

Motivation

Populations of Countries:

- Three main drivers: fertility, mortality, migration.
- In less developed countries: mainly by fertility rates
- In developed nations: international migration

Future Trends:

- Given predictions of the population of Africa increasing from 1 to 4 billion people
- Presents tremendous opportunities and risks.
- By capturing the migration decision model of migrants, it will allow policy makers to come up with better informed decisions.

Decision Model

Migration decision based on country networks:

- **Alliance / Hostility:** Derived from GDELT dataset. Based on events occurring between countries, mapped to CAMEO Code. The average score then gives an indication of relationship (alliance/hostility) between countries.
- **Linguistic Similarity:** Common languages between countries.
- **Proximity:** Distance between countries.
- **Sea Level:** Population between 5 meters (in percentage) of countries.
- **Economic Disparity:** GDP per Capita – as economic indicator
- **Migrant (Origin-Destination Migrant Stock):** Initialized using actual figures, and shifted (during simulation) as a confluence of fertility, mortality and migration. Creates a positive network externality effect for future migrants.

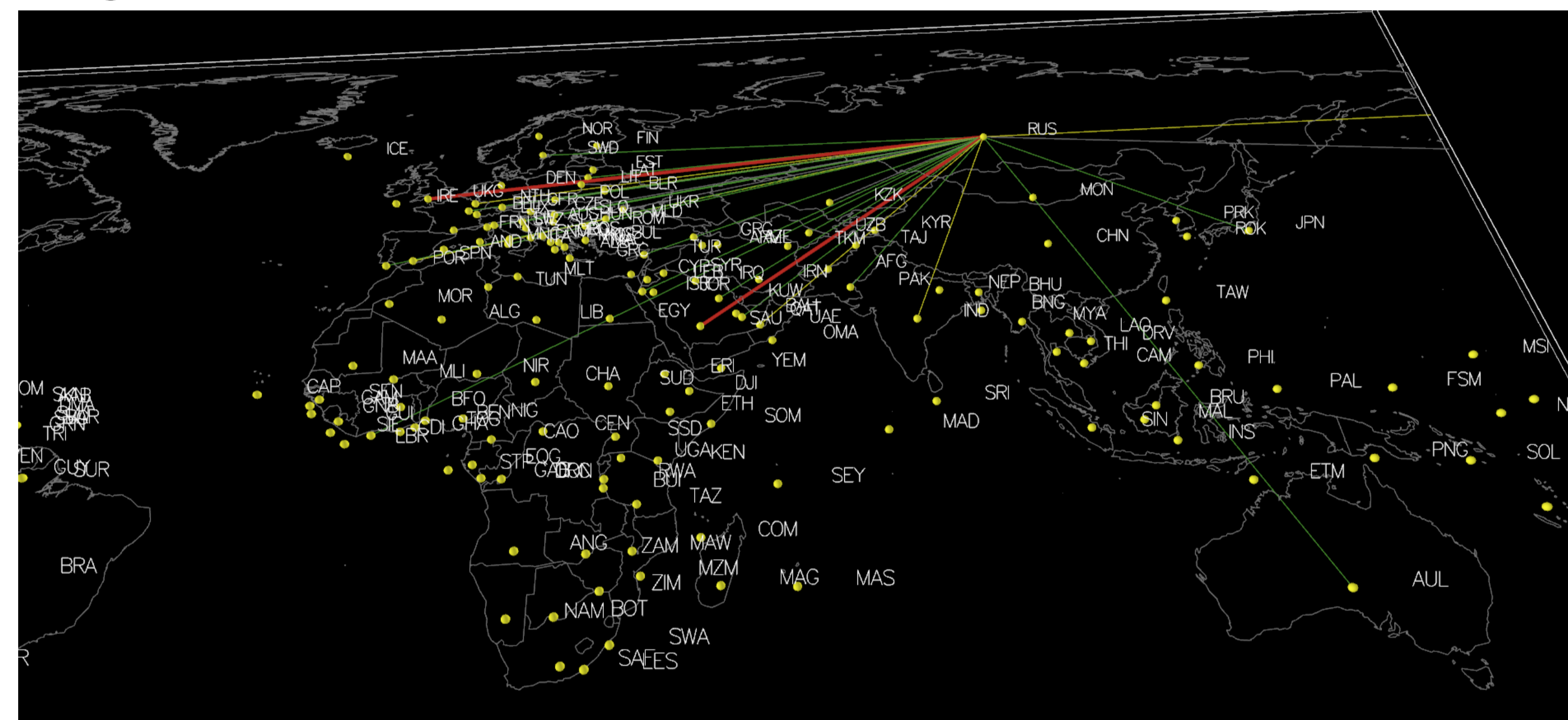
Main source of data: World Bank, US Census Bureau, United Nations, GDELT.

Agent-Based Modelling & Simulation

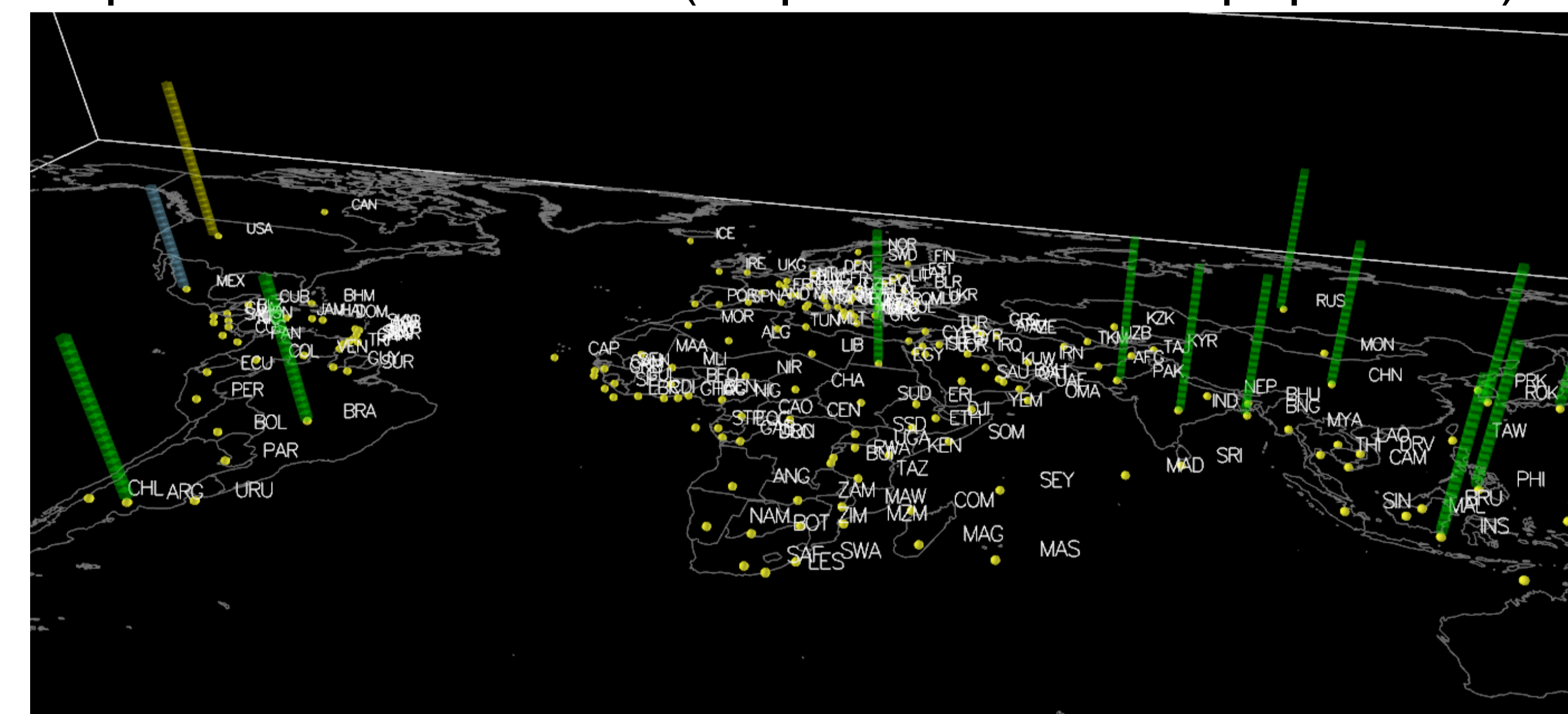
Agent-Based Model (ABM) developed using NetLogo 3D 5.2.0.

Input: Country Networks
Output: Population and Age Distribution

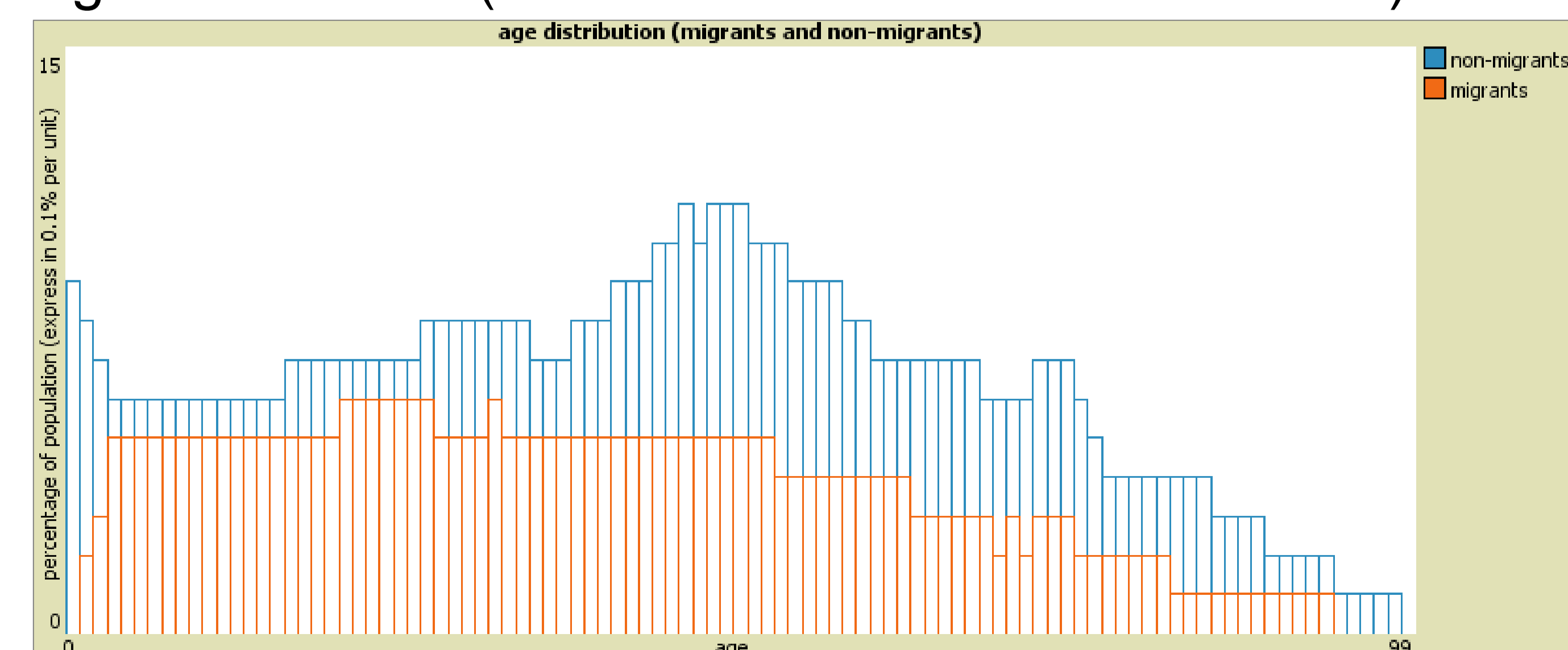
Migration between Countries:



Population of Countries (as percent of initial population):



Age Distribution (initialized with actual distributions):

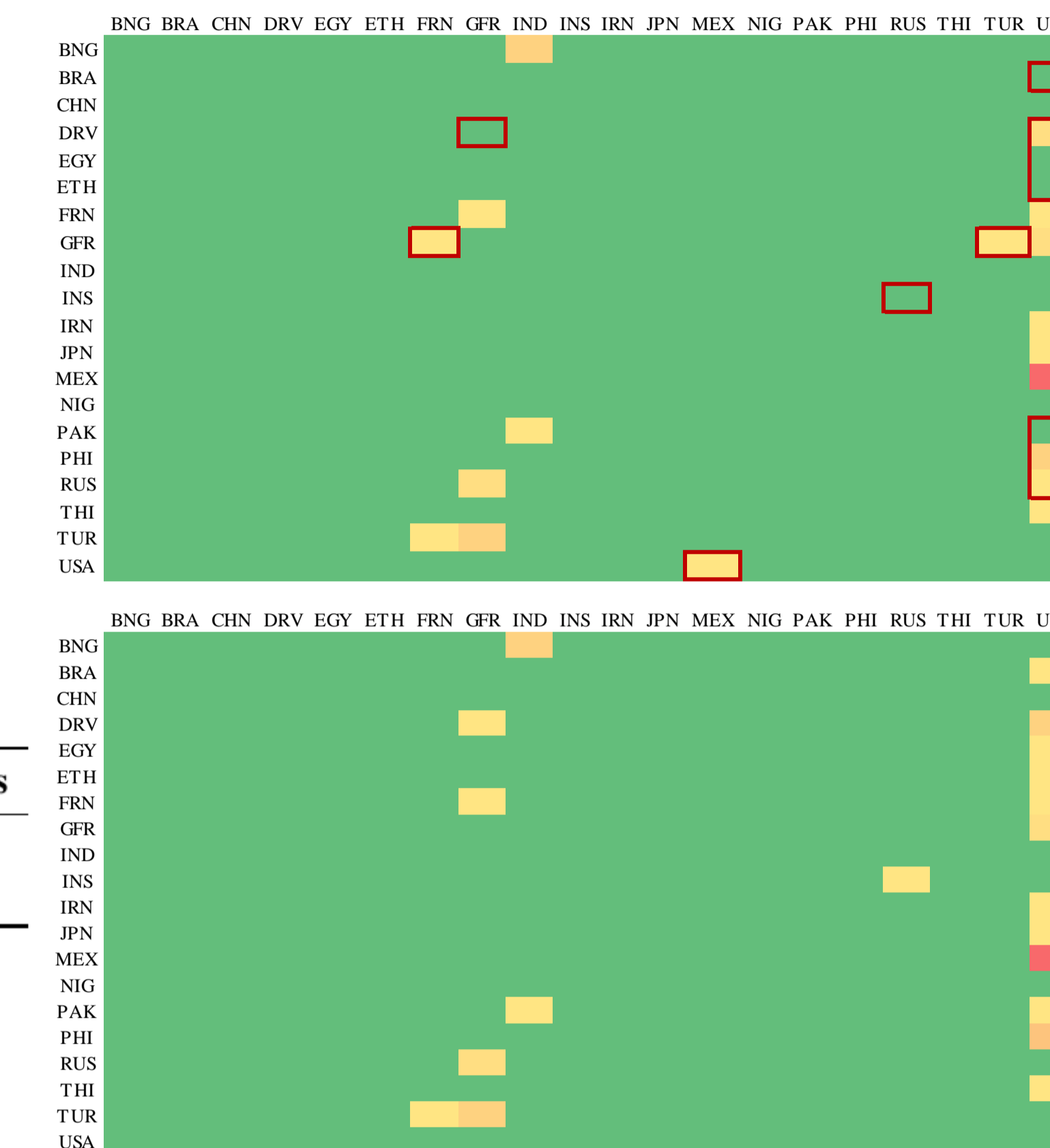


Validation: Migration Probabilities

Average Error
(Migration Probabilities):

$$AE = \frac{\sum_{i,j,t} |P_{i,j}^t - \widehat{P}_{i,j}^t|}{|I| \times |J| \times |T|}$$

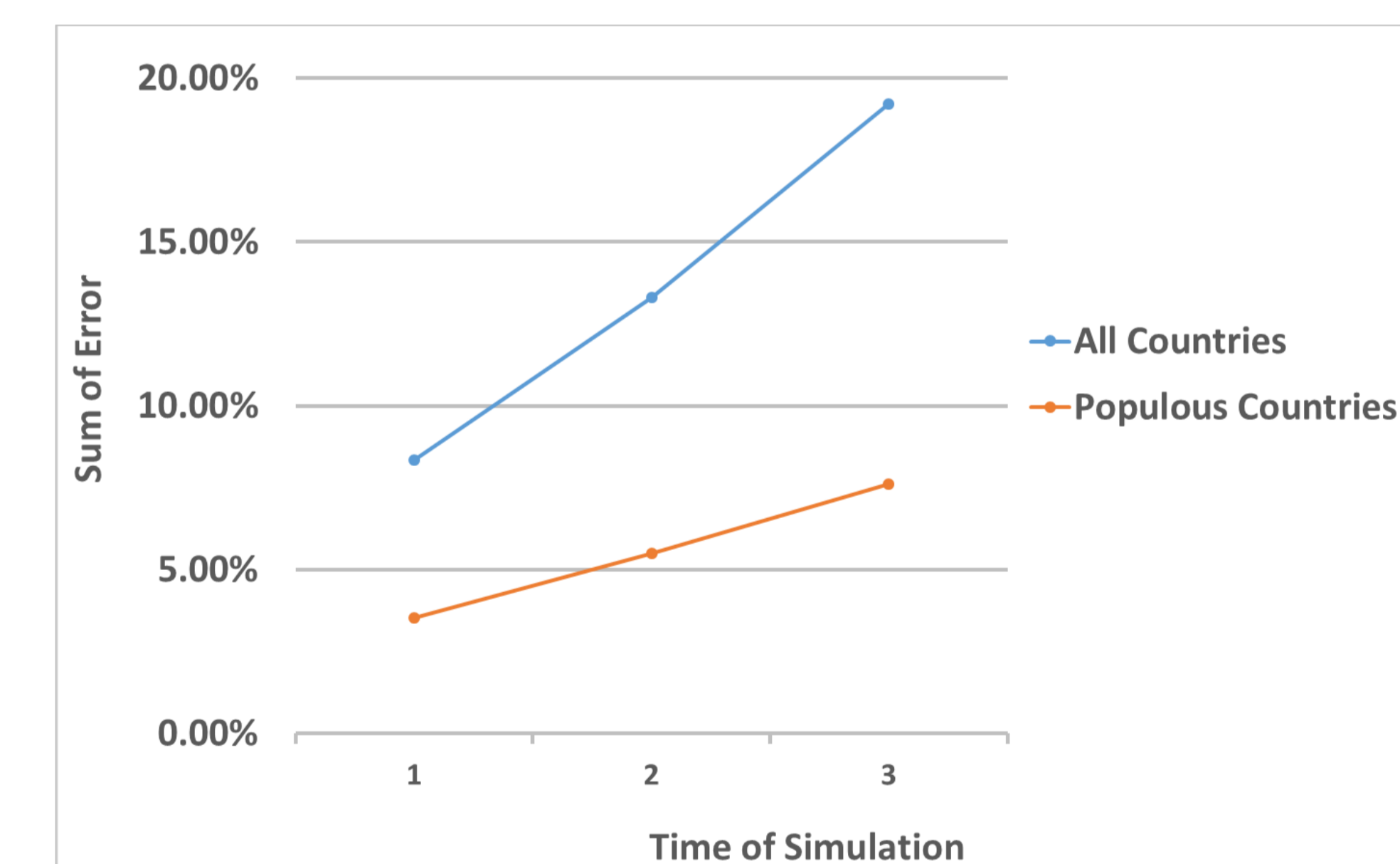
	Populous Countries	All Countries
Average Error	0.037 %	0.057 %
Standard Deviation	0.253 %	1.346 %



Validation: Population

Average Error
(Population):

$$AE = \frac{\sum_{i,t} \frac{|Pop_i^t - \widehat{Pop}_i^t|}{Pop_i^t}}{|I| \times |T|}$$



Contributions

- Use of ABMS (Agent-Based Model and Simulation) to mimic migration between countries
- Taking into consideration wide range of country networks, including alliance, linguistic similarity, and migrant networks.
- Initialized and validated with actual data from multiple sources.
- Confluence of fertility, mortality and migration leads to shifts in populations.