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Analysing individual performance in golf using the ISOPAR Method

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1. Introduction

Classical performance analysis in golf usually relies on statistical performance indicators. Most of these indicators are defined by classifying shots with respect to the distance to the hole (James, 2007). Performance indicators such as driving distance, approach shot accuracy or putting average are commonly used for performance analysis in golf (James & Rees, 2008) but ignore most of the factors which make up the difficulty of a shot. They do not take into account environmental influences like the ball lie, break or slope in putting, and compare shots within certain classes which are not comparable. Furthermore, most of these performance indicators each represent more than one ability. For example, putting is a composite measure of several abilities since the starting position of the first putt is determined by the approach shot. Hence, players who are able to perform approach shots well give themselves easier putts. Moreover, the starting location of the approach shot is determined by its previous shot. Thus, putting average is a composite measure of several abilities.

The lack of performance indicators for individual shots lead us to the development of the ISOPAR method (Stöckl, Lamb, & Lames, 2011) alongside two other groups developing similar performance indicators (Broadie, 2012; Fearing, Acimovic, & Graves, 2011). Whereas the approaches of Fearing et al. (2011) and Broadie (2012) are statistical and are based on distance (Broadie, 2012, also includes a classification of the ball lie), the ISOPAR method indirectly considers all factors which influence the performance of a golfer (Stöckl, Lamb, & Lames, 2012). The ISOPAR method provides a) visualisation of unique areas on a golf hole and b) a measure of performance for individual shots, Shots Saved. The performance indicator Shots Saved describes the

quality of a shot with respect to the field's performance by the difference between the difficulty of its starting location and the difficulty of its finishing location. Additionally, Shots Saved describes the shot's contribution to the overall performance of a player.

In this study, we analysed PGA Tour ShotLink™ data measured during tournaments in 2011 using the ISOPAR method focusing on the THE PLAYERS Championship. Based on the stability findings of Scheid (1990) we studied the stability of individual player's performance with respect to different shot types. Scheid revealed that a player's hole score or round score is not affected by his/her performance on the previous hole(s) or by holes performance in the previous round(s). Using the performance indicator Shots Saved we investigated the stability of individual player's performance. For example, was driving performance stable throughout the four rounds of THE PLAYERS Championship. Furthermore, we analysed whether golfers with certain playing characteristics might have an advantage playing at TPC Sawgrass – the site of THE PLAYERS Championship.

2. Methods

ISOPAR values and ISOPAR maps are calculated using information about shots. These information need to contain the location from where a shot was taken and the number of remaining shots until the ball was holed from this location. In this study we used data from the PGA TOUR ShotLink™ database. This database contains information on every shot taken during all PGA Tour tournaments since 2003 (except majors and match-play events). We calculated ISOPAR values and ISOPAR maps for 2,754 holes played in 153 rounds based on data of 1,009,362 measured shots from 38 PGA Tour tournaments in 2011.

The calculation of ISOPAR values and ISOPAR maps is realised in three and four steps respectively. The algorithm of the ISOPAR method was programmed with MATLAB 2011b using built-in MATLAB procedures for many of the steps. More details of the method are given in Stöckl et al. (2011) and Stöckl et al. (2012). For this reason only a summary of the different steps is provided:

- (1) A two dimensional grid is assigned to the hole. In this study a mesh size of two inches was used.
- (2) At the grid nodes ISOPAR values are calculated using an exponential smoothing algorithm (Hamilton, 1994). In this study a smoothing parameter of 0.17 was used.
- (3) Based on the ISOPAR values from the previous step a three dimensional, continuous ISOPAR surface is generated through a cubic spline interpolation (Fahrmeir, Kneib, & Lang, 2009).
- (4) Using the continuous ISOPAR values so-called *iso*-lines are calculated for certain levels of performance. In this study we calculated *iso*-lines at 0.2 intervals.

Furthermore, the ISOPAR method allows a description of the quality of a player's performance using the performance indicator Shots Saved. Shots Saved describes the quality of a shot with respect to the performance of the field and the contribution of each shot to the overall performance of a player (Stöckl et al., 2012). For the different analyses in this study we looked at the performance of five different shot types identified by ShotLink™: drives, long approach shots, short approach shots, around the green shots, and putts.

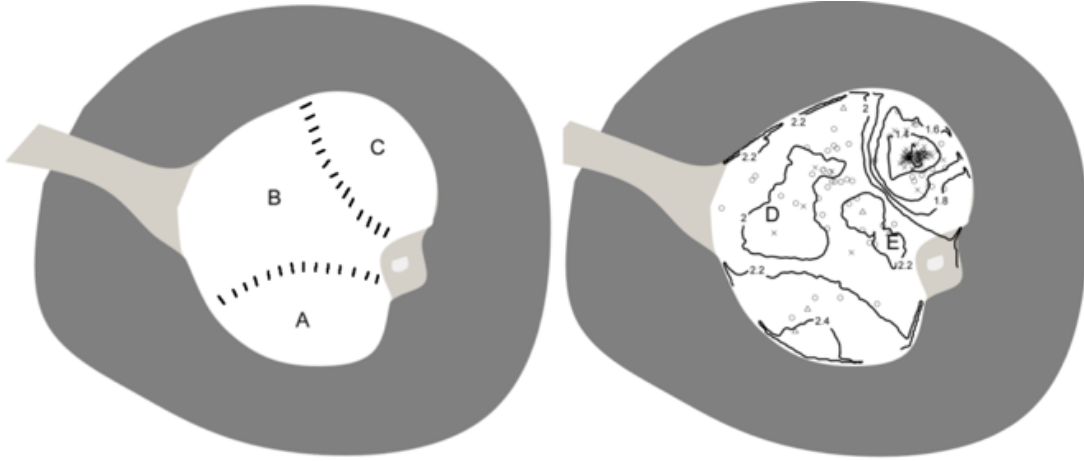


Figure 1. The 17th hole at TPC Sawgrass in 2011 (round 4), the dark surrounding is water. On the left panel three distinct changes in elevation (shown by hashed lines) divide the green into sections A, B, and C. On the right, the *iso*-lines and ball locations (X – 1 putt, circle – 2 putt, triangle 3 putt) are superimposed on the green. D and E represent putts of different difficulty although the distance is similar.

3. Results and Discussion

In this section we focused our analyses on one tournament, THE PLAYERS Championship in 2011. First, we analysed an ISOPAR map of the famous island green 17th hole at TPC Sawgrass. Second, we studied individual player’s performance with respect to different shot types.

3.1. *The island green at TPC Sawgrass*

We analysed an ISOPAR map of the famous island green at TPC Sawgrass (see Figure 1). The island green 17th is a par three, which typically plays between 130 and 140 m. The green is divided up into three different areas; there is a tier each at the right (section C in Figure 1) and the left of the green (section A in Figure 1) which are located slightly lower than the middle tier (section B in Figure 1). *iso*-lines represent areas of equal number of remaining shots until the ball was holed. Similar to isobar maps, from where the method gets its name, closely packed *iso*-lines represent larger change in difficulty and spread out *iso*-lines represent less change in difficulty (Lamb, Stöckl, & Lames, 2011; Stöckl et al., 2012).

In round four of THE PLAYERS Championship the pin was located on the lower right tier of the green (section C in Figure 1). The *iso*-lines are not circularly shaped around the hole which indicates that difficulty did not increase equally as distance from the hole increased. In contrast, classical performance analysis supposes difficulty being equally distributed around the hole and increasing equally as the distance to the hole increases (see Fearing et al., 2011; James, 2007). Furthermore, the density of the *iso*-lines shows the change in difficulty from tier to tier. The pack of *iso*-lines $iso_{1.6}$, $iso_{1.8}$ and $iso_{2.0}$ roughly illustrates the gradient between the right tier and the middle tier. The left tier was also separated from the middle tier by an *iso*-line, the $iso_{2.2}$.

On the middle tier there are two interesting areas from which the shot difficulty differed – the area within the closed $iso_{2.0}$ (section D in Figure 1), from where the field took fewer than two strokes, and the area within the closed $iso_{2.2}$ (section E in Figure 1), from where the field took more than 2.2 strokes. From the area within the

Table 1. Spearman rank correlations between players’ performance in different shot types and players’ performance at THE PLAYERS Championship and players’ average performance in 2011, represented by the PGA Tour’s money per event ranking, respectively.

	Drives	Long Approach Shots	Short Approach Shots	Around the Green Shots	Putts
THE PLAYERS	.57	.42	.22	.10	.34
Money per event (2011)	.61	.46	.29	.27	.22

*iso*_{2.0} players faced nearly a straight downhill putt and some of them were even able to make their putts from there. From the area within the *iso*_{2.2} players had to deal with break and therefore find the right speed so that the ball reached the fall line leading to the hole. These putts were more difficult to play shown by the higher ISOPAR values. Therefore, from this area within the *iso*_{2.2} some players needed three putts to hole out.

3.2. *Analysing individual player’s performance*

First, we analysed whether THE PLAYERS Championship, which always takes place at TPC Sawgrass, favours certain characteristics of play. To answer this question we calculated Spearman rank correlations between players’ tournament ranks and players’ performance ranks in the different shot types (see Table 1). To be able to find out whether these findings are unique to THE PLAYERS Championship we calculated Spearman rank correlations between players’ money per event ranks in 2011, which we used to represent average performance throughout the year, and players’ average performance ranks for the different shot types in 2011 (see Table 1). The correlation coefficients for THE PLAYERS and the average of 2011 are quite similar. There are only small differences in correlations for two shot types: around the green shots ($\rho = .10$ at THE PLAYERS and $\rho = .27$ in 2011) and putting ($\rho = .34$ at THE PLAYERS and $\rho = .22$ in 2011).

Furthermore, the correlations in Table 1 reveal that the performance in the long game (drives, long approach shots) influences overall performance more than the performance in the short game (short approach shots, around the green shots, and putts). Similarly, Broadie (2008) also reported that for prototypical professional golfers, long game shots contributed more to overall performance than short game shots.

Second, we analysed players’ performance at THE PLAYERS compared to their average performance in 2011 and eventually compared their performance of different rounds at THE PLAYERS. Table 2 shows the performance of the top three of THE PLAYERS with respect to the different shot types. Choi and Toms, who had to play a playoff to determine the winner, show different characteristics of play. Accordingly, Choi had roughly an average long game but performed well in the short game, especially putting where he saved 1.890 shots per round with respect to the average performance of the field. Toms had a very good long game where he picked up about 1.8 strokes per round by driving and long approach shots on the average of the field. Compared to their average performance in 2011 the top three performed better in nearly all shot types. Of course, this is not surprising since THE PLAYERS Championship was one of their best performances of the season.

Table 2. Shots Saved values per round for the different shot types of the top three at THE PLAYERS Championship including their Shots Saved values per round in 2011.

Player	Tournament and Year	Drives	Long Approach Shots	Short Approach Shots	Around the Green	Putts
Choi	PLAYERS	0.173	-0.162	0.403	0.379	1.890
	2011	-0.078	0.200	0.111	0.233	0.139
Toms	PLAYERS	1.086	0.775	0.042	0.315	0.545
	2011	0.005	0.147	0.021	0.114	0.369
Goydos	PLAYERS	1.060	0.494	0.161	0.663	0.052
	2011	-0.407	-0.046	0.219	-0.103	-0.527

Table 3 shows each Choi’s performance, winner of the tournament, and Donald’s performance, who was ranked as the world’s best golfer for several weeks in 2011, in the four rounds of THE PLAYERS. The pattern of both players’ performance illustrates unstable performance from round to round in all shot types. So, players do not only perform unstable from round to round (Scheid, 1990), but also perform different in these five different shot types from round to round.

4. Conclusion

In this study we have applied the ISOPAR method to performance analysis of the PGA TOUR. THE PLAYERS Championship was shown to slightly favour good short game performance compared to the rest of the tournaments in 2011. Analysis of individual players revealed that the top finishers at THE PLAYERS Championship had contrasting strengths and weaknesses. This suggests that there is not a prerequisite style of play to perform well at TPC at Sawgrass.

5. Acknowledgments

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Table 3. Sum of Shots Saved for the different shot types of Choi, the winner, and Donald.

Player	Round	Drives	Long Approach Shots	Short Approach Shots	Around the Green	Putts
Choi	1	0.012	1.148	0.259	-0.807	1.264
	2	-0.002	-0.082	0.014	-0.012	4.123
	3	0.371	-1.133	1.145	1.062	2.265
	4	0.311	-0.580	0.192	1.271	-0.093
Donald	1	0.313	-0.376	NA	-0.781	2.857
	2	0.501	1.006	0.105	0.704	0.685
	3	0.955	-0.738	0.313	0.113	-0.202
	4	-1.215	2.161	-0.039	-0.081	-1.914

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