

Epidemic Model Building Tutorial

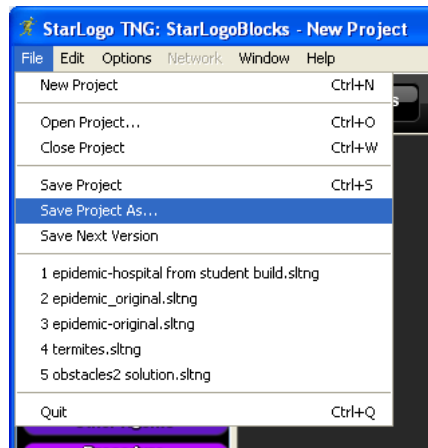
1 How to Build a Basic Epidemic Model

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How to Build a Basic Epidemic Model

Part 1: Setup

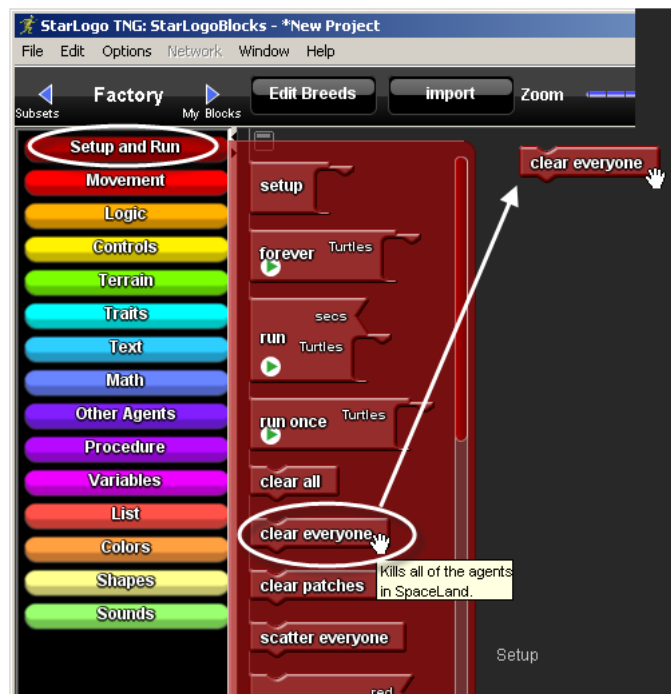
Start StarLogo TNG software



Start the StarLogo TNG software.

File menu --> save project as --> epidemic basic

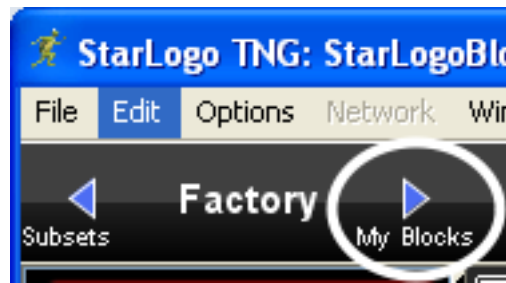
Clear everyone



Navigate to the *Setup* page of the canvas, either by scrolling to that page or using the minimap.

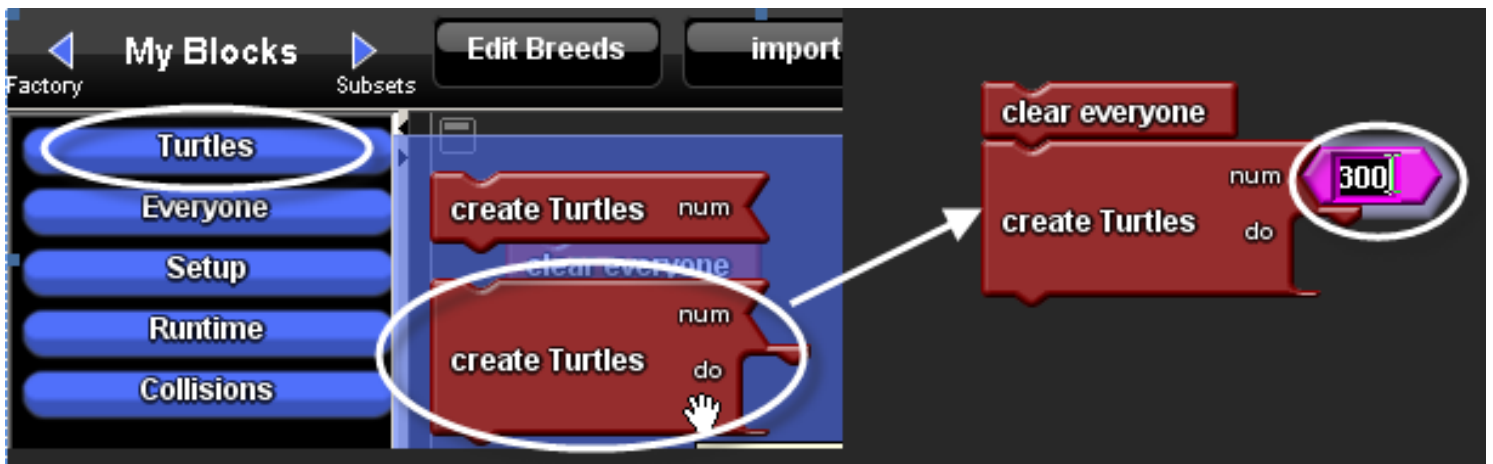
Open the **Setup and Run drawer**, drag out the clear everyone block, and drop it anywhere on the *Setup page*.

My blocks palette



Click on **My Blocks** to go to the My Blocks palette.

clear everyone



Open the **Turtles** drawer, drag out a create Turtles with do block and attach it beneath the clear everyone block. When the create Turtles with do block comes out, it includes a number. Click on the number and type in 300.

set color



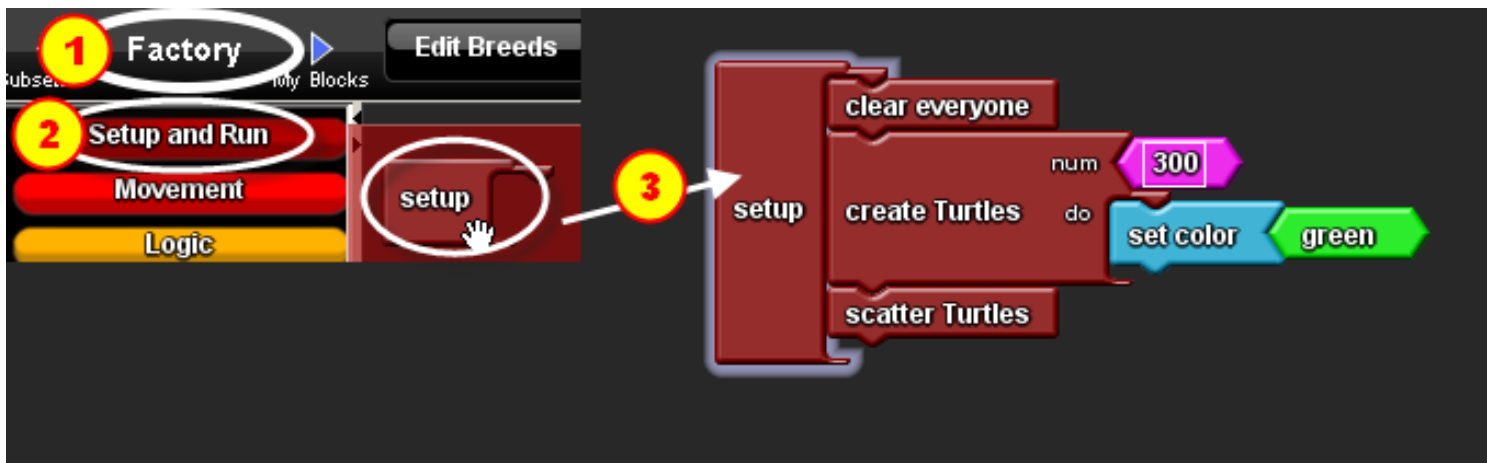
1. Go back to the **Factory** palette.
2. Open the **traits** drawer.
3. Drag out the set color block and attach it to the do section of the create Turtles block.
4. Click on the drop down menu on the red color block and change it from Red to Green.

scatter turtles



1. Go to the **My Blocks** palette.
2. Open the **Turtles** drawer.
3. Drag out a scatter Turtles block and attach it to the bottom of the stack.

setup



1. Go to the **Factory** palette.
2. Open the **Setup and Run** drawer.
3. Drag a Setup block to the stack so that the setup block stretches to fit the stack of blocks.

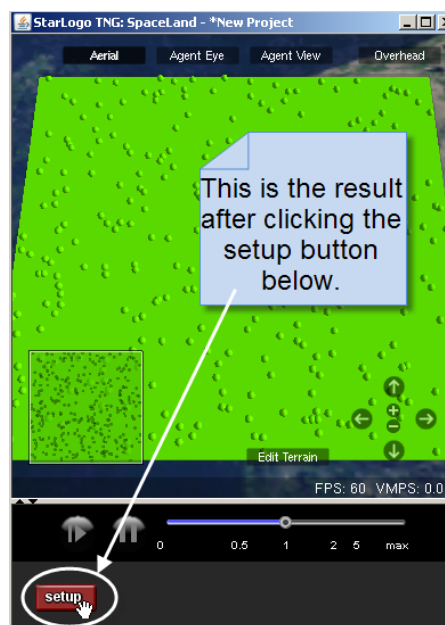
The Setup block runs once to set the initial conditions of the simulation. In this case, we want to delete all agents from the previous run, create 300 turtle agents and set their color to green (to represent 300 healthy individuals), and scatter them randomly in **Spaceland**. Note that turtles are the default agent, but both the name and shape can be changed in the **Breed Editor**.

Breed editor



1. Click on the **Edit Breeds** button near the top of the canvas to open the **Breed Editor**.
2. Select the Basic Shapes category.
3. Choose the sphere shape.
4. Click OK.

Setup button



To test the Setup block, look at the **Runtime** space underneath **Spaceland**. You should see a button named Setup. Click it once and you will see the agents created and dispersed.

Extension!

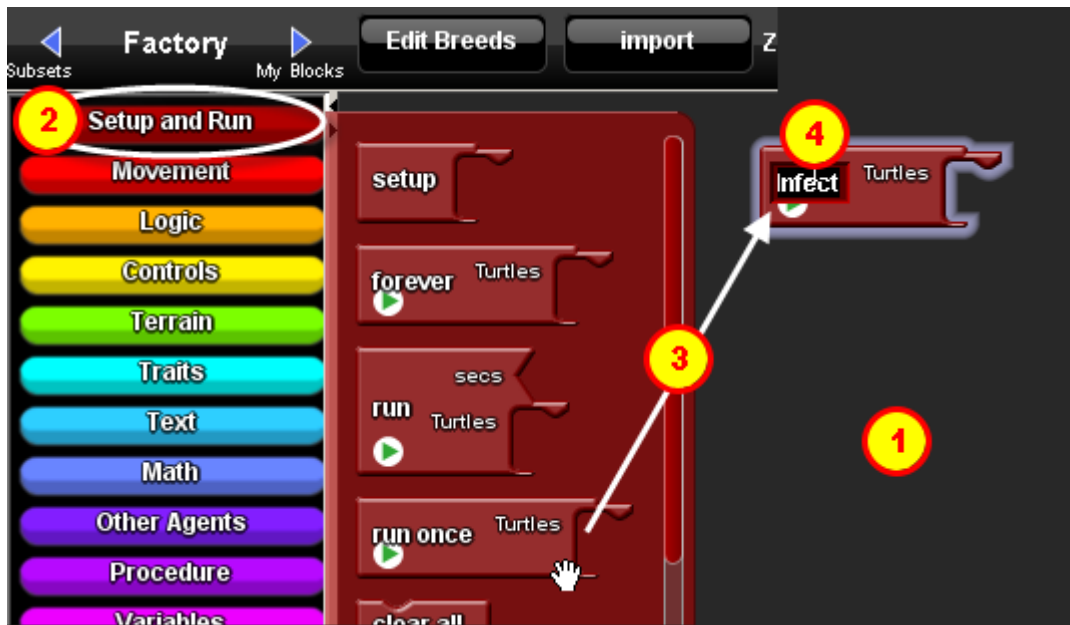


You may use any shape from the **Breed Editor**. However, if you use a shape like Lego man (in People category), you will need to add a block to the create Turtles block to see the color of the agent. The block is model skin off and can be found in the **traits drawer**.

Part 2: Seeding the Infection

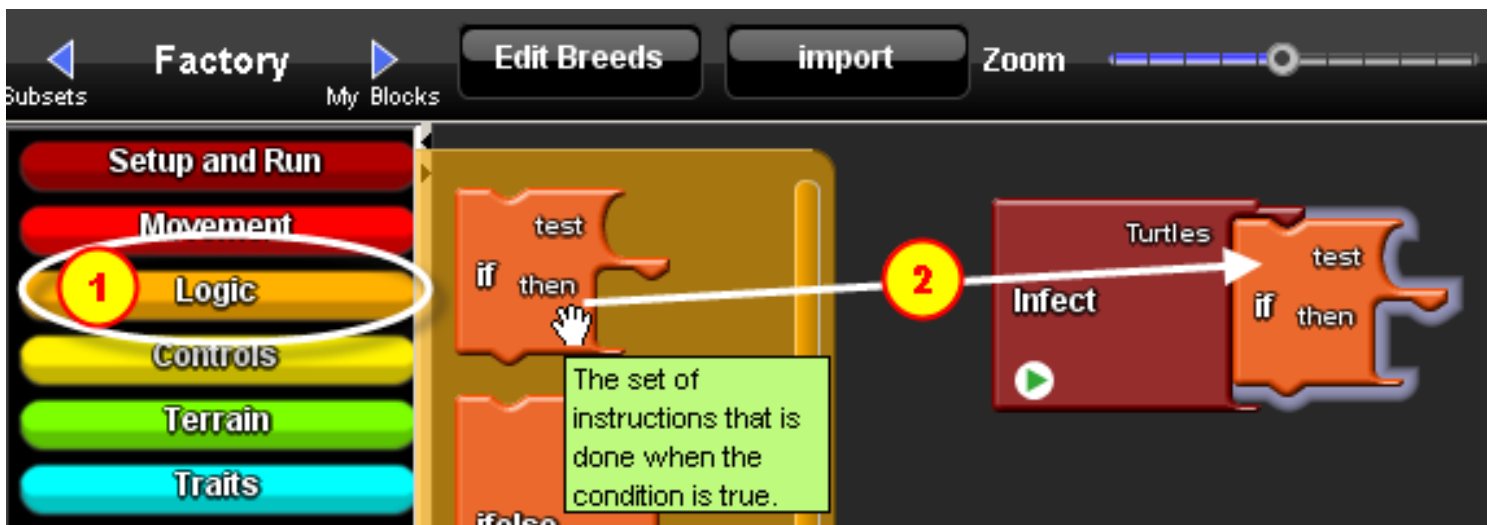
Now let's infect some of the Turtles to start.

Run Once



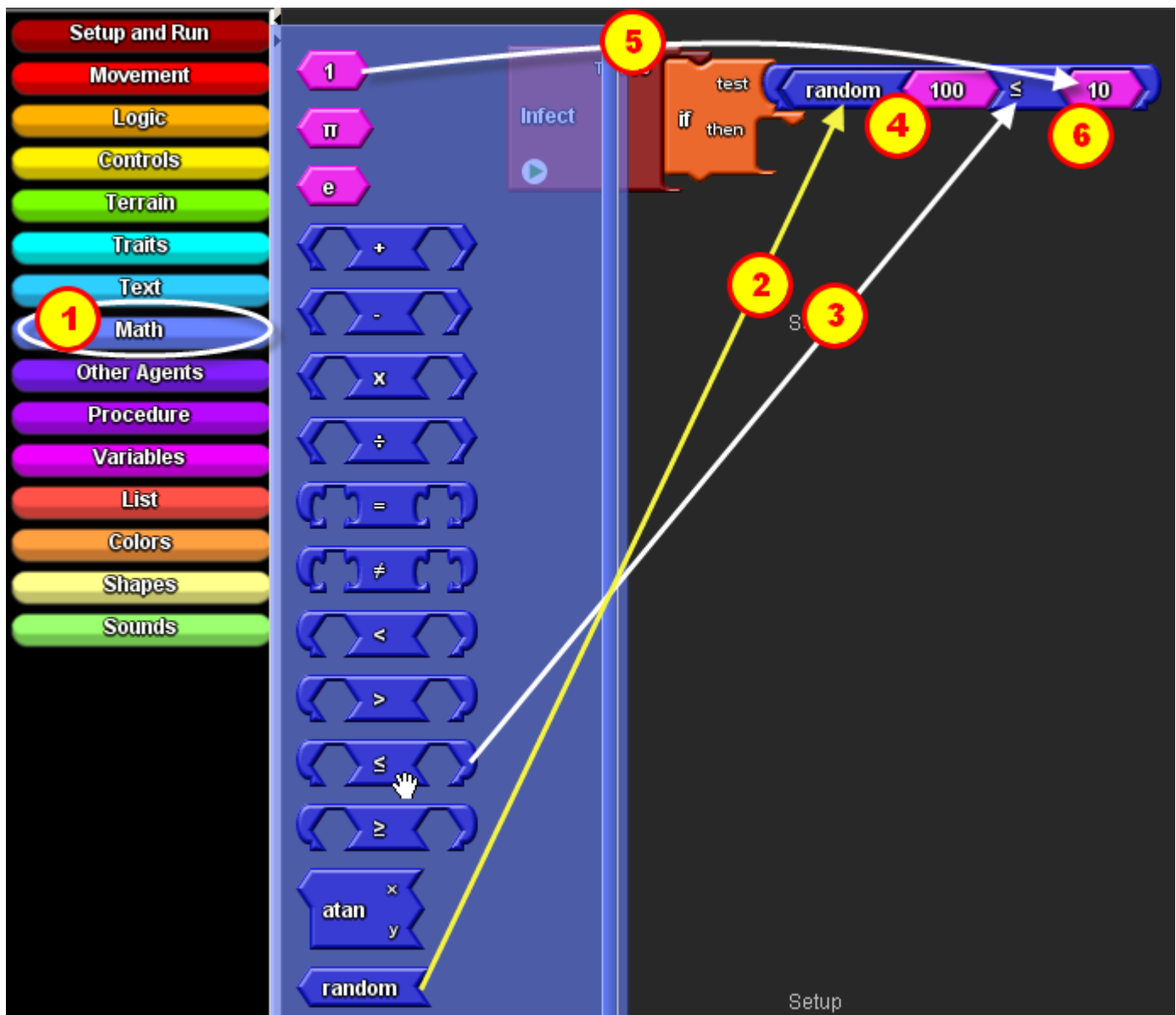
1. Go to the *Setup canvas page*.
2. Open the **Setup and Run** drawer.
3. Drag a Run Once block to the **Setup page**.
4. Click where it says Run Once and edit the name to say Infect.

If block



1. Open the **Logic** drawer.
 2. Drag out an If block and attach it inside the Infect block.
- Note that the If block has two parts - a test section and a then section.

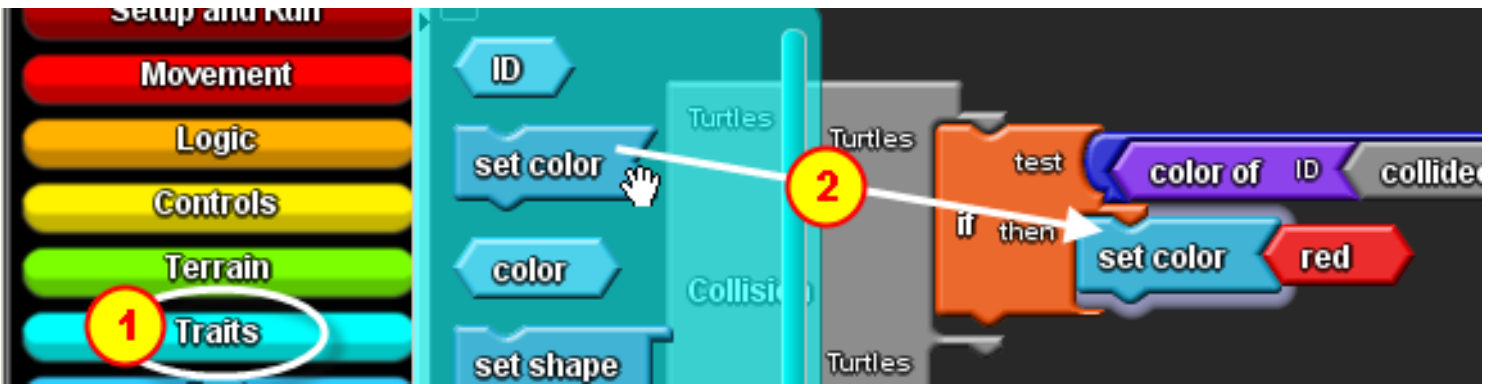
10% chance



Let's say that we want each agent to have a 10% chance of being infected at the start of the simulation. We do this by instructing each turtle agent to draw a number between 1 and 100, and if that number is less than or equal to 10, it will be infected.

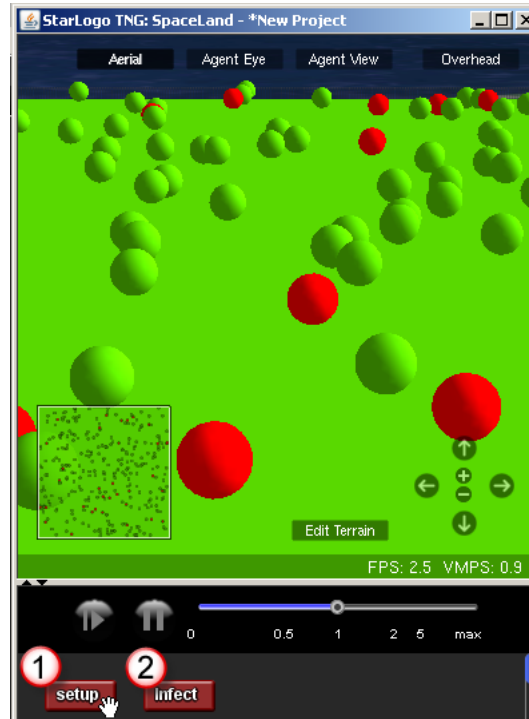
1. Open the **Math drawer**.
2. Drag out a <=block (less or equal) and attach it to the rounded test section on the If block.
3. Open the **Math drawer** again, drag out a random block, and attach it to the left side of the ≤≥ block.
4. Click on the pink number block and change it to the 100.
5. Open the **Math drawer**, drag out a pink number 1 block, attach it to the right side of the <=block. (less or equal)
6. Click on the pink number block and change it to 10.

Set color



1. Open the **Traits** drawer.
2. Drag out a Set Color block and attach it to the Then part of the If block. Leave the color as red. Remember, the red color means that the turtle agent is infected.

Test your program



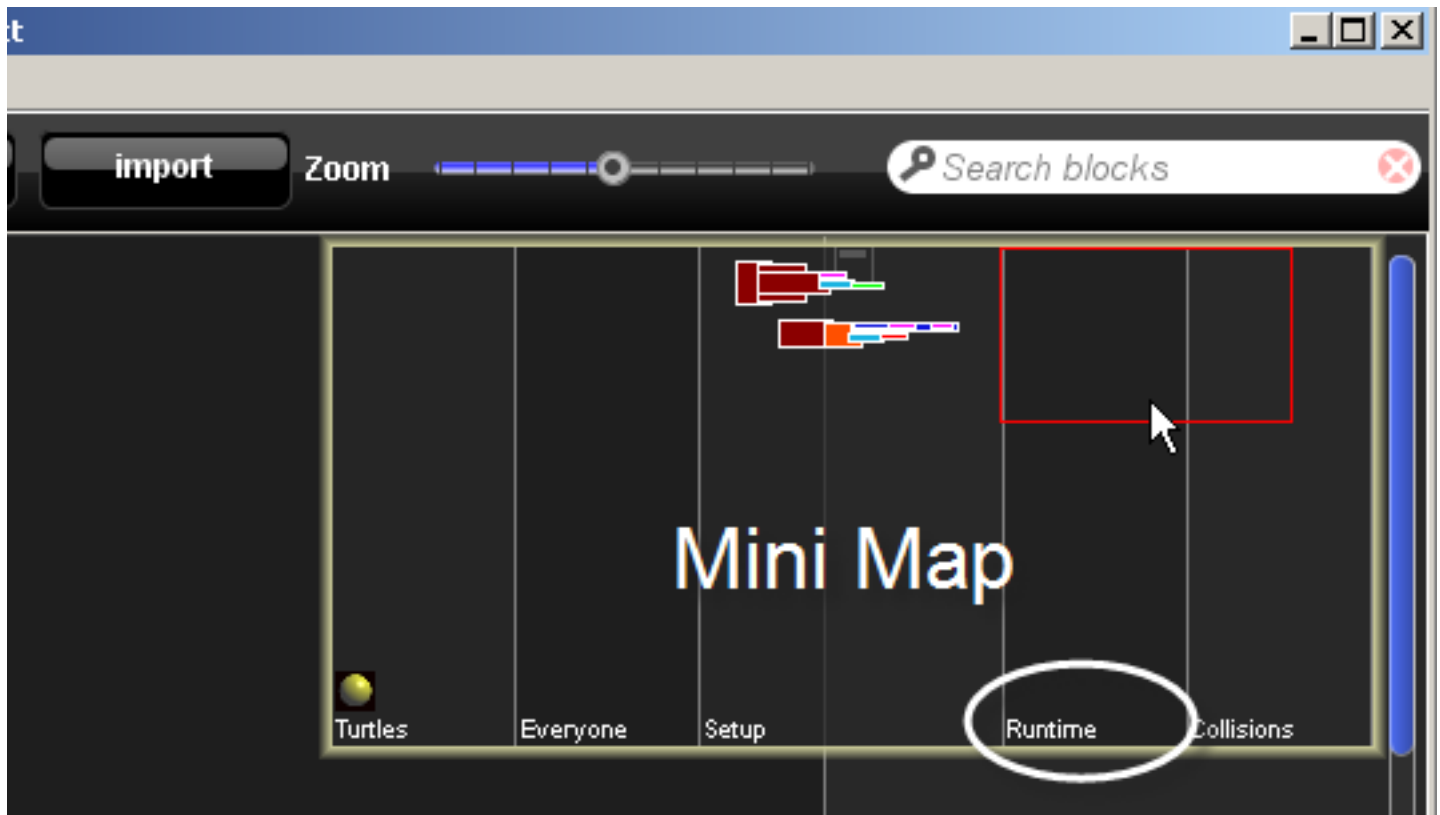
Look at the **Runtime** space under **Spaceland** and you should see a **button** named **Infect** next to the **Setup** button.

1. Click **setup** once.
 2. Click **Infect** once.
- You should see several red spheres and a lot of green ones.

Part 3: Motion

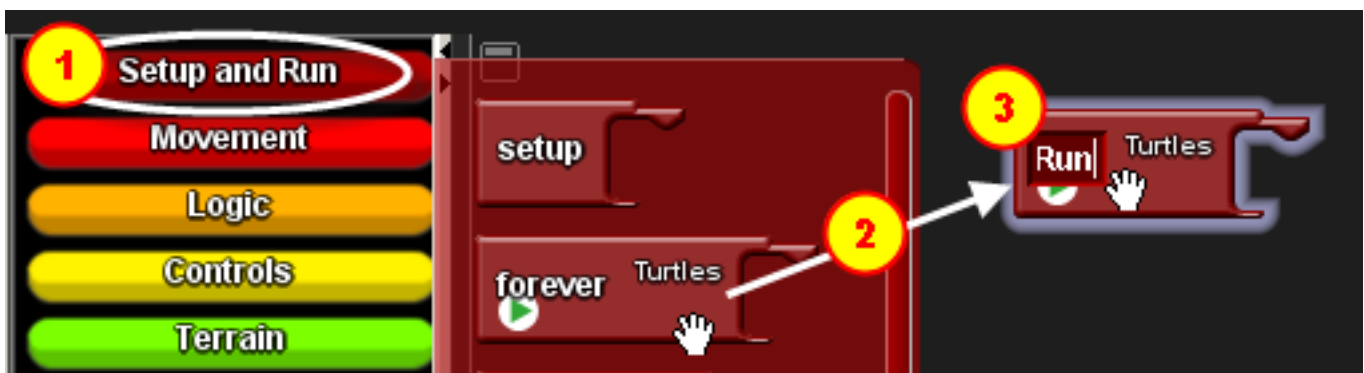
Let's get the agents to move around.

Runtime page



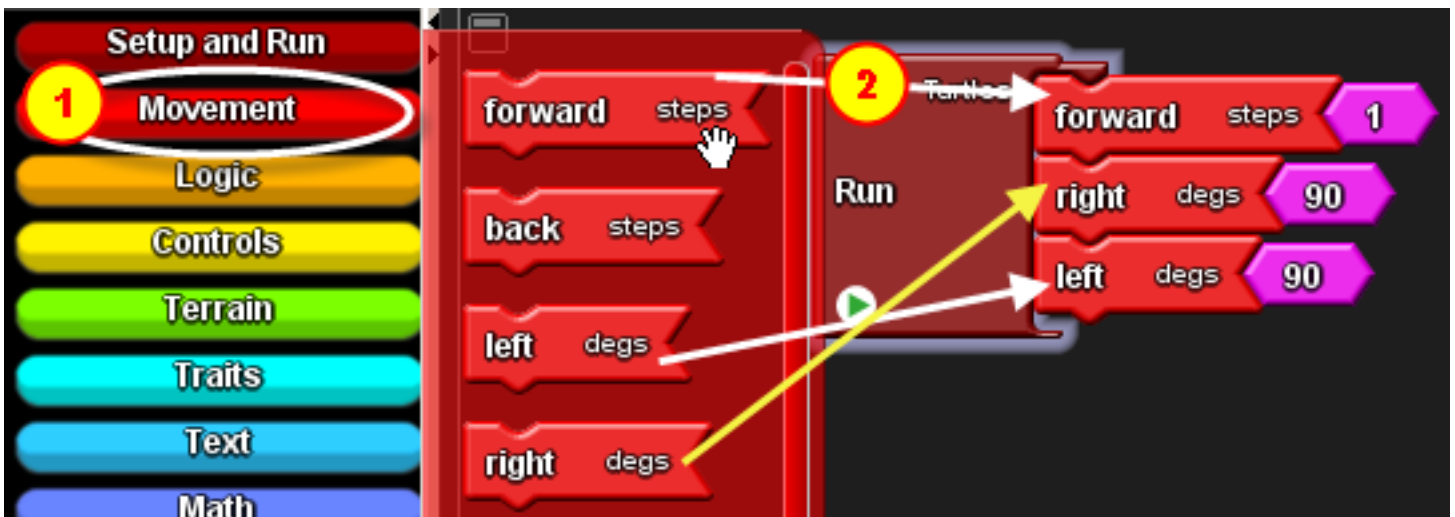
Navigate to the *Runtime* page of the **Canvas** by using the scrollbars or **mini-map**.

Forever block



1. Open the **Setup and Run** drawer.
2. Drag the Forever block to the *Runtime* page.
3. Click on the Forever block label and change it to say Run.

Movement blocks



1. Open the **Movement** drawer.
2. Drag out a forward block, a right block, and a left block, and attach them to the Forever (Run) block.

Delete some blocks



Delete the 90 from the Left and Right blocks by dragging those numbers to the **trash can**.

Random block



1. Open the **Math** drawer.
 2. Drag out two random blocks and attach them to the Left and Right blocks.
- Now the agents should move forward 1 and then turn a little to the left or right randomly.

Test your program

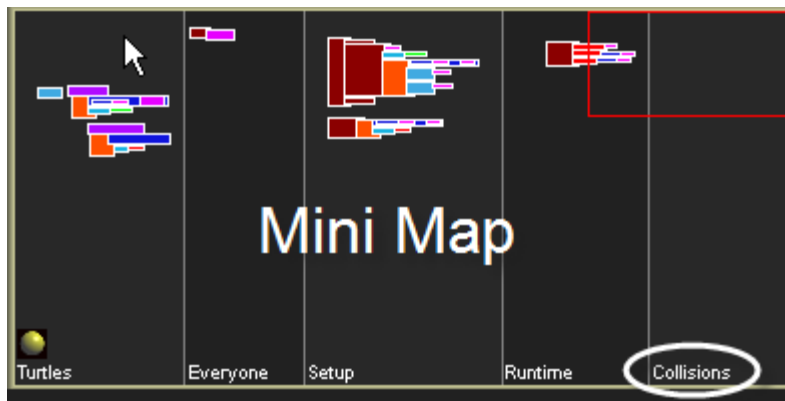


Go to the **Runtime area** in the **Spaceland** window and click once on your **Run button**. A green highlight around the **Run button** shows that the program is running.

Part 4: Infection

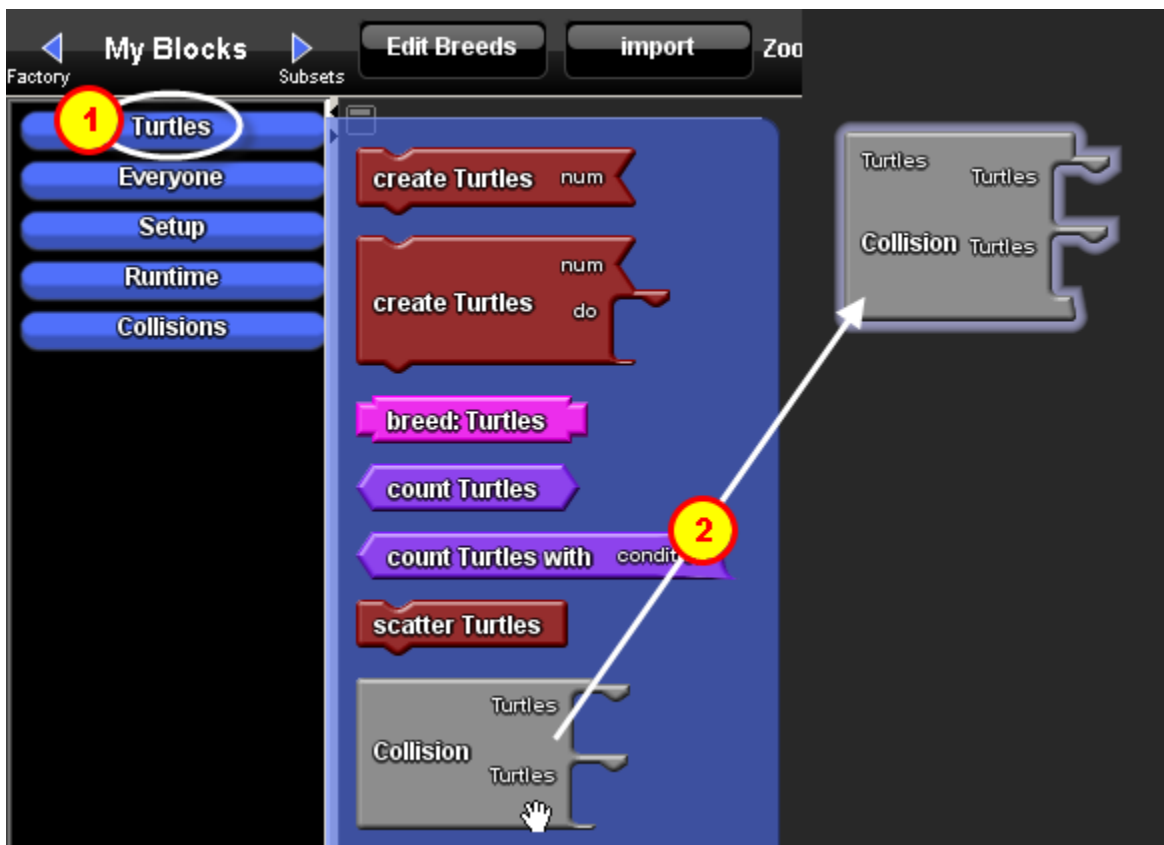
We will make infection happen when agents collide with each other.

Collisions page



Navigate to the *Collisions* page of the **Canvas**.

Collision block



1. In the **My Blocks** palette, open the **Turtles** drawer.
 2. Drag out the Collision block that is between Turtles and Turtles.
- Collision blocks are automatically run when agents collide into each other.

If block



We will use an If block to test if one of the two collidEE turtles is red. If so, then the turtle agent that isn't red will turn its own color to red, to show that it's been infected by the sick turtle that it collided with.

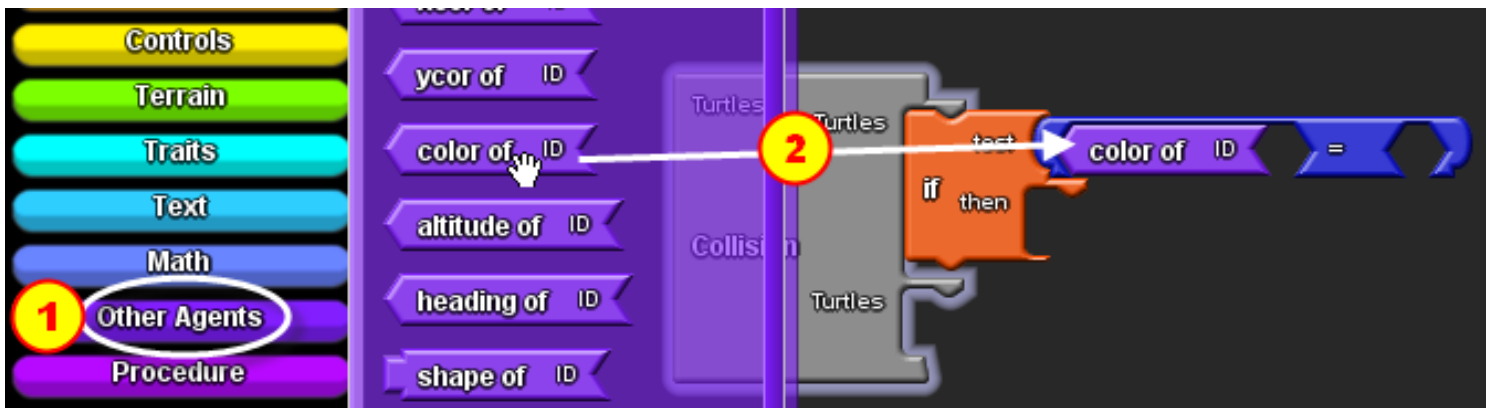
1. In the **Factory palette**, open the **Logic drawer**.
2. Drag out an If block and attach it to the first Turtles hook in the Collision block.

= block



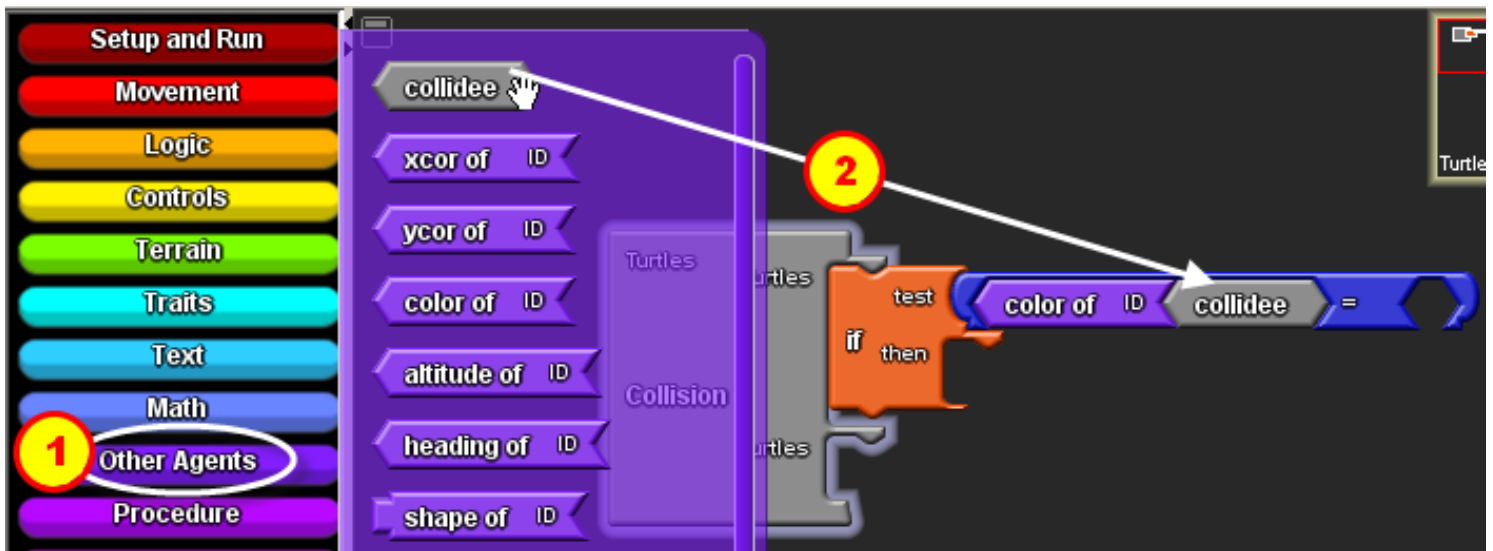
1. Open the **Math drawer**.
2. Drag out an = block and attach it to the test section of the If block.

color of block



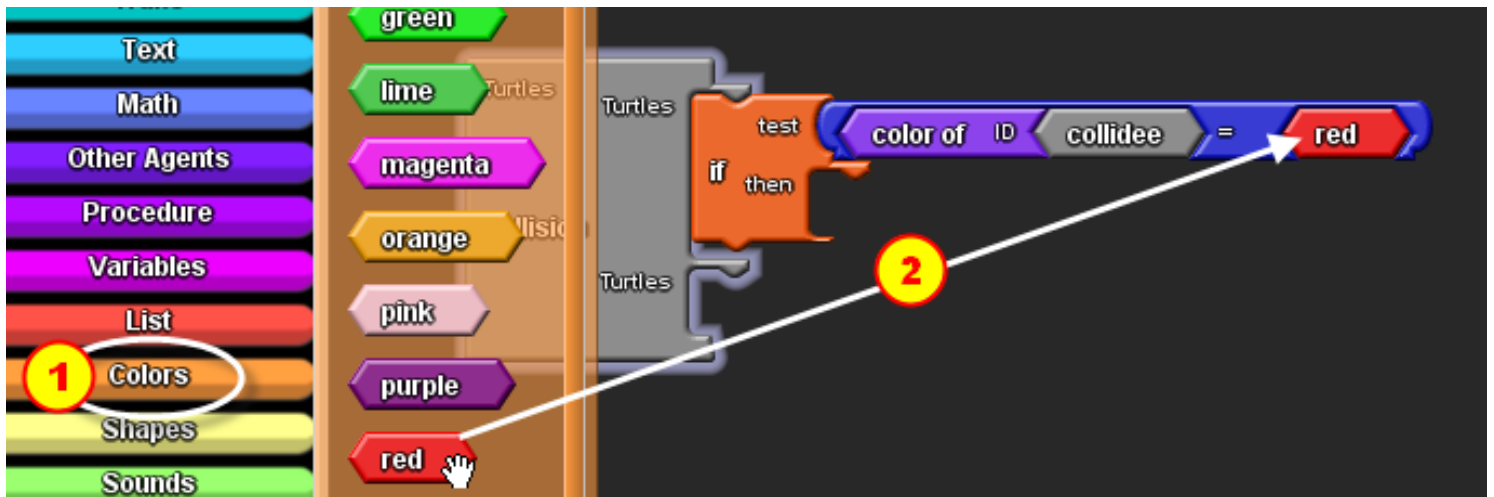
1. Open the **Other Agents** drawer.
2. Drag out a color of block and attach it to the left side of the = block. The left edge of the color of block should line up with the left side of the hole in the = block so that it snaps into place when you drop the color of block.

collidee block



1. Open the **Other Agents** drawer.
2. Drag out a collidee block and attach it to the right of the color of block.
The combination of color of - collidee blocks reports the color of the agent who was just collided into.

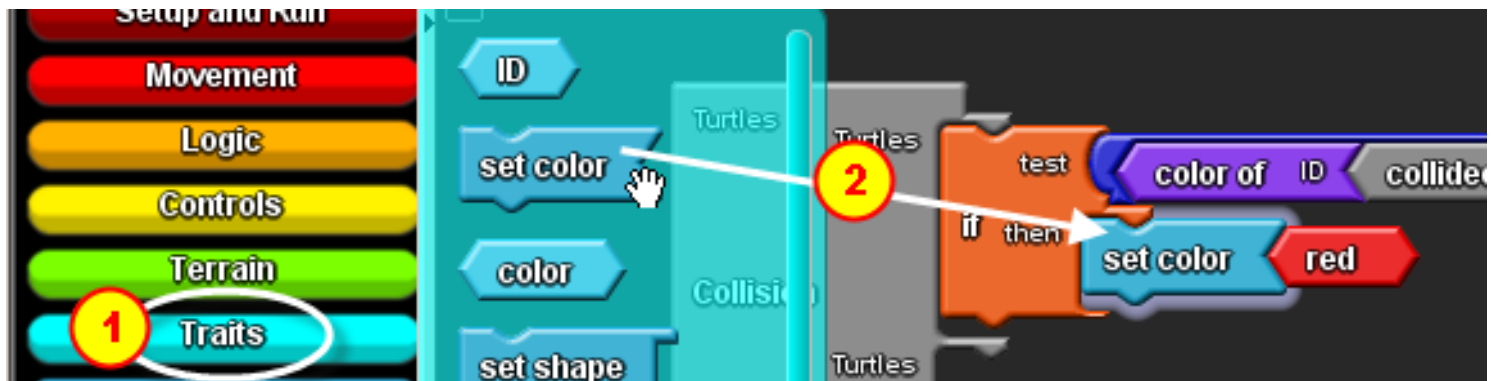
red block



We want to test to see if the color of - collidee reports red as the collidee's color.

1. Open the **Colors** drawer.
2. Drag out a red block and attach it to the right side of the = block.

set color block



If the collidee's color is red, then we want the agent that did the colliding to turn its color to red to show that it's been infected by the collidee.

1. Open the **Traits** drawer.
2. Drag the set color block to the then section of the if block. The set color block automatically comes with the default color red.

Copy and Paste



Collision blocks only get run once for each pair of collisions. So the top and bottom of the collision should be the same in this case, in order to make sure to check for both cases, in which either agent is infected. It is easy to copy the set of blocks you just put together to the bottom portion.

1. Click on the If block and press Ctrl-c (or command-c in Macs) to copy.
2. Press Ctrl-v (or command-v in Macs) to paste.
3. Attach the new copy to the bottom Turtles section of the Collision block.

Test your program



Run your model by clicking on the **Run button** in the **Runtime** area of the **Spaceland window**. You should see the infection spreading as the turtles move around and more and more turn red.

Part 5: Recovery

Now we want to create a variable controlled by a slider that determines the probability of recovery after an agent gets infected.

Shared number variable



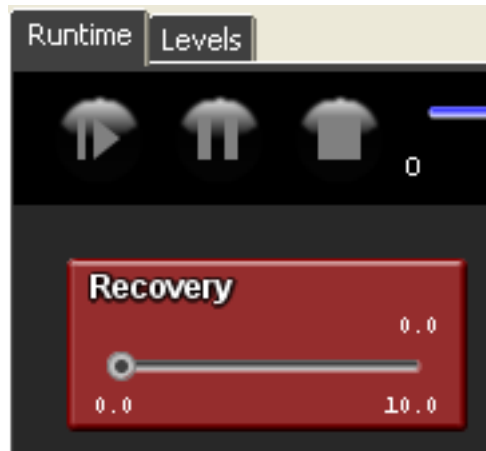
Go to the *Everyone* page of the **Canvas**. Click on the **Variables** drawer and drag a Shared number block onto the *Everyone* page. Click on the shared number label and rename it Recovery.

Slider block



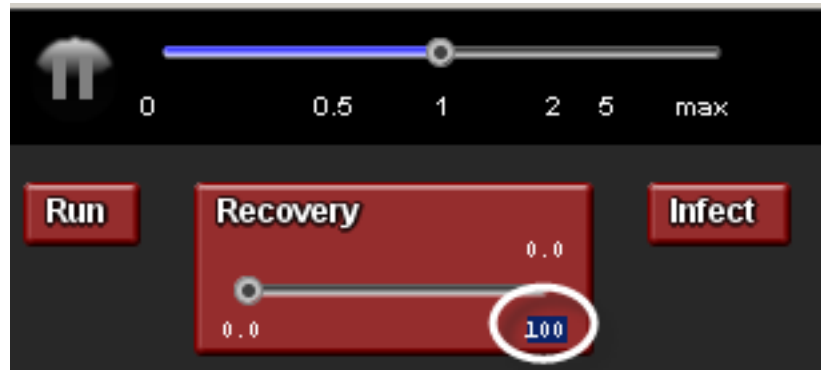
Open the **Setup and Run** drawer, drag out a Slider block and attach it to the left-hand side of the Recovery variable.

Slider in Runtime



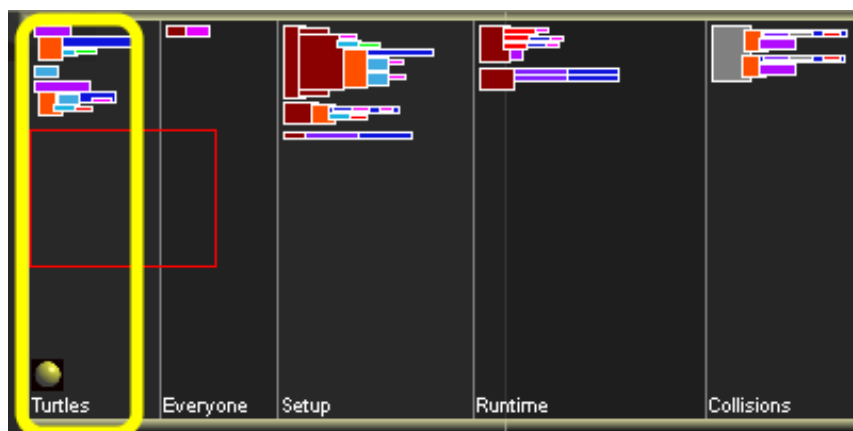
Look at the **Runtime** section of the **Spaceland** window and you should see the **slider** appear. Now, whenever the **slider** is moved, the value of the Recovery variable is set accordingly.

Adjusting maximum value of slider



Since the Recovery variable represents a percentage, you want the variable's value to be set between 0 and 100. To change the upper limit of the **slider**, click on the number on the bottom right end of the **slider** to highlight it and type in 100.

Go to Turtles page



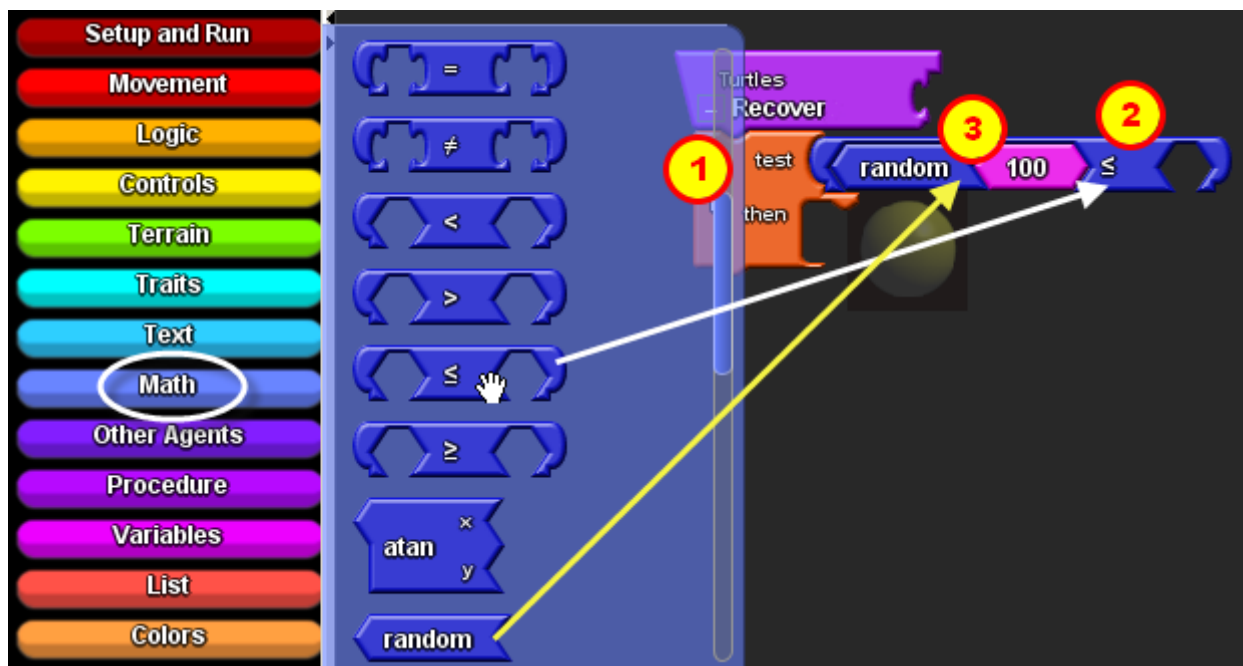
To use the Recovery variable in the model, first go back to the *Turtles page* on the **canvas**.

Declare Recover procedure



Make a new procedure that defines how Turtles recover. Open the **Procedures drawer**, drag out a Procedure block, and put it on the *Turtles* page. Rename the procedure Recover.

If random 100



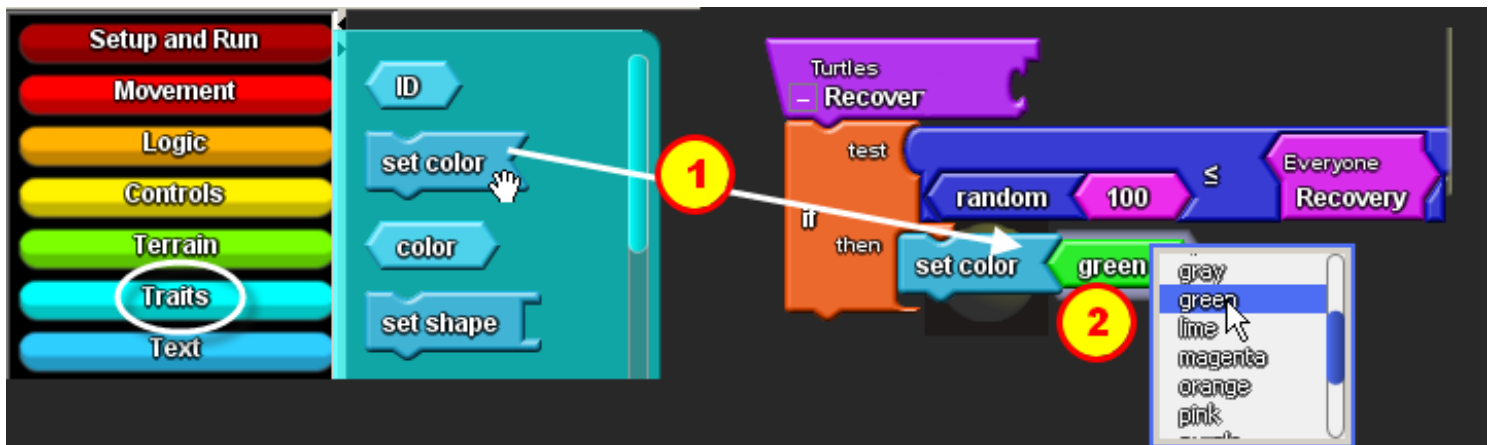
1. Open the **Logic drawer** to get an If block and attach it to the bottom of the Recover procedure. We want turtles to recover with a percentage chance determined by the slider.
2. So get a <=block (less or equal) and attach it to the test section of the If block.
3. Now assemble and attach the blocks random-100 on the left side of the <=block (less or equal).

Recovery variable-"getter"



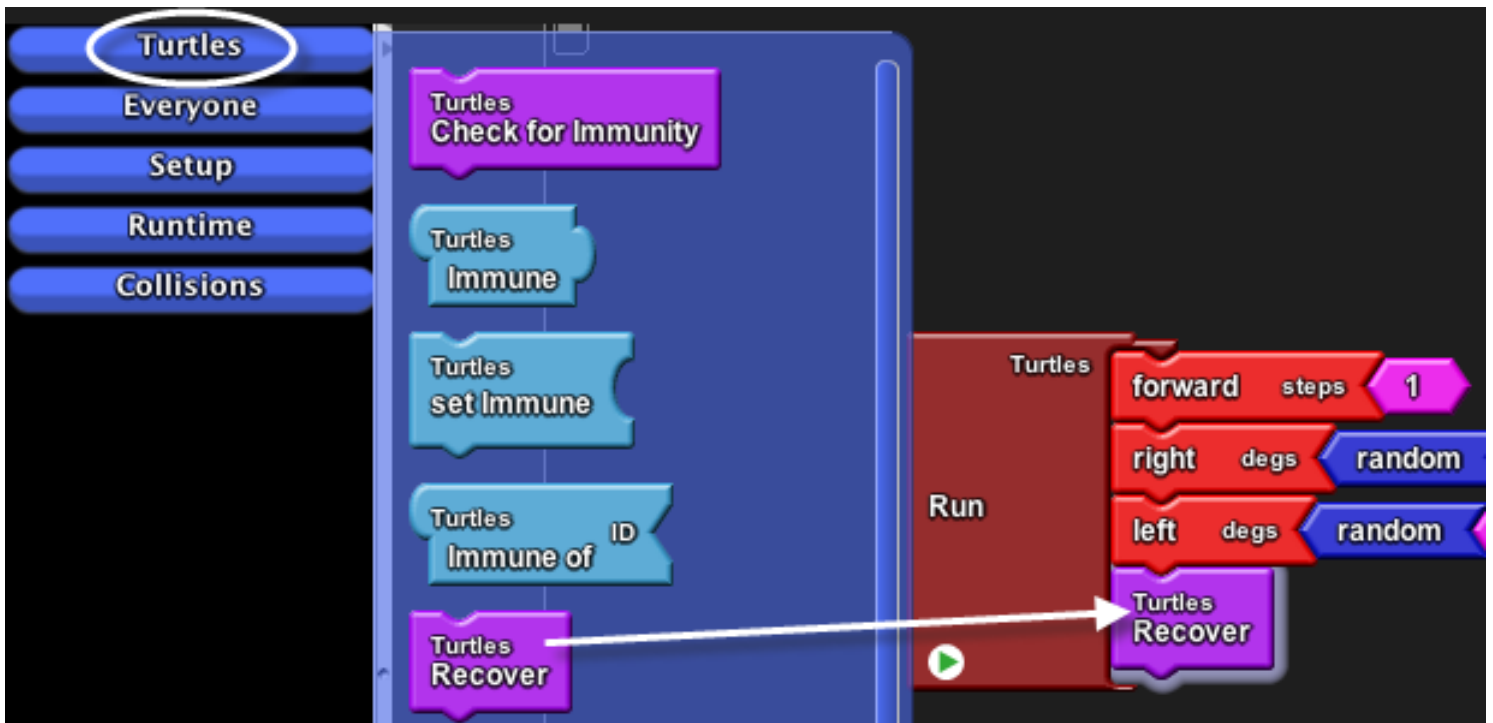
Go to the **My Blocks** palette, open the **Everyone** drawer, and get the Recovery block, which contains the current value of the **slider**. Attach this to the right side of the <=block (less or equal).

Then set color



1. Open the **Colors** drawer, drag and attach Set Color block to the Then section of the If block.
2. Use the drop down menu on the right end of the Red block to change it to Green.

Run block



We want the turtle agents to run this procedure as part of the Run block (forever loop). So navigate to the Run block on the *Runtime page* of the **canvas**. Go to the **My blocks palette** and open the **Turtles drawer**. Drag out the Recover block. This block "calls" the Recover procedure, which means that it represents the stack of block that you made for the Recovery procedure.

Test your program

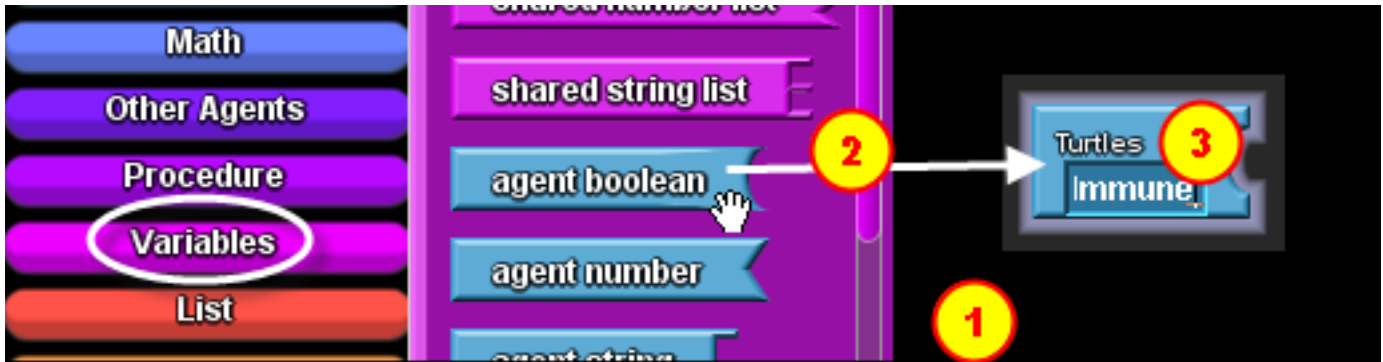


Run your model by clicking on the **Run button** in the **Runtime area** of the **Spaceland window**. You should see differences in how quickly the red agents turn green as you move the slider up and down.

Part 6: Immunity

In many populations some individuals start out with some immunity to a disease. We can easily model that here by giving some of the agents an attribute called "immunity." We will create a new variable for each agent that can be set to True if the agent is immune to the disease, and False if the turtle can get sick.

Agent Boolean block



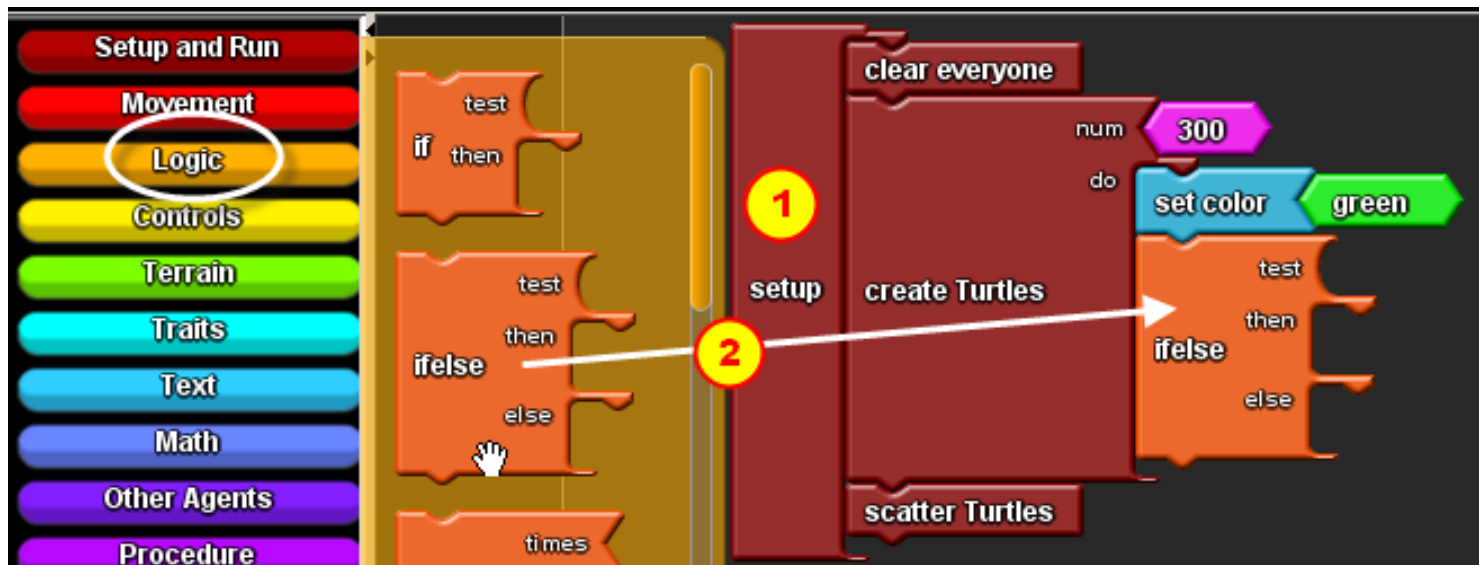
1. Go to the *Turtles* page of the **Canvas**.
2. Open the **Variables** drawer and drag out a Agent Boolean block. You'll see that it gets labeled Turtles if the block has been properly placed on the *Turtles* page.
3. Change the name of this block by selecting the Agents Boolean text and typing in immune.

new immune blocks



Go to the **My Blocks** palette, open the **Turtles** drawer and you'll see some new blocks there. Each Turtles agent now has an immune variable that you can get or set with these blocks.

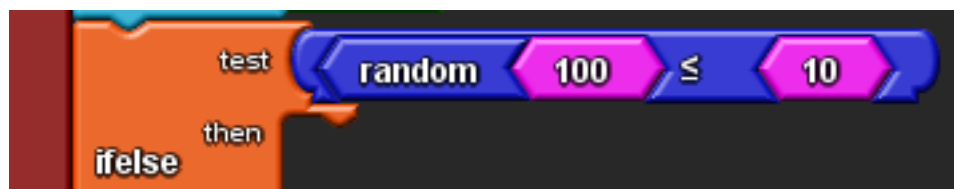
initialize immune variable in setup



We will set the immune variable to be true for some randomly selected turtles during setup.

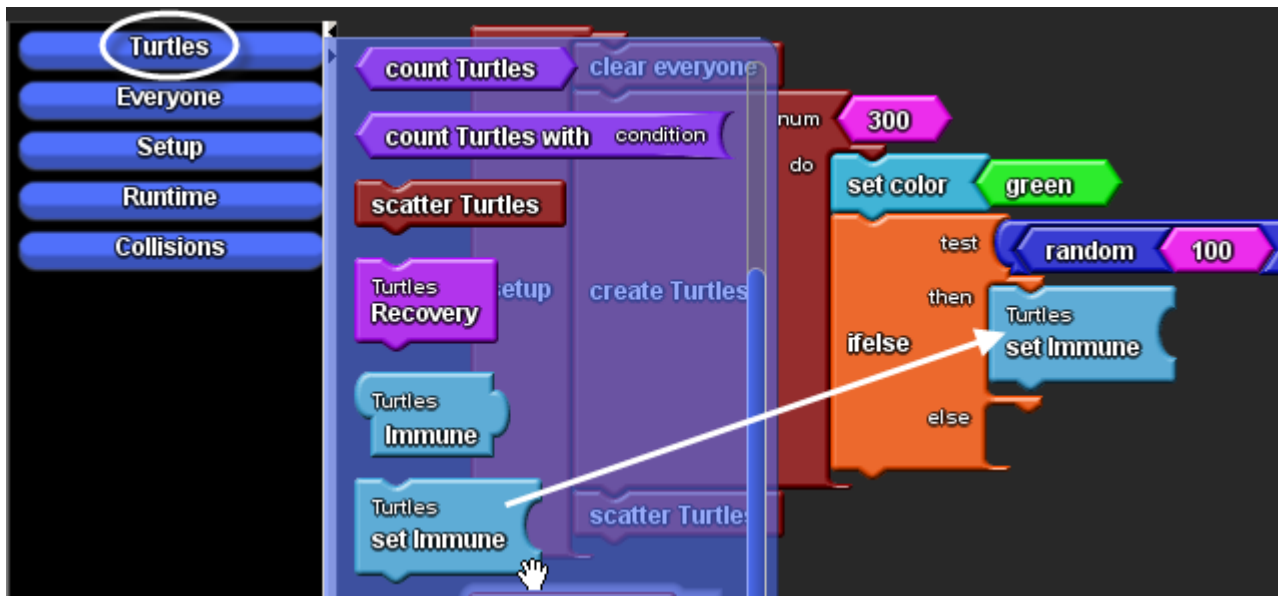
1. Go to the setup block on the *setup page* of the **canvas**.
2. Open the **Logic drawer**, drag out the if-else block and attach it beneath the set color block in the setup block.

ifelse test condition



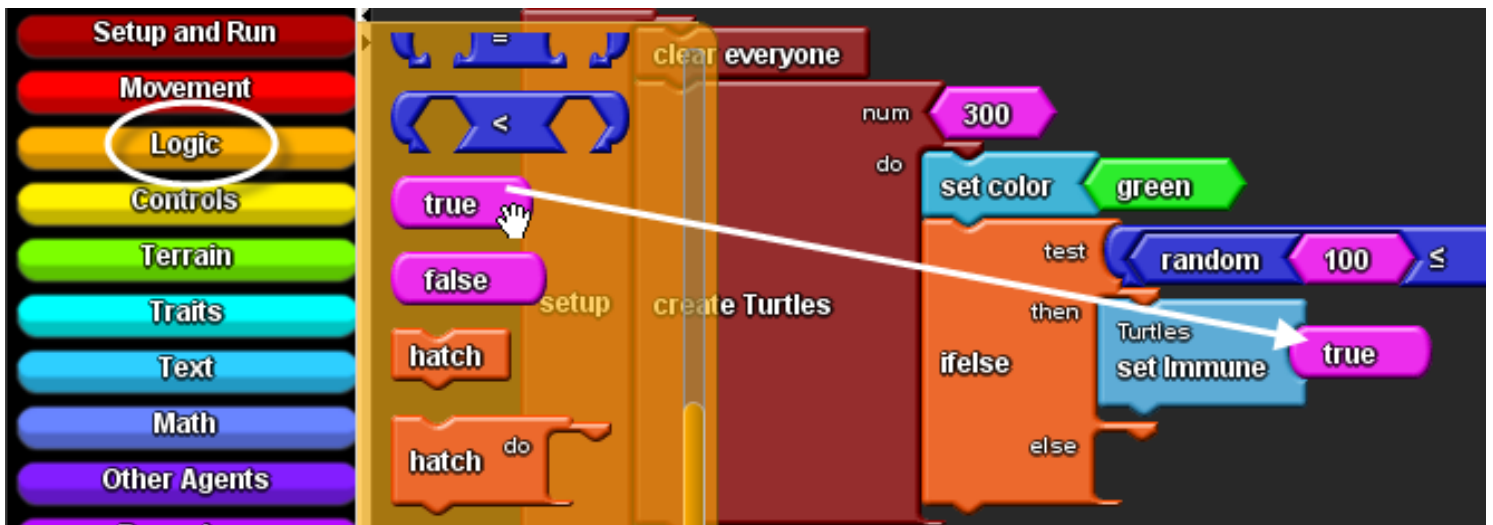
For the test condition, put together the blocks random 100 \leq 10, the same blocks you previously put together for the Infect block. You can find all the blocks in the **Math drawer**. Remember, this means that the test condition will only be true about 10% of the time. So you will make about 10% of the turtles immune to the disease.

set immune block



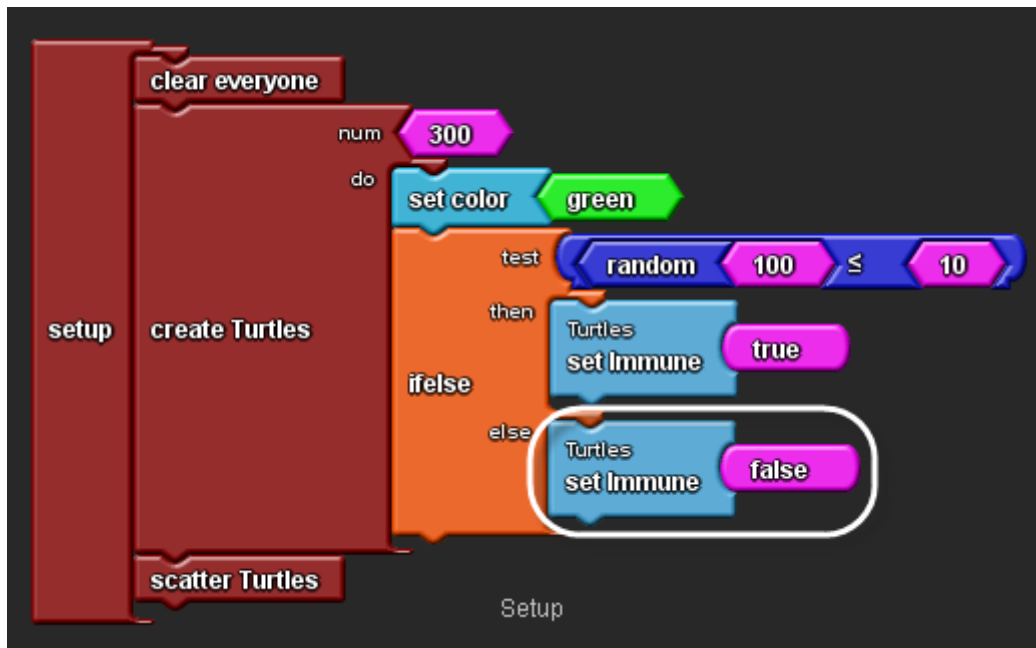
In the **My Blocks** palette, open the **Turtles** drawer, drag out the set immune block and connect it the then section of the ifelse block.

set immune block to true



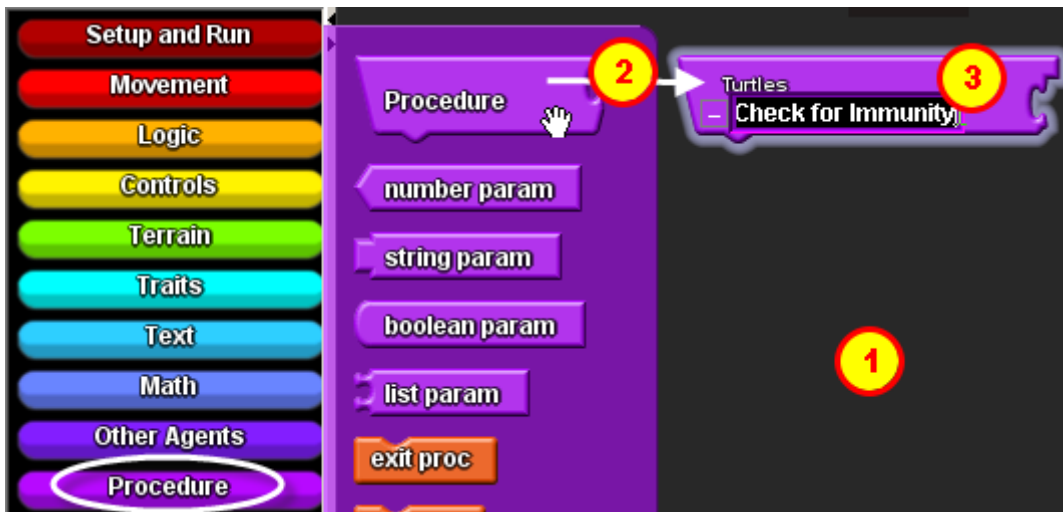
In the **Factory** palette, open the **Logic** drawer, drag out a true block and connect it to the right side of the Set immune block.

set immune block to false



1. In the **My Blocks palette**, open the **Turtles drawer**, drag out a second set immune block, and attach it to the else part of the ifelse block.
2. In the **Factory palette**, open the **Logic drawer**, drag out the false block and connect it the right side of the set immune block. This means, if a turtle agent didn't get selected to be immune, the agent sets its immune variable to false.

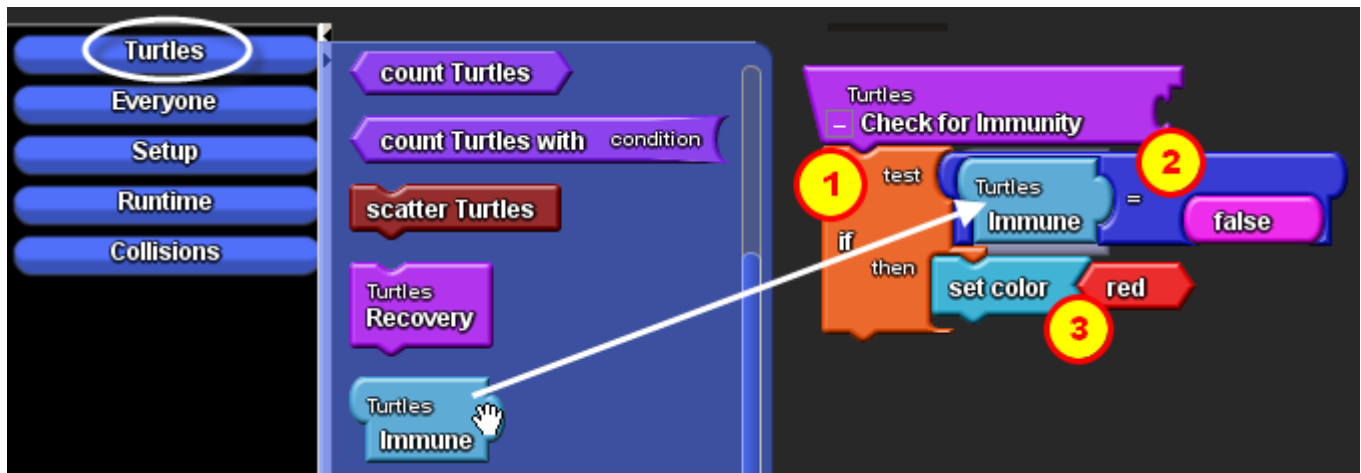
Check for immunity procedure



Now we have created some immune agents that are roughly 10% of the population. But they won't know what being "immune" means until you define it.

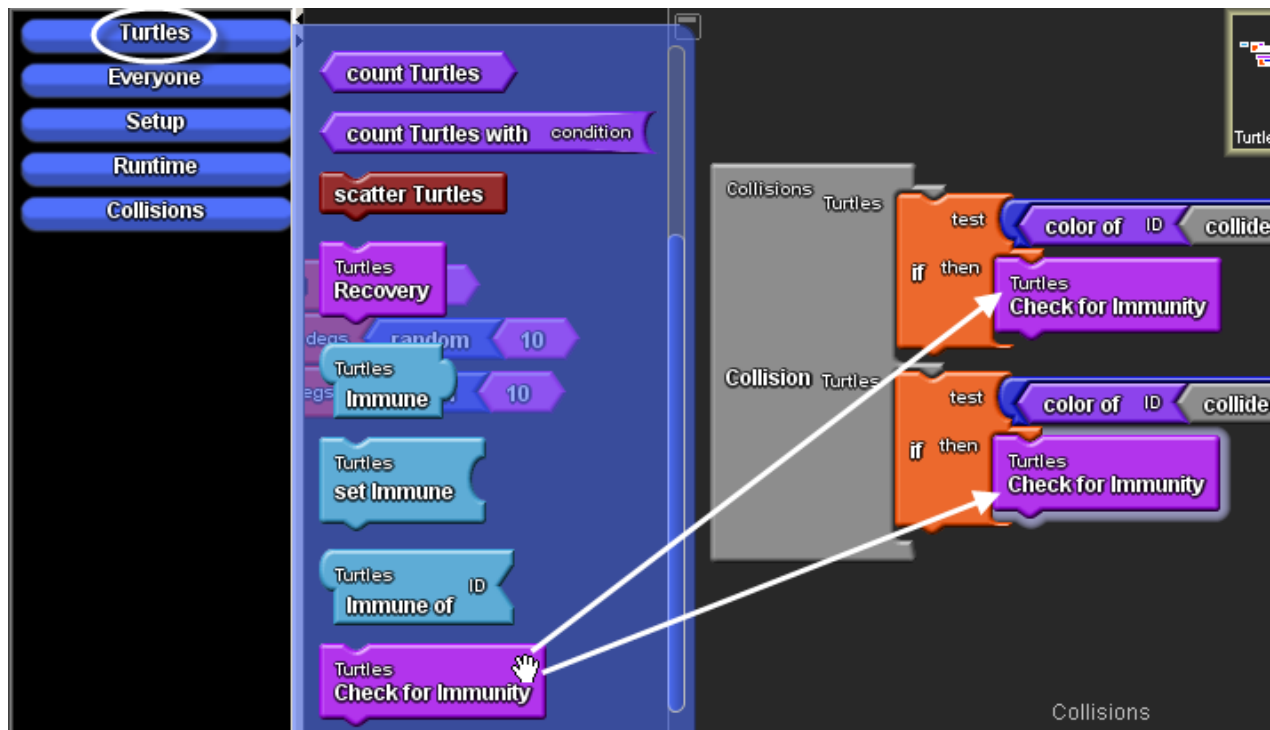
1. Go to the *Turtles page* of the **Canvas**.
2. Open the **Procedures drawer** and drag out a new Procedure block to the *Turtles page*.
3. Rename the procedure Check for Immunity.

Defining Check for immunity procedure



1. Open the **Logic drawer**, drag out an If block and attach it to the Check for Immunity procedure.
2. For the test, assemble the expression immune = false. The immune variable block is found in the **Turtles drawer**. The = block is found in the **Math drawer**. The false block is found in the **Logic drawer**. This expression checks to see if the immune variable is set to false, meaning that the turtle agent is NOT immune.
3. If the immune variable is false, then you want to set the color of the turtle agent to red to show that it got sick. The set color block is found in the **Colors drawer**. It comes with red already attached.

Using the Check for immunity procedure



1. Go to the *Collisions page* and find the Collision block between Turtles and Turtles.
2. Drag the two set color red blocks to the trash.
3. In their place, open the **Turtles drawer**, drag out two Check for immunity procedure blocks.

Test your program

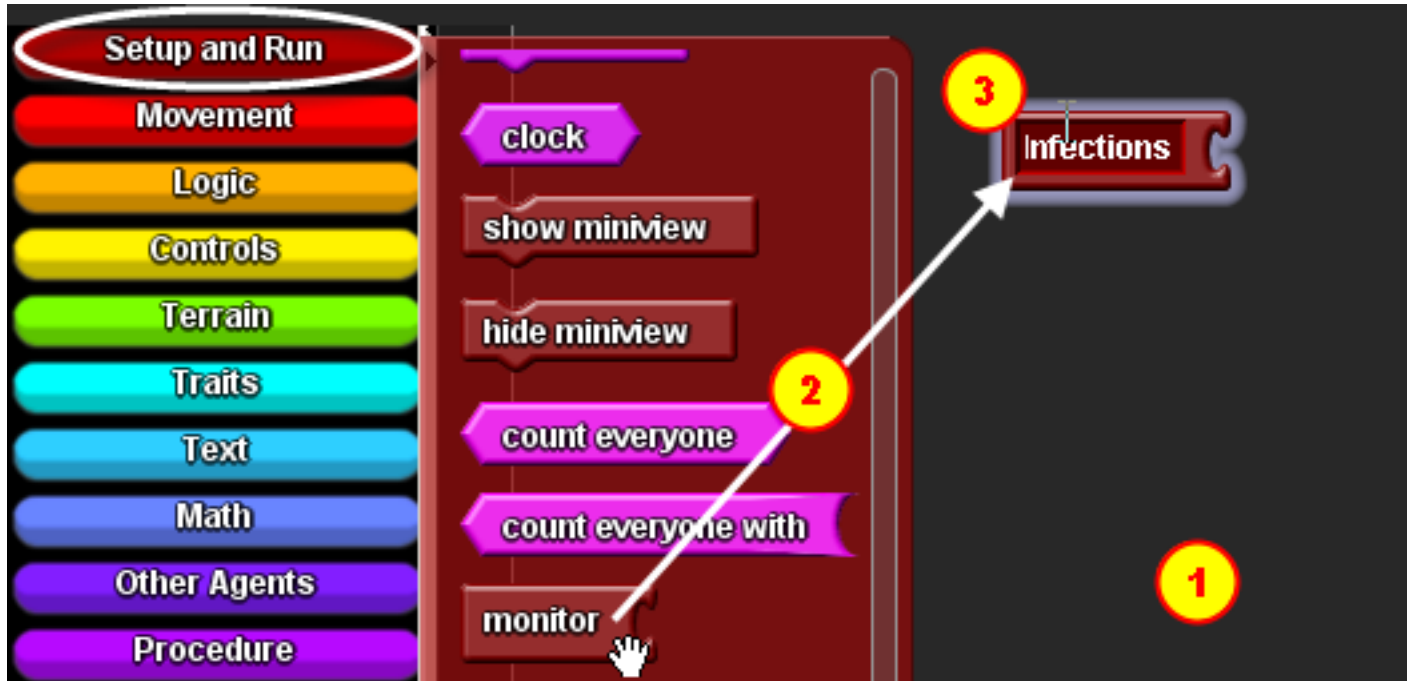


Run the model and you should notice that some turtles agents never get sick. Do the immune turtles help to slow down the epidemic? What do you think would happen if you increase the percentage of immune turtles in a population to 20% or even 50%?

Part 7: Monitoring the Situation

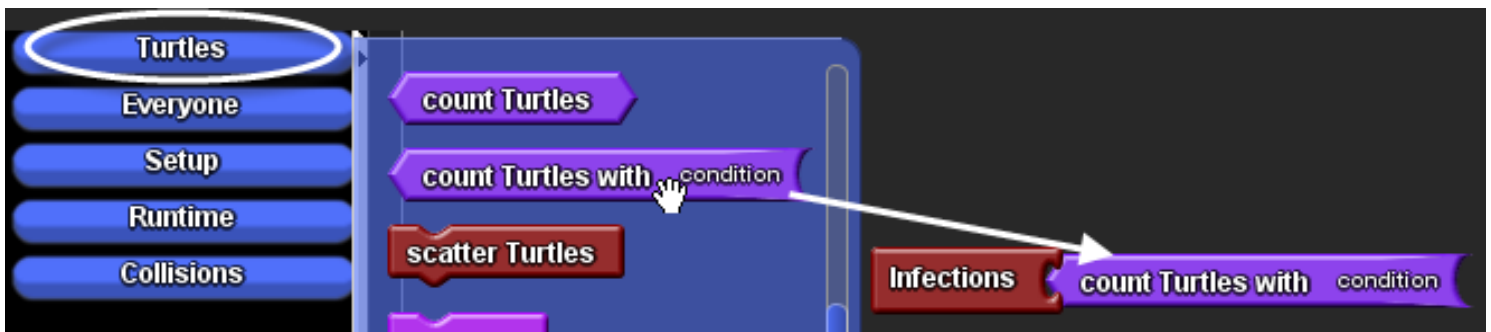
So just how would you know if there are fewer red agents than there were before? It would be useful to monitor this by showing the number of red agents while the simulation is running.

Monitor



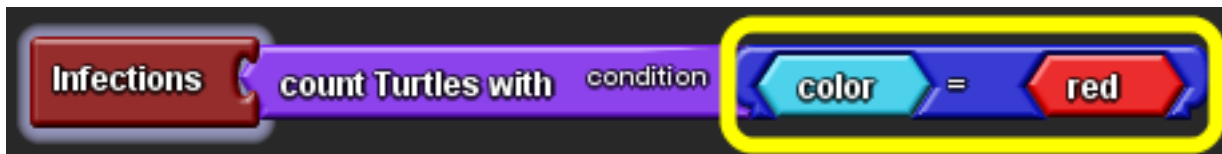
1. Go to the *Setup page* of the **Canvas**.
2. Open the **Setup and Run** drawer and drag out a monitor block.
3. Change the name of the monitor block to Infections.

Count Turtles With Block



In the **My Blocks** palette, open the **Turtles** drawer, drag out a Count Turtles With block and attach it to the right side of the Infections (Monitor) block.

color = red



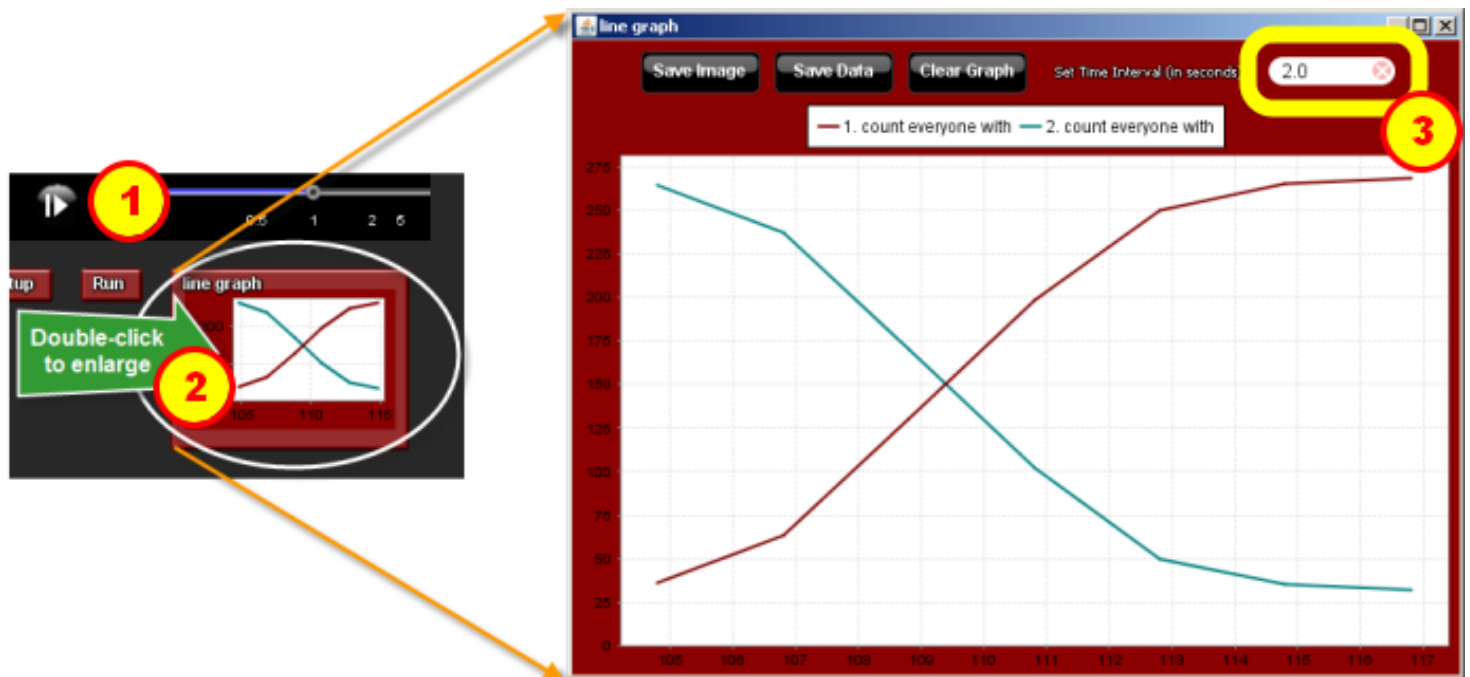
Since you want to count the number of red turtles, assemble the expression `color = red`. The `=` block is in the **Math drawer**. The `color` block is in the **Traits drawer**. The `red` block is in the **Colors drawer**.

Test Your Program



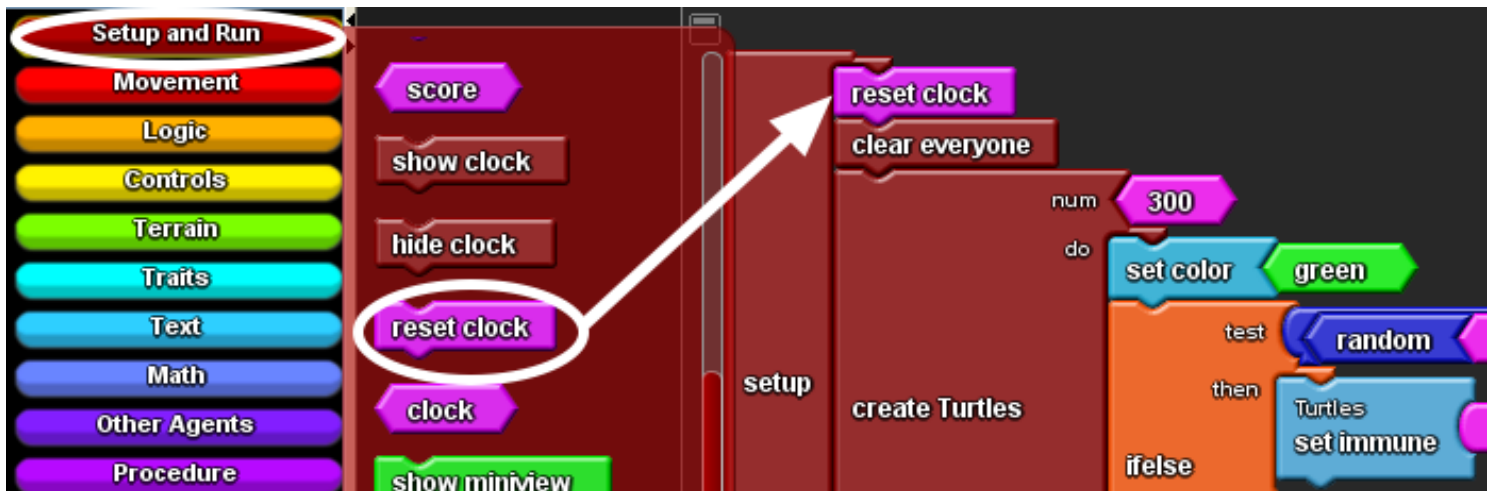
Click setup and then run. There is now a **Monitor** called `Infections` that tells you how many infected agents are currently in your simulation.

Line graph



1. Go to the **Runtime section** of the **Spaceland window**. Click setup and run. Watch the values in the line graph change over time as the simulation runs.
2. Double-click on the line graph block to open the graph in a new window and you can resize.
3. To show a smoother curve, lower the "set time interval" value from the default 2.0 to a smaller value, like 0.5.

reset clock



The line graph will continue its plot on the same graph, even if you click setup and run again. In order. To program it to start plotting at time = 0, add a reset clock block to the existing setup block. The reset clock block is found in the **Setup and Run** drawer.

next steps

We've covered many of the basics of building a model in StarLogo TNG. Experiment with some variations on this model, and see what you can do. Try showing all the immune turtles as a certain color. Try adding code to make the Turtles immune after they recover. How do you think this will affect the numbers of infected and healthy over time? You can also take a look at the other tutorials on the StarLogo TNG website.