Mathematical Modeling Approach to Predict Athletic Time, Performance

R.K.Mishra*, Simaranjeet Kaur

Department of Mathematics, SLIET Deemed University, Longowal, Punjab, India

*Corresponding Author: ravkmishra@yahoo.co.in

Copyright © 2013 Horizon Research Publishing All rights reserved.

Abstract As we know that the sporting achievement is always interesting fascinating to human. The major of performance to improve the record and broken as with time, keeping the importance of the subject we have decided to study the problem as suggested by D.Edward & M.Hamson [1]. In this communication we have collected the data for 200m men/ women race athlete time for all three medalists (Gold, silver & bronze) in Olympics from last 60 years i. e. from 1948 to 2008. All the data have been presented in tabular form. It have been observed that the steady fall in winning times for the men's race indicates that no limiting time for runner at all, which seems unreasonable.

We may conclude that the linear model is only valid for a limited range of the years (It may be less than 60 years of the span). Obviously a different model would seem more suitable as $T = a \exp(-b)$. Another important conclusion is that, the more rapid improvement shown in women's performance could indicates a closing up winning times with the men so that there would be equality between men's and women's time near about the year 2090 if performance improvement continued at the same rate.

Keywords Mathematical Modeling, Modeling of Athlete Time Performance, Mathematical Analysis of Athlete Time

1. Introduction

A mathematical model is a description of a system using mathematical concepts and language of mathematics. Mathematical models are used not only in the natural sciences but now in these days every part of real life situation, a mathematical model can be broadly defined as a formulation or expression of the essential features of a physical or, process in mathematical terms. In the past Indians Babylonians and Greeks indulged in understanding and predicting the natural phenomena through their knowledge of mathematics [1-3]. The architects, artisans and craftsman based on many of their works of art on geometric

principles. We can divide the modeling process in to three main process i.e formulation, finding solution and interpretation and evaluation. After building the model we are required to communicate our conclusion as part of solution here in this paper we have studied the real life athletic time problems.

As we know that the sporting achievement is always interesting fascinating to human. The major of performance to improve the record and broken as with time. Now in these days the youth are adopting sports as the carrier also, keeping the importance of the subject we have decided to study the problem as compiled the most recent data as suggested by D.Edward & M.Hamson [1]. In this communication we have presented the data for 200m men/ women race in Olympics from last 60 years i. e. from 1948 to 2008, we have also collected the record for *all the three medals i.e. gold, silver and bronze* all the data have been presented in tabular form.

2. Problem Description for Athletic Time

It has been observed that in athletics track events winning times are coming down for both man's and women's races. So it was decided to investigate the time achieved for the 200 m by both men and women in the Olympics games. Here with the help of mathematical modeling we wish to investigate/predict the following two queries:

- Is there any limiting time for any human to complete a 100/200/400 m race?

- Will the times of women always be inferior to men?

Data have been collected from the available resources and presented here for the period 1948 to 2008, for the men's and also for women .

3. Formulation of Mathematical Modelling

To formulate the mathematical modeling we are required

the data which is given in the table

3.1 (a) we can observe easily regarding the preponderance of USA winner the times have been decreasing. Although the modern measuring techniques provide the reliable measurement up to the quoted precision. It has been also observed that since 1968 it has been possible to measure correct to the nearest one hundredth of a second. Its practically impossible to imagine what 0.01 sec actually records, but to help we can calculate now for a runner how much will he travel in 0.01 sec.

3.1. Data Representation for Gold Medalists

Following are the data representation for Gold medalists

Table 3.1 (a). Men's 200 m Gold Medalist

YEAR	NAME	COUNTRY	TIME (Sec)
1948	Melvin Patton	United state of America	21.1
1952	Andy Stanfield	United state of America	20.7
1956	Bobby Morrow	United state of America	20.6
1960	LiviaBerruti	Italy	20.5
1964	Henry Carr	United state of America	20.3
1968	Tommy Smith	United state of America	19.83
1972	Valery Borzov	Ustawa Republic Solvenje	20.0
1976	Don Quarrie	Jamaica	20.23
1980	Pietro Mennea	Italy	20.19
1984	Carl Lewis	United state of America	19.80
1988	Joe DeLoach	United state of America	19.75
1992	Mike Marsh	United state of America	20.01
1996	Michael Johnson	United state of America	19.32
2000	Konstantions Kenteris	Greece	20.08
2004	Shawn Crawford	United state of America	19.79
2008	Usain Bolt	Gemica	19.3

Table 3.1 (b). Women's 200m Gold Medalist

YEAR	NAME	COUNTRY	TIME/s
1948	Fanny Blankers-Koen	Netherland	24.4
1952	Marjorie Jackson	Australia	23.07
1956	Betty Cuthbert	Australia	23.04
1960	Wilma Rudolph	United state of America	24.00
1964	Edith McGuire	United state of America	23.00
1968	Irena Szewinska	Poland	22.5
1972	Renate Stecher	East Germany	22.4
1976	Barbal Wockel-Eckert	East Germany	20.37
1980	Barbal Wockel-Eckert	East Germany	22.03
1984	Valerie Brisco-Hooks	United state of America	21.81
1988	Florence Griffith-Joyner	United state of America	21.34
1992	Gwen Torrence	United state of America	21.81
1996	Marie-Jose Perec	France	22.12
2000	Pauline Davis Thompson	United state of America	20.84
2004	Veronica Campbell	Germany	22.05
2008	Veronica Campbell	Germany	21.74

Assumptions:

Running 200m in (say) 20 sec gives an average speed of 10m/s. So the athlete travels $10 \times 0.01\text{m}$ in one hundredth of second = 0.1m = 10cm. This is a realistic viewable gap between athletes provide the finish can be photographed. It would seem that a time quoted correct to three place is not realistic

Figure 3.1. Graph for Men V/S Women's times for 200 m (Gold medalist)

3. (A) Mathematical Analysis of 200 M (Gold Medalist)

The shown figure is self explanatory regarding the performances of both men and women athlete for 200 m race. In ordered to answer the two questions 1 and 2 as described in the section, we have tried to model the patterns of data. And it appears that a downward trend is shown for both men and women as expected. We notice that the performance in both the men's and women's event has slightly deteriorated since 1988 and later the two data sets are very close to each other.

Here We wish to predict that what winning times will be achieved in the future? And how we may compare for both. Looking at the graph in fig 3.1, we have extrapolated forward over the next 20 or 30 years or so and obtain answers to (1) and (2). For the purpose of best fit and prediction we have found the equations : $y = -0.039x + 101.2$ & $R^2 = 0.518$ for Women's and

$$y = -0.021x + 62.36 \text{ \& } R^2 = 0.717 \text{ for men's.}$$

3.2. Data Representation for Silver Medalists

Following are the data representation for Silver medalists

Table 3.2 (a). Men's 200m SILVER Medalist

YEAR	NAME	COUNTRY	TIME/s
1948	Barney bell	United state of America	21.1
1952	Thane Baker	United state of America	20.8
1956	Andy Stanfield	United state of America	20.7
1960	Les Carney	United state of America	20.6
1964	Paul Drayton	United state of America	20.05
1968	Peter Norman	Australia	20.00
1972	Larrydla Black	United state of America	20.19
1976	Millard Hampton	United state of America	20.29
1980	Allan Wells	Gesellschaft Burgerlichen Rechets	20.21
1984	Kirk Baptiste	United state of America	19.96
1988	Carl Lewis	United state of America	19.79
1992	Frankie Fredericks	Non Aligned Movement	20.13
1996	Frankie Fredericks	Non Aligned Movement	19.68
2000	Darren Campbell	Gesellschaft Burgerlichen Rechets	20.14
2004	Bernard Williams	United state of America	20.01
2008	Shawn Crawford	United state of America	19.96

Table 3.2 (b). Women's 200m Silver Medalist

YEAR	NAME	COUNTRY	TIME/s
1948	Audrey Willanson	Gesellschaft Burgerlichen Rechets	25.10
1952	Bertha Brouwer	Netherland	24.20
1956	Christa Stubnick	Germany	23.70
1960	Jutta Heine	Germany	24.40
1964	Irena Szewinska	Poland	23.10
1968	Raelene Boyle	Australia	22.70
1972	Raelene Boyle	Australia	22.45
1976	Annegret Richter	Fedral Republic of Germany	22.39
1980	Natalya Bolchina	Ustawa Republic Solvenje	22.19
1984	Florence Griffith –Joyner	United state of America	22.04
1988	Grace Jackson	Jamiaca	21.72
1992	Julit Cuthdert	Jamiaca	22.02
1996	Merlene Ottey-page	Jamiaca	22.24
2000	Susanthika Jayasingh	Sri Lanka	22.28
2004	Allyson Felix	United state of America	22.18
2008	Allyson Felix	United state of America	21.93

Figure 3.2. Graph for Men V/S Women's times for 200 m (Silver medalist)

Mathematical Analysis for 200 M (Silver Medalist)

As per previous case here also downward trend is shown for both men and women as expected. For the purpose of best fit and prediction we have found the equations : $y = -0.045x + 112.0$ & $R^2 = 0.716$ for Women's and $y = -0.015x + 51.54$ & $R^2 = 0.609$ for men's.

3.3. Data Representation for Bronze Medalists

Following are the data representation for Bronze medalists

Table 3.3 (ab). Men's 200m Bronze Medalist

YEAR	NAME	COUNTRY	TIME/s
1948	Lloyd Labeach	Panama	21.2
1952	James Gathrs	United state of America	20.8
1956	Thane Baker	United state of America	20.9
1960	Abdoulaye Seye	France	20.7
1964	Edwin Roberts	Turkmenistan	20.6
1968	Johan Carlos	United state of America	20.00
1972	Pietro Mennea	Italy	20.30
1976	Dwayne Evans	United state of America	20.43
1980	Don Quarrie	Germany	20.29
1984	Thomas Jefferoson	United state of America	20.26
1988	Robson Da Silva	Brazil	20.04
1992	Michael Bats	United state of America	20.38
1996	Auto Bolden	Turkmenistan	19.80
2000	Auto Bolden	Turkmenistan	20.20
2004	Justin Gatlm	United state of America	20.03
2008	Walter Dix	United state of America	19.68

Table 3.3(b). Women's 200m Bronze Medalist

YEAR	NAME	COUNTRY	TIME/s
1948	Audrey Patterson	United state of America	25.20
1952	Nadezhda Khnykina	Ustawa Republic Solvenje	24.20
1956	Marlene Mathews	Australia	23.80
1960	Dorothy Hyman	Gesellschaft Burgerlichen Rechets	24.70
1964	Marilyn Black	Australia	23.10
1968	Jenifer Lamy	Australia	22.80
1972	Irena Szewinska	Poland	22.74
1976	Renate Specher	G D R	22.74
1980	Merlene Ottey-page	Jamiaca	22.20
1984	Merlene Ottey-page	Jamiaca	22.09
1988	Heike Drechsler	G D R	21.95
1992	Merlene Ottey-page	Jamiaca	22.09
1996	Mary Onyal	Nigeria	22.38
2000	Beverly Mcdonald	Jamiaca	22.35
2004	Debbie Ferguson	Bahrain	22.30
2008	Kerron Stewart	Jamiaca	22.00

Mathematical Analysis for 200 M (Bronze Medalist)

As per previous case here also downward trend is shown for both men and women as expected. For the purpose of best fit and prediction we have found the equations : $y = -0.045x + 112.6$ & $R^2 = 0.718$ for Women's and $y = -0.018x + 56.86$ & $R^2 = 0.733$ for men's.

Figure 3.3. Graph for Men V/S Women's times for 200 m (Bronze medalist)

4. Result and Discussion of the Problem

The characteristics of the solution in all the above cases are almost same. A downward trend is shown for both men and women as expected. We notice that the performance in both the men's and women's event has slightly deteriorated since 1988. It is also easy to see that two are more data are very close to each other. To return in to the desired prediction as we know the fact that one of the important uses of mathematical modeling is essentially about making reliable and useful predictions . So the issue here is to be predicting from the given data what winning times will be achieved in the future. Looking at the above graphs in each category [Gold, Silver, and Bronze]. We wish to extrapolate forward over the next 40 or 50 years or so and obtain answers to (1) and (2) as desired in the problem description. By looking at the data a simple linear fit for the original raw data have been carried out since neither set suggests clearly any alternative fitting function as shown in the figures for each category [Gold, Silver, and Bronze] . Following conclusion may be made:

- From the above graphs, it is clear that linear models for the 200 m times may be acceptable over the periods covered by the data, what credibility can be placed on times predicted in years ahead? The steady fall in winning times for the men's race indicates that no limiting time for runner at all which seems unreasonable.

we must conclude that the linear model is only valid for a limited range of the years (It may be less than 50 years of the span) Obviously a different model would seem more suitable as

$$T = a \exp(-b)$$

Or

$$T = c + a \exp(-bt)$$

- **For Gold medalists** see [Figure 3.1] If we take $Y=0$ at $x=62.36/0.021=2969$. Using the model question **first has not been satisfactorily answered so for**

using the suggested models. With regard to question two, we predict that looking at [Figure (3.1, 3.2 & 3.3)] it is clear that the line for the women's race is steeper than that for the men. ***The more rapid improvement shown in women's performance could indicates a closing up winning times with the men so that there would be equality between men's and women's time near about the year 2090 if performance improvement continued at the same rate.***

- In Gold medalists there would be equality by about the year 2090. In case of Silver medalists there would be equality near about 2060 and for Bronze medal there is equality between men's and women's times near about 2070.
- Similar interpretations have been also found in other cases (Silver and Bronze).

Acknowledgements

The authors thank the anonymous referee whose valuable comments and suggestions have helped us to submit the revised version of this manuscript.

REFERENCES

- [1] J.N Kapur (1994) "Mathematical Modelling " H.S Poplai for Eastern Limited
- [2] Ions, Journal of the institute of mathematics and its Applications, vol. 19, 2000.
- [3] J.G Andrews and R.R. McLone (1976) Mathematical Modelling, Butterworth's, London.
- [4] Dilwyn Edwards & Mike Hamson, Guide to Mathematical modeling, (2001).