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The Second "Little Red Book"

Does a Relationship Exist between the Loft of Golf Club and the Distance Traveled by the Golf Ball?

Morgan Cannon
University of Mississippi

INTRODUCTION: STATEMENT OF TASK AND PLAN

The game of golf is one that requires both physical precision and concentration of the mind. Globally, people of all ages are devoted to mastering the challenge of golf. According to Rice University's "Is There a Relationship between the Club Face Angle and the Distance Traveled by the Ball", by studying the relationship between mind, body, and equipment, players may improve their game. The purpose of this study is to investigate a potential relationship between club face angle, and the distance a golf ball travels after stricken.

Golf is defined as playing a ball with a club in an effort to hit balls into holes in a few strokes as possible. The game is played with 14 clubs max, the choice of which is at the discretion of the player. Each club has a different loft, or club face angle in order to produce shots that travel at varied lengths. Typically, golf bags contain 2 woods, a putter, and 11 irons. Woods are used off the tee, and are intended to produce the longest shot possible for a golfer, usually. A putter is used on the green to get the ball to the hole. Irons are used, in most cases, to hit the ball to the green after the tee shot. Irons vary in loft and club length, and are chosen based on how far away the ball is from the green/hole.

In this investigation, woods and putters are disregarded, as the data produced would not be as relevant or consistent to this investigation as the results produced by the

(11) irons. The data draws from results from a player's use of a Sand Wedge (SW), a Lob Wedge (LW), a Pitching Wedge (P), and irons 2,3,4,5,6,7,8, and 9. As previously stated in the research question, two factors are observed: the loft of the iron (club face angle), and the distance a golf ball travels when stricken with the iron. With consideration to different stances and swings, for example chip shots use a half swing whereas fairway irons require a full bodied swing, the test subject attempts to be as consistent as possible with regards to force. Wes Cain, amateur of Fairhope Boys Golf Team in Fairhope, Alabama is the test subject. Wes is ranked 2839 overall worldwide, according to Junior Golf Scoreboard. His outstanding record as an amateur and consistent swing allows for increased accuracy in my investigation, as opposed to using a lesser qualified test subject. The swing Wes attempts to recreate on each repetition is a full bodied swing, and his stance is approximately 58 inches in width. Furthermore, Wes completes 5 trials at Rock Creek Golf Club, and 5 trials at Lakewood Golf Club. To determine if a correlation is present between loft and distance, the mean is calculated, along with the construction of a scatterplot with LSRL, a residual plot, Pearson Product Moment Correlation calculations, and the coefficient of determination r^2 .

INFORMATION, MEASUREMENT, AND MATHEMATICAL PROCESSES

Does a Relationship Exist between the Loft of a Golf Club and the Distance Traveled by the Ball?

In this investigation, an attempt is made to gain the most accurate results by conducting a total of 10 trials at 2 different golf clubs, Rock Creek and Lakewood of

Fairhope, Alabama. To measure the distance the ball travels, a range finder is used (Bushnell Golf Tour Pro v3 Slope Patriot Pack), which considers differences in elevation when calculating distance traveled and is highly accurate. The results are as follows:

Distance Traveled (Yards)											
Rock Creek Golf Club (T1-T5)						Lakewood Golf Club (T6-T10)					
Club	Loft	Trial 1	2	3	4	5	6	7	8	9	10
2	20°	193	189	189	185	184	188	191	192	184	192
3	23°	177	174	172	181	180	174	179	174	173	179
4	25°	169	168	158	163	161	166	156	160	169	158
5	28°	145	155	146	145	151	154	155	148	148	146
6	31°	139	138	145	135	144	141	137	145	142	138
7	34°	127	135	135	125	126	132	135	131	128	125
8	37°	125	117	119	116	117	124	119	121	121	115
9	41°	105	105	112	112	114	109	106	109	115	112
P	45°	100	102	105	102	103	101	98	97	101	104
SW	55°	56	59	60	58	63	65	60	59	57	61
LW	60°	31	33	33	30	35	31	28	30	27	34

These results clearly indicate that as the loft of a club increases, the distance a golf ball travels decreases. This initial data alone is

not enough to illustrate a correlation. Below is a table that represents the **total** and **mean distances** (in yards).

MEAN

$$20^\circ \quad 193 + 189 + 189 + 185 + 184 + 188 + 191 + 192 + 184 + 192 = 1,887 \text{ yards}$$

$$1,887 \text{ (yards)} / 10 \text{ (trials)} = 188.7 \text{ yards}$$

$$23^\circ \quad 177 + 174 + 172 + 181 + 180 + 174 + 179 + 174 + 173 + 179 = 1,763 \text{ yards}$$

$$1,763 \text{ (yards)} / 10 \text{ (trials)} = 176.3 \text{ mean distance in yards}$$

$$25^\circ \quad 169 + 168 + 158 + 163 + 161 + 166 + 156 + 160 + 169 + 158 = 1,628 \text{ yards}$$

$$1,628 \text{ (yards)} / 10 \text{ (trials)} = 162.8 \text{ yards}$$

$$28^\circ \quad 145 + 155 + 146 + 145 + 151 + 154 + 155 + 148 + 148 + 146 = 1,493 \text{ yards}$$

$$1,493 \text{ (yards)} / 10 \text{ (trials)} = 149.3 \text{ yards}$$

$$31^\circ \quad 139 + 138 + 145 + 135 + 144 + 141 + 137 + 145 + 142 + 138 = 1,404 \text{ yards}$$

$$1,404 \text{ (yards)} / 10 \text{ (trials)} = 140.4 \text{ yards}$$

$$34^\circ \quad 127 + 135 + 135 + 125 + 126 + 132 + 135 + 131 + 128 + 125 = 1,299 \text{ yards}$$

$$1,299 \text{ (yards)} / 10 \text{ (trials)} = 129.9 \text{ yards}$$

$$37^\circ \quad 125 + 117 + 119 + 116 + 117 + 124 + 119 + 121 + 121 + 115 = 1,194 \text{ yards}$$

$$1,194 \text{ (yards)} / 10 \text{ (trials)} = 119.4 \text{ yards}$$

$$41^\circ \quad 105 + 105 + 112 + 112 + 114 + 109 + 106 + 109 + 115 + 112 = 1,099 \text{ yards}$$

$$1,099 \text{ (yards)} / 10 \text{ (trials)} = 109.9 \text{ yards}$$

$$45^\circ \quad 100 + 102 + 105 + 102 + 103 + 101 + 98 + 97 + 101 + 104 = 1,013 \text{ yards}$$

$$1,013 \text{ (yards)} / 10 \text{ (trials)} = 101.3 \text{ yards}$$

$$55^\circ \quad 56 + 59 + 60 + 58 + 63 + 65 + 60 + 59 + 57 + 61 = 598 \text{ yards}$$

$$598 \text{ (yards)} / 10 \text{ (trials)} = 59.8 \text{ yards}$$

$$60^\circ \quad 31 + 33 + 33 + 30 + 35 + 31 + 28 + 30 + 27 + 34 = 312 \text{ yards}$$

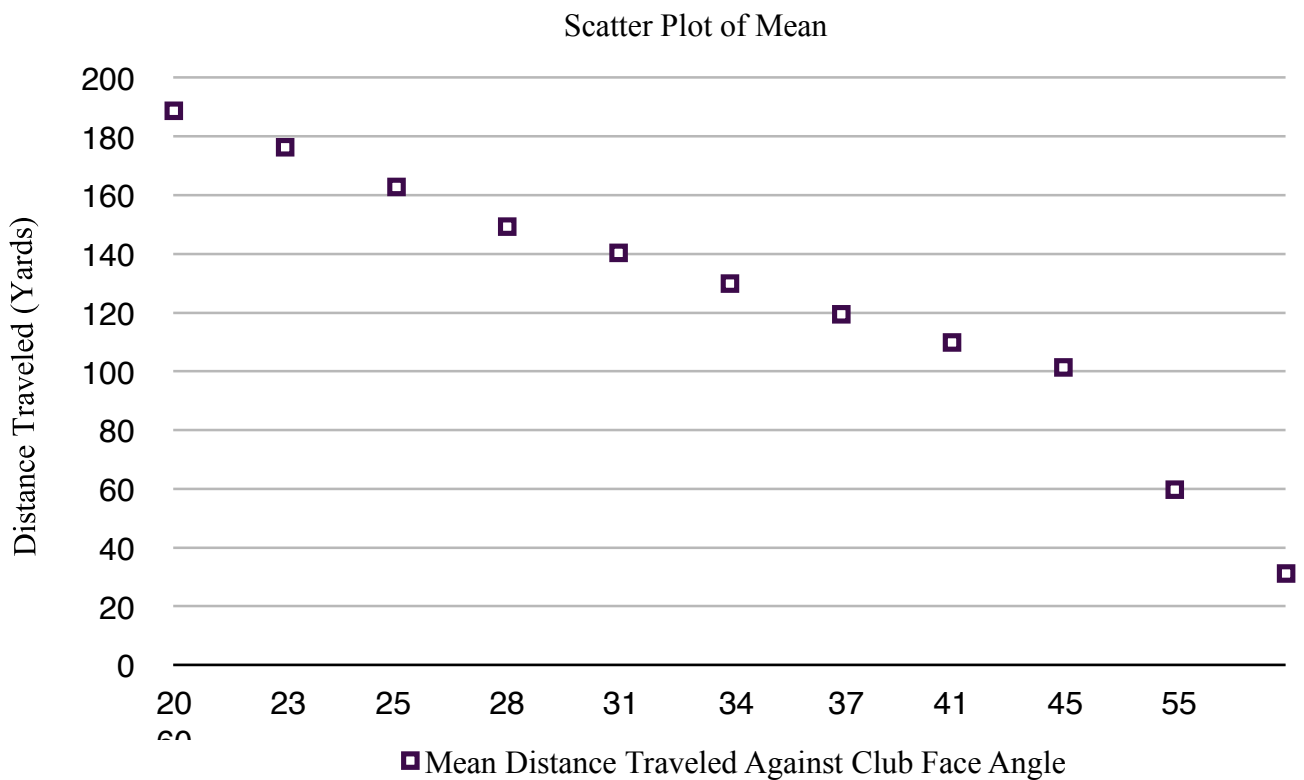
$$312 \text{ (yards)} / 10 \text{ (trials)} = 31.2 \text{ yards}$$

Loft	Distance Traveled (yards)	Mean Distance (yards)
20°	1,887	188.7
23°	1,763	176.3

Loft	Distance Traveled (yards)	Mean Distance (yards)
25°	1,628	162.8
28°	1,493	149.3
31°	1,404	140.4
34°	1,299	129.9
37°	1,194	119.4
41°	1,099	109.9
45°	1,013	101.3
55°	598	59.8
60°	312	31.2

LEAST SQUARES REGRESSION LINE (LSRL)

Predicted $Y = a + bX$



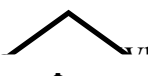
L_1 = Loft (degrees)
 L_2 = Distance (yards)
 linreg (a+bx) L_1 L_2 Y_1

LinReg a+ bx	
y=	a + bx
a=	2574.084792
b=	-36.65396671
r^2 =	0.9896304375
r=	0.9948017076

LSRL: distance = 2574.08 - 36.65 (loft)

LSRL Interpretation:

Slope For every 1 degree increase in loft, distance should decrease by an average of approximately 36.65 yards.

Y-Int  never loft is 0 degrees, the ball should travel approximately 2574.08 yards.

Above, is a **scatter plot** and the calculated **LSRL** that illustrates the average distance traveled against the loft of the club. In observing the graph, it can be seen that there exists a strong negative correlation. Next, a residual plot is used for further support in this investigation. Then, to further support the idea that a relationship exists between distance traveled and club

face angle, the **Pearson Product-Moment Correlation Coefficient** is used to measure the linear correlation between variables X and Y (distance and angle) to determine a value of 1 (positive correlation), 0 (no correlation), and -1 (negative correlation).

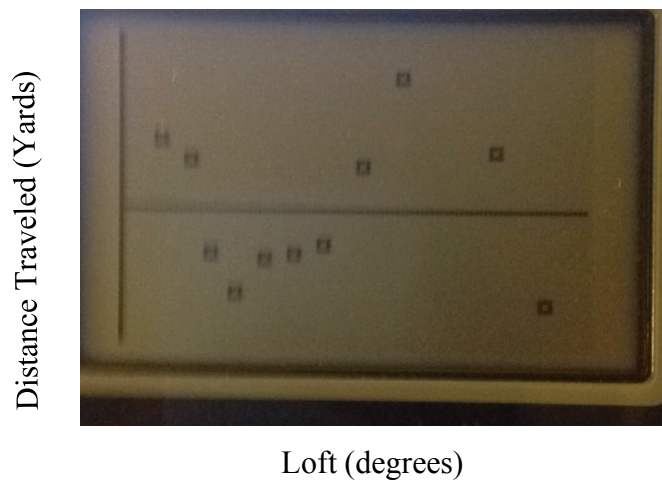
L_1 = Loft (degrees)

L_2 = Distance (yards)

L_3 = RESID

Because the residual plot displays almost no pattern, the a linear model is appropriate.

Residual Plot



Club	Angle (Degrees) X	Distance (Yards) Y
2	20	188.7
3	23	176.3
4	25	162.8
5	28	149.3
6	31	140.4
7	34	129.9
8	37	119.4
9	41	109.9
P	45	101.3
SW	55	59.8
LW	60	31.2

X	Y	XY	X²	Y²
20	188.7	3774	400	35607.69
23	176.3	4054.9	529	31081.69
25	162.8	4070	625	26503.84
28	149.3	4180	784	22290.49
31	140.4	4352	961	19712.16
34	129.9	4417	1156	16874.01
37	119.4	4418	1369	14256.36
41	109.9	4506	1681	12078.01
45	101.3	4559	2025	10261.69

$$r_{xy} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

X	Y	XY	X ²	Y ²
55	59.8	3289	3025	3576.04
60	31.2	1872	3600	973.44
Total= 399	Total= 1369	Total= 43491.5	Total= 16155	Total= 193215.42

$$n=11$$

$$\sum x = 399$$

$$\sum y = 1369$$

$$\sum xy = 43491.5$$

$$\sum x^2 = 16155$$

$$\sum y^2 = 193215.42$$

$$\frac{43491.5 - 11(399/11)(1369/11)}{\sqrt{16155 - 11 \times (399/11)^2} \sqrt{193215.42 - 11 \times (1369/11)^2}} =$$

$$r = \frac{-6165.863636}{41.01440988 \times 151.1196456} = \frac{-6165.863636}{6198.083084} = -0.9948017076$$

$$\frac{-6165.863636}{41.01440988 \times 151.1196456}$$

$$\frac{-6165.863636}{6198.083084}$$

$$41.01440988 \times 151.1196456$$

$$= 6198.083084 = -0.9948017076$$

$$r = \text{approx. } -0.995$$

$$r^2 = \text{approx. } 0.990 = 99\%$$

Since $r = \text{approx. } -0.995$, it can be seen that there is a strong, negative, linear association between the angle of a golf club and the distance the golf ball travels. Since $r^2 = \text{approximately } 99\%$, approximately 99% of the variation in distance is explained by the linear relationship with loft. The correlation coefficient r measures the strength of a linear relationship between two variables on

a scatterplot, and -0.995 indicates a strong, negative, linear relationship between loft and distance traveled. A high percentage, such as 99%, indicates that the model explains all the variability in the response data. Generally, the smaller the club face loft, the greater the distance traveled by the ball.

VALIDITY AND CONCLUSION

Strengths	Weaknesses
Topic for investigation was not difficult to conduct	Only 10 trials (samples) were taken/ conducted
The topic and results were easily predicted and as expected	Accuracy/ consistency of a single golfer as test subject varies

Improvements
Take more samples
Use different golfers (additional)
Use different range finders to ensure accurate distance

In the research, an attempt is made to maintain a collection of data, in order to receive the most accurate results, by using golfer Wes Cain, who attempted to maintain the most identical swing possible. As it is practically impossible to maintain identical club speed and height each rep, Wes's golf instructor, observed his swing during the data collection process. Two variables were

not controlled during the data collection process, the length of the club shafts, which differed between irons, and the weight of the club heads. Altering these variables would challenge the results' use by golfers, as most do not alter their shafts and club head weights to be of equal length and heaviness.

In conclusion, this investigation resulted in support for the hypothesis. It

appears that there is a strong, negative, linear association between the loft of a golf club and distance traveled by the ball.

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