Assignment for the EDSD 2020 course "Population projections"

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Please send your solutions at basellini@demogr.mpg.de with a single `.pdf` file containing your answers, as well as the `R` codes and data to generate the results. It can also be an Rmarkdown document. **Reminder**: choose only 6 of the following exercises, and work in team with your group members.

Question 1

Take the population time-series for any country (data from HMD or UN), and answer to the following three questions:

- Project the population 20-year ahead using the constant exponential model (baseline projection)
- Make an assumption about one of the demographic components, and compare this projection with the baseline one
- Assume that your observed data ends 5 years before the last available data point, and project the population for 5 years. Are the projected values close to the observed ones?

Question 2

Take the population for any country (for example, use data from the HMD), as well as data for person-years and fertility rates (for example, take data from HMD and HFD). Divide the population into 5 years age groups and project the population for 5 years ahead for each sex separately. Plot and compare your results with the baseline population.

Question 3

Starting from the following equation

$$N_0^F(t+5) = B^F[t, t+5]\frac{L_0^F}{5\,\ell_0} \tag{1}$$

show how we can derive

$$N_0^F(t+5) = \sum_x N_x^F(t) b_x^F \tag{2}$$

Question 4

Take again the population that you used for Question 2. Project the population for 5 years ahead, but this time use matrix formulas. Compare your results with the projections that you obtained in Question 2. Are they the same?

Question 5

Project your chosen population by sex for $n = 20$ periods ahead and show your results.

Question 6

Following up on Question 5, include migration in your projection 20 period ahead. You can either use observed net migration counts (you can estimate them from the balancing equation of population growth) or the Rogers-Castro migration schedule (try to find reasonable data on total net migration counts).

Question 7

Project your chosen population by sex for $n = 20$ periods ahead, making time-specific assumptions about one or more demographic components.

Question 8

Derive the long-term growth rate and population distribution by eigendecomposing your Leslie matrix, and compare your results with those that you obtain from a long projection of your population. As a second step, modify your starting population by randomly re-assigning elements on $\boldsymbol{N}(t)$ to different age groups, and project the new population in the long term. Compute the long-term growth rate and distribution of this second population, and compare it to the first.

Bonus

For exercise 5 to 8, present your results with the aid of a shiny app or an animation