

Measuring Population Change

- If past trends in population growth can be expressed in a mathematical model, there would be a solid justification for making projections on the basis of that model.
 - Demographers developed an array of models to measure population growth; four of these models are usually utilized.











Arithmetic Change

• The arithmetic growth rate is expressed by the following equation:

$$r = \left(\frac{P_t - P_0}{t}\right) \div P_0 \times 100$$

Geometric Change
Geometric population growth is the same as the growth of a bank balance receiving compound interest.
According to this, the interest is calculated each year with reference to the *principal plus previous interest payments*, thereby yielding a far greater return over time than simple interest.
The geometric growth rate in demography is calculated using the 'compound interest formula'.



Geometric Change

- Under arithmetic growth, successive population totals differ from one another by a constant amount.
- Under geometric growth they differ by a constant ratio.
- In other words, the population totals for successive years form a geometric progression in which the ratio of adjacent totals remains constant.

Geometric Change

- However, in reality population change may occur almost continuously – not just at yearly intervals.
- Recognition of this led to a focus on exponential growth, which more accurately describes the continuous and cumulative nature of population growth.











Exponential Change

The shorter the interval over which increments occur, the faster the population increases – just as the balance in a bank account with daily interest rate grows more quickly than one with yearly interest.









Exponential Change

- Example:
- If the population of Egypt increased from 48 million in 1986 to 60 million in 1996, calculate the annual growth rate in the intercensal period using the exponential growth rate.
- Calculate the growth rate using the geometric method and compare the results.

Logistic Change

- Recognition that populations *cannot* grow indefinitely has led to interest in other mathematical approaches to representing population growth and defining its upper limit.
- One of the best known is the logistic curve.
- The model assumes an upper limit to the number of population a country or a region can maintain.
 - Fitting a logistic model for population growth requires more data than just population trends in the past.









			Population Doubling Time at Different Annual Rates of Growt			
		Annual rate of growth	Doubling time	Annual rate of growth	Doubling time	
		0.1	693.1	2.1	33.0	
	10 m	0.2	346.6	2.2	31.5	
		0.3	231.0	2.3	30.1	
	and the Case	0.4	173.3	2.4	28.9	
		0.5	138.6	2.5	27.7	
		0.6	115.5	2.6	26.7	
		0.7	99.0	2.7	25.7	
	N VAR	0.8	86.6	2.8	24.8	
		0.9	77.0	2.9	23.9	
		1.0	69.3	3.0	23.1	
		1.1	63.0	3.1	22.4	
		1.2	57.8	3.2	21.7	
ath.		1.3	53.3	3.3	21.0	
1.0		1.4	49.5	3.4	20.4	
30		1.5	46.2	3.5	19.8	
4	- And	1.6	43.3	3.6	19.3	
145 1		1.7	40.8	3.7	18.7	
		1.8	38.5	3.8	18.2	
		1.9	36.5	3.9	17.8	
		2.0	34.7	4.0	17.3	

Doubling Time

- Doubling time cannot be used to project future population size, because it assumes a constant growth over decades, whereas growth rates change.
- Nonetheless, calculating doubling time helps sketch how fast a population is growing at the present time.



