**CS&SS/SOC/STAT 563 — Statistical Demography — Spring 2022 - Homework no. 5**

Due Monday May 16 at 2:15pm on the course Canvas website.

1. Obtain the values of life expectancy at birth for Nicaragua for 1950-2020 from the 2019 World Population Prospects and write them out in your homework.

   (a) Fit a version of the six-parameter double logistic gain model by numerical optimization to the gains in life expectancy, assuming that the error variance remains constant over time (this will just give one set of double logistic parameter values and an estimated error variance).

   (b) Plot the observed gains against their fitted values, and comment on the fit.

   (c) Find the predictive distribution of Nicaragua life expectancy for 2020-2025 conditional on this model, analytically or by simulation. Plot the distribution and give its median and a 95% prediction interval.

2. A fully converged simulation for Bayesian modeling and projection of female life expectancy at birth is available on the Homework web page. This is based on WPP 2015 data, and treats 2015 as the present year. It consists of three MCMC chains, each of length 160,000, thinned by 50, and 1,000 project trajectories for both female and male life expectancy. After unpacking you will find a README file that contains the code used to generate the simulation.

   (a) Use the get.e0.mcmc and get.e0.prediction functions to obtain the MCMC and prediction objects, respectively. What are the contents of these objects?

   (b) Assess the double logistic fit for each of Senegal and Ghana.

   (c) Compare the fitted model for the two countries. In which one has life expectancy been rising faster, empirically, and according to the model?

   (d) Assuming conditional independence of life expectancy gain between countries given the model parameters (a reasonable assumption), compute the probability that the female $e_0$ of Senegal will be larger than the female $e_0$ of Ghana in 2020-2025. Also, find the probability that the female $e_0$ of Senegal will be larger than the female $e_0$ of Ghana in all 16 future five-year periods from 2020 to 2100 (Note: this is just one number, not 16). (Hint: the pmax [pmin] function gives element-wise maximum [minimum])