Project 1: The World Population in the Year 2050

The issue of population is one that affects all us both locally and globally. How the population grows in a local region has a profound impact on such factors as energy consumption, pollution, water consumption, and services the local government provides. This has a strong ripple effect on the world population as the world seeks to meet the needs of its population. The demographics of the world population are also changing and with it, the way the world meets the needs of the population. The difficulty in predicting future population growth is that there are so many factors that can influence change. The best we can do is use a model and try to predict what the future population will be. Just like weather forecasting, the further into the future we try to predict, the more uncertain our prediction becomes. The UN published a report in 1998 that predicted the world population in 2050. Just two years later, they had to revise their prediction by 4.5%.

In this project, you will examine the issue of population from a global perspective, keeping in mind that how the world population grows will have a profound effect on all of us locally. In part 1, you will examine the world population figures for the last fifty-seven years (1950 – 2006). You will then examine six regression models (i.e., "equations that are fitted to match the data") and then try to use one of those models to predict the world population in the future. In part 2, you will read the article, "World Population Prospects The 2006 Revision" written by the United Nations and address some issues raised by that article and compare their predictions with yours.

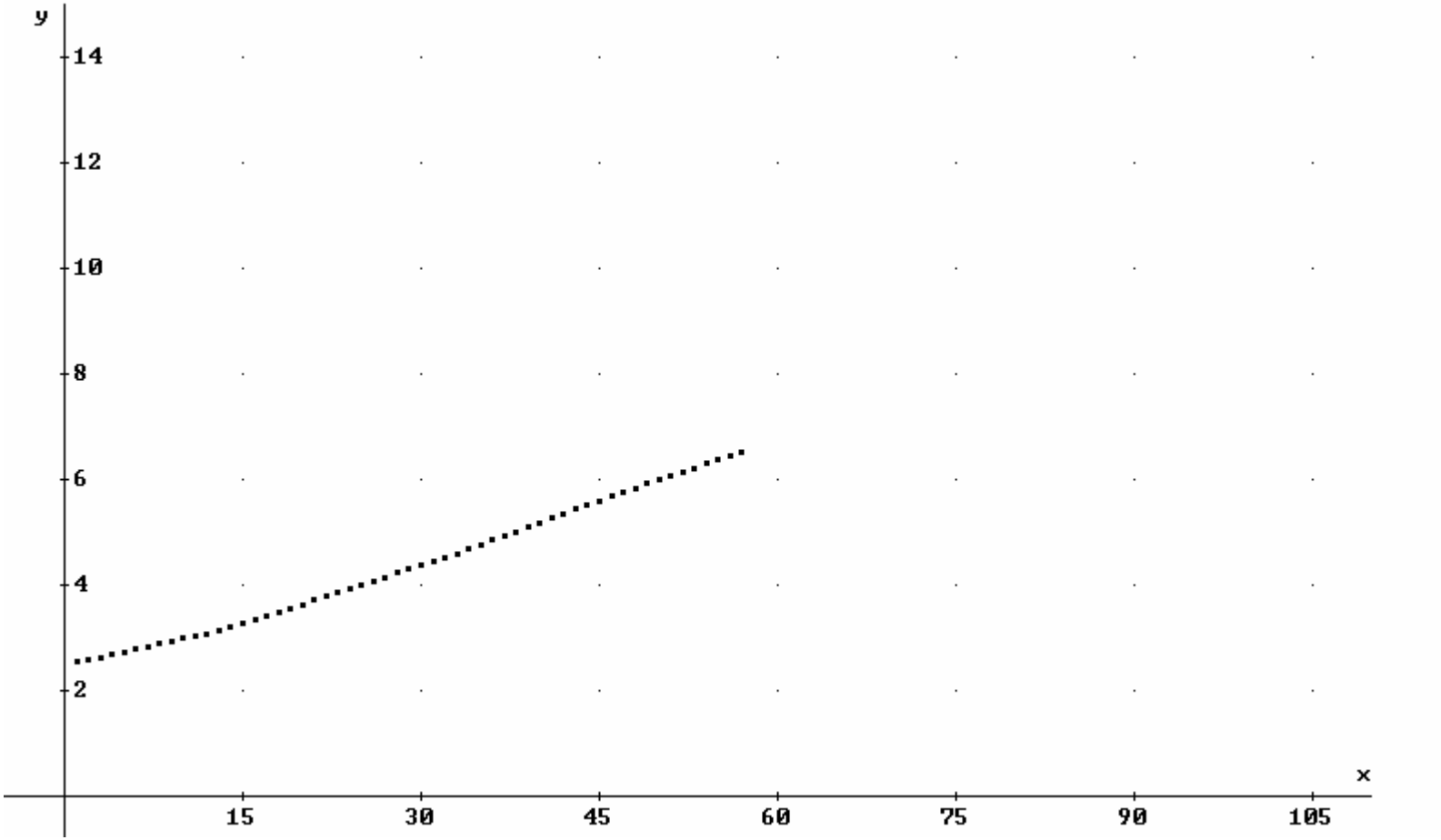
The next eight pages of this handout have the raw data and the regression models with the corresponding graphs. In all of these models, $x = 1$ corresponds to 1950. The r^2 number just measures how closely the model fits the data; the closer r^2 is to one, the better the fit. Take some time to examine those pages and then answer the questions on page 10 and 11.

Total Midyear Population for the World: 1950 – 2006

Year	x years after 1949	Population (in Billions)	Average growth rate	Year	x years after 1949	Population (in Billions)	Average growth rate
1950	1	2.5565	1.47%	**1980**	31	4.4471	1.68%
1951	2	2.5943	1.61%	**1981**	32	4.5225	1.73%
1952	3	2.6363	1.70%	**1982**	33	4.6016	1.75%
1953	4	2.6816	1.77%	**1983**	34	4.6827	1.69%
1954	5	2.7296	1.87%	**1984**	35	4.7625	1.69%
1955	6	2.7810	1.89%	**1985**	36	4.8537	1.70%
1956	7	2.8340	1.95%	**1986**	37	4.9268	1.73%
1957	8	2.8898	1.94%	**1987**	38	5.0127	1.71%
1958	9	2.9463	1.76%	**1988**	39	5.0993	1.68%
1959	10	2.9986	1.39%	**1989**	40	5.1857	1.68%
1960	11	3.0406	1.33%	**1990**	41	5.2734	1.58%
1961	12	3.0814	1.80%	**1991**	42	5.3572	1.54%
1962	13	3.1373	2.19%	**1992**	43	5.4405	1.47%
1963	14	3.2068	2.19%	**1993**	44	5.5213	1.43%
1964	15	3.2779	2.08%	**1994**	45	5.6010	1.43%
1965	16	3.3468	2.07%	**1995**	46	5.6817	1.40%
1966	17	3.4169	2.02%	**1996**	47	5.7616	1.36%
1967	18	3.4866	2.04%	**1997**	48	5.8406	1.33%
1968	19	3.5583	2.07%	**1998**	49	5.9187	1.29%
1969	20	3.6328	2.05%	**1999**	50	5.9956	1.26%
1970	21	3.7079	2.06%	**2000**	51	6.0717	1.24%
1971	22	3.7853	1.99%	**2001**	52	6.1475	1.21%
1972	23	3.8613	1.94%	**2002**	53	6.2226	1.20%
1973	24	3.9368	1.87%	**2003**	54	6.2974	1.19%
1974	25	4.0113	1.79%	**2004**	55	6.3729	1.19%
1975	26	4.0837	1.72%	**2005**	56	6.4491	1.18%
1976	27	4.1547	1.71%	**2006**	57	6.5256	1.17%
1977	28	4.2263	1.68%	**2007**	58		
1978	29	4.2977	1.71%	**2008**	59		
1979	30	4.3720	1.70%	**2009**	60		

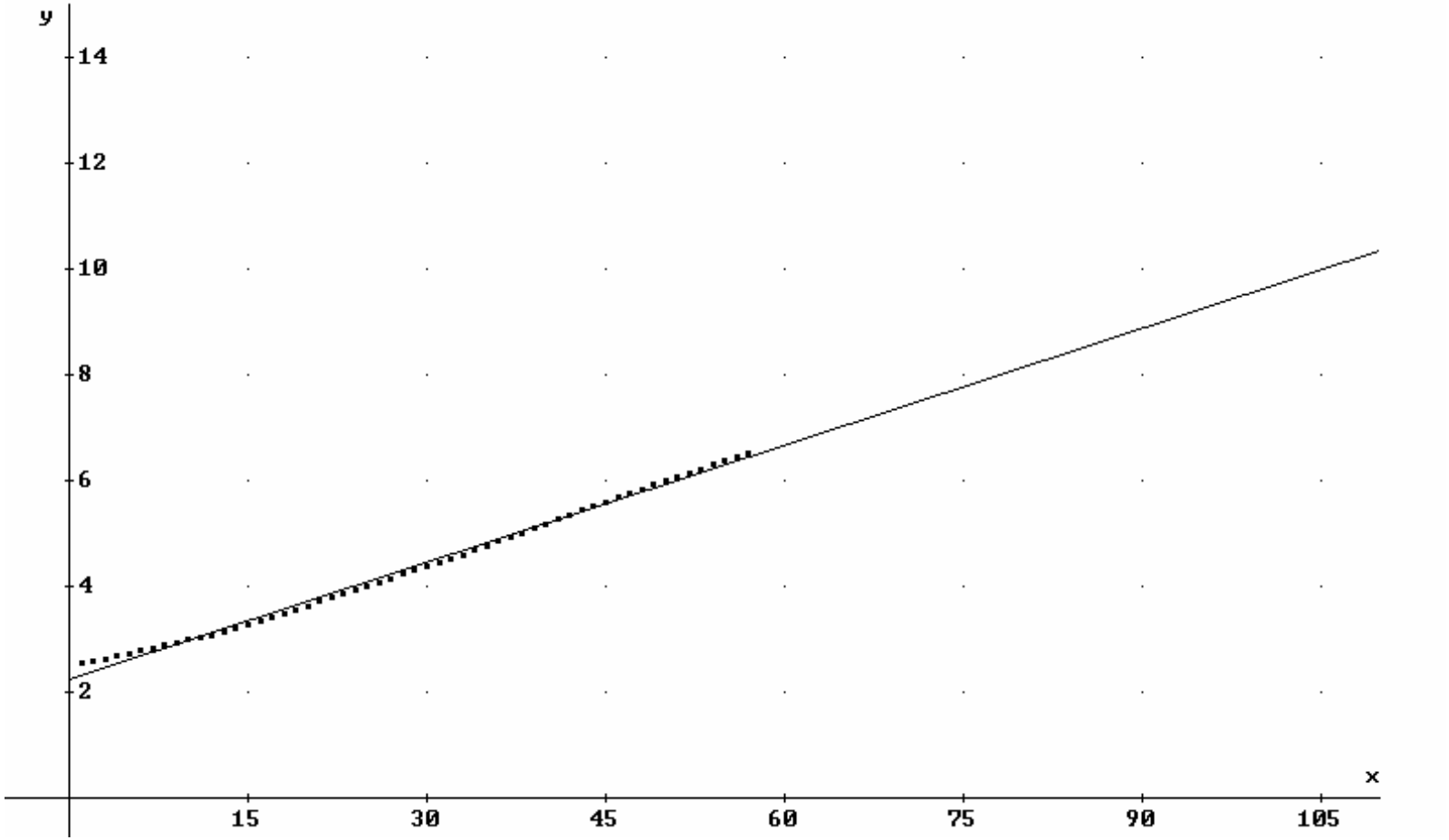
Source: US Census Bureau

Plot of Total Midyear Population for the World (in billions): 1950 – 1999
(x = 1 corresponds to 1950)



Linear Regression

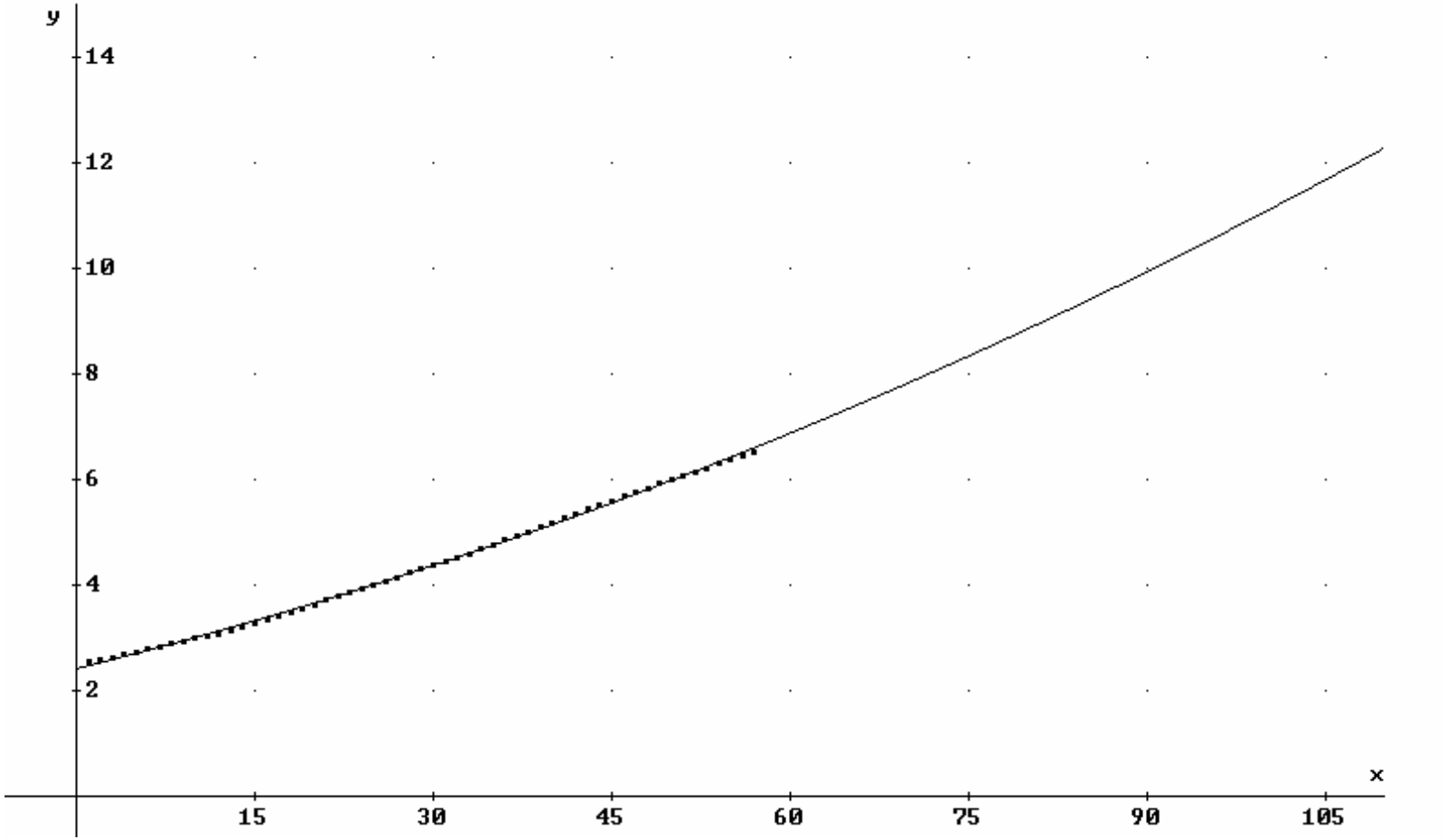
$y = 0.07371163469x + 2.24558013784$
$(r^2 = 0.995408)$



Projected Population in 2050 using this model is: 9.69 Billion

Quadratic Regression

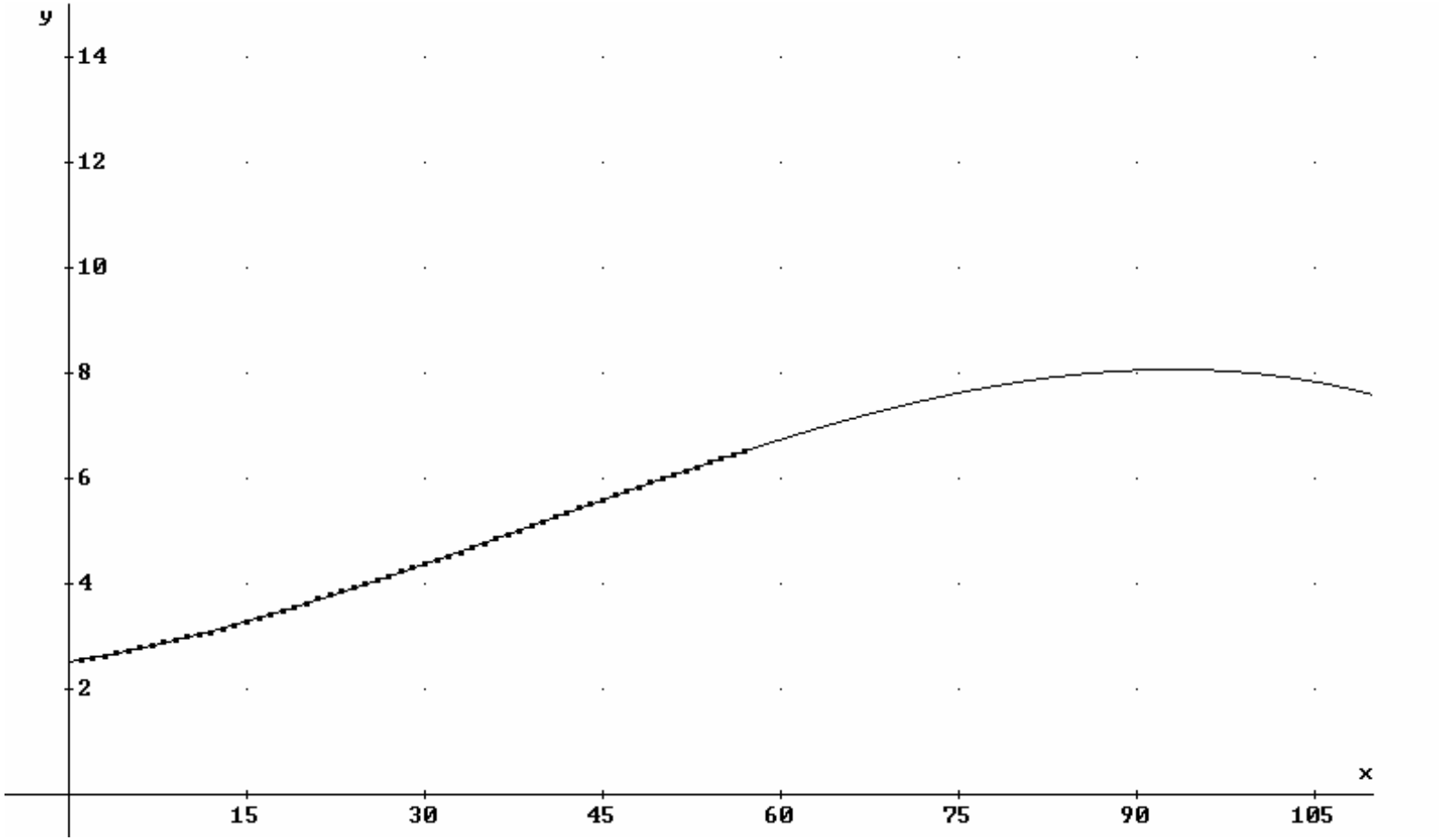
$y = 3.08076495 \cdot 10^{-4} x^2 + 0.055843197998x + 2.42128643199$
$(r^2 = 0.99917)$



Projected Population in 2050 using this model is: 11.20 Billion

Cubic Regression

$y = -9.565789 \cdot 10^{-6} x^3 + 0.001140300159x^2 + 0.036367251104x + 2.51948882433$
($r^2 = 0.999925$)

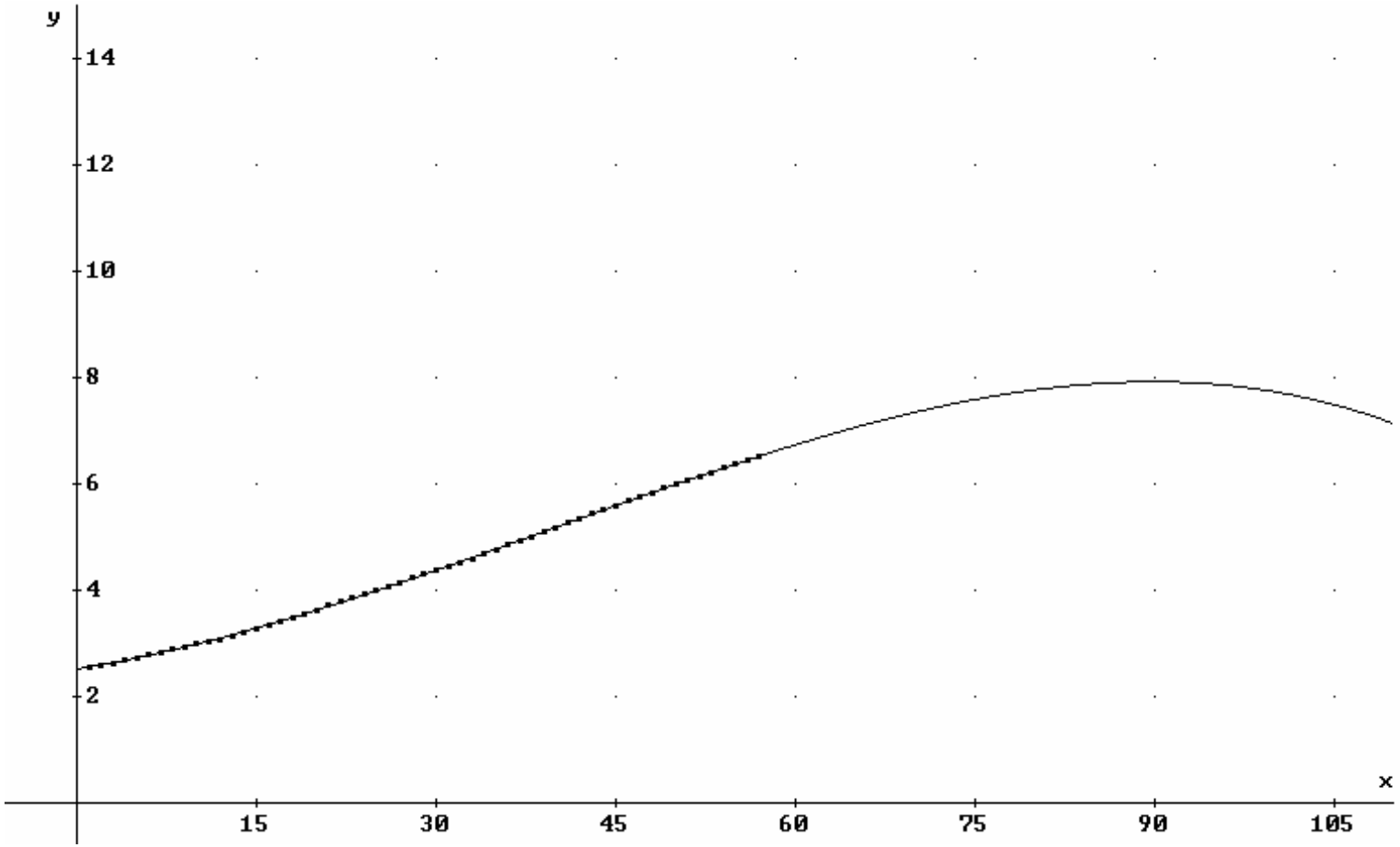


Projected Population in 2050 using this model is: 7.97 Billion

Quartic Regression

$y = -1.1804 \cdot 10^{-8} x^4 - 8.196494 \cdot 10^{-6} x^3 + 0.001088943169x^2 + 0.037042802509x + 2.5173767848$

($r^2 = 0.999925$)

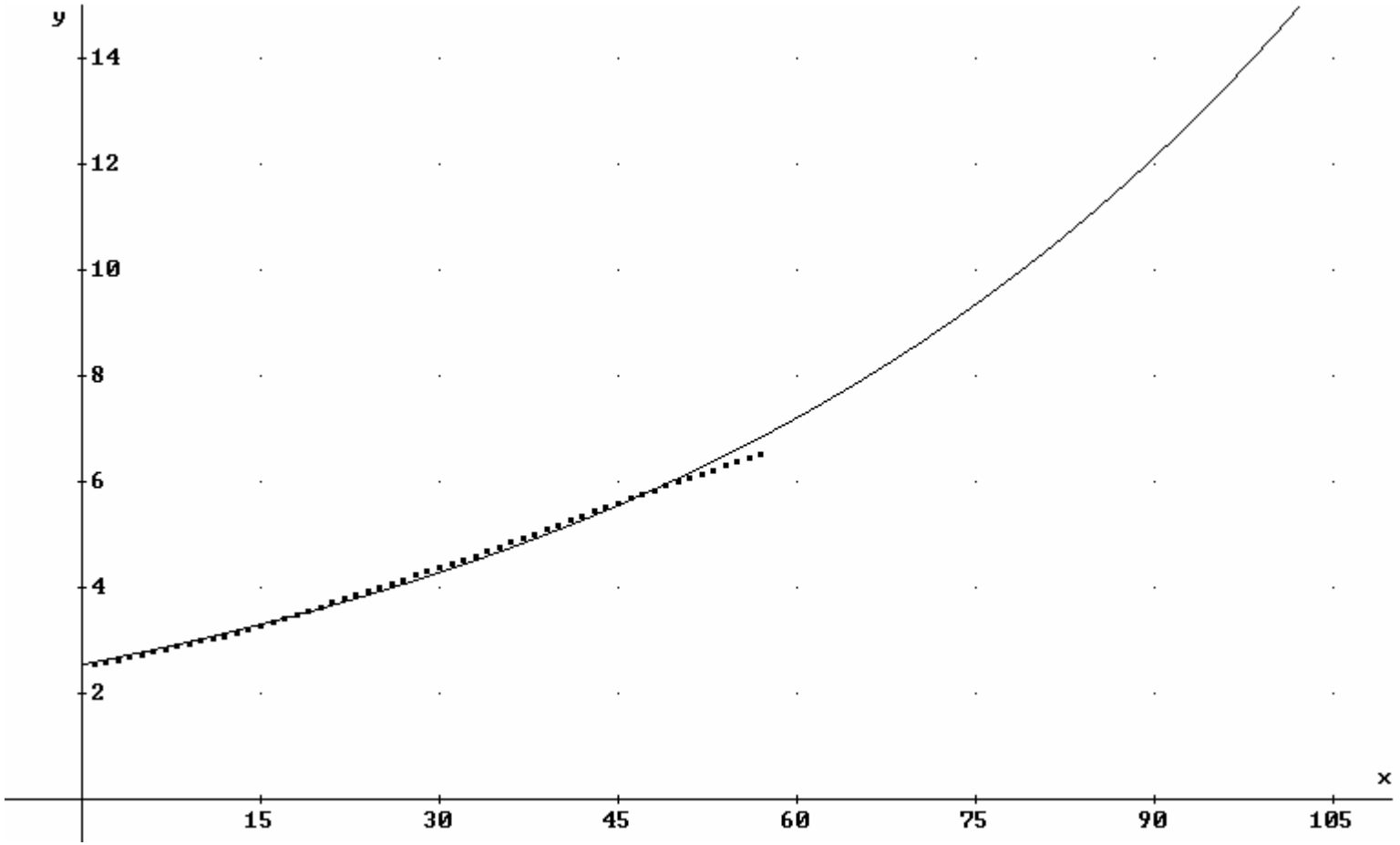


Projected Population in 2050 using this model is: 7.69 Billion

Exponential Regression

$y = 2.54659690309e^{0.017346502951x}$

$(r^2 = 0.995874)$

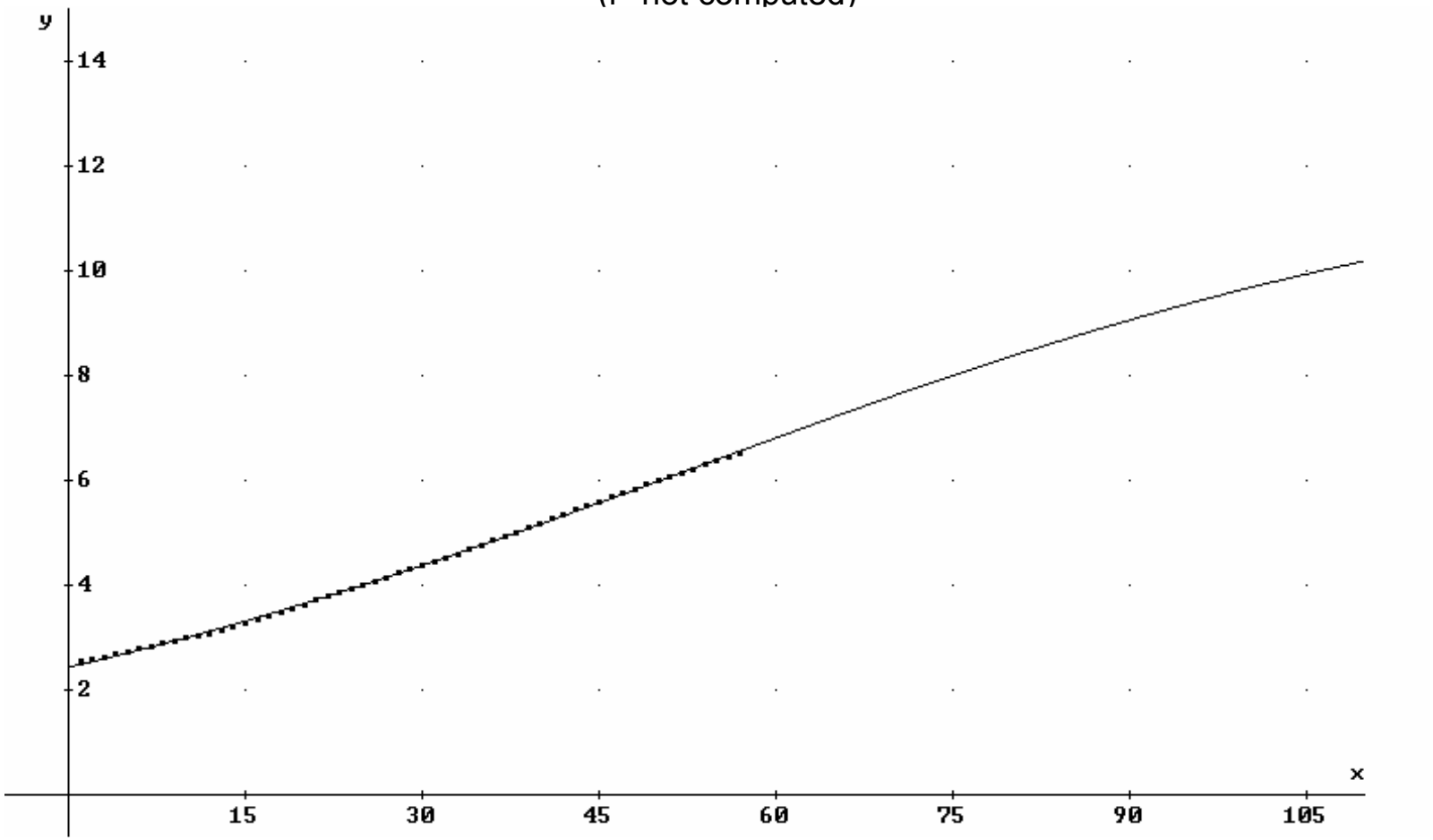


Projected Population in 2050 using this model is: 14.68 Billion

Logistic Regression

$$y = \frac{12.350765464183}{1+4.0755977487969e^{-0.02687184696042x}}$$

(r^2 not computed)



Projected Population in 2050 using this model is: 9.72 Billion

Answer the following questions on a separate piece of paper:

Part 1

1) In examining the data and the six regression models, which model would you use to predict the world population in the future? Why?

2) Using the model you picked in question 1, calculate the world population for the years 2010, 2015, 2020, 2025 (x = 61, x = 66, x = 71, and x = 76).

3) The table below is the predicted world population for the years 2010, 2015, 2020, 2025 done by the US Census Bureau. Calculate the percent difference between your predictions and the US Census Bureau's and write a one sentence comment on those differences ($\frac{\text{Your Prediction} - \text{Census'}}{\text{Census'}} \cdot 100\%$).

Year	x years after 1949	Population (in Billions)
2010	61	6.8349
2015	66	7.2259
2020	71	7.6034
2025	76	7.9586

4) Using the model you selected in question 1, calculate the world population for the year 2050. Does this answer seem reasonable?

5) Using the model you selected in question 1, what will happen to the world population in the long run? (Hint: find $\lim_{x \to \infty}$).

Part II

On my website, there is the article: "World Population Prospects The 2006 Revision" produced by the United Nations Administration. To access it, go to www.countingbear.com and click on Math 1325 Written Projects. Then, click on World Population Prospects The 2006 Revision below Written Project #1. Please read the entire article and then answer the following questions:

6) Is the UN's prediction (medium variant) for 2050 the same as yours in question #4? List at least three important assumptions is the UN making in their prediction?

7) What was the most interesting and/or alarming prediction in this article? Why? How should this issue be addressed?

8) An executive of a corporation makes the following statement: "We are assuming that there will be 9 billion in the world in 2050." Is this statement reasonable? Why or why not?

9) Using the logistics regression, what will happen to the world population in the long run (hint: $\lim_{x \to \infty} e^{-\#(x)} = 0$)?