## Homework Assignment 11: Due at the beginning of class 10/23/02

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

- Create equations for exponential functions using a pair of points.
- Find equations for exponential functions using regression and tables of data.
- Use logarithms to solve equations that involve exponential functions.
- Learn about the scale of the HIV/AIDS pandemic in the former Soviet states.

**Note:** **In order to complete Question 1, you will have to read a short information bulletin from the U.S. Department of State. This report is provided as a separate file that you can read on-line or print out.**

"KALININGRAD, RUSSIA – The young man sitting before the psychiatrist stared darkly at the wall and bit his lip to keep from crying. He had answered a dozen questions about his sexual habits and absorbed in silence a lecture about how AIDS would change his life.

'Aleksei, everything now is up to you,' the psychiatrist, Oleg Petrosuk, told him gently. 'If you take care of yourself you can live a long time. I know how hard this is, but you have to believe me: nothing ends here.'

As if in answer, Alexsei stripped to the waist. He has three tattoos, but the one that draws the eye covers his left shoulder. It is a skull engulfed in huge batwings. Above the wings two English words have been burned into his skin: 'No Future.'"[1]

The first epidemic of HIV/AIDS in a former Soviet state was reported in 1996 in the Baltic city of Kaliningrad. The epidemic was initially confined to male injection drug users (IDUs) and their sexual partners, but quickly spread to the city's female sex workers, many of whom also used injection drugs and contracted HIV by sharing contaminated needles. In the four years following this initial outbreak, HIV/AIDS has been spread (predominantly through sharing of contaminated needles and contaminated drugs) to 82 of the 89 cities in the Russian Federation[2].

**1.** Read the U.S. Department of State bulletin on the HIV/AIDS epidemic in the former Soviet states. Let $T$ represent the number of years since 1990 and $H(T)$ represent the number of people with HIV/AIDS in the Russian Federation. List the information from the State Department bulletin that tells you what sort of function $H(T)$ is and what values of the function you are given. Use this information to find a formula for the function $H(T)$.

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[1] This excerpt is quoted directly from: Specter, M. 1997. At a western outpost of Russia, AIDS spreads like a forest fire. *The New York Times*, November 4, 1997.

[2] Source: Stephenson, J. 2000. HIV/AIDS surging in Eastern Europe. *Journal of the American Medical Association*, 284: 3113-3114.

**2.** According to the Centers for Disease Control and Prevention (CDC)[3], at the end of the year 2001 a total of 816,149 cases of HIV/AIDS had been reported in the United States. In what year will the total number of HIV/AIDS cases in the Russian Federation reach this level?

**3.** As indicated in the State Department bulletin, data on HIV/AIDS infections in Eastern Europe and the former Soviet states is difficult to collect[4]. Nevertheless, the United Nations has made some efforts to assess the scale of this HIV/AIDS epidemic. Table 1[5] (below) gives the total number of people officially registered as infected with HIV/AIDS in the Russian Federation from 1997 to 2001.

| Year | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|
| T | 7 | 8 | 9 | 10 | 11 |
| HIV/AIDS patients (thousands of people) | 6.12 | 10.993 | 31.428 | 89.796 | 173.0 |

Table 1: Number of people officially registered as infected with HIV/AIDS in the Russian Federation, 1997-2001.

Does the data in Table 1 show a **perfectly exponential** relationship, as was implied by the State Department bulletin? If so, find an equation for the number of people officially registered as suffering by HIV/AIDS in the Russian Federation as a function of *T*. If Table 1 does *not* show a perfectly exponential relationship, then find an equation for the simple function (linear, exponential, power) that does the best job of representing the trend in Table 1.

**4.** Russian doctor Vadim Pokrovsky is the director of the Center for AIDS Prevention and Treatment in Moscow. Dr. Pokrovsky became involved with HIV/AIDS in 1989 when he diagnosed almost 250 children with AIDS. He has stated publicly[6] that he believes the actual number of people infected with HIV to be five times the official figures[7]. How would you transform the equation from Question 3 to bring it into line with Dr. Pokrovshy's statements? Create an

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[3] Source: Centers for Disease Control and Prevention. 2001. *HIV/AIDS Surveillance Report*, 13(2): 8.

[4] In part, this is because many of the political leaders of the former Soviet states do not want to concede that their countries have a serious problem with HIV/AIDS infections. For more on the danger that massive levels of HIV/AIDS infections may pose to governments and the social infrastructure of countries, see: Sealey, G. 2002. "Security threat: AIDS not just health crisis, experts fear." Available on-line from http://www.abcnews.com/

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

[6] Source: Filipov, D. Russia struggles to treat AIDS patients. *The Boston Globe*, 21 July 2002, p. A17.

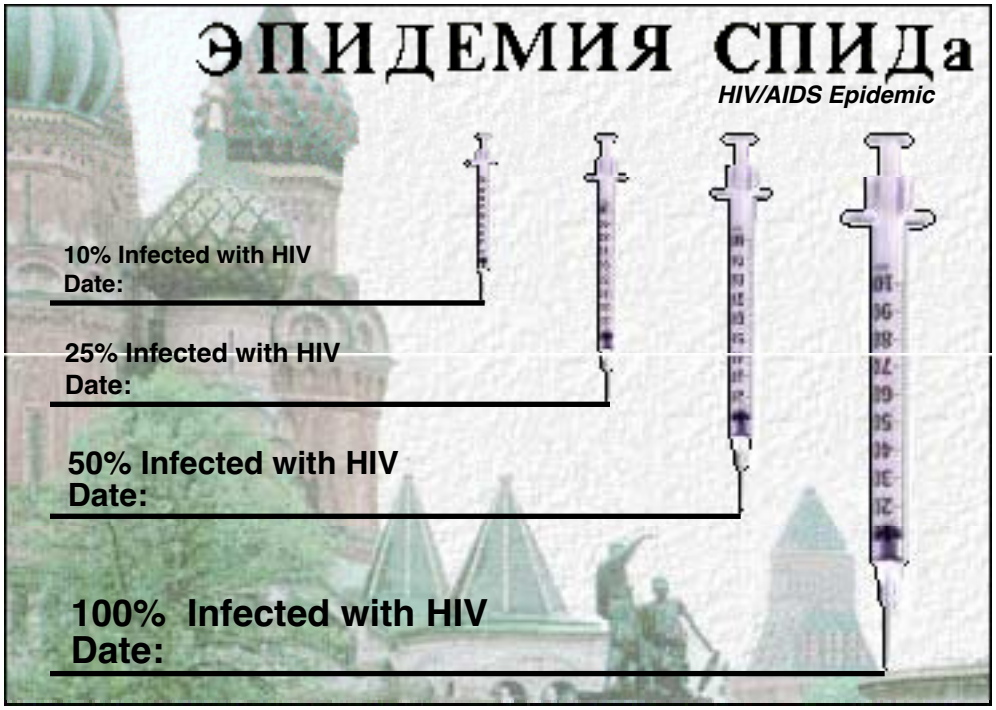
[7] According to the U.S. Department of State, there is often a significant stigma attached to HIV/AIDS infection in Russia. As a result, many people who have engaged in risky behaviors (sharing needles, unprotected sex, sex with prostitutes) are reluctant to have themselves tested. For more, see: http://usinfo.state.gov/regional/eur/russia/aids-061402.htm

equation for $P(T)$, the actual number (according to Dr. Pokrovsky) of people in the Russian Federation who are infected with HIV/AIDS.

**5.** In 2002, the CIA[8] estimated that the population of the Russian Federation was 144,978,573 and that the annual population growth rate was −0.33%. If the function $R(T)$ represents the population of the Russian Federation (in units of thousands of people) then the information from the CIA can be used to create the equation:

$$R(T) = (150844.7924) \cdot (0.9967)^T .$$

You are not required to derive or justify the equation for $R(T)$. Instead, use the equation for $R(T)$ and the equation that you found in Question 4 to complete the graphic (see below).




**NOTE:** 1. You should hand in a completed graphic as part of your homework assignment.

2. You may find the following algebraic fact useful when working on this problem. Suppose that $M$ and $N$ are both positive numbers. Then:

$$\frac{M^T}{N^T} = \left(\frac{M}{N}\right)^T .$$

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