

# Measuring Brutality in Disc Golf Course Design

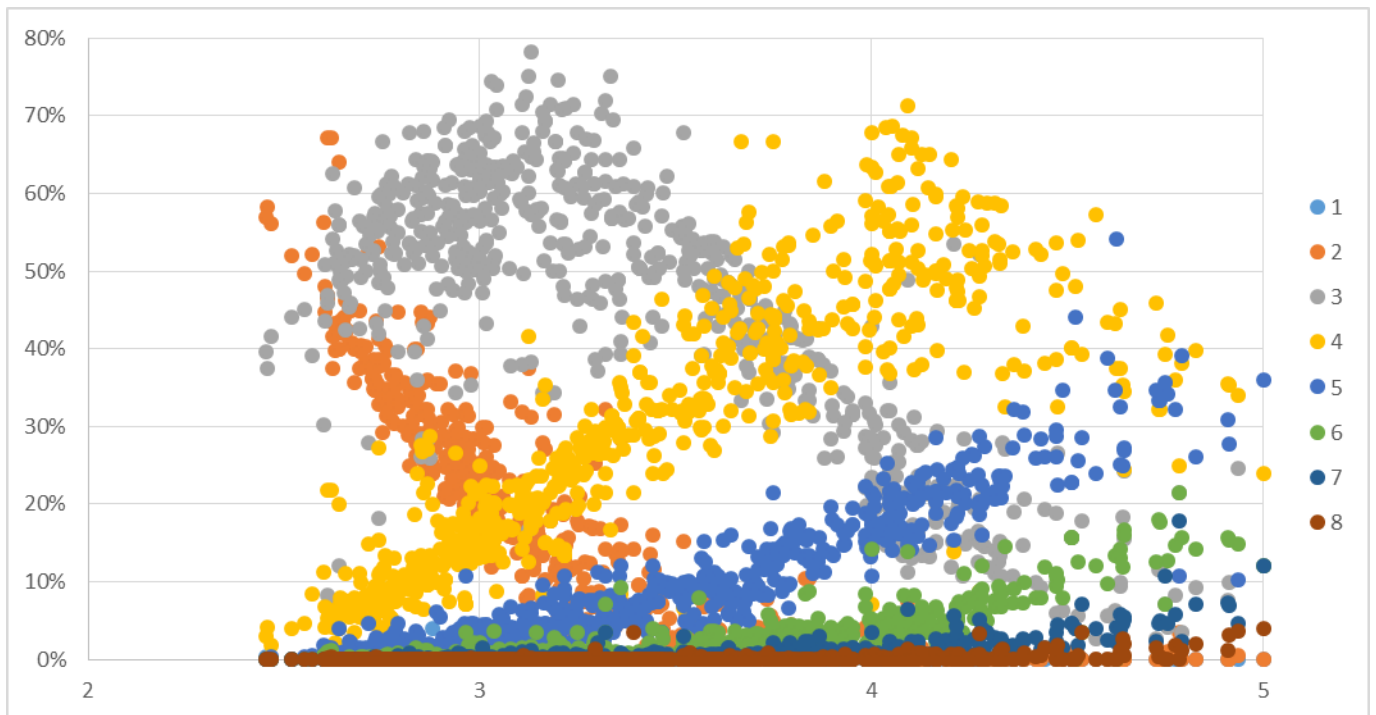
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At the Ledgestone Open, the Tournament Director set out to make holes that test the toughest players in the world. To do this, he added stringent rules and defined landing zones. Together, these rule- and design- modifications produced a distribution of scores that was fundamentally different than what is seen on most other disc golf courses. This paper attempts to find and measure the difference by comparing the actual distribution of scores to the distributions that would be expected from vanilla holes.

## Vanilla Holes

The following chart shows the frequency of various scores as a function of average score. This was calculated using a data base of scores from 692 holes. The frequencies and average scores include all the players.



As can be seen, the frequency of a particular score (like the gray 3s) peaks when the average score of a hole is near that score. Also, the pattern seems to follow a bell curve.

This can be approximated by normal distributions with  $X$  being the average score of the hole. Specifically, the mean for the distribution of score  $N$  is  $N+1$ . The standard deviation for the distribution of score  $N$  for average score  $X$  is  $0.325677+0.121968*X$ .

Using these normal curves, we can plug in an average score, and get the expected distribution of scores for regular disc golf holes. As an example, here is the regular distribution for a hole that averages 3.25:

Score	1	2	3	4	5	6
Frequency	0.7%	16%	54%	28%	2.1%	0.02%

## Difficulty, Wide-Open Score, Regular Trouble, and Brutality

Difficulty is measured by average score.

Wide-open score is the portion of the average score which is solely determined by length. It is the score that would be expected on a flat hole with no obstacles.

Trouble is anything besides length that increases the average score. An example would be uphill elevation. Regular Trouble acts much like additional length.

Brutality is anything that increases the magnitude, but not the frequency, of higher scores. In other words, brutality is more-than-normal punishment for unavoidable mistakes.

An example of brutality would be a penalty throw for missing an intended landing zone with no option to lay up. Note that the usual number of players could be expected to hit the landing zone, so the frequency of low scores would not be affected much.

Because the frequency of low scores is relatively unaffected by brutality, the brutality-free distribution can be approximated by looking at the regular hole which has the nearly the same frequency of low scores as the hole being examined. The amount of brutality is the amount by which the higher-than-regular scores increase the average score of the hole being examined.

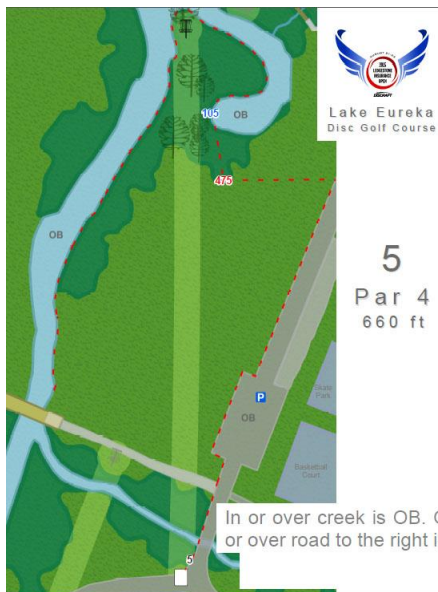
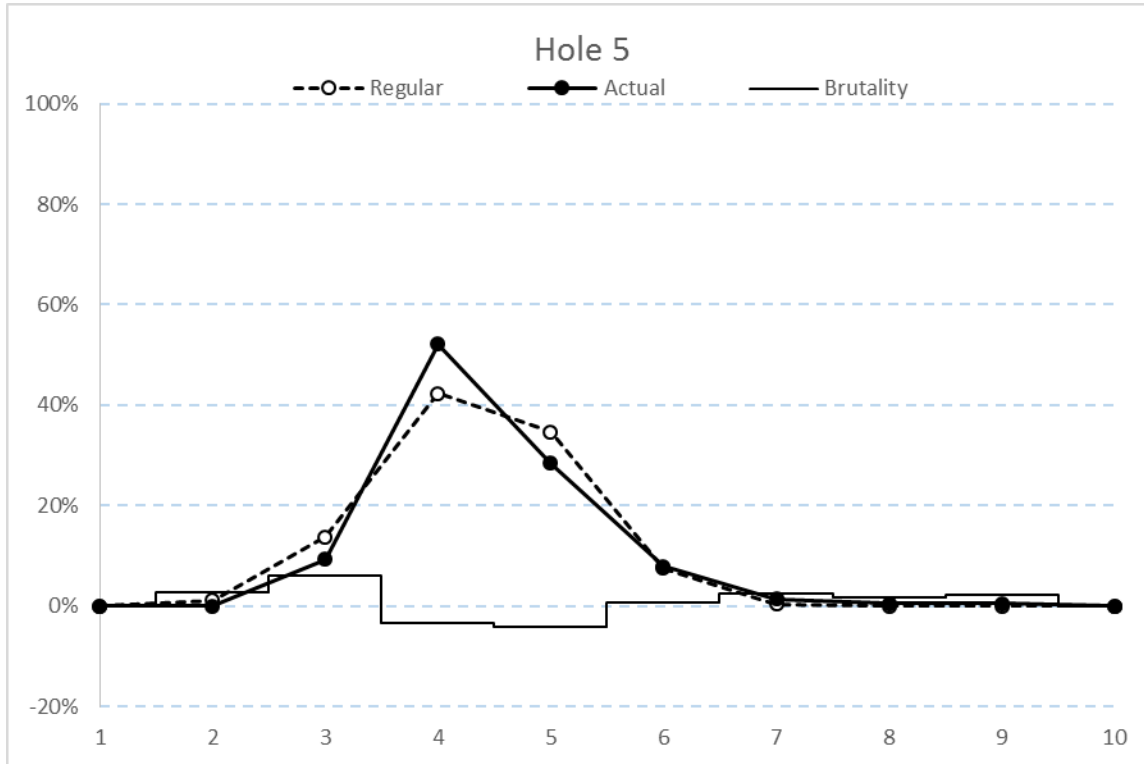
Subtracting out the brutality leaves the sum of wide-open score and regular trouble. Subtracting out the wide-open score leaves regular trouble.

For Eureka Temp, the scores break down like this:

Hole	Wide-Open Score	+ Regular Trouble	= Average Regular Score	+ Brutality	= Actual Average Score
1	2.52	0.02	2.55	0.25	2.79
2	4.22	0.96	5.17	1.26	6.43
3	2.46	-0.08	2.37	0.23	2.60
4	2.56	0.21	2.77	0.59	3.36
5	3.56	0.80	4.36	0.07	4.43
6	2.71	0.99	3.71	1.74	5.45
7	3.61	0.27	3.88	1.05	4.93
8	2.40	0.07	2.47	0.11	2.57
9	2.71	0.52	3.24	0.97	4.21
10	2.53	0.66	3.19	1.09	4.27
11	3.70	0.69	4.39	0.14	4.53
12	3.49	0.43	3.92	0.42	4.33
13	2.74	0.22	2.96	0.02	2.98
14	2.35	0.29	2.64	0.33	2.98
15	2.38	0.23	2.61	0.23	2.83
16	2.90	0.45	3.35	0.17	3.53
17	2.94	0.24	3.18	0.92	4.09
18	2.67	-0.28	2.39	0.32	2.72

## Detailed Examples

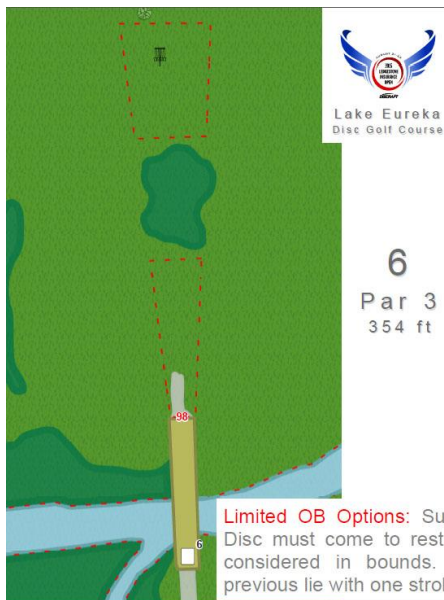
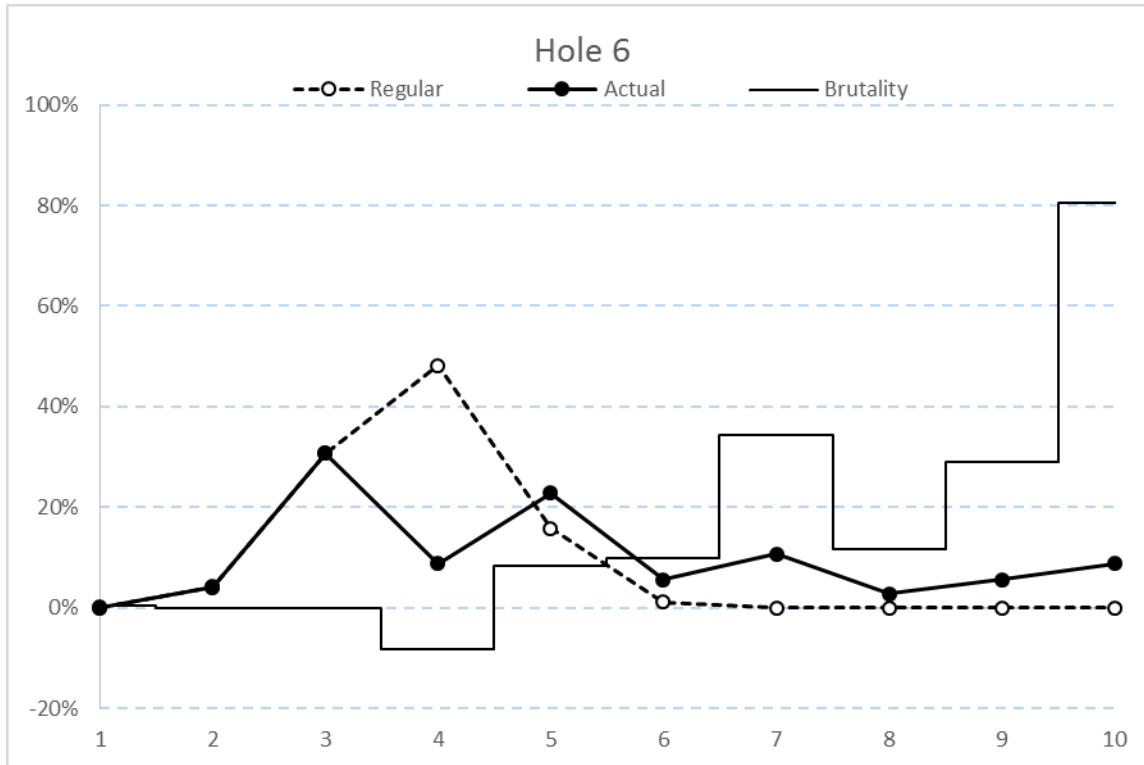
Hole 5 has the least brutality, yet has plenty of regular trouble. Its profile looks much like a regular hole. Any brutality calculated might be just noise.



Hole 6 had the most brutality. Something turned a lot of what would otherwise be 4s into higher scores.

Note: On this chart brutality is scaled for the impact it had. So, scores of 10 and up added 0.81 throws to the average score.

The saw-tooth pattern of the distribution of actual scores indicates that penalties were handed out 2 at a time, and could be handed out multiple times to the same player. Errors that would regularly turn a 3 into a 4, actually turned a 3 into a 5 with echoes at 7, 9, 11, etc.



## **The Impact of Brutality**

It is tempting to ask how the tournament would have been different without the brutality. However, any hypothesis about what the scores would be without the brutality would be speculation. Generating a brutality-free set of scores may tell us more about the chosen method of erasing the brutality than about the brutality itself.

What would be preferable would be at least one more round at the same course with the same players with no artificial out of bounds and/or with regular OB rules.