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CSE Semester Project, Fall 2019	Start:	17/09/2016
8 ECTS credits	End:	20/12/2016 (approx.)

Modeling the evolution of world populations through the McKendrick–von Foerster equation

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Description

World populations evolve in space and time following fertility, mortality and migration dynamics. Most European countries, including Switzerland, are in an "ageing" phase, where newborns are decreasing and mean population age is around 40 years. In many other parts of the world, instead, population is in a rapid-growth phase that can lead to large migration flows. For systems in which the age structure of a population is relevant, the McKendrick–von Foerster (MKVF) equation can be conveniently used to describe the temporal evolution of the population. The MKVF equation can be written as:

$$\frac{\partial n}{\partial t} + \frac{\partial n}{\partial a} = \sum_i f_i(a,t)\, n \qquad (1)$$

where $n(t,a)$ represents the number of individuals with age a at time t, the index i refers to the different flows of individuals (i.e. newborns, immigration/emigration and deaths) and f is a function that quantifies the rate of such flows. The existence of detailed world databases (see Figure 1) allows to infer the shape of the rate functions and to make predictions of future world populations.

Task description

1. adapt problem formulation to human populations (IC, BC, constraints)
2. develop an effective numerical implementation of the MKVF equation
3. test different forms of the rate functions $f_i(a,t)$
4. apply the model to available data provided by the UN World Population Prospect

Required

- strong programming skills (possibly in Python or Matlab)

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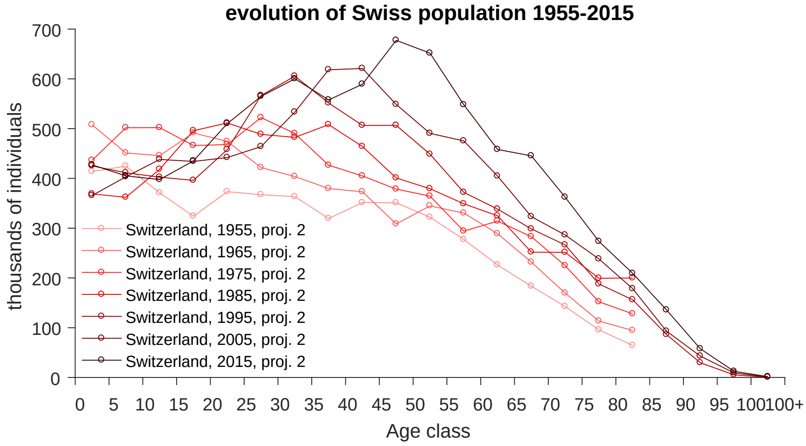

Figure 1: Example of UN population data: age structure of the Swiss population over the last 60 years