

# Driving Further

## Teachers Notes and Answers

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TI-Nspire™



Activity



Student



30 min

## Introduction

More sophisticated club technology and customisation combined with stronger athletes is a recipe for producing longer drives off the tee, but just how much further is the modern golfer driving? The PGA and LPGA have been measuring and recording drive distances for a number of years with some surprising results.

What does it matter? For the golf courses, tournament organisers and golfers themselves it matters a great deal. The USGA (United States Golfing Association) is considering introducing 'reduced-distance' golf balls. Their claim is that golfers are driving the ball so far now that some holes and courses are being rendered almost useless. It would be incredibly expensive to change the length or nature of specific holes on a golf course as this would most likely necessitate changing the entire course. It is not possible to wind back the clock on athletic performance, but it is possible to reduce the efficiency of golf balls so they simply don't go as far.



Your task is to explore how much the distances have changed and whether or not to 'putt' and end to this proposed 'course' of action.



## Data

### PGA (Men's) – Average driving distance measured in metres.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000
Distance	238.2	238.1	239.5	241.0	243.7	244.8	247.4	249.1	249.8
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Distance	249.4	254.9	255.6	261.4	262.0	263.7	264.2	263.9	262.7

### LPGA (Women's) – Average driving distance measured in metres.

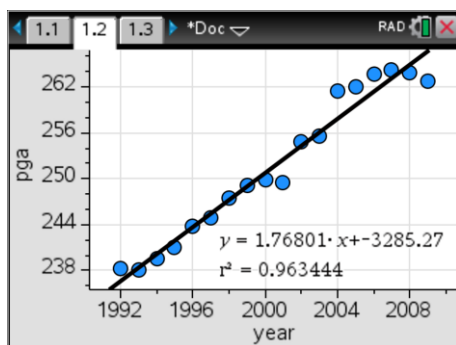
Year	1992	1993	1994	1995	1996	1997	1998	1999	2000
Distance	204.1	206.9	207.2	213.4	213.0	216.1	216.4	217.7	218.0
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Distance	221.7	226.9	228.3	228.2	224.6	229.6	227.6	225.4	228.9

**Question: 1**

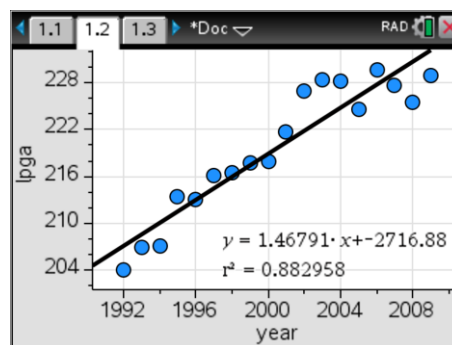
Plot the graphs for the average driving distances versus year for both the PGA and LPGA data and comment on the trends.

(Two separate graphs)

PGA ( $r^2 = 0.963$  ... strong positive correlation)



LPGA



Both PGA and LPGA competitors are gradually improving driving distance. PGA improvements equate to approximately 1.77m per year while LPGA improvements equate to approximately 1.45m per year. PGA data shows a temporary stagnation whilst LPGA data shows a greater variation in recent times.

**Question: 2**

Is a linear model appropriate for either of these data sets?

For the data provided a linear model shows a relatively strong correlation for both PGA and LPGA.

**Question: 3**

Find the equations of the line of best fit for the two sets of data plotted.

PGA regression equation:  $y = 1.77x - 3285$  (shown on graph)

LPGA regression equation:  $y = 1.47x - 2716$  (shown on graph)

**Question: 4**

Assuming that the trends continue into the future answer the following questions:

a) Estimate the average driving distances for both tours in the year 2018.

$$\text{PGA: } y = 1.77 \times 2018 - 3285 \\ \approx 287m$$

$$\text{LPGA: } y = 1.47 \times 2018 - 2716 \\ \approx 250m$$

b) When will the average driving distance for the men's tour be 310 metres?  $\approx 2033$

c) When will the average driving distance for the women's tour be 270 metres?  $\approx 2034$

d) Will the average driving distance for women's tour ever be higher than the average for the men's tour, according to the models obtained, if so, when?

According to the data the men will continue to hit further than the women and this gap will continue to grow. However if the equations could be extrapolated in either direction, in 1893 men and women would have been driving the ball just 62 metres and driving it backwards prior to 1858 and 1850 for men and women respectively.

e) Comment how realistic the predictions are by comparing the predictions to recent, real data. The following two websites can be used to collect data.

<https://www.pgatour.com/stats/stat.101.html>

<http://www.lpga.com/statistics/>

LPGA prediction: 245m compared with actual (2018) 232m.

PGA prediction: 283m compared with actual (2018) 271m.

Both of these predictions are relatively inaccurate and both over-shoot the actual driving distance suggesting that the linear model needs to be reconsidered and that a limited driving distance exists for both males and females.

### Question: 5

Will the driving distances grow without bounds? Discuss.

The relative inaccuracies associated with even the short term predictions suggest that a linear model is not suitable and that a limiting distance exists for both male and female golfers.

### Extension

The 5<sup>th</sup> hole at the Flinders Golf course is a par 5, 490m journey. In 1992 a professional golfer could plan to reach the slight dog-leg with a good first drive of 240m. Assuming the second shot is approximately 10% to 15% shorter than the drive off the tee, a professional golfer could hope to hit their second shot 210m and therefore finish with a relatively short 40m approach shot to the green. This places the golfer on the green leaving a regulation 2 putt finish.



Show how this hole is already under threat of becoming a par 4 and that further into the future it becomes *readily* achievable.

The coefficient of restitution (COR) of a golf ball is a measure of the energy returned when struck. Golf balls typically have a COR of 0.8. (80%) If this figure directly relates to driving distance, explore an appropriate COR value to ensure this Par 5 hole remains challenging for the next 10 years. (Justify your calculations / recommendations)

### PGA

Assuming the linear model:

In 2028 golfers will be driving approximately  $1.768 \times 2028 - 3285 \approx 300\text{m}$  with their tee shot and approximately  $0.85 \times 300 \approx 255\text{m}$  with their second shot producing a total distance of  $300 + 255 = 555\text{m}$ .

If the third shot is supposed to be approximately 40m from the green (hole) then coefficient of restitution would need to be reduced to approximately 65%. (See below)

Current COR = 0.8

Suppose COR = 1.0 then 2028 driving distance would be extended to approximately 694m, assuming direct correlation between coefficient and driving distance. Proposed driving distance needs to be a total of 450m, therefore  $450/694 \approx 0.65$ .

Accurate modelling is extremely challenging. As mentioned the linear model in this situation is not particularly accurate, a logistic model is more likely to provide a suitable model. Such a function predicts that driving distances will remain around 270m. Whilst these distances already impact some holes on some courses other solutions are available such as rewarding accuracy by narrowing fairways or varying the approach to a green to make it more challenging.

## LPGA

Assuming a linear model:

By 2028 women will be driving approximately 260m. A simple solution would be to simply have them use the existing men's tee. If the linear model is rejected in favour of a logistics curve then female tee shots are predicted to reach 230m which is similar to the 2018 driving distances. Therefore retaining the existing golf balls would be reasonable and having females tee off from the men's tee!