

```

; The mask-wearing? and mask-wearing-proportion variables were added to represent
; the behavior of individuals wearing masks to prevent the spread of the disease.

; mask-wearing? is a boolean variable that indicates whether a person is wearing a
mask or not.
; It is randomly assigned to each person during the make-turtles procedure, based
on the mask-wearing-proportion value.

; mask-wearing-proportion is a numerical variable that represents the proportion of
the population that is wearing masks.
; It is set by the user when the model is initialized.

; In the spread-infection procedure, the mask-wearing? variable is used to
determine the probability of transmission between linked individuals.
; If both individuals are wearing masks, the probability of transmission is reduced
by a factor of prob-of-mask-spread, which is also set by the user.

; Ahmet Furkan Ün
; Enis Mert Kuzu
; Taner Giray Sönmez

```

```

turtles-own [
  infected?    ;; has the person been infected with the disease?
  mask-wearing?
]

patches-own [
  p-infected?  ;; in the environmental variant, has the patch been infected?
  infect-time  ;; how long until the end of the patch infection?
]

```

```

;;;;;;;;;;;;
;;; Setup Procedures ;;;
;;;;;;;;;;;;

```

```

to setup
  clear-all
  set-default-shape turtles "person"
  make-turtles
  ask patches [ set p-infected? false ]
  infect
  recolor
  if variant = "network" [ make-network ]
  reset-ticks
end

```

```

to make-turtles
  create-turtles num-people [
    set infected? false
    set mask-wearing? (random 100) < mask-wearing-proportion
    setxy random-xcor random-ycor
  ]
end

```

```

to make-network
  repeat connections-per-node * count turtles / 2 [
    ;; pick a random missing edge and create it
  ]
end

```

```

    ask one-of turtles [
      create-link-with one-of other turtles with [ not link-neighbor? myself ]
    ]
  ]
  layout-circle turtles max-pxcor - 1
  repeat 20 [ do-layout ]
end

```

```

to infect
  ask n-of num-infected turtles [
    set infected? true
    if variant = "environmental" [
      ;; the patch under an infected turtle becomes infected:
      set p-infected? true
    ]
  ]
end

```

```

to recolor
  ask turtles [
    ;; infected turtles are red, others are gray
    set color ifelse-value infected? [ red ] [ gray ]
  ]
  ask patches [
    ;; infected patches are yellow, others are black
    set pcolor ifelse-value p-infected? [ yellow ] [ black ]
  ]
end

```

```

;;;;;;;;;;;;;
;;; Main Procedures ;;;
;;;;;;;;;;;;;

```

```

to go
  if all? turtles [ infected? ] [ stop ]
  spread-infection
  recolor
  move
  tick
end

```

```

to spread-infection
  ask patches with [ p-infected? ] [
    ;; count down to the end of the patch infection
    set infect-time infect-time - 1
  ]
  ask turtles with [ infected? ] [
    ifelse variant = "network" [
      ;; in the network variant, the disease spreads through links
      ask link-neighbors [
        ifelse
          (mask-wearing?) and (not infected?) [
            set infected? random 100 < probab-of-mask-spread
          ]
          [
            set infected? true
          ]
      ]
    ]
  ]
end

```

```

[ ;; in other variants, the disease spreads spatially
  ask turtles-here [
    let transmission-probability 1.0
    if mask-wearing? [
      set transmission-probability transmission-probability * prob-of-mask-spread
    ]
    if random 100 < transmission-probability [
      set infected? true
    ]
  ]
  if variant = "environmental" [
    ;; in the environmental variant, it spreads to patches as well
    if infected? [set p-infected? true]
    set infect-time disease-decay
  ]
]
]
if variant = "environmental" [
  ;; the turtles that are on an infected patch become infected
  ask turtles with [ p-infected? ] [
    set infected? true
  ]
]
ask patches with [ p-infected? and infect-time <= 0 ] [
  set p-infected? false
]
end

```

```

;;;;;;;;;;;;;;
;;; Layout ;;;
;;;;;;;;;;;;;;
to move
  ifelse variant = "network" [
    ;; the number 10 here is arbitrary; more repetitions slows down the
    ;; model, but too few gives poor layouts
    repeat 10 [ do-layout ]
  ]
  [ ;; in non network variants, persons move around randomly
    ask turtles [
      fd 1
      rt random 30
      lt random 30
    ]
  ]
end

```

```

to do-layout
  layout-spring turtles with [ any? link-neighbors ] links 0.4 6 1
  display ;; so we get smooth animation
end

```

```

;; This procedure allows you to run the model multiple times
;; and measure how long it takes for the disease to spread to
;; all people in each run. For more complex experiments, you
;; would use the BehaviorSpace tool instead.

```

```

to my-experiment
  repeat 10 [
    set num-people 50
    setup
  ]

```

```
    while [ not all? turtles [ infected? ] ] [ go ]
    print ticks
]
end
```

```
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; See Info tab for full copyright and license.
```

```
@#$@#$#@
```

```
GRAPHICS-WINDOW
```

```
393
```

```
17
```

```
852
```

```
477
```

```
-1
```

```
-1
```

```
11.0
```

```
1
```

```
10
```

```
1
```

```
1
```

```
1
```

```
1
```

```
0
```

```
1
```

```
1
```

```
1
```

```
-20
```

```
20
```

```
-20
```

```
20
```

```
1
```

```
1
```

```
1
```

```
ticks
```

```
30.0
```

```
BUTTON
```

```
100
```

```
110
```

```
180
```

```
145
```

```
setup
```

```
setup
```

```
NIL
```

```
1
```

```
T
```

```
OBSERVER
```

```
NIL
```

```
NIL
```

```
NIL
```

```
NIL
```

```
1
```

```
BUTTON
```

```
100
```

```
150
```

```
180
```

```
185
```

```
go
```

go  
T  
1  
T  
OBSERVER  
NIL  
NIL  
NIL  
NIL  
0

SLIDER  
190  
60  
380  
93  
num-people  
num-people  
2  
500  
200.0  
1  
1  
NIL  
HORIZONTAL

BUTTON  
10  
150  
90  
185  
go once  
go  
NIL  
1  
T  
OBSERVER  
NIL  
NIL  
NIL  
NIL  
0

BUTTON  
10  
190  
180  
223  
redo layout  
do-layout  
T  
1  
T  
OBSERVER  
NIL  
NIL  
NIL  
NIL  
0

```
SLIDER
190
150
380
183
connections-per-node
connections-per-node
0
5.0
1.2
0.1
1
NIL
HORIZONTAL
```

```
SLIDER
10
60
180
93
num-infected
num-infected
0
num-people
21.0
1
1
NIL
HORIZONTAL
```

```
PLOT
10
235
381
500
Infection vs. Time
Time
NIL
0.0
10.0
0.0
1.0
true
true
"" "if variant = \"environmental\" [\n  create-temporary-plot-pen \"patches\"\n  plotxy ticks count patches with [ p-infected? ] / count patches\n]"
PENS
"people" 1.0 0 -5298144 true "" "plot count turtles with [ infected? ] / count
turtles"
```

```
MONITOR
10
100
90
145
Infected
count turtles with [ infected? ]
3
```

1  
11

CHOOUSER

10  
10  
180  
55  
variant  
variant  
"mobile" "network" "environmental"  
1

SLIDER

190  
190  
380  
223  
disease-decay  
disease-decay  
0  
10  
10.0  
1  
1  
ticks  
HORIZONTAL

SLIDER

190  
100  
375  
133  
mask-wearing-proportion  
mask-wearing-proportion  
0  
100  
83.0  
1  
1  
%  
HORIZONTAL

SLIDER

195  
20  
377  
53  
prob-of-mask-spread  
prob-of-mask-spread  
0  
100  
0.0  
1  
1  
%  
HORIZONTAL

@#\$#@#\$#@

## ## ACKNOWLEDGMENT

This model is 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.

\* Wilensky, U. & Rand, W. (2015). Introduction to Agent-Based Modeling: Modeling Natural, Social and Engineered Complex Systems with NetLogo. Cambridge, MA. MIT Press.

This model is in the IABM Textbook folder of the NetLogo Models Library. The model, as well as any updates to the model, can also be found on the textbook website: <http://www.intro-to-abm.com/>.

## ## WHAT IS IT?

This model explores the spread of disease in a number of different conditions and environments. In particular, it explores how making assumptions about the interactions of agents can drastically affect the results of the model.

## ## HOW IT WORKS

The SETUP procedure creates a population of agents. Depending on the value of the VARIANT chooser, these agents have different properties. In the NETWORK variant they are linked to each other through a social network. In the MOBILE and ENVIRONMENTAL variants they move around the landscape. At the start of the simulation, NUM-INFECTED of the agents are infected with a disease.

The GO procedure spreads the disease among the agents. In the case of the NETWORK variant this is along the social network links. In the case of the MOBILE or ENVIRONMENTAL variant, the disease is spread to nearby neighbors in the physical space. In the case of the ENVIRONMENTAL variant the disease is also spread via the environment. Finally, if the variant is either the MOBILE or ENVIRONMENTAL variant then the agents move.

## ## HOW TO USE IT

The NUM-PEOPLE slider controls the number of people in the world.

The VARIANT chooser controls how the infection spreads.

NUM-INFECTED controls how many individuals are initially infected with the disease.

The CONNECTIONS-PER-NODE slider controls how many connections to other nodes each node tries to make in the NETWORK variant.

The DISEASE-DECAY slider controls how quickly the disease leaves the current environment.

To use the model, set these parameters and then press SETUP.

Pressing the GO ONCE button spreads the disease for one tick. You can press the GO button to make the simulation run until all agents are infected.

The REDO LAYOUT button runs the layout-step procedure continuously to improve the layout of the network.

## ## THINGS TO NOTICE



How do the different variants affect the spread of the disease?

In particular, look at how the different parameters of the model influence the speed at which the disease spreads through the population. For example, in the "mobile" variant, the population (NUM-PEOPLE) clearly seem to be the main driving force for the speed of infection. Is that the case for the other two variants as well? Some suggestions of parameters to vary are given below under THINGS TO TRY.

Another thing that you may have noticed is that, in the "network" variant, there are cases where the disease will not spread to all people. This happens when the network has more than one [components]([https://en.wikipedia.org/wiki/Connected\\_component\\_%28graph\\_theory%29](https://en.wikipedia.org/wiki/Connected_component_%28graph_theory%29)) (isolated nodes, or groups of nodes that are not connected with the rest of the network) and that not all components get infected with the disease right from the start. NetLogo's [network extension](<http://ccl.northwestern.edu/netlogo/docs/nw.html>) has [a primitive](<http://ccl.northwestern.edu/netlogo/docs/nw.html#weak-component-clusters>) that can help you identify the components of a network.

### ## THINGS TO TRY

Set different values for the DISEASE-DECAY slider and run the ENVIRONMENTAL variant. How does the DISEASE-DECAY slider affect the results?

Similarly, set different values for the CONNECTIONS-PER-NODE slider and run the NETWORK variant. How does the CONNECTIONS-PER-NODE slider affect the results?

If you open the BehaviorSpace tool, you will see that we have a defined a few experiments that can be used to explore the behavior of the model more systematically. Try these out, and look at the data in the resulting CSV file. Are those results similar to what you obtained by manually playing with the model parameters? Can you confirm that using your favorite external analysis tool?

### ## EXTENDING THE MODEL

Can you think of additional variants and parameters that could affect the spread of a disease?

At the moment, in the environmental variant of the model, patches are either infected or not. DISEASE-DECAY allows you to set how long they stay infected, but they are fully contagious until they suddenly stop being infected. Do you think it would be more realistic to have their infection level decline gradually? The probability of a person catching the disease from a patch could become smaller as the infection level decreases on the patch. If you want to make the model look really nice, you could vary the color of the patch using the [`scale-color`](<http://ccl.northwestern.edu/netlogo/docs/dictionary.html#scale-color>) primitive.

### ## RELATED MODELS

NetLogo is very good at simulating the spread of epidemics, so there are a few disease transmission model in the library:

- HIV
- Disease Solo
- Disease HubNet
- Disease Doctors HubNet
- epiDEM Basic
- epiDEM Travel and Control
- Virus on a Network

Some communication models are also very similar to disease transmission ones:

- Communication T-T Example
- Communication-T-T Network Example
- Language Change

### ## NETLOGO FEATURES

One particularity of this model is that it combines three different "variants" in the same model. The way this is accomplished in the code of the model is fairly simple: we have a few ``if``-statements making the model behave slightly different, depending on the value of the `VARIANT` chooser.

A more interesting element is the `**Infection vs. Time**` plot. In the "mobile" and "network" variants, the plot is the same: we simply plot the number of infected persons. In the "environmental" variant, however, we want to plot an additional quantity: the number of infected patches. To achieve that, we use the "Plot update commands" field of our plot definition. Just like the "Pen update commands", these commands run every time a plot is updated (usually when calling `[`tick`](http://ccl.northwestern.edu/netlogo/docs/dictionary.html#tick)`). In this case, we use the `[`create-temporary-plot-pen`](http://ccl.northwestern.edu/netlogo/docs/dictionary.html#create-temporary-plot-pen)` primitive to make sure that we have a pen for the number of infected patches, and actually plot that number:

```
...
if variant = "environmental" [
  create-temporary-plot-pen "patches"
  plotxy ticks count patches with [ p-infected? ] / count patches
]
...
```

One nice thing about this NetLogo feature is that the temporary plot pen that we create is automatically added to the plot's legend (and removed from the legend when the plot is cleared, when calling `[`clear-all`](http://ccl.northwestern.edu/netlogo/docs/dictionary.html#clear-all)`).

### ## HOW TO CITE

This model is part of the textbook, "Introduction to Agent-Based Modeling: Modeling Natural, Social and Engineered Complex Systems with NetLogo."

If you mention this model or the NetLogo software in a publication, we ask that you include the citations below.

For the model itself:

\* Rand, W., Wilensky, U. (2008). NetLogo Spread of Disease model.  
<http://ccl.northwestern.edu/netlogo/models/SpreadofDisease>. Center for Connected Learning and Computer-Based Modeling, Northwestern Institute on Complex Systems, Northwestern University, Evanston, IL.

Please cite the NetLogo software as:

\* Wilensky, U. (1999). NetLogo. <http://ccl.northwestern.edu/netlogo/>. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

Please cite the textbook as:

\* Wilensky, U. & Rand, W. (2015). Introduction to Agent-Based Modeling: Modeling Natural, Social and Engineered Complex Systems with NetLogo. Cambridge, MA. MIT Press.

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<!-- 2008 Cite: Rand, W., Wilensky, U. -->

@#\$@#\$#@

default

true

0

Polygon -7500403 true true 150 5 40 250 150 205 260 250

airplane

true

0

Polygon -7500403 true true 150 0 135 15 120 60 120 105 15 165 15 195 120 180 135 240 105 270 120 285 150 270 180 285 210 270 165 240 180 180 285 195 285 165 180 105 180 60 165 15

arrow

true

0

Polygon -7500403 true true 150 0 0 150 105 150 105 293 195 293 195 150 300 150

box

false

0

Polygon -7500403 true true 150 285 285 225 285 75 150 135

Polygon -7500403 true true 150 135 15 75 150 15 285 75

Polygon -7500403 true true 15 75 15 225 150 285 150 135

Line -16777216 false 150 285 150 135

Line -16777216 false 150 135 15 75

Line -16777216 false 150 135 285 75

bug

true

0

Circle -7500403 true true 96 182 108

Circle -7500403 true true 110 127 80

Circle -7500403 true true 110 75 80

Line -7500403 true 150 100 80 30

Line -7500403 true 150 100 220 30

butterfly

true

0  
Polygon -7500403 true true 150 165 209 199 225 225 225 255 195 270 165 255 150 240  
Polygon -7500403 true true 150 165 89 198 75 225 75 255 105 270 135 255 150 240  
Polygon -7500403 true true 139 148 100 105 55 90 25 90 10 105 10 135 25 180 40 195  
85 194 139 163  
Polygon -7500403 true true 162 150 200 105 245 90 275 90 290 105 290 135 275 180  
260 195 215 195 162 165  
Polygon -16777216 true false 150 255 135 225 120 150 135 120 150 105 165 120 180  
150 165 225  
Circle -16777216 true false 135 90 30  
Line -16777216 false 150 105 195 60  
Line -16777216 false 150 105 105 60

car  
false

0  
Polygon -7500403 true true 300 180 279 164 261 144 240 135 226 132 213 106 203 84  
185 63 159 50 135 50 75 60 0 150 0 165 0 225 300 225 300 180  
Circle -16777216 true false 180 180 90  
Circle -16777216 true false 30 180 90  
Polygon -16777216 true false 162 80 132 78 134 135 209 135 194 105 189 96 180 89  
Circle -7500403 true true 47 195 58  
Circle -7500403 true true 195 195 58

circle  
false

0  
Circle -7500403 true true 0 0 300

circle 2  
false

0  
Circle -7500403 true true 0 0 300  
Circle -16777216 true false 30 30 240

cow  
false

0  
Polygon -7500403 true true 200 193 197 249 179 249 177 196 166 187 140 189 93 191  
78 179 72 211 49 209 48 181 37 149 25 120 25 89 45 72 103 84 179 75 198 76 252 64  
272 81 293 103 285 121 255 121 242 118 224 167  
Polygon -7500403 true true 73 210 86 251 62 249 48 208  
Polygon -7500403 true true 25 114 16 195 9 204 23 213 25 200 39 123

cylinder  
false

0  
Circle -7500403 true true 0 0 300

dot  
false

0  
Circle -7500403 true true 90 90 120

face happy  
false

0  
Circle -7500403 true true 8 8 285  
Circle -16777216 true false 60 75 60

Circle -16777216 true false 180 75 60  
Polygon -16777216 true false 150 255 90 239 62 213 47 191 67 179 90 203 109 218 150  
225 192 218 210 203 227 181 251 194 236 217 212 240

face neutral

false

0

Circle -7500403 true true 8 7 285

Circle -16777216 true false 60 75 60

Circle -16777216 true false 180 75 60

Rectangle -16777216 true false 60 195 240 225

face sad

false

0

Circle -7500403 true true 8 8 285

Circle -16777216 true false 60 75 60

Circle -16777216 true false 180 75 60

Polygon -16777216 true false 150 168 90 184 62 210 47 232 67 244 90 220 109 205 150  
198 192 205 210 220 227 242 251 229 236 206 212 183

fish

false

0

Polygon -1 true false 44 131 21 87 15 86 0 120 15 150 0 180 13 214 20 212 45 166

Polygon -1 true false 135 195 119 235 95 218 76 210 46 204 60 165

Polygon -1 true false 75 45 83 77 71 103 86 114 166 78 135 60

Polygon -7500403 true true 30 136 151 77 226 81 280 119 292 146 292 160 287 170 270  
195 195 210 151 212 30 166

Circle -16777216 true false 215 106 30

flag

false

0

Rectangle -7500403 true true 60 15 75 300

Polygon -7500403 true true 90 150 270 90 90 30

Line -7500403 true 75 135 90 135

Line -7500403 true 75 45 90 45

flower

false

0

Polygon -10899396 true false 135 120 165 165 180 210 180 240 150 300 165 300 195  
240 195 195 165 135

Circle -7500403 true true 85 132 38

Circle -7500403 true true 130 147 38

Circle -7500403 true true 192 85 38

Circle -7500403 true true 85 40 38

Circle -7500403 true true 177 40 38

Circle -7500403 true true 177 132 38

Circle -7500403 true true 70 85 38

Circle -7500403 true true 130 25 38

Circle -7500403 true true 96 51 108

Circle -16777216 true false 113 68 74

Polygon -10899396 true false 189 233 219 188 249 173 279 188 234 218

Polygon -10899396 true false 180 255 150 210 105 210 75 240 135 240

house

false

0  
Rectangle -7500403 true true 45 120 255 285  
Rectangle -16777216 true false 120 210 180 285  
Polygon -7500403 true true 15 120 150 15 285 120  
Line -16777216 false 30 120 270 120

leaf  
false  
0  
Polygon -7500403 true true 150 210 135 195 120 210 60 210 30 195 60 180 60 165 15 135 30 120 15 105 40 104 45 90 60 90 90 105 105 120 120 120 105 60 120 60 135 30 150 15 165 30 180 60 195 60 180 120 195 120 210 105 240 90 255 90 263 104 285 105 270 120 285 135 240 165 240 180 270 195 240 210 180 210 165 195  
Polygon -7500403 true true 135 195 135 240 120 255 105 255 105 285 135 285 165 240 165 195

line  
true  
0  
Line -7500403 true 150 0 150 300

line half  
true  
0  
Line -7500403 true 150 0 150 150

link  
true  
0  
Line -7500403 true 150 0 150 300

link direction  
true  
0  
Line -7500403 true 150 150 30 225  
Line -7500403 true 150 150 270 225

pentagon  
false  
0  
Polygon -7500403 true true 150 15 15 120 60 285 240 285 285 120

person  
false  
0  
Circle -7500403 true true 110 5 80  
Polygon -7500403 true true 105 90 120 195 90 285 105 300 135 300 150 225 165 300 195 300 210 285 180 195 195 90  
Rectangle -7500403 true true 127 79 172 94  
Polygon -7500403 true true 195 90 240 150 225 180 165 105  
Polygon -7500403 true true 105 90 60 150 75 180 135 105

plant  
false  
0  
Rectangle -7500403 true true 135 90 165 300  
Polygon -7500403 true true 135 255 90 210 45 195 75 255 135 285  
Polygon -7500403 true true 165 255 210 210 255 195 225 255 165 285  
Polygon -7500403 true true 135 180 90 135 45 120 75 180 135 210

Polygon -7500403 true true 165 180 165 210 225 180 255 120 210 135  
Polygon -7500403 true true 135 105 90 60 45 45 75 105 135 135  
Polygon -7500403 true true 165 105 165 135 225 105 255 45 210 60  
Polygon -7500403 true true 135 90 120 45 150 15 180 45 165 90

square  
false  
0  
Rectangle -7500403 true true 30 30 270 270

square 2  
false  
0  
Rectangle -7500403 true true 30 30 270 270  
Rectangle -16777216 true false 60 60 240 240

star  
false  
0  
Polygon -7500403 true true 151 1 185 108 298 108 207 175 242 282 151 216 59 282 94  
175 3 108 116 108

target  
false  
0  
Circle -7500403 true true 0 0 300  
Circle -16777216 true false 30 30 240  
Circle -7500403 true true 60 60 180  
Circle -16777216 true false 90 90 120  
Circle -7500403 true true 120 120 60

tree  
false  
0  
Circle -7500403 true true 118 3 94  
Rectangle -6459832 true false 120 195 180 300  
Circle -7500403 true true 65 21 108  
Circle -7500403 true true 116 41 127  
Circle -7500403 true true 45 90 120  
Circle -7500403 true true 104 74 152

triangle  
false  
0  
Polygon -7500403 true true 150 30 15 255 285 255

triangle 2  
false  
0  
Polygon -7500403 true true 150 30 15 255 285 255  
Polygon -16777216 true false 151 99 225 223 75 224

truck  
false  
0  
Rectangle -7500403 true true 4 45 195 187  
Polygon -7500403 true true 296 193 296 150 259 134 244 104 208 104 207 194  
Rectangle -1 true false 195 60 195 105  
Polygon -16777216 true false 238 112 252 141 219 141 218 112

Circle -16777216 true false 234 174 42  
Rectangle -7500403 true true 181 185 214 194  
Circle -16777216 true false 144 174 42  
Circle -16777216 true false 24 174 42  
Circle -7500403 false true 24 174 42  
Circle -7500403 false true 144 174 42  
Circle -7500403 false true 234 174 42

turtle  
true

0

Polygon -10899396 true false 215 204 240 233 246 254 228 266 215 252 193 210  
Polygon -10899396 true false 195 90 225 75 245 75 260 89 269 108 261 124 240 105  
225 105 210 105  
Polygon -10899396 true false 105 90 75 75 55 75 40 89 31 108 39 124 60 105 75 105  
90 105  
Polygon -10899396 true false 132 85 134 64 107 51 108 17 150 2 192 18 192 52 169 65  
172 87  
Polygon -10899396 true false 85 204 60 233 54 254 72 266 85 252 107 210  
Polygon -7500403 true true 119 75 179 75 209 101 224 135 220 225 175 261 128 261 81  
224 74 135 88 99

wheel  
false

0

Circle -7500403 true true 3 3 294  
Circle -16777216 true false 30 30 240  
Line -7500403 true 150 285 150 15  
Line -7500403 true 15 150 285 150  
Circle -7500403 true true 120 120 60  
Line -7500403 true 216 40 79 269  
Line -7500403 true 40 84 269 221  
Line -7500403 true 40 216 269 79  
Line -7500403 true 84 40 221 269

x  
false

0

Polygon -7500403 true true 270 75 225 30 30 225 75 270  
Polygon -7500403 true true 30 75 75 30 270 225 225 270

@#\$#@#\$#@

NetLogo 6.3.0

@#\$#@#\$#@

@#\$#@#\$#@

@#\$#@#\$#@

<experiments>

<experiment name="population-density" repetitions="10"  
runMetricsEveryStep="false">

<setup>setup</setup>

<go>go</go>

<metric>ticks</metric>

<enumeratedValueSet variable="variant">

<value value="&quot;mobile&quot;"/>

</enumeratedValueSet>

<enumeratedValueSet variable="connections-per-node">

<value value="4.1"/>

</enumeratedValueSet>

<steppedValueSet variable="num-people" first="50" step="50" last="200"/>

<enumeratedValueSet variable="num-infected">



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        <value value="1"/>
    </enumeratedValueSet>
    <enumeratedValueSet variable="disease-decay">
        <value value="0"/>
    </enumeratedValueSet>
</experiment>
<experiment name="degree" repetitions="10" runMetricsEveryStep="false">
    <setup>setup</setup>
    <go>go</go>
    <timeLimit steps="50"/>
    <metric>count turtles with [infected?]</metric>
    <enumeratedValueSet variable="num-people">
        <value value="200"/>
    </enumeratedValueSet>
    <steppedValueSet variable="connections-per-node" first="0.5" step="0.5"
last="4"/>
    <enumeratedValueSet variable="disease-decay">
        <value value="10"/>
    </enumeratedValueSet>
    <enumeratedValueSet variable="variant">
        <value value="&quot;network&quot;"/>
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    <enumeratedValueSet variable="num-infected">
        <value value="1"/>
    </enumeratedValueSet>
</experiment>
<experiment name="environmental" repetitions="10" runMetricsEveryStep="false">
    <setup>setup</setup>
    <go>go</go>
    <metric>ticks</metric>
    <enumeratedValueSet variable="num-people">
        <value value="200"/>
    </enumeratedValueSet>
    <enumeratedValueSet variable="connections-per-node">
        <value value="4"/>
    </enumeratedValueSet>
    <steppedValueSet variable="disease-decay" first="0" step="1" last="10"/>
    <enumeratedValueSet variable="variant">
        <value value="&quot;environmental&quot;"/>
    </enumeratedValueSet>
    <enumeratedValueSet variable="num-infected">
        <value value="1"/>
    </enumeratedValueSet>
</experiment>
<experiment name="density-and-decay" repetitions="10"
runMetricsEveryStep="false">
    <setup>setup</setup>
    <go>go</go>
    <metric>ticks</metric>
    <enumeratedValueSet variable="variant">
        <value value="&quot;environmental&quot;"/>
    </enumeratedValueSet>
    <steppedValueSet variable="disease-decay" first="0" step="1" last="10"/>
    <enumeratedValueSet variable="num-infected">
        <value value="1"/>
    </enumeratedValueSet>
    <steppedValueSet variable="num-people" first="50" step="50" last="200"/>
    <enumeratedValueSet variable="connections-per-node">
        <value value="4"/>
    </enumeratedValueSet>

```

```
</enumeratedValueSet>
</experiment>
</experiments>
@#$#@#$#@
@#$#@#$#@
default
0.0
-0.2 0 0.0 1.0
0.0 1 1.0 0.0
0.2 0 0.0 1.0
link direction
true
0
Line -7500403 true 150 150 90 180
Line -7500403 true 150 150 210 180
@#$#@#$#@
1
@#$#@#$#@
```