EpiDEMExtended

A NetLogo disease spreading simulation based on epiDEMBasic

What is it?

EpiDEMEXtended is a NetLogo simulator, extension of epiDEMBasic.

epiDEMBasic is a simple disease spreading simulator:

- SIR model
- Individuals move randomly
- Infection due to closeness
- Allows to modify:
  - Population size
  - Infection transmission probability
  - Average recovery time
  - Probability of recovering
- Shows various outputs

Added elements

The enhancements that epiDEMExtended apports to epiDEMBasic are:

- People divided into age classes
- People divided into families
- Houses
- Activities
- People now move following cycles of activities
- Quarantine
- Environmental disease transmission
- Various outputs

Activities

Immobile agents reached by people during their movement cycle. They are divided into 4 categories:

- Leisure activities
- Education activities
- Health activities
- Professional activities

Activities may suffer the establishment of different levels of quarantine:

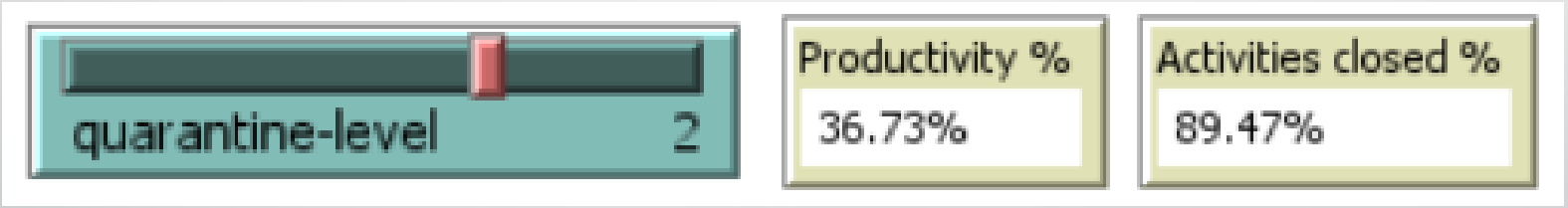
- Level 0 -> no quarantine declared, all activities open
- Level 1 -> education activities closed
- Level 2 -> only factories, hospitals and clinics stay open
- Level 3 -> only hospitals and clinics stay open

Activities

Activities can be added by the defining their:

- kind
- production-value
- smart-working-capability

Productivity of the area



People

Moving agents divided into age classes:

Age class	Main activity
0-4	Stay home
5-14	Primary school students
15-19	Secondary school students
20-24	University students
25-39	Young workers
40-64	Old workers
>= 65	Recreational

Each age-class has a different disease susceptibility (based on real data from an Italian Covid-19-related study).

Families

Groups of people created depending on user-defined parameters and a set of rules:

- People 0-4, 5-14, 15-19 always have two parents
- People 20-24 may live with parents or alone or with a roommate
- People 25-39, 40-64 may live alone or in a couple
- Families will have at most 4 members
- Families will have at most 2 children

} may not always hold

Movement

People move following activities cycles. The user must define activities and their duration. The possible activities are:

- "home"
- "school"
- "work"
- "recreation"
- Combinations of them (variability)

activities-durations.txt

```
;; cycle-25-39
"work"    8
"home"    4
"recreation-home"    3
"home"    9
```

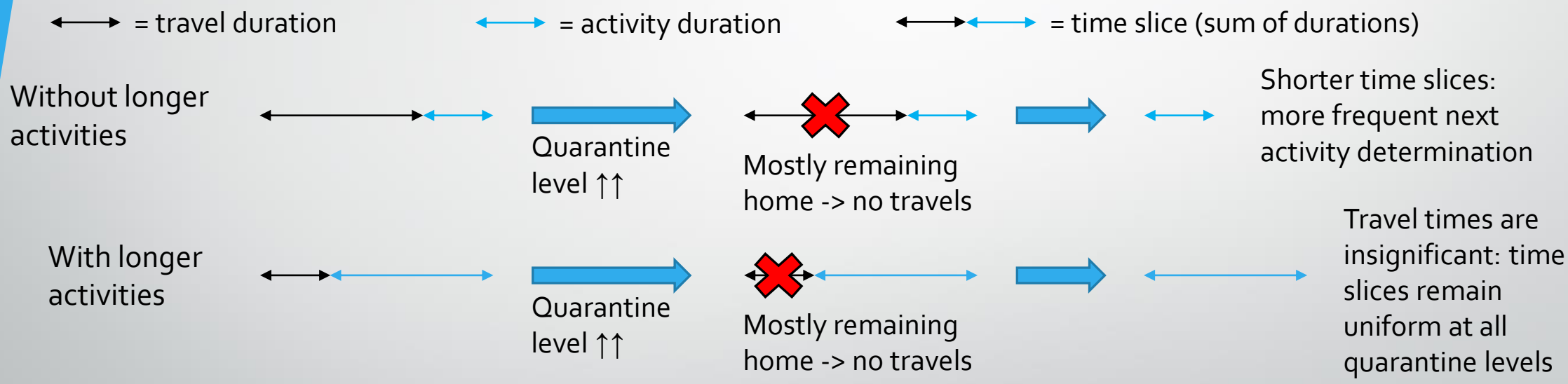
A single cycle should last 24 hours (ticks) -> activities may be shorter than the average travelling time -> switch more-realistic-activities-durations?.

Quarantine limits movement -> substitutes closed activities with "home".

Illegal behaviours problem

Possibility to activate illegal behaviours -> switch possible-illegal-behaviours?.

Automatically enables more-realistic-activities-durations? to avoid the illegal behaviours problem.



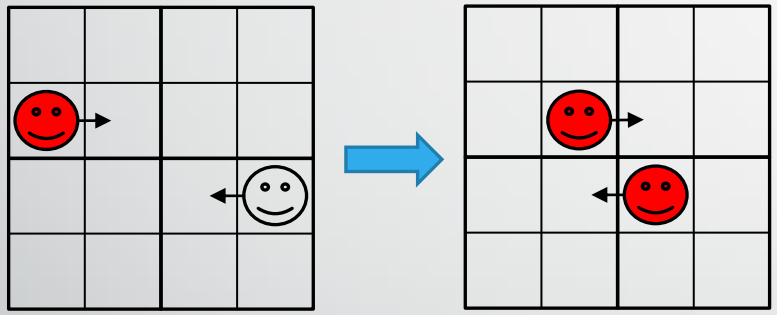
Proper tuning of the multiplicative factor is critical.

Infection

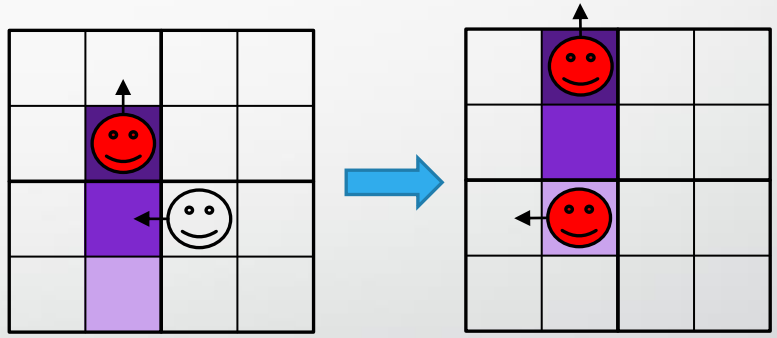
People can get infected in two ways:

- Direct disease transmission -> due to closeness
- Environmental disease transmission -> due to infected floating particles

Direct transmission



Environmental transmission



Spreading speed may be too high -> infect-each-n-ticks.

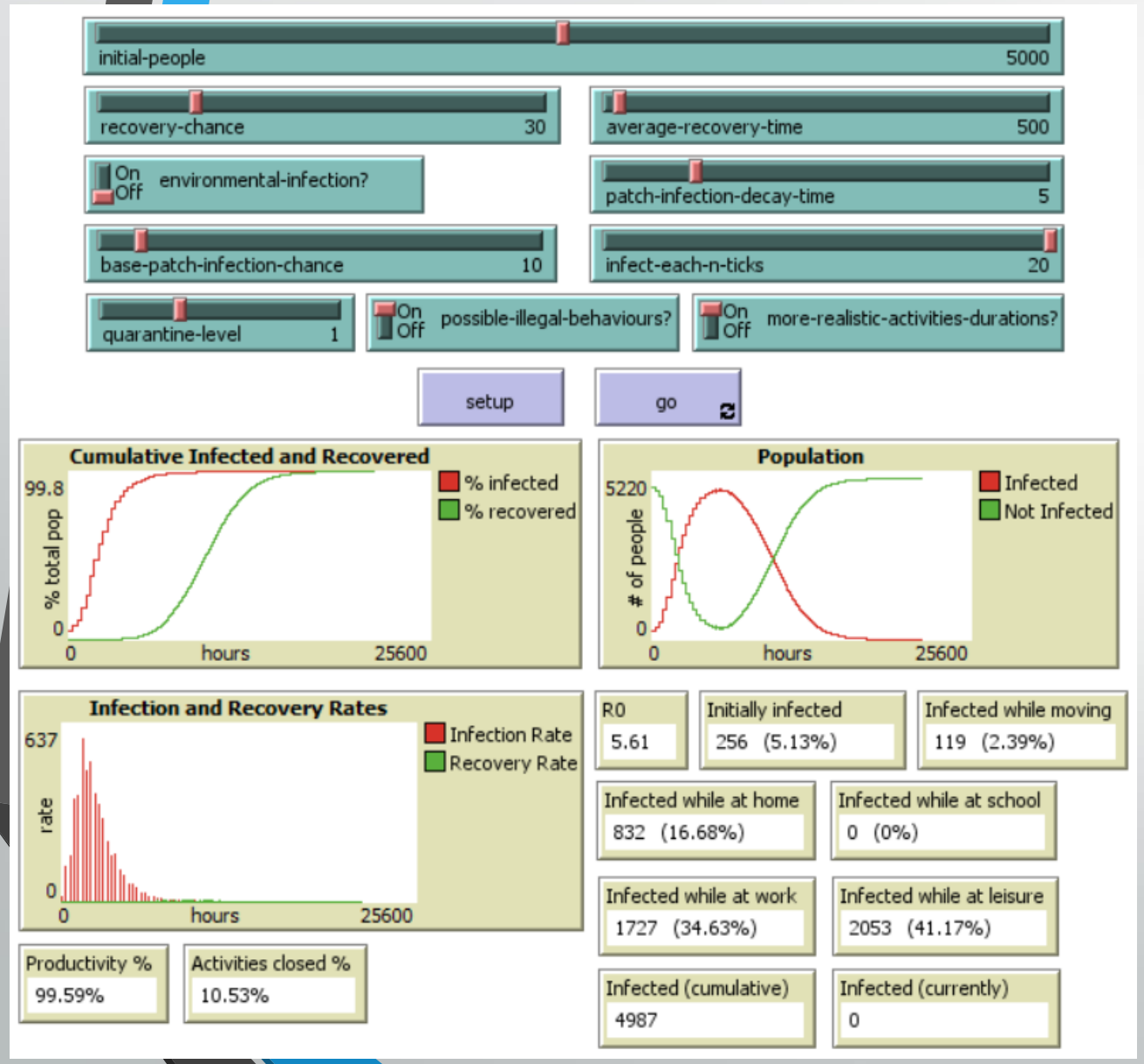
Various infection counters have been added as outputs.

Results – no quarantine run

The used parameter configuration scales up the time related elements by 15.

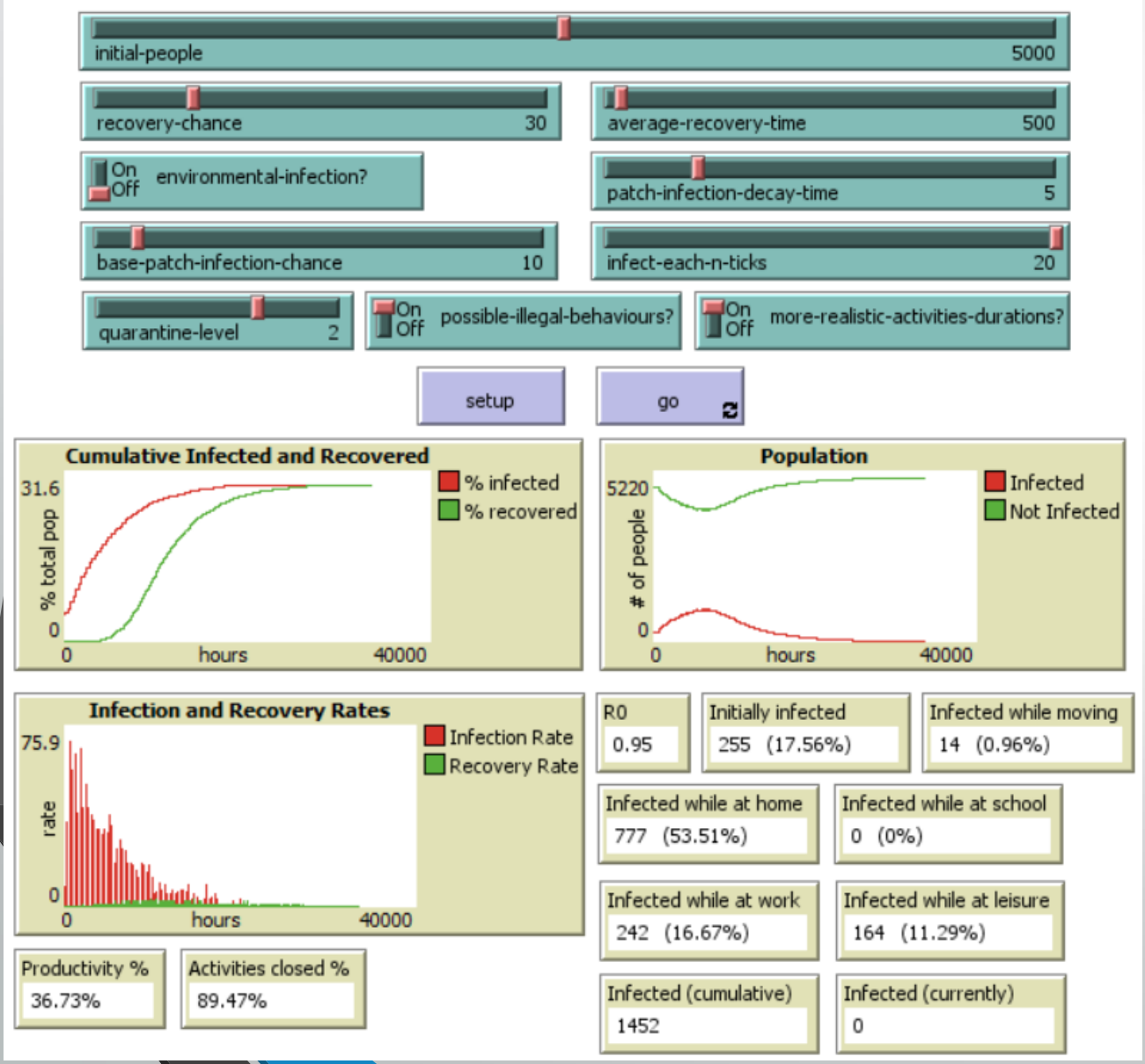
- Nearly all people got infected
- Most of the people got infected while doing their main dutiful activity

Results – quarantine level 1 run



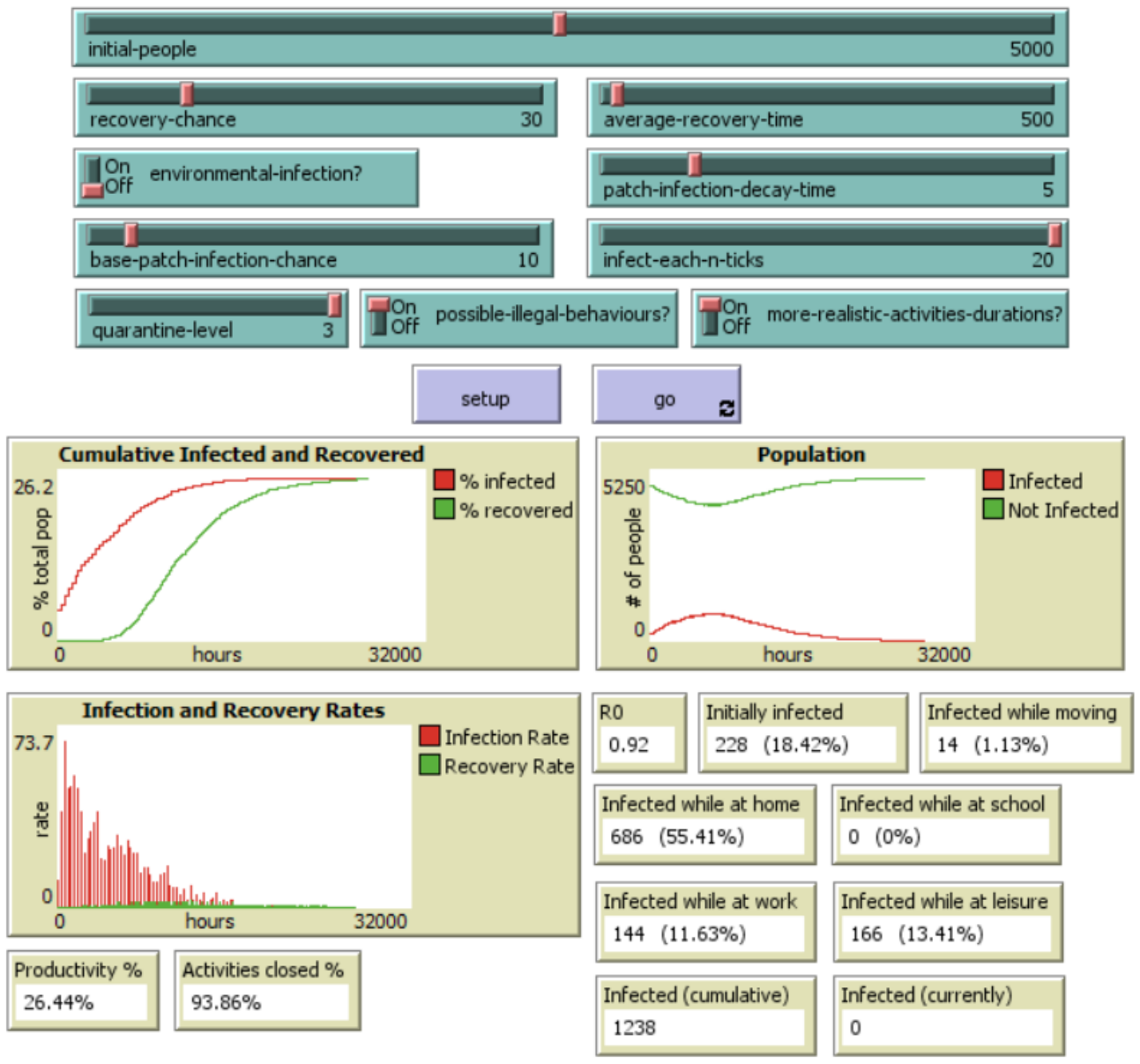
- Still high number of infections
- No people infected at school and less at work
- Higher infections at leisure activities and home
- Slight productivity loss

Results – quarantine level 2 run



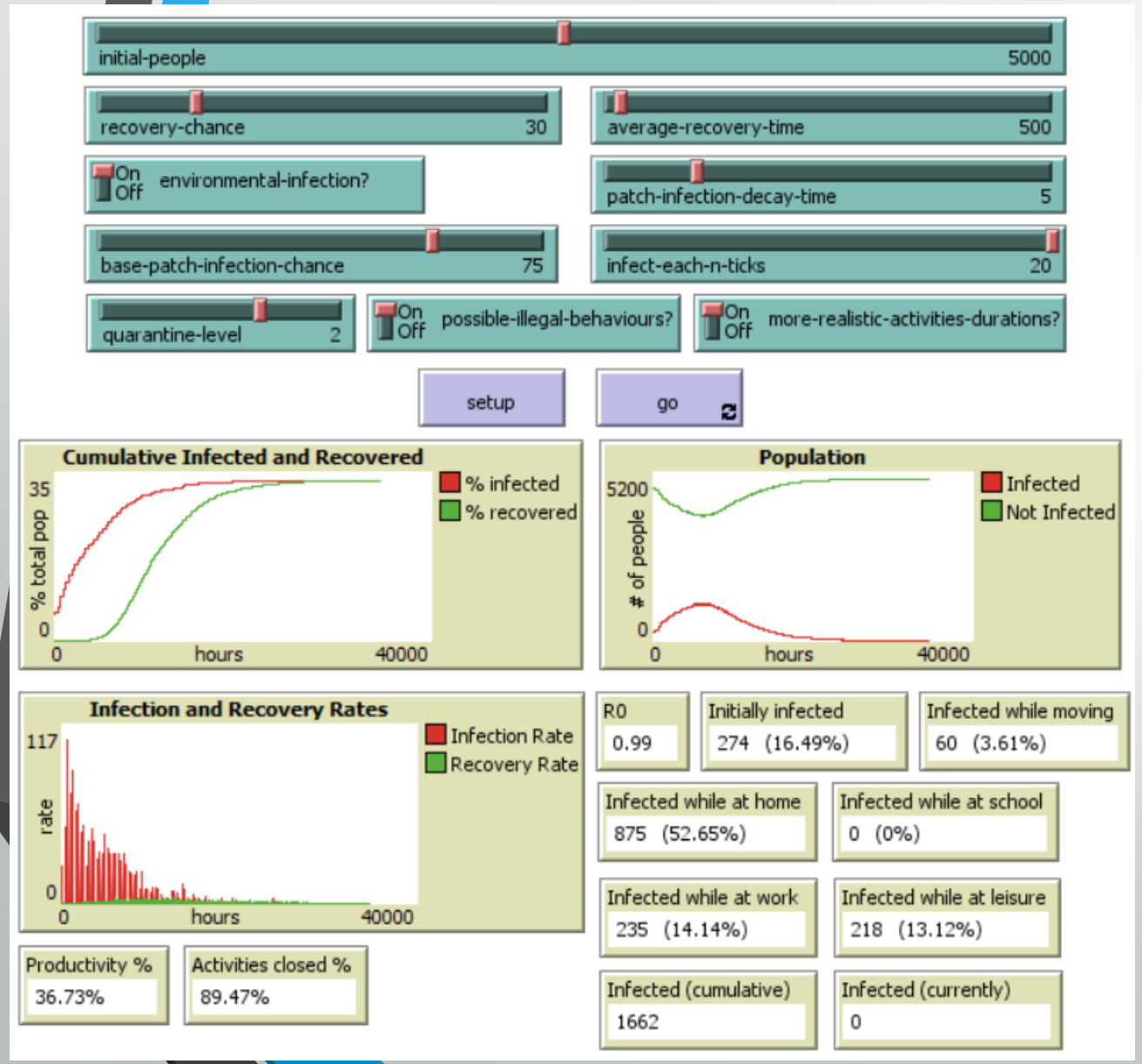
- Significant improvement in the number of infections
- Relatively high number of infections at home
- Some people infected while at leisure
- R0 very low
- Productivity dropped

Results – quarantine level 3 run



- Similar results to level 2
- Less infected while at work
- R0 went slightly down
- Productivity is extremely low

Results – environmental infection run



- Similar results to the normal level 2 run
- Higher number of people infected while moving

Conclusions and future developments

EpiDEMExtended is a NetLogo disease spreading simulator that is:

- Quite realistic
- Highly configurable

Future developments:

- Tuning of the factor by which multiply the time-related elements
- SIRD model
- Mutation of the virus

Thanks for your time and attention!