LAB 2

The Limit of Swimming Speed

Finding Limits

It is often said in sports that records are made to be broken. This saying suggests there is no limit to athletic performance.

In some sports, such as the men's 100-meter freestyle, the record time is no longer being broken as often or by as much as in the past.

Observations

The men's 100-meter freestyle record in 1956 was 55.4 seconds. By 1976 the record had dropped about 10.8% to 49.44 seconds. In that period, new records had been set 17 times.

Since then, there has not been as much improvement on the record. The record time has only dropped about 2.5% since 1976 to 48.21 seconds and new records have been set six times.

Purpose

In this lab, you will analyze the record times of the men's 100-meter freestyle to determine if there is a lower limit on the time it takes a man to swim 100 meters. You will be given an equation that models the record times and find its lower limit graphically, numerically, and analytically. You will use *Mathematica* to verify your results.

References

For more information about swimming and its records, visit Swimnews online at :

http://www.swimnews.com.

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Data

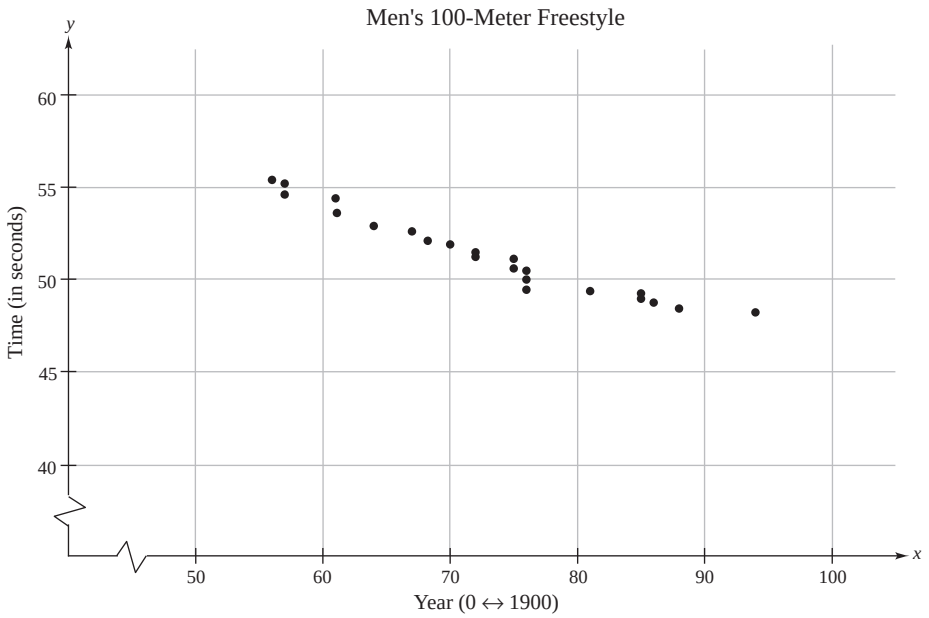
The year of a record set in the men's 100-meter freestyle and the record time in seconds is given in the table below. Let x represent the year, where $x = 0$ corresponds to 1900. Let y represent the record time in seconds.

Year, x	56	57	57	61	61	64	67	68	70
Time, y	55.4	55.2	54.6	54.4	53.6	52.9	52.6	52.2	51.9

Year, x	72	72	75	75	75	76	76	76	81
Time, y	51.47	51.22	51.12	51.11	50.59	50.39	49.99	49.44	49.36

Year, x	85	85	86	88	94
Time, y	49.24	48.95	48.74	48.42	48.21

A scatter plot of the data is given below.



The data in the table and the scatter plot are stored in the *Mathematica* file called LAB02.NB.

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Exercises

Name _____

Date _____ Class _____

Instructor _____

1. ***Limited or Unlimited?*** Is there a limit to human athletic performance or is there no limit? List several reasons why you think there is a limit or several reasons why you think there isn't a limit to human athletic performance.

2. ***Graphical Estimation.*** Use the scatter plot given in this lab's Data to estimate a reasonable lower limit on the time it takes a man to swim 100 meters. Explain how you determined this limit. Estimate the record for the men's 100-meter freestyle in the year 2000.

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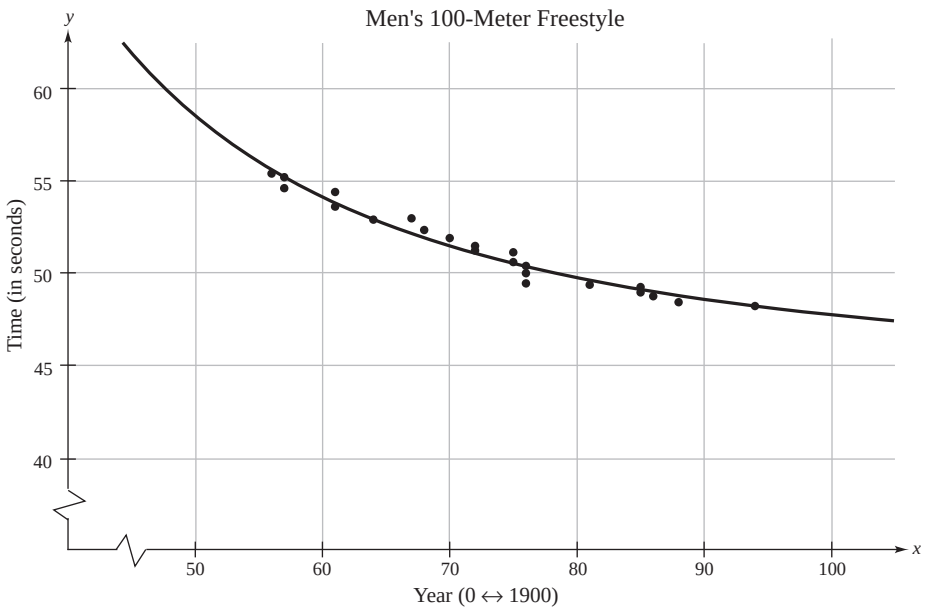
3. ***Analytical Estimation.*** A model for the men's 100-meter freestyle record times in seconds is given by

$$y = \frac{38{,}504.4888 + 44.37530536x^2}{1 + x + x^2},$$

where $x = 0$ represents 1900. The model and the data points are shown in the graph below. Use this model to predict a reasonable record for a man to swim 100 meters in the year 2000. Explain how you determined your answer.



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4. ***Numerical Estimation.*** In this lab's *Mathematica* file, the limit of the model

$$y = \frac{38{,}504.4888 + 44.37530536x^2}{1 + x + x^2}$$

is given as x approaches 100. Compare this estimation of the record for the men's 100-meter freestyle record time in 2000 with those you found in Exercises 2 and 3. Which estimate seems more reasonable to you? Why?

5. ***Complete the Table.*** In this lab's *Mathematica* file, the limit of the model

$$y = \frac{38{,}504.4888 + 44.37530536x^2}{1 + x + x^2}$$

is given as x approaches 100. Write the result of this calculation in the table below. Edit the *Mathematica* file to find the limit of the model for the remaining values of x given in the table. Record the results below.

Year, x	100	150	200	250	300
Time, y					

What conclusions can you make about the existence of a lower limit on the time it takes a man to swim 100 meters?

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6. ***A Model for all Years?*** Do you think the model

$$y = \frac{38{,}504.4888 + 44.37530536x^2}{1 + x + x^2}$$

is a good estimation of record times for any year or is the model only good for particular years? Explain how you reached your conclusion and determine which years the model could be used to estimate record times. Use *Mathematica* to analyze the model graphically and numerically. (Note: In 1905 the men's 100-meter freestyle record was 1:05.8 or 65.8 seconds.)

7. ***Enough Proof?*** Do you think the results of this lab are enough to prove that there is a limit to how fast a man can swim 100 meters? Why or why not?

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