Problem Set 1: Understanding World Population Dynamics

Due 2/26, adapted from QSS 1.5.2

Submit your R code as well as a short writeup of your answers on Blackboard.

Understanding population dynamics is important for many areas of social science. We will calculate some basic demographic quantities of births and deaths for the world's population from two time periods: 1950 to 1955 and 2005 to 2010. We will analyze the following CSV data files - `Kenya.csv`, `Sweden.csv`, and `World.csv`. Each file contains population data for Kenya, Sweden, and the world, respectively. The table below presents the names and descriptions of the variables in each data set.

Name	Description
`country`	Abbreviated country name
`period`	Period during which data are collected
`age`	Age group
`births`	Number of births in thousands (i.e., number of children born to women of the age group)
`deaths`	Number of deaths in thousands
`py.men`	Person-years for men in thousands
`py.women`	Person-years for women in thousands

Source: United Nations, Department of Economic and Social Affairs, Population Division (2013). *World Population Prospects: The 2012 Revision, DVD Edition.*

The data are collected for a period of 5 years where *person-year* is a measure of the time contribution of each person during the period. For example, a person that lives through the entire 5 year period contributes 5 person-years whereas someone who only lives through the first half of the period contributes 2.5 person-years. Before you begin this exercise, it would be a good idea to directly inspect each data set. In R, this can be done with the `View` function, which takes as its argument the name of a `data.frame` to be examined. Alternatively, in RStudio, double-clicking a `data.frame` in the `Environment` tab will enable you to view the data in a spreadsheet-like view.

Question 1

We begin by computing *crude birth rate* (CBR) for a given period. The CBR is defined as:

$$\text{CBR} = \frac{\text{number of births}}{\text{number of person-years lived}}$$

Compute the CBR for each period, separately for Kenya, Sweden, and the world. Start by computing the total person-years, recorded as a new variable within each existing `data.frame` via the `$` operator, by summing the person-years for men and women. Then, split each dataset into two, one for the 1950-1955 period, and one for the 2005-2010 period (so you should have six datasets). Compute the CBR for each region/period and store them in one vector with appropriate labels. Briefly describe patterns you observe in the resulting CBRs.

Question 2

The CBR is easy to understand but contains both men and women of all ages in the denominator. We next calculate the *total fertility rate* (TFR). Unlike the CBR, the TFR adjusts for age compositions in the female

population. To do this, we need to first calculate the *age specific fertility rate* (ASFR), which represents the fertility rate for women of the reproductive age range $[15, 50)$. The ASFR for age range $[x, x + \delta)$, where x is the starting age and δ is the width of the age range (measured in years), is defined as:

$$\text{ASFR}_{[x,\ x+\delta)} \ = \ \frac{\text{number of births to women of age } [x,\ x + \delta)}{\text{Number of person-years lived by women of age } [x,\ x + \delta)}$$

Note that square brackets, [and], include the limit whereas parentheses, (and), exclude it. For example, $[20, 25)$ represents the age range that is greater than or equal to 20 years old and less than 25 years old. In typical demographic data, the age range δ is set to 5 years. Compute the ASFR for Sweden and Kenya as well as the entire world for each of the two periods. Store the resulting ASFRs separately for each region. What does the pattern of these ASFRs say about reproduction among women in Sweden and Kenya?

Question 3

Using the ASFR, we can define the TFR as the average number of children women give birth to if they live through their entire reproductive age.

$$\text{TFR} = \text{ASFR}_{[15,\ 20)} \times 5 + \text{ASFR}_{[20,\ 25)} \times 5 + \cdots + \text{ASFR}_{[45,\ 50)} \times 5$$

We multiply each age-specific fertility rate rate by 5 because the age range is 5 years. Compute the TFR for Sweden and Kenya as well as the entire world for each of the two periods. As in the previous question, continue to assume that women's reproductive age range is $[15, 50)$. Store the resulting TFRs for all period-regions in one vector (of length six), with appropriate labels. In general, how has the number of women changed in the world from 1950 to 2000? What about the total number of births in the world?