A Method for Mathematically Comparing the Performances of Disc Golf Courses

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It is known that some disc golf courses are better tests of skill than others. This paper presents a method to compare how well disc golf courses perform against each according to their ability to sort players by skill.

Method

The job of a disc golf course is to rank players by how well they play that day. (Fun and entertainment are hobbies.) This means handing out different scores to different players in a way that is not random.

The amount of information in a set of scores given out to a specific group of players can be represented by the Scoring Spread Width of Total Scores.

> Scoring Spread Width = 2 raised to the absolute value of the sum of the frequency of each score times the $\log_2$ of the frequency.

However, there is not an absolute scale for what is a "good" spread, because the spread is heavily dependent on the number of players being observed and the range of their skill levels. A course that was played by everyone at Am Worlds will obviously have a much wider Scoring Spread of Total Scores than a course which was played only by the finalists of the Open division at a small tournament.

Therefore, the group of players to be observed needs to be standardized before course performances can be compared to each other.

One way to standardize the set of plaeyrs would be to find a core group of players that play a lot of tournaments, then evaluate all courses based on the Scoring Spread Width of Total Scores they assigned to the core group.

However, that approach limits the number of players being observed and the number of events that can be observed.

The approach I chose is to compare pairs of courses head-to-head based on their shared sets of players.

For both of the above methods, the shared group of players could, perhaps, be expanded by adding to the mix some different players of the same rating. I chose not to pursue that expansion because of difficulties of choosing among several possible players of the same rating. Also, it may not be accurate to say that all players of the same rating present similar challenges to the courses which are trying to rank them.

Example of One Match

There was a set of 16 players who played both The Santa Cruz Masters Cup presented by Innova - National Tour/Delaveaga Disc Golf Course/8209 ft and The Rumble 2019 presented by Discraft and Clint's Draft House/Camden 2/Rumble.

Delaveaga gave these players scores of 61, 67, 76, 69, 61, 70, 70, 72, 69, 69, 69, 69, 72, 69, 83, and 86.

Camden 2 gave these players scores of 50, 53, 58, 53, 51, 56, 56, 56, 54, 54, 54, 55, 57, 55, 67, and 69.

The histogram by score looks like this:
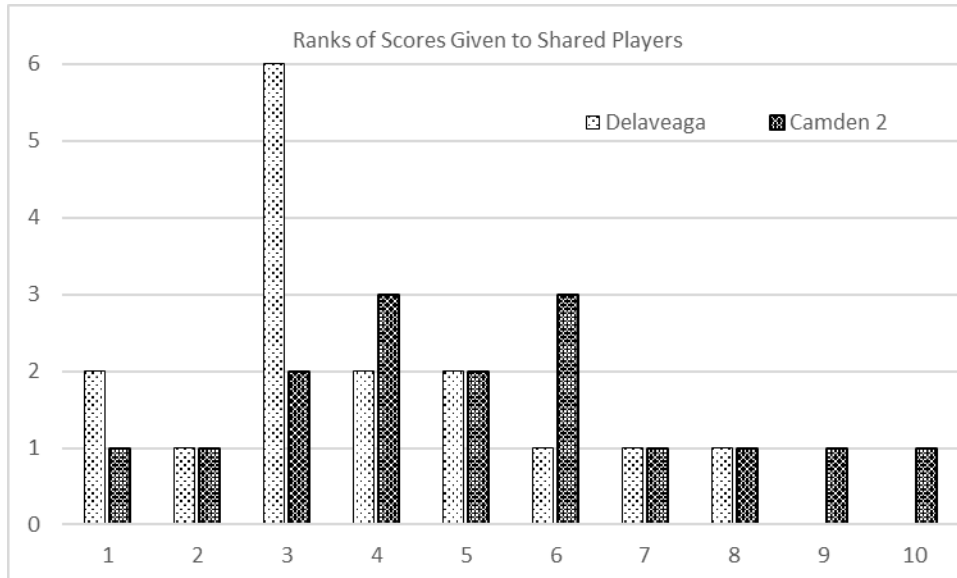
Delaveaga scores were more clumpy. It gave these players fewer distinct scores and gave a single score to more players. In terms of Scoring Spread Width of Total Scores, Delaveaga's was 6.30 while Camden 2's was 8.91. So, Camden 2 won this match-up.

Note that the order of the scores does not matter, nor does the assignment of those scores to individual players. There is no presumption about what the "right" scores would be for each player. Only randomness can give out wrong scores, and it has already been established less randomness results in better Scoring Spread Width of Total Scores.

Practical Limitations

- For data, I used the scores I already had available from my work with par. These are mostly from big events. For instance, all had the common feature of recording individual hole scores. (The hole-by-hole scores are not used for this comparison.)
- Some courses were used for more than one round for a particular event. To compare these courses to courses that were used only once, I selected the score from the first round each player played on a course at an event.
- I included only matches between courses that had at least 16 players in common. I only included courses that could be compared to at least five other courses.

- It is important to note that this method quantifies the observed *performance* of a course against a select group of performances by other courses. It is not an actual measurement of a *characteristic* of a course (as, for example, length would be.) Just as a player can have good or bad rounds, a course's performance may fluctuate around its underlying ability. And just as a player may perform better on certain courses, a course may perform better for certain types of players.
- Some courses hosted mostly MPO, or mostly AMs, or mostly FPO. There may not have been enough overlap to compare courses that served different groups. However, within each of these groups the performances should be reliably ranked.

Power Factors

After all the matches were computed and the winners found, there remained the problem of ranking the courses by their overall performance across all matches.

One way this could have been done would be with a single-elimination bracket. However, the match-ups don't fit into a bracket.

So, I computed a Power Factor for each course. The probability that course A will win a match against course B is computed with

$$1/(1+10^{(PB-PA)}).$$

Where PB is the Power Factor for course B and PA is the Power Factor for course A.

I then solved for the power factors which would generate expected wins equal to actual wins for each course.

Finally, the Power Factor can be used to rank courses according to how well they sorted players by skill. As you can see from the formula, the specific value of a Power Factor is meaningless by itself. The only thing that matters is the difference between the factors of the two courses being compared.

Results

The award for **Best Performance by a Course in 2019** goes to Quaker's Challenge at Pinchot State Park – in the QC-L/8,222 foot layout, during the 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy.

Courses, sorted by Power Factor, are listed on the following pages.

3.65 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Quaker's Challenge at Pinchot State Park - QC-L/8222

3.07 = 2019 United States Disc Golf Championship/Winthrop University/Gold B

3.07 = 2019 DGPT Tour Championship/Hornets Nest Park/DGPT Championship MPO Layout; 18 holes; Par 63; 8,905 ft.

2.66 = 2019 United States Disc Golf Championship/Winthrop University/Gold A

2.36 = 2019 PDGA Professional Disc Golf World Championships/Lake Eureka/9647

2.24 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Heritage Hills Disc Golf Course - HH/10641

1.55 = The Rumble 2019 presented by Discraft and Clint's Draft House/West Lake/Long

1.33 = 2019 DGPT - MVP Open at Maple Hill/Maple Hill/Golds; 18 holes; Par 60; 8,500 ft

1.25 = DGPT - Discraft's Portland Open presented by Bevel Craft Brewing/Blue Lake/10,220 ft

1.18 = 2019 Dynamic Discs Glass Blown Open - National Tour/Emporia Country Club/MPO

1.14 = DGPT - Idlewild Open driven by Innova Discs & The Nati/Idlewild/DGPT MPO; 18 holes; Par 68

1.02 = DGPT - AbsoluteXtracts presents the San Francisco Open driven by Innova at Gleneagles DGC/Gleneagles DGC/MPO

0.93 = The Ed Headrick Disc Golf Hall of Fame Classic presented by REC TEC Grills - National Tour Finale/WR Jackson Memorial Disc Golf Course/Jackson Long - MPO ; 18 holes; Par 68; 10,485 ft.

0.86 = Santa Cruz Masters Cup presented by Innova - National Tour/Delaveaga Disc Golf Course/8209 ft

0.83 = DGPT - Discraft Ledgestone Insurance Open 2019/Lake Eureka/9,647 ft, MPO

0.79 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Ship Rock Disc Golf Course - SR/6068

0.75 = 2019 Texas State Disc Golf Championships Presented by Discraft/Spring Valley Golf & Disc Golf/Gold

0.72 = 2019 Canadian National Disc Golf Championships Powered By Innova Champion Discs/Hillcrest Farm Disc Golf Course/Hillcrest Long (Blue); 18 holes; Par 66; 7,314 ft.

0.71 = 2019 PDGA Professional Disc Golf World Championships/Northwood/Gold 9299

0.69 = European Open 2019/The Beast/European Open 2019; 18 holes; Par 64; 2,738 m

0.62 = The Majestic 2019/Blue Ribbon Pines Disc Golf Course/BRP Pro 27 holes, 10,160 ft

0.56 = The Rumble 2019 presented by Discraft and Clint's Draft House/Camden 2/Rumble

0.47 = Beaver State Fling presented by KEEN - National Tour/Milo West/8681

0.40 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Codorus State Park - Blue - CSB/6489

0.34 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Codorus State Park - Red - CSR/7223

0.27 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Coyote Hills - CH/5910

0.26 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Klines Run Disc Golf Course - KR/6260

0.22 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Muddy Run Disc Golf Course - MR/8687

0.12 = Discraft's CCR Open 2019/Burchfield Park - Devil's Den - Renegades Trail/MPO layout; 18 holes; Par 66; 9,154 ft.

0.10 = Santa Cruz Masters Cup presented by Innova - National Tour/Delaveaga Golf Course/8713 ft

0.09 = Southwest Funding presents the Nick Hyde Memorial powered by Hyzerbomb driven by Innova - Pro Weekend/Harry Myers Park/Gold

0.07 = DGPT - 2019 Great Lakes Open presented by DISCRAFT/Toboggan/Long; 18 holes; Par 62; 9,461 ft.

0.01 = 2019 Delaware Disc Golf Challenge - National Tour/Iron Hill/Gold (MPO) ; 18 holes; Par 69; 10,240 ft.

-0.56 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Codorus Township Park - CT/5490

-1.14 = Beaver State Fling presented by KEEN - National Tour/Milo East/8596

-1.25 = 2019 Dynamic Discs Glass Blown Open - National Tour/Emporia Country Club/FPO

-1.58 = 2019 Canadian National Disc Golf Championships Powered By Innova Champion Discs/Huck It Middleton Disc Golf Course/Huck It Longs - Hurricane Dorian Baker's Dozen; 13 holes; Par 44; 5,062 ft.

-1.69 = 2019 United States Women's Disc Golf Championships - presented by Spotsy Disc Golf Club and Driven by Innova Discs/Hawk Hollow/USWDGC - Pool A; 18 holes; Par 65; 7,999 ft.

-1.69 = 2019 PDGA Professional Disc Golf World Championships/Northwood/Blue 7677

-1.83 = 2019 United States Women's Disc Golf Championships - presented by Spotsy Disc Golf Club and Driven by Innova Discs/Loriella Park/USWDGC - Pool A; 18 holes; Par 63; 7,189 ft.

-1.84 = DGPT - 2019 Great Lakes Open presented by DISCRAFT/Toboggan/Short; 18 holes; Par 60; 7,986 ft.

-2.13 = 2019 PDGA Professional Disc Golf World Championships/Sunset Hills/7539

-2.36 = 2019 PDGA Amateur Disc Golf World Championships- Powered by Prodigy/Boulder Woods at Pinchot State Park - BW/4845

-2.59 = DGPT - Discraft Ledgestone Insurance Open 2019/Sunset/7,045 ft

-4.01 = DGPT - Discraft's Portland Open presented by Bevel Craft Brewing 2019/Blue Lake/8,980 ft

Future Enhancements

Because this method does not rely on hole-by-hole scores, it could be applied to the results on the PDGA's Event Results pages. This would allow for more comparisons between courses, as well as comparisons between rounds on the same course.

Bonus Speculation

Power Factor as a Function of Course Length

$y = 0.0004x - 3.3691$
$R^2 = 0.158$
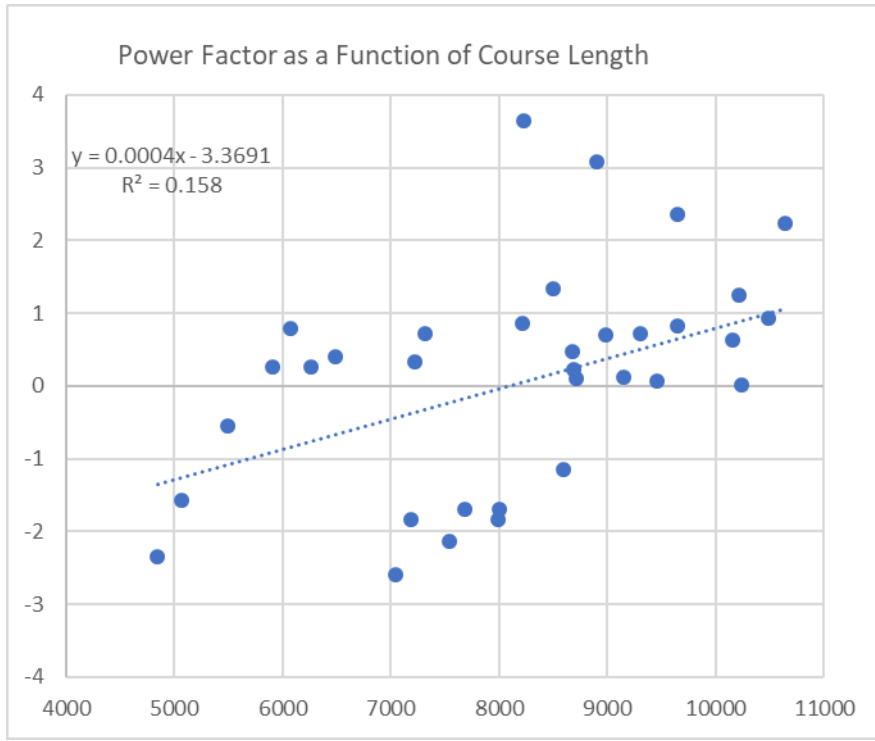
Unsurprisingly, there seems to be a relationship between course length and the ability of a course to sort players by skill. However, length isn't everything; it's only 15.8% of everything. If length were everything, one could expect that adding 2400 feet to a course would improve the course so much that it would outperform the shorter length 90% of the time.