Agent-based models of non-pharmaceutical interventions for epidemic control

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1 Introduction

2 Description of Model

The Current Modifications of the model relate to allowing 10 of the Model Parameters that relate to Compliance to be dynamically updated each day dependent on a given rule these 10 Parameters are.

- TESTING_COMPLIANCE_RATE_SYMPTOMATIC (what proportion of agents take a test immediately as a result of having symptoms)

- TESTING_COMPLIANCE_RATE_TRACED (what proportion of agents take a test immediately as a result of being informed they are a close contact)

- TESTING_COMPLIANCE_RATE_RANDOM (what proportion of agents will do surveillance)

- TRACING_COMPLIANCE_RATE (what proportion of agents comply with contact tracing)

- ISOLATION_COMPLIANCE_RATE_SYMPTOMATIC_INDIVIDUAL (what proportion of agents will isolate given they have a symptomatic case)

- ISOLATION_COMPLIANCE_RATE_SYMPTOMATIC_GROUPMATE (what proportion of agents will isolate given one of their group mates has a symptomatic case)

- ISOLATION_COMPLIANCE_RATE_POSITIVE_INDIVIDUAL (what proportion of agents will isolate given a positive result from a test)

- ISOLATION_COMPLIANCE_RATE_POSITIVE_GROUPMATE (what proportion of agents in a group isolate given one of them has a positive result from a test)

- ISOLATION_COMPLIANCE_RATE_POSITIVE_CONTACT (what proportion of agents isolate given they are a close contact)

- ISOLATION_COMPLIANCE_RATE_POSITIVE_CONTACTGROUPMATE (what proportion of agents in a group isolate given one of them is a close contact)

A simple model might only use a few of these compliance parameters such as

- TESTING_COMPLIANCE_RATE_SYMPTOMATIC = 0.8

- TESTING_COMPLIANCE_RATE_RANDOM = 0.3

- ISOLATION_COMPLIANCE_RATE_POSITIVE_INDIVIDUAL = 0.8

so in this model 80% of agents comply with surveillance testing 30% of agents will take a test if they develop a symptomatic case and 80% of agents will isolate given they have a positive test

The idea of a global state is added to the world based on facts all agents would know one example being the number of agents in the network that have had a positive test within the last 2 weeks (a simplification of "active cases" which we will call it from now on)

The model may incorporate 2 types of agent based characteristics to make these rates non-static, they can be split into global states impacting a parameters value and individual agents situation impacting their compliance An example of global states impacting parameter values following on on from the previous example might be

- TESTING_COMPLIANCE_RATE_SYMPTOMATIC = 0.8 + proportion of active cases

- TESTING_COMPLIANCE_RATE_RANDOM = 0.3 + (proportion of active cases * 5)

- ISOLATION_COMPLIANCE_RATE_POSITIVE_INDIVIDUAL = 0.8 + proportion of active cases

so if at a particular time 7% of the network was an active case then

- TESTING_COMPLIANCE_RATE_SYMPTOMATIC = 0.8 + 0.07 = 0.87

- TESTING_COMPLIANCE_RATE_RANDOM = 0.3 + 0.35 = 0.70

- ISOLATION_COMPLIANCE_RATE_POSITIVE_INDIVIDUAL = 0.8 + 0.07 = 0.87

An example of individual agents situations impacting their compliance may relate to the network itself and an agents close contacts. For example TESTING_COMPLIANCE_RATE_SYMPTOMATIC may be overwritten to follow a

certain rule such as 0.8 OR 1 if the particular agent has at least one close contact in isolation

In the first case we assume agents act mostly based on the global situation and in the latter case they act based on their own individual situation, It is possible to combine both approaches

The model assigns compliance by giving each agent an initial compliance score that judges their behavior for example in a model with 10 agents one possible generation could be [0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1] . But currently the compliance scores are randomly uniformly generated between 0 and 1. Let us continue this example and show the agents behavior under a couple situations firstly when 0% of the network has an active case

- TESTING_COMPLIANCE_RATE_SYMPTOMATIC = .80

- TESTING_COMPLIANCE_RATE_RANDOM = 0.30

- ISOLATION_COMPLIANCE_RATE_POSITIVE_INDIVIDUAL = 0.80

to see if an agent is compliant with a given action we see if if their compliance value is less than the current value for that parameter for example agents 1 though 8 will test if they have a symptomatic case and will isolate given a positive test, and agents 1 though 3 will comply with regular surveillance testing

secondly lets assume later on one agent returns a positive test this means 10% of the population has an active case

- TESTING_COMPLIANCE_RATE_SYMPTOMATIC = 1

- TESTING_COMPLIANCE_RATE_RANDOM = 0.8

- ISOLATION_COMPLIANCE_RATE_POSITIVE_INDIVIDUAL = 1

now agents 1 though 10 will test if they have a symptomatic case and will isolate given a positive test, and agents 1 though 8 will comply with regular surveillance testing

3   How to Judge The Effect Parameters Have on A Model?

On average, what percentage of the population caught the contagion

On average, how many days did it take for the outbreak to stop with 0 active cases