**Methodology**

The methodology for simulation patient mobility is composed by the following steps:

1. Population sampling: N patients (i.e., N = 100.000) are extracted from the whole Italian population (Sicily, Sardinia and small islands are not considered in this analysis) adopting a stratified random sampling methodology to accurately reflects the population under investigation. The sampling procedure considers two risk factors: age and gender. Even if, no spatial distribution has been considered the number of patients extracted in this step statistically covers the stratification by province (RMSE = 0.002 and R = 0.99). This step of the methodology has been performed outside the Netlogo environment and in particular implemented in Excel using Visual Basic for Application programming language.
2. Access to care simulation: the simulation process is composed by 52 sessions (i.e., ticks representing the 52 weeks of a year) each one composed by 1000 patients to be hospitalized and cared for hip replacement, with a total number of 52k interventions. Note that in 2019 the total number of interventions for hip replacement were around 100k. The simulation process is composed by the following steps:
   1. Patient extraction & placement: one patient is extracted from the population sampling defined in the first step of the methodology. The extraction is carried out using the Netlogo function *one-of* that reports a random item from the population list. Subsequently, a new turtle with all the information that describes the patient is created and placed over the environment on the basis of the municipality where the patient resides. Patient characteristics (that includes regional and province characteristics as well as accessibility and quality of hospital services) are also used to define the liability index that captures the probability that the patient is willing to move outside his/her region of residence for accessing to hospital hip replacement service. In particular, the liability index value is between 0 (the patient is not inclined to move for access to hospital) and 1 (the patient would certainly move for accessing to the service). This step is performed for the whole population included in the specific week/tick under analysis.
   2. Patient movement: once the 1000 patients are extracted and placed over the environment, the simulation process can start. In particular, a patient is randomly extracted (see function *one-of*) and moved toward a target (i.e., hospital) depending on the liability index and the availability and accessibility of resources. In particular, hereafter the two equations adopted to compute the accessibility level to intra-regional (Eq. 1) and extra-regional (Eq. 2) hospitals are reported:

Eq. 1

Eq. 2

The adoption of these two formulas allows to distribute the probability over the hospitals so that sum of the total accessibility of intra-regional hospitals is always *1 – liability* and the sum of the total accessibility of extra-regional hospitals is always *liability*. Once these indices are computed, the application extracts the target hospital using the *weighted-one-of-list* function, where the probability of each item being picked is proportional to the relevant weight.

Finally, the patient is placed over the relevant patch where the hospital is located. A flag set to TRUE identifies this patient as cared (so that he/she cannot be extracted anymore) and the capacity of the target hospital is reduced by one so to control whether it can host other patients or not.

**File system**

1. estrazione\_elenco\_popolazione\_ABM4health: file excel con codice VBA per generare la popolazione di riferimento. La distribuzione avviene per comune e ogni comune ha un numero di pazienti proporzionale alla % di donne e all’età media della popolazione, entrambi fattori di rischio per accedere al servizio di sostituzione dell’anca.
2. Cartella database\_ABM4healthcare
   1. Elenco\_popolazione: la popolazione estratta al punto 1
   2. Dati\_comuni: informazioni del singolo comune compresa disponibilità ospedale e dati sull’ospedale
   3. Dati\_province: informazioni a livello provinciale e regionale (es. tempi di attesa)
   4. Dati\_comune\_upgrade: se richiesto il sistema aggiorna i dati dei comuni con le nuove informazioni. Servirà per eseguire il modello con ad esempio un numero di letti in più nello specifico ospedale
   5. Dati\_province\_upgrade: come sopra ma sulle province e regioni (es. tempi di attesa)
   6. Matrice\_distance: matrice contenente le distanze fra comuni (righe) e ospedali (colonne) in minuti. Dati ISTAT.
3. Cartella output
   1. Una volta completata la simulazione nel file output.csv viene riportato, per ogni paziente:
      1. Ticks: numero del tick
      2. id\_municipality: codice comune residenza
      3. regpaz: regione residenza paziente
      4. propaz: provincia residenza paziente
      5. reghos: regione ospedale destinazione
      6. prohosp: provincial ospedale destinazione
      7. stay: true se paziente rimasto in regione, false se andato fuori regione
      8. liability: indice di liability
      9. waiting, satisfy, int\_intra, ret\_intra, beds\_intra: dati specifici del singolo paziente