Homework Assignment 8: Due at the beginning of class 10/16/02

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.
- Combine existing functions to create new functions.
- Use functions to make predictions.

Note: To expedite your work in Questions 1 and 2, plots of all of the data sets are available. You can download the graphs as a separate file if you want to.

> "Penahlonga, Zimbabwe – They didn't call Arthur Chinaka out of the classroom. The principal and Arthur's uncle Simon waited until the day's exams were done before breaking the news: Arthur's father, his body wracked with pneumonia, had finally dies of AIDS. They were worried that Arthur would panic, but at 17 years old he didn't. He still had two days of tests, so while his father lay in the morgue, Arthur finished his exams. That happened in 1990. Then in 1992, Arthur's uncle Edward died of AIDS. In 1994, his uncle Richard died of AIDS. In 1996, his uncle Alex dies of AIDS. All of them are buried on the homestead where they grew up and where their parents and Arthur still live, a collection of thatch-roofed huts in the mountains near Mutare, by Zimbabwe's border with Mozambique. But HIV hasn't finished with this family. In April, a fourth uncle lay coughing in his hut, and the virus had blinded Arthur's aunt Eunice, leaving her so thin and weak she couldn't walk without help. By September both were dead."[1]

Of all the countries in the world, those in eastern and southern Africa (from Kenya to South Africa) have been the hardest hit in the AIDS pandemic[2]. After approximately twenty years[3], HIV has caused the deaths of more than eleven million Africans and infected over twenty-two million others[4]. About ten percent of the world's people[5] live in sub-Saharan Africa, but the region is home to more than 66% of all the world's AIDS sufferers – with disproportionately many in the 15 to 49 year old age range.

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[1] Quoted directly from: Schoofs, M. 1999. AIDS: The agony of Africa. Part 1: The virus creates a generation of orphans. *The Village Voice*, November 9, 1999.

[2] Source: UNAIDS. 2002. *Report on the Global HIV/AIDS Epidemic*. Geneva Switzerland: Joint United Nations Program on HIV/AIDS.

[3] Mann, J. M. 1989. AIDS: A worldwide pandemic. In M. S. Gottlieb, D. J. Jeffries, D. Mildvan, A. J. Pinching, T. C. Quinn and R. A. Weiss. Eds. *Current Topics in AIDS*. *Volume 2*. New York: John Wiley and Sons.

[4] Source: UNAIDS. 2002. *Report on the Global HIV/AIDS Epidemic*. Geneva Switzerland: Joint United Nations Program on HIV/AIDS.

[5] Source: *CIA World Fact Book, 2002*. Available on-line from: http://www.cia.gov/

As people in the 15 to 49 year old age group contract the virus and slowly die, their children are left behind. After witnessing the slow and usually painful demise of their parents, the children are taken in by relatives – often only to see the horrific saga repeated as their uncles and aunts slowly waste away and die – or left to fend for themselves[6]. More than twelve million of the children in sub-Saharan Africa have lost their parents to AIDS. These AIDS orphans outnumber the children (this is, *all* children, orphaned or not) of the United Kingdom[7], and their ranks are growing with worrisome speed[8].

In this homework, you will create functions to predict the number of children orphaned by AIDS in two sub-Saharan countries: Zimbabwe and South Africa. Zimbabwe currently has the highest number of people suffering from AIDS (on a per capita basis) of any country in the world[9], and South Africa has the greatest number of children orphaned by AIDS of any country in the world[10]. Ultimately, you will make predictions for the percentage of each country's population that will be made up of children who have been orphaned by AIDS.

1.   In this question, the independent variable x is defined to be:

- **Independent variable:** x = number of years since 1990.

Table 1[11] (below) gives the number of children in **Zimbabwe** who were orphaned by AIDS between 1990 and 2005[12], in units of thousands of people. Table 2[13] (see next page) gives the population of **Zimbabwe** from 1990 to 1999, in units of thousands of people.

Find a formula for the function (linear, exponential or power) that does the best job of predicting the number of AIDS orphans in **Zimbabwe**, and a second formula (linear, exponential or power) that does the best job of predicting the population of **Zimbabwe**.

Year	1990	1995	2001	2005
X	0	5	11	15
AIDS orphans (thousands of people)	59	320	782	1140

Table 1: Number of AIDS orphans in Zimbabwe, 1990-2005.

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[6] Source: Clarke, L. 2002. AIDS legacy – orphan gangs roam inner cities. *The Independent*, May 10, 2002.

[7] Source: http://news.bbc.co.uk/1/hi/health/1328886.stm

[8] Source: ABC News. 2002. African meeting calls for focus on AIDS. September 10, 2002. Available on-line from: http://abcnews.go.com/wire/Living/reuters20020910_597.html

[9] Source: *CIA World Fact Book*, 2002. Available on-line from: http://www.cia.gov/

[10] Source: UNAIDS. 2002. *Report on the Global HIV/AIDS Epidemic*. Geneva Switzerland: Joint United Nations Program on HIV/AIDS.

[11] Source: UNAIDS. 2002. *Report on the Global HIV/AIDS Epidemic*. Geneva Switzerland: Joint United Nations Program on HIV/AIDS.

[12] This is an estimate produced in the UNAIDS report.

[13] Source: http://www.library.uu.nl/wesp/populstat/Africa/africa.html

Year	x	Population (thousands)	Year	x	Population (thousands)
1990	0	9947.0	1995	5	11011.0
1991	1	10080.0	1996	6	11248.0
1992	2	10352.0	1997	7	11468.0
1993	3	10638.0	1998	8	11689.0
1994	4	11002.0	1999	9	11904.0

Table 2: Population of Zimbabwe, 1990-1999.

2. In this question, the independent variable x is defined to be:

- **Independent variable:** x = number of years since 1990.

Table 3[14] (see below) gives the number of children in   **South Africa** who were orphaned by AIDS between 1990 and 2005[15], in units of thousands of people. Table 4[16] (see below) gives the population of **South Africa** from 1990 to 2000, in units of thousands of people.

Find a formula for the function (linear, exponential or power) that does the best job of predicting the number of AIDS orphans in **South Africa**, and a second formula (linear, exponential or power) that does the best job of predicting the population of **South Africa**.

Year	1990	1995	2001	2005
X	0	5	11	15
AIDS orphans (thousands of people)	1	61	662	1328

Table 3: Number of AIDS orphans in South Africa, 1990-2005.

Year	x	Population (thousands)	Year	x	Population (thousands)
1991	1	37944.0	1994	4	41591.0
1992	2	39763.0	1999	9	43054.8
1993	3	40677.0	2000	10	43421.0

Table 4: Population of South Africa, 1990-2000.

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[14] Source: UNAIDS. 2002. *Report on the Global HIV/AIDS Epidemic*. Geneva Switzerland: Joint United Nations Program on HIV/AIDS.

[15] This is an estimate produced in the UNAIDS report.

[16] Source: http://www.library.uu.nl/wesp/populstat/Africa/africa.html

3.   In this question, the independent variable x is defined to be:

- **Independent variable:** x = number of years since 1990.

Create equations for each of the following functions:

- $Z(x)$ = the percentage of the population of **Zimbabwe** who are children orphaned by AIDS.

- $A(x)$ = the percentage of the population of **South Africa** who are children orphaned by AIDS.

4.   Use the equations that you have obtained for the functions $Z(x)$ and $A(x)$ to complete the Table 5 (below).

Year	Percentage of Zimbabwe's population who are AIDS orphans	Percentage of South Africa's population who are AIDS orphans
2002		
2005		
2010		
2050		
2070		

Table 5: Predictions for percentage of population who are children orphaned by AIDS.

NOTE: **You should hand in Table 5 (or a version of Table 5) with your completed homework assignment.**

5.   If the trends in population growth and AIDS that you have identified actually continue, when will all of the people in South Africa be children orphaned by AIDS?

Epilogue:

- Average lifetime cost of treatment for one HIV/AIDS patient[17]: $119,000.
- Average cost of apprehending, convicting and imprisoning one non-violent marijuana distributor[18]: $408,000.
- Projected cost of providing the latest antiretroviral therapy for *all* HIV/AIDS patients in Zimbabwe for one full year[19]: $18,000,000.
- Office of National Drug Control Policy annual budget for 2002[20]: $18,882,000.

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[17] Hellinger, F. J. 1993. The lifetime cost of treating a person with HIV. *Journal of the American Medical Association*, 270: 474-478.

[18] Caulkins, J. P., C. P. Rydell, W. L. Schwabe and J. Chiesa. 1997. *Mandatory Minimum Sentences: Throwing Away the Key or the Taxpayer's Money?* Summit PA: National Book Network.

[19] Annan chides U.S. for "shameful" level of aid. *Washington Post*, May 22, 2000.

[20] Office of National Drug Control Policy. 2002. *National Drug Control Strategy FY 2003 Budget Summary.* Washington DC: Executive Office of the President.