Measuring The Fit of a Disc Golf Course to The Players That Play It

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Tournament Directors can increase the value of their services by providing appropriate disc golf courses for the various skill levels of the players. This paper presents a way to measure how well a course fits the skills of the players.

Fit

Fit, as used here, is based on two ideas, both related to scores:

> One, that course can be too hard or too easy for certain players.
>
> Two, that a course should provide variety to players, with some holes that can be completed with few throws, and some that take several throws.

So, "fit" means scores that are not too high or too low or too monotonous. This will be further refined later.

Other aspects of fit, like simple rules for new players, or sufficient room for spectators for top-level competition, are not covered here.

Ideal

Many designers and course designers seem to be gravitating toward a consensus that an ideal course would be par 63, with more par 3s than anything else, a couple of par 5s, one par 2 (or "ace-able par 3"), with the rest par 4.

This gives us a basis for the ideal scoring distribution. However, a par 63 course would normally allow more than one 2, and some 6s. So, what we want for the ideal distribution is the scores that would actually happen on a par 63 course.

I looked at the thousands of rounds of data I have about scores and calculated the scoring distribution for each standard par from 2 to 5. These are the results:

Par \ Score	1	2	3	4	5	6	7	8	9	Average
2	0%	67%	27%	5%	0%	0%	0%	0%	0%	2.38
3	0%	19%	58%	18%	3%	1%	0%	0%	0%	3.08
4	0%	1%	20%	49%	22%	6%	1%	0%	0%	4.19
5	0%	0%	1%	18%	41%	26%	10%	3%	1%	5.37

Applying the 1x2, 9x3, 6x4, 2x5 mix of pars gives us the following for the ideal scoring distribution for 18 holes.

1	2	3	4	5	6	7	8	9	Throws
0.025%	14%	37%	28%	14%	5.2%	1.5%	0.41%	0.16%	65.96

With this distribution, most of the throws (27.69) actually happen on the par 3 holes, only a few (2.38) happen on the par 2, and 25.15 happen on the par 4s, with 10.74 coming from the par 5s.

The total score of about 66 might seem high at first glance. That's not the scores we see from the lead card at top events, and it's not the scores we see at most courses in causal play.

> However, lead cards are the exception. Those players are playing above their rating for that event. Grabbing the latest DGPT event (Portland Open 2022), we find that the average score for the entire field was 67.09.
>
> Also however, if we consider that most courses are out-dated (from the all par 3 era), or limited by land or money constraints, perhaps the scores we are accustomed to are the result of disc golf not being fully grown yet.

Quantifying the Fit

We want to see how close a course's actual scores are to the ideal scoring distribution. Since "close" implies distance, let's use statistical distance, specifically, Bhattacharyya distance. This compares the frequency of each score in the actual distribution to the frequency of each score in the ideal distribution.

1. For each score, find the product of the actual frequency times the ideal frequency.
2. Take the square root of the resulting products.
3. Sum the square roots.
4. Bhattacharyya distance is the negative of the log of the sum.
5. However, I want the best Fit to be 100%, so I use 1 minus the distance.

The order of the scores doesn't matter, just how many of each there are. The number of holes doesn't really matter either, the same ideal frequencies can be used for any number of holes. For example, on a 27-hole course there should be about ten scores of 3.

This method can be applied to the scores from a single course from any group of players: one round by one player, or many rounds from one player, or many rounds from players of a given skill level, or all players in a division, or all players from an event. There's no reason it couldn't also be applied to the entire set of courses at one event.

Samples

For a player (on a course with the 1/9/6/2 distribution of pars) who scores par on every hole, the fit is 94.68%.

All birdies = 76.95%,

All par = 94.68%

All bogeys = 78.60%,

All double bogeys = 41.91%,

All triple bogeys = negative 7.47%,

All par plus four = negative 52.90%.

Negative values are nothing to be concerned about. Fit is defined as one minus distance, and distances can be bigger than 1.

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Here are all the scores from Prodigy Disc Pro Tour 2022 - Heinola, which admirably served a fairly narrow band of skill levels using just one course.

1	2	3	4	5	6	7	8	9	10
1	711	2,268	1,809	793	257	73	24	3	1

The average score was 65.79, and the fit is 99.89%. This shows that the ideal distribution is not unobtainable, and that it is close to the goal TDs are currently shooting for.

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Let's look at flat scores. All 2s would be a fit of 7.18%, all 3s = 53.69%, all 4s = 38.17%, all 5s = 2.46%, and all 6s = -46.72%.

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To see how much of the fit is dependent on only the average score, a course that gives out only 3s and 4s and averages 65.96 would only have a fit of 75.74%.

It is possible to have a course that averages 76.70 which would have a fit of 96.07%, or a course that averages 60.86 which would have a fit of 94.81%.

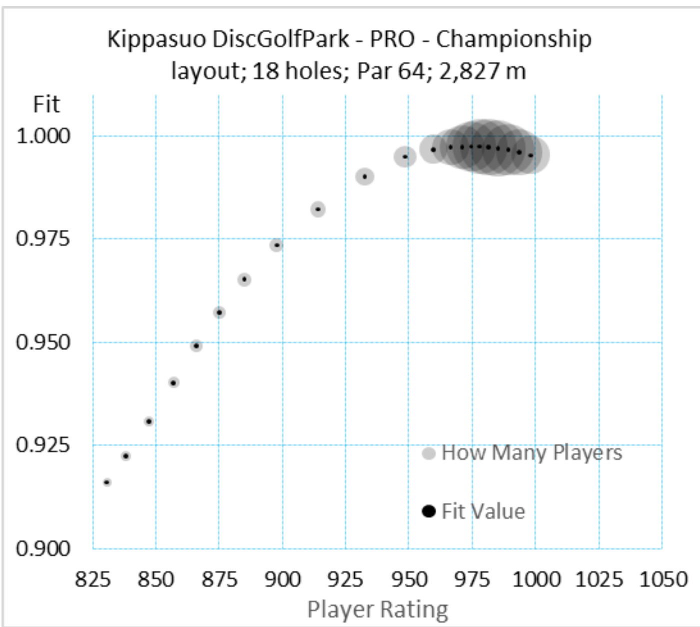
Representation of Fit Across Skill Levels

For post-event analysis it would be helpful to be able to see the distribution of ratings of players who played a course, plus the fit at various skill levels.

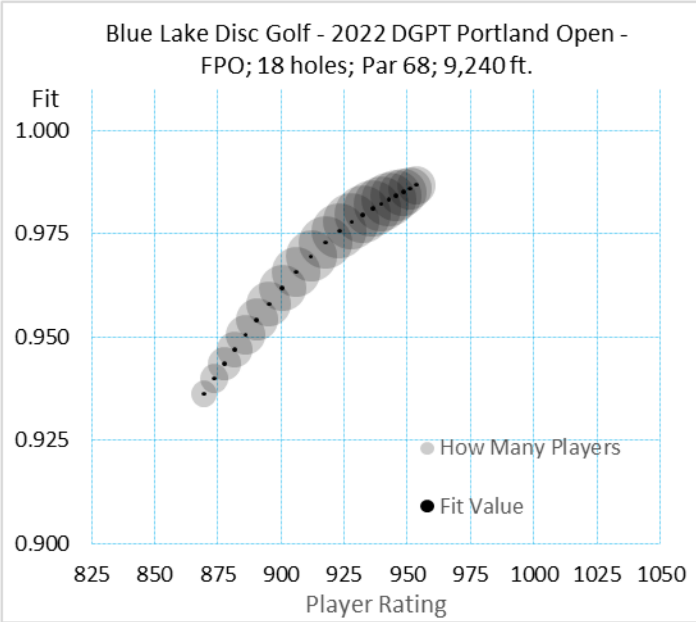
A bubble chart can show this, with the x-axis being player rating, the y-axis being the fit, and the size of the bubble representing the number of players. However, showing each individual player - or each unique rating - is too chaotic.

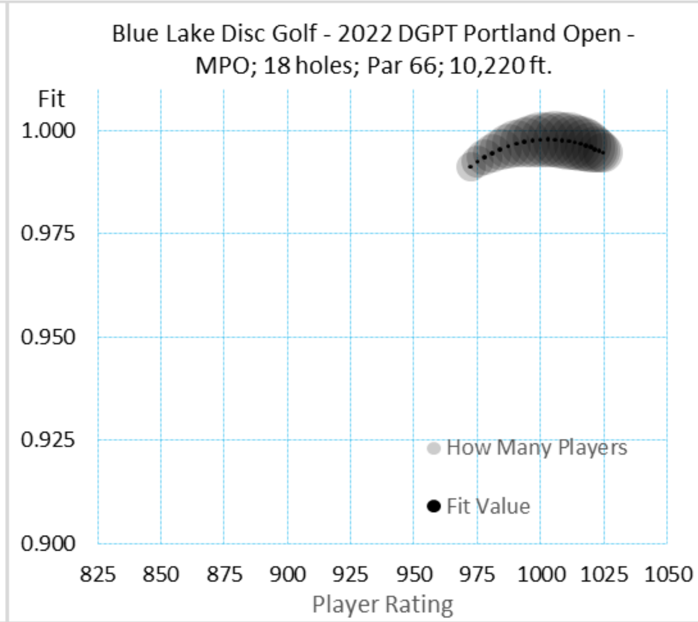
To group and smooth the results, I chop the range of ratings into 21 equal parts and summarize each section. The average rating, the fit of the frequencies of all their scores, and the number of players are shown on the bubble graph.

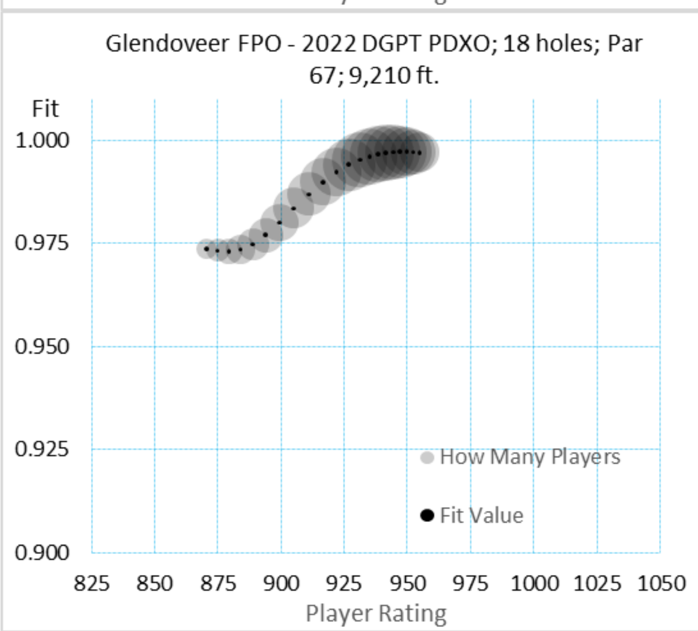
Here is the graph for the Prodigy Disc Pro Tour 2022 - Heinola. This shows how similar (most of) the players were in skill level, and the excellent fit for them. It also shows the few lower-rated players for whom the course was not as good a fit.

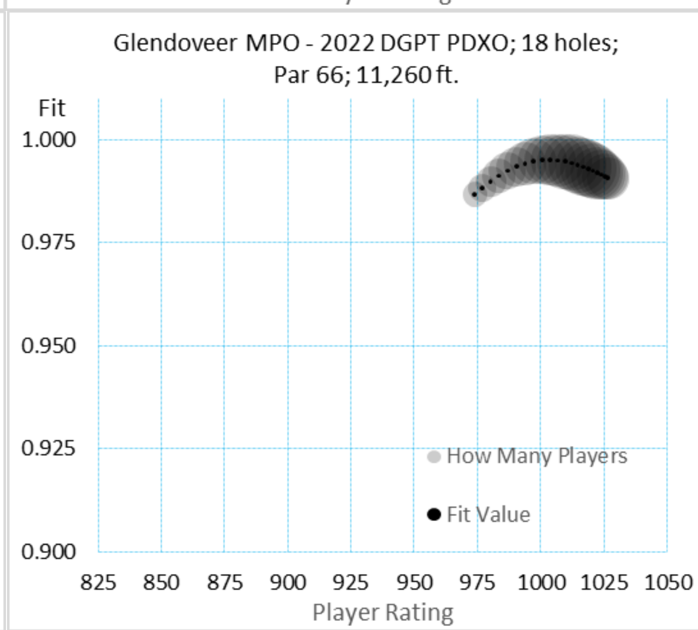


Here are the graphs from 2022 DGPT - Portland Open presented by Dynamic Discs.









From the chart upper left, we can see that Blue Lake's FPO layout is too hard for FPO. The fit keeps going up as ratings go up - which means fit goes up as scores go down. So, Blue Lake should be made easier to be a better fit for FPO.

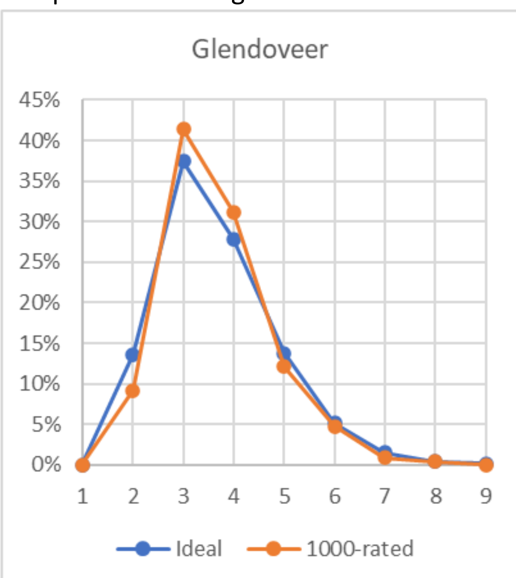
How much easier? Let's focus on the FPO players rated 850 and up as contenders. The mix of high and low scores is already pretty good, so if we just reduce the average score, it should result in a good fit for the contenders. The average score for these players was 71.77, which was also the average score for a 935-rated player. The fit for a 935-rated player was 98.07%. The 65.96 average of the ideal distribution corresponds to a rating of 1013, which would have a fit of 99.60%.

To get the average score down to optimal, the course would need to be shortened by 1500 feet, or about 85 feet per hole.

From the chart upper right, we can see that Blue Lake's MPO layout has its maximum fit for players just above 1000-rated. Higher ratings and lower ratings don't have quite as good a fit.

From the chart lower left (above), we can see that the FPO layout on Glendoveer was much better optimized for FPO players than Blue Lake. However, its best fit is for 947-rated players. Shortening the course by 425 feet is indicated.

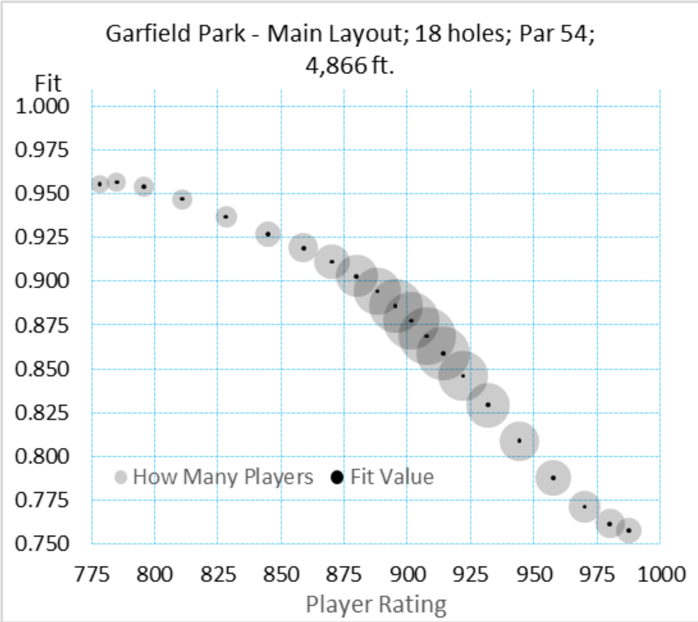
From the chart lower right (above), we can see that Glendoveer was also optimized fairly well for the MPO players, but not as well as Blue Lake. The average score is already close to ideal, so we need to compare the scoring distribution for 1000-rated players to the ideal.



We see there are too many 3s (a common problem), too many 4s, and not enough 2s.

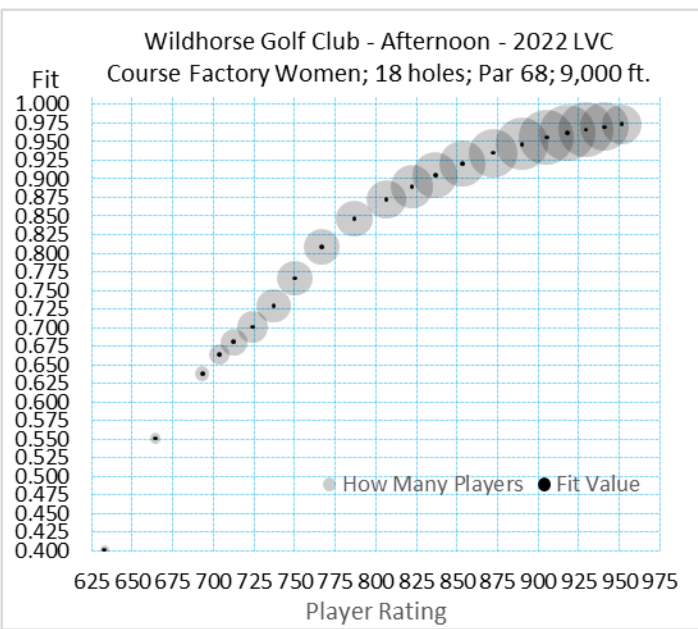
Looking at the distribution of scores by hole (not shown) I see holes #3, #6, and #13 have more than the recommended cap of 66% of the scores being equal to 3. Holes #7, #9, and #17 look to be 4-heavy for holes of that difficulty.

Here is an example of a course that was too easy for the field.



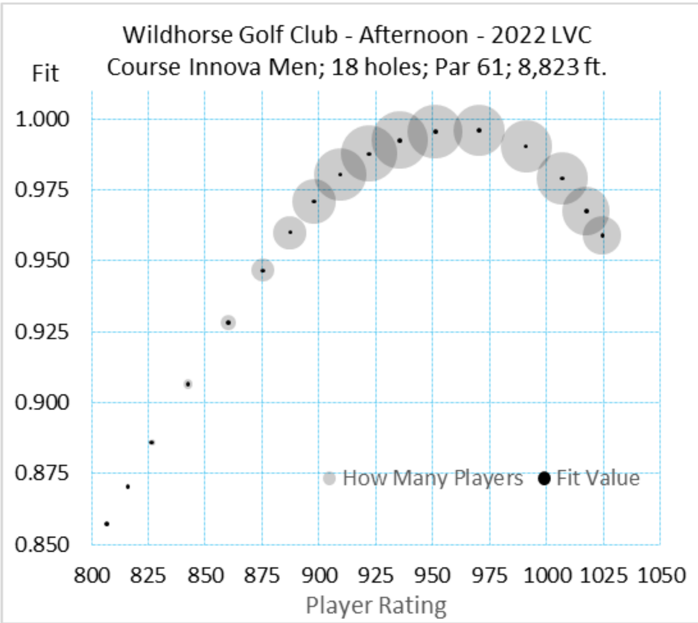
The fit gets better as the rating goes down, and the fit is never very good. This means the fit would be better for everyone if the course was made more difficult. Or, if another course was substituted.

Here is an example of a course that tried to serve too many lower rated players with a course that was still too hard for the highest-rated in the field.



The fit is not great, and is still on an upward trend at the highest ratings, so the course would fit the players better if it were made easier. For the lower rated players, a different course (or set of tees or baskets) would be needed to provide a good fit.

Here is an example of what happens when a Blue-level course tries to host all the Mixed skill levels.



The fit is pretty good at about 950, but for players scoring either lower or higher than an Advanced player, the fit is not as good. Perhaps it would help to add some longer tees or targets, as well as some shorter tees or targets, and split the field into three parts.

Conclusion

With the proper visualization, a modification of Bhattacharyya distance from an ideal distribution to measure can quickly show how well a course fits a group of players, and can lead to course improvement.

Amendment 7/4/2022

I think the ideal used above results in too high of scores. We rarely see any courses that create scores of 67 for 1000-rated players.

So, rather than use the par 63-based ideal pulled out of thin air, I decided to assume that the biggest events have been doing a good job of fitting the course to 1000-rated players. Whether they have or not, this is what people have come to expect. So, trying to fit courses to this ideal will not result in anything too weird.

I looked at the scoring distributions of all holes from events that had at least 100 rounds of data for 1000-rated players. The average of these results in the following Ideal distribution of scores (per 18 holes):

Score	Per 18
1	0.0041
2	3.0533
3	7.4112
4	5.0281
5	1.8003
6	0.5155
7	0.1381
8	0.0367
9	0.0125

This creates an average score of 3.44 per hole, or 61.92 per 18 holes, or 92.88 per 27 holes.

While it would be tempting to ignore the less-frequent scores, having a smattering of 1s, 7s, etc. is actually fairly important to the ability of a course to separate players by skill.