Local Variations due to Stochastic Factors in the School/LTC/Bar Multiverse

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Introduction

The fundamentals of this Covid-19 agent-based simulation model have been presented previously. Basically, there are 9 Universes in the Multiverse of 100 persons, divided into cohorts of students, teachers, LTC residents, LTC and Bar staff, grandparents and spouses in families.

In this set of trials, we have, using the newly introduced capability of setting the parameters within an input file, explored the variations in simulated epidemics when intrinsic movement within universes are very low, but stochastic differences come about just through the introduction of persons moving between universes, as their new positions are randomly allocated.

These changes in movements are sufficient, in these repeated simulations of one set of parameters, described below, and the movement schedules as described in the medrxiv.org paper on the Multiverse.

The Parameter File



The population and the movements of the individuals are specified in the pop100.csv file, also described previously, and the important thing to note is that as persons move to different Universes (bar, LTC, playground, etc) they were assigned different roles and different mingleFactors (“mF”) as part of the personal property of agents for the time they are in a Universe.

The mF parameters shown above are for Universes as specified in column 3, and the effective mingle Factor for a person is the product of the Universe mF and the person’s assigned mF. The mFs are used to generate the next position for an agent given their current position of (x, y).

The HzR parameter is the Hazard Radius, which applied globally to all agents. However, the size factor (“sizeF’) parameter for a Universe (column 3) is a multiplier of the size of the agent when injected into a Universe they travel to, and on departure, their new size is divided by the size factor, to give them a Universe-neutral size.

The RedDays parameter is the number of days from incubation till an infected agent is no longer infective. The value of 11.2 implies that, given the model of an infected agent turning from presymptomatic (color blue) to red (symptomatic) on day 5.2 after infection, the symptomatic state is 11.2 – 5.2 = 6 days. This is a global setting.

The Repeated Runs

The program was modified to provide a set of summary statistics on termination (function wrapup( )), and these data are of two classes.

The first is the distribution of spared and infected agents among the cohorts, and the second is the number of infections that took place within a Universe. In other words, if susceptible (“green”) turned to infected (“yellow”) state within a Universe, the count of infections in that Universe increases by one.

The Results

As a preamble, the 10 trials are fairly consistent both for total survivals and for time to self-termination when there are no more infectives.

The cases.csv file starts with 5 infected students, ID=10 to 14.



Some Observations

Second Row – total survivors – these runs are fairly close to one another, but if we look at two similar trials, we see different internal events.

The YELLOW highlights – Trial 1 and Trial 9

- they have 42 and 43 survivors in 815 and 837 generations respectively.

- however, total students infected for Trial 1 is 19 versus 23 for Trial 19

- total LTC residents infected for Trial 1 is 13, but only 8 for Trial 19

- in Trial 1 (bottom yellow highlight), 20 infections took place in U6 LTC; for Trial 9, only 9

The GREEN highlights – Trial 4 and Trial 5

- they both have 39 survivors, but Trial 4 took 904 generations while Trial 5 took 1074

- the infections in LTC were 13 for Trial 4, but 20 in Trial 5, even though the number of LTC

residents infected were about the same: 10 for Trial 4, and 12 for Trial 5

- for the school Universes, Trial 4 had infections take place in 4 Universes, but one in Trial 5

Discussion

The same parameters generate similar epidemics when viewed at a high level of total cases alone, as we do with the mass-effect approach.

The internal dynamics of infections in heterogeneous environments can be quite different, even if they look the same from the general view.

The local view, however, affects individual persons who live their lives in local contexts. The variation in the cases infected within LTC (third row from bottom) range from 9 to 20. This brings to the fore the important question of the appropriate level of aggregation of cohorts in understanding the progress of a stochastically driven epidemic. The same set of parameters can lead to similar overall results but different local variations, and these can be of vital interest to those persons locally affected.

APPENDIX. Some different Multiverse Dynamics (total population view)

