How S.I.s.a.R. works

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Abstract

A short note on how S.I.s.a.R. (Pescarmona *et al.*, 2020) works.

Contents

1 A day of the simulation

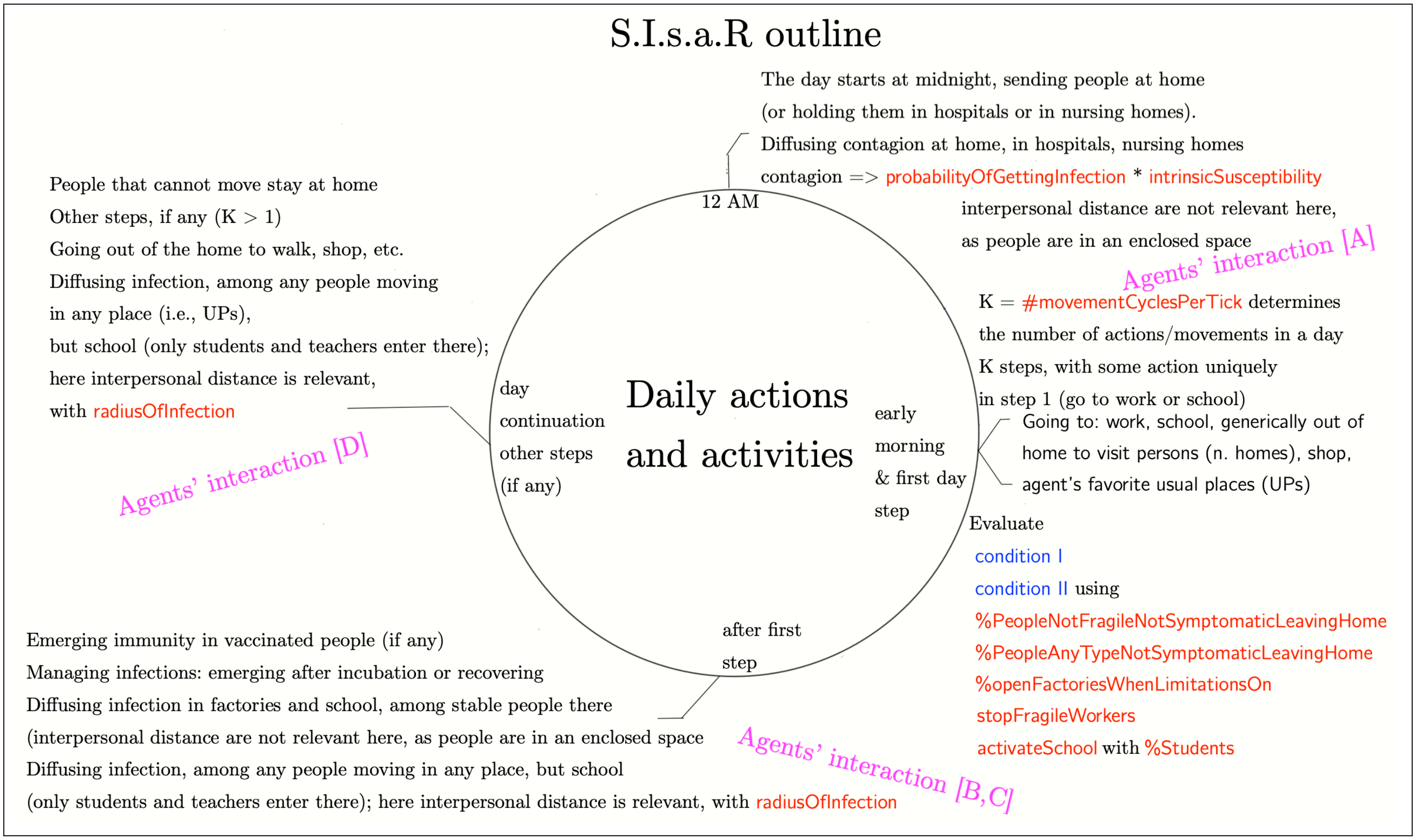

Figure 1: A day in the simulation, with N repetition where N is the duration of a specific outbreak; look at Section 2 for the conditional actions, Section 3 for the parameters, and Section 4 for details on the interactions

2 Conditional actions

condition I Symptomatic persons are at home or in a hospital or a nursing home and do not move.

condition II People not constrained by *condition I* can move if (basic rule) no limitations/lockdown *OR* one of the following situations:

1. hospital healthcare operators, nursing home healthcare operators;

2. all people as `%PeopleAnyTypeNotSymptomaticLeavingHome` (3, iii);
3. regular people as `%PeopleNotFragileNotSymptomaticLeavingHome` (3, iv;
4. workers following `%openFactoriesWhenLimitationsOn` (3, v);
5. teachers if `activateSchool` is *true* (3, vi);
6. students if `activateSchool` is *true* with %students > 0 (3, vii);

3 Parameters

In round brackets we report the short names if used in program scripts. About the days, please interpolate the dates of Table 1.

i `probabilityOfGettingInfection` (`prob`): 0.05 (starting phase); 0.02 at day 49 (adoption of non-pharmaceutical measures); 0.035 at day 149 (some relaxation in compliance); 0.02 at day 266 (again, compliance to rules);

ii `intrinsicSusceptibility` based on `intrinsicSusceptibilityFactor` set to 5 in Eq. 1

$$intrinsicSusceptibility = intrinsicSusceptibilityFactor^{groupFragility} \tag{1}$$

with $groupFragility$ exponent set to:

1 for extra-fragile persons,

0 for fragile persons,

-1 for regular persons,

-2 young people from 0 to 24 years old;

iii `%PeopleAnyTypeNotSymptomaticLeavingHome` (`%PeopleAny`) determines, in a probabilistic way, the number of all people going around in case of limitations/lockdown; the limitation operates only if the lockdown is on (see above); in use at (day) 20, 90; at 28, 80; at 31, 0; at 106, 80; at 110, 95; at112, 85; at 117, 95; at 121, 90; at 259, 90; at 266, 80; at 277, 50; at 302, 70; at 320, 90; at 325, 50; at 329, 80; at 332, 50; at 336, 80; at 337, 50; at 339, 80;

iv `%PeopleNotFragileNotSymptomaticLeavingHome` (`%PeopleNot`) determines, in a probabilistic way, the number of regular people going around in case of limitations/lockdown; the limitation operates only if the lockdown is on (into our simulated world, from day 20); `%PeopleNot` values: at (day) 31, 80; at 35, 70; at 36, 65; at 38, 15; at 42, 25; at 84, 30; at 106, 0; at 302, 90; at 325, 50; at 332, 50; at 337, 50; at 339, 100; at 349, 90;

the parameters iii and iv in some phase change very frequently, reproducing into the model the uncertainty of the decisions that was happening in the real world in the same periods;

NB, the parameters iii and iv produce independent effects, as in the following examples: (a) the activation of *%PeopleAny at 31, 0* and, simultaneously, of *%PeopleNot at 31, 80*, means that people had to stay home on that day, but people specifically not fragile could go out in 80% of the cases; (b) *%PeopleAny at 339, 80* and, simultaneously, *%PeopleNot at 339, 100* means that fragile and not fragile persons cannot always go around, but only in the 80% of the cases, instead considering uniquely non-fragile persons they are free to go out; the construction is an attempt to reproduce a fuzzy situation;

in future versions of the model, we will define the quotas more straightforwardly:

- `%FragilePeopleNotSymptomaticLeavingHome`;
- `%NitFragilePeopleNotSymptomaticLeavingHome`;

v `%openFactoriesWhenLimitationsOn` (`%Fac`) determines, in a probabilistic way, what factories (small and large industries, commercial surfaces, private and government offices) are open when limitations are on; if the factory of a worker is open, the subject can go to work, avoiding restrictions (but uniquely in the first step of activity of each day); `%Fac` is in use at (day) 38, value4 0; at 49, 20; at 84, 70; at 106, 100; at 266, 90; at 277, 70; at 302, 80; at 320, 90; at 325, 30; at 329, 90; at 332, 30; 336, 90; at 337, 30; at 339, 100;

vi `stopFragileWorkers` (`sFW`); if set to 1, fragile workers (i.e., people fragile due to prior illnesses) can move out of their homes following the iii and iv parameters, but can go to work in no case; the regular case is that the workers (fragile or regular) can go to their factory (if open) also when limitations are on; in one of the experiments we used `sFW` with set to 1 (on) at day 245 and to 0 (off) at day 275;

alternatively, we also have the `fragileWorkersAtHome` parameter; if on (set to 1) the total of the workers is unchanged, but the workers are all regular; we can activate this counterfactual operation uniquely at the beginning of the simulation;

vii when `activateSchools` (`aSch`) is on (set to 1) teachers and students go to school avoiding restrictions (but uniquely in the first step of activity of each day); `\%Students` limits to its value the quota of the students moving to school; the residual part is following the lessons from home; we used `aSch` at (day) 1, on; at 17, off; at 225, on; at 325, off; at 339, on; we used `1%st` at (day) 0, 100; at 277, 50; at 339, 50; at 350, 50 (repeated values are not relevant for the model, but for the memory of the programmer-author);

viii `radiusOfInfection` (`radius`) with value 0.2; the effect of the contagion—outside enclosed spaces, or there, but for temporary presences—is possible within that distance; in the model, space is missing of a scale, but forcing the area to be in the scale of a region as Piedmont, 0.2 is equivalent to 20 meters; we have to better calibrate this measure, with movements and probabilities; this is a key step in future developments of the model.

4 Agents' interaction

We underline that our tool is not based on microsimulation sequences, calculating contagions agent by agent, following their characteristics and ex-ante probabilities. It implements a true agent-based simulation, with the agents acting and, most of all, interacting, thus generating contagions.

Each run creates a population following expected characteristics but with small random specifications to assure heterogeneity in agents. The daily choices of the agents are partially random to reproduce real-life variability.

Contagions arise from agents' interactions, in four situations, as specified in Fig. 1:

A - in houses (at night), hospitals, nursing homes;

B - in schools, workplaces in general, among people stable there;

C - in the same places (excluding schools) by people temporary there and in open spaces;

D - interactions mainly in open spaces.

At `https://terna.to.it/simul/contagionSequences.pdf`, in Section "2 The visualization of the sequences of contagions in simulated epidemics" and in "A Appendix: Analyzing examples of contagion sequences" we have the visualizations of the effects of those sequences of interactions-contagions.

5 Model calendar

Day 1 is fixed at Feb 4^{th}, 2020.

Day	Date
25	28- 2-2020
50	24- 3-2020
75	18- 4-2020
100	13- 5-2020
125	7- 6-2020
150	2- 7-2020
175	27- 7-2020
200	21- 8-2020
225	15- 9-2020
250	10-10-2020
275	4-11-2020
300	29-11-2020
325	24-12-2020
350	18- 1-2021
375	12- 2-2021
400	9- 3-2021
425	3- 4-2021
450	28- 4-2021
475	23- 5-2021
500	17- 6-2021
525	12- 7-2021
550	6- 8-2021
575	31- 8-2021
600	25- 9-2021
625	20-10-2021
650	14-11-2021
675	9-12-2021

Table 1: The days of the simulation and their position in the calendar

References

Pescarmona, G., Terna, P., Acquadro, A., Pescarmona, P., Russo, G. and Terna, S. (2020). *How Can ABM Models Become Part of the Policy-Making Process in Times of Emergencies–The SISAR Epidemic Model*. In ≪RofASSS≫.
URL `https://rofasss.org/2020/10/20/sisar/`