Analyzing the Driving Distance of a Golfer

New Mexico

Supercomputing Challenge

Final Report

April 2, 2014

Team 141

School of Dreams Academy

Student Researcher:

Jose Montoya

Teacher:

Creighton Edington

“Analyzing the Driving Distance of a Golfer”
Table of Contents

Executive Summary ................................................................. 4

Introduction .................................................................................. 5

Statement of Problem ................................................................. 6

Procedural Plan and Methods used to Conduct Experiment ..................... 7

Mathematical Model ................................................................. 13

i. Model Number One ............................................................. 13
ii. Model Number Two ............................................................ 15
iii. Model Number Three .......................................................... 16

Computational Model ................................................................. 18

i. Layout of the Computational Model ........................................ 19
ii. How was the Netlogo Model Conducted? ............................... 21
iii. Why are there circle in Appendix A.? ................................. 22
iv. Explanation of the Code in Appendix E. ................................. 22
v. Future Plans and Implementations into the Model ....................... 23

Data Collection and Factors vs. Driving Distance .............................. 24

i. Swing Speed vs. Driving Distance ....................................... 24
ii. Height vs. Driving Distance ............................................... 28
iii. Weight vs. Driving Distance ............................................. 32

Results ........................................................................................... 35

Discussion .................................................................................... 37

Conclusion .................................................................................... 37

Most Significant Accomplishment ................................................ 38

Acknowledgments ........................................................................ 39

“Analyzing the Driving Distance of a Golfer” 2
References ............................................................................................................. 40

Appendix A: Photo Showing how the Shots of the Golfer in the Code will end up .... 41
Appendix B: Data Collection for Ten Male and Female Golfers ......................... 42
Appendix C: Dictionary of Related Terms .......................................................... 50
Appendix D: Development of pitch Shot Percentages ................................. 52
Appendix E: Code from Netlogo Representing a Golfer Playing a Hole ........... 54

“Analyzing the Driving Distance of a Golfer” 3
Executive Summary

With this project, “Analyzing the Driving Distance of a Golfer” I wanted to find a basis of where I would be able to hit in the future based on my height and weight that the doctors predicted for me. I wanted to find several ways that a golfer would be able to find his or her average driving distance. Different ways can include a computation model, mathematical model and a swing speed monitor. I collected statistics from two-hundred and one male and one-hundred female golfers. These statistics included height, weight, swing speed, average carry distance and average driving distance. All data collection was from the PGA Tour (Professional Golf Association), LDA (Long Drivers of America), and LPGA Tour (Ladies Professional Golf Association) web pages.

In the end, I found out that the driving distance of a golfer is based on weight, height and most importantly the swing speed of the golfer. The weight of a golfer helped me find the golfers driving distance when two golfers were the same height but different weights. Golfers who are the same height but different weights will have a minimal effect on their driving distance.

The ideal male golfer has a height of 6’ 3” to 6’ 7”. The best weight for maximum driving distance for the golfers at these heights is between 200 and 240 pounds. The ideal female golfer has a height of 5’ 7” to 5’ 11”. For females height is the key factor because the weight of female golfers was unable to be found during research. The maximum driving distance for women was around 260 yards while the maximum driving distance for males was around 310 yards. At my predicted height and weight, I will be able to swing the golf club at 111 mph and hit the golf ball 270 yards on average.
Introduction

Two-hundred-and-ninety-two yards, 272 yards, and 285 yards are just some of the average distances of the most famed golfers of our pastime. These golfers include Tiger Woods, Jack Nicklaus, and Matt Kuchar. All three of these golfers are taller than five feet ten inches and are tour professionals.

I am 5’ 1” and I love to play the game of golf, but I can only hit the golf ball 195 yards. The question is, will I ever be able to be a pro golfer, or does our height limit us to put-putting around?

My project, *Analyzing the driving distance of a golfer*, is focused on the height and weight of each golfer and how far they drive the ball off a tee and the carrying and roll of the of the ball using drivers. Using the dependent variable, the distance traveled by the golf ball and the independent variable, the height and weight of each golfer, I will determine the effects of height and weight on the distance of a golf ball.

I participate in golf throughout the year. As an active golfer I chose this project to determine my standards when it comes to maximum and average distances that I will be able to hit a golf ball. My project, *Analyzing the distance of a golfer* will give me vital information on how height and weight of a person affects the distance of a golf ball and help me develop better course management.

For those who may be unaware of some golf terminology in this report I included a glossary of golf-related terms to help the readers better understand my project. Please see Appendix C. for definitions of golf-related terms. Thanks!

“Analyzing the Driving Distance of a Golfer” 5
Statement of Problem

Thousands of people start the game of golf every year. Unfortunately, hundreds of beginners enter the game ready to hit the golf ball three-hundred yards like professionals. The golfers who expect to hit long drives when they start the game of golf tend to quit the game when they find themselves not hitting the golf ball to their expectations. This ultimately leads to a golfer’s disappointment because of their expectations on driving distance. Consequently, data collection is needed to study golfers driving distance and to determine a way to show golfers their future driving distances.

There are nine factors that could be included in this project, but three main factors. These factors include height, weight and swing speed. One of the factors that cause golfers a decrease in swing speed and driving distance includes lag. Lag is the power that it takes a golfer to hit the golf ball with force. If a golfer lacks power they will lose swing speed and most importantly, driving distance. In Figure one the golfer is pictured mid-swing. For a golfer to receive ultimate power, they must keep an L or V shape during their swing. As seen in the photo, the golfer positioned himself in an L shape and later into a V shape. The problem is that to test the driving distance of a golfer, I need all of them to have proper lag. Therefore, I only used LDA, LPGA, and PGA tour golfers in this experiment. The picture on the next page is (Figure 1) from Golf Digest Magazine. The picture shows the lag of a golf swing. One of the factors I considered as the independent variable for the driving distance of a golfer included lag. Lag is the source of force on the golf ball and can affect the driving distance of a golfer by 10’s of yards.
Lag – Lag is the force to hit a golf ball. Golfers who hit the golf ball with lag increase their driving distance and swing speed because lag applies force towards the club head and the golfer’s ability. For me, lag affects my driving distance the most. Players with more experience than myself have an easier time hitting the ball with more distance because they have more lag in their swing than myself. This is because I am eight to fifteen inches shorter than most professional golfers. According to Chuck Evans from an Article on the About.com webpage he states, “The Golfing Machine, by Homer Kelley, describes this "secret" as "clubhead lag" and cites that "it is simple, elusive, indispensable, without substitute or compensation and always present””(Evans). The book by Homer Kelly introduces the effects of driving distance and the lag of golfers driving distance. Without lag the swing of a golfer will have no wrist cock and no release of energy and power. This results in a huge slice for a golfer. Fortunately, all golfers researched are trained professionals and have a constant lag of force behind their drives.
**Procedural Plan and Methods used to Conduct Experiment**

The procedural plan consists of researching hundreds of golfer’s data from the 2013 PGA Tour, LPGA Tour, and LDA web pages and implementing the data into different models. The procedures conducted are as followed:

1. Go to a local golf course and begin a warm-up.

2. After you warm-up take out your Golf Course G.P.S. and hit twenty drives.

3. Walk towards your golf balls and write down your distance in yards for each golf ball hit that is near each other. Avoid outliers while writing down your data.

4. Using the Swing Speed Monitor test your swing speed in miles per hour by hitting ten drives.

5. Write down your height into inches and your weight in pounds.

Steps 1-5 were used to get my personal data for the research. The original plan was for me to test my driving distance based on my height, weight and swing speed. Then I would compare the data of PGA Tour golfers based on their height and weight.

6. Log onto the Professional Golf Association webpage (www.pgatour.com) and research several male and female golfers in the Players page and collect their name,
7. Collect the data using the metric system. This means convert height into centimeters and weight into kilograms. Swing speed will be in mile per hour and carry and driving distance will be in meters.

8. Once the data is collected from the Professional Golf Association Tour website and converted into metric units of measurement (height, weight, swing speed, driving distance, and carry distance) with the metric system the next step is to import the data of all golfers into an Excel spreadsheet.

9. Once the information is in an Excel spreadsheet, the next step is to include your own driving distance, carry distance, swing speed, height, and weight. Import the data into graphs labeled; maximum driving distance (height cm vs. distance), maximum driving distance (swing speed mph vs. distance), and maximum driving distance (weight kg vs. distance.)

10. Next, add your own personal data to study the results and decide if the data includes an outlier or if it follows the trend line.

“Analyzing the Driving Distance of a Golfer” 9
11. The next step is to create a computational model representing the maximum driving distance of the golfers used in the experiment.

The next steps are to compare the data collection in a computational model. In this case I used Netlogo to compare the driving distance of a golfer based on height, weight and swing speed.

12. To create the computational model you need to download Netlogo off the internet and begin a program.

13. Get pictures from different golf courses around your hometown that shows every hole in an aerial position.


15. Using written codes publish those pictures and set your area of the screen to the size of the pixels in the pictures. Ex. If a picture is 289x289 your screen in the Netlogo program needs to be 289x289

16. Lastly, import the data into the computational model and mathematical function.

* The mathematical model is only used to test the use of the data collected for future purposes. DD (Driving Distance in Meters) = Swing Speed (mph) * 2.29

“Analyzing the Driving Distance of a Golfer” 10
This mathematical model was formed with Tiger Woods 2013 PGA tour stats.

268.1(Driving Distance of Tiger Woods in meters) = 117 (Swing Speed) * 2.29 (x)

17. Ex. For a model researched based on height, find the equation on the Excel graph labeled Driving Distance vs. Height. This will give you an equation to imput as your variable in the code.

18. The first step to take once all of the needed data is converted into inches to centimeters for both male and female golfers and weight into kilograms for the golfers with available weight.

19. The next step is to convert the carry and driving distance of each golfer into meters from yards. Swing speed will stay the same, which is recorded in miles per hour.

20. The next step in analyzing the data is to import converted data into an Excel spreadsheet. This data includes height in centimeters, weight in kilograms, name of the golfer, and swing speed in miles per hour.

21. Graph the data into (Height in cm vs. Driving Distance), (Swing Speed vs. Driving Distance) and (Weight in kg vs. Driving Distance.)

22. The next step is to validate that the mathematical formula below follows your results for the recorded data. If yes, continue to step 7.

\[
DD \ (Driving \ Distance) = \text{Swing Speed} \times 2.29
\]
• The data can range from 2.19 to 2.39 if not equal to 2.29

23. If not, take the DD of the recorded data and divide by the Swing Speed of the golfers and collect that number as a key replacement number for 2.29. Continue to step 7.

24. Next, graph your carry distance in meters, weight in kg, driving distance in meters, swing speed in mile per hour and height in centimeters.

25. You will be able to analyze the graph once again. If your data matches with the trend line you will know your capabilities of driving distance and carry distance in the future based on your height, weight and swing speed. If you tend to be the obvious outlier you need to begin a new research with different golfers or study different swings and revise your data based on swing speed, driving distance, carry distance, weight and height.

In the end, four graphs were used to base height, weight, club degree angle, and swing speed of male and female golfers. A computational model in Netlogo was also constructed and a mathematical model.
Mathematical Model

Using the golfer’s height in centimeters and swing speed in kilometers per hour I constructed a system to measure driving distance of a golfer. Using the data collected from golfers such as those listed in Appendix B I imported this data into the mathematical model. Any mathematical model that wants to use can be used. Mathematical models can be written using yards, meters, miles per hour and any other correlated way of measuring distance.

Mathematical Model Number One:

This model uses Driving Distance in meters and Swing Speed in kilometers per hour. For each model the swing speed for each golfer is mandatory to find driving distance based on swing speed.

Ex. Swing Speed (kph) / (1.35 to 1.50) ➔ That is a range of numbers that you can divide by to get your driving distance in meters when your swing speed is in kilometers per hour.

\[ \text{Driving Distance (m)} = \frac{\text{Swing Speed (kph)}}{\text{m/kph}} \]

Tiger Woods: (PGA)

\[ \frac{268}{188.3} = 1.426 \]

\[ 268.1 = \frac{268.1}{188.3} \]

“Analyzing the Driving Distance of a Golfer” 13
Ian Poulter: (PGA)

\[
257.6 / 185.1 = 1.391
\]

\[
257.6 = 185.1 \cdot \frac{257.6}{185.1}
\]

Y. E. Yang: (PGA)

\[
262.2 / 178.6 = 1.468
\]

\[
262.2 = 178.6 \cdot \frac{262.2}{178.6}
\]

Jose Montoya: (Junior)

\[
187.5 / 136.8 = 1.37
\]

\[
187.5 = 136.8 \cdot \frac{187.5}{136.8}
\]

Carl Wolter: (LDA)

\[
301.8 / 217.8 = 1.385
\]

\[
301.8 = 217.3 \cdot \frac{301.8}{217.3}
\]

Emily Cho: (LPGA)

\[
228.4 / 164.2 = 1.39
\]

\[
228.4 = 164.2 \cdot \frac{228.4}{164.2}
\]
Yani Tseng: (LPGA)

\[ \frac{235.2}{167.4} = 1.405 \]

\[ 235.2 = 167.4 \times \frac{235.2}{167.4} \]

Mathematical Model Number Two: Mathematical model number shown below has a difference of two tenths. There is a difference because 2.29 is not a set number to say that there is a driving distance of Swing Speed multiplied by 2.29. This model represents the swing speed of a

Ex. \( \text{Driving Distance (m)} = \text{Swing Speed (mph)} \times (2.19-2.39) \)

Tiger Woods: (PGA)

\[ 268.1 = 117 \times 2.29 \]

Ian Poulter: (PGA)

\[ 257.6 = 115 \times 2.24 \]

Y. E. Yang: (PGA)

\[ 262.2 = 111 \times 2.36 \]

Jose Montoya: (Junior)

\[ 187.5 = 85 \times 2.21 \]

Carl Wolter: (LDA)

\[ 301.8 = 135 \times 2.24 \]

Emily Cho: (LPGA)

“Analyzing the Driving Distance of a Golfer” 15
Mathematical Model Number Three: This mathematical model uses the driving distance for golfers in yards and their swing speed in miles per hour. In America, this mathematical model would be the easiest to conduct. Driving distance in America is conducted in yards while the swing speed is conducted in miles per hour. Therefore, this model is the easiest to present to the Professional Golf Association of America. The model multiplies the golfers swing speed in miles per hour and a range of numbers between 2.25 and 2.45.

Ex. Driving Distance (yds.) = Swing Speed (mph) x (2.35-2.60)  
Range of numbers that can be multiplied by the Swing Speed of a golfer in miles per hour to get a predicted total for driving distance in yards.

Yani Tseng: (LPGA)

\[ 228.4 = 102 \times 2.24 \]

\[ 235.2 = 104 \times 2.26 \]

Tiger Woods: (PGA)

\[ 293.2 = 122 \times 2.40 \]

Ian Poulter: (PGA)

\[ 281.7 = 115 \times 2.45 \]

Y. E. Yang: (PGA)

\[ 286.7 = 111 \times 2.58 \]
Jose Montoya: (Junior)

\[201.1 = 85 \times 2.37\]

Carl Wolter: (LDA)

\[330 = 135 \times 2.44\]

Emily Cho: (LPGA)

\[249.8 = 102 \times 2.45\]

Yani Tseng: (LPGA)

\[257.2 = 104 \times 2.47\]
Computational Model

At first the idea was to make a computational model in Netlogo to show an image of a driving range with multiple golfers simulating a drive at their respective height. Over the course of time the model was inaccurate and did not represent the driving distance of a golfer as well as it should have. Therefore, I changed the concept and simulated a hole on a golf course.

My new idea was to simulate a hole with one golfer playing the designated hole in Netlogo. In my model I am representing a single hole at a golf course. At the beginning of the code I can input the golfer’s gender, height, weight and swing speed. The hole will stay the same, but the golfer can change. The golfer’s driving distance can change due to any of the factors that can affect the drive of a golfer. These factors include: height, weight, and swing speed, type of golf course, club degree angle, weather, lag, carry distance and experience.

The driving distance of a golfer model helps other golfers develop course strategy and improve course management skills. Golfers who import their data into the computational model will better understand their game and expectations of where they should be at the respective height, weight and swing speed. The following pages describe why I chose to complete my computational model the way that I did.
I. Layout of the Computation Model

This is a screenshot from the code that I made in Netlogo. The screenshot above shows the amount of shots that it takes a golfer of “x” height, “y” weight, and “s” swing speed to hit a golf ball into a hole. The hole represented in the screenshot is a triple dogleg. This means that there are three corners on the hole. The green patches represent the fairway that the turtle (golf ball) travels on. The brown patches represent trees as an example of strategy while playing a golf hole. The first shot represents the average drive for the golfer playing that hole at “x” amount of height and weight. The code differentiates between a golfer’s weight and height and determines the average driving distance for that golfer. While making two Excel graphs I determined a formula

“Analyzing the Driving Distance of a Golfer” 19
representing the golfer’s height and imported the formulas main numbers into the code to represent an actual driving distance for a golfer. The purpose of the code was to represent one turtle to be the driving distance of the golfer, but after the full research was conducted, I decided to represent the code as a hole in golf. Below is a screenshot of my code using the function “to golf.” In the Appendix my whole code is written.

```
to tee-off ;; this is the drive which is the longest of the shots
    facexy 24 20
    right random 5
    left random 5
    forward (25 + (random 2))
    set hit hit + 1
    wait .5
end

to second-shot ;; this is the second shot and we begin a right and left random
    ifelse ycor > (((-1 ^ xcor ^ .833) + 17.165 )
        [ facexy 40 8
        ]
        [ facexy 42 12
            set color yellow
        ]
    right random 5
    left random 5
    forward (24 + (random 3))
    set hit hit + 1
    wait .5
end

to third-shot ;; This shot has two options aim area a or aim area b
    ifelse ycor > (((xcor ^ .588 ) + 17.94) 
        [ facexy 75 21
            set color white
        ]
        [ facexy 75 11
            set color red
        ]
    right random 5
    left random 5
    forward (24 + (random 3))
    set hit hit + 1
end
```

Figure 3

“Analyzing the Driving Distance of a Golfer” 20
II. How did I conduct the Netlogo Model?

At first, I made the course layout. The hole represented in the code is 800 yards. The gray is considered out of bounds and the brown is considered as trees to act as an obstacle. The green grass is the fairway, while the lime colored grass is the green. I then made a tee box for the golfer to start. My next step was to begin golfing.

I called my function “golf” and began a layout using the code “to golf.” I then picked a spot on the course where the average driving distance of a 5’ 10” golfer would be hit. I then made a function to make the shot of the golfer forty yards less than their drive until they get to their drive on their fourth shot. On the fifth shot the golfer will hit a pitch shot to the green. My development method of this process is in Appendix D. On the sixth and seventh shot if not in the hole yet the golfer will make an attempt at the hole by putting the ball. Finally, at the end of the code the shot counter counts the amount of tries it takes the golfer to hit into the 800 yard hole.
III. Why are there circles on the screenshot in Appendix A.?

These circles represent the landing area of the golf ball. On the first shot there is one full circle for landing spot. See (Figure 17). On the second shot there are two possible landing spots for optimum strategy. The third landing spot has four possible landing spots. The fourth landing spot has eight possible landing spots. All shots from there have a chance of pitching the golf ball into the hole. This leads to a pitch and putt game for shots five through seven. The minimum and maximum amount of tries it takes to get into the hole.

IV. Explanation of the Code from Appendix E.

The code begins by setting the patches at their set designated spot. The trees (brown patches) are set at the third dogleg. Out of bounds is defined as gray. The fairway consists of three doglegs and the green is at the leg of the last dogleg. The first shot begins the “to golf” sequence. This sequence begins with a 280 yard drive from a 5’10” golfer. The next three shots are hit as woods. These shots are forty yards less on average than the shots from a driver. Therefore, these equal 240 yards. The distance, however, is not always 240 yards because the dog legs offer the golfer strategy on where they should hit their next shot. The fifth shot is a pitch shot while the last two shots, if not made are putts from the green or fringe. The code then finishes and the shot counter counts how many shots it took the golfer to hit into the 800 yard hole. That is the description of the code that I conducted through the challenge.
V. Future Plans with this Code

With this code I want to model golf courses across the state of New Mexico. My next step is to import the driving distance of those at “x” height, “y” weight and “s” swing speed. Once this can be implemented I want to give my Computational Model to these respective golf courses to help their golfers know their expectations on that golf course. I hope that this information could be posted on the golf courses web page and they can accredit me as the creator of the golf simulator at their course.

My model will have trees to act as brown and water to act as blue. The green color will be fairway and the lime color will be the green. The red will be a hazard and the hole will always be black. Out of bounds will be gray and yellow will represent the rough.

For this project the original plan was to find my future driving distance and compare them to PGA Tour golfers. This project became more complex and let me focus on several types of golfers at different ages. This was a cool project and for my Netlogo code I hope that it helps all golfers of all ages, heights, weights and swing speeds. Most importantly, I know that it will help me find my driving distance in the future. Along with the mathematical model, the computational model was added to my project to help me, but it turned out to help other golfers in the long run.
Data Collection and Factors vs. Driving Distance

I. Swing Speed vs. Driving Distance

The graph below (Figure 4) represents the driving distance of ten PGA Tour male golfers based on their swing speed. The graph proves that Driving Distance is affected enormously by swing speed. Male golfers with 120+ mph swing speeds are expected to hit the furthest.

Figure 4
The two graphs on the next page include my driving distance and swing speed. The first graph is a scatter plot graph. In the first graph (Figure 5) the number at the bottom left is my average swing speed and driving distance. This helped me understand how the height, weight and swing speed affects the driving distance of a golfer the most. The next graph (Figure 6) shows a linear angle of the male golfer’s swing speed and driving distance correlation. This assured me that I will be able to hit 270+ yards if I get a 110+ mph swing speed.

The swing speed for male golfers on the PGA Tour affects their driving distance the most. The graphs represented below gave me the idea to incorporate swing speed and its affect on driving distance in my mathematical and computational model because it is affected the most out of the three independent variables. This finalized my research and let me focus on predicting and finding the driving distance of others. Thus, allowing me to develop the mathematical model and computational model.

In an article about the factors on the driving distance of a golfer Sandy Reese states, “If your swing speed with the driver doesn't exceed 100 mph you are giving up distance.” A golfer who swings the club less than 100 mph loses a lot of distance. Based on the graphs that include me I am hitting the golf ball on a linear plane. I am not losing distance with my swing speed, but I am shorter than all of the PGA Tour golfers listed on the graph. This is a huge factor that affects driving distance based on height and weight vs. swing speed. It is cool to see a correlation between the three factors and become one.
Figure 5

Figure 6

“Analyzing the Driving Distance of a Golfer” 26
The graph below represents the driving distance of ten female golfers on the LPGA Tour. This graph proves that the driving distance of a female golfer is affected by the swing speed, but is more vital for male golfers. For females, the swing speed is only a small factor in determining the driving distance of a golfer. Females with swing speeds over 96 mph are expected to hit the furthest.

![Female Driving Distance(yd) vs. Swing Speed(mph)](image)

Figure 7

The four graphs shown on pages 28-30 develop an idea of how swing speed affects the driving distance of male and female golfers. In figures three and four my data was added to the collected data from ten PGA Tour golfers. Comparing these data points I follow a steady linear path and will be able to hit in the 270’s with a 110 mph swing speed. My predicted swing speed was 111 mph.
II. Height vs. Driving Distance

Figure 8

Figure 8 (above) shows ten male golfers’ height in centimeters and their driving distance in meters. The graph shows a good linear progression until the golfers get around 193 centimeters in height. This is a noticeable difference of 21 meters. My first observation was that I could not figure out why there was such a difference, but after some more research I concluded that the golfer who hit the furthest weighed more than the golfer who hit the least. In conclusion, when a golfer is the same height as another golfer the lightest golfer is more likely to hit lesser in driving distance than the one with a bigger build.
Figure 9

Male Height (cm) vs. Driving Distance (m) including Jose Montoya

Figure 10

Male Height (cm) vs. Driving Distance (m) including Jose Montoya

“Analyzing the Driving Distance of a Golfer” 29
In figure nine on page twenty-nine I added my height in centimeters based on my driving distance in meters. Noticeably I am the outlier in the sequence. In figure ten on page seventeen this is proven based on the linear line conducted. The line is above my height by about 30 meters. Based on my height I am hitting my drive 30 meters less than those at my height on average. The statistics that I received encouraged me to want to increase my driving distance and conduct a new experiment with my data based on my height. The graph below shows my data with my new average driving distance in meters. In figure eleven I am still below the average but I increased my driving distance by about 20 meters over the course of the new experiment and the old one. I am more pleased with these results then the last one.

Figure 11
In figure twelve I entered data from ten touring professionals on the LPGA Tour. The data entered included the golfer’s height in centimeters and their driving distance in meters. In conclusion, I discovered that when female golfers are taller than 6’ they tend to hit shorter distances than those at 5’ 10” and 5’ 11”. This left me clueless. These golfers who hit shorter may have a faster swing speed but have a more flexible shaft for their club. This is another factor that can play into the driving distance of female golfers. Every golfer needs their correct shaft. For females height and swing speed were the two main factors (independent variables) that I conducted experiment with. Weight could not be recorded because LPGA Tour golfer’s weight is not posted to the public. I assume that weight has the same affect on female driving distance as it does on male driving distance.
III. Weight vs. Driving Distance

Figure 13

Figure thirteen (above) includes ten PGA Tour male golfers weight in kilograms and driving distance in meters. The weight of the golfer shows a positive relationship with the driving distance of a golfer. The graph on page thirty-three (Figure 14) includes my weight in kilograms and my driving distance in meters. Noticeably, my driving distance is less than those on average at my weight. In figure fifteen the linear graphs shows that my weight does not show where my average driving distance should be. My BMI may not be where it should be because I am heavier than most at my height, but my driving distance was still not where it should be. Based on the two graphs on page twenty-one I need to try and be at about fifty-three kilograms based on my height and driving distance. This will give me maximum driving distance for my height at 5’ 2”.

“Analyzing the Driving Distance of a Golfer” 32
“Analyzing the Driving Distance of a Golfer” 33
A graph conducted with female weight vs. driving distance could not be made because weight on female golfers was not listed to the public on the Players page on the LPGA Tour web page. This led to a lot of research to find the weight of a list of active LGPA Tour golfers. This was not able to be accomplished during the research of the golfer’s weight. Therefore, I added a new factor for the driving distance for a female golfer.

In figure sixteen I created this graph to represent driving distance for women who hit a certain club degree angle. I listed club degree angles from 7.5° to 12.5° to help myself understand the affects of driving distance and club degree angle for women. The best driver for women is between 9° and 10°. This increases the chances of driving further.

Figure 16
Results

The research presented in this project determined that the height of a golfer has a positive correlation with golf ball driving distance. Along with height, weight and club degree angle are two factors that play into golf ball driving distance. In the graph located in Data and Results the ten points from PGA Tour golfers shows how height affects golf ball driving distance.

The distance of a drive for a male golfer is affected widely based on height. A 5’10” golfer is expected to hit about 280 yards on average while a 6’ tall man is expected to average in the lower 300’s. For a female the dipping point or decreasing yardage point starts at 6’ tall. For both male and female golf ball driving distance is positively correlated with height.

The swing speed of a golfer affects the mathematical model the most. When multiplying the swing speed with an independent variable we get the golfers driving distance. This model proved to be very effective. In the graphs that represent swing speed and its correlation with golf ball driving distance it resembles a huge correlation. The swing speed follows a linear graph for all PGA golfers and myself. This showed me that when I am swinging the club at my expected 111 mph that I will be able to hit the ball on average in the 270’s in yardage. This surprised me and I was very surprised with this result.

The weight of a golfer affected the driving distance when two golfers were at the same height. Angel Cabrera is the same height as Jason Day. These two golfers have a distance of twenty-one meters apart. Angel Cabrera is thirty pounds heavier than Jason Day. Therefore, I predicted that the weight had a positive correlation on golf ball driving distance when a golfer is at the same height as another golfer, but one is heavier than the other.
Throughout this project I wanted to find a prediction for my golf ball driving distance. In the end I found out that I will hit the ball about 270 yards with a 111 mph swing speed. I also found out that this is a great yardage to begin strategy on the golf course to better my course management. My three main goals at the beginning of this project have been accomplished. They include:

1) Create a computational model representing the driving distance of a golfer
2) Find my expected driving distance when I am older
3) Improve my course management

Therefore, this project was a success and my results were proved to be true. The four factors: weight, height, club degree angle and swing speed all affect the driving distance of a golfer in their own special way and circumstance.
**Discussion**

With this project, I learned that height and swing speed are the main factors in being able to increase driving distance and is not dependent on weight. The average driving distance for professional golfers is 270 yards if they are six-feet tall and shorter. Therefore, by researching this project, I expect in the future for myself to be capable of hitting up to 270 yards on average.

I also learned that weight and club degree angle affect the driving distance at point where the golfer's height and/or swing speed are the same. At first it was difficult to understand this concept, but with some thought I came up to this conclusion.

I also learned that the driving distance is affected by the health of a golfer. Consequently, the maximum or average driving distance of a golfer decreases at a point of health. In the future, I plan to write a code for local golf courses in New Mexico to give their members a hint on where they will be able to hit a golf ball using the NetLogo model.

**Conclusion**

By analyzing the driving distance of a golfer, I have concluded that the height of a golfer affects the golf ball height and velocity. Weight affects the golfer’s driving distance positively until the golfer reaches a point that he/she cannot physically golf at their highest potential. Consequently, his/her driving distance will decrease at this point. The most ideal golfer for a male would have a range of 6’3” – 6’7” in height and 180 lbs – 300 lbs in weight. The best rate for a male at this height or for considerations of health and fitness is between 200 and 240 lbs. For females, the most ideal golfer is between 5’6” and 5’11”. A female who grows taller than six foot is most likely to increase swing speed but decrease loft in a shot.

“Analyzing the Driving Distance of a Golfer” 37
Most Significant Achievement on the Project

During the last six months I have had thousands of significant achievements through this project, but one comes to mind that affected a golfer’s life. That golfer is not me. One of the “senior” golfers at my local golf course was getting frustrated one afternoon because he was not hitting the golf ball to his expectations.

Later in the week I gathered some of his data such as: weight, swing speed, height, club degree angle, and age and experience level. I researched some golfers from the Champions Tour (a tour strictly for those between the ages of 50 and 70) and gathered some of their data. After I collected this data I took a video of my friend’s swing and showed him where his power is coming through. I entered his data into the mathematical model and came up that his average driving distance would be calculated at 168 yards. With this data available I asked him to hit a few golf balls for me and that I would track them with my Golf Course G.P.S. I collected the data one after a time. The numbers included: 166, 168, 169 and 170 yards. I was surprised that my mathematical and computational model worked based on my observations through a video and simple data collection and research. Personally, helping by friend Steve was the most significant achievement during this project.
Acknowledgements

To those who helped with “Analyzing the Driving Distance of a Golfer”,

Thanks! Thank you for the time and dedication you took to help me improve my knowledge on the best sport out there. Thanks for teaching me how to create a function in Netlogo or how to simply label graphs using Excel. Thank you mom! You took me to the golf course throughout the fall so that I could test data from different golfers. Thank you Mr. Creighton Edington! You taught me to learn from my mistakes and take my level of programming to the next level by creating my own functions. You are one of the greatest teachers of all time. Thanks for staying at school for me to finish a part in my program that I wanted to complete before the Interim Report was supposed to be completed. Thanks Steve for letting me use you to test my mathematical and computational model! A big thanks to the PGA professional at Tierra Del Sol and Isleta golf course for mentoring me on the effects of driving distance and the possible factors that could come into play. Thanks to my past teammates Ana and Nick! You began research so that I would not have to type three-hundred numbers of data for golfers. Thanks for trying to take the challenge! Thanks Supercomputing Challenge Consult for being on my back for due dates and important dates. Finally, big thanks to the School of Dreams Academy for letting me come to the best school ever! This was such a great experience!

Supercomputingly yours,

- Jose Montoya

Team 141 “Analyzing the Driving Distance of a Golfer”
References


Appendix A: Photo showing how the Shots of the Golfer in the Code will End Up

Figure 17

“Analyzing the Driving Distance of a Golfer” 41
Appendix B: Data Collection for Ten Male and Female Golfers

Male Golfers

Eric Axley
Male
Height:
6 ft, 0 in
Weight:
185 lbs
Driving Distance:
276.5

Sang-Moon Bae
Male
Height:
6 ft, 0 in
Weight:
180 lbs
Driving Distance:
285.3

Jonas Blixt
Male
Height:
5 ft, 10 in

“Analyzing the Driving Distance of a Golfer” 42
Weight:
164 lbs
Driving Distance:
283.7

**Angel Cabrera**
Male
Height:
6 ft, 0 in
Weight:
210 lbs
Driving Distance:
294.0

**K.J. Choi**
Male
Height:
5 ft, 8 in
Weight:
185 lbs
Driving Distance:
278.3
Jason Day
Male
Height:
6 ft, 0 in
Weight:
195 lbs
Driving Distance:
299.3

Luke Donald
Male
Height:
5 ft, 9 in
Weight:
160 lbs
Driving Distance:
278.1

Jason Dufner
Male
Height:
5 ft, 10 in
Weight:
180 lbs
Driving Distance:
285.9

Harris English
Male
Height:
6 ft, 3 in
Weight:
185 lbs
Driving Distance:
295.2

Gonzalo Fdez-Castano
Male
Height:
5 ft, 11 in
Weight:
187 lbs
Driving Distance:
287.0
Female Golfers

Chie Arimura
Female
Height:
5 ft, 2 in
Weight:
Unknown
Driving Distance:
236.5

Christel Boeljon
Female
Height:
5 ft, 5 in
Weight:
Unknown
Driving Distance:
245.4

Irene Cho
Female
Height:
5 ft, 6 in
Weight:
Unknown

“Analyzing the Driving Distance of a Golfer” 46
Driving Distance:
242.6

**Paula Creamer**
Female
Height:
5 ft, 9 in
Weight:
Unknown
Driving Distance:
245.9

**Laura Diaz**
Female
Height:
5 ft, 8 in
Weight:
Unknown
Driving Distance:
242.1

**Jodi Ewart Shadoff**
Female
Height:
5 ft, 5 in
Weight:

“Analyzing the Driving Distance of a Golfer” 47
Unknown
Driving Distance:
258.3

**Sandra Gal**
Female
Height
6 ft, 0 in
Weight:
Unknown
Driving Distance:
252.8

**Jennifer Gleason**
Female
Height
5 ft, 4 in
Weight:
Unknown
Driving Distance:
229.7
Sophie Gustafson
Female
Height
5 ft, 10 in
Weight:
Unknown
Driving Distance:
256.2

Maria Hjorth
Female
Height
5 ft, 9 in
Weight:
Unknown
Driving Distance:
253.5
Appendix C: Dictionary of Related Terms

**Fairway** - The fairway is the closely mown area that usually runs between the tee box and putting green of a golf hole, and is the target for golfers on all holes other than par-3s (Kelly).

**Green** - The green, or putting green, is the culmination of a golf hole, where the flagstick and hole are located (Kelly).

**Out of Bounds** - "Out of bounds" refers to those areas outside the golf course from which play is not allowed, or any area designated as out of bounds by the committee (Kelly).

**Tee Box** - The teeing ground is the starting point on each hole of a golf course (Kelly).

**P.G.A** – “Professional Golf Association”

**L.P.G.A** – “Ladies Professional Golf Association”

**L.D.A** – “Long Drivers of America”

**Junior** – A golfer under the age of eighteen

**Rough** – The long grass on the sides of the fairway.

**Lag** – A swing term. This is the moment where the strongest elbow is to the side of the golfer and releases energy from the hips to the golf ball creating more club head speed.

**Swing Speed** - The speed at which a golfer swings the club, defined by how fast the club head is traveling at the moment it makes impact with the ball (Kelly).

**Slice** – For right-handed golfers – a shot forced to the right.

**Draw** - For right-handed golfers – a shot that gradually spins to the left creating more distance for a golf ball.

**Hook** - For right-handed golfers – a shot forced to the left

**Fade** - For right-handed golfers – a shot that travels slightly to the right.
Address - Contrary to popular belief, this is not where the mailman delivers to but it is the position of one’s body taken just before the golfer hits the ball. You will often hear the term “addressing the ball” which means the golfer is standing there preparing to hit the ball (“Waggle”).

Wood – A club (either wood or metal) which is used for shots requiring a lot of distance (“Waggle”).

Dogleg – This is one of two things. It is either one of four things that Rover walks on or it is a hole that goes straight for a while then has a bend (or “dogleg”) to the left or right. You decide which fits here (“Waggle”!)

Hole – A 4 inch round receptacle on the green that you try to get your ball into (“Waggle”).

Pitch – A short high arcing shot that lands on the green and usually stops quickly (“Waggle”).

Putt – A shot that rolls on the green hit with the putter (“Waggle”).
Appendix D: Development of Pitch Shot Percentages

Figure 18

<table>
<thead>
<tr>
<th>Yards to the hole</th>
<th>Percentage of a made shot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>99%</td>
</tr>
<tr>
<td>2</td>
<td>90%</td>
</tr>
<tr>
<td>5</td>
<td>60%</td>
</tr>
<tr>
<td>10</td>
<td>30%</td>
</tr>
<tr>
<td>20</td>
<td>13%</td>
</tr>
<tr>
<td>50</td>
<td>6%</td>
</tr>
<tr>
<td>75</td>
<td>4%</td>
</tr>
<tr>
<td>100</td>
<td>2%</td>
</tr>
</tbody>
</table>

“Analyzing the Driving Distance of a Golfer” 52
<table>
<thead>
<tr>
<th>Distance</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>1%</td>
</tr>
<tr>
<td>200</td>
<td>0.6%</td>
</tr>
<tr>
<td>250</td>
<td>0.1%</td>
</tr>
<tr>
<td>300</td>
<td>0.001%</td>
</tr>
</tbody>
</table>

Figure 19
Appendix E: Code from Netlogo Representing a Golfer Playing a Hole

;; 11/26/2013 Code made by Jose Montoya

;; Analyzing the Driving Distance of a Golfer

;; Beginning of a program representing an 800 yard hole and a 5'10" golfer with a swing speed of
114 mph

globals [ hit ]

to setup ;; the set up of the code begins
    clear-all
    ask patches
    [ set pcolor grey ]
    ask patches
    [ let fairway (pxcor - pycor)
      “Analyzing the Driving Distance of a Golfer” 54
    ]
if fairway >= -3 and fairway <= 3 and pxcor <= 20
[
  set pcolor green ;; this sets the color of the fairway to green at the first length
]
]
ask patches
[
  let fairway (pxcor - pycor)
  if fairway > -3 or fairway < 3 and pxcor >= 20 and pxcor < 32 and pycor <= 23 and pycor > 15
    [  
      set pcolor green ;; the next long strap of fairway
    ]
  ]
]
let fairway \((-1 \times \text{pxcor} \times 0.66) + 36\)

if \(\text{fairway} < \text{pycor} \text{ and } \text{fairway} > (\text{pycor} - 8) \text{ and } \text{pxcor} \geq 32 \text{ and } \text{pxcor} \leq 48\)

set pcolor green ;; the fairway that is landed on the golfer's third and fourth shot

ask patches

let fairway \((\text{pxcor}) - (4 \times \text{pycor})\)

if \(\text{fairway} \geq -3 \text{ and } \text{fairway} \leq 28 \text{ and } \text{pxcor} \geq 48 \text{ and } \text{pxcor} \leq 72 \text{ and } \text{pycor} \geq 5\)

set pcolor green ;; the last piece of fairway

“Analyzing the Driving Distance of a Golfer” 56
ask patches
[
  if pxcor >= 72 and pxcor <= 78 and pycor > 10
  set pcolor green
]
]

ask patches
[
  if pxcor >= 72 and pxcor <= 78 and pycor > 30
  set pcolor lime ;; the green or also known as the putting surface
]

“Analyzing the Driving Distance of a Golfer” 57
ask patches

[  
  if pycor <= (1.7 * pxcor) - 88 and pxcor >= 60 and pxcor <= 71 and pycor <= 30 and pycor <= 30  
  [  
    set pcolor brown ;; this is the trees obstacle  
  ]
]

ask patch 75 34 ;; set the patch at the starting position

[  
  set pcolor black

“Analyzing the Driving Distance of a Golfer” 58
ask patch 0 4
[ set pccolor red ;; if the code is sent in an area of bad we will add red ]

ask patch 4 0
[ set pcolor red ;; if the code is in that same area it will show red for bad ]

create-turtles 1 ;; this creates our turtle the golf ball
[ set size .5
  set color white ]
set shape "circle"

setxy 1 1

set pen-size .3

pen-down

set hit 0

]

reset-ticks

end

to go

if count turtles = 0

[

stop

]

ask turtles ;; this begins the golfing game

“Analyzing the Driving Distance of a Golfer” 60
[ifelse hit = 0

golf
]

[pitching-game
]

to golf ;; this is the order of the shots and we are defining them

tee-off

second-shot

third-shot

fourth-shot

“Analyzing the Driving Distance of a Golfer” 61
pitching-game

to tee-off ;; this is the drive which is the longest of the shots

facexy 24 20

right random 5

left random 5

forward (26 + ( random 3))

set hit hit + 1

wait .5

to second-shot ;; this is the second shot and we begin a right and left random

ifelse ycor > ((-1 * xcor * .833) + 37.166 )

[  
facexy 48 8
]

“Analyzing the Driving Distance of a Golfer” 62
[facexy 42 12
set color yellow
]

right random 5
left random 5
forward (24 + (random 3))
set hit hit + 1
wait .5
end
to third-shot ;; This shot has two options aim area a or aim area b
ifelse ycor >= ((xcor *.588) + 17.94)
[facexy 75 21
set color white

“Analyzing the Driving Distance of a Golfer” 63
right random 5

left random 5

forward (24 + (random 3))

set hit hit + 1

wait .5

to fourth-shot ;; The fourth shot sets up a shot to the green

ifelse xcor >= 72

[ facexy 75 34

set color white

“Analyzing the Driving Distance of a Golfer” 64
right random 5
left random 5
forward (14 + ( random 3))
set hit hit + 1
wait .5
end
to pitching-game ;; you either make it or you don't

let chance-input distancexy 75 34 * 10

let chance-output (56.808 * (e ^ (-0.03 * chance-input)))

ifelse random 100 < chance-output

[ "Analyzing the Driving Distance of a Golfer" 65]
facexy 75 34

forward (chance-input / 10)

set color white

]

[ facetxy 75 34

forward (chance-input / 10 + ( random 2 - random 2))

set color blue

]

set hit hit + 1 ;; this counts the shots

if xcor = 75 and ycor = 34 or pcolor = black

[ die

]

end

;; Finished with the program and all the golf shots are counted to determine amount of shots it
take the golfer to hit into the 800 yd hole

“Analyzing the Driving Distance of a Golfer” 66