steve Wheatcroft is used to illustrate that small differences in strokes gained putting (0.06 strokes per round) can lead to larger ranking differences (12 ranking positions) for players lower in the rankings.*

Discussion/Practical application: Even though the difficulty of individual putts can vary greatly when additional green contour information is used, over the course of a season, many of these factors tend to 'average out.' For example, there does not tend to be systematic differences in the fraction of more difficult double-breaking or downhill left-to-right breaking putts faced by players. This is different than the distance factor, where players do systematically face longer-than-average or shorter-than-average putts over the course of a season. The green contour model can be used to more accurately measure putt difficulty and can be used to better identify particular strengths and weaknesses of putters.

References:

Broadie, M., 2008, "Assessing Golfer Performance Using Golfmetrics," in *Science and Golf V: Proceedings of the World Scientific Congress of Golf*, eds: D. Crews and R. Lutz, Energy in Motion Inc., Mesa, Arizona, 253-262.

Penner, A.R., 2002, "The physics of putting," *Canadian Journal of Physics*, Vol. 80, 83-96.