Disease Dynamics (ABM)

This tutorial describes how to construct a model of an infectious disease using Insight Maker. Agent-Based Modeling techniques are used in the construction of this model. Before starting the tutorial, make sure you have familiarized yourself with how to create primitives and run models.

1 Create a new **State** named **Healthy** .

2 Create a new **State** named **Infected** .

3 Create a new **State** named **Recovered** .

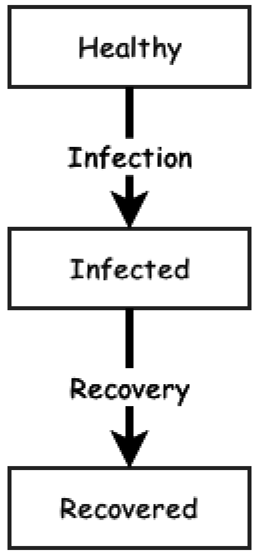
4 The model diagram should now look something like this:

> States represent the condition someone is in. So in our model a person can either be healthy, infected, or recovered from the infection. Now, lets add transitions that move a person from state to state.

5 Create a new **Transition** going from the primitive **Healthy** to the primitive **Infected** . Name that transition **Infection** .

6 Create a new **Transition** going from the primitive **Infected** to the primitive **Recovered**. Name that transition **Recovery**.

7 The model diagram should now look something like this:



> Please note that in this model someone who is recovered cannot become sick again. They have gained immunity to the disease.
>
> Now that the model structure has been designed, let's add equations and configure the primitives.

8 Change the **Initial Active** property of the primitive **Healthy** to **true**.

> When a state is active, it means a person is in that state. By setting **Healthy** to start **true**, we have the person start in the healthy state.

9 Change the **Trigger Type** property of the primitive **Infection** to **Probability**.

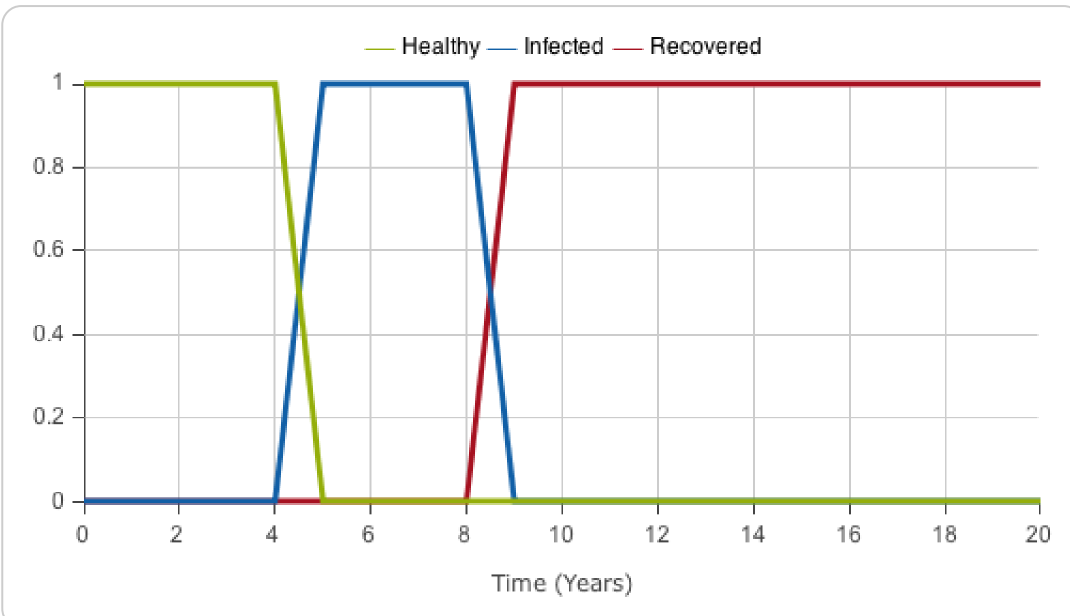
10 Change the **Value/Equation** property of the primitive **Infection** to **0.3**.

11 Change the **Trigger Type** property of the primitive **Recovery** to **Probability** .

12 Change the **Value/Equation** property of the primitive **Recovery** to **0.2** .

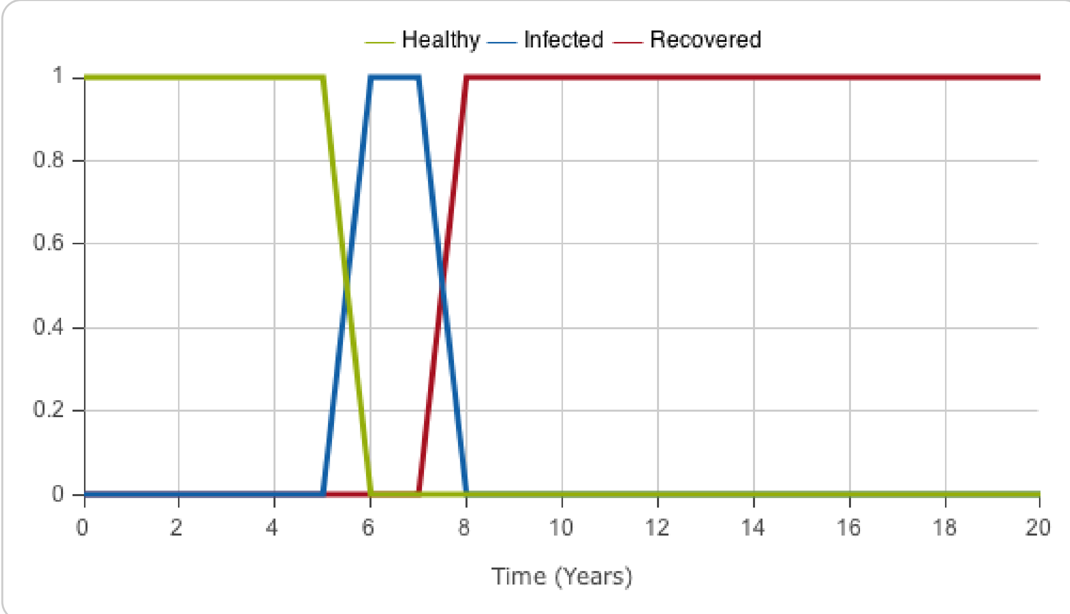
> Using the **Probability** type for the transition trigger means that the person has a fixed probability of transitioning from one state to the next each year.

13 Run the model. Here are sample results:

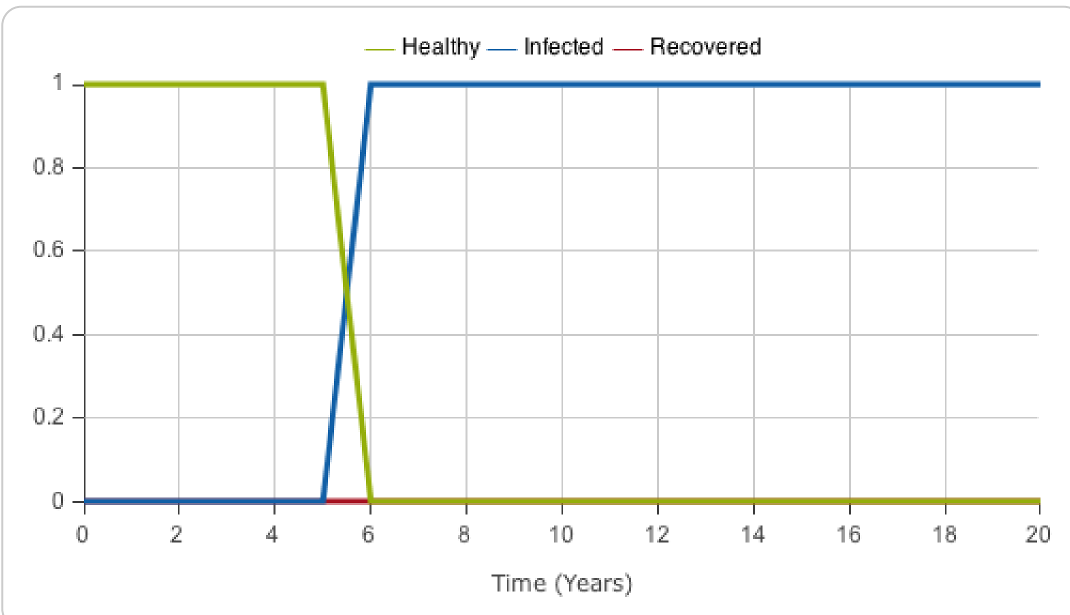


> Don't worry if your results do not look exactly like this. This is a stochastic model so each time we run it, we will get different results. Let's give it a try.

14 Run the model. Here are sample results:



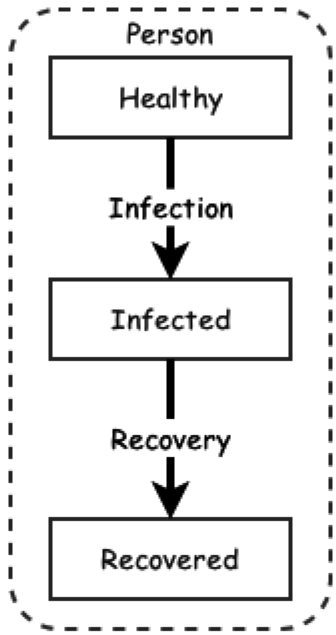
15 Run the model. Here are sample results:



> When a state takes on the value **1** it means the person is in the state. We can see how the person moves from healthy, to infected, to recovered in these three different simulation runs. Right now we are only simulating a single person. Let's extend our model to simulate a population of people.

16 Create a new **Folder** named **Person** . The folder should surround the primitives **Healthy** , **Infected** , **Recovered** , **Infection** and **Recovery** .

17 The model diagram should now look something like this:

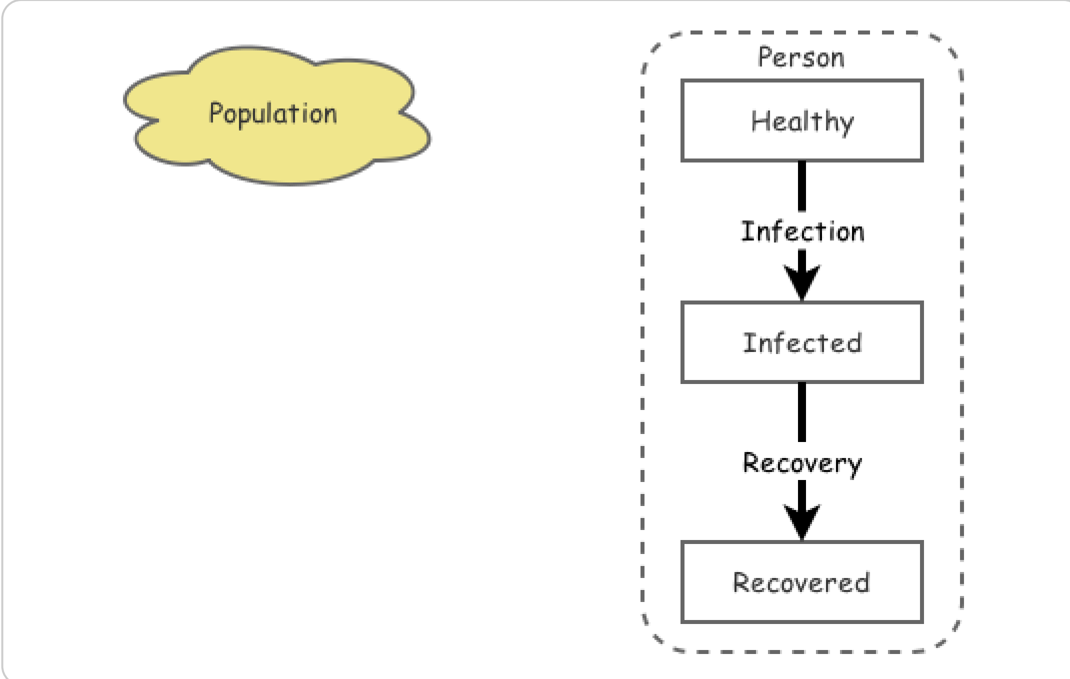


18 Change the **Behavior** property of the primitive **Person** to **Agent** .

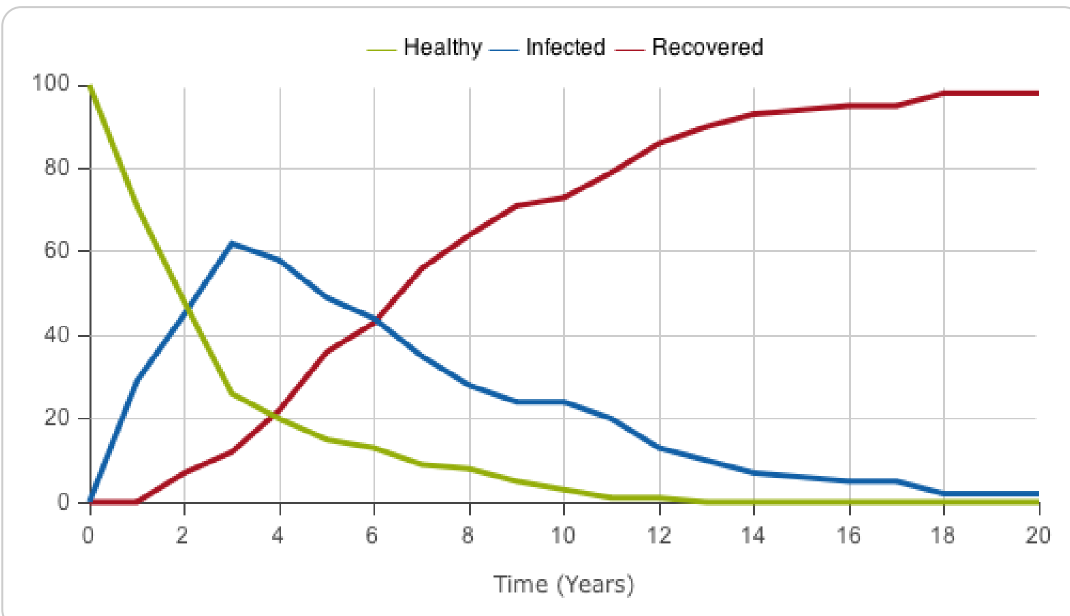
19 Create a new **Agent Population** named **Population** .

20 Change the **Agent Base** property of the primitive **Population** to **Person** .

21 The model diagram should now look something like this:



22 Run the model. Here are sample results:



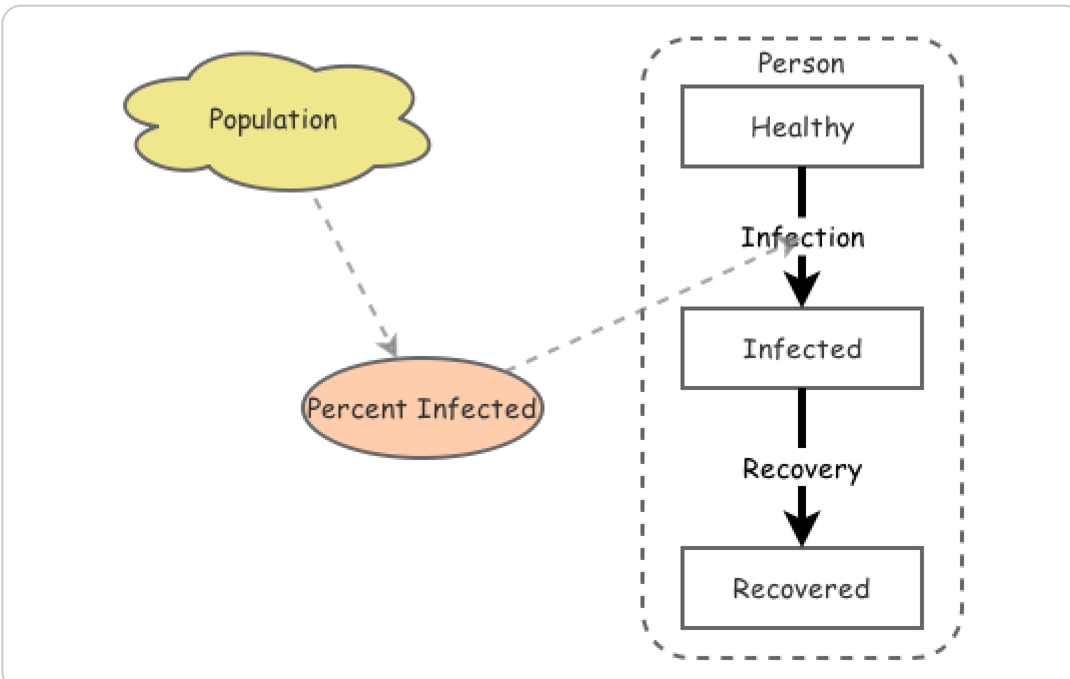
> That looks pretty good! We can see the disease gradually spread through our population of 100 people.
>
> However, right now the probability of a person getting sick is independent of the other people in the model. Let's change the model so the more sick people there are, the higher the likelihood that a healthy person will become sick.

23 Create a new **Variable** named **Percent Infected** .

24 Create a new **Link** going from the primitive **Population** to the primitive **Percent Infected** .

25 Create a new **Link** going from the primitive **Percent Infected** to the primitive **Infection** .

26 The model diagram should now look something like this:



> Now let's configure the value of **Percent Infected** and change the **Infection** transition to use it.

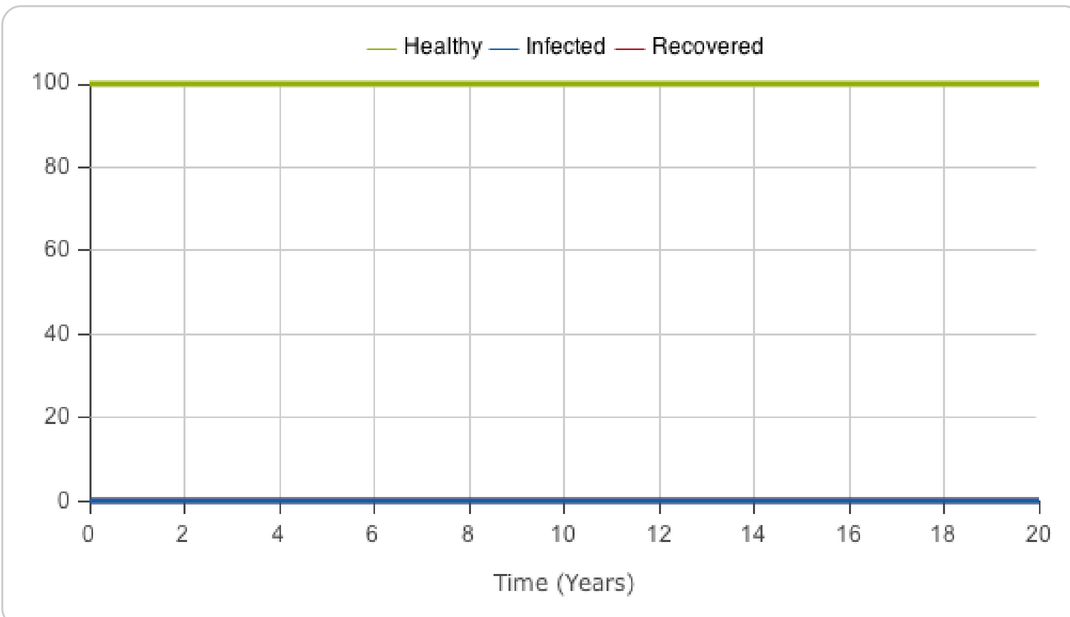
27 Change the **Equation** property of the primitive **Percent Infected** to **Count(FindState([Population], [Infected]))/PopulationSize([Population])** .

> This equation uses the **FindState** function to select all the people in the **Population** primitive who are in the **Infected** state. It then divides the count of those people by the total size of the population.

28 Change the **Value/Equation** property of the primitive **Infection** to **[Percent Infected]** , and the **Recalculate** property of the primitive **Infection** to **Yes** .

> The **Recalculate** property causes the infection rate to be recalculated and updated at every time step of the simulation.

29 Run the model. Here are sample results:



> Nothing happened because we don't have anyone to start the infection. Let's seed the model with a single initial infected person.

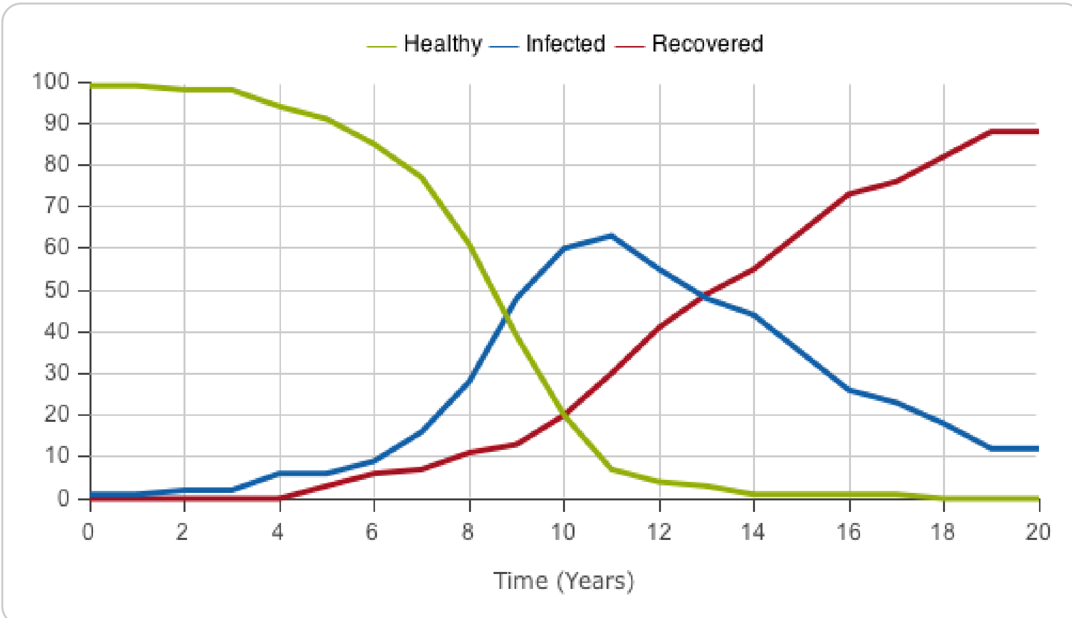
30 Change the **Initial Active** property of the primitive **Infected** to **Index(Self) == 1** .

31 Change the **Initial Active** property of the primitive **Healthy** to **Index(Self) <> 1** .

> Each of the people in the population is given an unique **Index**. The first agent will have an index of 1, the second an index of 2, and so on. **Self** always refers to the current agent. These equations will set the first agent

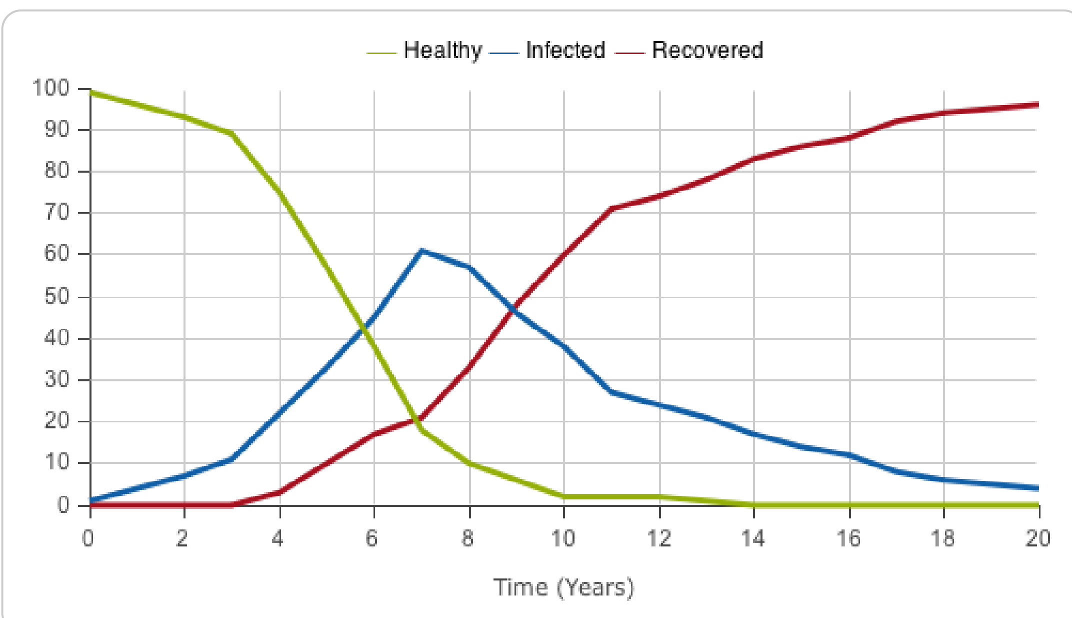
> created to start in the **Infected** state while all the other agents will start in the **Healthy** state.

32 Run the model. Here are sample results:



> Since this is a stochastic model, each time you run it, you will get slightly different results. Let's give it a try.

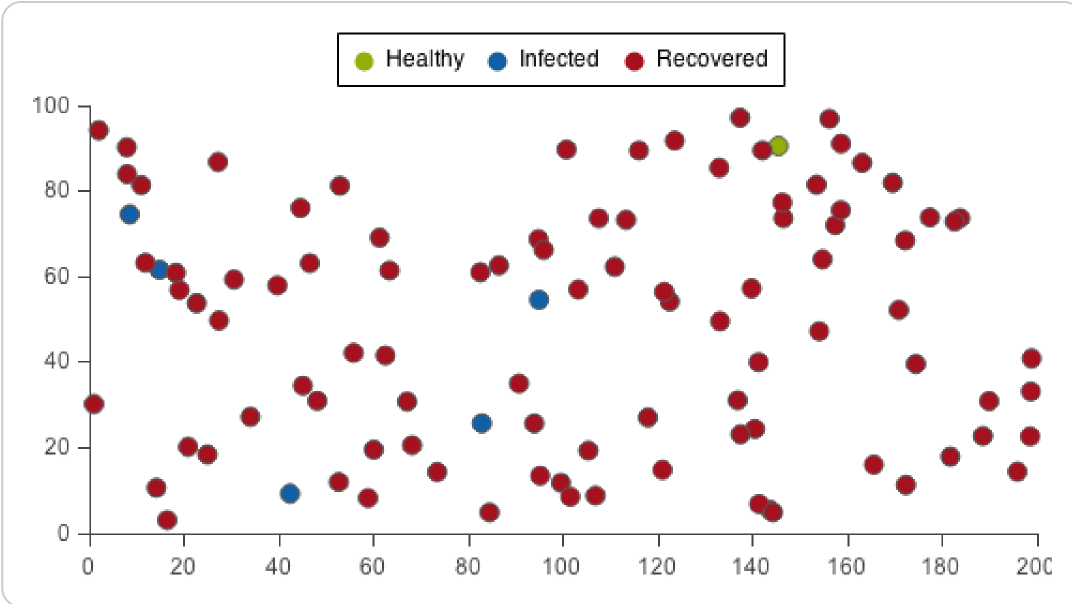
33 Run the model. Here are sample results:



34 Run the model. Here are sample results:

> That works great! We now have a full Agent-Based Model of disease.
>
> We can also configure the display type to be a map of the people in the model in a two-dimensional geography. Right now, people are placed randomly, but we could configure their locations or make them move around in response to different factors. We could also change the infection rate so the infection spread geographically.

35 Run the model. Here are sample results:


Healthy
Infected
Recovered
100
80
60
40
20
0
0
20
40
60
80
100
120
140
160
180
200