Biomedical Modeling: Some sample Agent-based epidemic models

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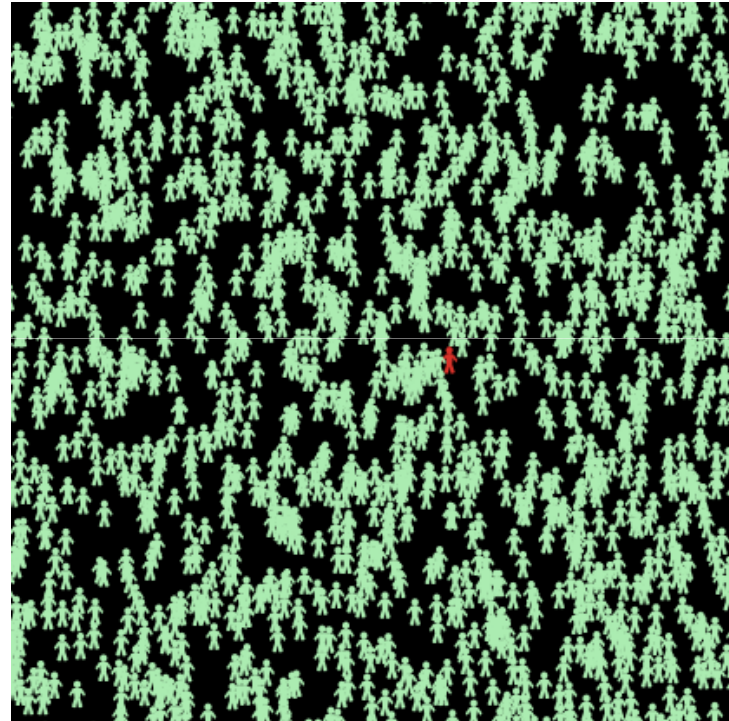University of Pittsburgh
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Typhoid Fever: A sample model from NetLogo User Community.

• Typhoid fever is an infectious water borne disease caused by Salmonella typhii.

•An epidemic simulation of typhoid fever was made to see the possibility typhoid spreading in population.

Three independent variables that give influence for possibility become complicated or not.

•LEVEL OF DESTRUCTION : The variable level of destruction, the highest is completely destroyed , lowest is no destruction.

•HUMANITARIAN ASSISTANCE : The variable that support for recovering people like education level (they know how to prevent and first aid), health facilities, rapid medical assistance and treatments.

•EDUCATION : Education background turtles are, 1 (elementary), 2 (junior), 3 (senior), 4 (College)

```
┌─────────────────────────────────────────┐
│ Initialization of  the model (create     │
│                  certain                  │
│ amount of people with certain            │
│ proportion have Typhoid)                 │
└─────────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────────┐      Every tick (simulation time
│                                           │              step)
│            People get older               │
│               Move                        │
│               Infect                      │
│               Recover                     │
│              Reproduce                    │
│                ….                         │
│                                           │
└─────────────────────────────────────────┘
                    │
                    ▼
        ┌───────────────────────────┐
        │ Output, visualization     │
        │     of the results        │
        └───────────────────────────┘
```

Initialize turtles

```
to setup-turtles
  set-default-shape turtles "person"
  crt people
    [ setxy random-xcor random-ycor
      set age random lifespan
      set typhoid-count 0
      set complications? false
      set size 1.25  ;; easier to see
      ifelse (who < 0.025 * people)
        [ get-typhoid ]
        [ get-healthy ] ]
end
```

how long the turtle has typhoid fever

Return turtle's ID

"go" procedure (execute every tick)

```
to go
  set days (days + 1)
  get-older
  move
  infect
  recover
  reproduce
  change-environment
  update-global-variables
  update-plot
  if count turtles with [typhoid?]  = 1 [stop]
end
```

"get-old" and "move" procedures

```
to get-older
  ask turtles
    [ set age (age + 1)
      if typhoid?
        [ set typhoid-count (typhoid-count + 1) ]
      ;; Turtles die of old age once their age equals the
      ;; lifespan (set at 1500 in this model).
      if age > lifespan
        [ die ] ]
end
```

Turtle will be removed from simulation

```
to move
  ask turtles
  [ rt random-float 10 - random-float 10
    fd 1 ]
end
```

Turtle turns right by number of degree

"Infect" procedure

```
to infect
  ask turtles with [typhoid?]
    [ ask other turtles-here with [ not complications? ]
      [ if (random-float 10) < level-destruction
          [ get-typhoid ] ] ]
end
```

The larger level-destruction, the higher chance people get Typhoid

"recover" procedure

```
to recover
    ask turtles with [typhoid?]
        [ if (random typhoid-count) > (lifespan * (education / 10))
            [ ifelse ((random-float 10) < humanitarian-assistance)
                [ get-healthy ]
                [ become-complication ] ] ]
end
```

The higher education level, the less need for humanitarian-assistance

The higher humanitarian-assistance, more chance to get healthy

"reproduce" procedure

Limiting the total amount of people

```
to reproduce
  ask turtles with [not typhoid?]
    [ if (count turtles) < carrying-capacity
        and (random lifespan) < average-offspring
      [ hatch 1                    ;; lahir anak 1
      [ set age 1 lt 45 fd 1 get-healthy ]]]
end
```
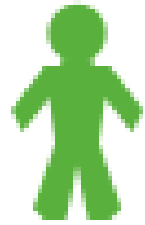
Create an identify turtle as partent

AIDS: A sample model from NetLogo Models Library.

• This model simulates the spread of the human immunodeficiency virus (HIV), via sexual transmission, through a small isolated human population.

• It therefore illustrates the effects of certain sexual practices across a population.
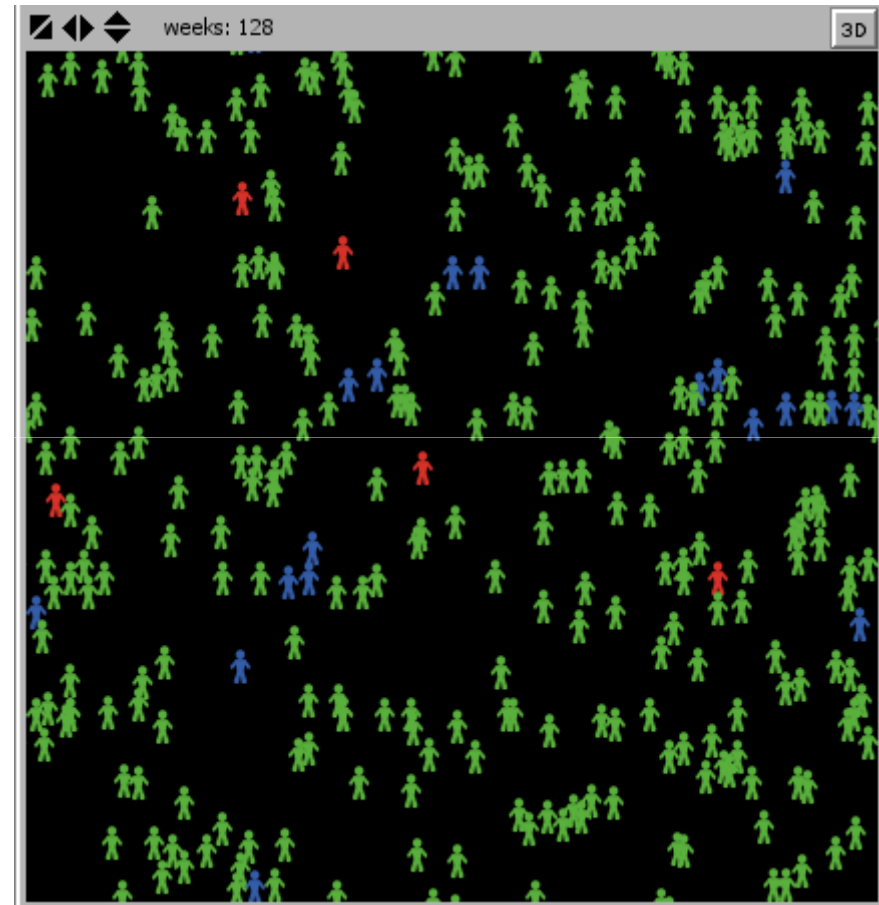
How HIV spreads

Healthy   →   Infected, but unknown   →   Infected, known

Infected, but unknown   →   Infected, but unknown   →   Infected, known

The model examines the emergent effects of four aspects of sexual behavior.

The population's tendency to practice abstinence

how changes in sexual mores in our society have contributed to increases in the prevalence of sexually transmitted diseases

The amount of time an average "couple" in the population will stay together

The population's tendency to use condoms

The population's tendency to get tested for HIV.

It may provide contemporary solutions to the problem.