World Population Growth (and the Exponential Model)

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Economic Demography

Econ/Demog c175

Week 1: Lecture B

Spring 2017

Class activity: Generational Population Growth

- We'll simulate generational growth, with each row of class a generation.
- Everyone in front row gets out a piece of paper.
- Everyone in class computes generational growth implied by their own family.
- Let's see what happens.

Format of sheet

Generation		# of kids	"1-sex"	cumulative product
		N	N/2	multiply
0		3	1.5	1.5
1		1	.5	.75
2		2	1	.75
3	…		…	…

Discussion

- What happened?
- If we shift order of generations, would it matter?
- Is this a good statistical estimate of your parent's generations growth rate? What might be wrong?

Exponential Growth and 10,000 Years of Humanity

An overview of all of humanity's past and its future

World Population Size

Year	Millions
-8,000	4
1	211
500	200
1000	290
1500	473
1750	764
2000	6,080
2015	7,218

Source of Pop. Estimates: Weeks

World Population Size

Year	Millions	Growth rate (persons per yr)	(%)
-8,000	4	25k	
1	211	-22k	
500	200	180k	
1000	290	366k	
1500	473	1,160k	
1750	764	21,000k	
2000	6,080	75,000k	
2015	7,218		

The exponential model

- Our model

$$N(t) = N(0)\, e^{nt}$$ (economists use "n"; demographers use "R")

- Why exponential? Because absolute growth depends on size. What other processes feature proportional growth?

- Take natural logarithm. What is "n" (or "R") on the graph of log population vs. time?

Exponential growth for generations?

- Let's say a mother has 2 daughters (who survive to adulthood).
- What is the exponential growth rate, assuming that the average generation length is 30 years?
- 3 daughters?
- 1 daughter?
- 1.01 daughters? [Lab 1, Question 2]

World Population Size

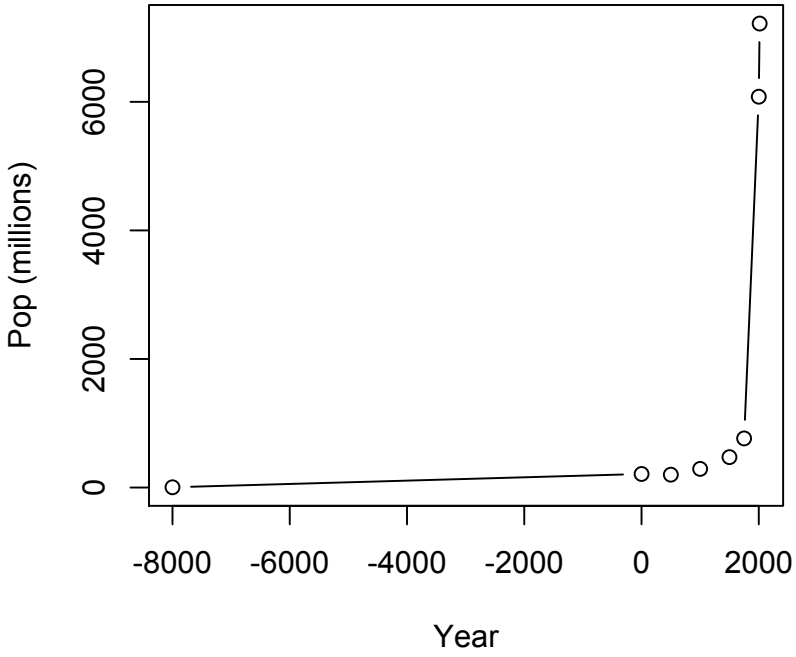
Year	Millions	Growth rate (persons per yr)	Growth rate (%)
-8,000	4	25k	~ 0
1	211	-22k	~ 0
500	200	180k	0.1
1000	290	366k	0.1
1500	473	1,160k	0.2
1750	764	21,000k	0.8
2000	6,080	75,000k	1.1
2015	7,218		

Notes on exponential growth

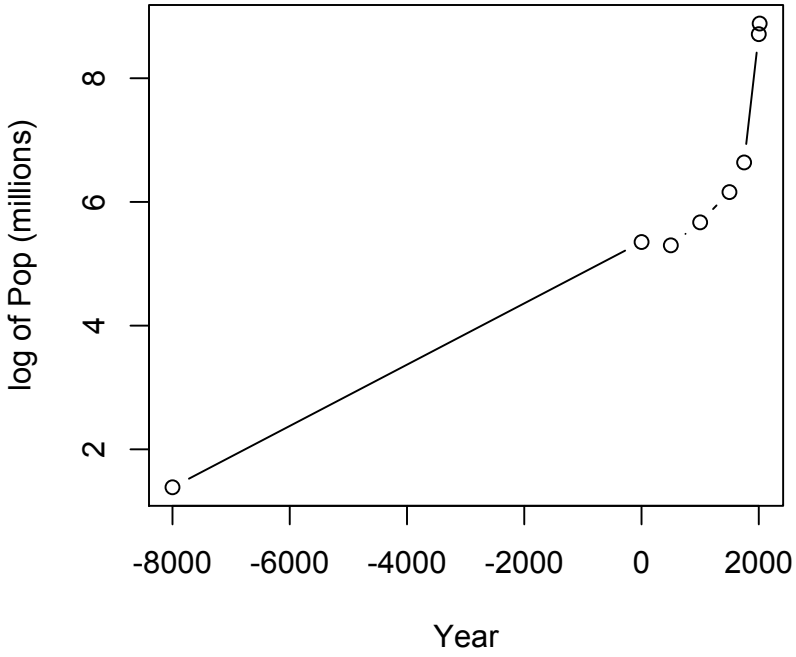
- The exponential growth rate tells us the constant growth rate that matches our observations
- It is hypothetical. Can be calculated even when the population doesn’t grow constantly.
- We can also piece together periods of constant growth (“piecewise exponential”)

Seeing World Population Growth

Original scale



Log-scale



What is average exponential growth rate *n* over last 10,000 years?

Has the growth rate been constant or increasing?

Conclusions (exponential growth)

- The reason for using the exponential model is that population growth is proportional (depends on size of current population)
- We get constant exponential growth if birth and death rates stay constant
- Very powerful

  (even tiny growth rate will compound enormously over time)

Conclusions
(Human Population History)

- The 3 puzzles of human population

1. How did population growth stay so close to zero? Why? (Malthus, next week)
2. What happened that caused/allowed population to grow (Solow, Boserup)
3. Why is population growth slowing recently?

Questions?

- Population growth?
- Course logistics?
- Anything else?
- [Now we turn to Lab 1 to get started with R and Rstudio]