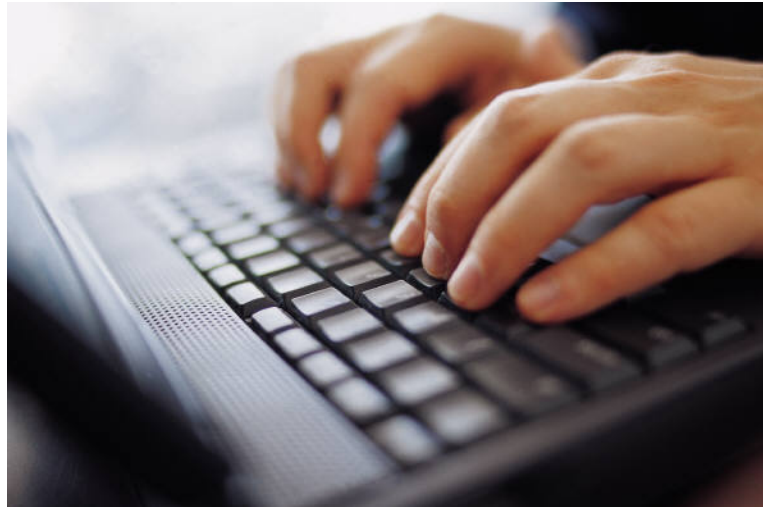# The Embedded Environment
The Network & regular spatial embedding in agent-based modeling

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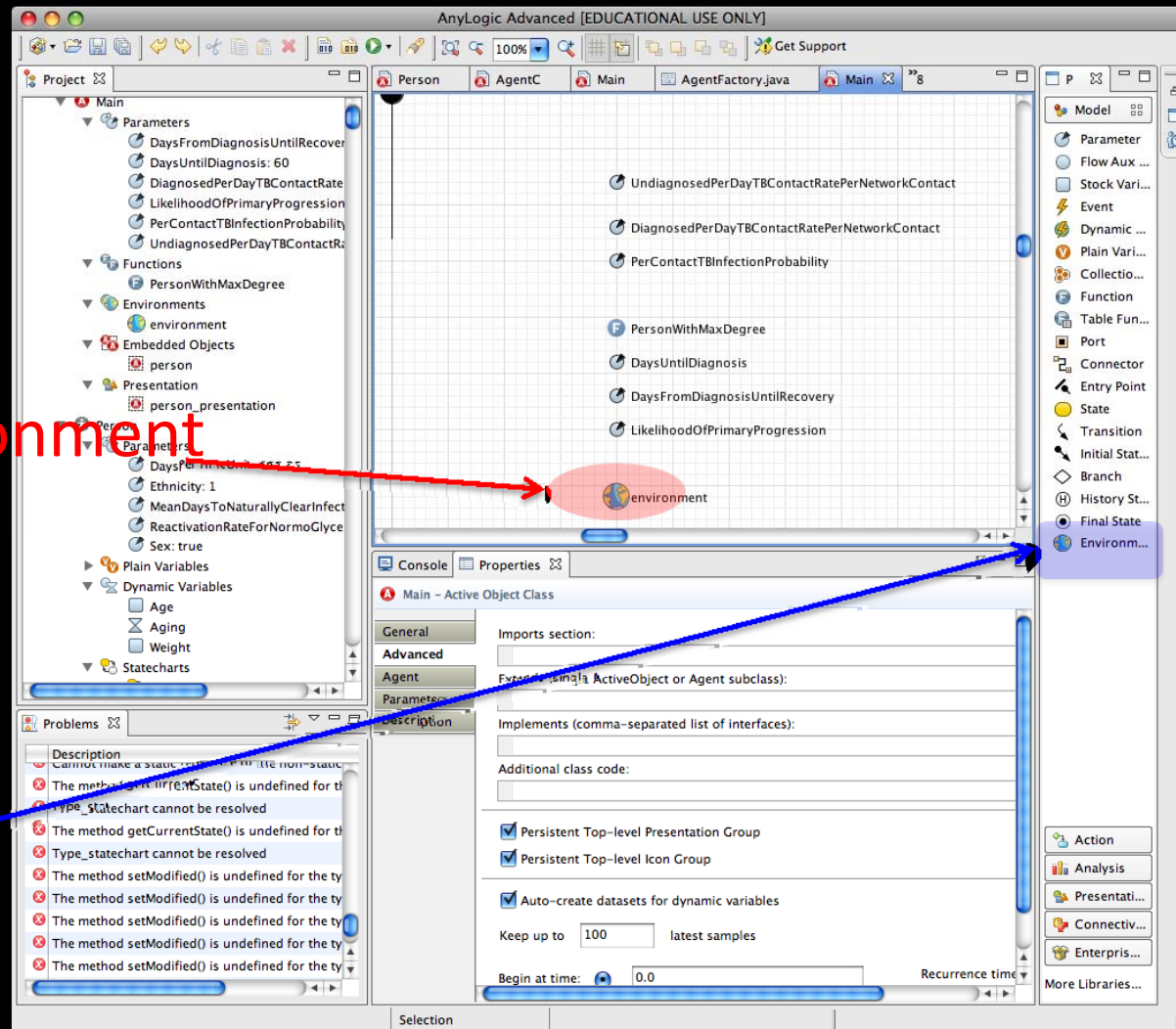
Hands on Model Use Ahead

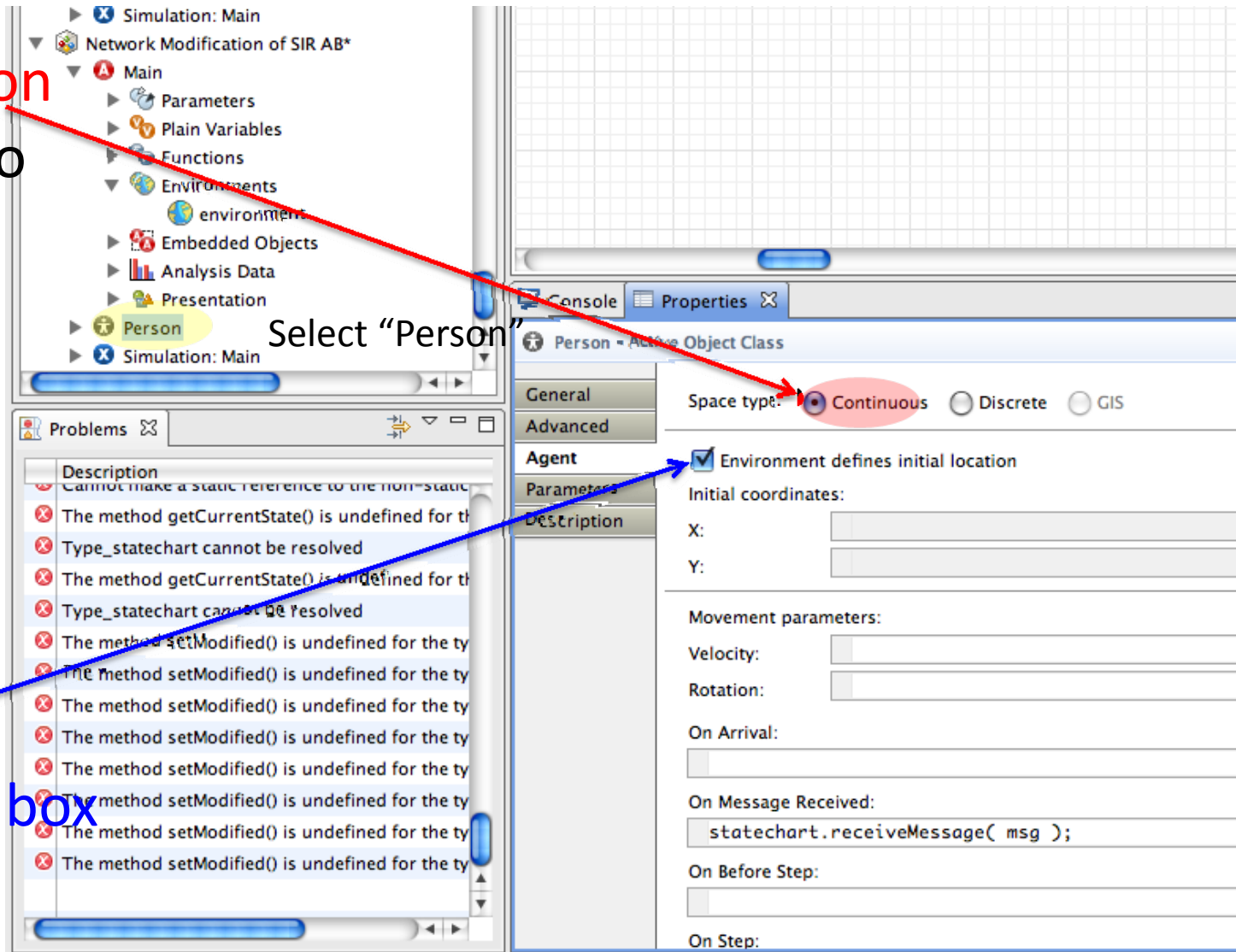

Load model: TBv1.alp

Environment Objects:
The Key to Agent Embedding

This environment object was added from here

Agent Needs to "Know about" Environment

This radio button setting needs to Agree with the Space type of the environment!

Make sure this box is checked!

Select "Person"

Spatial Types Supported

- Continuous
  - No interference between agents
  - Continuous movement (via velocity)
  - Only spatial dimensions required

- Discrete
  - Space is tesselated into cells
  - Mutual exclusion of agents from a given cell
  - Space information requires dimension & rows/columns (for count of cells in X & Y location)

Discrete Space

- Common Built-in methods
    - Finding empty cells
    - Jumping to cells
    - Moving to nearby cells
- Neighborhood models
    - Moore: 4 neighbors (in Cardinal directions)
    - Euclidean: 8 neighbors

Continuous Space

- Continuous
  - X & Y location
  - Velocity
  - Rotation
- Movement
  - "moveTo" starts agent moving towards a destination (per velocity & shortest path)
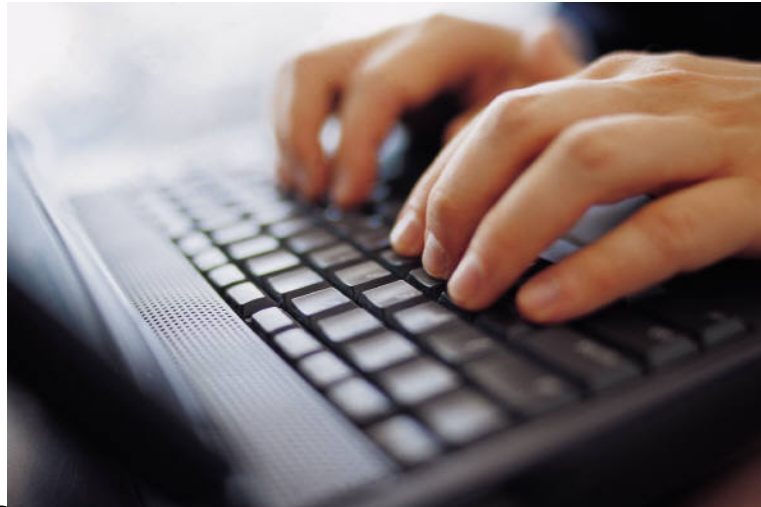 - "jumpTo" directly moves agent to destination

Networks & Spatial Layouts

- Distinct node attributes: Location & connections
  - Spatial layouts determine where nodes appear in space (and often on the screen)
  - Network type determines who is connected to who
  - For the most part, these characteristics are determined independently
- Network topologies (conectedness) can be defined either *alternative to* or *in addition to spatial layouts*
  - Agents will have spatial locations in either case

Hands on Model Use Ahead

Load model: Spatial SEIR with Waning Immunity.alp

Network Types

Interaction Between Network & Location 1

- For one type of networks (Distanced Based), whether there is a connection between A and B depends on the distance between A & B
  - This sets connectivity based on location considerations!

Distance-Based Layout
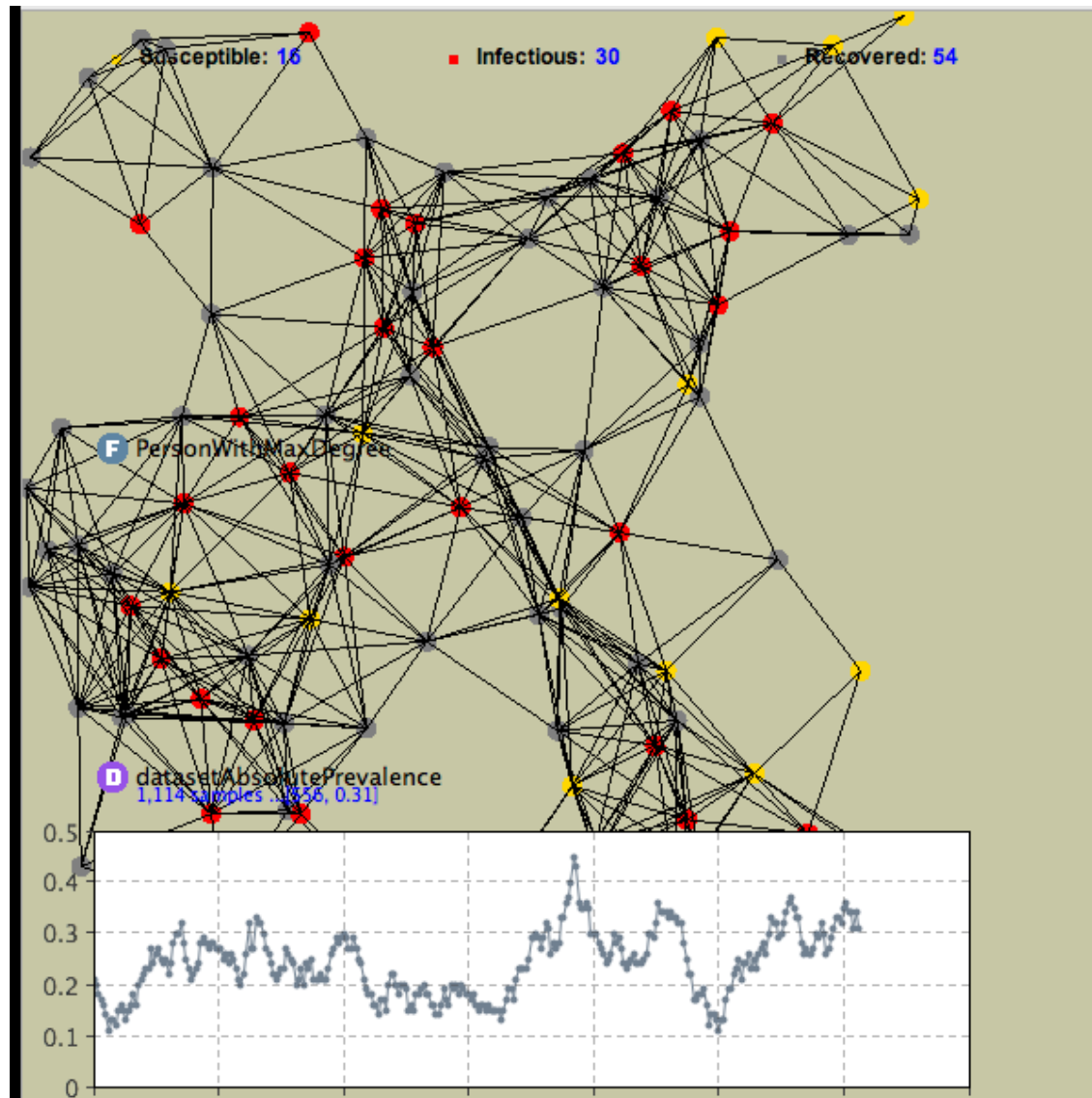
Property for Distance-Based Layout: Distance Threshold

Random Connections

With Random Connections

Scale-Free Network

Scale-Free Network

High degree node
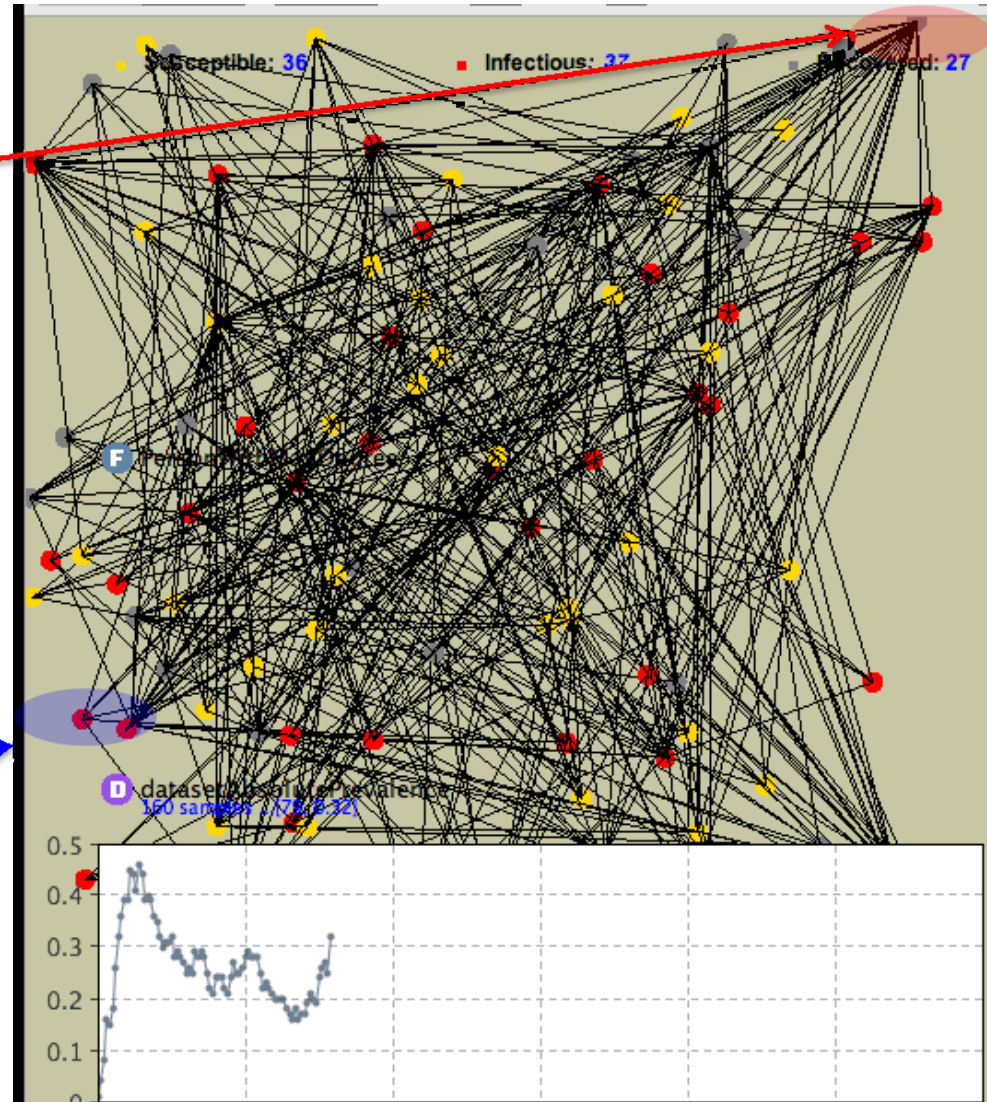
Low degree node

Layout Types
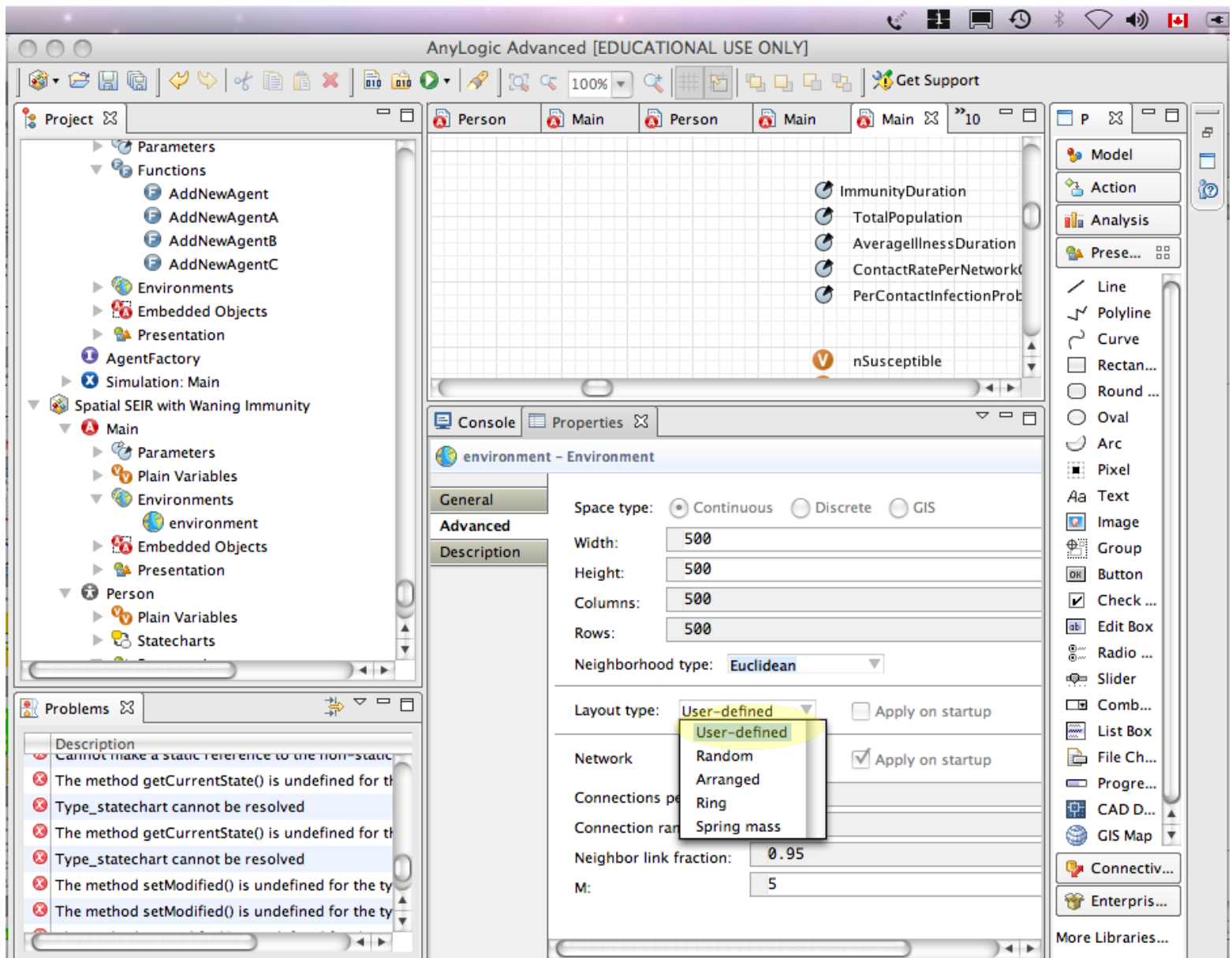
Layout Type

- **Random**: Uniformly distribute X and Y position of nodes

- **Arranged**: Set node locations in a regular fashion (normally in a 2D grid)

- **Ring**: Set node locations in periodically spaced intervals around a ring shape

- **Spring Mass**: Adjust node locations such that node locations that are most tightly connected tend to be closer together
  - (Sets location based on network!)

- In a Spring-mass layout, the nodes that are highly connected will tend to be clustered

- Here, we are determining the location based on the connectivity!

Network with Multiple Agent Classes
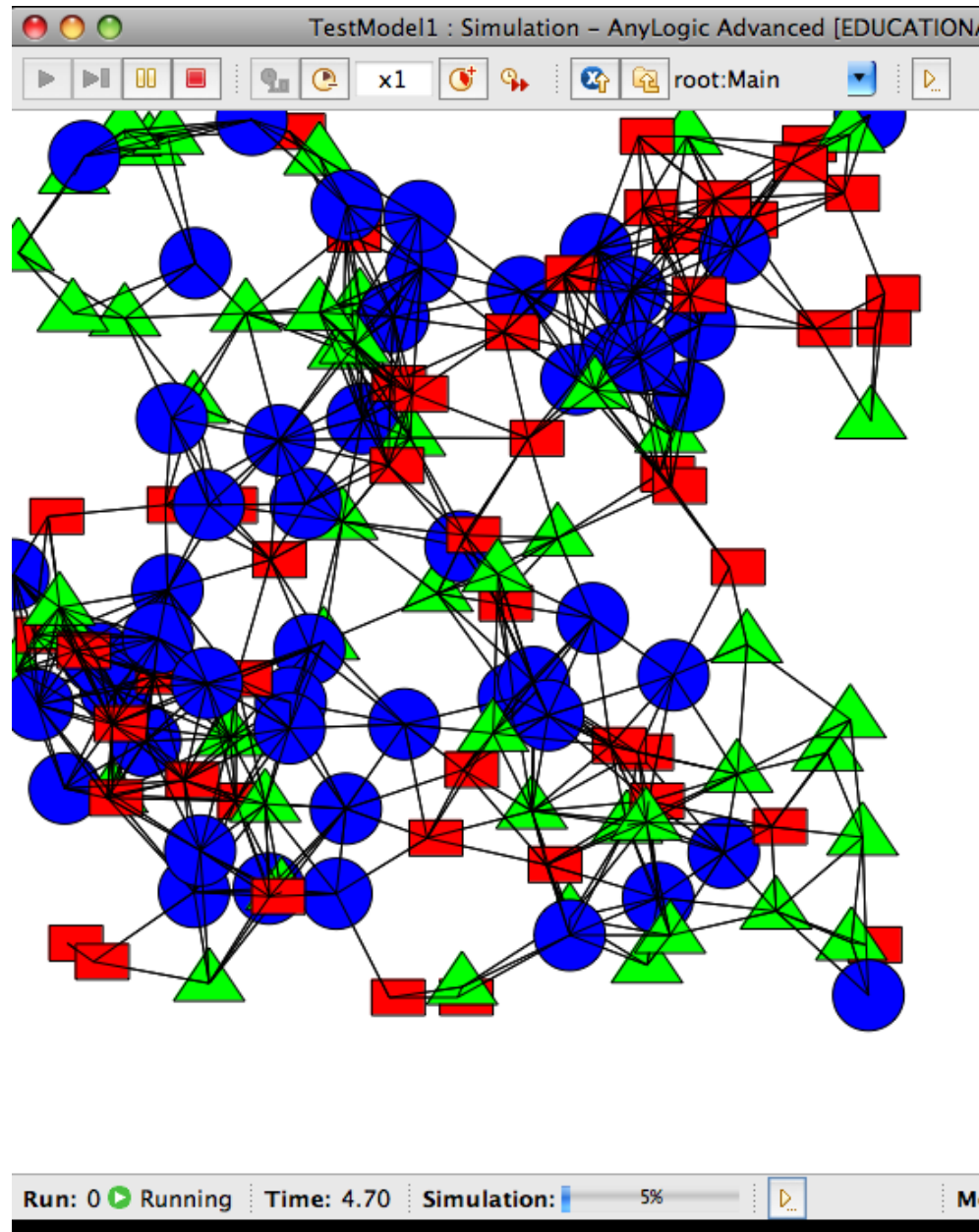
Realizing Multiple Agent Classes Sharing Same Network

- Create an agent superclass
- Create multiple subclasses of that superclass
  - In "Properties"
    - indicate that "Extends" superclass
    - Provide constructor to associate with agent population & Main class
- For the Agent population, use a replication of 0
- Create Startup code for "Main" that adds the various types of agents to the model
  - This uses code adopted from Java code output by build