Introduction

This model is an extension of the spread of disease model from Chapter Six of the book “Introduction to Agent-Based Modeling: Modeling Natural, Social and Engineered Complex Systems with NetLogo”, by Uri Wilensky & William Rand.
The goal was to create a model of the novel coronavirus 2019 or covid-19.

Major extensions include the addition of travel behaviour that is based around patches that are assigned to be “businesses”. Agents are then assigned a business that they then travel to and from at a random time of day, each day. Different infection stages have been added to simulate the transition from infected, to contagious, to symptomatic and finally to recovered. Included is a slider for how likely symptomatic turtles are to work. A basic variable for the economy has also been added that is based on how many turtles are working. Finally an intervention policy option has been added that shuts down businesses for two weeks that show a symptomatic case.

Setup

The first setup I attempted to model was that of the city of melbourne, a densely populated area.

I did this using the following data:
500 000 employed
16,800 businesses

At a scale of 1:1000

1 turtle = 1k employed
1 business = 1k businesses

I ended with the parameters 500 turtles and 17 businesses. I set the number of initial infected to 1 to simulate a single area where an outbreak may start.

Results

For my “city” setup with zero restrictions in place, symptomatic patients moving freely and no policy intervention, I observed many patterns. R0 typically would start at approximately 0.9, then decrease linearly. Interestingly a clear wave like pattern in infected patients emerged, with big days and small days. There was a light doubling effect in the number of infected per day but not enough to warrant exponential growth. It was clear that the worst case scenario was when a turtle who lived far from his workplace became infected. This usually led to a second pocket or hot spot of infections as shown in fig. 1. In the end the disease spread through almost 100% of the population every run.

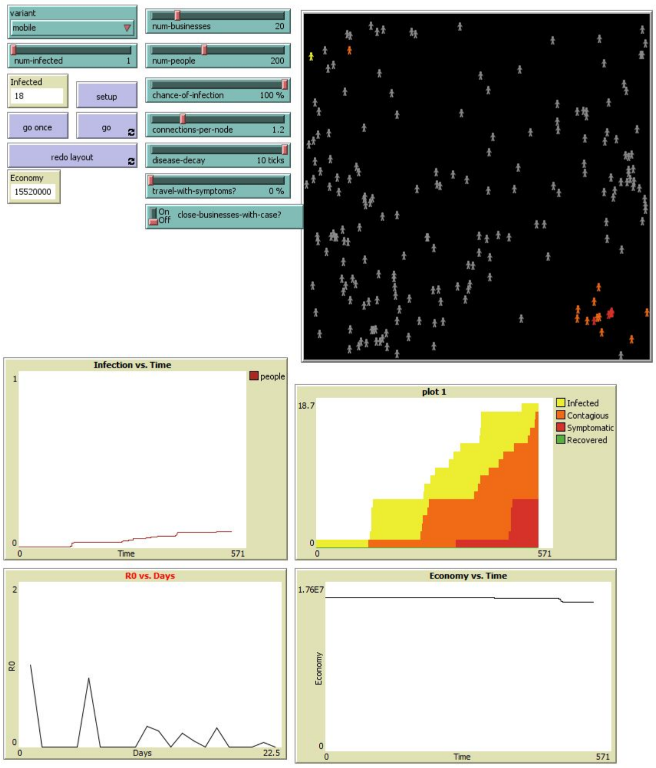

Fig. 1 Example of Second hotspot forming. Note: Figures taken from example not using “City” setup, but represent a similar result.

The next set of tests I ran with the travel-with-syptoms? setting at 50%. I found that this had a significant impact not on halting the spread of the virus, but in delaying the increase in cases per day until a certain point, at which the cases would surge significantly as shown in fig. 2.

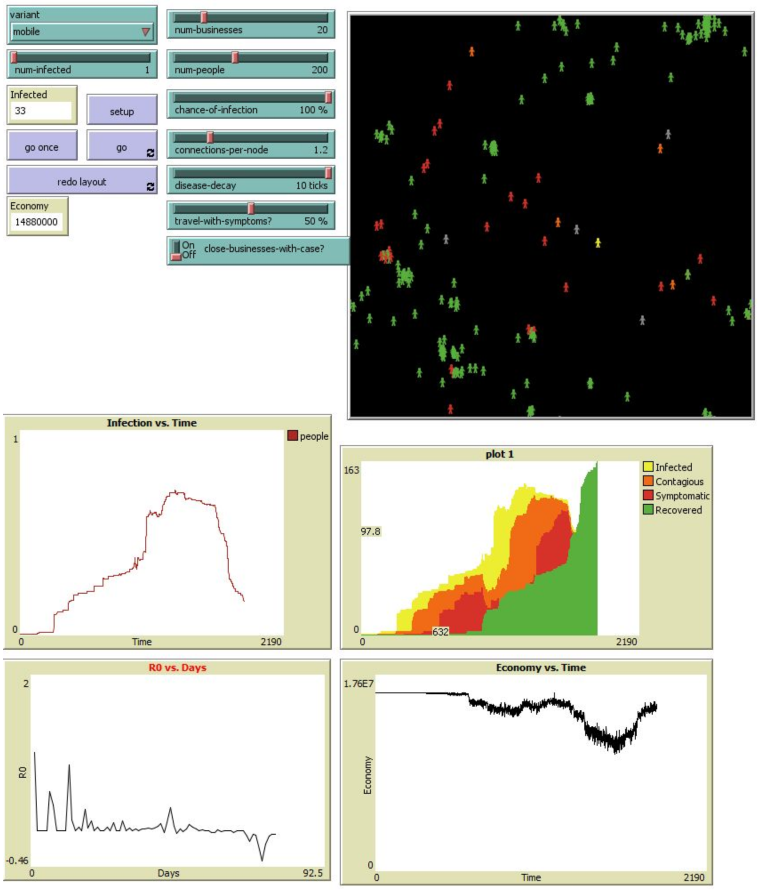

Fig 2. Delayed Surge of Cases

This effect was not observed on every run however, with some runs seeing little difference to the previous setup. The effect on the economy was noticeable but not of much note, with dips only going to approximately 80% the normal value.

Lowering the value travel-with-symptoms value further to only 25% saw no major difference. The only change worth noting was that the economy took a further dip, but again only to around 70% of the normal.

Setting the value to 0% saw no major change in the behaviour to the disease either, and in fact seemed to increase the likelihood of the delayed surge effect previously noted. A key difference at 0% however was that the economy was now receiving a very significant hit, particularly in circumstances where there was a big surge rather than a steady increase. In some runs the hit to the economy left it near 30% of its normal value, see fig. 3.

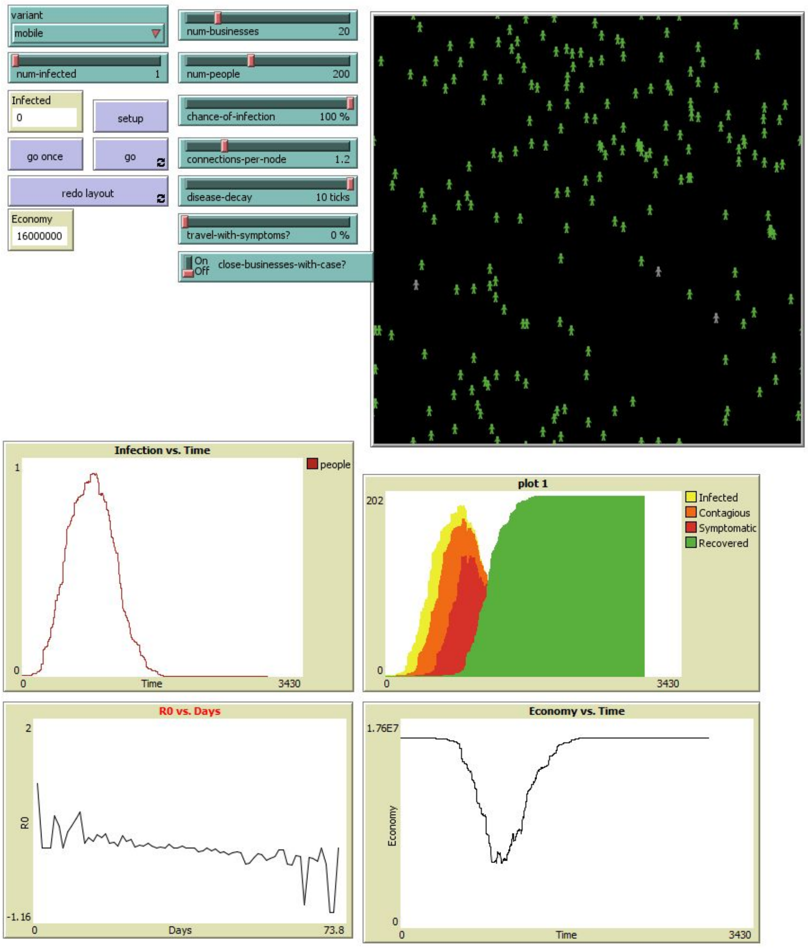

Fig 3. Note the significant trough in the Economy vs Time plot.

This next set of runs the close-businesses-with-case? policy was turned on. This option simply made every turtle stop working if there was a symptomatic case discovered at their workplace. Much like the travel-with-symptoms parameter this policy did not achieve much other than delaying the spread of the disease. Most notably in some examples, spread would be neutered but not stopped at a certain point. Interestingly I found the hit to the economy was worse in the long run, with a value of 70% of the normal persisting for a significant period, however gone was the huge trough seen when only symptomatic individuals were not working, see fig. 4.

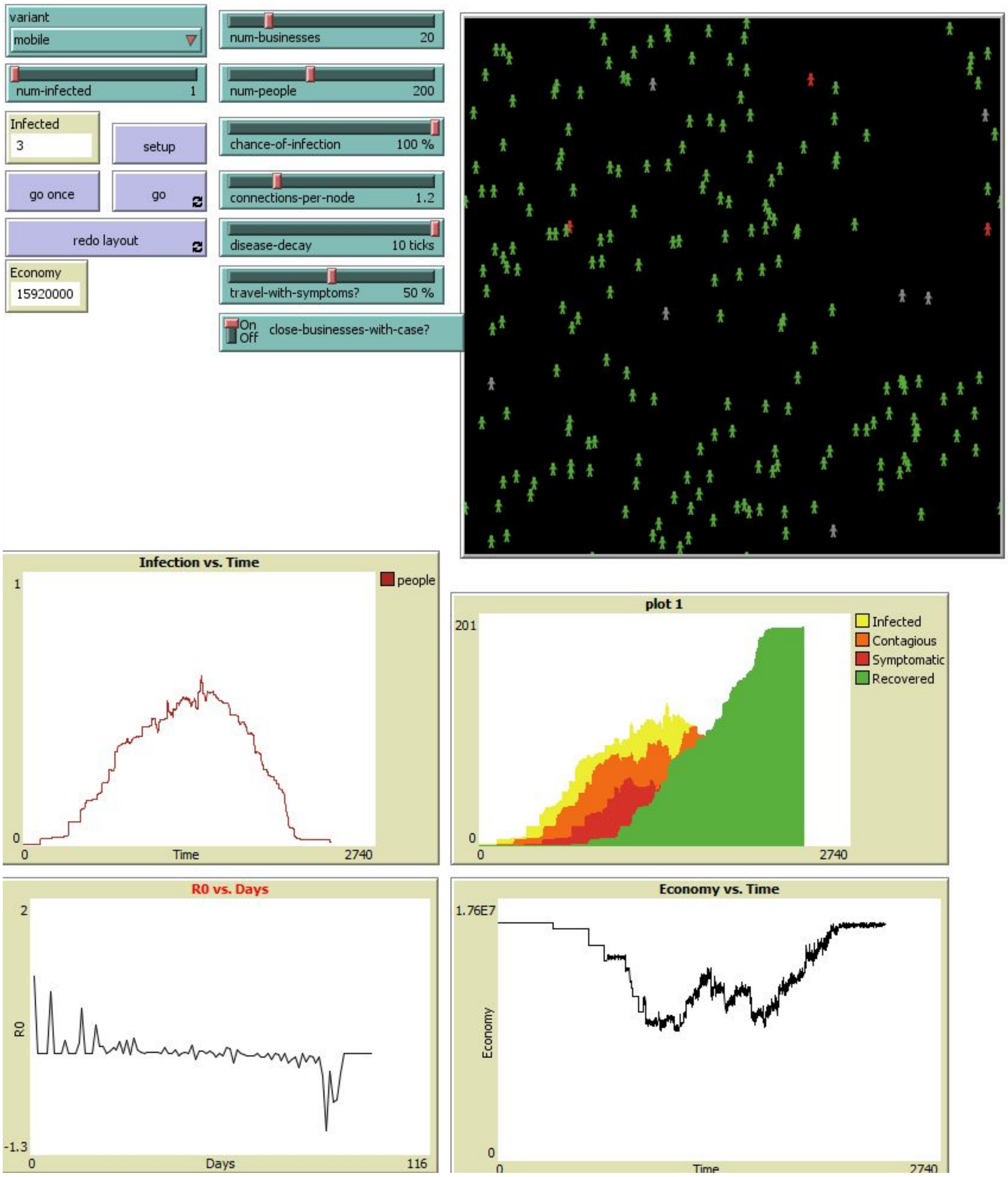

Fig 4. Observe the lesser peak in Infections vs. Time and the wide but shallow trough in the Economy vs. Time plot.

ODD Description