Problem Set 2: Solutions

Demography Camp

Summer 2013

Question 1

On December 31 2012, Belleville, Illinois had a population of 32,324 people. Over the next 12 months, 3213 babies were born, 4573 people died, 2015 people moved into Belleville, and 3073 people left.

Part 1

Write you the population balance equaction for Belleville, IL for 2013.

$$P(Belleville\ 2013) = P(Belleville\ 2012) + B(Belleville\ 2013) - D(Belleville\ 2013)$$

$$+ I(Belleville\ 2013) - E(Belleville\ 2013)$$

$$P(Belleville\ 2013) = 32,324 + 3213 - 4573 + 2015 - 3073$$

Part 2

What is the population of the town at the end of the year?

$$P(Belleville\ 2013) = 29,906$$

Question 2

Nigeria's population in 2010 was 158,423,182 with a growth rate of 2.5% a year.

The United States population was 309,349,689 in 2010 with a growth rate of 0.7% a year.

Part 1

If these rates remain constant into the future, in what year will Nigeria and the United States have the same size population?

$$P(Nigeria) \cdot e^{r(Nigeria) \cdot t} = P(United\ States) \cdot e^{r(UnitedStates) \cdot t}$$

$$\frac{P(N)}{P(U)} = \frac{e^{r(U) \cdot t}}{e^{r(N) \cdot t}}$$

$$\frac{P(N)}{P(U)} = e^{r(U) \cdot t - r(N) \cdot t}$$

$$\frac{P(N)}{P(U)} = e^{t \cdot (r(U) - r(N))}$$

$$log\left(\frac{P(N)}{P(U)}\right) = t \cdot (r(U) - r(N))$$

$$\frac{log\left(\frac{P(N)}{P(U)}\right)}{r(U) - r(N)} = t$$

$$\frac{log\left(\frac{158,423,182}{309,349,689}\right)}{0.007 - 0.025} = t$$

$$t = 37.17792\ years$$

The populations will be of equal size in 2047.

Part 2

How big will these twin populations be?

Choose either country (you should get the same answer!):

$$P(2047) = P(2010) \cdot e^{r \cdot t}$$

Nigeria:
$$401,303,393 = 158,423,182 \cdot e^{(0.025 \cdot 37.17792)}$$

USA:
$$401,303,393 = 309,349,689 \cdot e^{(0.007 \cdot 37.17792)}$$

Question 3

Who is the "at-risk" population if I am calculating a:

Part A

Divorce Rate?

Married people

Part B

Maternal Mortality Rate?

Pregnant and recently postpartum women

Question 4

Imagine a population that had 100 people at time t, 130 people at time t+1, and 150 people at time t+2. What would be the estimated number of person years lived between time t and t+2 if:

Part A

You used the midpoint to estimate person years?

$$Midpoint\ Population\ \cdot\ Length\ of\ Interval$$
$$130 \cdot 2 = 260\ Person\ Years$$

Part B

You used the average of the beginning and end to estimate person years?

$$Average\ Population\ \cdot\ Length\ of\ Interval$$
$$\frac{100 + 150}{2} \cdot 2 = 250\ Person\ Years$$