Homework Assignment 10: Due at the beginning of class 10/21/02

The specific learning goals of this assignment are for you to:

- Decide what kind of function (linear, exponential or power) would do a good job of representing the trend in a set of data.
- Find equations for linear, exponential and power functions.
- Decide which functions will have inverses that are also functions.
- Calculate equations for inverses of functions.
- Sketch the graph of the inverse of a function.
- Use inverses to make predictions.
- To learn about the scale of the HIV/AIDS pandemic at home and overseas.

Note: **To expedite your work in Question 1, plots of the data in Table 1 are available. To expedite your work in Question 4, a conveniently sized set of coordinate axes is available. You can download these graphs as separate files if you want to.**

1.   Table 1[1] (below) shows the cumulative total number of people who have contracted HIV/AIDS in the United States, South Africa and the world as a whole. In each case, (United States, South Africa and worldwide) determine what kind of function would do the best job of representing the trend shown in Table 1. You don't have to confine yourself to linear exponential and power functions if you can see a pattern in one of the data sets that seems to strongly suggest that another type of function might be more appropriate.

	1993	1996	1997	1998	1999	2000	2001
	$X = 3$	$X = 6$	$X = 7$	$X = 8$	$X = 9$	$X = 10$	$X = 11$
United States	361,164	581,429	633,000	688,200	733,374	774,467	816,149
South Africa[2]	1,627,000	2,556,000	2,900,000	3,700,000	4,200,000	4,400,000	5,000,000
World-wide[3]	No data	22,600,000	30,600,000	33,400,000	33,600,000	36,100,000	40,000,000

Table 1: Cumulative totals for number of people who have contracted HIV/AIDS.

[1] The data in Table 1 was compiled from the following sources:
- Centers for Disease Control. HIV/AIDS Surveillance report. Volumes 2-13. Available on-line from: http://www.cdc.gov/hiv/stats/hasrlink.htm
- UNAIDS. 2002. *Report on the Global HIV/AIDS Epidemic*. Geneva Switzerland: Joint United Nations Program on HIV/AIDS.
- Fleming, P. L., R. H. Byers, P. A. Sweeney, D. Daniels, J. M. Karon and R. S. Janssen. 2002. HIV prevalence in the United States. *Paper Presented at the 9th Conference on Retroviruses and Opportunistic Infections.* (February 24-28, 2002. Seattle WA.)

[2] The figures given for South Africa after 1996 are estimates calculated by the South African Society of Actuaries. The figures are thought to be accurate to the hundreds of thousands.

[3] The worldwide totals are estimates calculated by the United Nations HIV/AIDS Task Force. These estimates are thought to be accurate to the hundreds of thousands.

2.   Use the regression capabilities of a graphing calculator (or by any other method that you are familiar with) to find equations for functions that predict the cumulative total number of HIV/AIDS cases in the United States, South Africa and worldwide. In each case, your function should use x (the number of years since 1990) as the **independent** variable.

3.   In this question you will consider only the function that you have found for the United States. Is the inverse a function in its own right? Briefly explain how you can tell and find a formula for the inverse.

4.   In this question you will consider only the function that you found for the worldwide total. Is the inverse a function in its own right? Briefly explain how you can tell and sketch a graph of the inverse.

NOTE: A set of coordinate axes is available as a separate, downloadable file.

5.   The inverse of the function for South Africa is a function in its own right. If we use the variables:

- x = years since 1990
- a = number of HIV/AIDS cases reported in South Africa

then a formula for the inverse of the function that you found in Question 2 is:

$$x = \frac{1}{\ln(1.154245856)} \cdot \ln\left(\frac{a}{1086107.822}\right)$$

You do not need to verify that this formula is correct[4].

Use the formula given above, together with your answers to Questions 3 and 4 to complete the graphics[5] shown on the next page. You should hand in your completed graphics as your answer to Question 5.

Epilogue

- Average cost of developing a completely new pharmaceutical drug[6]: $700 million.
- Average cost of developing a completely new pharmaceutical drug[7]: $107 million.
- Amount spent in the United States on illicit drugs in 1998[8]: $66 billion.

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[4] If you are not familiar with the *ln* function, just use that key on your calculator to obtain numerical answers for now – this function (the natural logarithm) will be explained in class very soon.
[5] These graphics were created with images from: http://www.tech-res-intl.com/hivaids/ and http://www.sccs.swarthmore.edu/~mccoy1/dali.gif
[6] Source: Pharmaceutical Research and Manufacturer's of America.
[7] Source: Public Citizen, Inc. (The consumer group founded by Ralph Nader.)
[8] Source: Office of National Drug Control Policy. 2000. *What America's Users Spend on Illegal Drugs, 1988-1998*. Washington DC: Government Printing Office.

History of the HIV/AIDS Pandemic: United States

10,000,000 HIV/AIDS cases
Date:

1,000,000 HIV/AIDS cases
Date:

100,000 HIV/AIDS cases
Date:

1,000 HIV/AIDS cases
Date:

History of the HIV/AIDS Pandemic: South Africa

10,000,000 HIV/AIDS cases
Date:

1,000,000 HIV/AIDS cases
Date:

100,000 HIV/AIDS cases
Date:

1,000 HIV/AIDS cases
Date:

History of the HIV/AIDS Pandemic: Worldwide

10,000,000 HIV/AIDS cases
Date:

1,000,000 HIV/AIDS cases
Date:

100,000 HIV/AIDS cases
Date:

1,000 HIV/AIDS cases
Date: