

An Initial Glimpse of AnyLogic & Emergence: Modifying an Existing Model

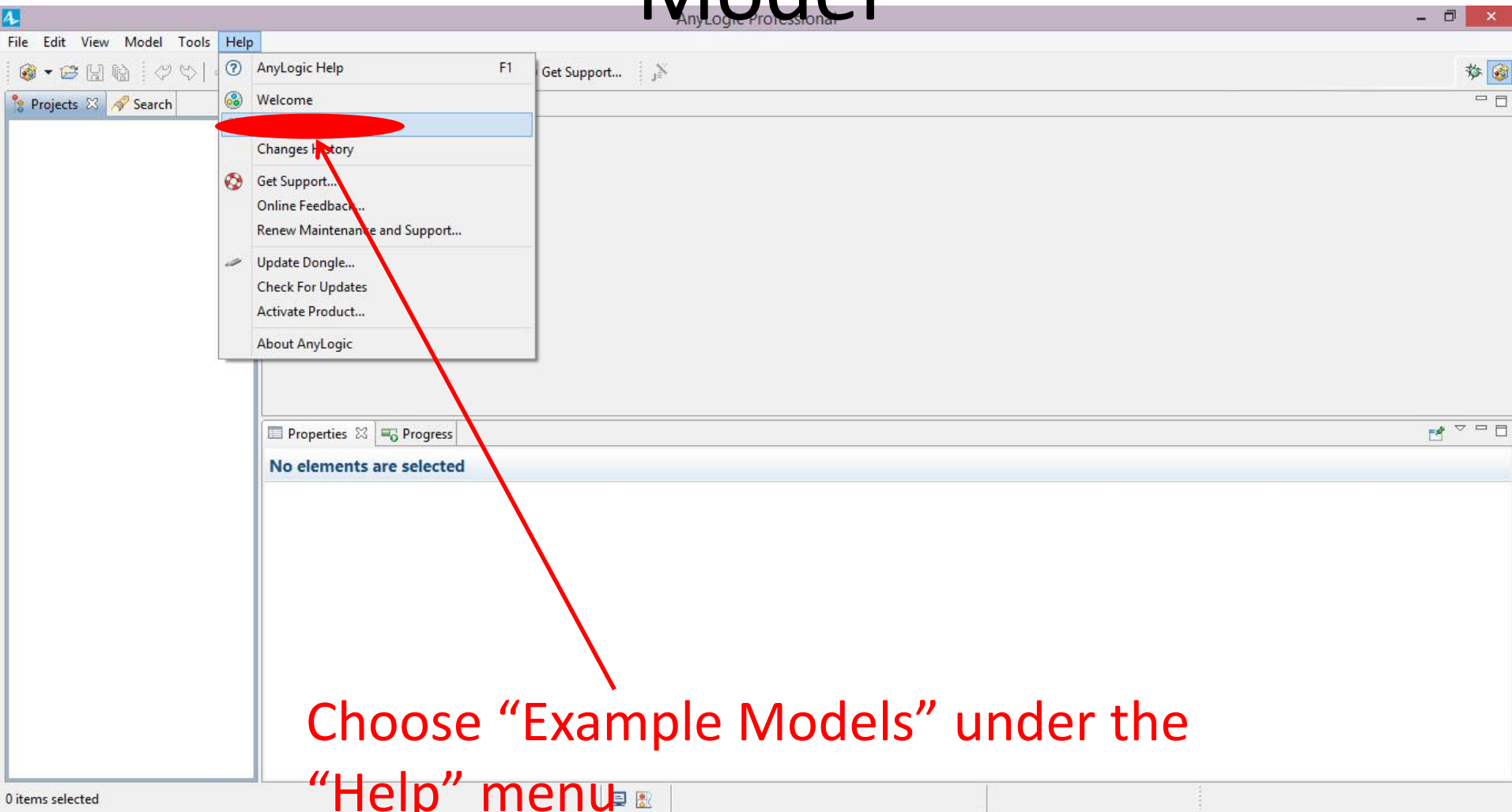
Nathaniel Osgood

Using Modeling to Prepare for Changing Healthcare Needs

Duke-NUS

April 16, 2014

Opening an AnyLogic Example Model



Choose "Example Models" under the "Help" menu

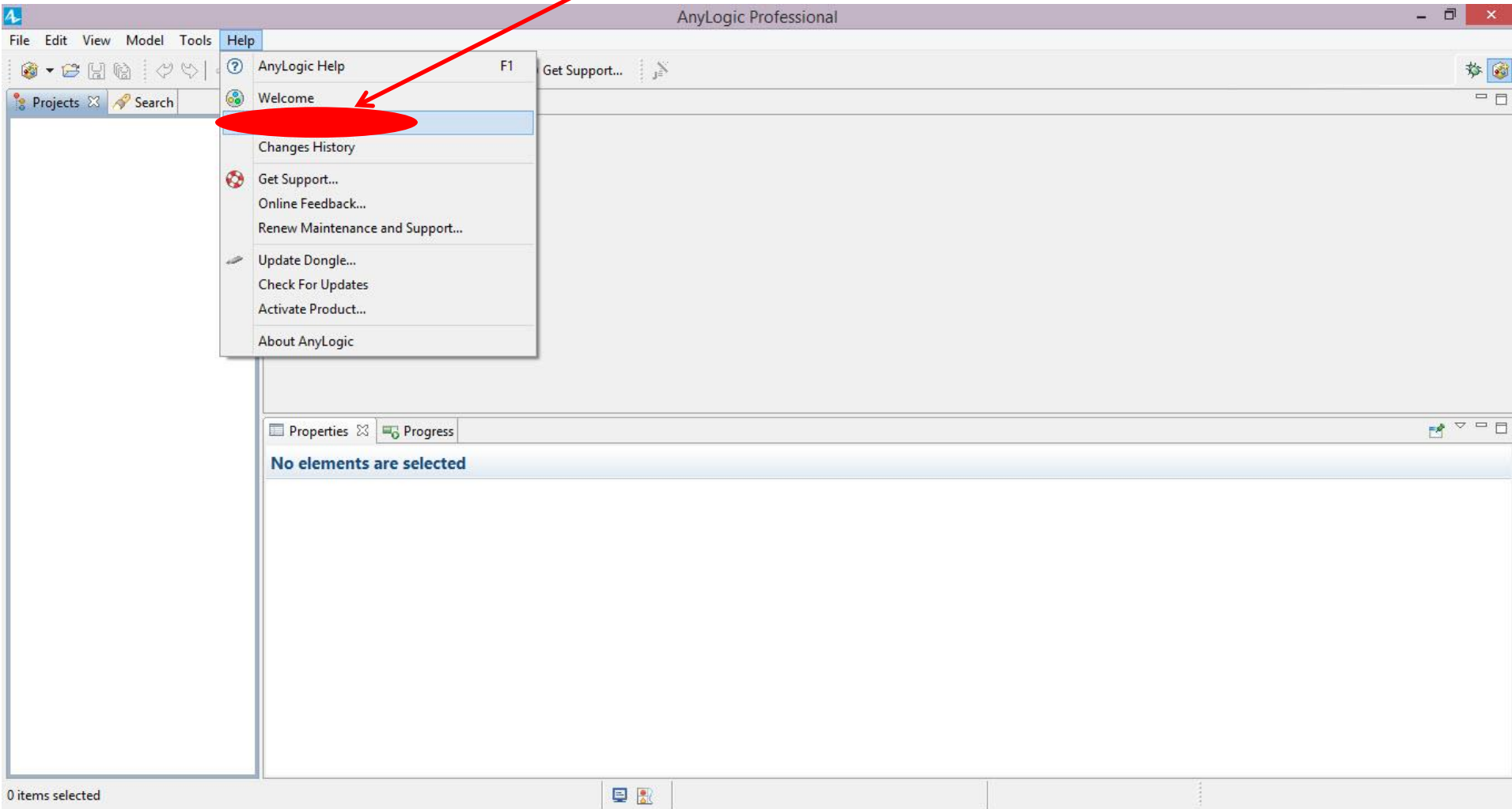


Hands on Model Use Ahead



Load AnyLogic Example Model: SIR Agent Based.alp

Request "Example Models" via Help Menu



Select “How-To Models”

The screenshot displays the AnyLogic Professional software interface. The window title is "AnyLogic Professional". The menu bar includes "File", "Edit", "View", "Model", "Tools", and "Help". A "Welcome" tab is open. The main area features the AnyLogic logo and navigation links: "Getting Started with AnyLogic", "What's New in AnyLogic", "Professional Features", "Example Models", and "Ask Question/Get Support". A "Show on startup" checkbox is visible in the top right. A central panel titled "How-To Models" is open, showing a list of model categories on the left and a list of specific model topics on the right. A red arrow points from the title "Select 'How-To Models'" to the "How-To Models" section. The "Examples" folder is circled in red, and a red arrow points from it to the "How-To Models" section.

anylogic®

Getting Started with AnyLogic What's New in AnyLogic Professional Features **Example Models** Ask Question/Get Support

Show on startup

Examples

Models from 'The Book of Simulation Models' (48)

All models (48)

Agents (4)

Database connectivity (3)

Enterprise Library (14)

Execution control (1)

Experiments (1)

Miscellaneous (5)

Old Pedestrian Library (11)

Presentation (7)

Statecharts (1)

System dynamics (1)

Models from the 'Business Dynamics' Book

How-To Models

- [Agent Moving Along Path](#)
- [Agent Network and Layouts Demo](#)
- [Bass Diffusion Arrays](#)
- [Calculator](#)
- [Changing Entity Shape](#)
- [Choosing Closest Resource](#)
- [Compare Runs Experiment](#)
- [Connecting Enterprise Library Objects Dynamically](#)
- [Controlling Model With Keyboard](#)
- [Conveyor with Dynamic Speed](#)
- [Defining Area Throughput](#)
- [Defining a Work Schedule for Resources](#)
- [Delay Object with Pull Protocol](#)

Scroll Down to & Click on “SIR Agent Based”

AnyLogic Professional

File Edit View Model Tools Help

Welcome

anylogic®

Show on startup

Getting Started with AnyLogic What's New in AnyLogic Professional Features **Example Models** Ask Question/Get Support

- Examples
- Models from 'The Big Book of Simulation Models'
- How-To Models
 - All models (48)
 - Agents (4)
 - Database connectivity (3)
 - Enterprise Library (14)
 - Execution control (1)
 - Experiments (1)
 - Miscellaneous (5)
 - Old Pedestrian Library (11)
 - Presentation (7)
 - Statecharts (1)
 - System dynamics (1)
- Models from the 'Business Dynamics' Book

[Reading and Writing Excel Files](#)

[Releasing Resource on Timeout](#)

[Running the Model from Outside Without Presentation Window](#)

[SIR in GIS Based Space](#)

[Scrollable Presentation](#)

[Several Floors](#)

[Shape Replication](#)

[Slideshow Presentation](#)

[Source Arrival Modes](#)

[Stairs](#)

[Storage with Initial Stock](#)

[Suspendable Delay Object](#)

[Swimming Pool](#)

[Synchronization of Chart Scales](#)

Use Scroll bar to scroll down this list

Model Focus: Spatial Spread of an Infectious Disease

- This model simulates the spread of an infectious disease in a regular space
- The simulation starts with a single index infective case (towards lower right of space)
- Natural history of infection involves progression from Susceptible to Infected (& Infective) to Recovered
 - There is no waning of immunity in the original model
- If a given person is infective, the infection can spread from that person to their neighbours in the 4 cardinal directions (“North”, “South”, “East”, “West”) (i.e. Up, Down, Left, and Right)

Viewing the Model Structure

Double click on “Person” to see the associated state transition diagram. This diagram represents in a stylized fashion the progression of infection

The screenshot displays the AnyLogic Professional interface. On the left, the 'Projects' pane shows a tree view under 'SIR Agent Based' with 'Person' highlighted in red. A red arrow points from this 'Person' entry to the main workspace. The main workspace shows a stylized blue oval representing the 'Person' agent type, with a blue arrow pointing to it from the text above. The workspace also contains a 'color' variable and a 'chart' label. At the bottom, the 'Properties' pane is open for 'Person - Agent Type', showing fields for 'Name' (Person), 'Ignore' (unchecked), 'Agent actions', 'Entity actions', 'Use in flowcharts as' (Entity), and 'On enter flowchart block'. The status bar at the bottom indicates 'Time units: days' and 'X=...17'.

Run the Model (Right Click the Experiment "Simulation" & select

"Run")

The screenshot displays the AnyLogic Professional interface. At the top, the menu bar includes File, Edit, View, Draw, Model, Tools, and Help. Below it is a toolbar with various icons. The main workspace shows a statechart diagram with the following elements:

- A statechart labeled "statechart" with a start arrow pointing to a yellow "Susceptible" state.
- A transition labeled "Infection" leading to an orange "Infectious" state.
- A transition labeled "Recovery" leading from the "Infectious" state to a grey "Recovered" state.
- A "Contact" label is positioned near the "Infectious" state.

On the left, the "Projects" pane shows a tree structure with "SIR Agent Based" expanded to "Main". A red circle highlights "Main", and a red arrow points from the text "Right Click the Experiment 'Simulation'" to it. A context menu is open over "Main", with a blue circle highlighting the "Debug" option and a blue arrow pointing from the text "select 'Run'" to it.

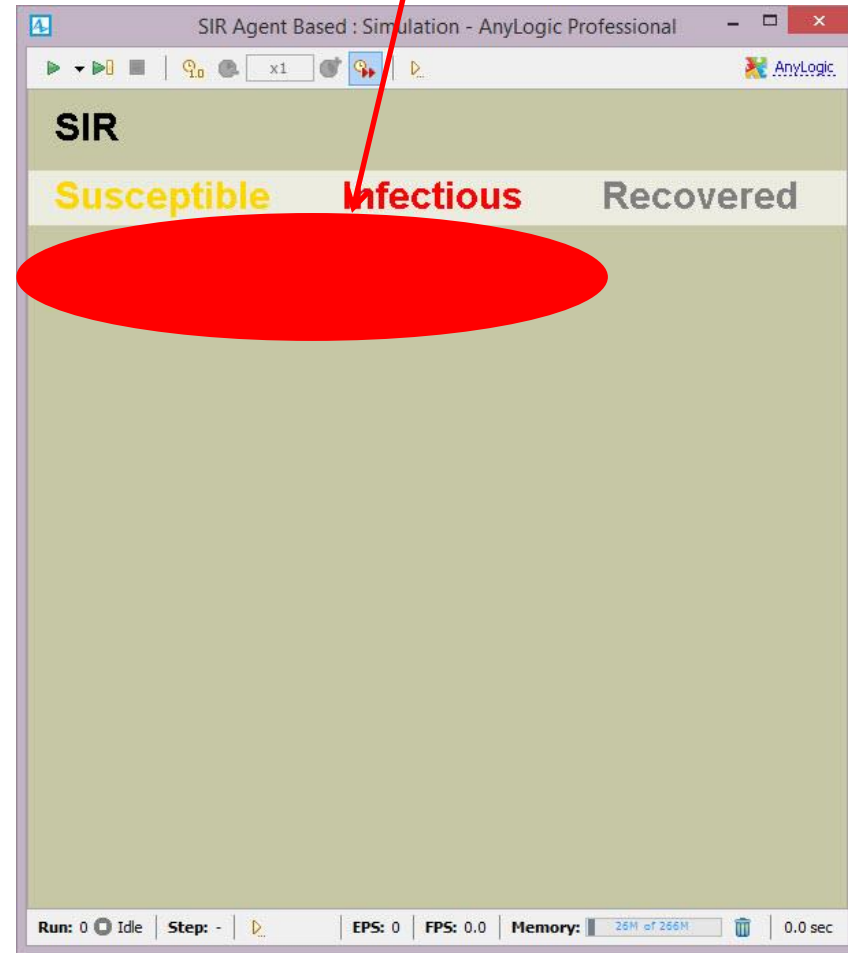
At the bottom, the "Simulation - Simulation Experiment" panel is visible, containing the following settings:

- Name: Simulation Ignore
- Top-level agent: Main
- Maximum available memory: 300 Mb
- Parameters section:
 - Average illness duration: 1.5

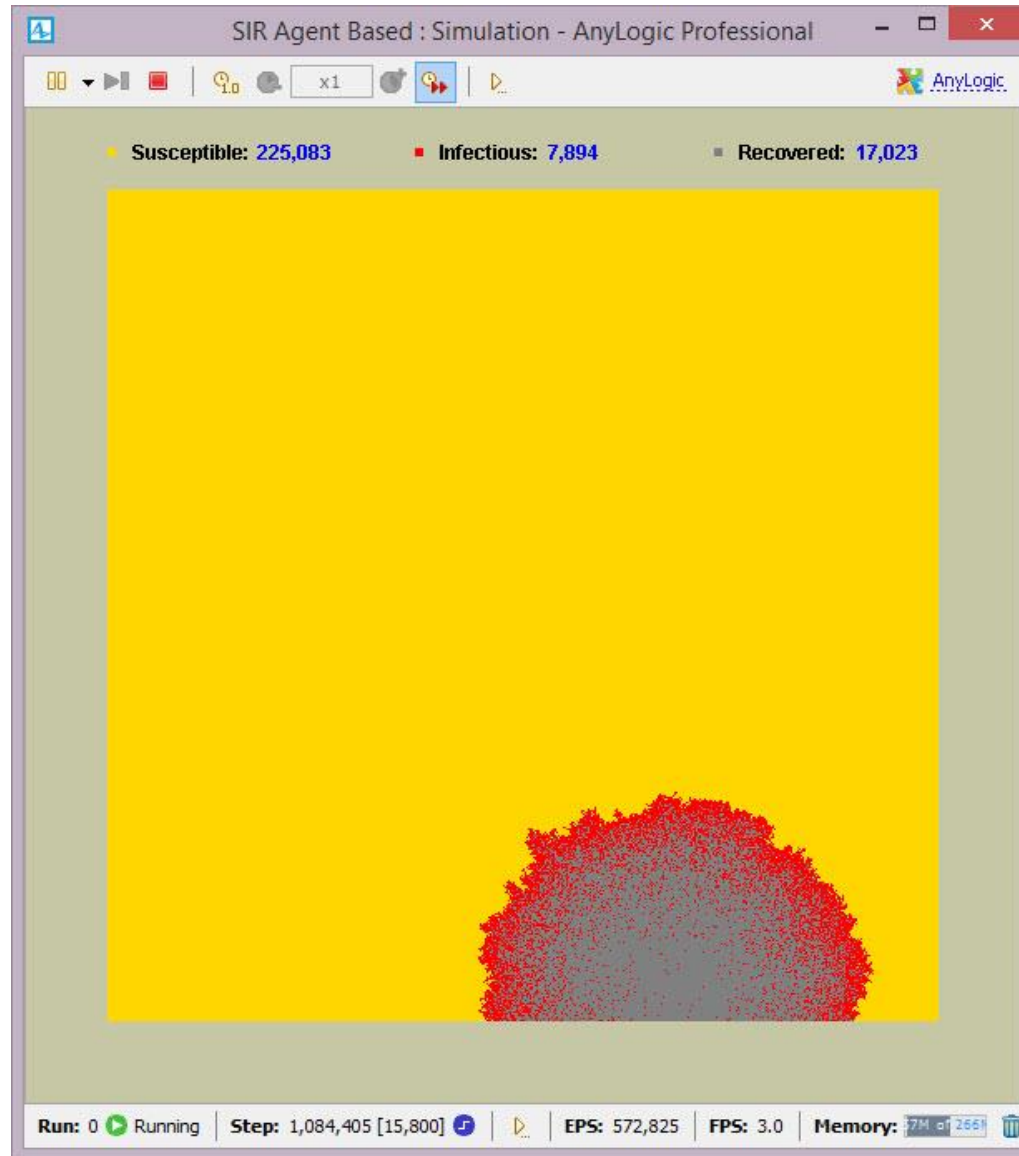
The status bar at the bottom indicates "SIR Agent Based", "Time units: days", and "X=...00".

What do You Expect to See?

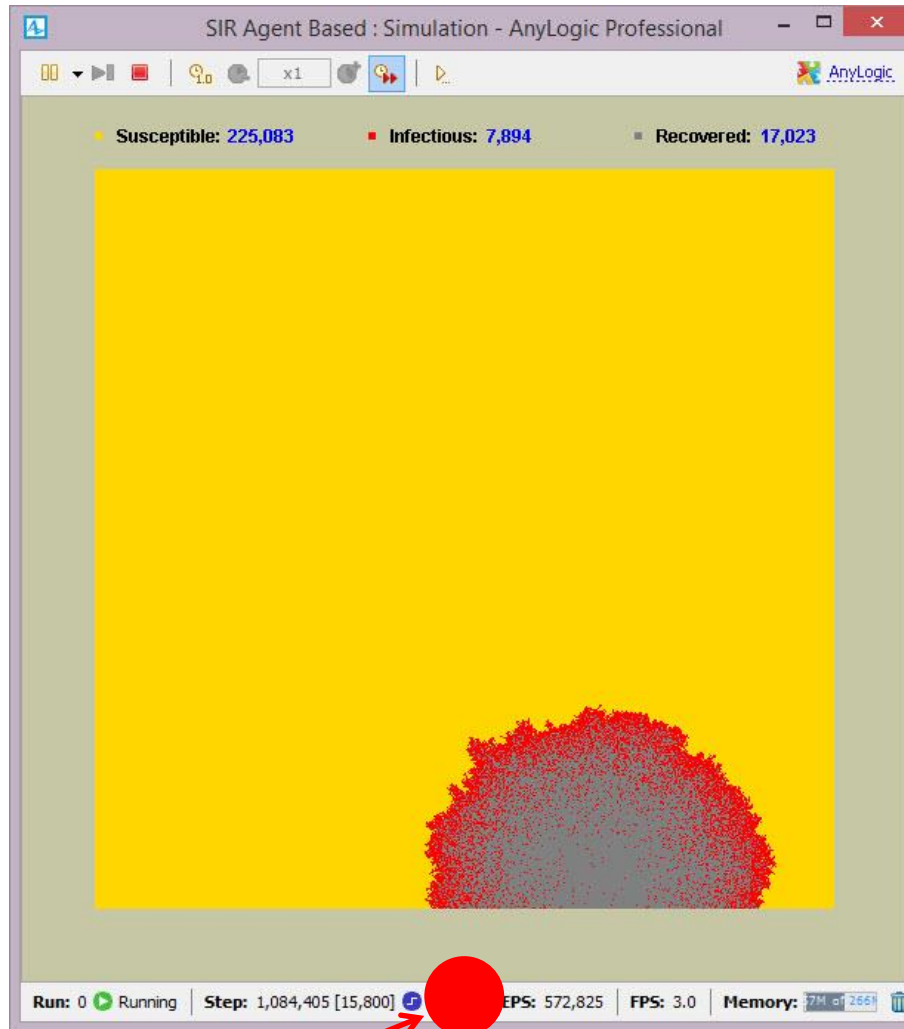
Press this button to start model execution



Example of Emergent Behaviour

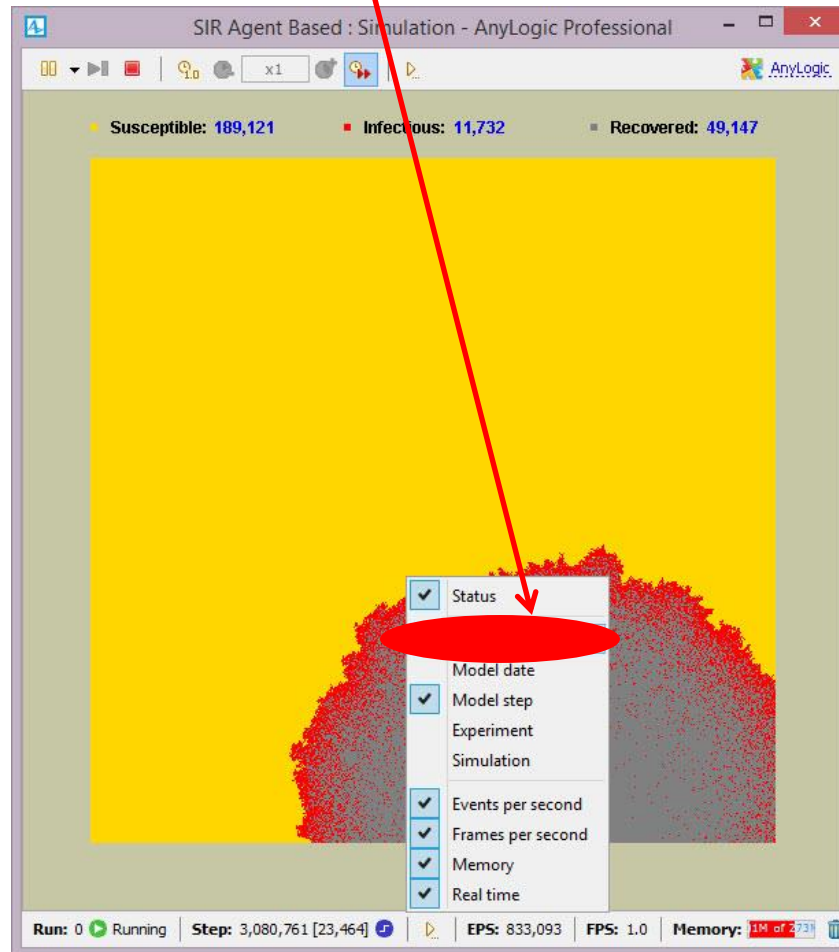


Make Sure Model Time is Visible

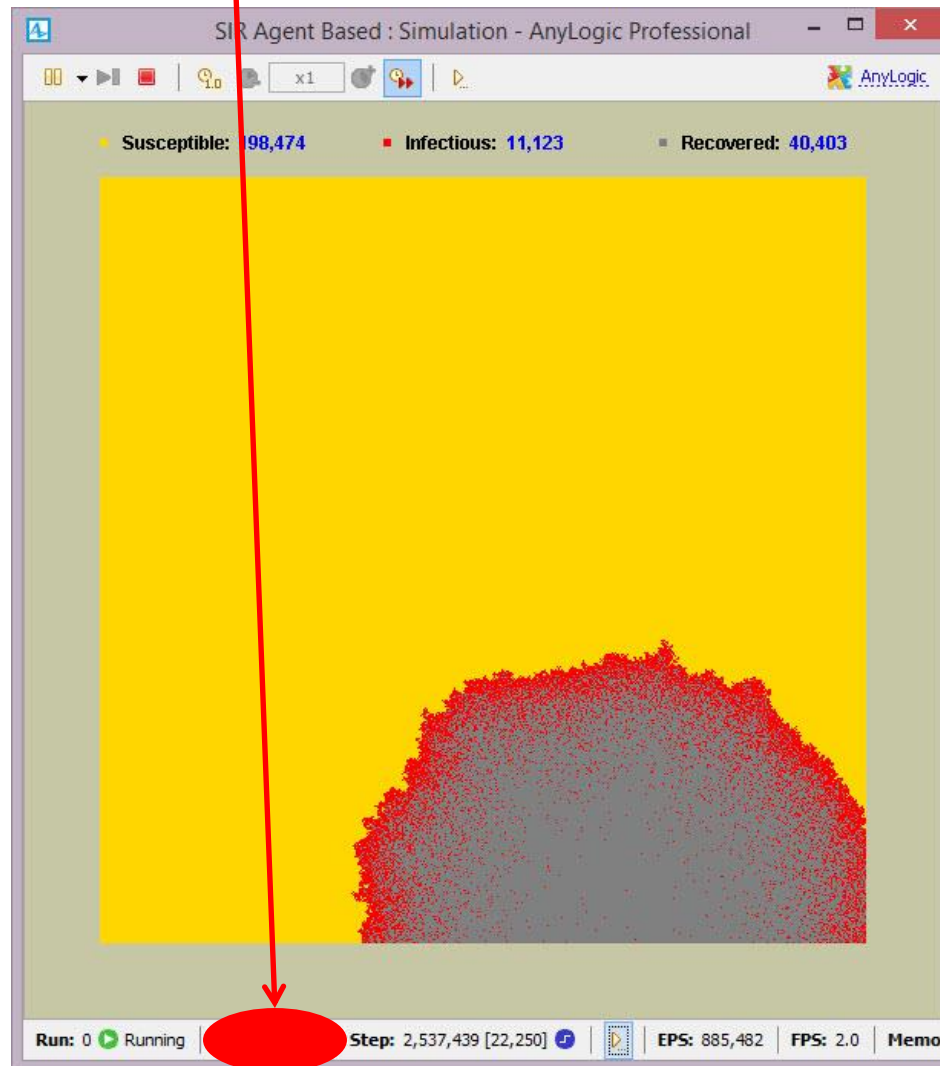


If no model time is visible on the bottom of the window, press **this button** to add a “model time” output

Select "Model Time" here (so a check mark appears)
(If a checkmark is already present, just click back on the
output window)



The Updated Window Should Include a **Model Time Output**



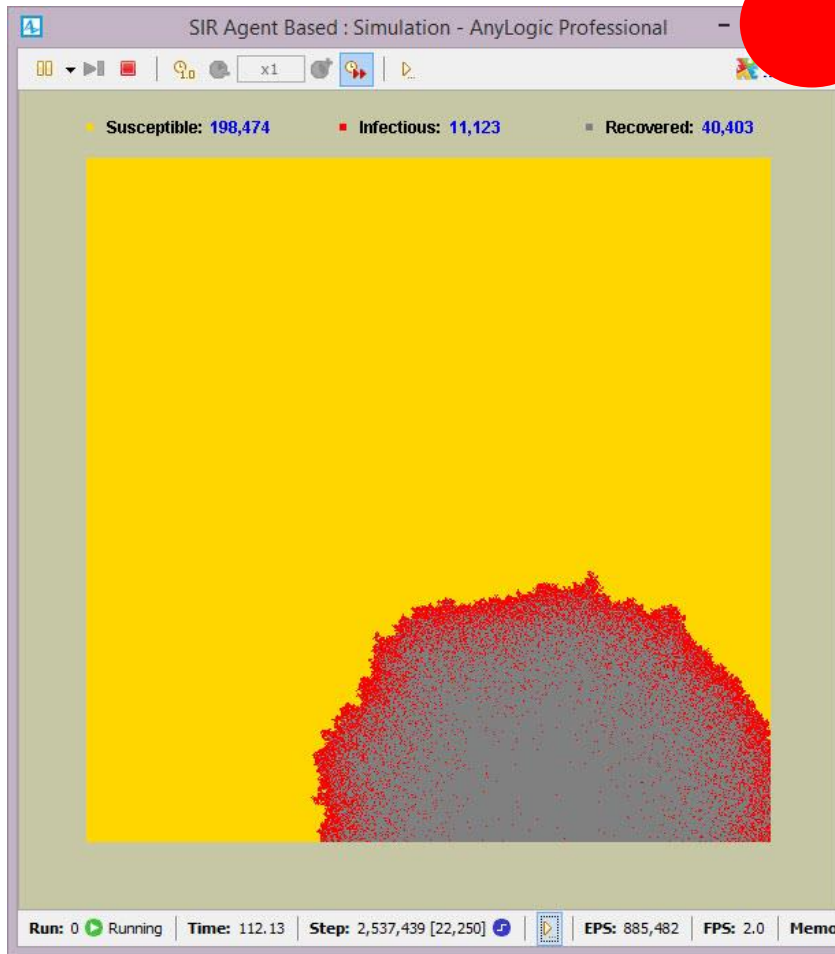
Stylized Measurement 1

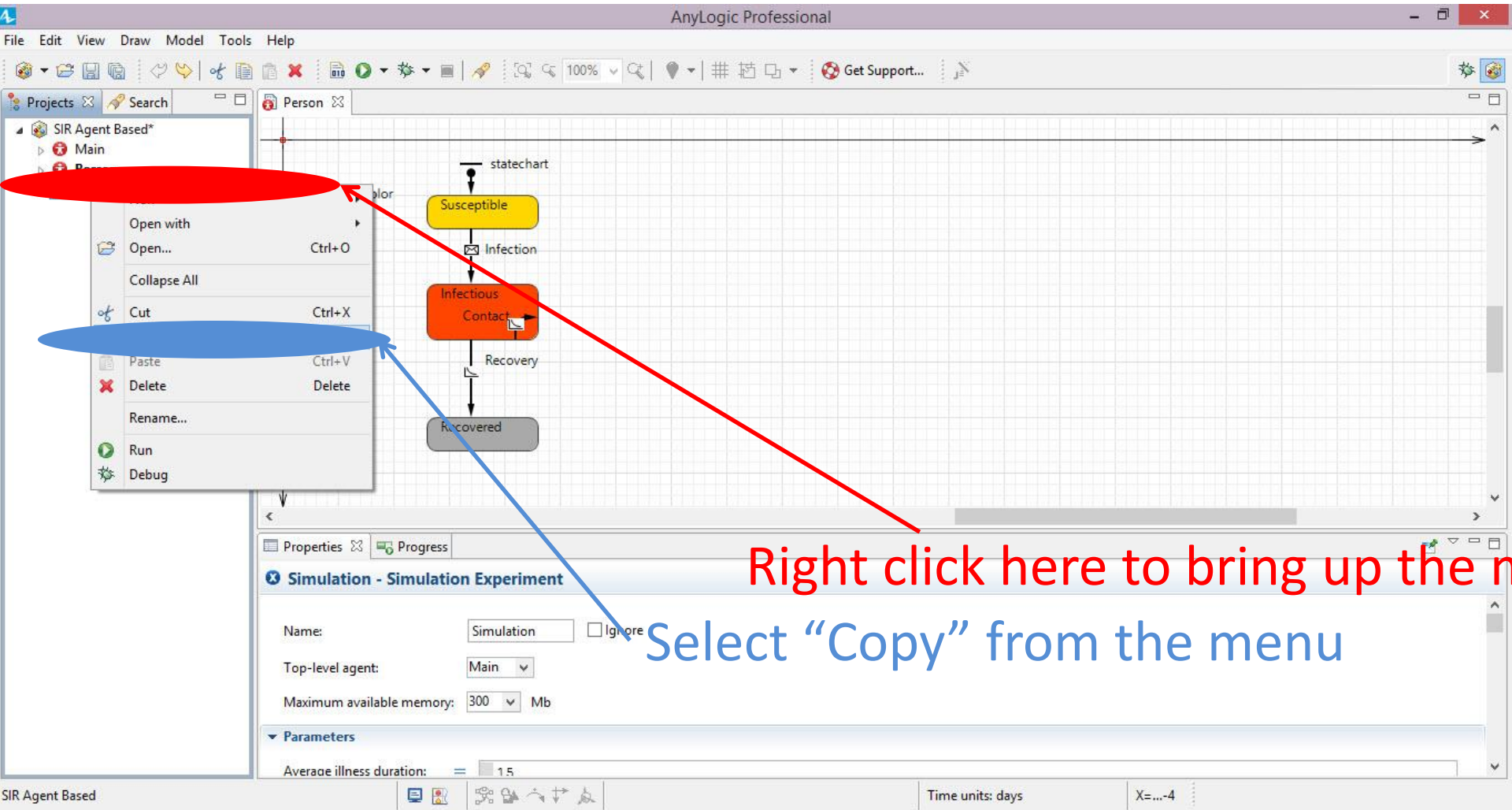
- How Long Does it Take for The Infection to Reach the Top or Left Boundaries?
- We'll compare this to the situation with other assumptions regarding the progression of the infection (as encoded by model "parameters")

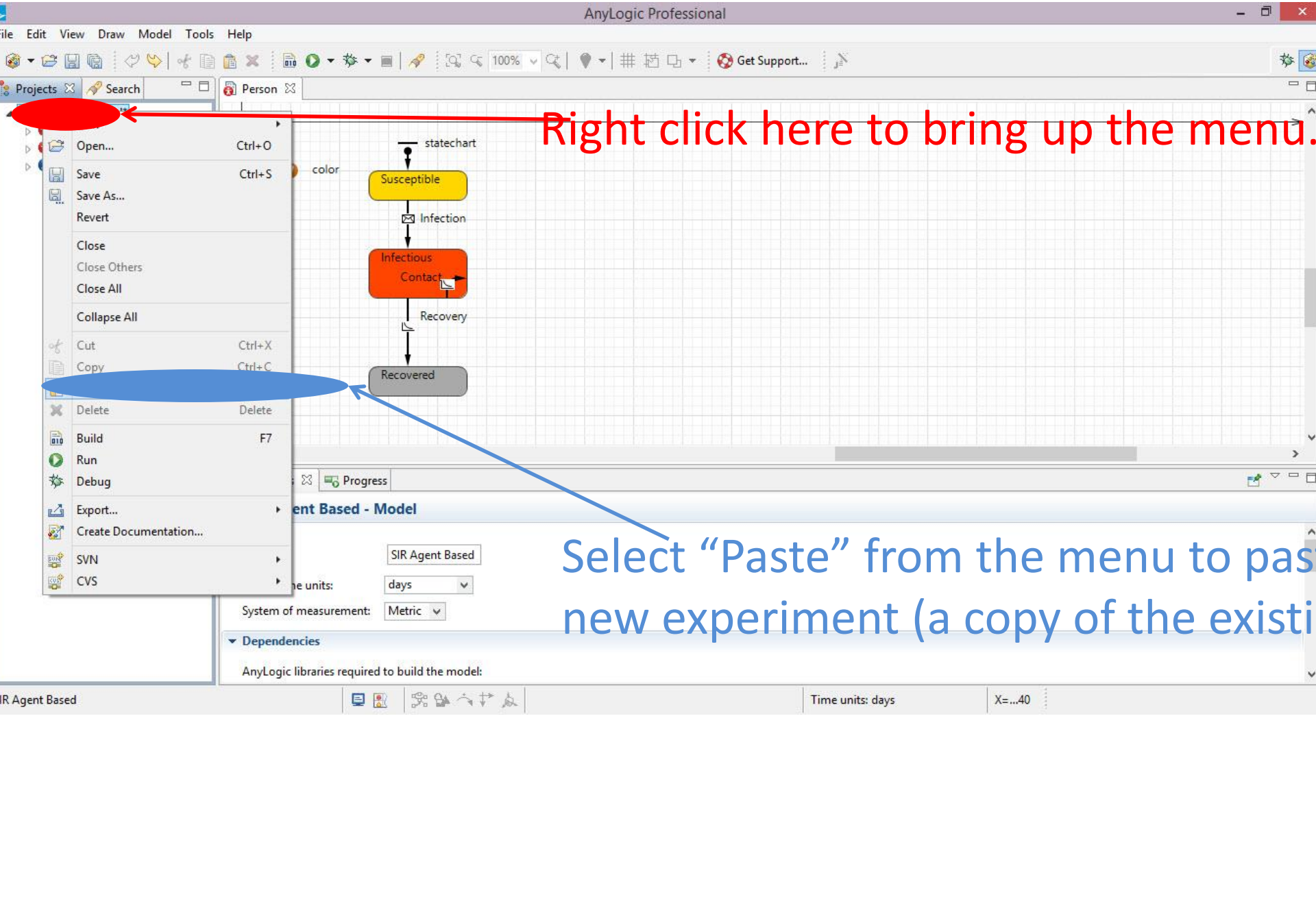
Press this button to stop model execution

The screenshot shows the AnyLogic Professional interface for an agent-based simulation. The window title is "SIR Agent Based : Simulation - AnyLogic Professional". The top status bar displays the following statistics: Susceptible: 198,474, Infectious: 11,123, and Recovered: 40,403. The main simulation area is a yellow rectangular field. In the bottom-right corner of this field, there is a dense cluster of agents, with red dots representing infectious individuals and grey dots representing recovered individuals. The bottom status bar shows the simulation is running, with a progress indicator, and provides the following data: Run: 0, Time: 112.13, Step: 2,537,439 [22,250], EPS: 885,482, FPS: 2.0, and a Memo button.

Close the window using this button







Right click here to bring up the menu.

Select "Paste" from the menu to paste into a new experiment (a copy of the existing model)

Your Screen Should Look as Follows

The screenshot displays the AnyLogic Professional interface. The main workspace shows a statechart for a 'Person' agent. The statechart starts with a 'statechart' entry point leading to a yellow 'Susceptible' state. From 'Susceptible', an 'Infection' event leads to an orange 'Infectious' state, which includes a 'Contact' sub-state. From 'Infectious', a 'Recovery' event leads to a grey 'Recovered' state. A 'color' property is visible on the left side of the diagram.

The interface includes a menu bar (File, Edit, View, Draw, Model, Tools, Help), a toolbar with various icons, and a 'Projects' panel on the left showing a tree view with 'SIR Agent Based*' and its sub-items: 'Main', 'Person', 'Simulation: Main', and 'Simulation1: Main'. The bottom status bar shows '0 items selected' and 'X=...87'.

Changing the Name of the Experiment

The screenshot displays the AnyLogic Professional interface. At the top, the title bar reads "AnyLogic Professional". Below it is a menu bar with "Edit", "View", "Draw", "Model", "Tools", and "Help". A toolbar with various icons is visible. On the left, a "Projects" pane shows a tree view with "SIR Agent Based*" containing "Main", "Person", and "Simulation: Main". The main workspace shows a state transition diagram for a "Person" agent. The states are "Susceptible" (yellow), "Infectious" (orange), and "Recovered" (grey). Transitions include "state change" from Susceptible to Infectious, "Infection" from Susceptible to Infectious, "Contact" from Infectious to Infectious, and "Recovery" from Infectious to Recovered. A red oval highlights the "color" property of the "Susceptible" state, with a red arrow pointing to it. A red text overlay reads: "1) Select here (the new experiment) so we can edit its properties (characteristics)". Below the diagram, the "Properties" pane is open for "Simulation1 - Simulation Experiment". A green oval highlights the "Name" field, which contains "Simulation1". A green text overlay reads: "2) Type the name 'SlowRecovery' for the new experiment". Other fields in the Properties pane include "Top-level agent" (Main), "Maximum available memory" (300 Mb), and "Parameters" (Average illness duration: 15, Contact rate: 1). The bottom status bar shows "Agent Based" and "Time units: days".

1) Select here (the new experiment) so we can edit its properties (characteristics)

2) Type the name "SlowRecovery" for the new experiment

Selecting the Model Used for this Experiment

The screenshot displays the AnyLogic Professional interface. On the left, a project tree shows the hierarchy: SIR Agent Based > Main > Person > Simulation: Main > SlowRecovery: Main. A red arrow points from the text "Select 'Main' here" to the "Main" folder in the tree. The main workspace shows a statechart for the "Person" agent, starting at "Susceptible" (yellow), transitioning to "Infectious" (orange) via "Infection", then to "Recovered" (grey) via "Recovery". A "Contact" transition is also shown from "Infectious". A "color" variable is visible. The bottom panel, titled "SlowRecovery - Simulation Experiment", shows the "Name" field set to "SlowRecovery", which is circled in red. Below it, the "Parameters" section shows "Average illness duration" set to 15 and "Contact rate" set to 1. The status bar at the bottom indicates "Time units: days".

File Edit View Draw Model Tools Help

Projects Search

SIR Agent Based

- Main
- Person
- Simulation: Main
- SlowRecovery: Main

Person

statechart

color

Susceptible

Infection

Infectious

Contact

Recovery

Recovered

Properties Progress Problems

SlowRecovery - Simulation Experiment

Name: SlowRecovery Ignore

Top-level agent

Maximum available memory

Parameters

Average illness duration: = 15

Contact rate: = 1

Time units: days

Select "Main" here

Altering Assumptions Regarding Infectiousness Duration (via **Parameters**)

The screenshot displays the AnyLogic Professional interface. The main workspace shows a diagram of the SIR model with three states: Susceptible (yellow), Infectious (red), and Recovered (grey). Below the diagram is a button labeled "Run the model and switch to Main view".

The bottom panel shows the "SlowRecovery - Simulation Experiment" parameters. The "Average illness duration" parameter is highlighted with a blue oval and a blue arrow pointing to the text "2) Make the illness duration 50". The "Maximum available memory" parameter is highlighted with a red oval and a red arrow pointing to the text "1) Select the 'Parameters' tab".

Parameter	Value
Maximum available memory	300 Mb
Average illness duration	50
Contact rate	1
Infection probability	0.5
Total population	250000

Time units: days X=...60

Run the Model (Right Click the Experiment "SlowRecovery" & select "Run")

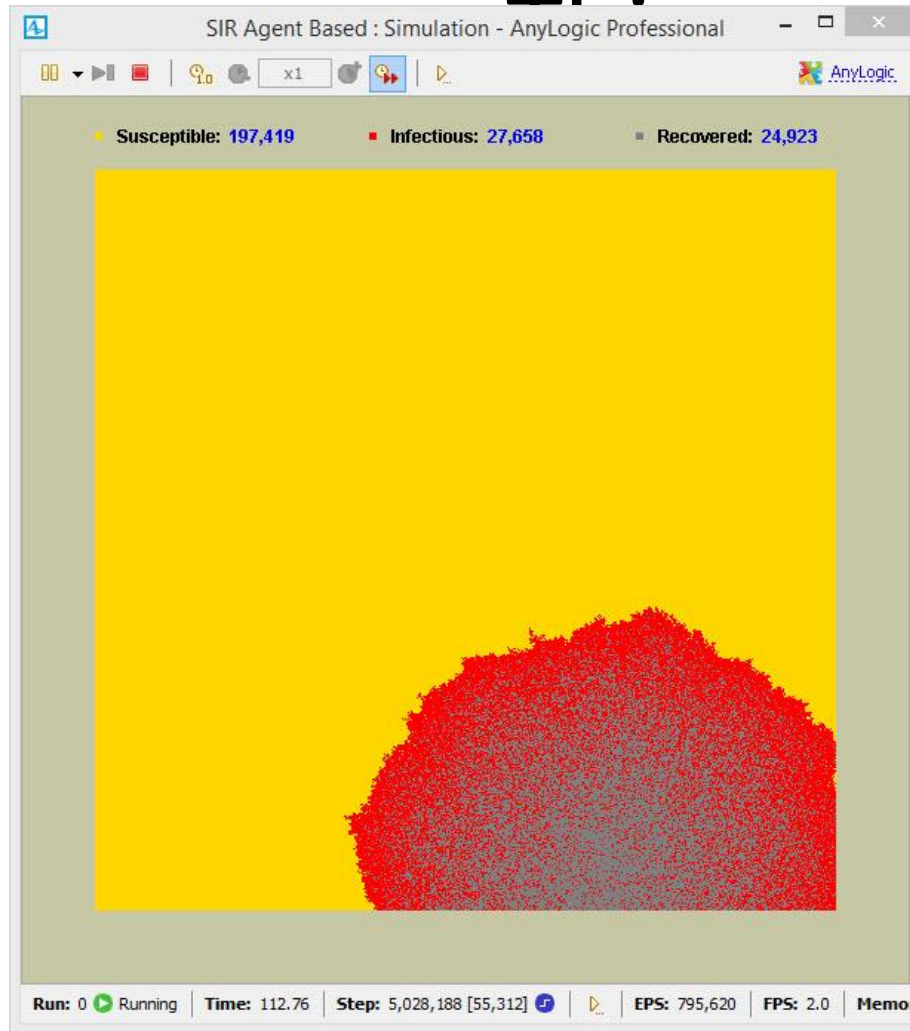
The screenshot displays the AnyLogic Professional interface for a simulation experiment titled "SlowRecovery". The main workspace shows a diagram of the SIR model with three compartments: Susceptible (yellow), Infectious (red), and Recovered (grey). Below the diagram, the "SlowRecovery - Simulation Experiment" panel is visible, containing a "Parameters" section with the following values:

Parameter	Value
Average illness duration	50
Contact rate	1
Infection probability	0.5
Total population	250000

The "Model time" section is also visible at the bottom of the panel. The interface includes a menu bar (File, Edit, View, Draw, Model, Tools, Help), a toolbar, and a project tree on the left. A red circle highlights the "Simulation: Main" item in the project tree, and a red arrow points from the text "Run" in the title to this item. A blue circle highlights the "Run" option in the context menu, and a blue arrow points from the text "Run" in the title to this option. The status bar at the bottom shows "Time units: days" and "X=...87".

What do You Expect to See?

You Should See Something Like



How quickly does the wave of infection take to reach the top border? How does this compare to the situation where we assumed a shorter period of infectiousness? Why?

Adding a Transition

The screenshot displays the AnyLogic Professional interface. The main workspace shows a statechart for a 'Person' agent. The statechart starts at a 'statechart' entry point leading to the 'Susceptible' state (yellow rounded rectangle). A transition labeled 'Infection' leads to the 'Infectious' state (orange rounded rectangle). From 'Infectious', a transition labeled 'Recovery' leads back to 'Susceptible'. There is also a 'Contact' transition from 'Infectious' to another state. A 'color' variable is shown next to the 'Susceptible' state. The Palette on the right contains statechart-related elements: Statechart Entry Point, State, Transition, Initial State Pointer, Branch, History State, and Final State. A red arrow points from the 'Statechart' icon in the Palette to the statechart diagram in the workspace.

Click on "Statechart" to view
The statechart-related palette

Adding a Transition

The screenshot displays the AnyLogic Professional interface. The main workspace shows a statechart for a 'Person' agent. The statechart starts at a 'statechart' entry point leading to the 'Susceptible' state (yellow rounded rectangle). A transition labeled 'Infection' leads to the 'Infectious' state (orange rounded rectangle). From 'Infectious', a transition labeled 'Recovery' leads to a state labeled 'Recovered' (partially visible). A red arrow points from the 'State' icon in the Palette to the 'Recovered' state in the diagram.

Person - Agent Type

Entity actions

Use in flowcharts as: Entity

On enter flowchart block:

On exit flowchart block:

On seize resource:

On release resource:

To add a transition to the statechart
Drag from “Transition” on the Palette to
the “Recovered” state

Connecting the Two States

While holding down the mouse button, drag the mouse to [here](#) and only then release the mouse button

1) Dragging the transition should have led to a connection here

2) Click on the other end of the transition,

transition - Transition

Timeout: 1

Action:

Guard:

1 error(s)

Time units: days

Give the transition a Name (Make sure it is selected by clicking on it)

The screenshot displays the AnyLogic Professional interface. The main workspace shows a statechart for a 'Person' agent. The states are 'Susceptible' (yellow), 'Infectious' (orange), and 'Recovered' (grey). Transitions include 'Infection', 'Contact', and 'Recovery'. A red circle highlights the 'waningImmunity' transition in the Properties window, with a red arrow pointing to it from the text 'Type the name ("waningImmunity") here'.

Properties window: **waningImmunity - Transition**

Name: waningImmunity Ignore

Triggered by: Timeout

Timeout: 1

Time units: days

Setting the Duration Until Immunity Wanes

The screenshot displays the AnyLogic Professional interface. The main workspace shows a statechart for a 'Person' agent. The states are: Susceptible (yellow), Infectious (orange), and Recovered (grey). Transitions include 'Infection' (Susceptible to Infectious), 'Recovery' (Infectious to Recovered), and 'waningImmunity' (Infectious to Susceptible). A 'color' variable is also shown. The Properties window at the bottom is set to 'waningImmunity - Transition'. The 'Name' is 'waningImmunity'. The 'Triggered by' field is highlighted with a red oval. The 'Timeout' field is highlighted with a blue oval. A red arrow points from the text '1) Make sure this is set to "Timeout"' to the 'waningImmunity' text in the 'Triggered by' field. A blue arrow points from the text '2) Set the waning time To 100' to the 'Timeout' field.

1) Make sure this is set to "Timeout"

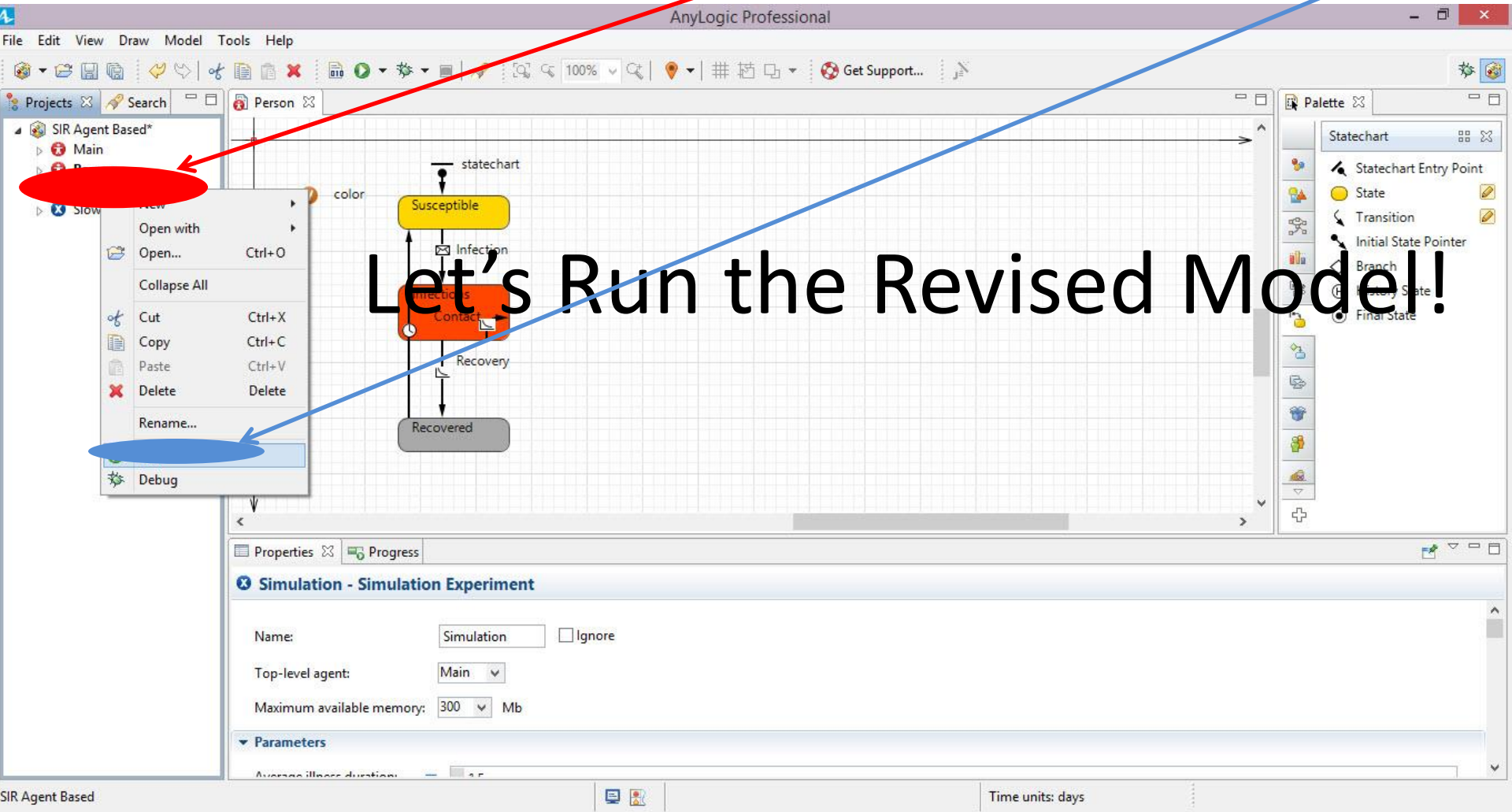
2) Set the waning time To 100

What do You Expect to See?

Run the original experiment ("Simulation") with the newly changed model by right clicking on "Simulation" & selecting

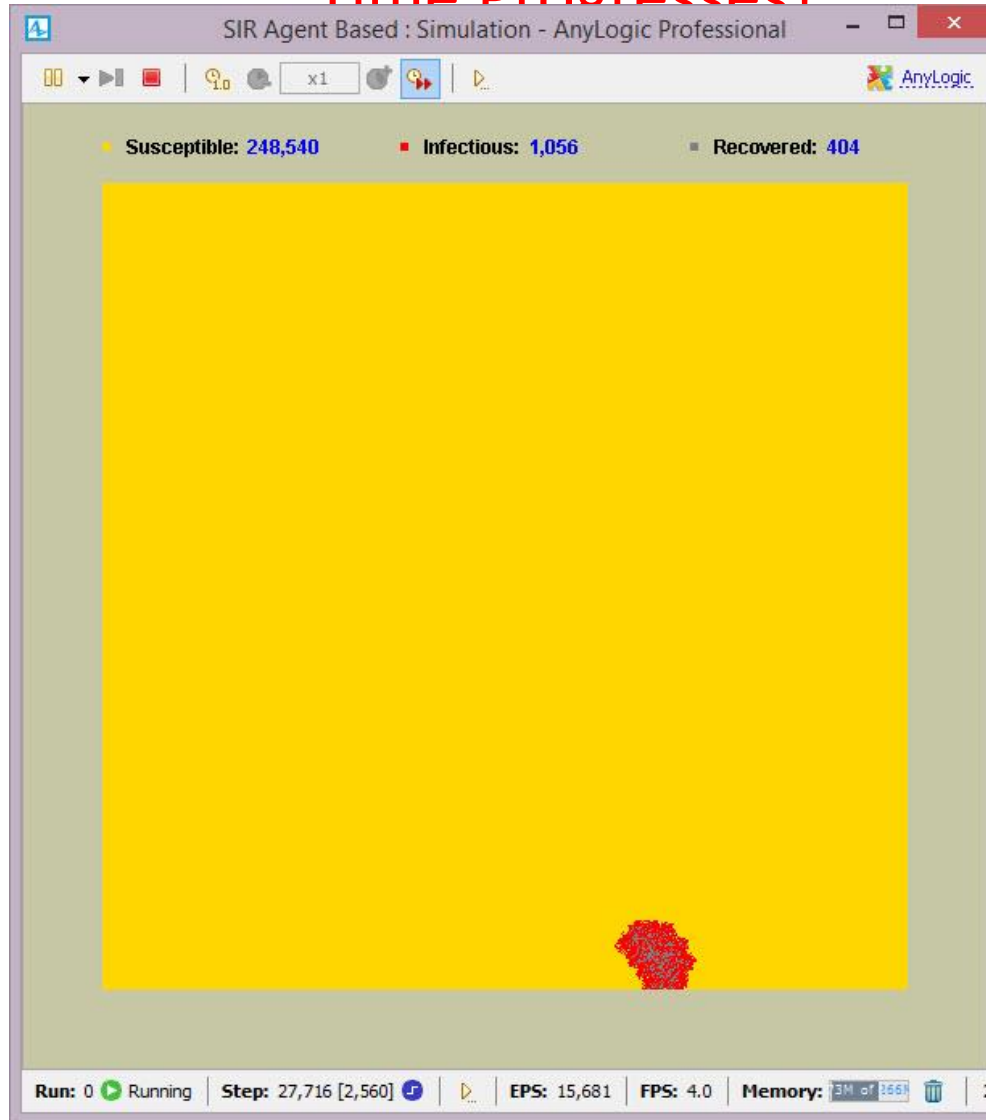
Run

Let's Run the Revised Model!

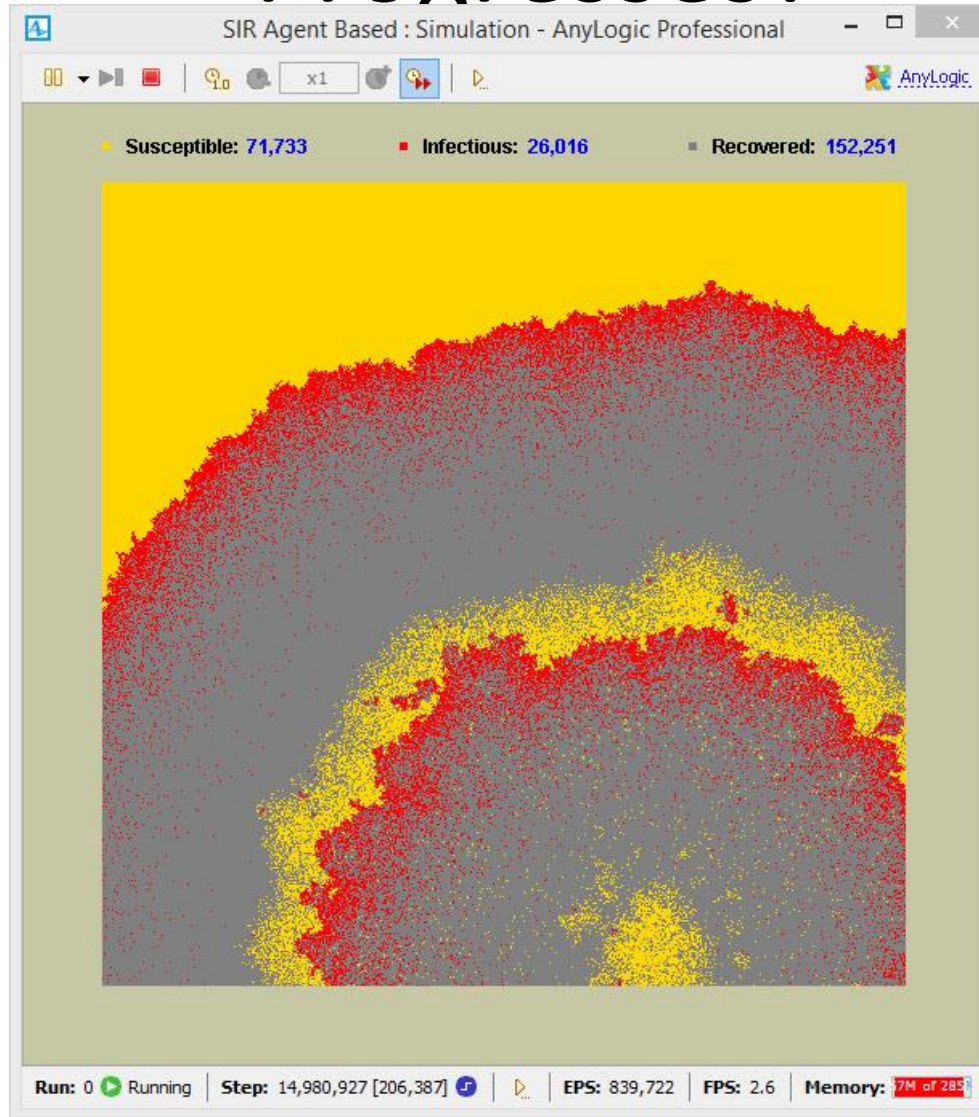


After starting the Model, you should see something like this. What happens as

Time Progresses?



What Happens as Time Progresses?



Use the Run Button & run the "SlowRecovery" Experiment

The screenshot displays the AnyLogic Professional interface. The main workspace shows a statechart for a 'Person' agent with the following states and transitions:

- Susceptible** (yellow state)
- Infectious** (orange state, containing a **Contact** sub-state)
- Recovered** (grey state)

Transitions include:

- Infection**: From Susceptible to Infectious.
- Recovery**: From Infectious to Recovered.
- Recovery**: From Infectious to Susceptible.

The **Projects** panel on the left shows a tree structure with 'SIR Agent Based*' expanded to 'Main' > 'Person' > 'Simulation: Main'. A red oval highlights the 'Simulation: Main' folder, and a red arrow points from the text above to this oval.

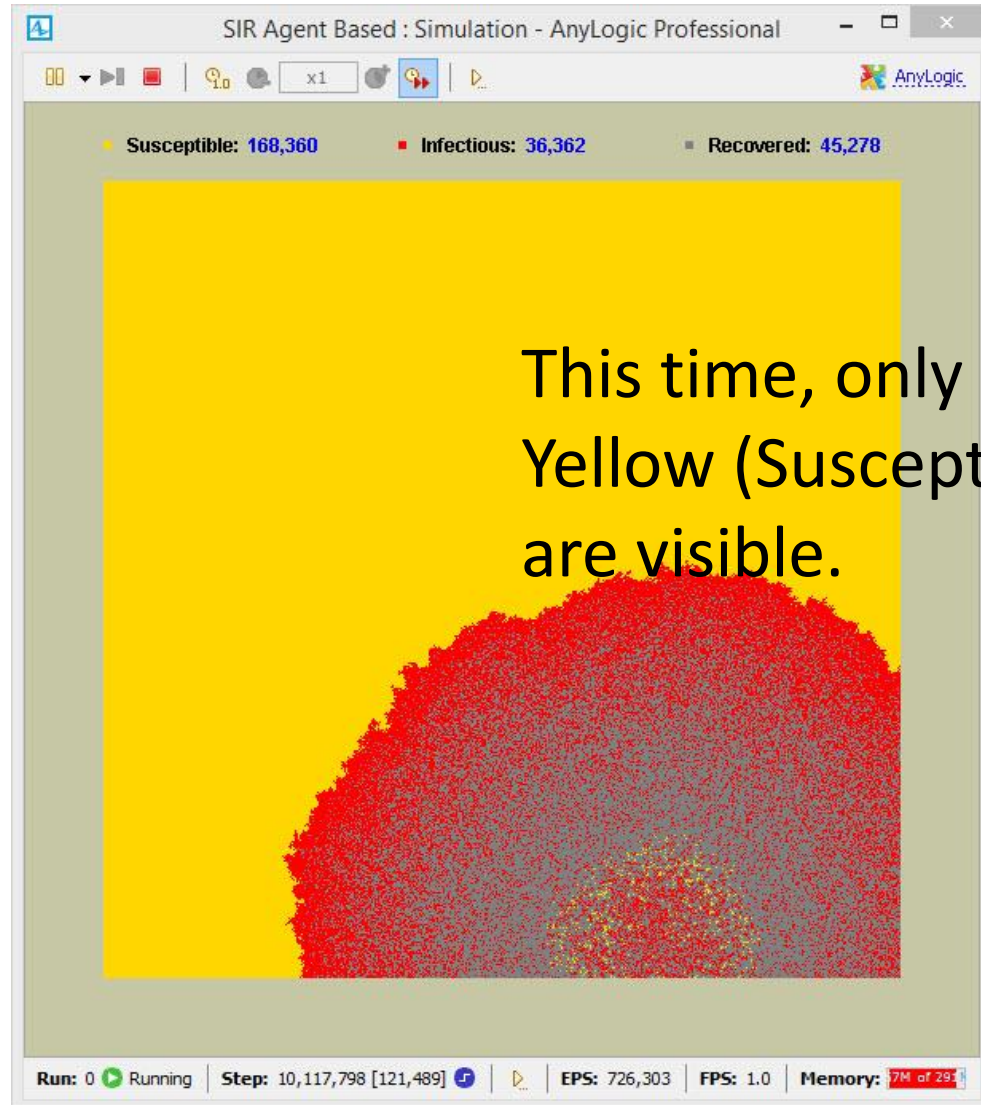
The **Run** button in the context menu is highlighted in blue. The **Statechart** palette on the right lists symbols for Statechart Entry Point, State, Transition, Initial State Pointer, Branch, History State, and Final State.

The **SlowRecovery - Simulation Experiment** window at the bottom shows the following configuration:

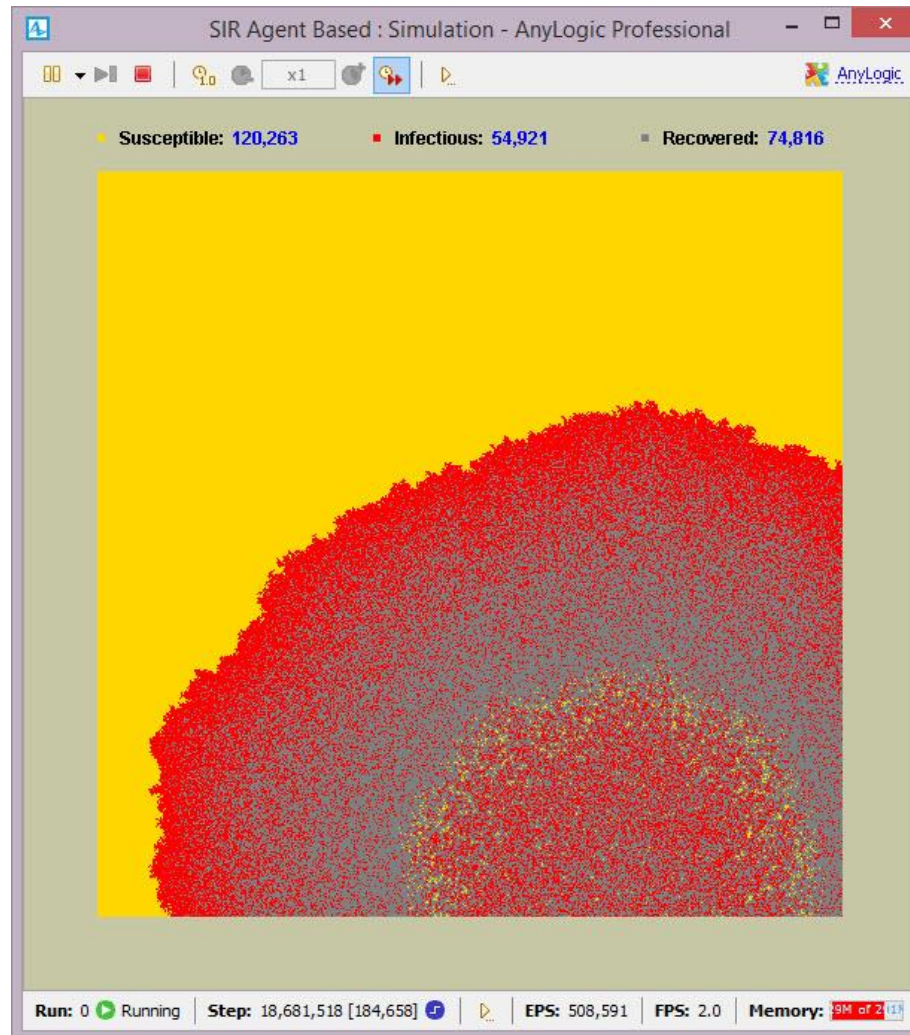
- Name: SlowRecovery Ignore
- Top-level agent: Main
- Maximum available memory: 300 Mb
- Parameters: Average illness duration: 10

The status bar at the bottom indicates 'SIR Agent Based' and 'Time units: days'.

Slow Recovery Results



As Time Progresses, Little Internal Structure – Why?



Stylized Measurement 2

- How Long Does it Take for The Infection to Reach the Top or Left Boundaries?
- How does this compare with the earlier experiment with a shorter duration of immunity?
- **Bonus question:** What would an aggregate (random mixing) model have predicted?

Observations

- A brief & informal glimpse of AnyLogic's user interface for building, modifying & running models
- Take-Home Points
 - Much of a model can be described graphically
 - Running a structurally simple model can lead to complex *emergent* patterns over time & space
 - Modifying the model quantitative assumptions (described by parameters) can significantly change results
 - Modifying the model structure can qualitatively change model behavior

What do You Expect to See?