Collecting, Outputting & Inputting Data in AnyLogic

Nathaniel Osgood

MIT 15.879

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Recording of Results

- A frequent modeler need is to record some components of model state over time
  - State variables (e.g. stocks)
  - States of agents
  - Summaries of model state
  - We informally term this a “trajectory file”
- *Trajectory recording is only supported by AnyLogic Professional*
- AnyLogic does allow for
  - Definition of *DataSets* that record recent values of parameters
  - Statistics summarizing model state
  - Reporting on values of data sets as a graph or table

Techniques for Outputting Data

- Ad-Hoc Exports from variables
- Manual copies from visible datasets
- Export to files
- Writing to console
- Export to databases
- [AnyLogic Professional] Dataset archiving
- Capturing images of graphs

Cross-Method Output Tips

- A convenient mechanism is to periodically output data using events (e.g. every time unit)
- Beyond output, be sure to save information on context of run
  - Model version (Use unique id that increment whenever change model)
  - Parameter assumptions
  - Intention
- Think carefully about whether want to save away intermediate data

Hands on Model Use Ahead

Load Sample Model:

SIR Agent Based Calibration

(Via “Sample Models” under “Help” Menu)

Techniques for Collecting & Outputting Data

- Ad-Hoc Exports from variables
- Pre-Prepared methods
  - Statistics
  - Charts
  - Manual copies from visible datasets
  - Export to files
  - Writing to console
  - Export to databases
  - [AnyLogic Professional] Dataset archiving
  - Capturing images of graphs

Add an Experiment

AnyLogic University [EVALUATION USE ONLY]

File Edit View Model Window Help

Projects

SIR Agent Based Calibration

Main

Perso

Calib

Mont

New

Open... Ctrl+O

Save Ctrl+S

Save As...

Revert

Close

Close Others

Close All

Collapse All

Cut Ctrl+X

Copy Ctrl+C

Paste Ctrl+V

Delete Delete

Refresh

Build F7

Run

Export...

Create Documentation...

Team

Check for Snapshot Compatibility

Model

Active Object Class

Experiment

Dimension

Java Class

Java Interface

Library

Person

Main

nInfectious

InfectiousDS

Problems

Description

SIR Agent Based Calibration - Model

General

Dependencies

Description

Name: SIR Agent Based Calibration

Package: sir_agent_based_calibration

File: C:\Program Files (x86)\AnyLogic 6_5 University\plugins\com.xj.anylogic.examples_6.5.

Palette

General

Parameter

Event

Dynamic Event

Plain Variable

Collection

Function

Table Function

Port

Connector

Environment

System Dynamics

Statechart

Actionchart

Analysis

Presentation

3D

Controls

Connectivity

Pictures

3D Objects

Enterprise Library

Pedestrian Library

Palettes...

SIR Agent Based Calibration - Model

Add an Experiment

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File Edit View Model Window Help

Projects
- SIR Agent Based Calibration
  - Main
  - Person
  - Calibration: Main
  - MonteCarlo2DHistogram: Main
  - Analysis Data
  - Presentation

Problems

Description	Locati

Person

New Experiment

Experiment

Select an experiment type, specify a name and choose a root (top-level) active object.

Name: SimpleExperiment

Main Active Object Class (root): Main

Experiment Type:
- Simulation
- Optimization
- Parameters Variation
- Compare Runs
- Monte Carlo
- Sensitivity Analysis
- Calibration
- Custom

Performs model runs with specified parameters, supports virtual and real-time modes, animation, model debugging

Copy model time settings from : Calibration

< Back | Next > | Finish | Cancel

Properties | Console

SIR Agent Based Calibration - Model

General | Dependencies | Description

Name: SIR Agent Based Calibration

Package: sir_agent_based_calibration

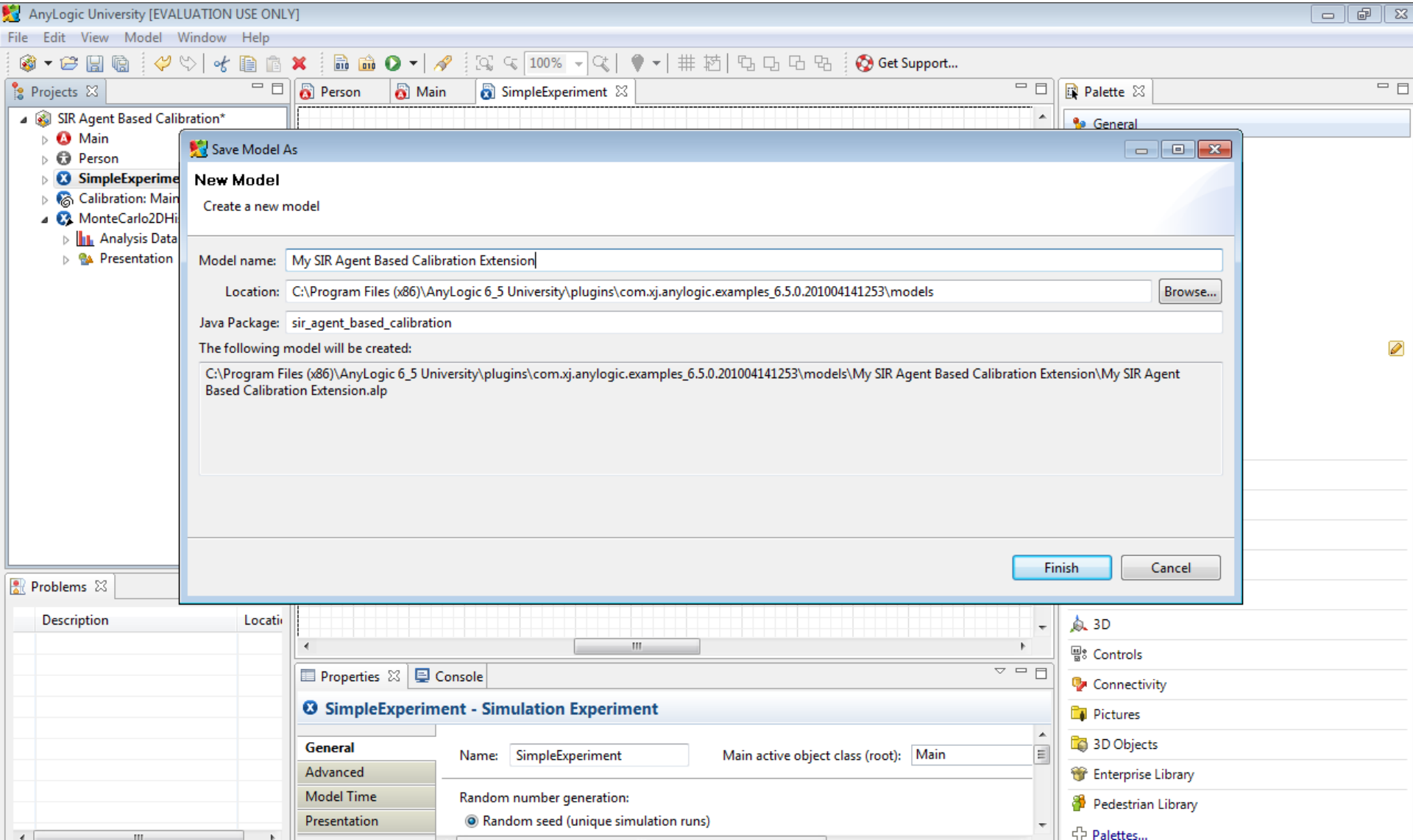
File: C:\Program Files (x86)\AnyLogic 6_5 University\plugins\com.xj.anylogic.examples_6.5.

Palette

General
- Parameter
- Event
- Dynamic Event
- Plain Variable
- Collection
- Function
- Table Function
- Port
- Connector
- Environment

System Dynamics
Statechart
Actionchart
Analysis
Presentation
3D
Controls
Connectivity
Pictures
3D Objects
Enterprise Library
Pedestrian Library
Palettes...

Save the Resulting Model (To Avoid Overwriting the Other Model)



Run the Experiment (To Verify Functionality)

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File Edit View Model Window Help

Projects

- My SIR Agent Based Calibration Extensi
  - Main
  - Person
  - SimpleExperiment: Main
  - Calibration: Main
  - MonteCarlo2DHistogram: Main
    - Analysis Data
    - Presentation

Recent Experiment

- My SIR Agent Based Calibration Extension / SimpleExperiment
- My SIR Agent Based Calibration Extension / Calibration
- My SIR Agent Based Calibration Extension / MonteCarlo2DHistogram

Person

AreaSide
TotalPopulation
AverageIllnessDuration
ContactRate
InfectionProbability
nInfectious
InfectiousDS
environment
people [..]

Palette

General
Parameter
Event
Dynamic Event
Plain Variable
Collection
Function
Table Function
Port
Connector
Environment
System Dynamics
Statechart
Actionchart
Analysis
Presentation
3D
Controls
Connectivity
Pictures
3D Objects
Enterprise Library
Pedestrian Library
Palettes...

Problems

Description | Locati

Properties | Console

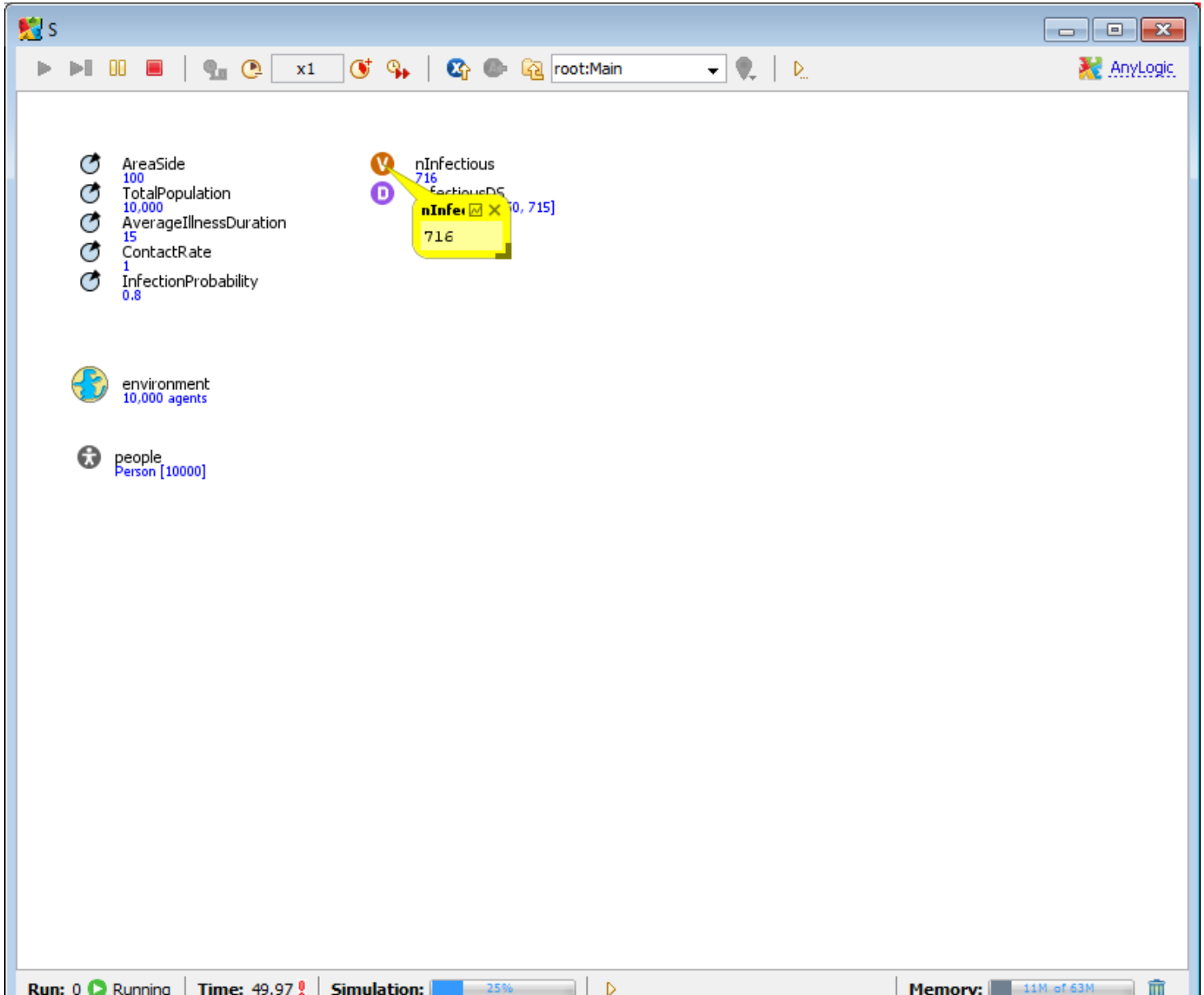
SimpleExperiment - Simulation Experiment

General
Advanced
Model Time
Presentation

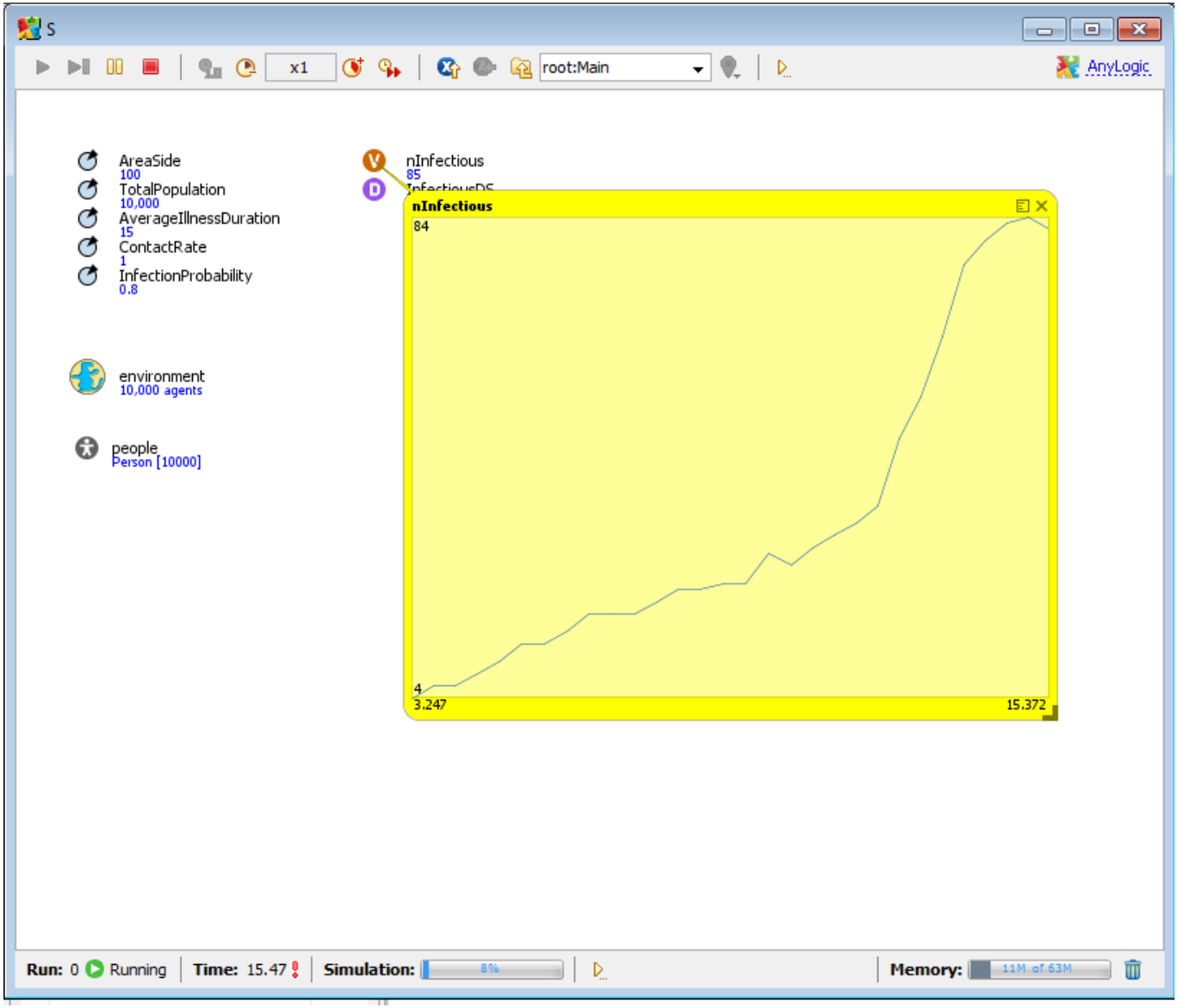
Name: SimpleExperiment
Main active object class (root): Main

Random number generation:
Random seed (unique simulation runs)

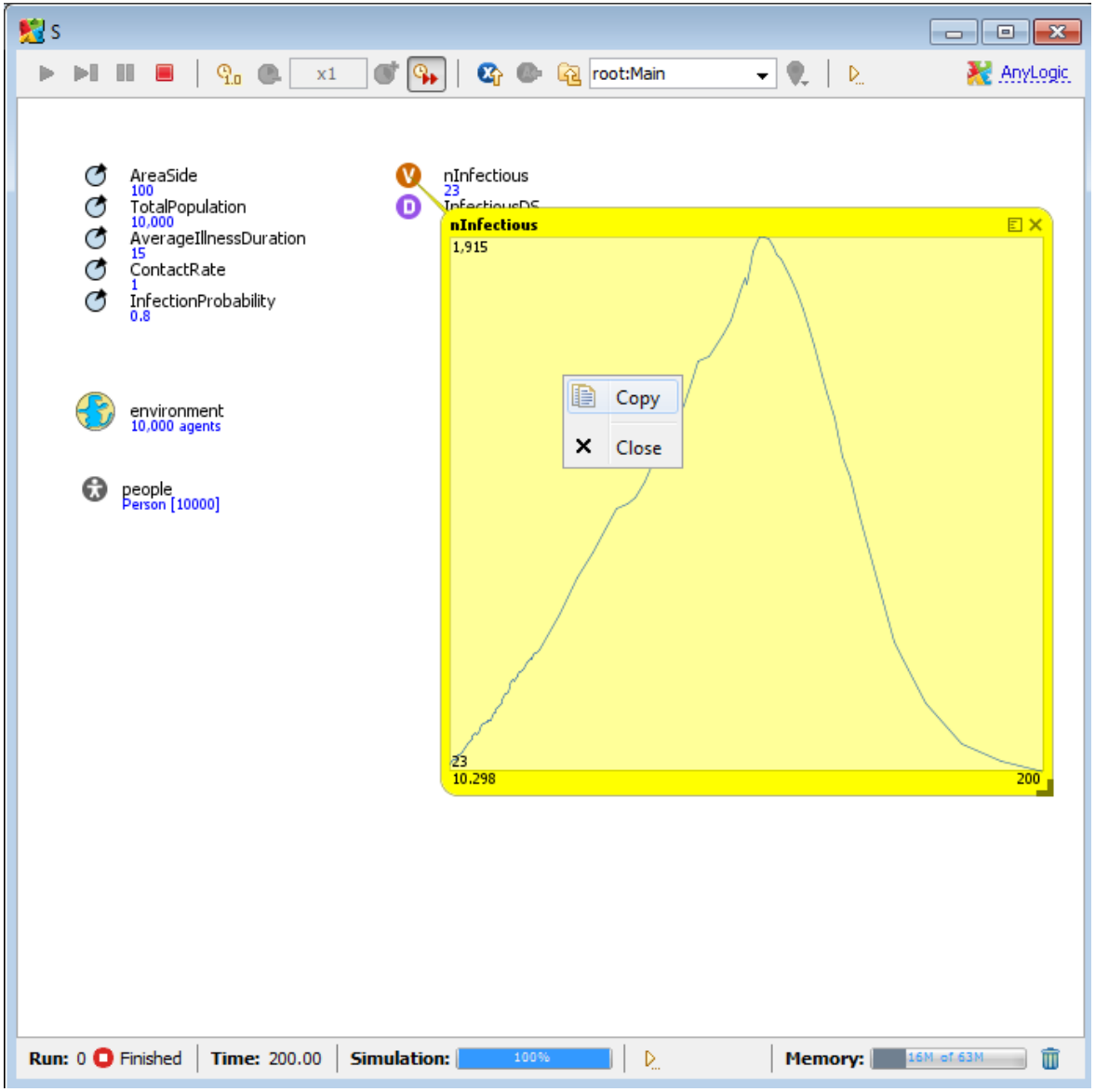
Click on Variable “nInfectious”



Graph of Variable



Right-Click to Copy the Numeric Data

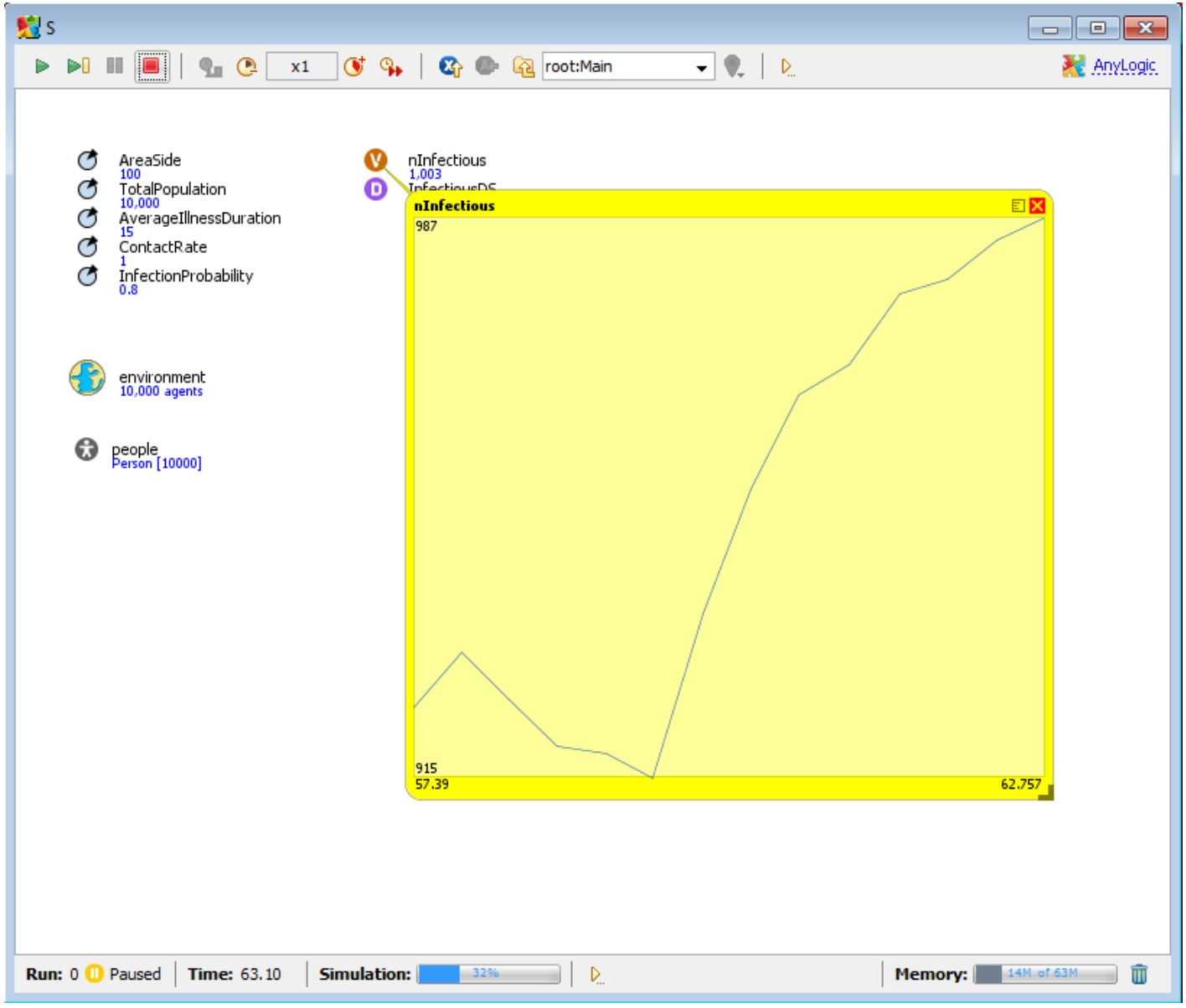


Pasting Into Excel

Book2

	A	B	C
1	10.2981	46	
2	10.7035	49	
3	11.11663	57	
4	11.52034	63	
5	11.94378	63	
6	12.34478	65	
7	12.76164	75	
8	13.17257	80	
9	13.57541	84	
10	13.9763	88	
11	14.42726	94	
12	14.85186	101	
13	15.2532	104	
14	15.68009	110	
15	16.08836	119	
16	16.50117	126	
17	16.91301	130	
18	17.33154	138	
19	17.76246	148	
20	18.1981	151	
21	18.6162	158	
22	19.04415	154	
23	19.4457	159	
24	19.86155	169	

Press Red “Stop” Button to Terminate Execution



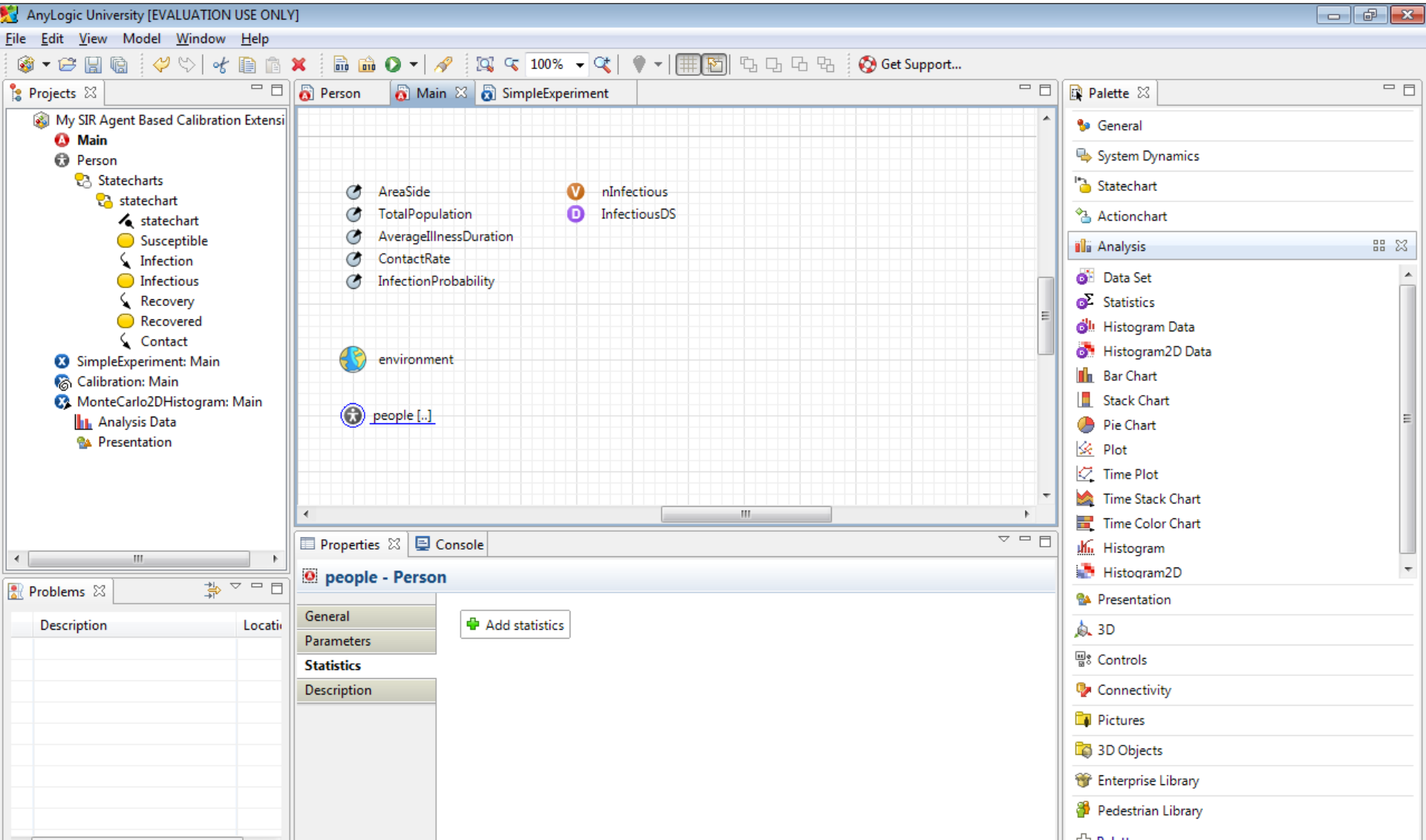
Techniques for Collecting & Outputting Data

- Ad-Hoc Exports from variables
- Pre-Prepared methods
  - Statistics
  - Charts
  - Manual copies from visible datasets
  - Export to files
  - Writing to console
  - Export to databases
  - [AnyLogic Professional] Dataset archiving
  - Capturing images of graphs

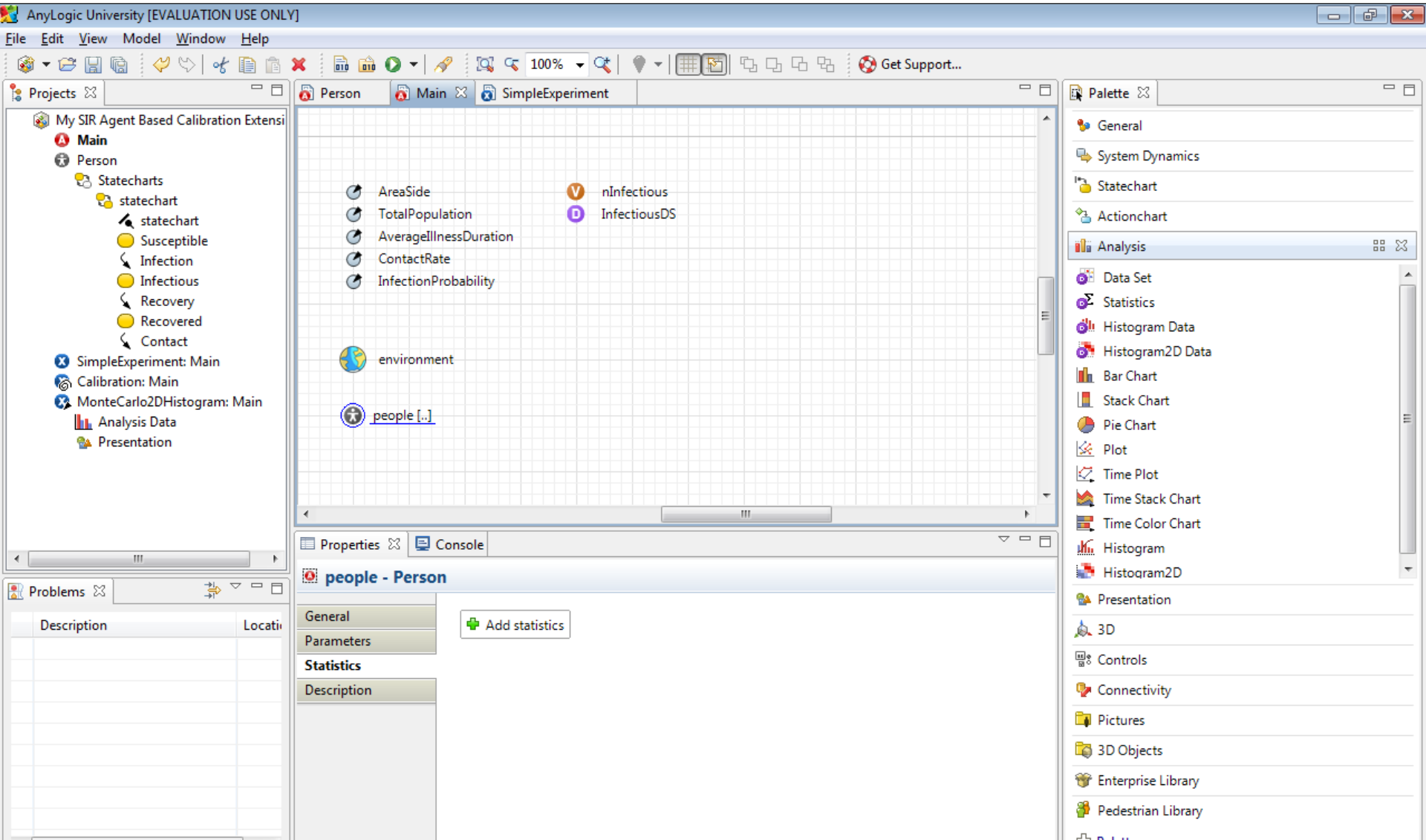
Statistics & Charts

- A population of agents can have associated statistics that calculate values
- Examples of things that can be computed with using AnyLogic's statistics
  - Count of agents in the population for which certain condition ("predicate") evaluates to true
  - Function of the values of some expression over the population
    - Maximum value
    - Minimum value
    - Average value
    - Sum (total) over population
  - Statistics can be defined as properties of the population

Select “People”, and Choose “Statistics”



Also, Expand “Statechart” Under “Person”



Click “Add Statistics”

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File Edit View Model Window Help

Projects

- My SIR Agent Based Calibration Extensi
  - Main
  - Person
    - Statecharts
      - statechart
        - statechart
        - Susceptible
        - Infection
        - Infectious
        - Recovery
        - Recovered
        - Contact
  - SimpleExperiment: Main
  - Calibration: Main
  - MonteCarlo2DHistogram: Main
    - Analysis Data
    - Presentation

Person | Main | SimpleExperiment

AreaSide
TotalPopulation
AverageIllnessDuration
ContactRate
InfectionProbability
nInfectious
InfectiousDS
environment
people [..]

Properties | Console

people - Person

General
Parameters
Statistics
Description

Add statistics

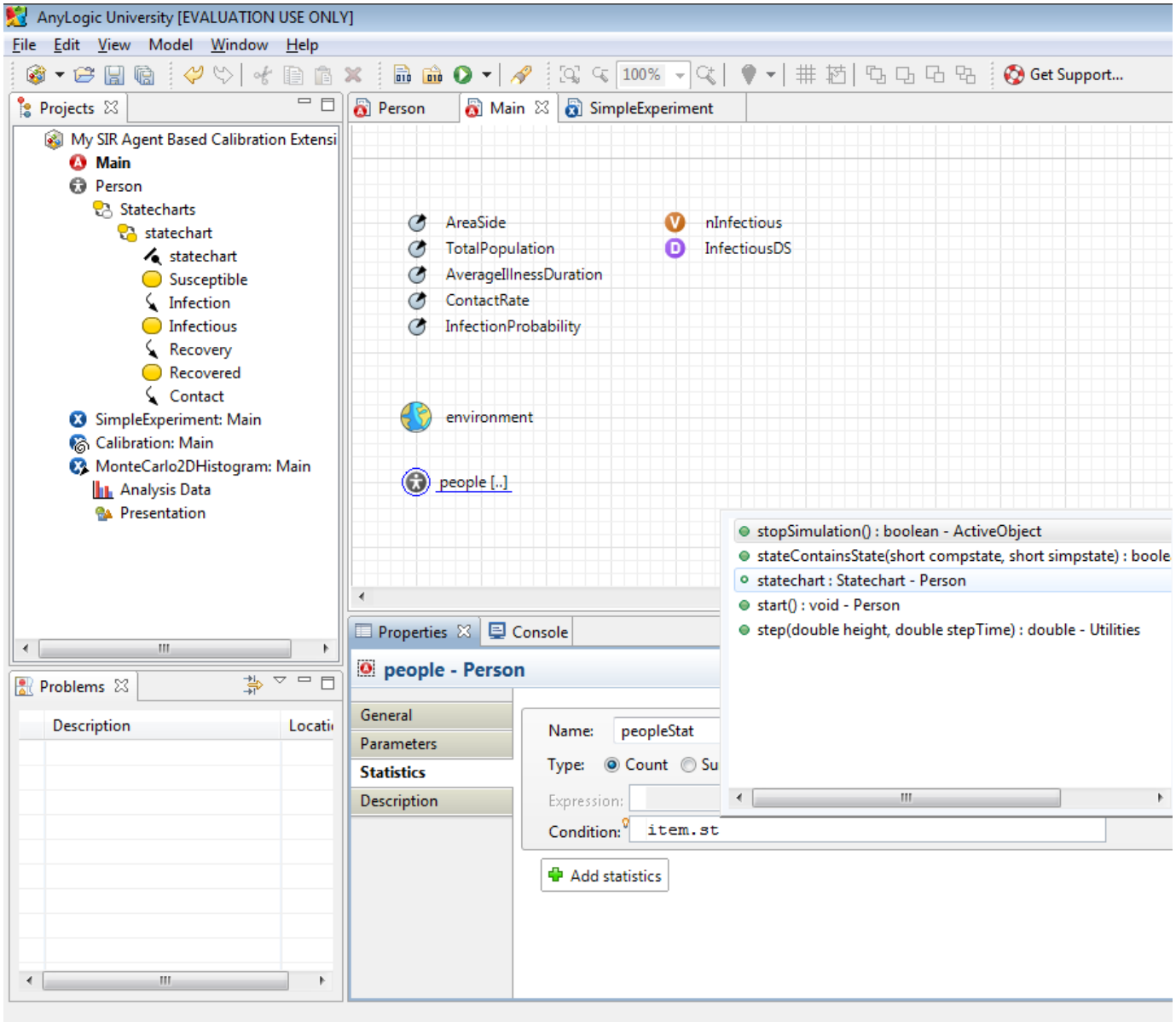
Problems

Description	Locati

Palette

- General
- System Dynamics
- Statechart
- Actionchart
- Analysis
  - Data Set
  - Statistics
  - Histogram Data
  - Histogram2D Data
  - Bar Chart
  - Stack Chart
  - Pie Chart
  - Plot
  - Time Plot
  - Time Stack Chart
  - Time Color Chart
  - Histogram
  - Histogram2D
- Presentation
- 3D
- Controls
- Connectivity
- Pictures
- 3D Objects
- Enterprise Library
- Pedestrian Library
- Palettes...

Fill in the “Condition” (Predicate) on Person



Continue Typing

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File Edit View Model Window Help

Projects

My SIR Agent Based Calibration Extensi
- Main
- Person
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    - statechart
      - statechart
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Person | Main | SimpleExperiment

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TotalPopulation
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nInfectious
InfectiousDS
environment
people [..]

isStateActive(short state) : boolean - Statechart

isStateActive

```
public boolean isStateActive(short state)
```

Returns true if the statechart is at the specified state, i.e. exactly in the state for a simple state and in one of its inner states for a composite state.

Parameters:
`state` - the state

Returns:
true if state is currently active

Press 'Tab' from proposal table or click for focus

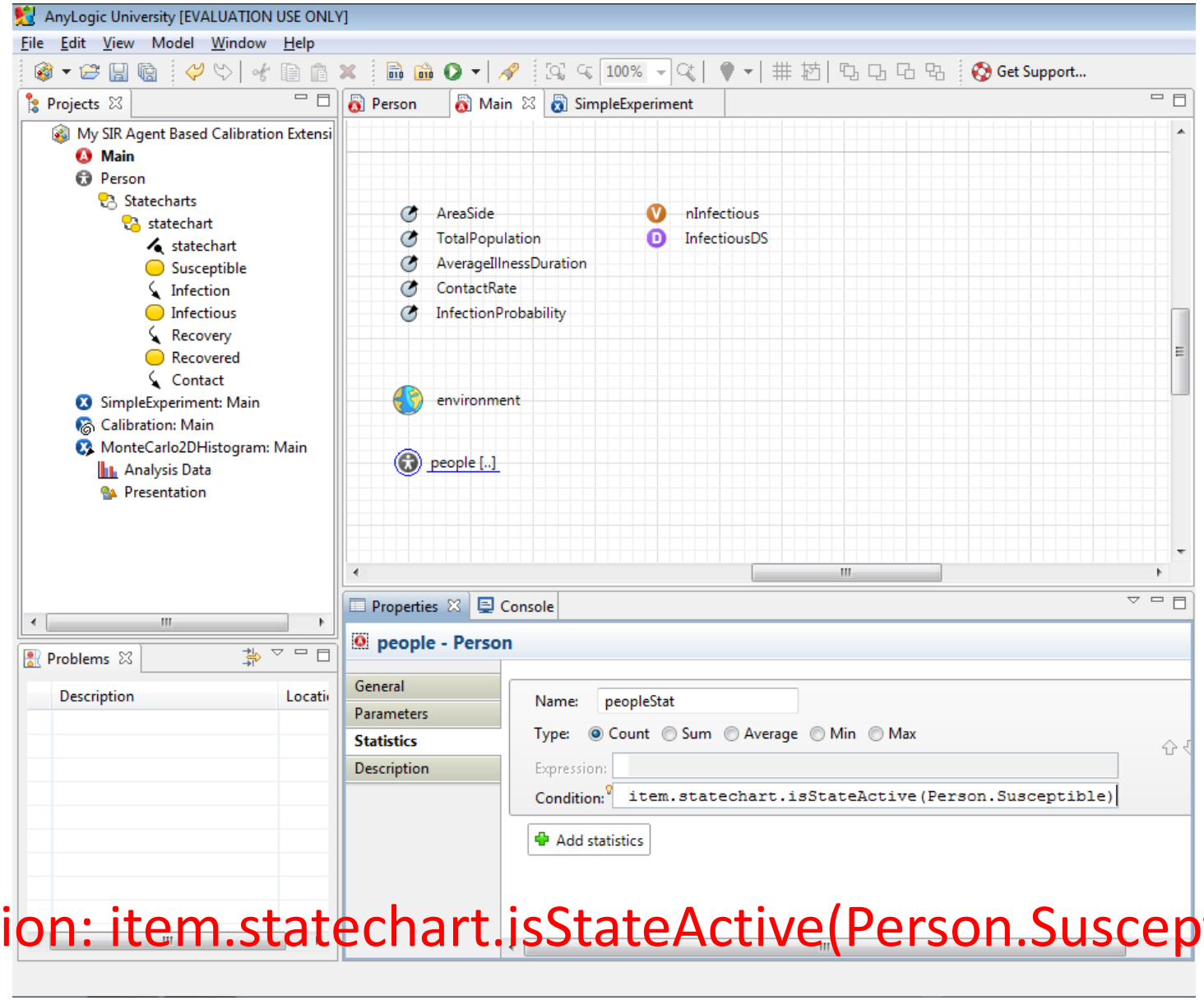
Condition: `item.statechart.is`

Add statistics

Problems

Description	Locati

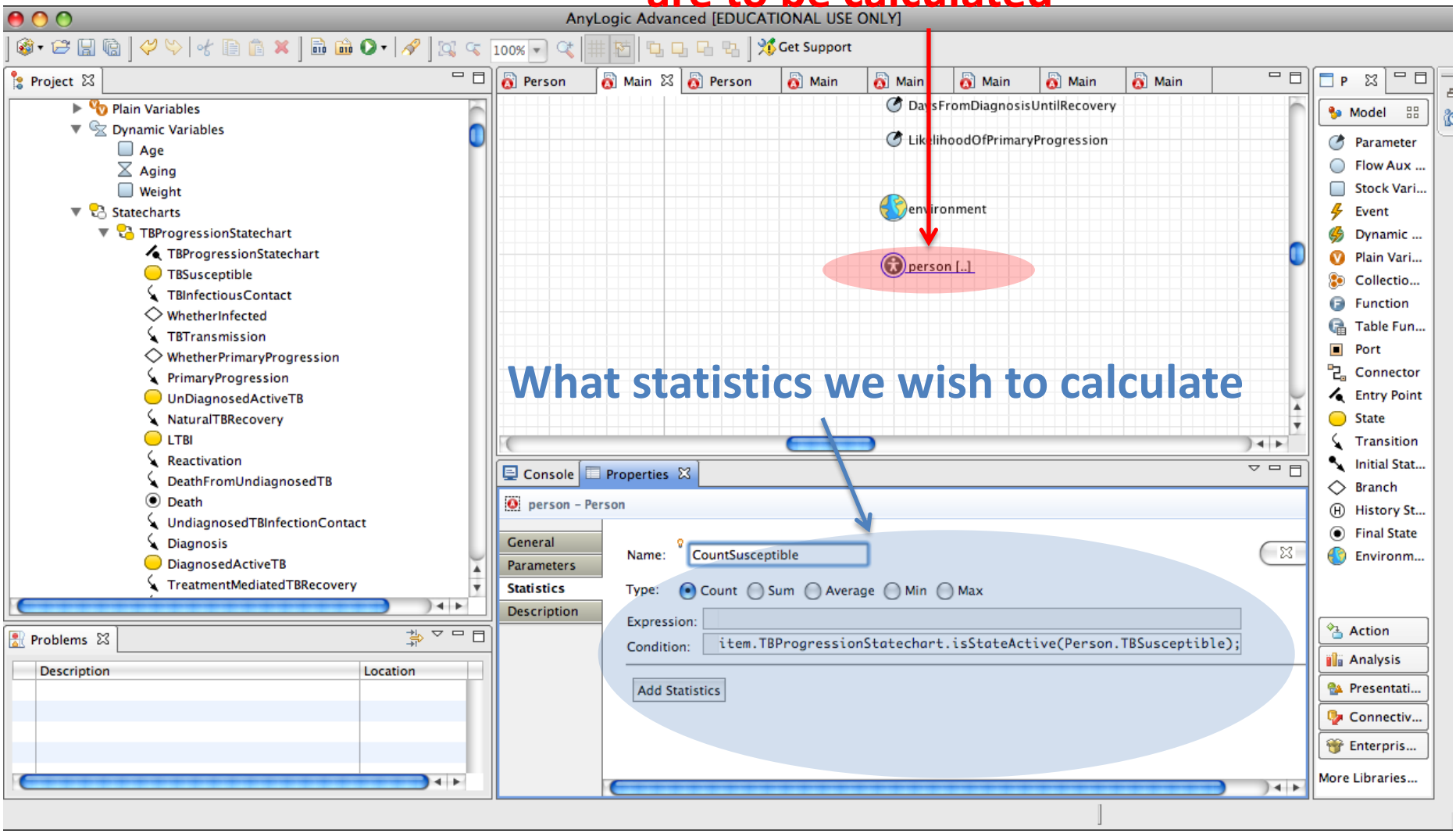
Full Expression



Expression: item.statechart.isStateActive(Person.Susceptible)

Example Statistics

The population in which the statistics are to be calculated



Name the Statistic “countSusceptible”

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File Edit View Model Window Help

Projects

- My SIR Agent Based Calibration Extensi
  - Main
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        - statechart
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Person | Main | SimpleExperiment

AreaSide
TotalPopulation
AverageIllnessDuration
ContactRate
InfectionProbability
nInfectious
InfectiousDS
environment
people [..]

Properties | Console

people - Person

General
Parameters
Statistics
Description

Name: countSusceptible

Type: Count Sum Average Min Max

Expression:

Condition: item.statechart.isStateActive(Person.Susceptible)

Add statistics

Problems

Description	Locati

Palette

- General
- System Dynamics
- Statechart
- Actionchart
- Analysis
  - Data Set
  - Statistics
  - Histogram Data
  - Histogram2D Data
  - Bar Chart
  - Stack Chart
  - Pie Chart
  - Plot
  - Time Plot
  - Time Stack Chart
  - Time Color Chart
  - Histogram
  - Histogram2D
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- Controls
- Connectivity
- Pictures
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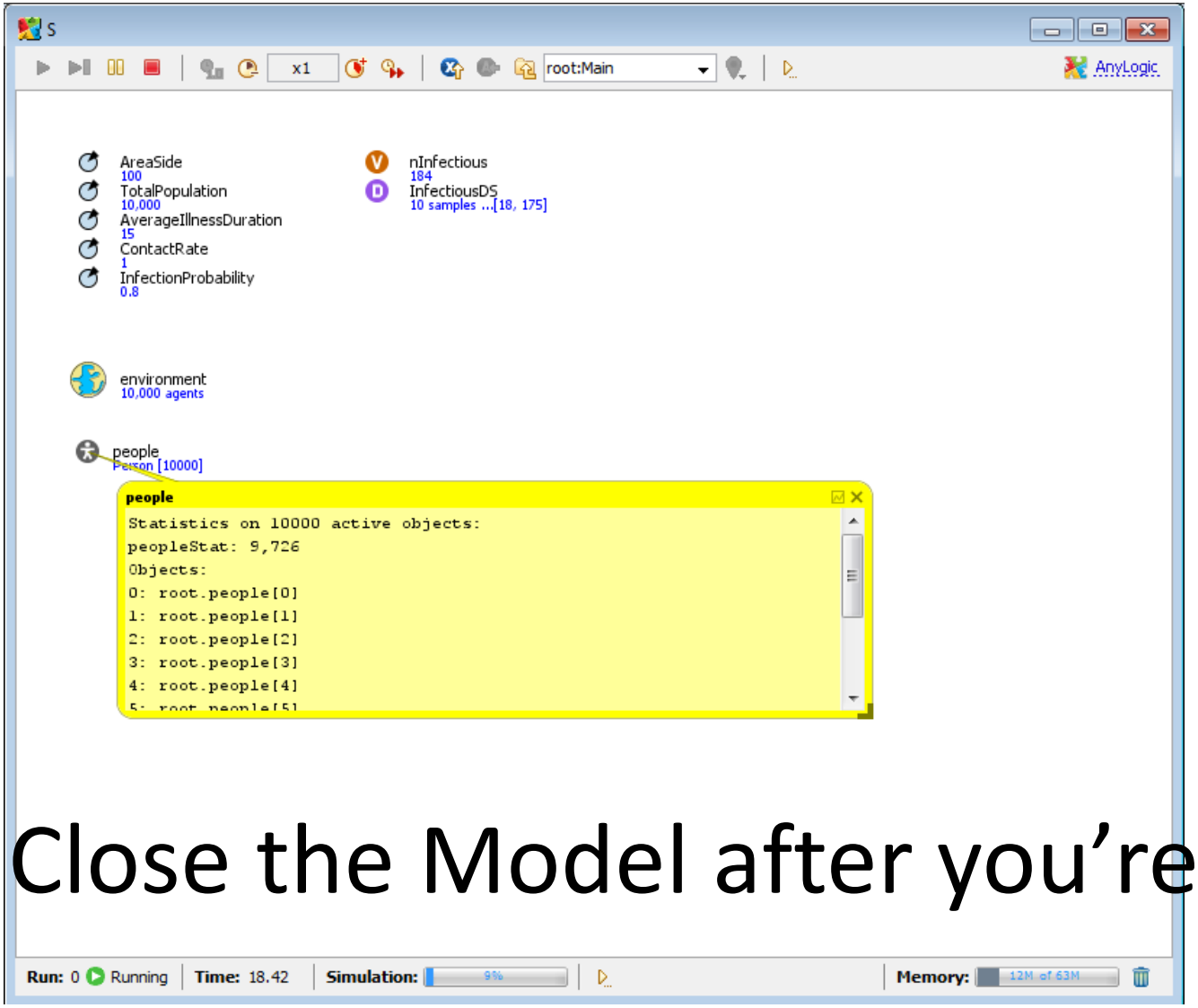
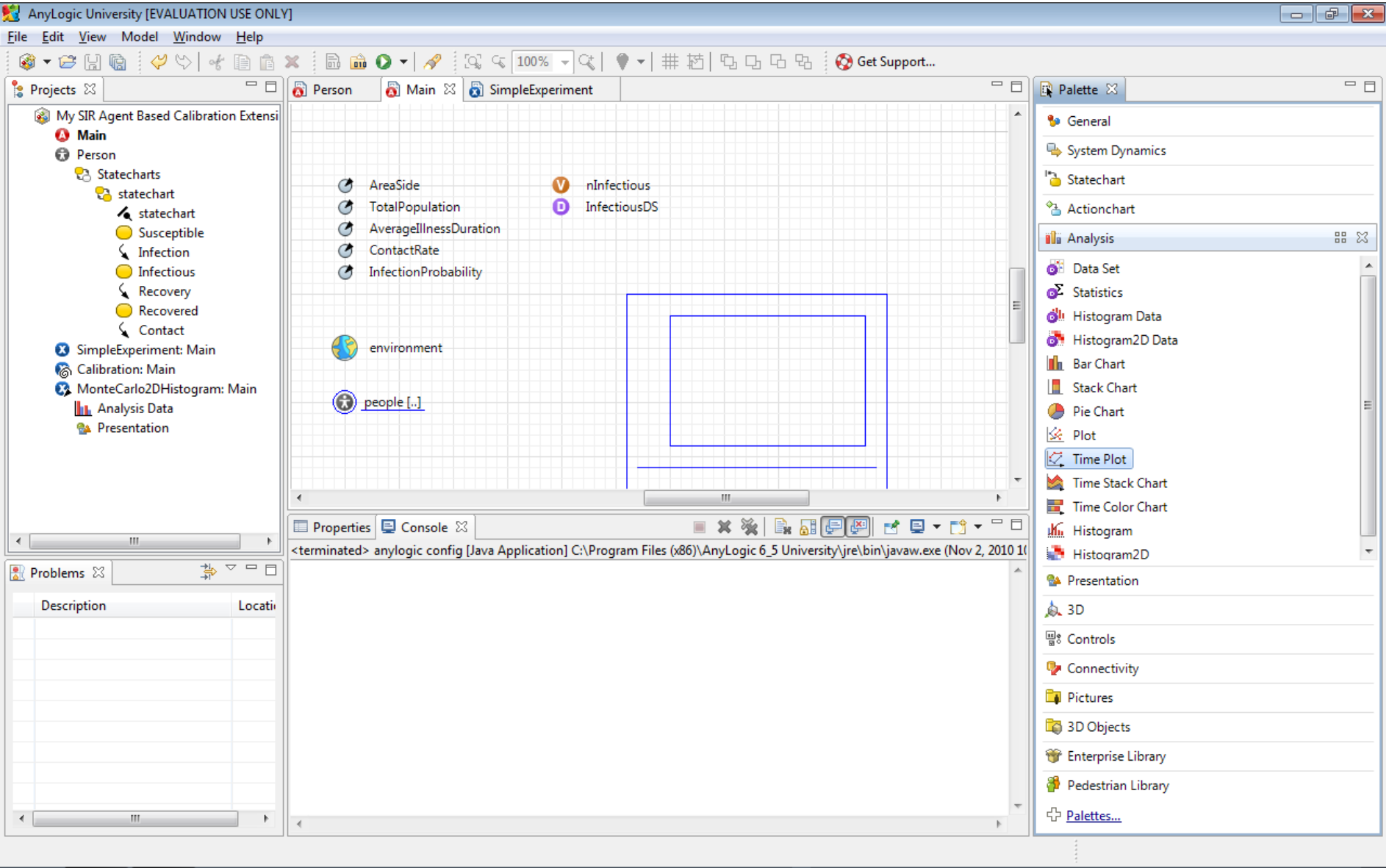
- Pedestrian Library
- Palettes...

Run the Model, and Click on “people”
The Statistic should be Visible



Close the Model after you’re done

Drag a “Time Plot” from the Palette to the “Main” Canvas



Enlarge the Chart

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File Edit View Model Window Help

Projects

- My SIR Agent Based Calibration Extensi
  - Main
  - Person
    - Statecharts
      - statechart
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Person | Main | SimpleExperiment

AreaSide
TotalPopulation
AverageIllnessDuration
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nInfectious
InfectiousDS
environment
people [..]

Palette

- General
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- Analysis
  - Data Set
  - Statistics
  - Histogram Data
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  - Bar Chart
  - Stack Chart
  - Pie Chart
  - Plot
  - Time Plot
  - Time Stack Chart
  - Time Color Chart
  - Histogram
  - Histogram2D
- Presentation
- 3D
- Controls
- Connectivity
- Pictures
- 3D Objects
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- Pedestrian Library
- Palettes...

Problems

Description	Locati

Properties | Console

plot - Time Plot

General | Advanced | Dynamic | Appearance | Description

Name: plot Show name Ignore Public

Add data item

Time Window: 100

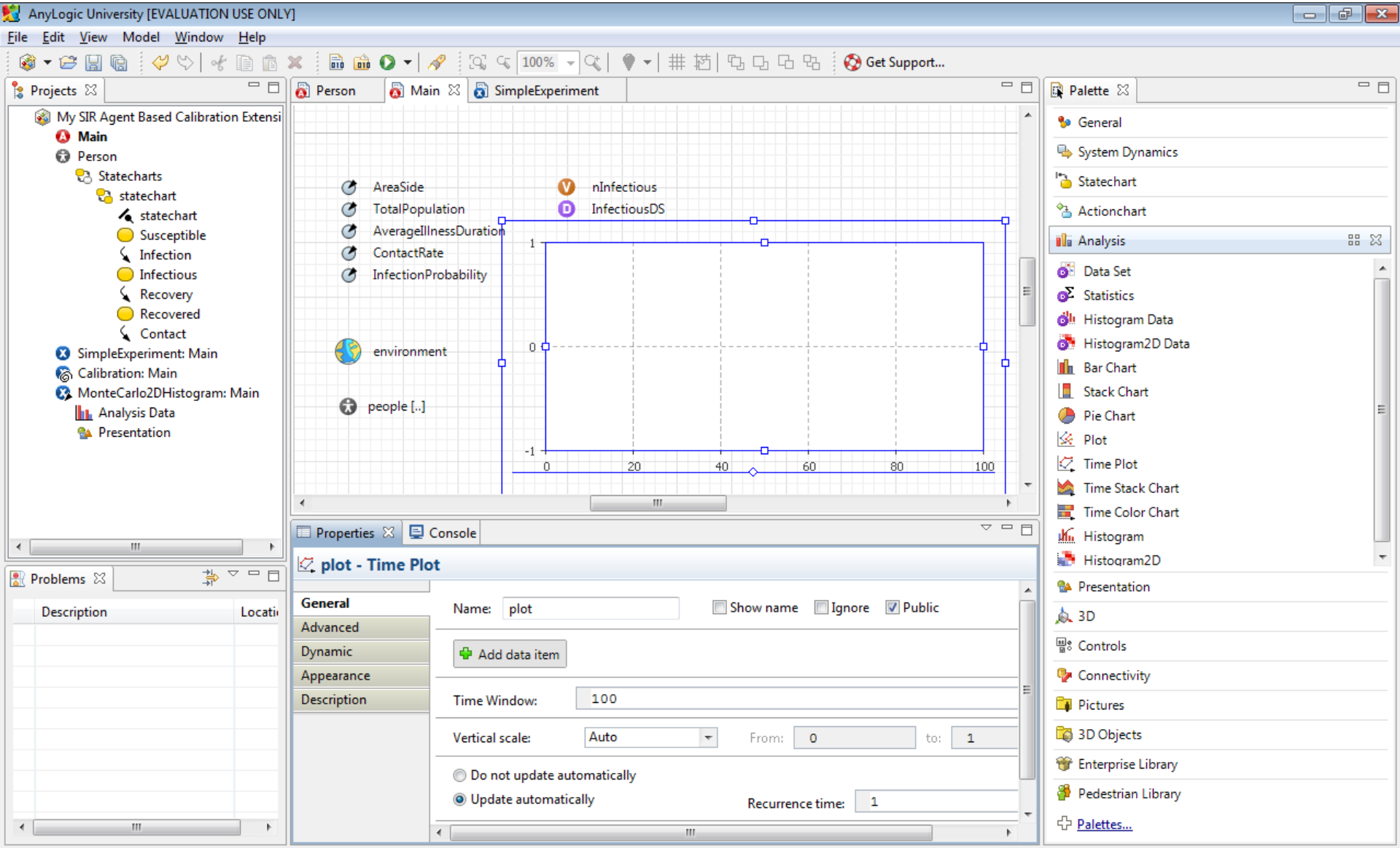
Vertical scale: Auto From: 0 to: 1

Do not update automatically

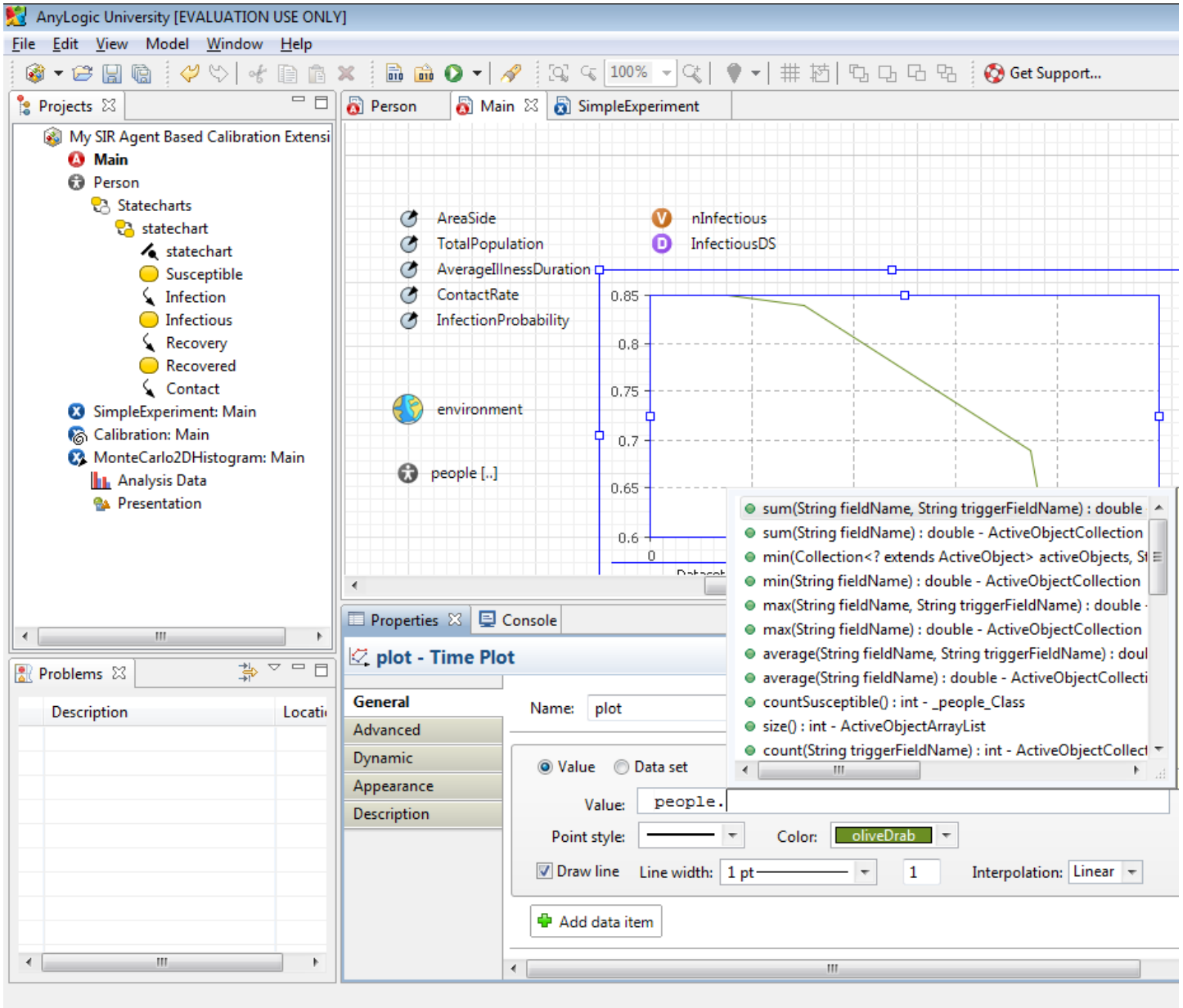
Update automatically Recurrence time: 1

plot - Time Plot | Selection | X=475, Y=169

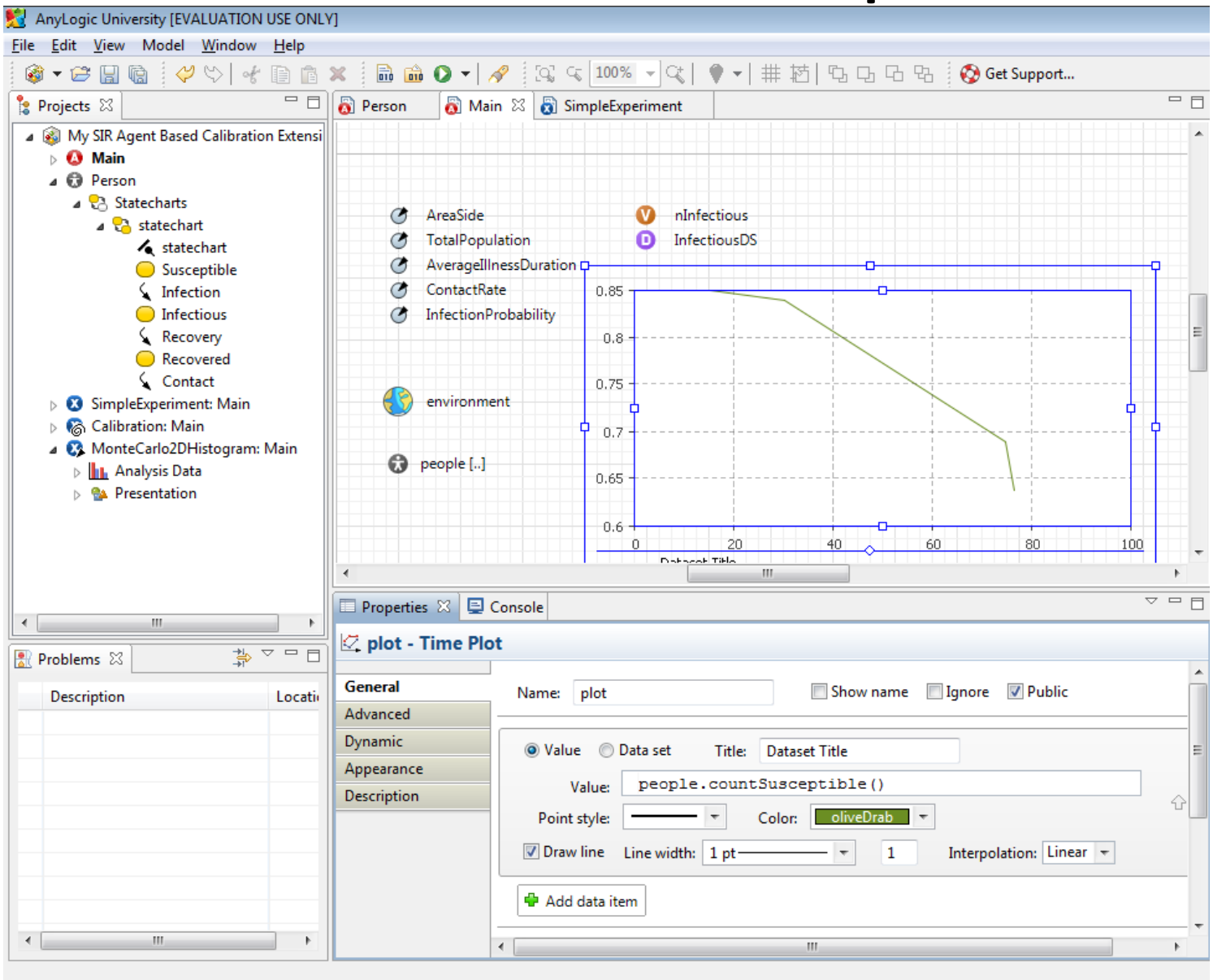
Click “Add Data Item”



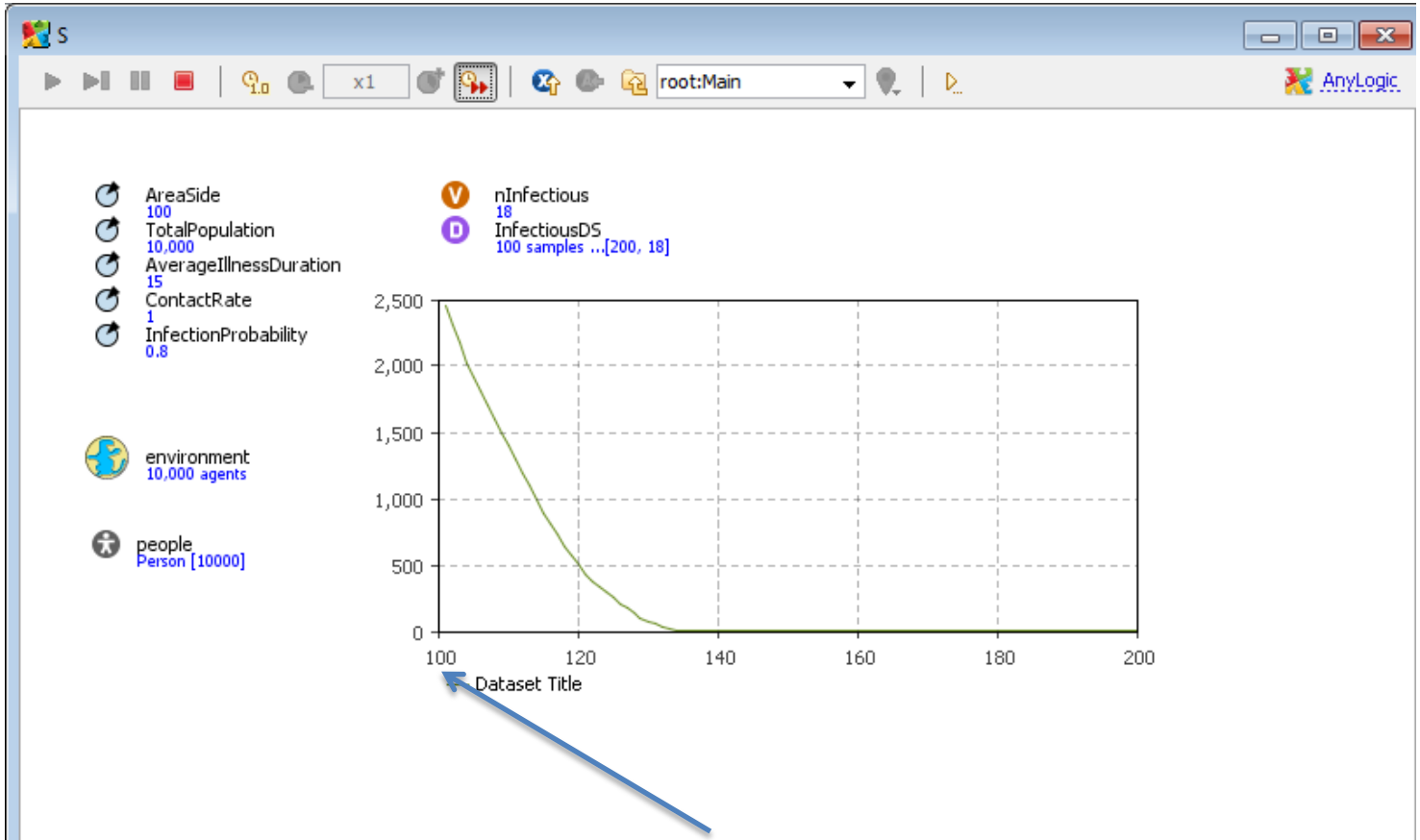
Put in “people.” and Press Ctrl-Space



Choose “Count Susceptible”

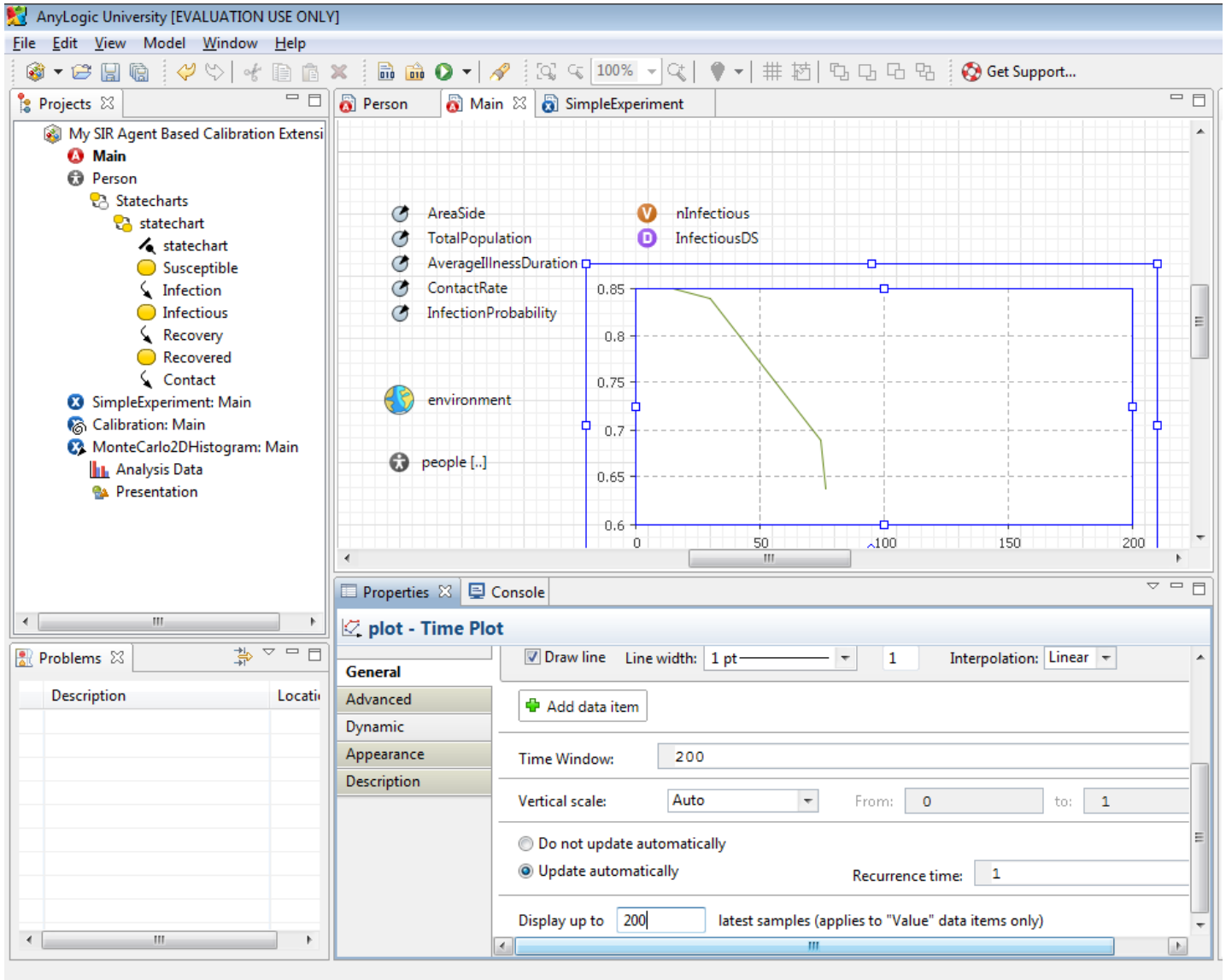


Now Run the Model

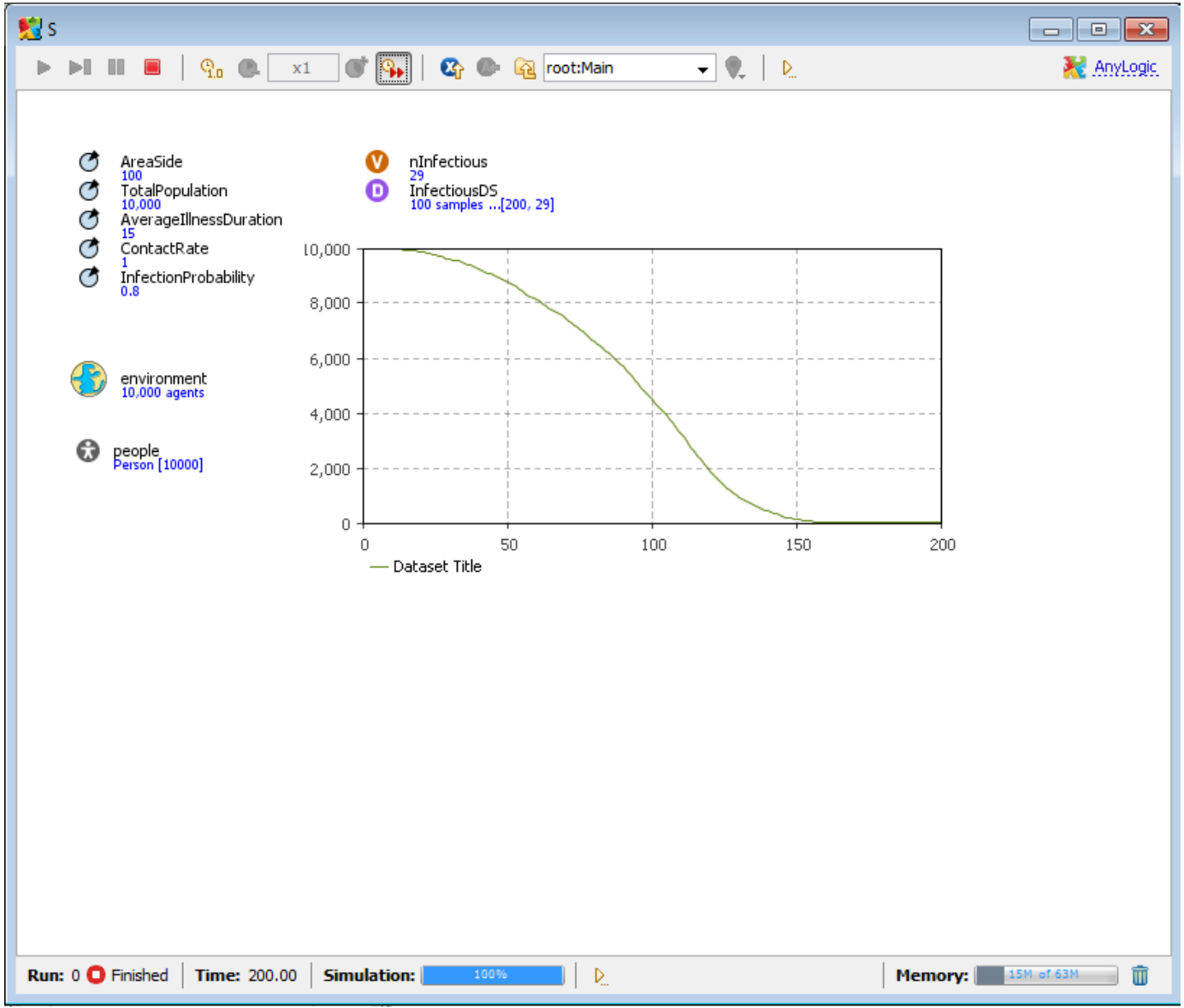


Notice that this only goes back to time 100

Stop the Simulation, and Click on the Plot. Change Time Window & Display Size to 200



This Captures the Full Time Range



Techniques for Collecting & Outputting Data

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- Pre-Prepared methods
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  - Writing to console
  - Export to databases
  - [AnyLogic Professional] Dataset archiving
  - Capturing images of graphs

Datasets

- Datasets store recent values of some quantities from the model
- Datasets can be exported easily using custom code
  - This can simply call the dataset’s toString method

Output: Datasets

AnyLogic Advanced [EDUCATIONAL USE ONLY]

Project

- TBv1*
  - Main
    - Parameters
      - DaysFromDiagnosisUntilRecovery: 30
      - DaysUntilDiagnosis: 60
      - DiagnosedPerDayTBContactRatePerNetworkContact: .
      - LikelihoodOfPrimaryProgression: .10
      - PerContactTBInfectionProbability: .50
      - UndiagnosedPerDayTBContactRatePerNetworkContac
    - Functions
      - PersonWithMaxDegree
    - Environments
      - environment
    - Embedded Objects
      - person
    - Analysis Data
    - Presentation
      - person_presentation
      - TimePlotAgentCount
  - Person
    - Parameters
      - DaysPerTimeUnit: 365.25
      - Ethnicity: 1
      - MeanDaysToNaturallyClearInfection: 180.00

Problems

Description	Location

Person | Main | Person | Main | Main | Main | Main | Main

environment

person [..]

dsSusceptibleCount

Console | Properties

dsSusceptibleCount – Data Set

General

Description

Name: dsSusceptibleCount

☑ Show Name ☐ Ignore ☐ Public ☑ Show At Runtime

☑ Use time as horizontal axis value

Horizontal axis value:

Vertical axis value: person.CountSusceptible()

Keep up to 1000 latest samples

◉ Do not update automatically

○ Update automatically

Begin at time: ○ 0.0 Recurrence time: 1

○ October 29, 2009 2:07:08 AM

Model

Action

Analy...

Data Set

Statistics

Histogra...

Histogra...

Bar Chart

Stack Chart

Pie Chart

Plot

Time Plot

Time Stac...

Time Col...

Histogram

Histogra...

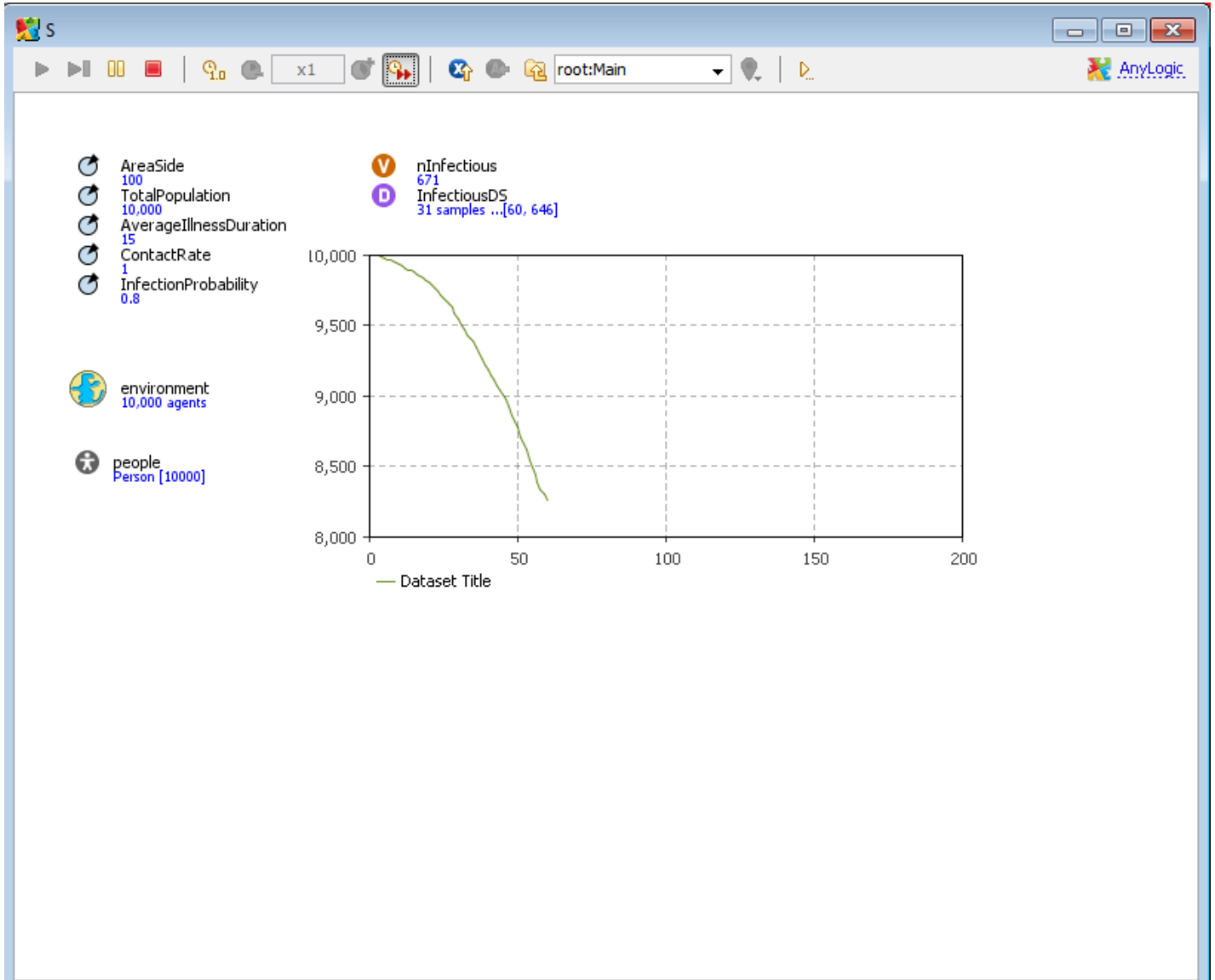
Presentati...

Connectiv...

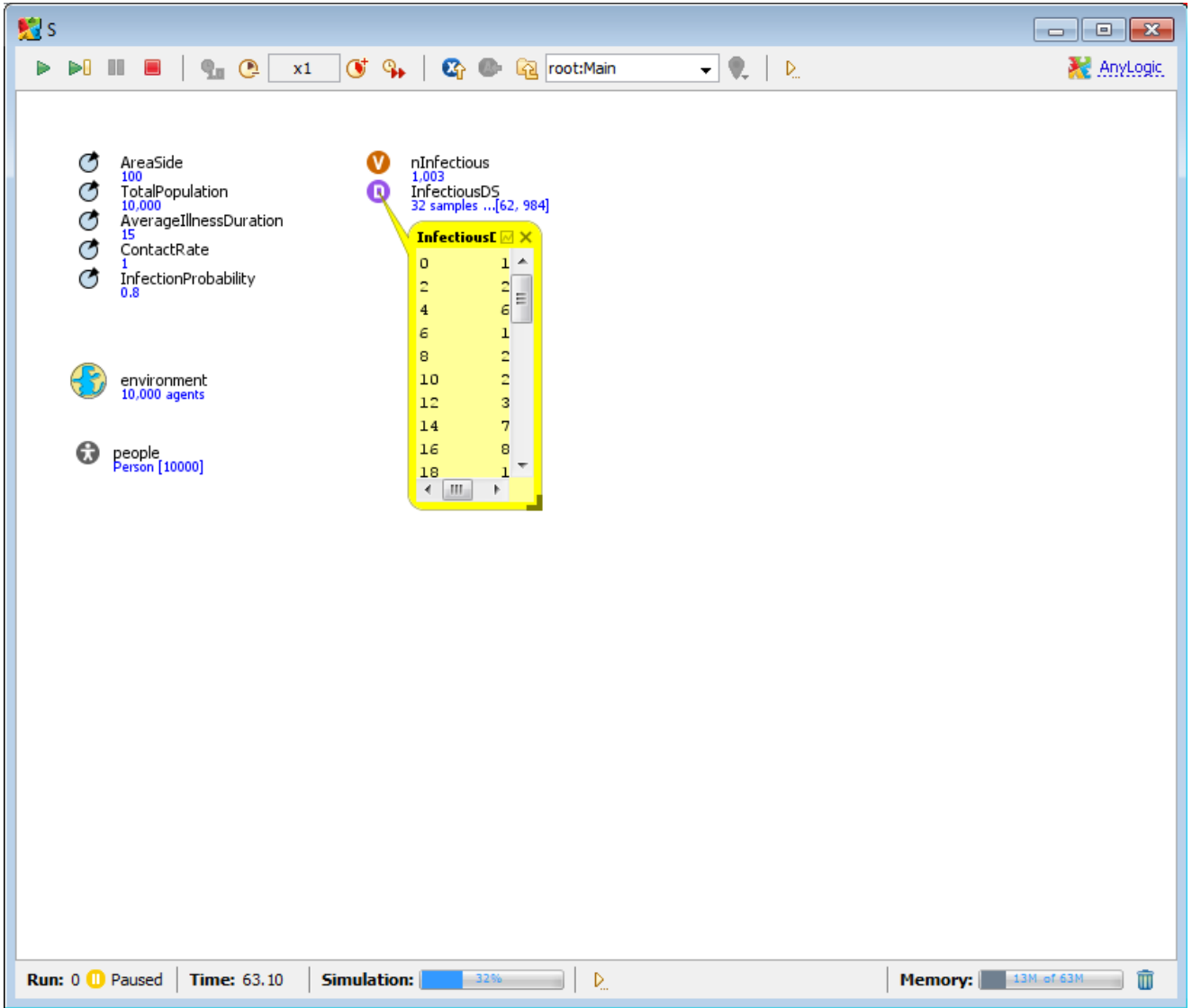
Enterpris...

More Libraries...

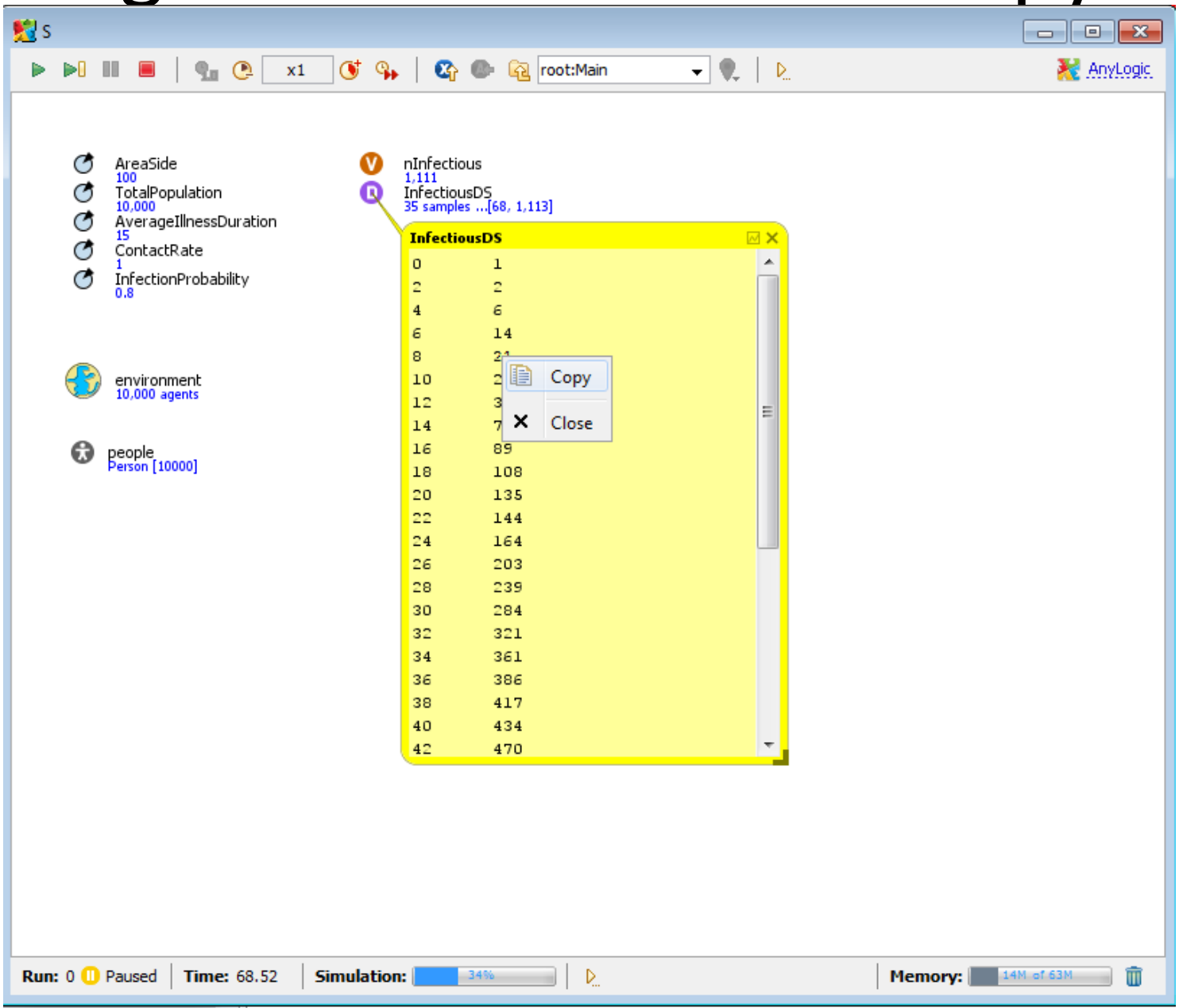
Run the Experiment & Click on "Infectious DS"



Click on “InfectiousDS” to See Data in Dataset



Right Click and Select “Copy”



Call Up Excel and Paste into It

Book1

	A	B	C	D
1	0	1		
2	2	2		
3	4	6		
4	6	14		
5	8	21		
6	10	28		
7	12	35		
8	14	77		
9	16	89		
10	18	108		
11	20	135		
12	22	144		
13	24	164		
14	26	203		
15	28	239		
16	30	284		
17	32	321		
18	34	361		
19	36	386		
20	38	417		
21	40	434		
22	42	470		
23	44	539		

Dataset Properties

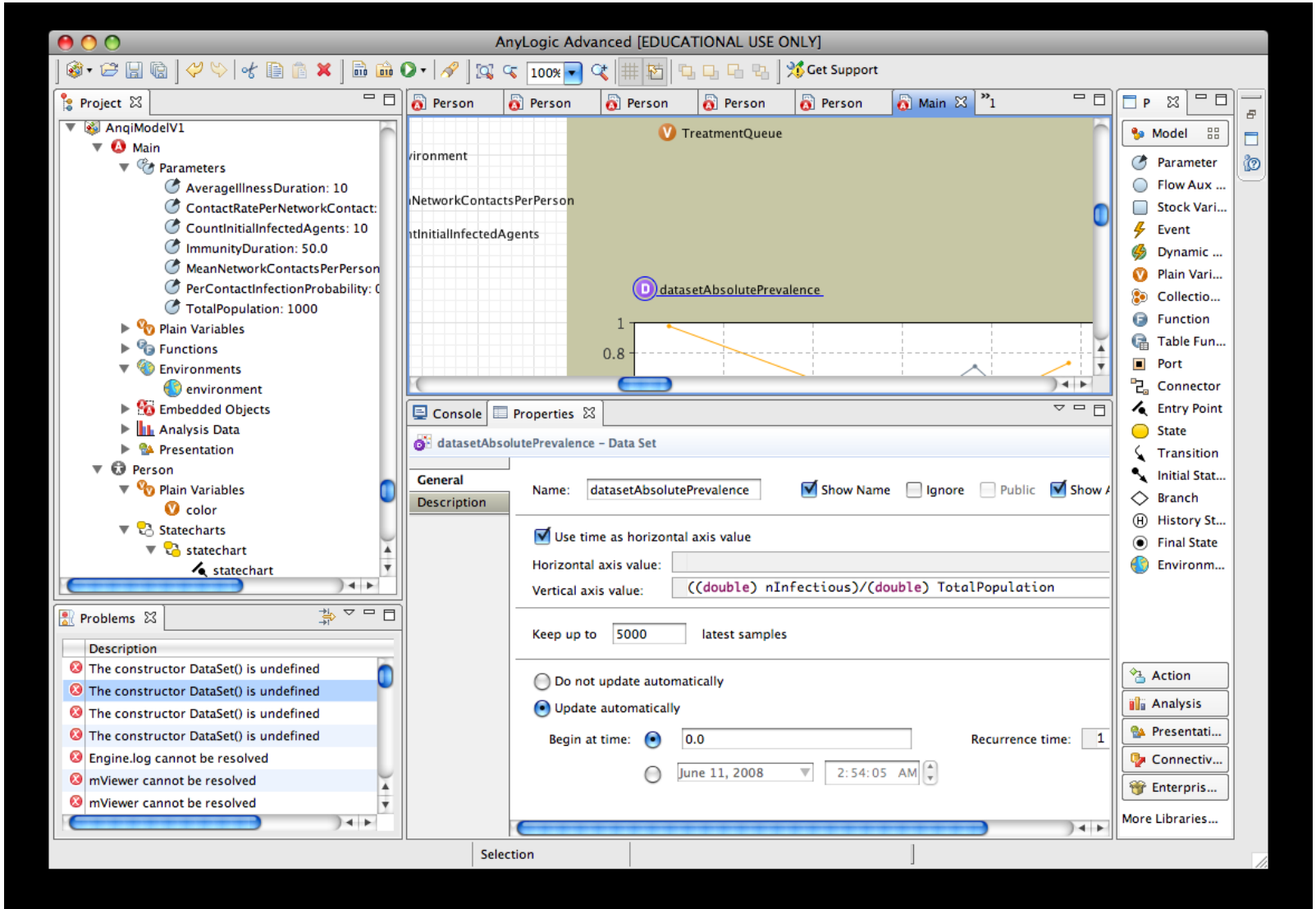
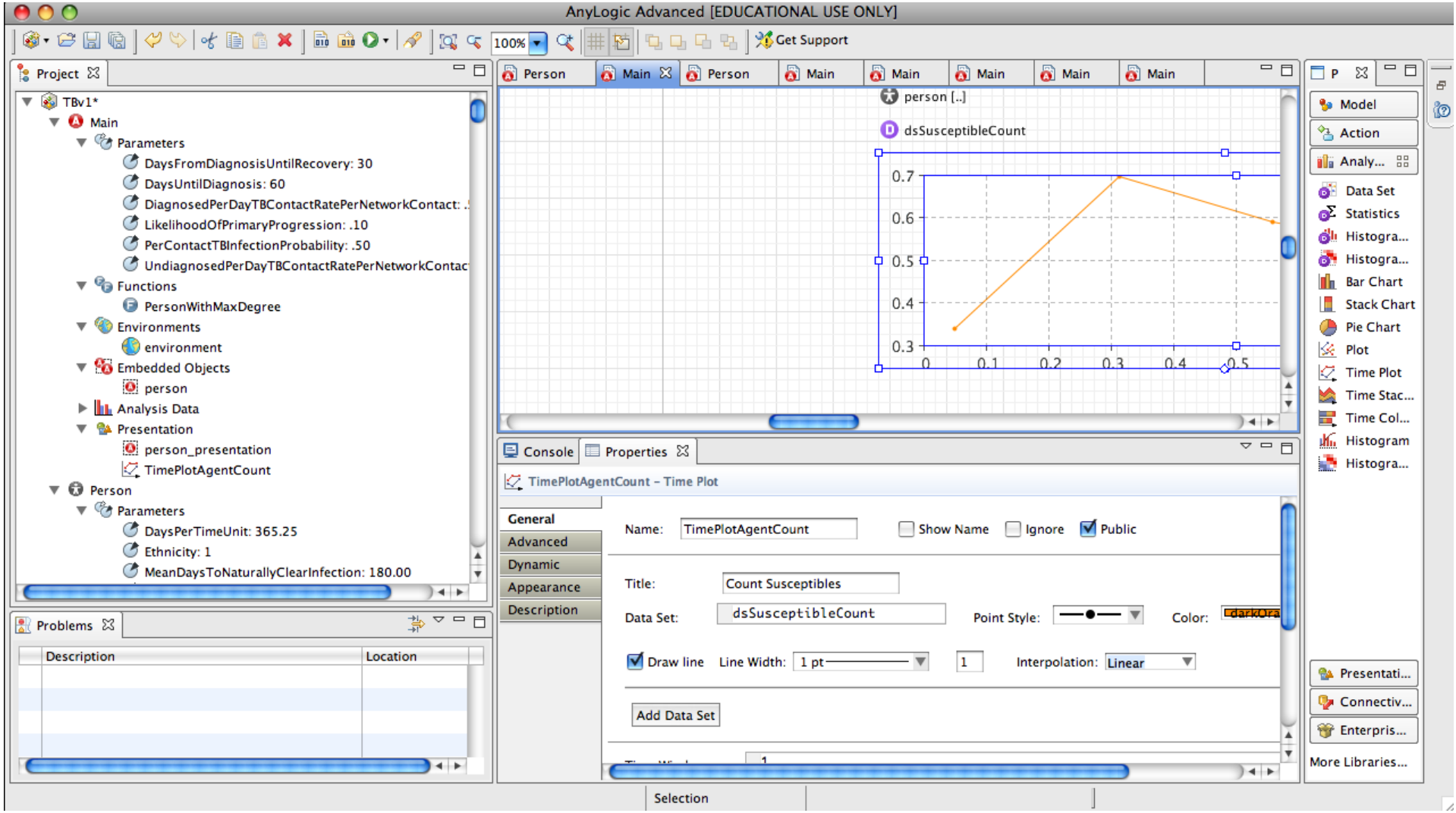
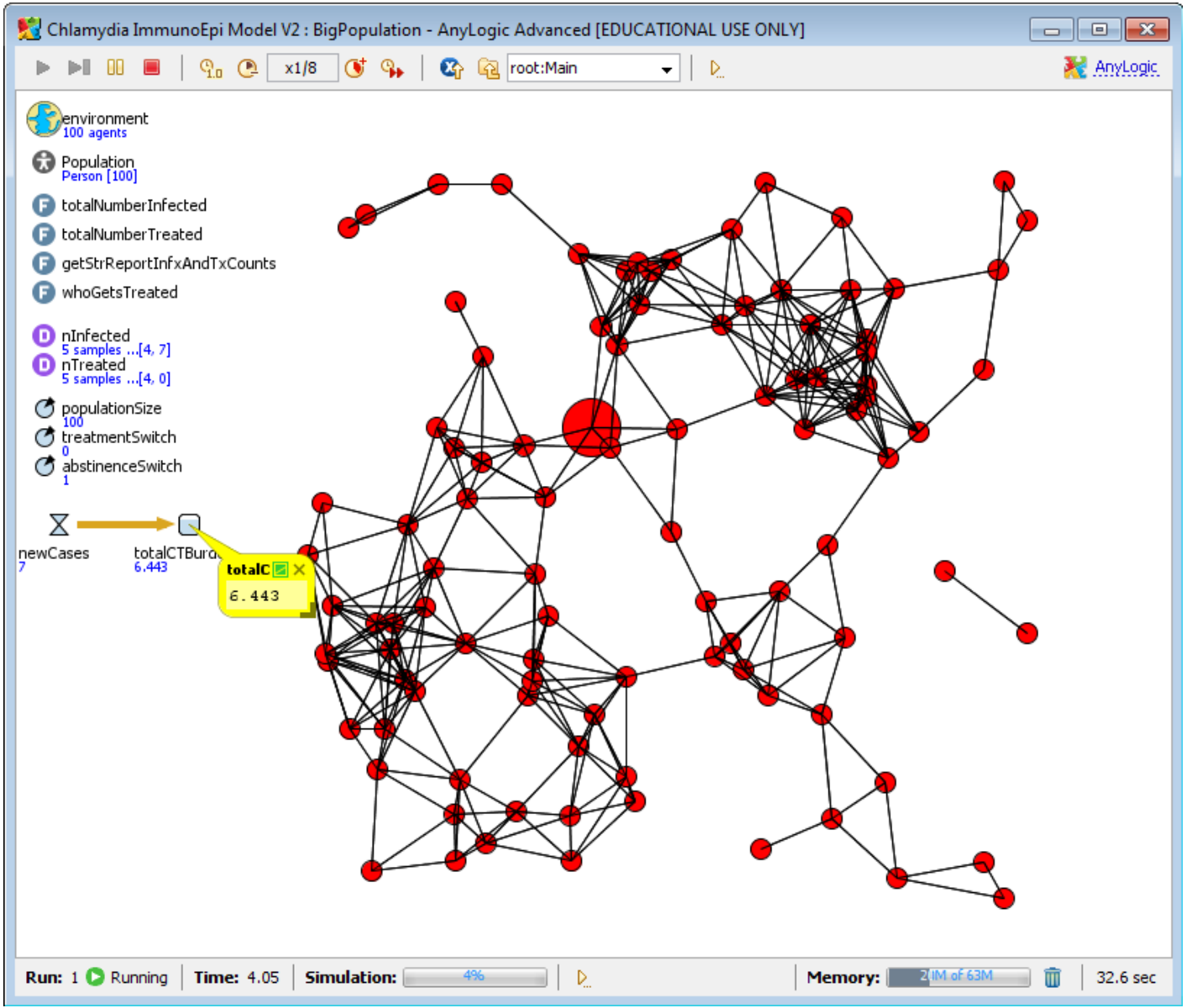


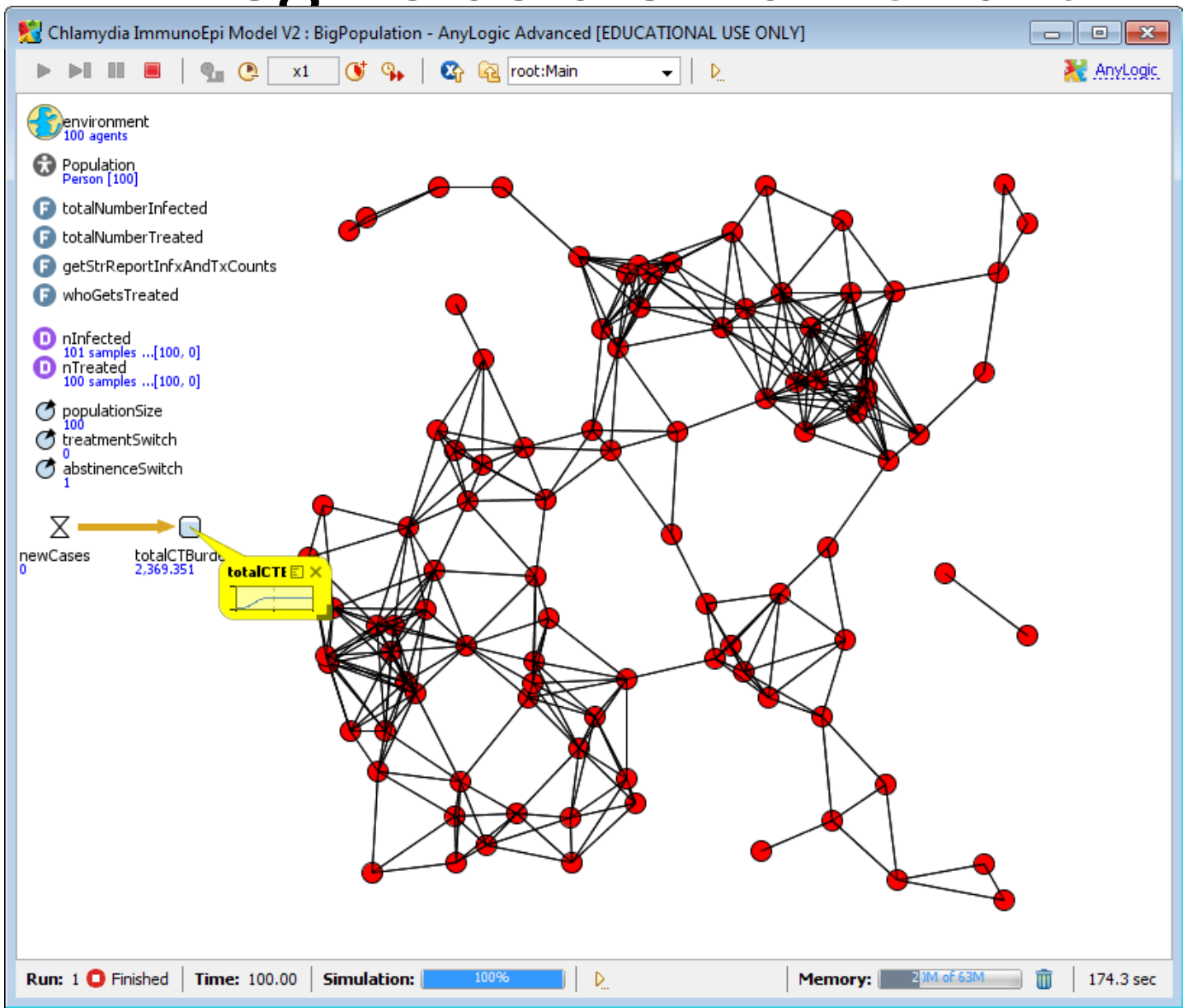
Chart Use of Datasets



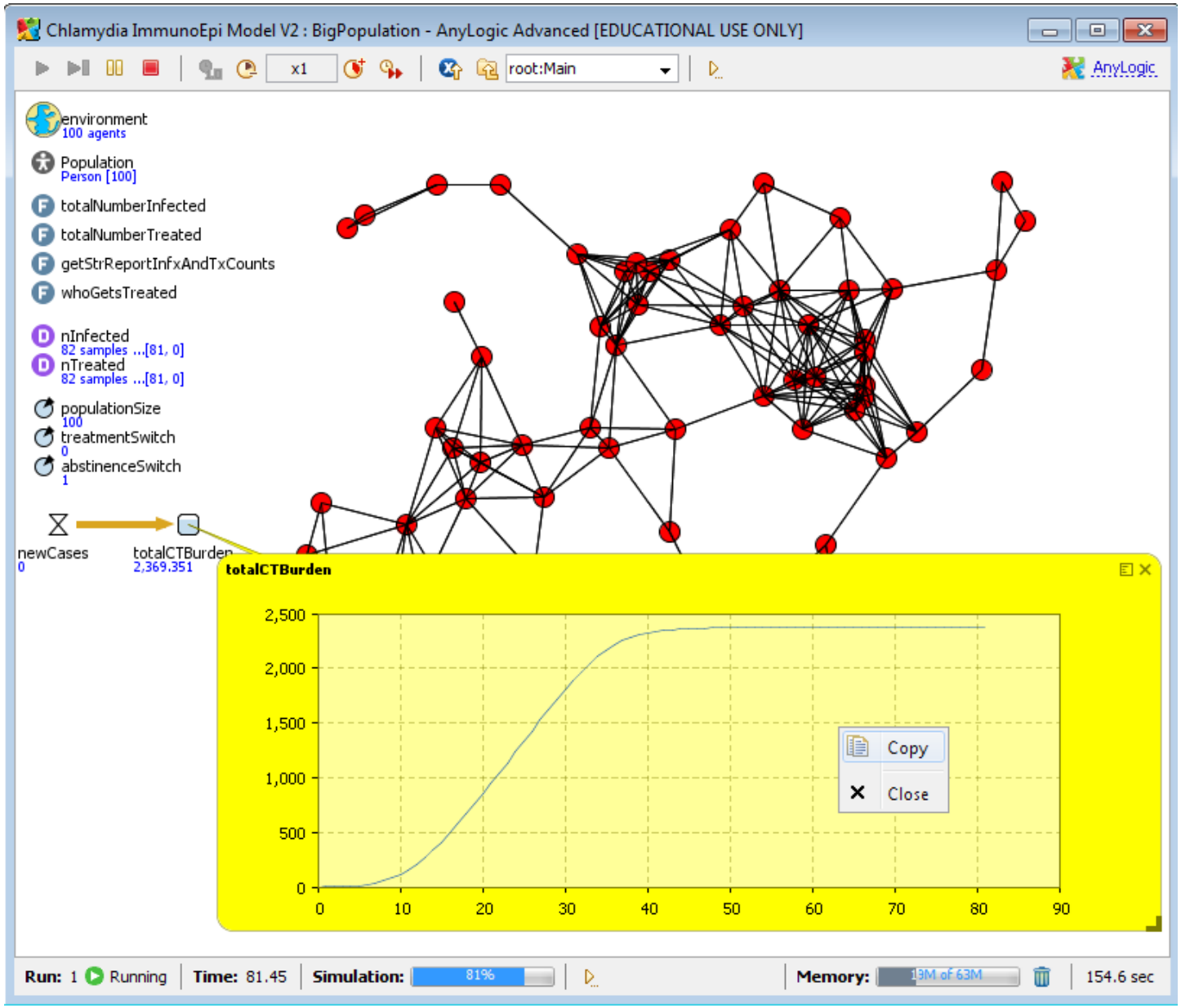
Ad-hoc Export



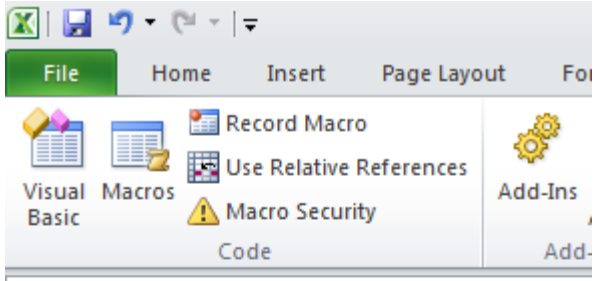
Begins as a Small Chart



Copying Data



Data Exported from Ad-Hoc Chart

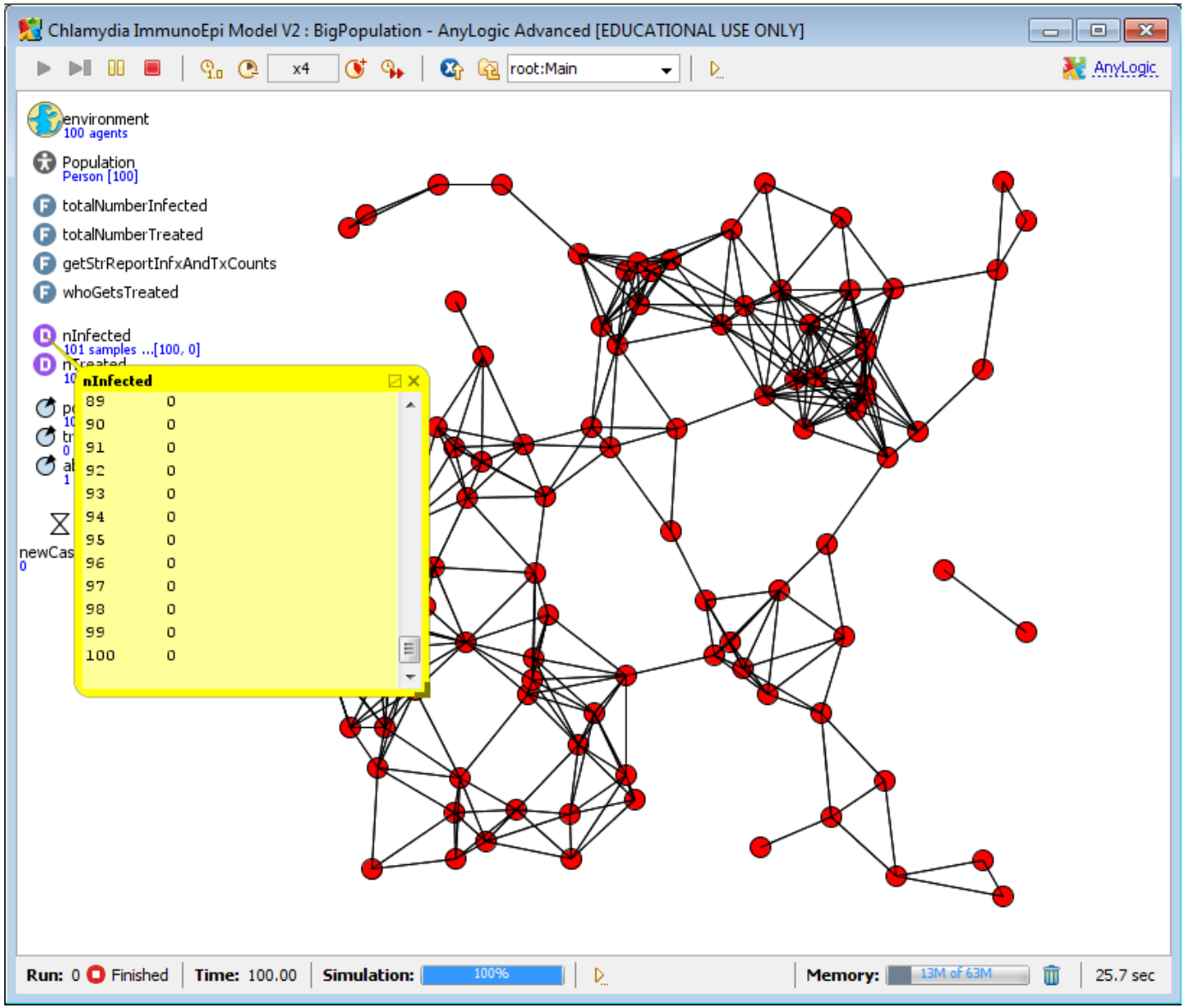


	A	B	C	D
1	totalCTBurden			
2	0	0		
3	1	0.599		
4	2	1.599		
5	3	2.599		
6	4	5.962		
7	5	12.962		
8	6	19.962		
9	7	36.189		
10	8	58.189		
11	9	81.872		
12	10	113.88		
13	11	154.932		
14	12	203.381		
15	13	265.744		
16	14	334.338		
17	15	406.615		
18	16	489.663		
19	17	574.663		

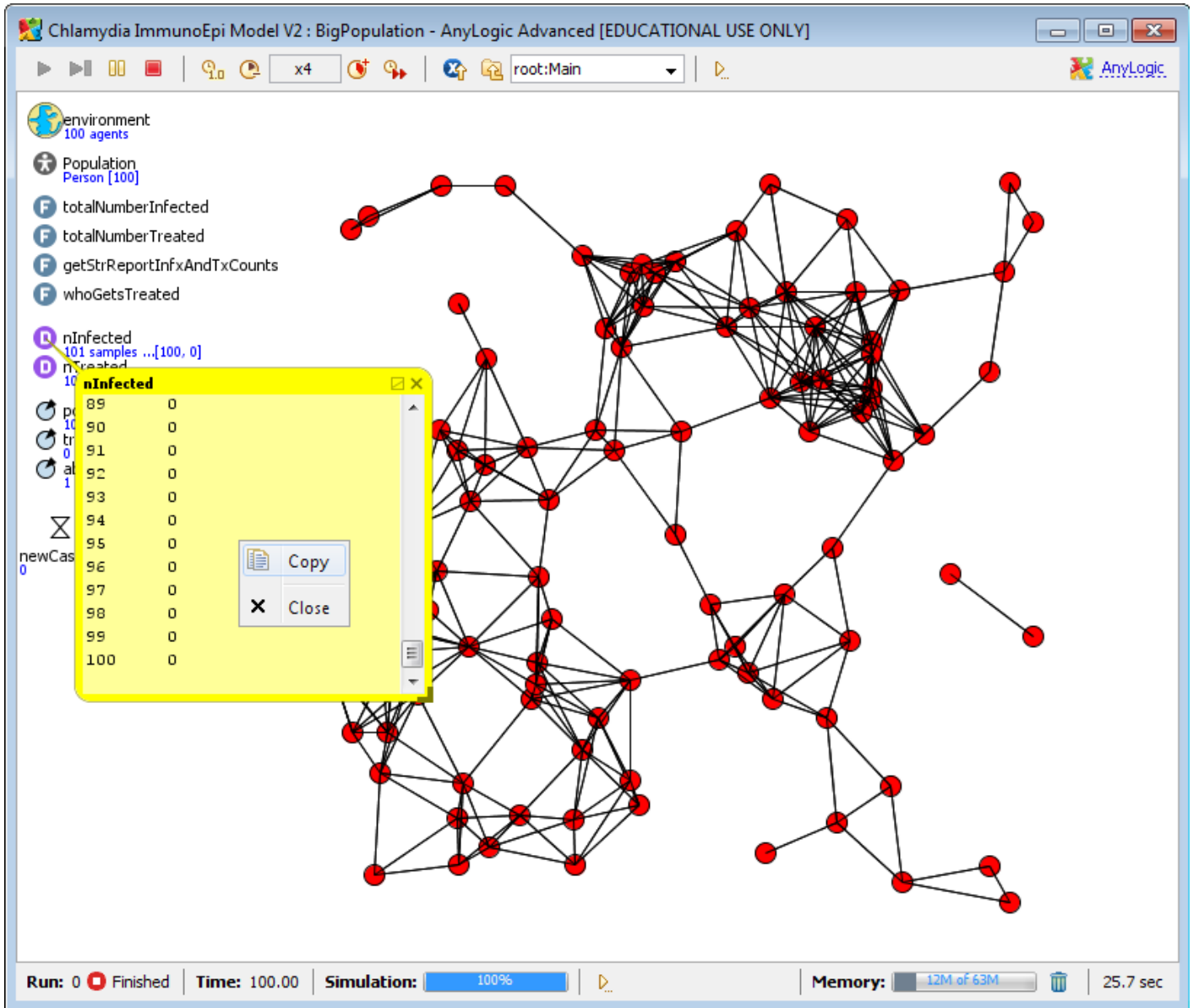
Techniques for Outputting Data

- Ad-Hoc Exports from variables
- Manual copies from visible datasets
- Capturing images of graphs
- Export to files
- Writing to console
- [AnyLogic Professional] Dataset archiving
- Export to databases

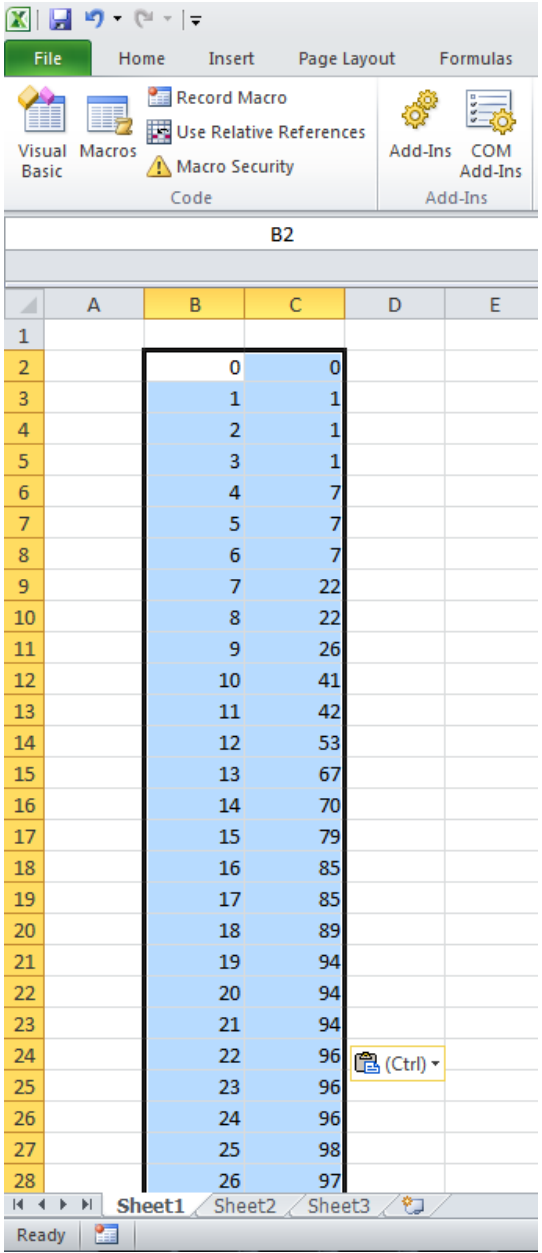
Manual Output from Datasets



Right Clicking Gives Context Menu

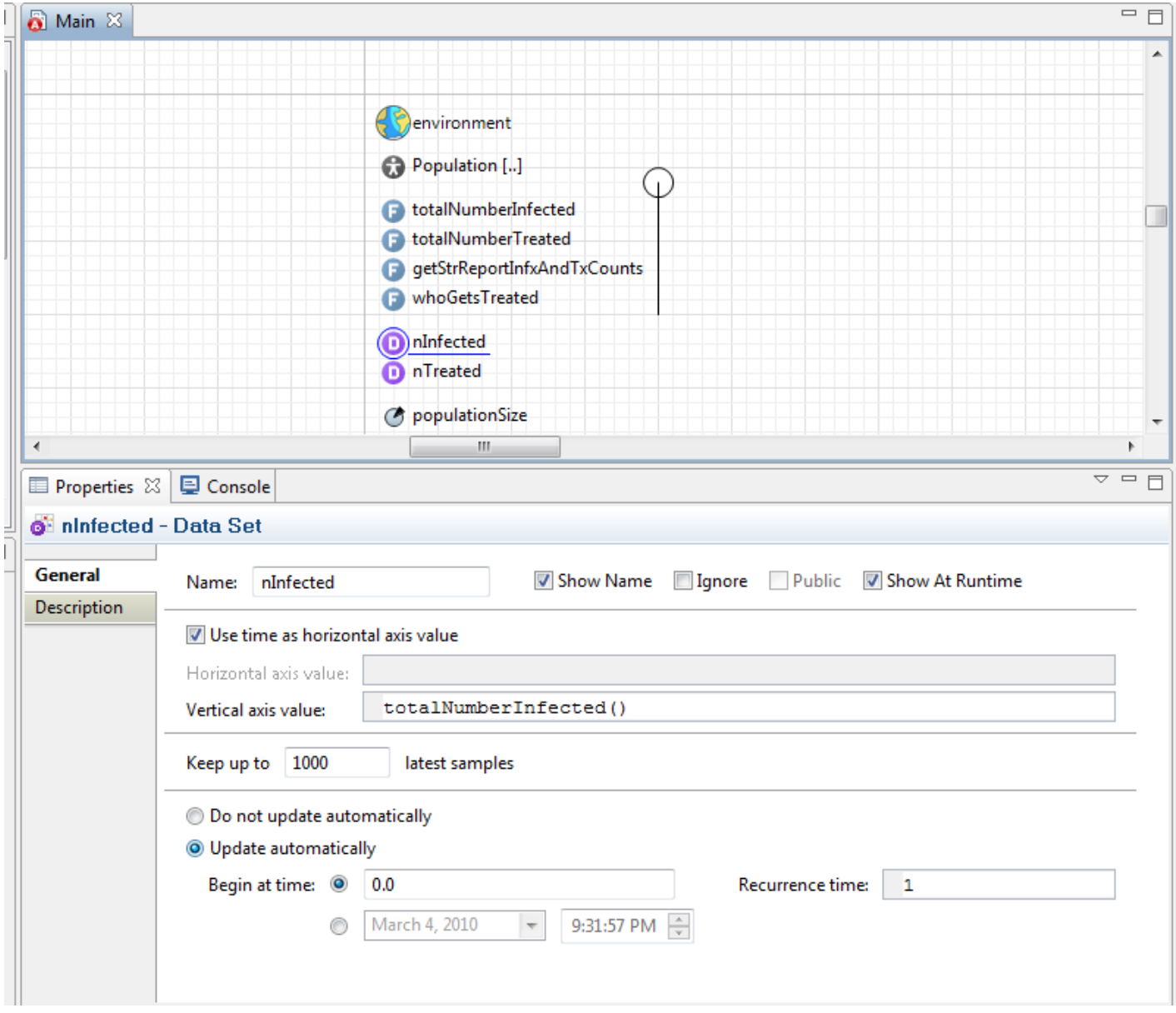


Copied Data Can be Pasted into Excel



	B	C
2	0	0
3	1	1
4	2	1
5	3	1
6	4	7
7	5	7
8	6	7
9	7	22
10	8	22
11	9	26
12	10	41
13	11	42
14	12	53
15	13	67
16	14	70
17	15	79
18	16	85
19	17	85
20	18	89
21	19	94
22	20	94
23	21	94
24	22	96
25	23	96
26	24	96
27	25	98
28	26	97

Declaratively Specifying Datasets



Supported Dataset Types

- Simple
  - holds values only -- no timestamps
- Timed
  - holds values and timestamps
- Phase
  - holds pairs of values but no timestamps
- Histogram
  - can define bins for data set
  - data set will record # falling in each bin

Techniques for Outputting Data

- Ad-Hoc Exports from variables
- Manual copies from visible datasets
- Capturing images of graphs
- Output to console
- Export to files
- [AnyLogic Professional] Dataset archiving
- Export to databases

Output to Console

- Pros
  - Easy to program
    - ActiveObject.traceln(String str) outputs string to console
    - System.out.println(String str) (Black)
    - System.err.println(String str) (Red)
  - Readily visible
  - Copy & Paste to another document
- Cons
  - May be mixed with other output (easy to miss other output)
  - Limited length
  - Depends on memory to copy
  - Less structured

Techniques for Outputting Data

- Ad-Hoc Exports from variables
- Manual copies from visible datasets
- Capturing images of graphs
- Writing to console
- Export to files
- [AnyLogic Professional] Dataset archiving
- Export to databases

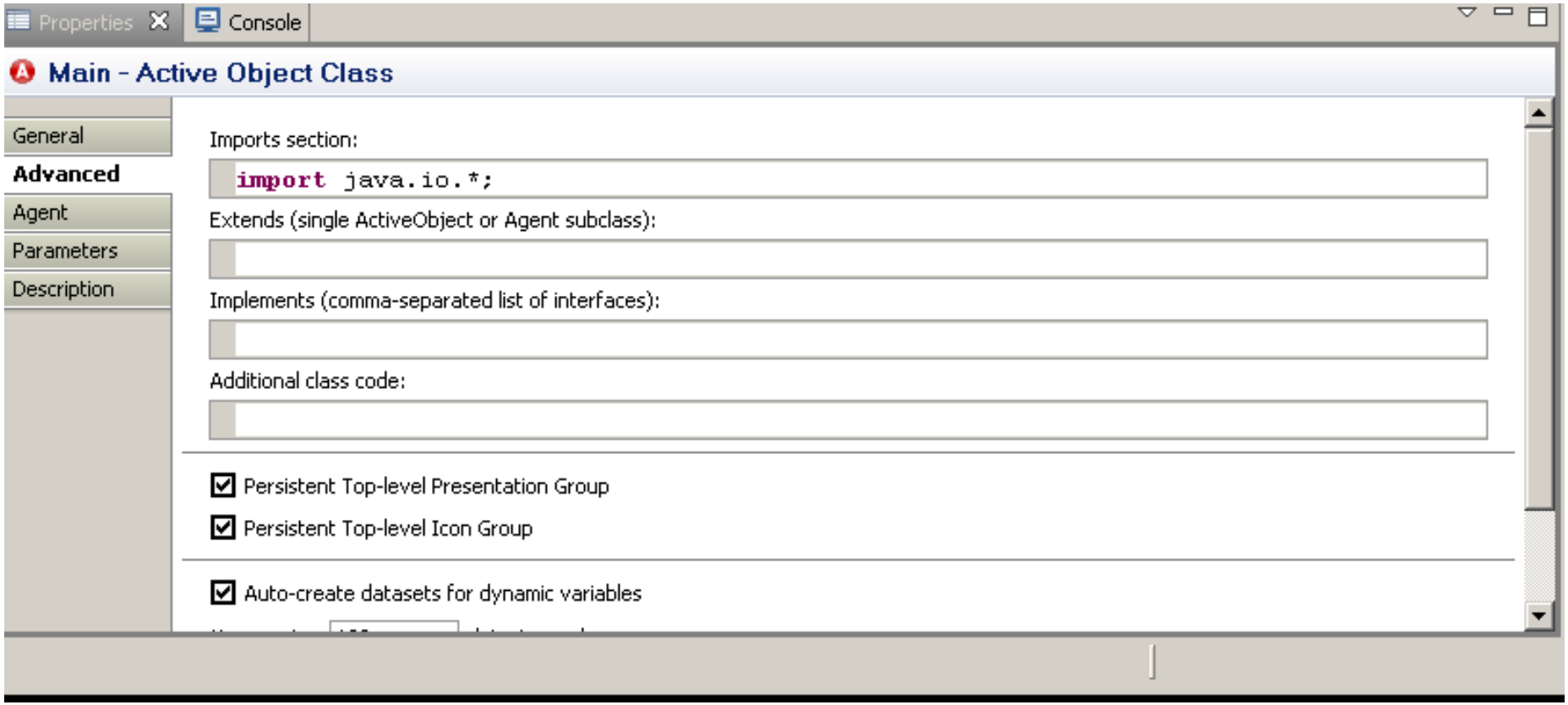
Data Output to File

- Pros
  - Simple to perform
  - Relatively easy to import into e.g. Excel, R, etc.
  - Files can be readily archived
- Cons
  - Awkward to draw combine from multiple files
  - Denormalization: Requires either
    - Duplication of scenario-wide information (e.g. parameter values) on each row
    - Separate header section & later section

Outputting a Dataset to a File Requires 2 Steps

- “Importing” (specifying how to find) the necessary Java code
- Defining the code

Step 1: Importing the Necessary Java Libraries



Step 2: Code to Export Dataset to File

```
try
{
  FileOutputStream fos = new
  FileOutputStream("Filename.tab");
  PrintStream p = new PrintStream(fos);
  p.println(datasetName.toString());  // outputs
  tab delimited values
}
catch (Exception e)
{
   traceln("Could not write to file.");
}
```

Substitute whatever file name you wish to use
You may wish to put a "path" in front of this

Substitute the name of the dataset
You wish to output

Suggestion: For greater versatility, place this in a function that takes the file name as a parameter.

Where to Put the Code to Output the Dataset
Option 1: In “Destroy Code” for Main

AnyLogic Advanced [EDUCATIONAL USE ONLY]

File Edit View Model Window Help

Project

- PodSchedule
- SimplePersonEntity
- TestPodSchedule
- TriggerDebugger
- EclipseDebuggingSimulation: Main
- Simulation: Main
- UnitTest: Main
- ABMModelWithBirthDeath*
  - Main
    - Parameters
    - Functions
    - Events
    - Environments
    - Embedded Objects
    - Analysis Data
      - datasetInfective
    - Presentation

Problems | Search

Description	Location

Main

Population [..]
datasetInfective
environment
offspringDistanceFromMother
initialPrevalenceOfInfection
immigrantsPerYear
ImmigrantArrival
prevalenceOfInfectionAmongImmigrants
MeanLifespan
selectPeopleMatchingSpecification
performActionOnPeopleMatchingPredicate
countPeopleMatchingMultipleSpecification

Properties | Console

Main - Active Object Class

General | Advanced | Agent | Parameters | Description

Name: Main Ignore

Agent Generic

Startup Code:

```
environment.deliverToRandom("Infect!");
```

Destroy Code:

```
try
{
  FileOutputStream fos = new FileOutputStream("Filename.tab");
  PrintStream p = new PrintStream(fos);
  p.println(datasetInfective.toString());  // outputs tab delimite
}
catch (Exception e)
```

Model

- Parameter
- Flow Aux ...
- Stock Vari...
- Event
- Dynamic E...
- Plain Varia...
- Collection ...
- Function
- Table Fun...
- Port
- Connector
- Entry Point
- State
- Transition
- Initial Stat...
- Branch
- History St...
- Final State
- Environment

Action | Analysis | Presentation | Connectivity | Enterprise ... | More Libraries...

Build completed successfully. Time: 0.941 s.

Selection

Where to Put the Code to Output the Dataset
Option 2: In "Action" for an Event Triggered at times

AnyLogic Advanced [EDUCATIONAL USE ONLY]

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  - Main
    - Parameters
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    - Analysis Data
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Problems | Search

Description	Location

Main

Population [..]
datasetInfective
environment
offspringDistanceFromMother
initialPrevalenceOfInfection
immigrantsPerYear
ImmigrantArrival
prevalenceOfInfectionAmongImmigrants
MeanLifespan
writeToFile
selectPeopleMatchingSpecification
performActionOnPeopleMatchingPredicate
countPeopleMatchingMultipleSpecification

Properties | Console

writeToFile - Event

General
Description

Name: writeToFile
☑ Show Name ☐ Ignore ☐ Public ☑ Show At Runtime

Trigger Type: Timeout
Mode: Occurs once

Occurrence time (absolute) ⦿ 0
○ September 1, 2011 4:12:49 PM

Action:

```
try
{
  FileOutputStream fos = new FileOutputStream("Filename.tab");
  PrintStream p = new PrintStream(fos);
  p.println(datasetInfective.toString());  // outputs tab delimite
}
```

Model

- Parameter
- Flow Aux ...
- Stock Vari...
- Event
- Dynamic E...
- Plain Varia...
- Collection ...
- Function
- Table Fun...
- Port
- Connector
- Entry Point
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Action
Analysis
Presentation
Connectivity
Enterprise ...
More Libraries...

Techniques for Outputting Data

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Output to Databases: Tradeoffs

- Pros
  - More flexible than string output to file
  - Can query from diverse tools (e.g. excel, R, SPSS, SAS, etc.)
  - Can easily clean up
  - For larger databases
    - Transactional (either writes entirely or not at all)
    - Can query from remote machines
- Cons
  - More programming
  - Need to set up a database

Output to Databases: Steps

- One Time:
  - Install database on computer
  - Add reference to database libraries
- Each time during simulation
  - Open database connection at start of model
  - Optionally, “insert” model version & parameter information into the database
  - Periodically during simulation
    - “insert” values into databases
  - At end of model execution, close database connection

Relevant Databases

- Databases most oriented towards single users & single computers
  - MS Access
  - H2
  - These databases less robust => risk of corruption
  - These are often quite fast
- Databases oriented towards multiple users & multiple computers
  - Oracle
  - DB2
  - MS SQL Server
  - Open source
    - Postgres
    - Derby
    - MySQL
- More robust
- Support remote access

Database Dependencies (MySQL database)

Properties | Console

RecreationOfAzizaModelCubeDataStorage_V4NoA...CGLTBI_NDOModificationsForTestingV2 - Model

General
Dependencies
Description

AnyLogic libraries required to build the model:

Name	Version	Location

Jar files and class folders required to build the model:

Location
mysql-connector-java-5.1.13-bin.jar

Options for Database Access

- AnyLogic Professional: Built-in visual database classes
  - Simplify the composition of database operations
- Direct calling of database operations in Java's "Java DataBase Connectivity" (JDBC) Library
  - Note ODBC "bridge" for windows database driver support
- Custom database classes
  - We would be happy to share our simple interface
  - More refined interfaces possible

Example Simple Database Class for SQL Relational Database Systems

A Method is associated with each of

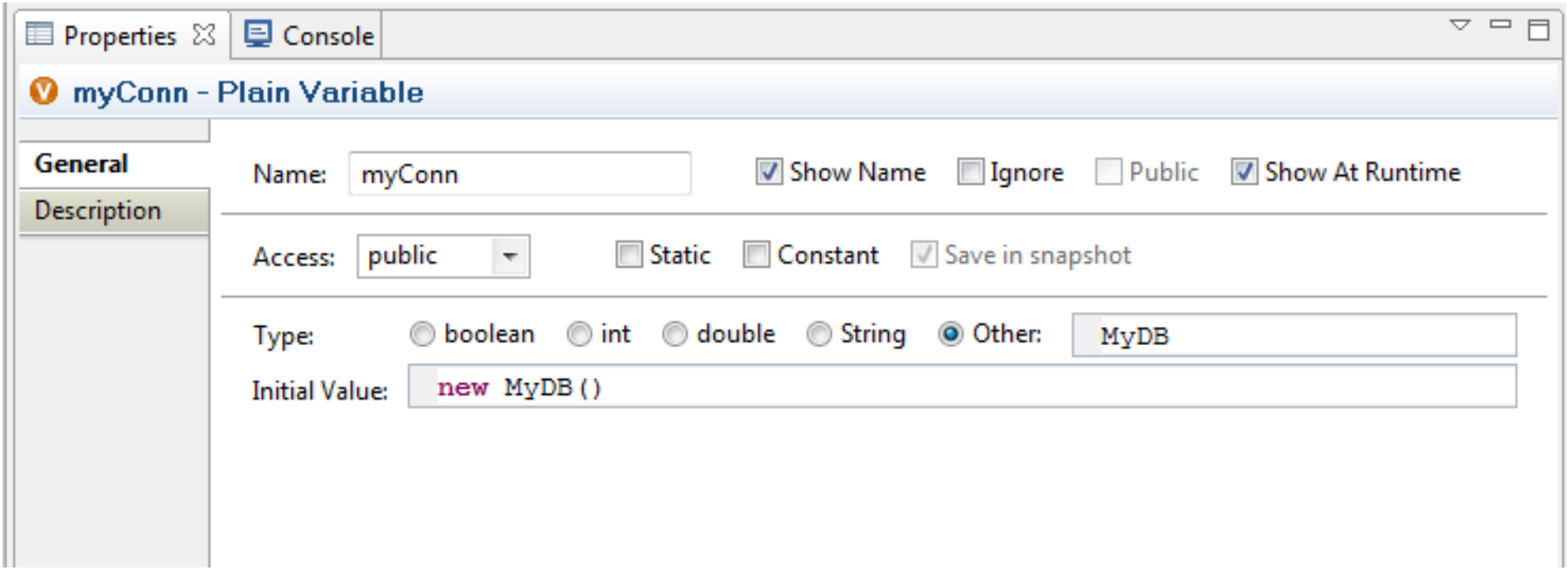
- Execute
- Query
- Insert

```
public class MyDB {
    private static String DriverName = "com.mysql.jdbc.Driver";
    private String dbURL = "jdbc:mysql://localhost:3306/mydb";
    private String dbuser = "root";
    private String dbpassword = "2005051146";
//This is due to consideration of conflicts between database of AnyLogic and java.sql.* package.
    private java.sql.Connection conn = null;
    private java.sql.Statement stmt = null;
    private java.sql.ResultSet rs = null;
    /**
     * Default constructor
     */
    public MyDB(){
     try{
      Class.forName(DriverName);
     }catch(java.lang.ClassNotFoundException e){
            System.err.println(e.getMessage());
            System.out.println("Error with constructor!");
    }
}
/**************************************************
     *method name: executeQuery()
     *Query
     *return value: ResultSet
**************************************************/
     public java.sql.ResultSet executeQuery(String sql){
            try{
                    conn = DriverManager.getConnection(dbURL,dbuser,dbpassword);
                    stmt = conn.createStatement();
                    rs=stmt.executeQuery(sql);
            }catch(SQLException ex){
                    System.err.println(ex.getMessage());
                    System.out.println("Error with executeQuery() method!");
                    }
            return rs;
     }

/**************************************************
      *method name: executeUpdate()
      *udpate, delete, and insert
      *return value: int
**************************************************/
     public int executeUpdate(String sql){
            int result=0;
            try{
                    conn = DriverManager.getConnection(dbURL,dbuser,dbpassword);
                    stmt=conn.createStatement();
                    result=stmt.executeUpdate(sql);
            }catch(SQLException ex){
                    result=0;
                    System.err.println(ex.getMessage());
                    }
            return result;
     }

 @Override
 public String toString() {
  return super.toString();
 }
}
```

Example: Execute Query

```
/*****************************************************
     *method name: executeQuery()
     *Query
     *return value: ResultSet
*****************************************************/
     public java.sql.ResultSet executeQuery(String sql){
             try{
                     conn = DriverManager.getConnection(dbURL,dbuser,dbpassword);
                     stmt = conn.createStatement();
                     rs=stmt.executeQuery(sql);
             }catch(SQLException ex){
                     System.err.println(ex.getMessage());
                     System.out.println("Error with executeQuery() method!");
                     }
             return rs;
     }
```

Setup for Database Class



Example Database Output Code

A database query language (SQL) statement

```
double simulated_time = time()+1975;
for(int k=0;k<Cube[0][0].length;k++){
        String sql ="INSERT INTO dataset(agegroup,ethnicity,state,modeltime,amount,simulation_id) VALUES (
                        "+1+","+0+","+k+","+simulated_time+","+Cube[1][0][k]+","+simulation_id+")";
        int ret = myConn.executeUpdate(sql);
        if(ret == 0){
           traceln("Adding new record"+1+" "+0+" "+k+" in "+Cube[1][0][k]+" dataset TABLE failed!");
          }
}
```

Requesting that the database class execute the SQL statemen

Checking to make sure that the insert worked properly

Database Output: Suggestions

- Maintain metadata
  - Purpose of run
  - Parameter settings
  - Model version (& possibly .alp file)
- Be mindful of performance & space burdens
  - Try to batch up data inserts
  - Be selective in what data to store, balancing pros & cons of storing more material
    - Pros: Analytic flexibility, greater understanding, less risk of having to re-run simulation
    - Cons: Mammoth database size, Impaired performance
  - Use a local database if possible

Database Input

- Database input can be desirable when “feeding in” certain data to model
  - Connection choreography
  - Agent movement patterns
  - Count of incident cases of a condition
  - Count of vaccinations over time
- Frequently this data is “quantized” into time units
  - In those cases, Dynamic Events can be helpful