Practical No. -7

Question 6:

1. Create Defence Model to stimulate Aircraft Behaviour

   i. Air Defence System Model

   ii. Modelling Approach: Agent-Based

   iii. Features: Agent Type, Agent Population, 3D, State chart, Event, Agent Movement, Agent Destruction, Scale

   Aim

   This practical guides users through the creation of an agent-based simulation model of a radar-based air defence system. The model involves various types of agents (bomber aircraft, radars, missiles, bombs, and buildings) interacting in a continuous 3D space. The objective is to protect ground facilities from incoming bombers using radars and guided surface-to-air missiles.

   Phase 1: Creating Assets

   - Create the basic assets required for the air defence system model, including buildings, radars, and missile launchers.
   - Set up the 3D environment to represent the airspace and ground facilities.
   - Create building agents representing the ground facilities to be protected.
   - Implement radar agents equipped with guided missile launchers to detect and engage incoming bombers.
   - Configure the radar coverage area and missile launch capabilities.

   Phase 2: Creating Bombs

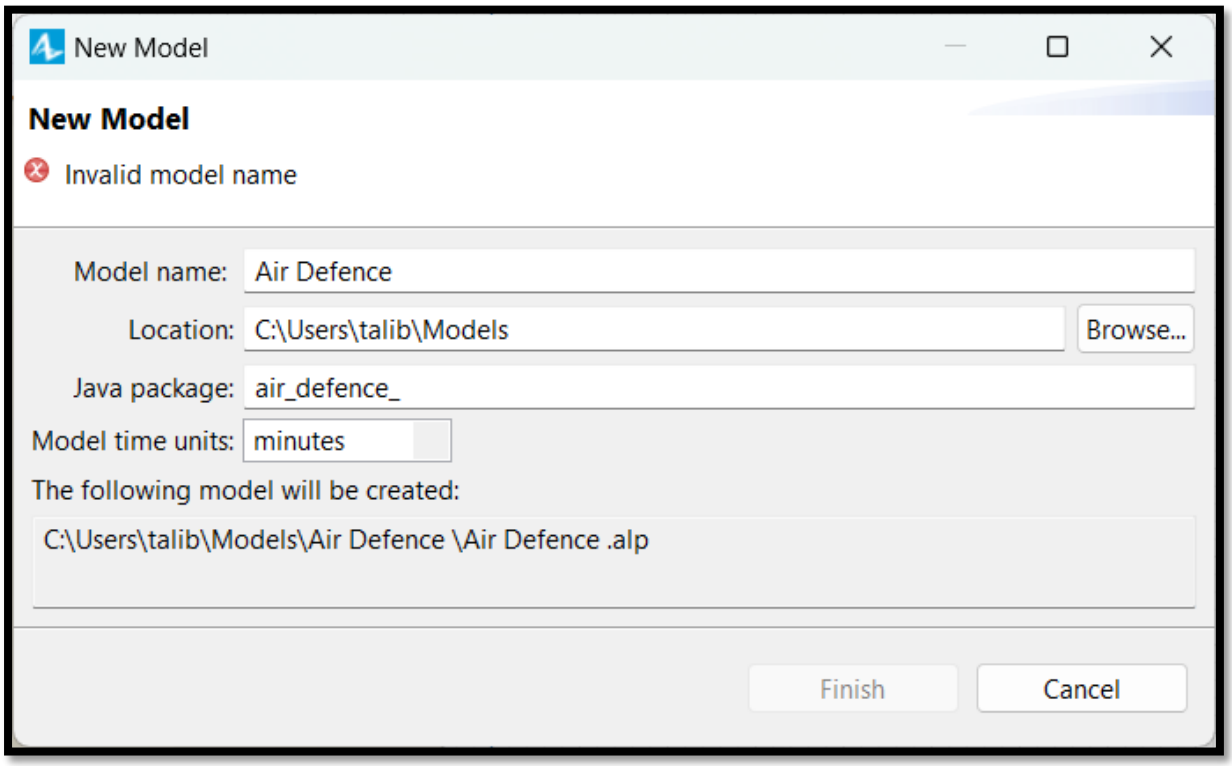
   - Introduce bomb-carrying bombers into the model and define their behaviour.
   - Define bomber agents with the capability to carry bombs.
   - Implement logic for bombers to approach designated target buildings.
   - Develop the bomb drop mechanism to simulate bombers dropping bombs on target buildings.
   - Configure bomber speed and altitude for realistic movement.

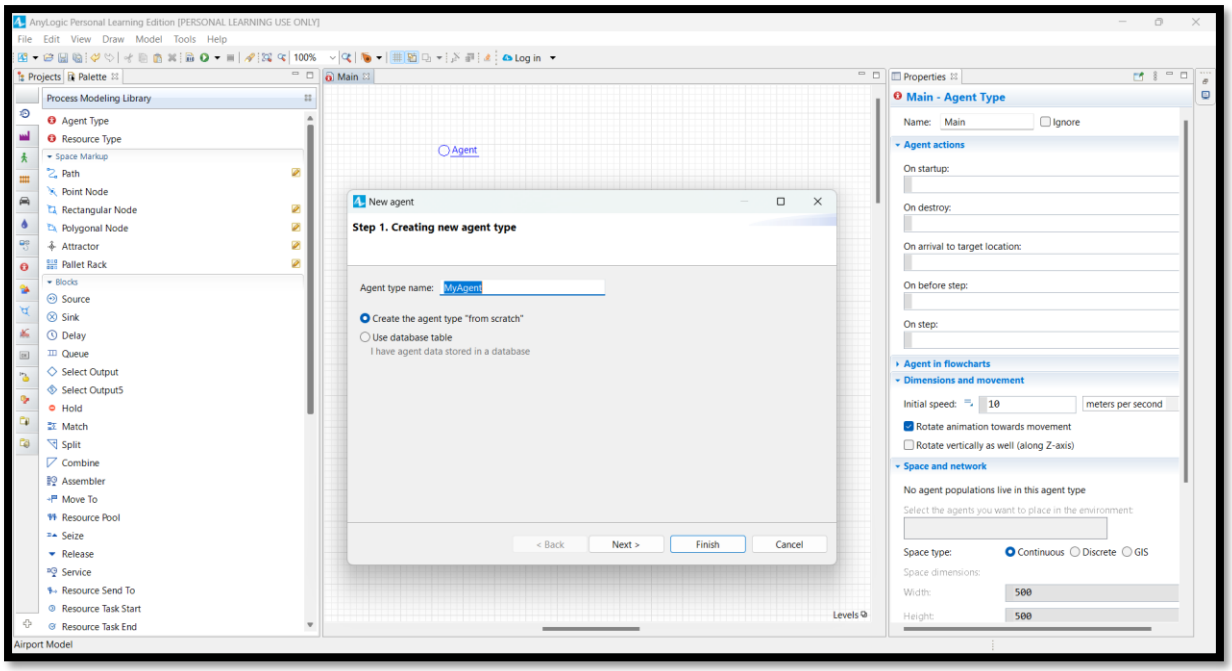
Phase 3: Creating Bombers

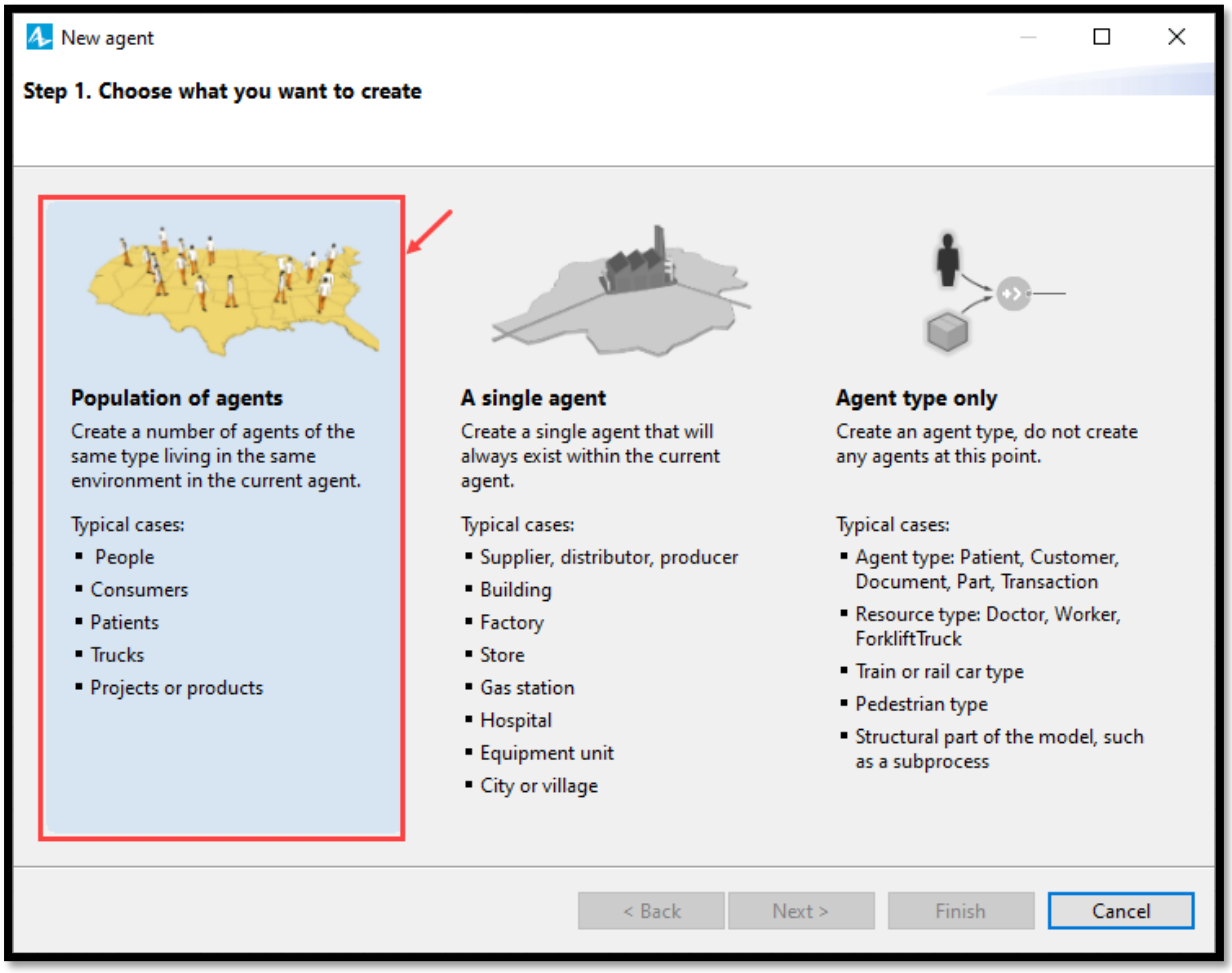
- Enhance the model by introducing bomber aircraft and specifying their mission behaviour.
- Integrate bomber agents into the model with realistic movement capabilities.
- Define the mission objective for bombers to target specific buildings.
- Implement logic for bombers to evade missile attacks and return to base after completing their mission.
- Validate bomber behaviour and interactions with other model components.

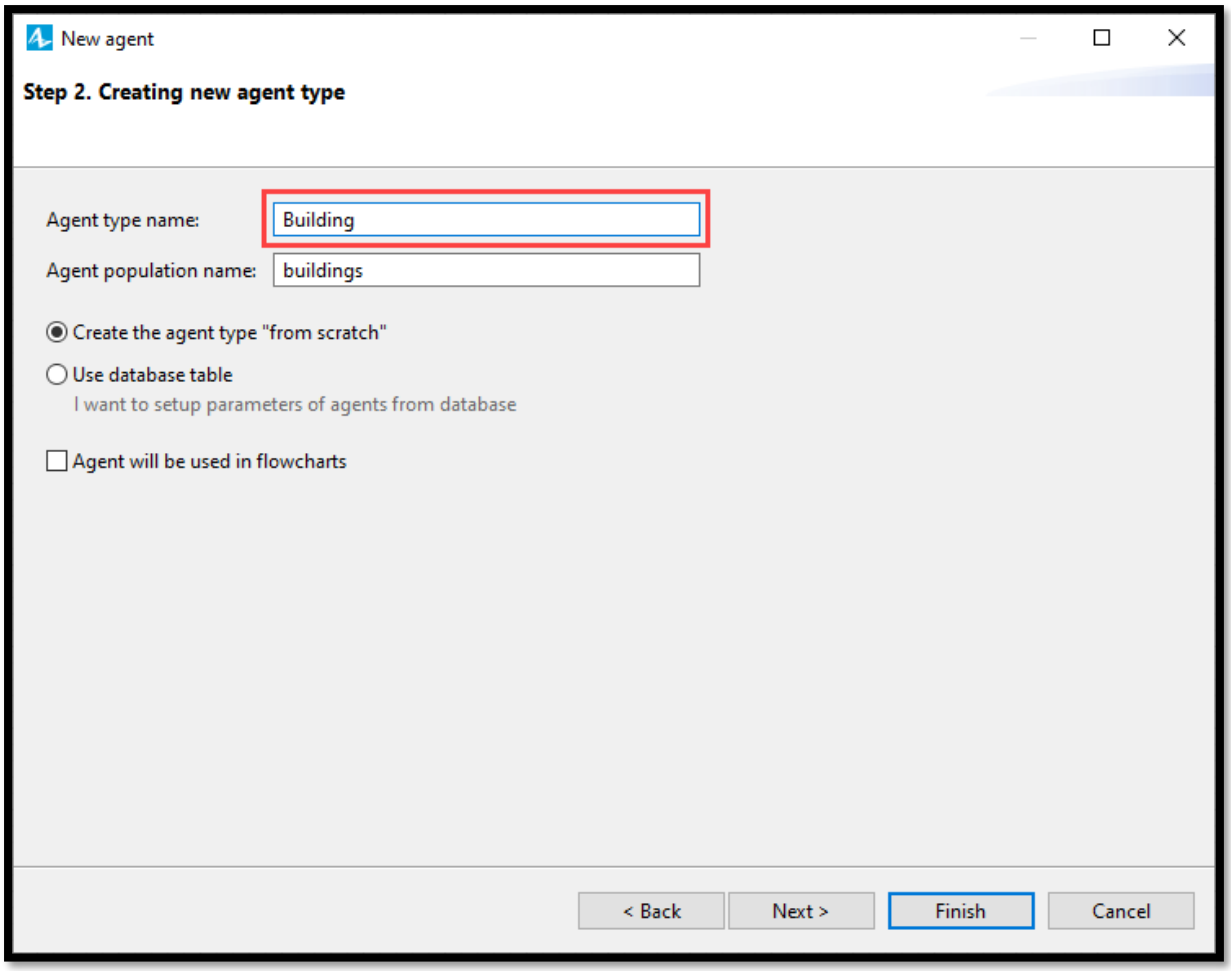
Phase 4: Adding Air Defence System

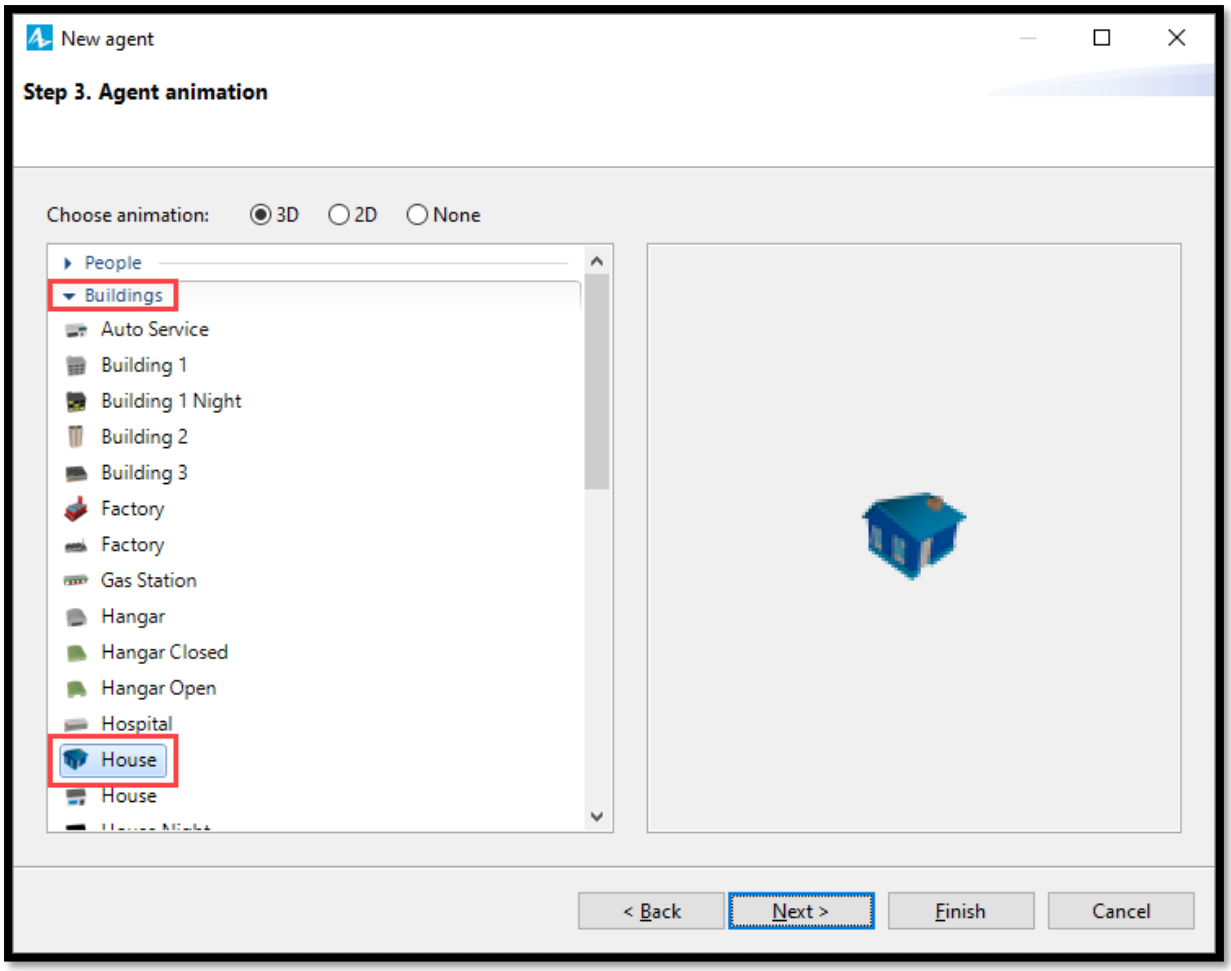
- Complete the model by incorporating the air defence system to engage and neutralize incoming bombers.
- Enhance radar agents to detect incoming bombers within their coverage area.
- Implement missile launch logic to engage detected bombers.
- Define missile behaviour to intercept and destroy targeted bombers.
- Validate the effectiveness of the air defence system in protecting ground facilities from bomber attacks.

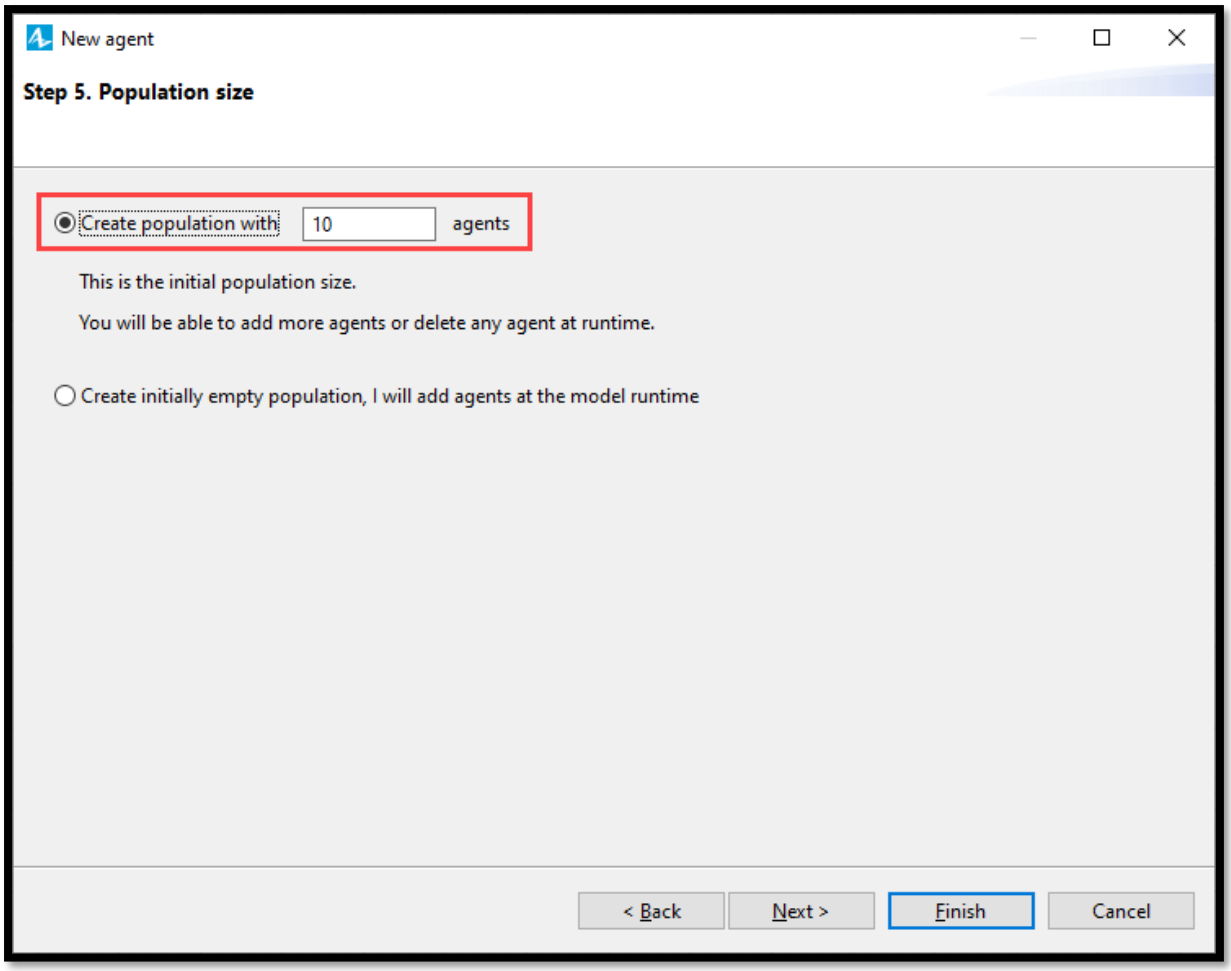


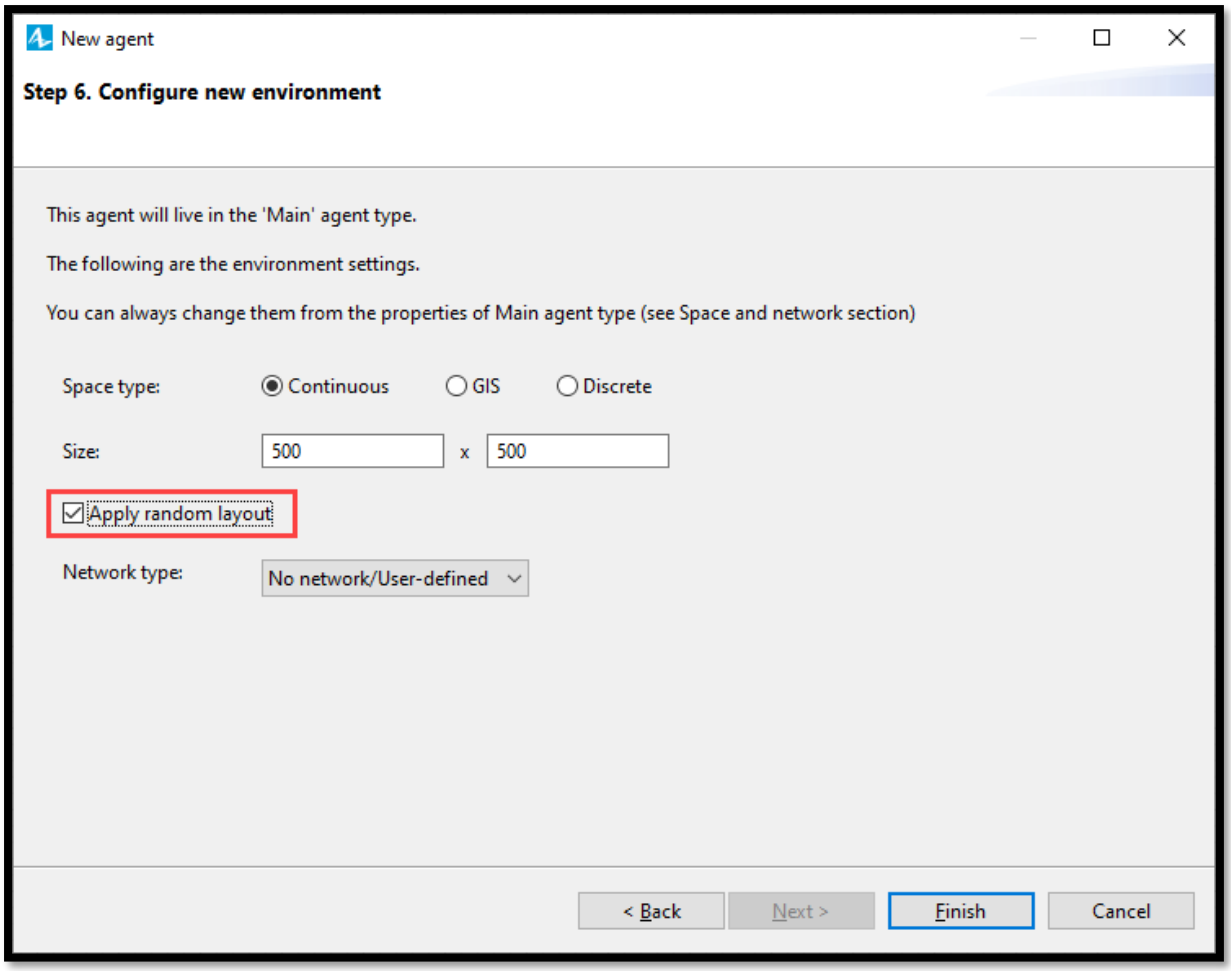

AnyLogic Personal Learning Edition [PERSONAL LEARNING USE ONLY]
File Edit View Draw Model Tools Help
Projects Palette
Process Modeling Library
Agent Type
Resource Type
Space Markup
Path
Point Node
Rectangular Node
Polygonal Node
Attractor
Pallet Rack
Blocks
Source
Sink
Delay
Queue
Select Output
Select Output5
Hold
Match
Split
Combine
Assembler
Move To
Resource Pool
Seize
Release
Service
Resource Send To
Resource Task Start
Resource Task End
Airport Model
Main
Agent
New agent
Step 1. Creating new agent type
Agent type name: MyAgent
Create the agent type "from scratch"
Use database table
I have agent data stored in a database
< Back
Next >
Finish
Cancel
Levels
Properties
Main - Agent Type
Name: Main
Ignore
Agent actions
On startup:
On destroy:
On arrival to target location:
On before step:
On step:
Agent in flowcharts
Dimensions and movement
Initial speed: 10
meters per second
Rotate animation towards movement
Rotate vertically as well (along Z-axis)
Space and network
No agent populations live in this agent type
Select the agents you want to place in the environment:
Space type: Continuous Discrete GIS
Space dimensions:
Width: 500
Height: 500

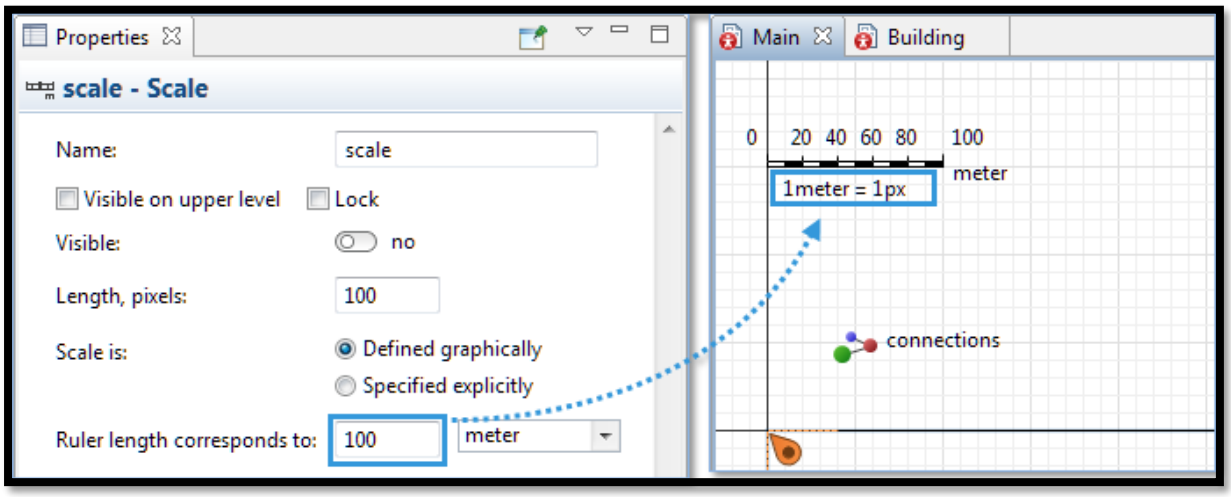

New agent
Step 1. Choose what you want to create
Population of agents
Create a number of agents of the same type living in the same environment in the current agent.
Typical cases:
People
Consumers
Patients
Trucks
Projects or products
A single agent
Create a single agent that will always exist within the current agent.
Typical cases:
Supplier, distributor, producer
Building
Factory
Store
Gas station
Hospital
Equipment unit
City or village
Agent type only
Create an agent type, do not create any agents at this point.
Typical cases:
Agent type: Patient, Customer, Document, Part, Transaction
Resource type: Doctor, Worker, ForkliftTruck
Train or rail car type
Pedestrian type
Structural part of the model, such as a subprocess
< Back
Next >
Finish
Cancel

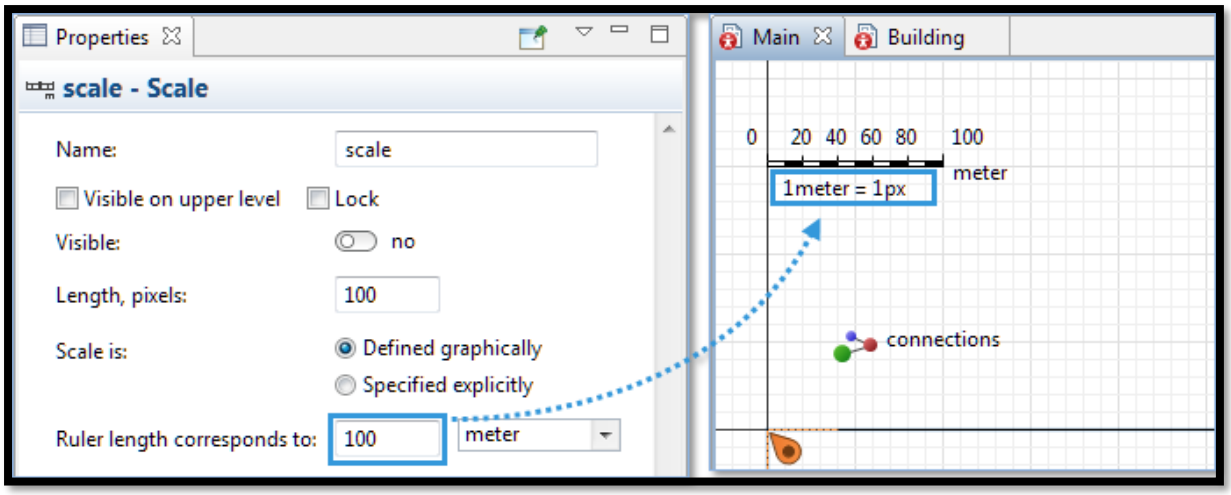

New agent
Step 2. Creating new agent type
Agent type name:
Building
Agent population name:
buildings
Create the agent type "from scratch"
Use database table
I want to setup parameters of agents from database
Agent will be used in flowcharts
< Back
Next >
Finish
Cancel

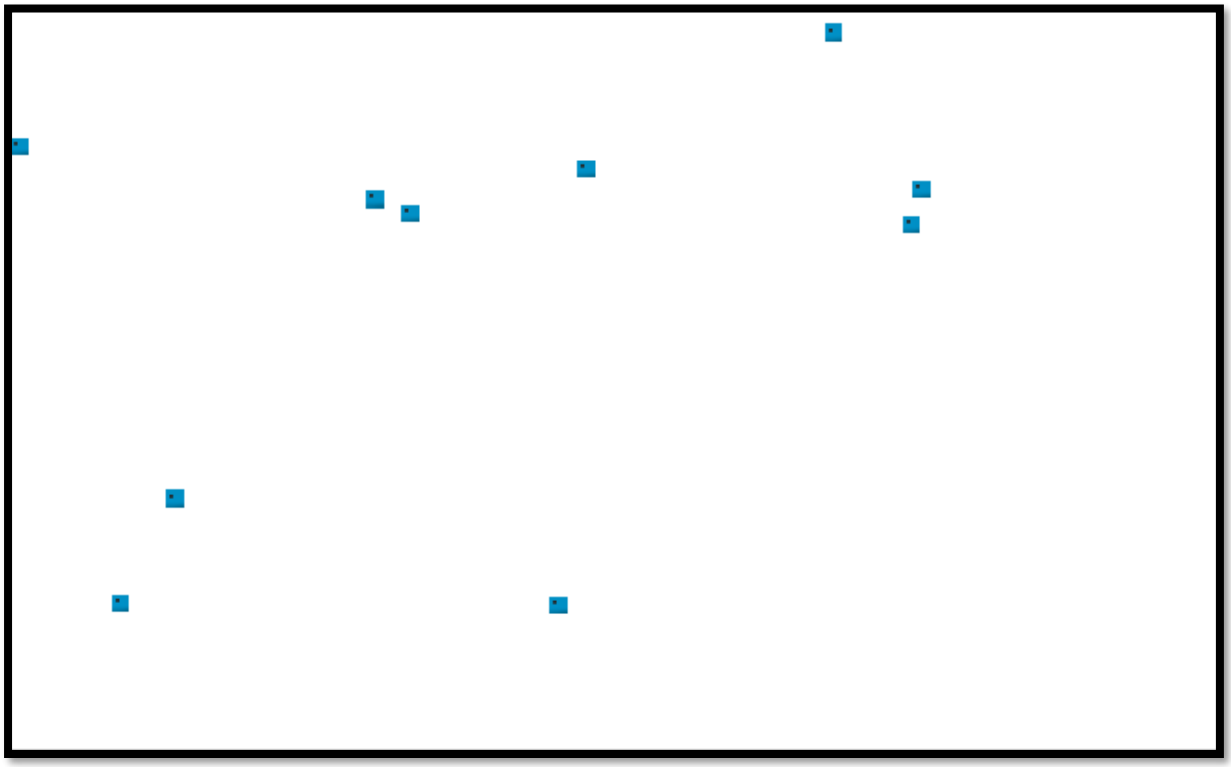

New agent
Step 3. Agent animation
Choose animation:
3D
2D
None
People
Buildings
Auto Service
Building 1
Building 1 Night
Building 2
Building 3
Factory
Factory
Gas Station
Hangar
Hangar Closed
Hangar Open
Hospital
House
House
< Back
Next >
Finish
Cancel

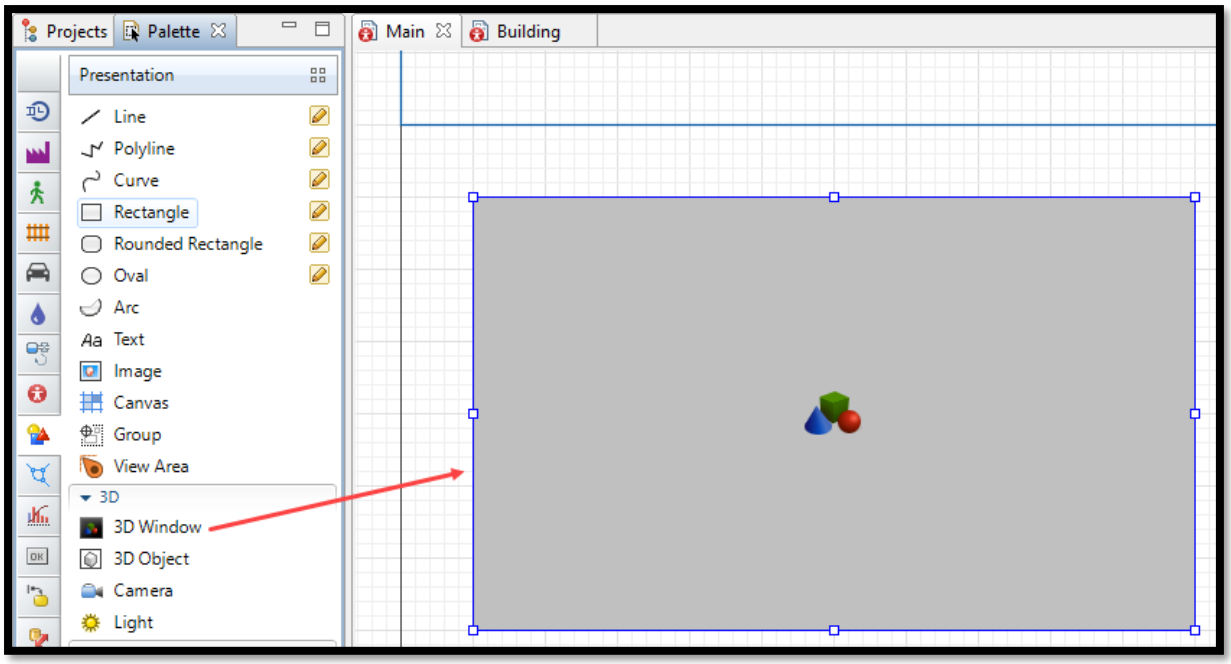

New agent
Step 5. Population size
Create population with
10
agents
This is the initial population size.
You will be able to add more agents or delete any agent at runtime.
Create initially empty population, I will add agents at the model runtime
< Back
Next >
Finish
Cancel

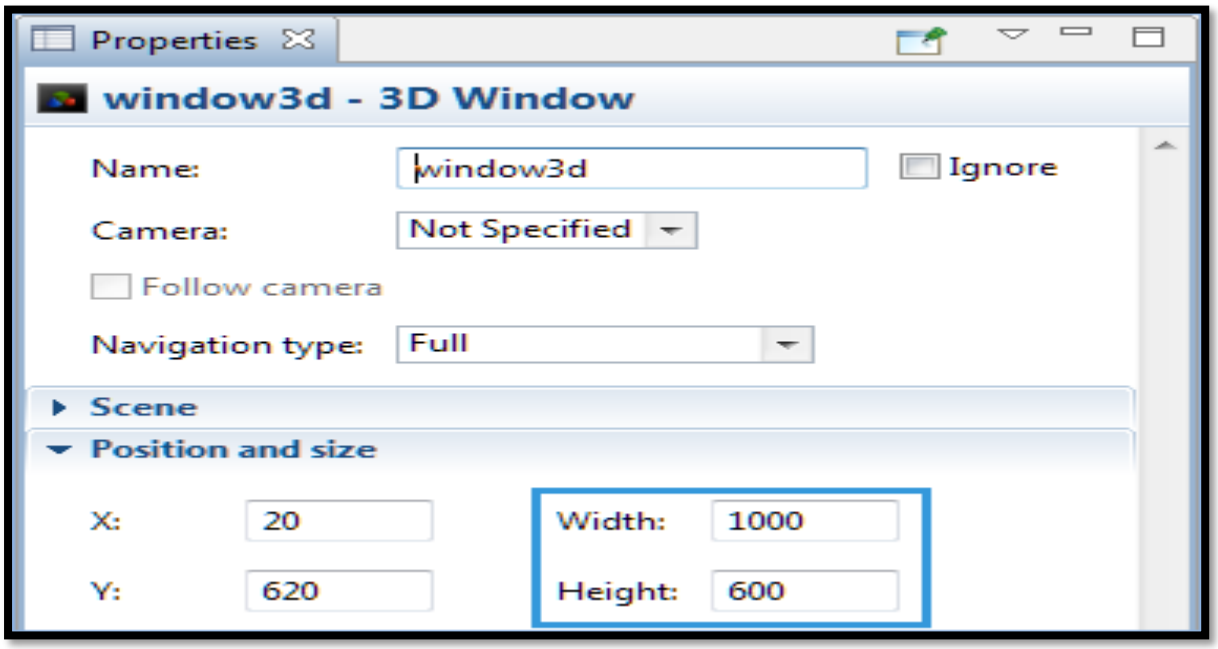

New agent
Step 6. Configure new environment
This agent will live in the 'Main' agent type.
The following are the environment settings.
You can always change them from the properties of Main agent type (see Space and network section)
Space type:
Continuous
GIS
Discrete
Size:
500
x
500
Apply random layout
Network type:
No network/User-defined
< Back
Next >
Finish
Cancel

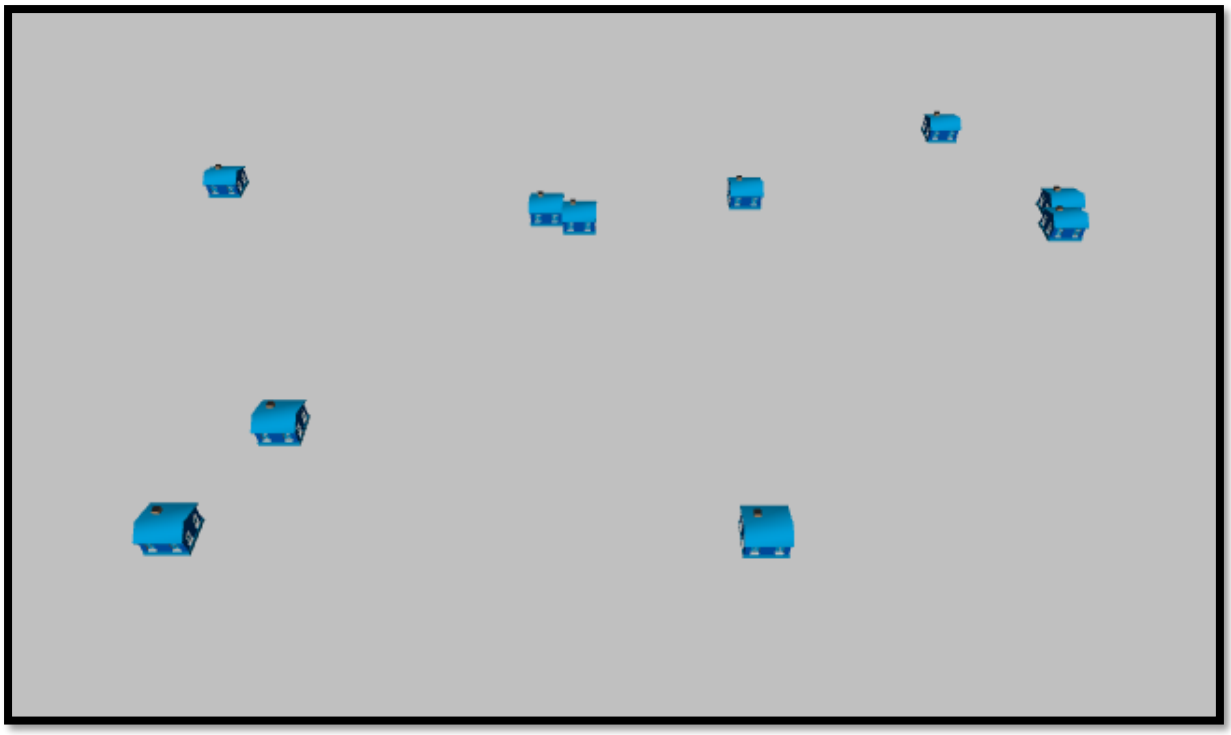

Properties
scale - Scale
Name:
scale
Visible on upper level
Lock
Visible:
no
Length, pixels:
100
Scale is:
Defined graphically
Specified explicitly
Ruler length corresponds to:
100
meter
Main
Building
0
20
40
60
80
100
meter
1meter = 1px
connections

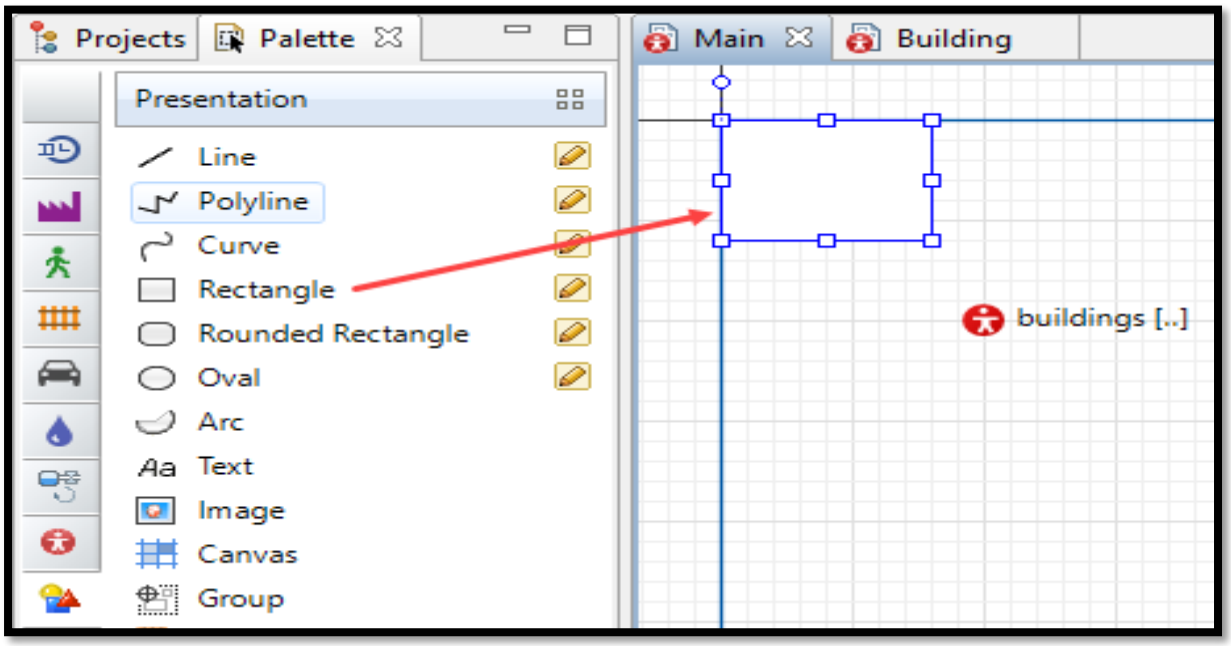

Properties
scale - Scale
Name:
scale
Visible on upper level
Lock
Visible:
no
Length, pixels:
100
Scale is:
Defined graphically
Specified explicitly
Ruler length corresponds to:
100
meter
Main
Building
0
20
40
60
80
100
meter
1meter = 1px
connections

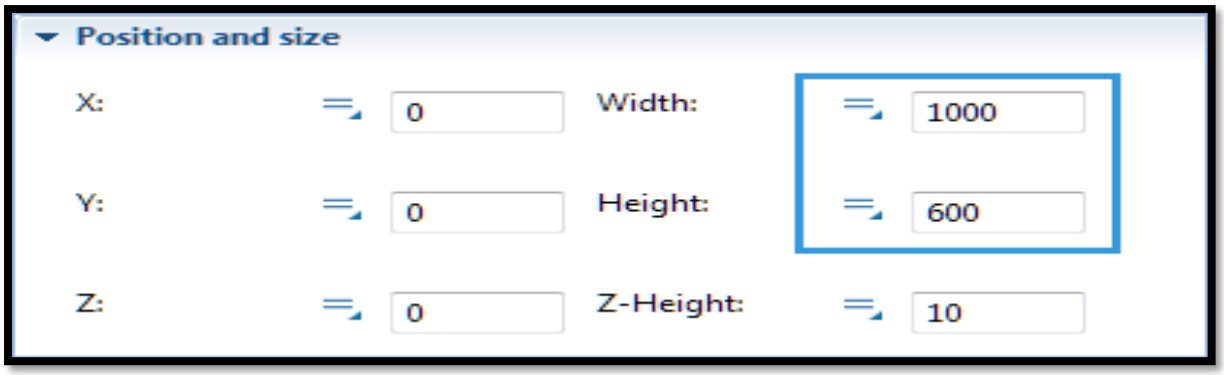


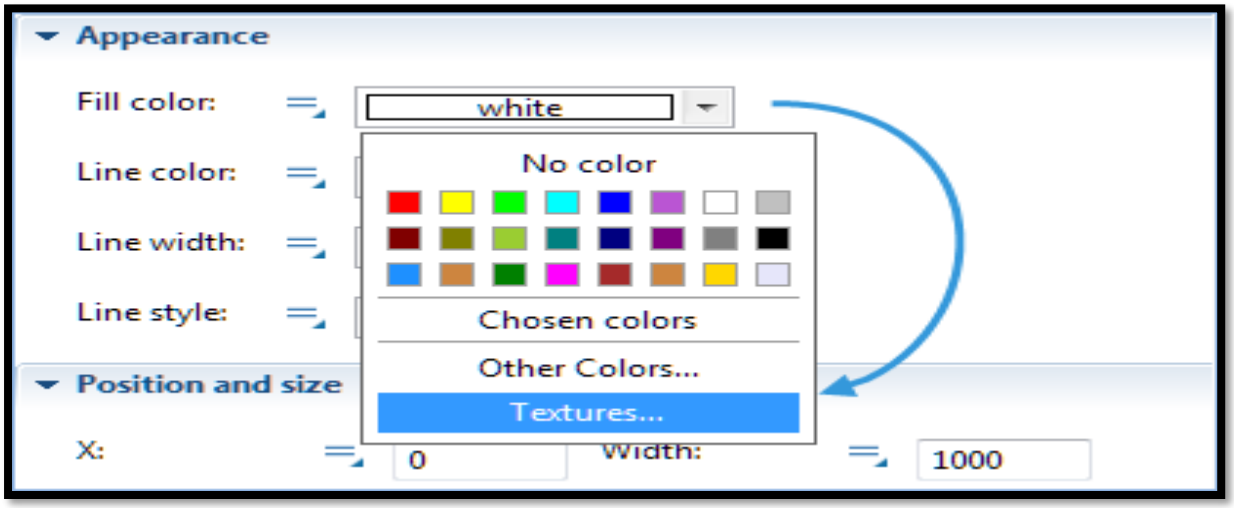

Projects
Palette
Main
Building
Presentation
Line
Polyline
Curve
Rectangle
Rounded Rectangle
Oval
Arc
Text
Image
Canvas
Group
View Area
3D
3D Window
3D Object
Camera
Light

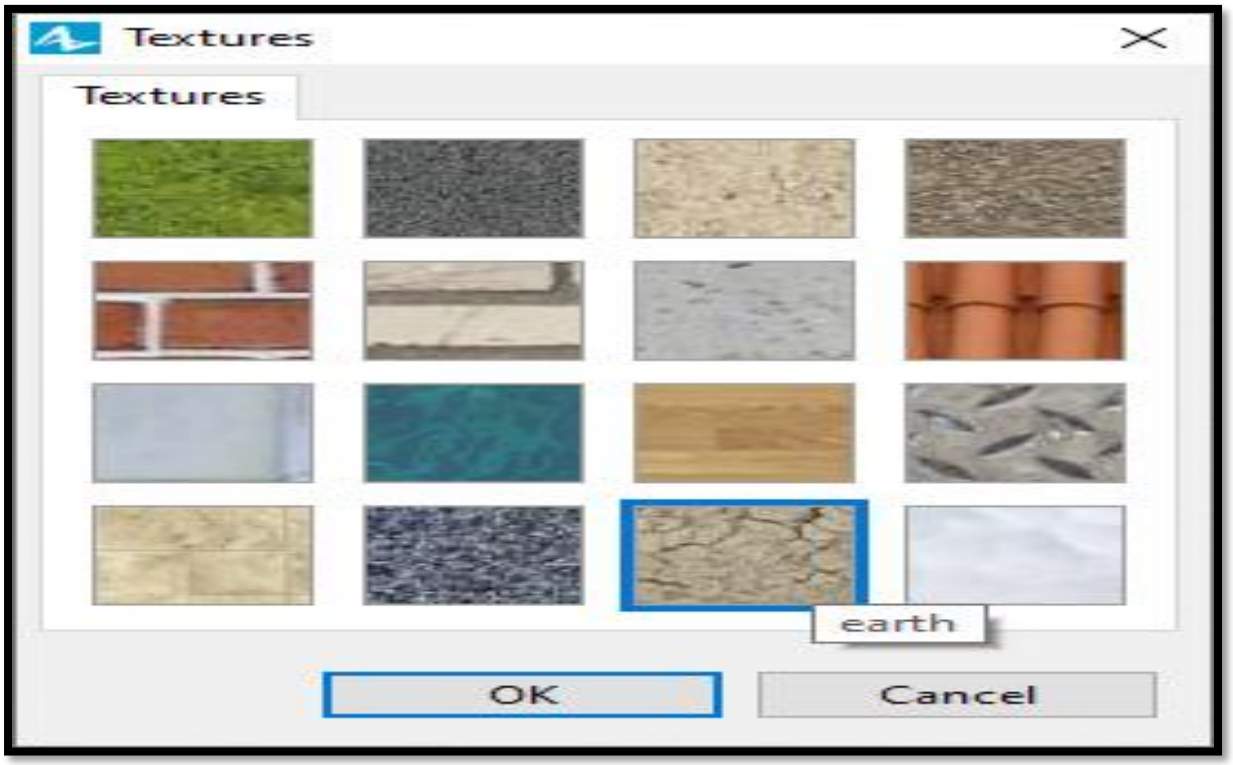

Properties
window3d - 3D Window
Name:
window3d
Ignore
Camera:
Not Specified
Follow camera
Navigation type:
Full
Scene
Position and size
X:
20
Y:
620
Width:
1000
Height:
600

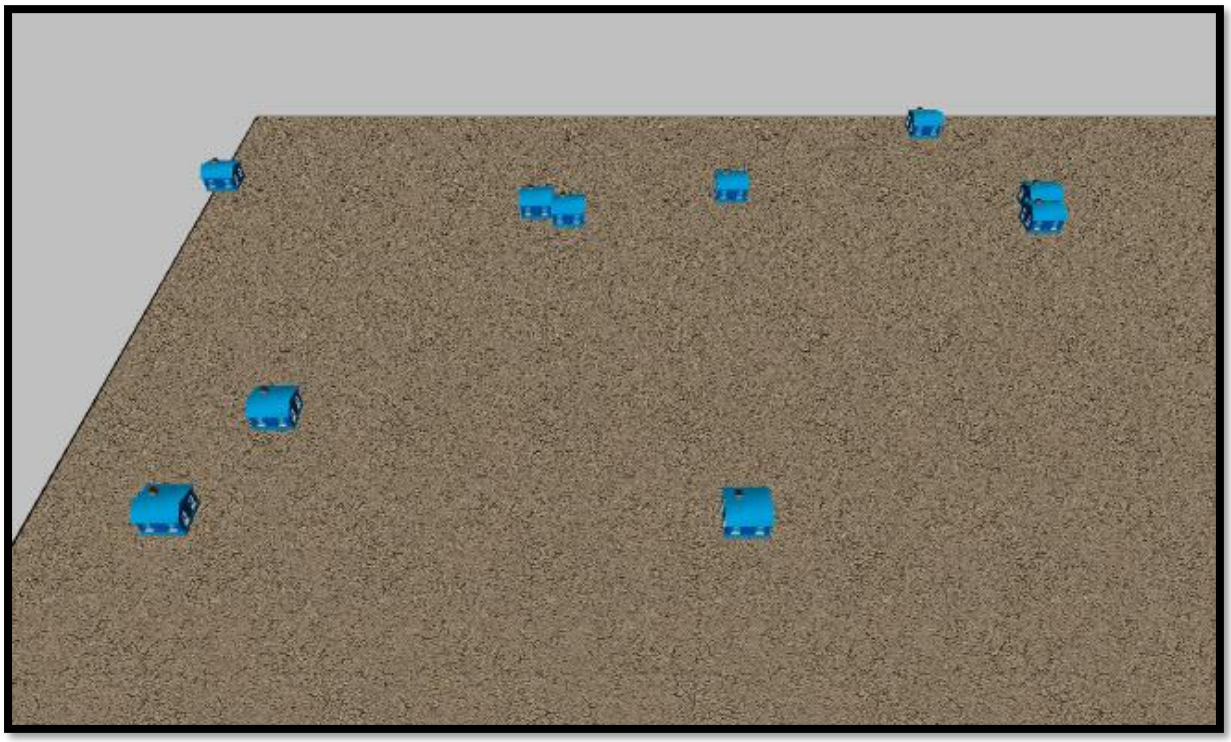


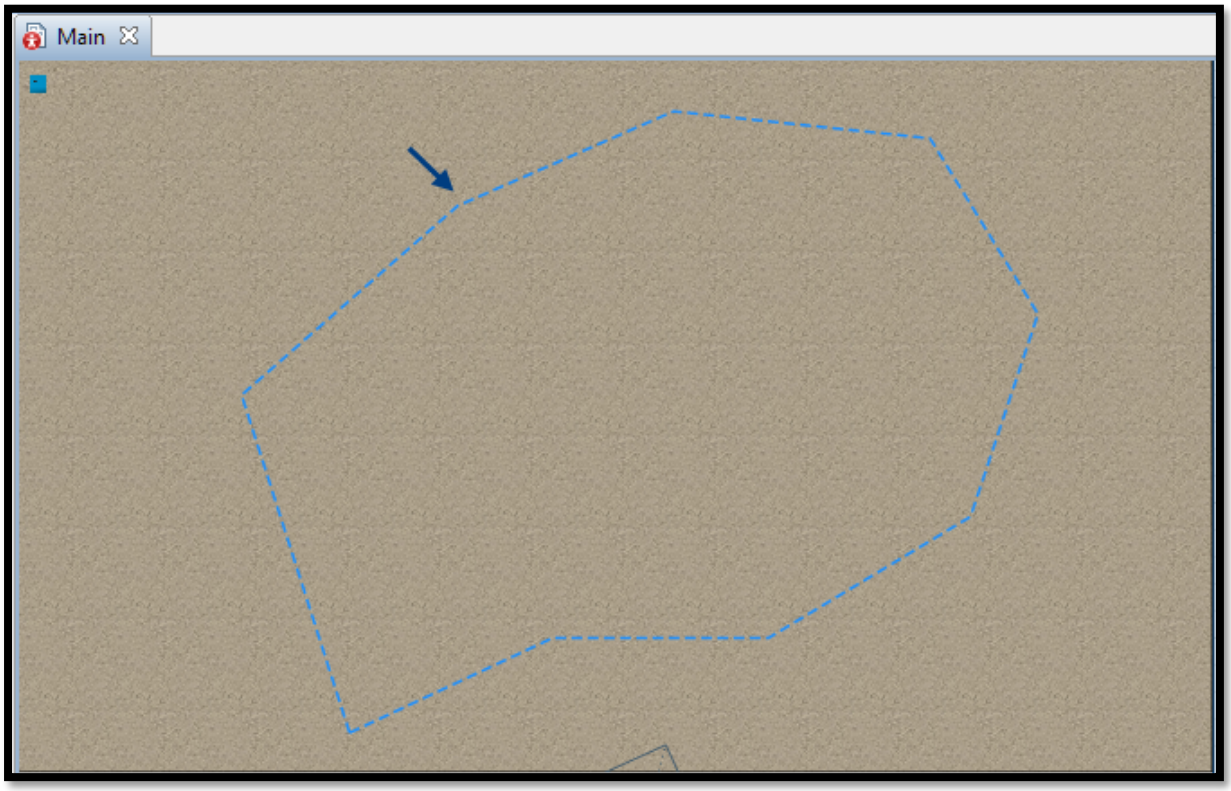

Projects
Palette
Presentation
Line
Polyline
Curve
Rectangle
Rounded Rectangle
Oval
Arc
Text
Image
Canvas
Group
Main
Building
buildings [..]

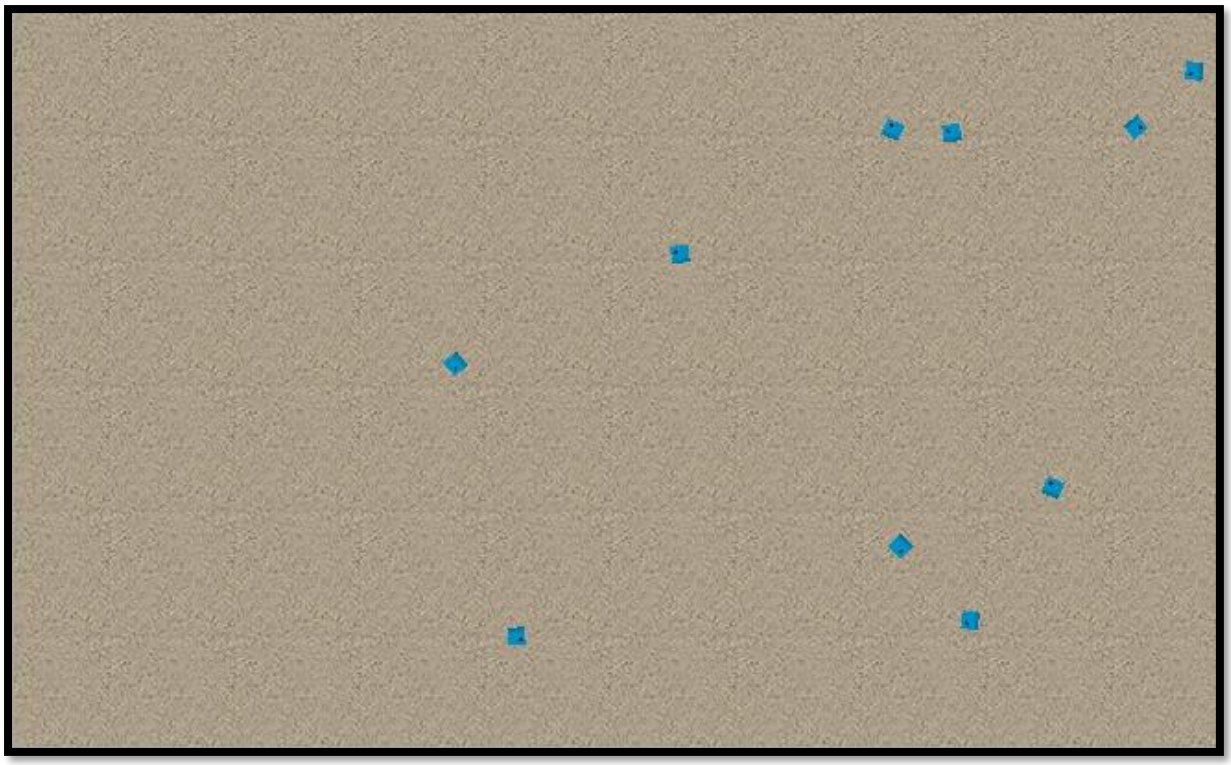

Position and size
X:
0
Width:
1000
Y:
0
Height:
600
Z:
0
Z-Height:
10

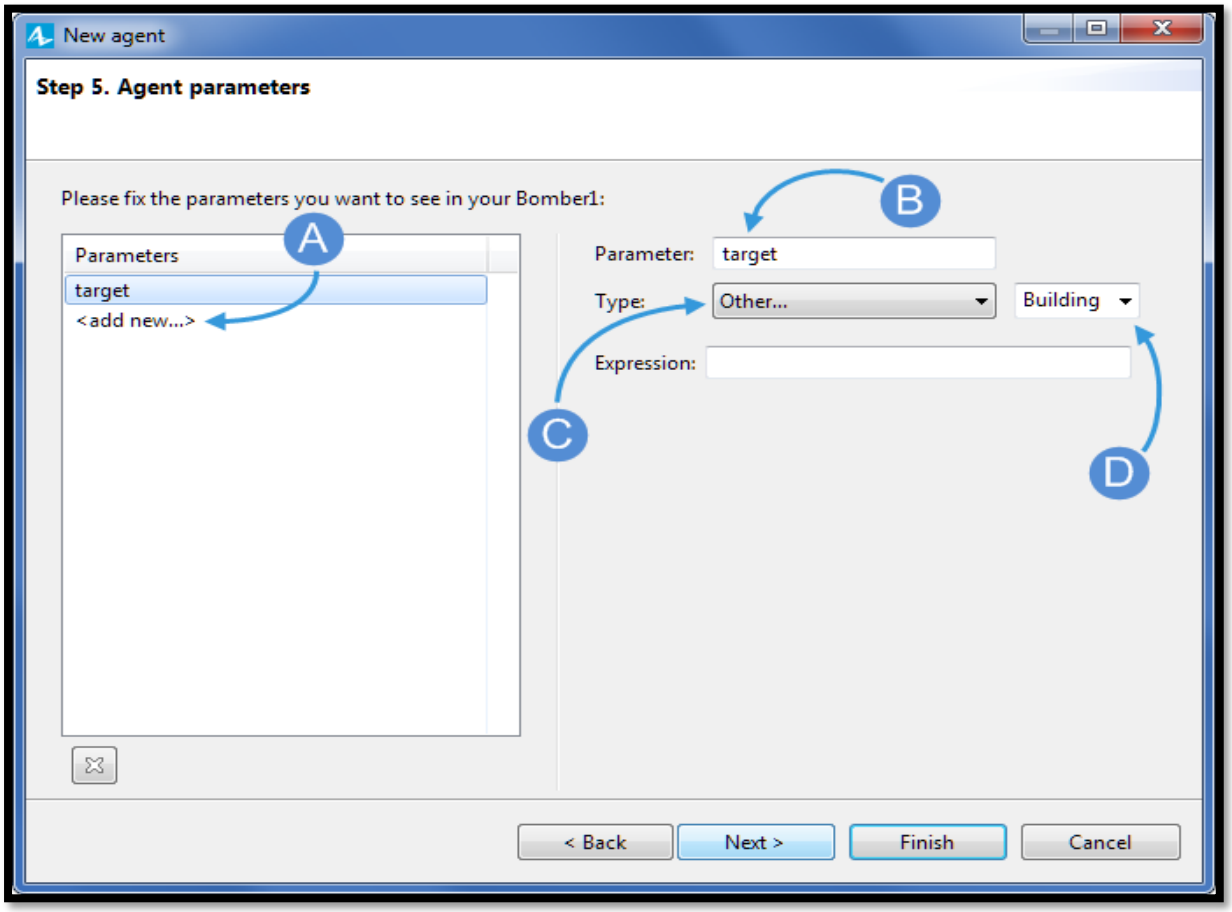

Appearance
Fill color:
white
Line color:
Line width:
Line style:
No color
Chosen colors
Other Colors...
Textures...
Position and size
X:
0
Width:
1000

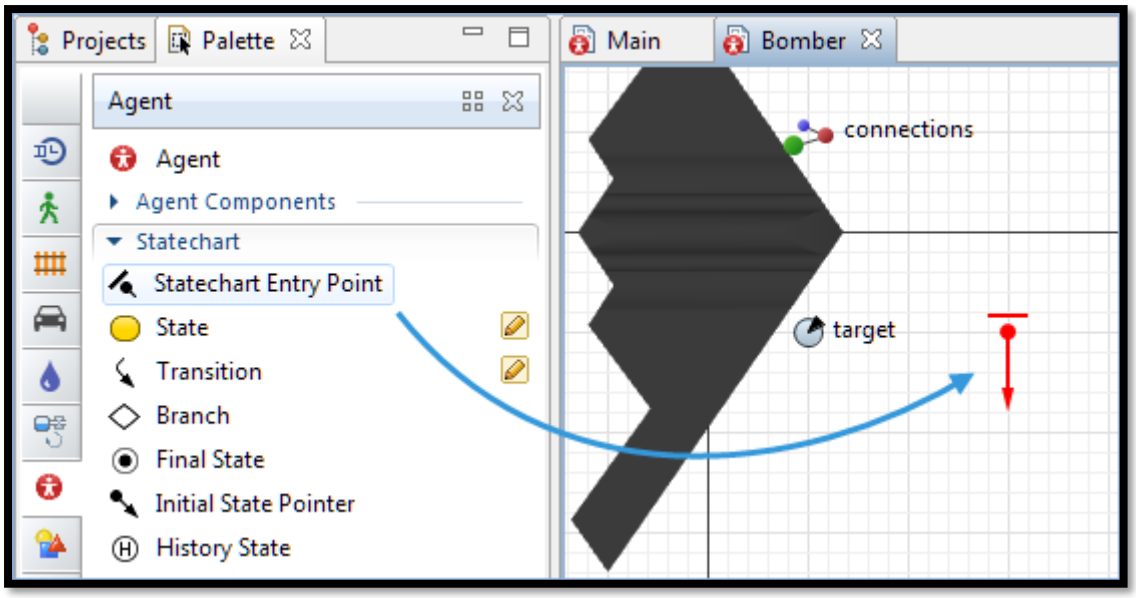

Textures
Textures
earth
OK
Cancel

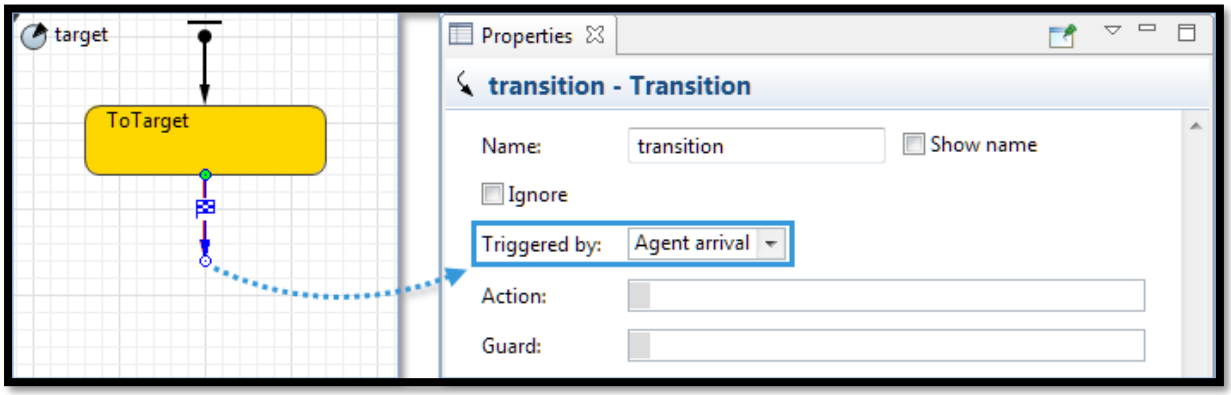


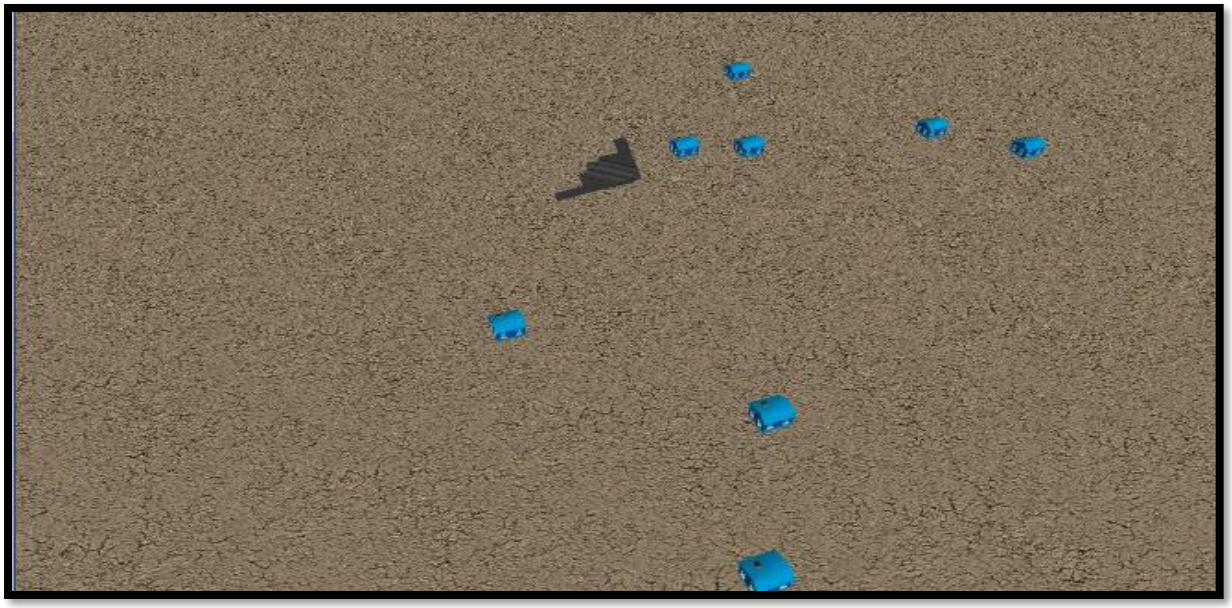

Main

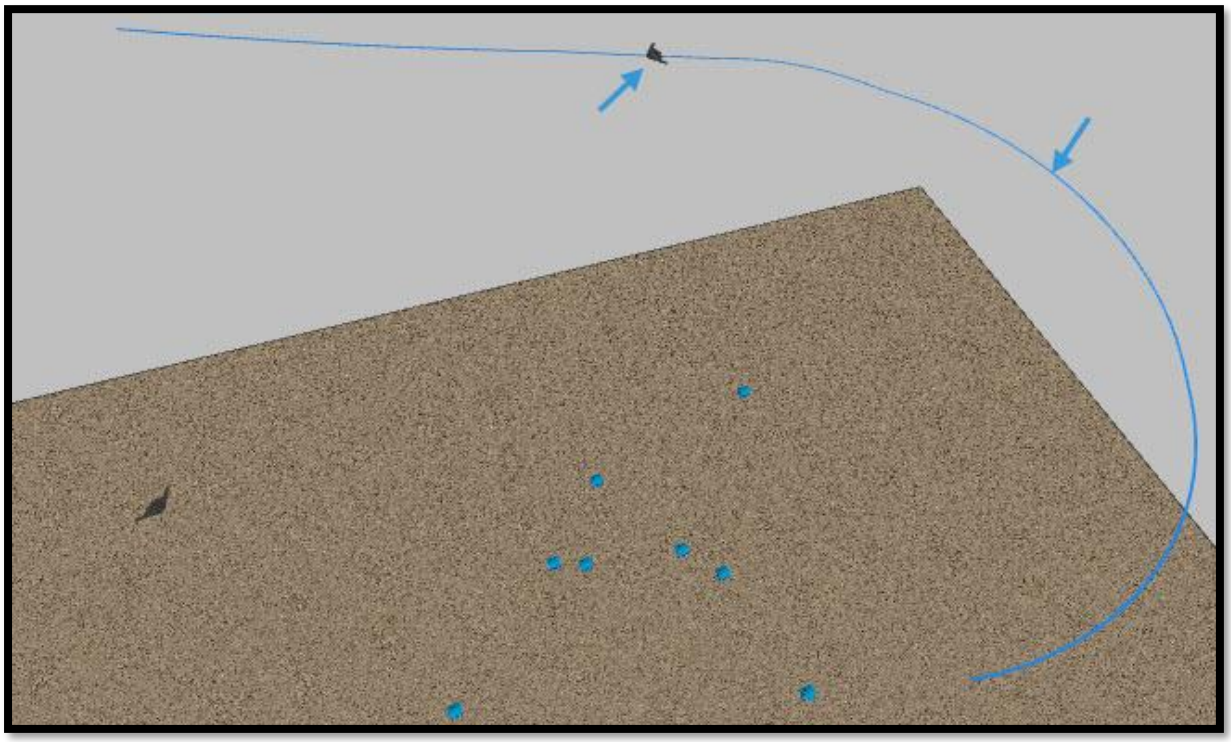


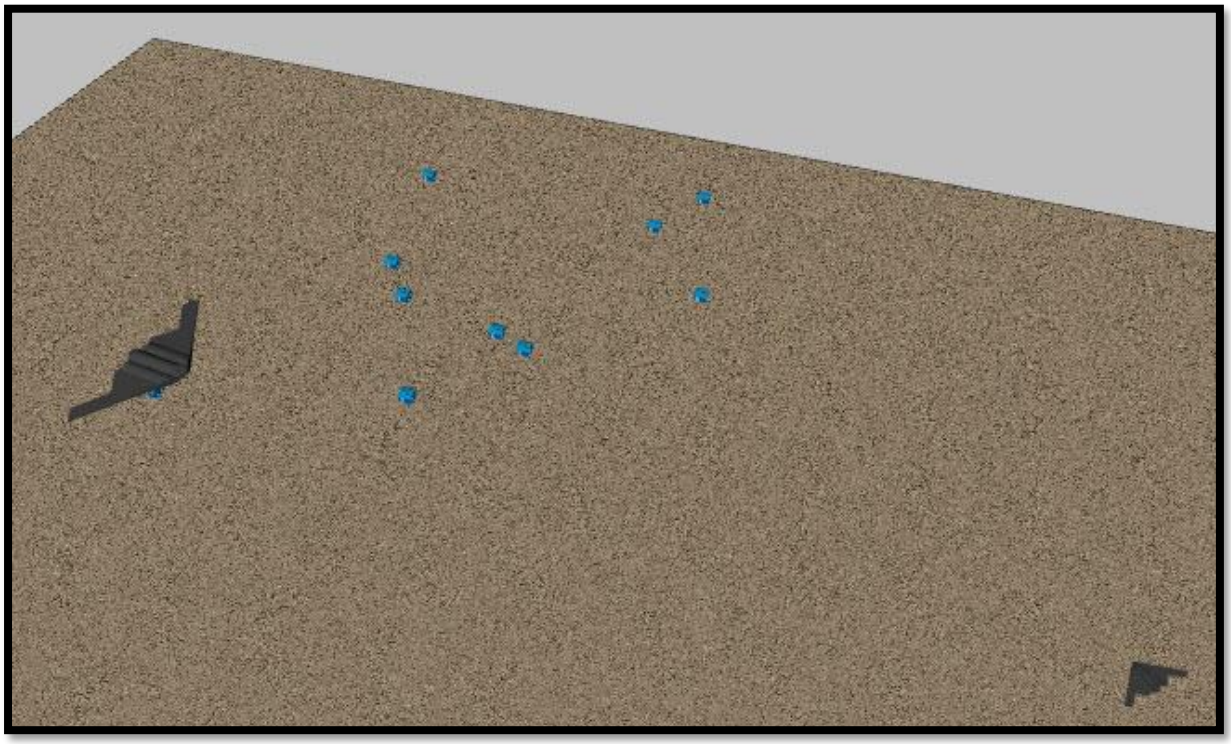

New agent
Step 5. Agent parameters
Please fix the parameters you want to see in your Bomber1:
A
B
C
D
Parameters
target
<add new...>
Parameter:
target
Type:
Other...
Building
Expression:
< Back
Next >
Finish
Cancel

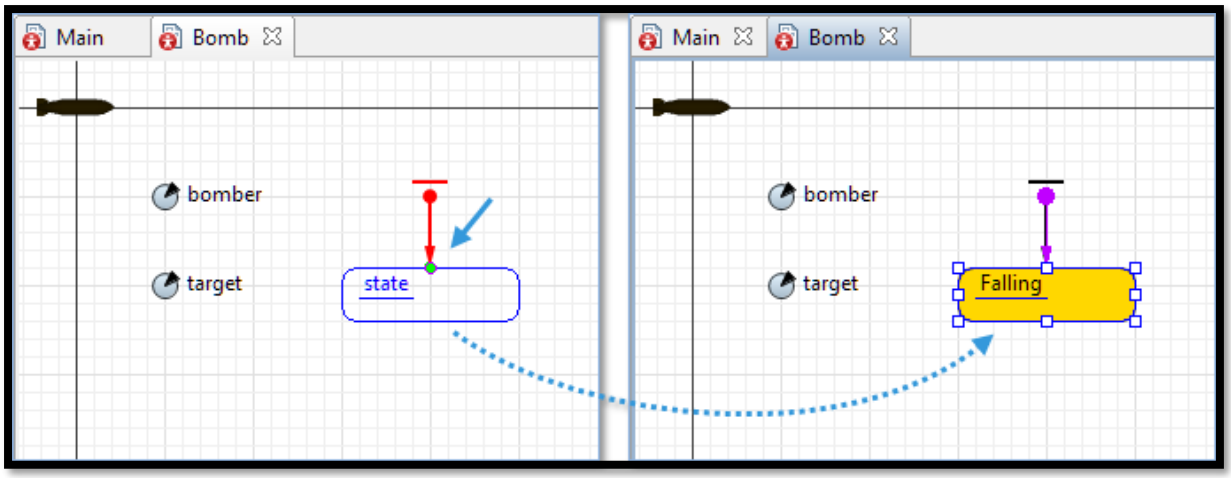

Projects
Palette
Agent
Agent
Agent Components
Statechart
Statechart Entry Point
State
Transition
Branch
Final State
Initial State Pointer
History State
Main
Bomber
connections
target

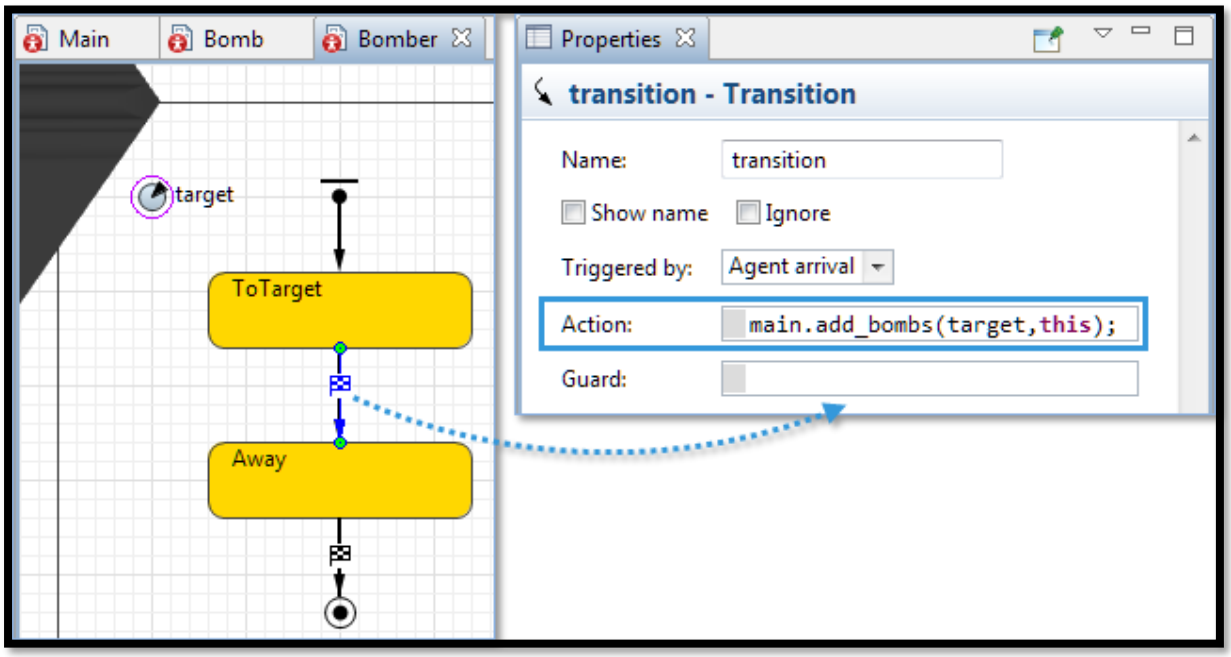

target
ToTarget
Properties
transition - Transition
Name:
transition
Show name
Ignore
Triggered by:
Agent arrival
Action:
Guard:

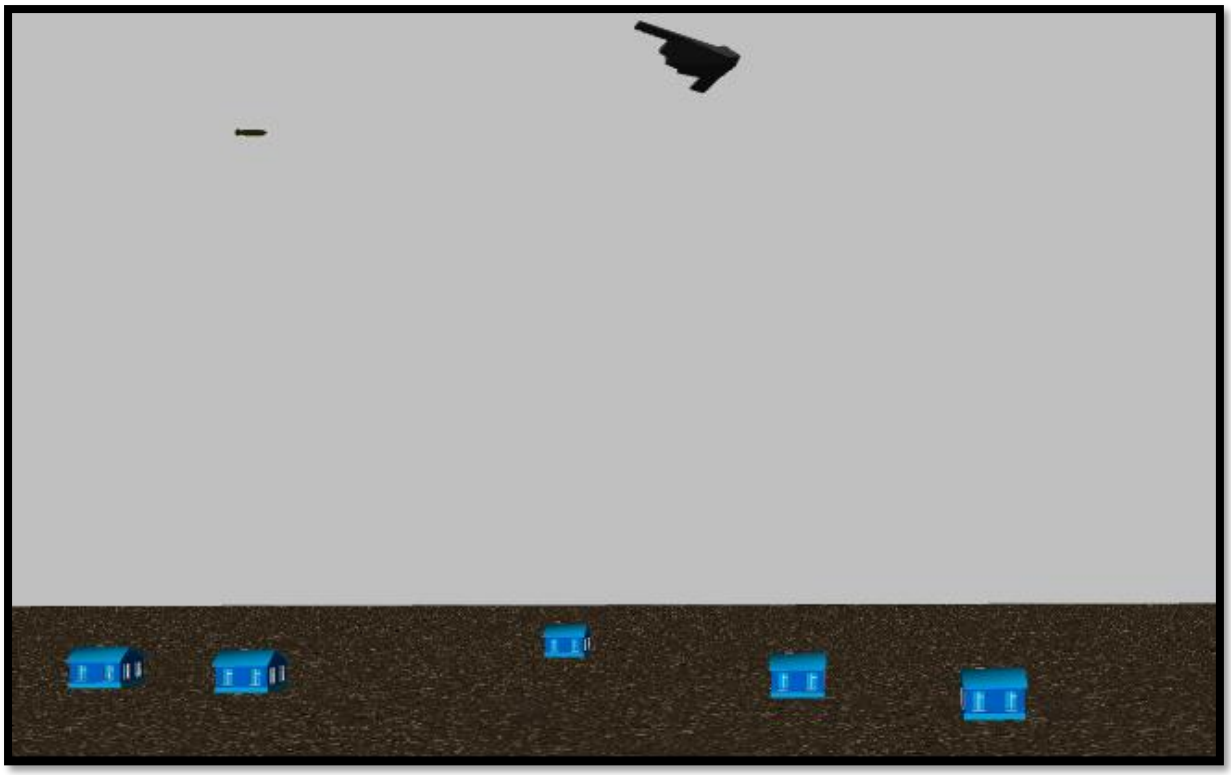


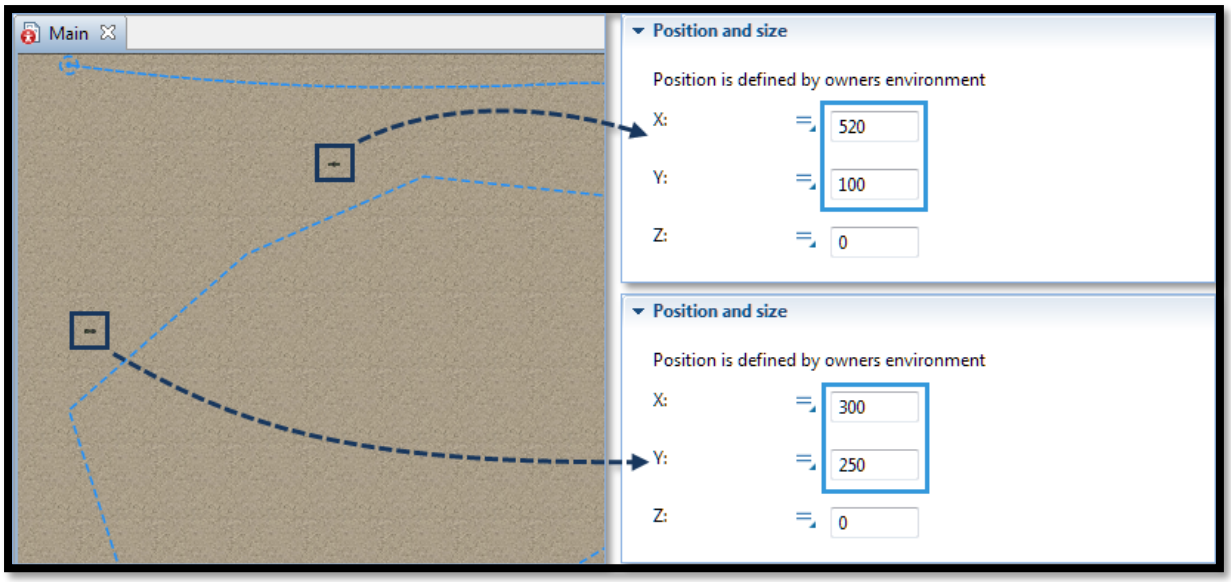


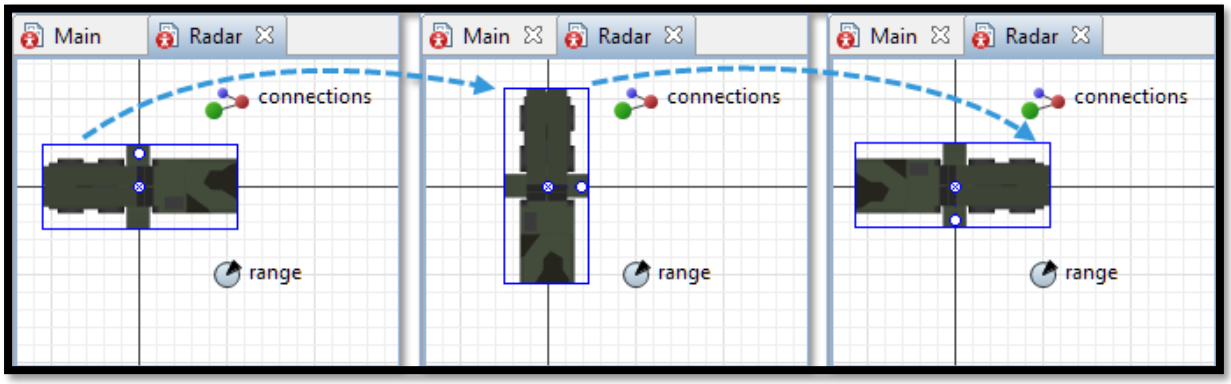


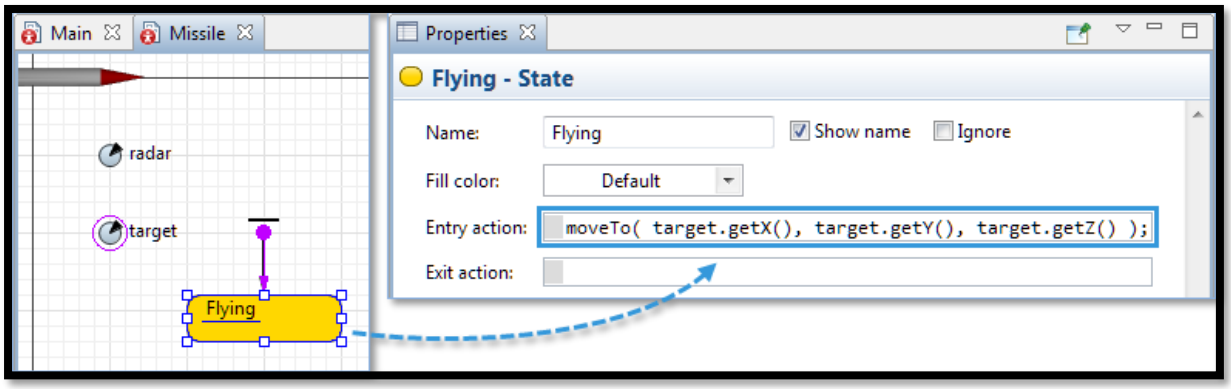

Main
Bomb
bomber
target
state
Main
Bomb
bomber
target
Falling

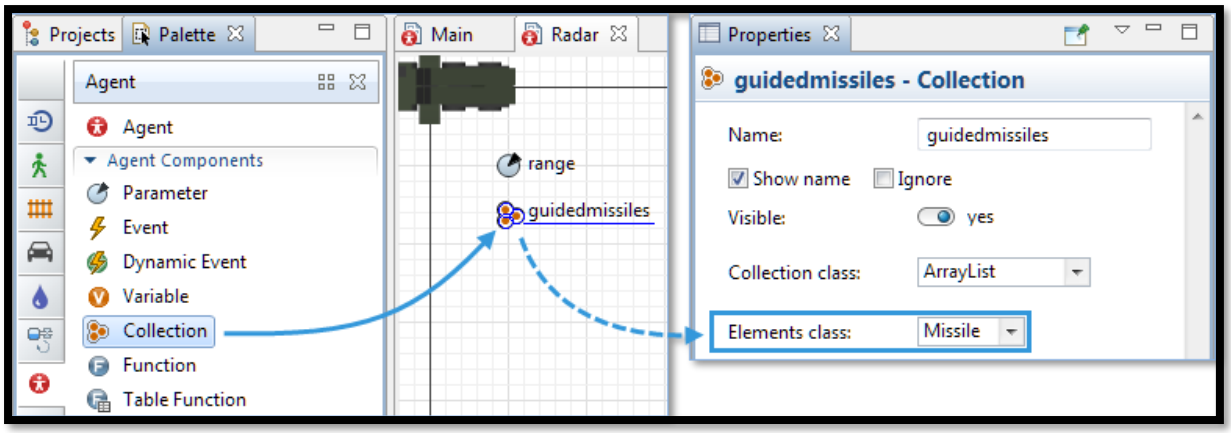

Main
Bomb
Bomber
target
ToTarget
Away
Properties
transition - Transition
Name:
transition
Show name
Ignore
Triggered by:
Agent arrival
Action:
main.add_bombs(target,this);
Guard:




Main
Position and size
Position is defined by owners environment
X:
520
Y:
100
Z:
0
Position and size
Position is defined by owners environment
X:
300
Y:
250
Z:
0

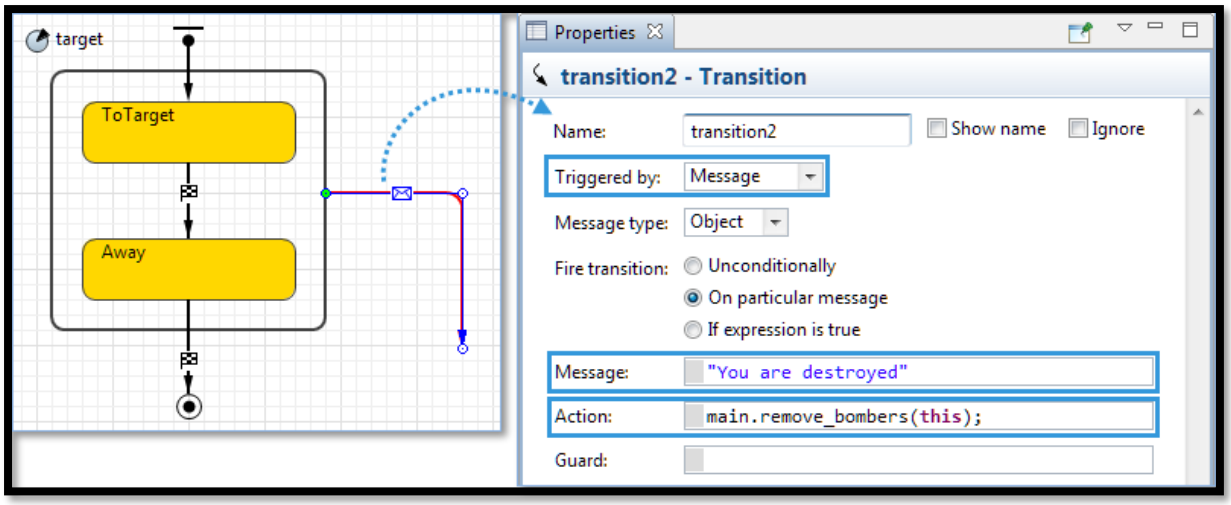

Main
Radar
connections
range
Main
Radar
connections
range
Main
Radar
connections
range

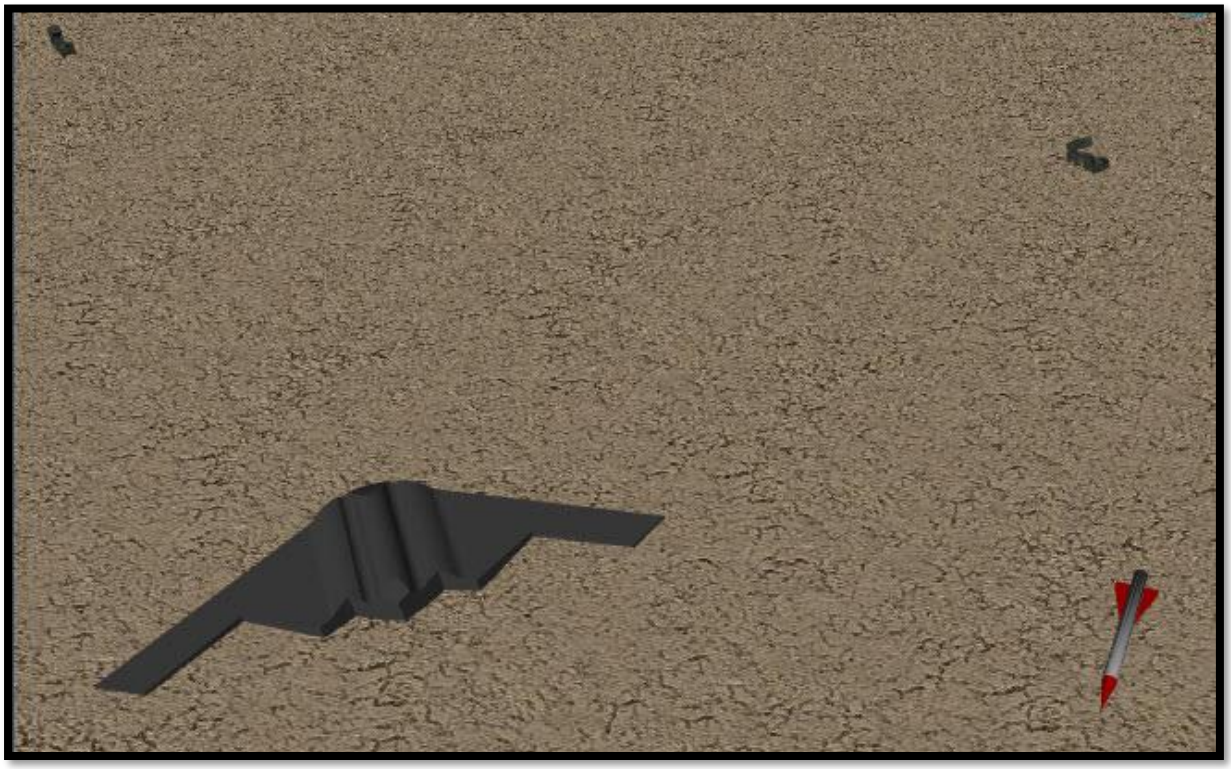

Main
Missile
radar
target
Flying
Properties
Flying - State
Name:
Flying
Show name
Ignore
Fill color:
Default
Entry action:
moveTo(target.getX(), target.getY(), target.getZ());
Exit action:

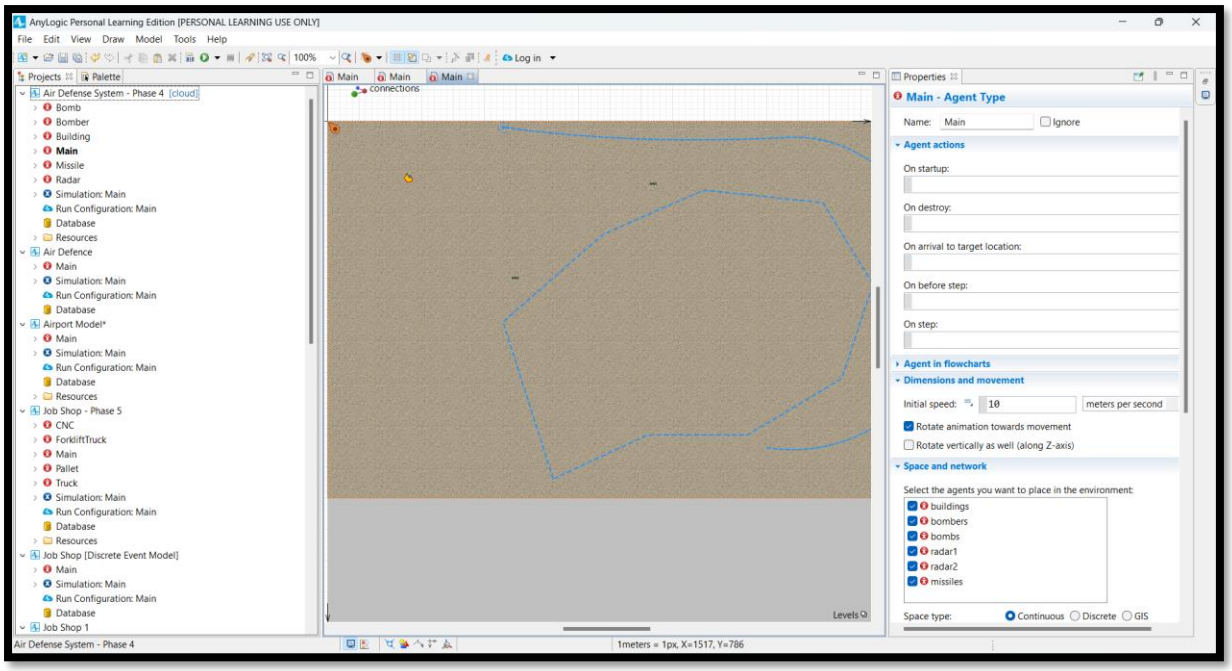


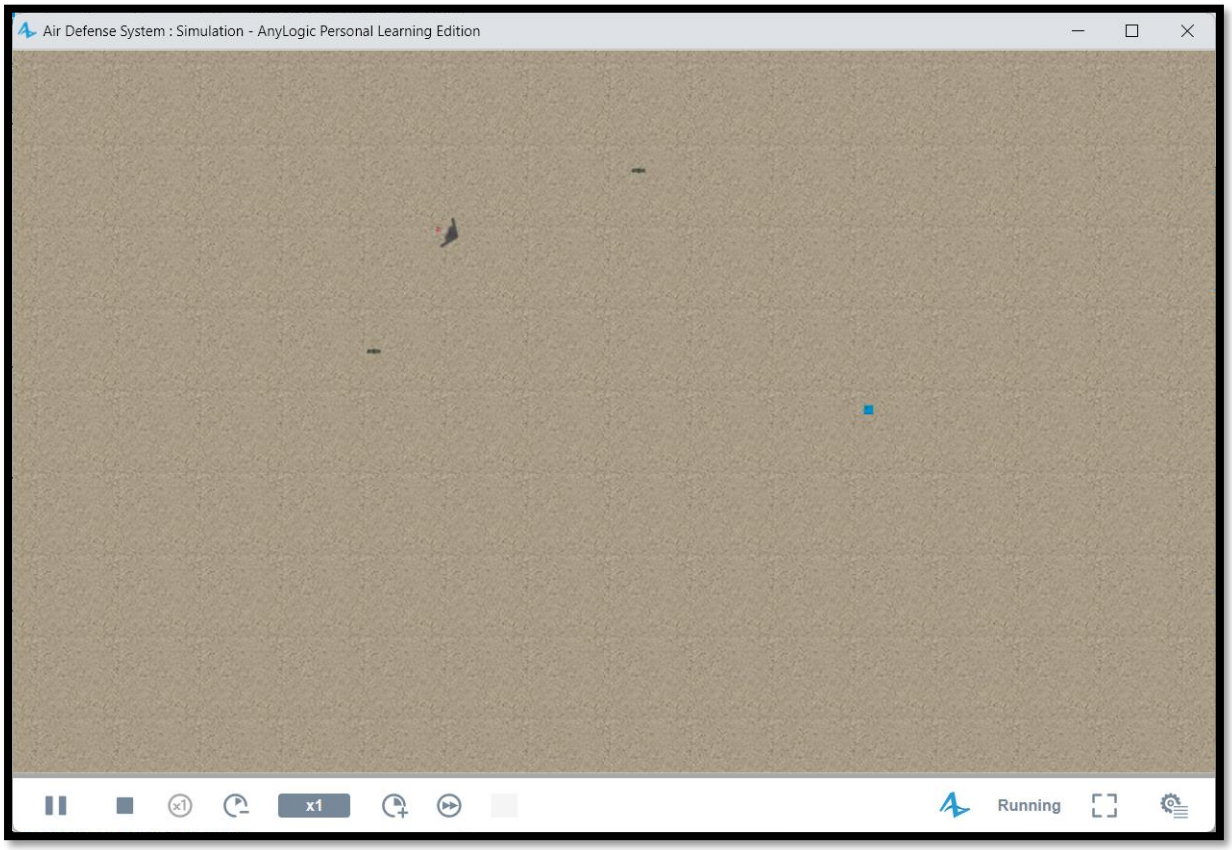
On step:

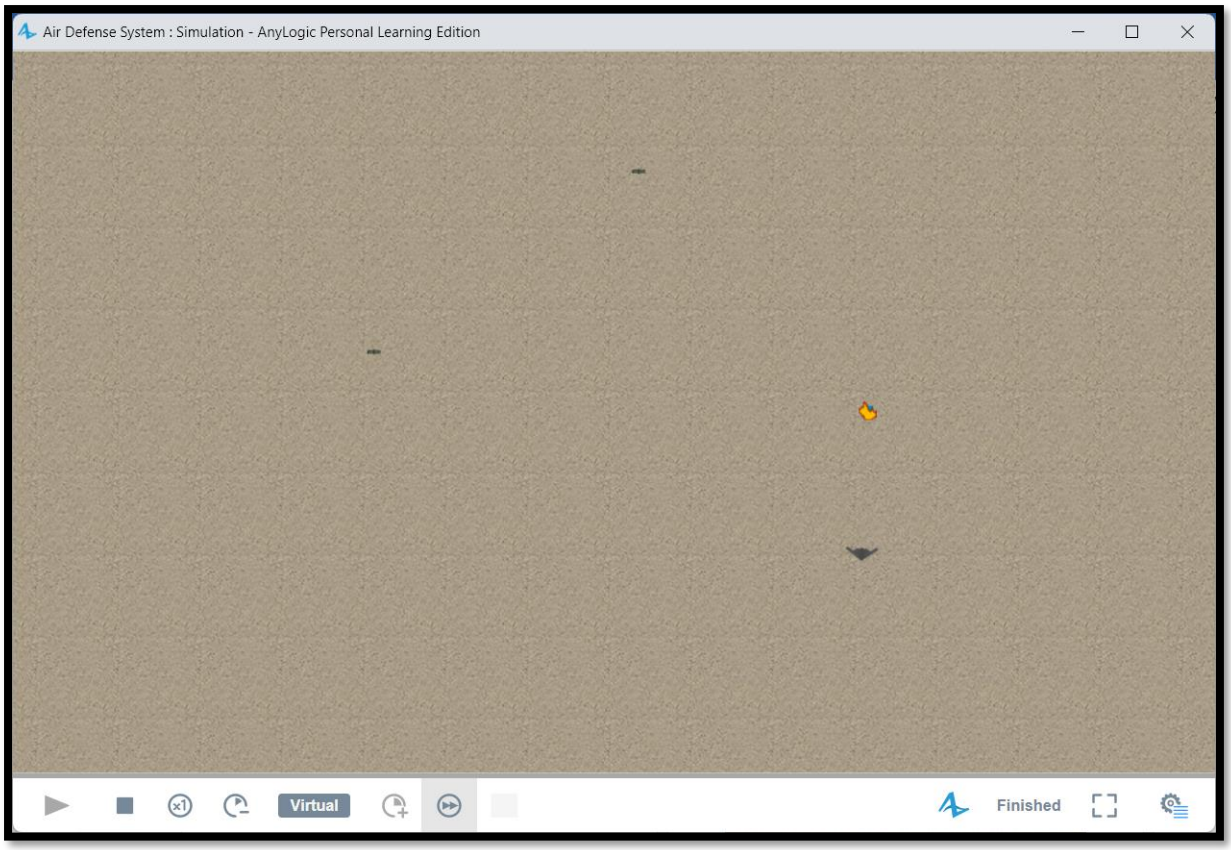
```
//for all bombers in the air
for( Bomber b : main.bombers ) {
    //if can't have more engagements, do nothing
    if( guidedmissiles.size() >= 2 )
        break;
    //if within engagement range
        //already engaged by another missile?
    if( distanceTo( b ) < range ) {
        boolean engaged = false;
        for( Missile m : main.missiles ) {
            if( m.target == b ) {
                engaged = true;
                break;
            }
        }
        if( engaged )
            continue; //proceed to the next bomber
        //engage (create a new missile)
        Missile m = main.add_missiles( this, b );
        guidedmissiles.add( m ); //register guided missile
    }
}
```


target
ToTarget
Away
Properties
transition2 - Transition
Name:
transition2
Show name
Ignore
Triggered by:
Message
Message type:
Object
Fire transition:
Unconditionally
On particular message
If expression is true
Message:
"You are destroyed"
Action:
main.remove_bombers(this);
Guard:




AnyLogic Personal Learning Edition [PERSONAL LEARNING USE ONLY]
File Edit View Draw Model Tools Help
Projects
Palette
Air Defense System - Phase 4 [cloud]
Bomb
Bomber
Building
Main
Missile
Radar
Simulation: Main
Run Configuration: Main
Database
Resources
Air Defence
Airport Model*
Job Shop - Phase 5
CNC
ForkliftTruck
Pallet
Truck
Job Shop [Discrete Event Model]
Job Shop 1
Main
connections
Levels
Properties
Main - Agent Type
Name: Main
Ignore
Agent actions
On startup:
On destroy:
On arrival to target location:
On before step:
On step:
Agent in flowcharts
Dimensions and movement
Initial speed: 10
meters per second
Rotate animation towards movement
Rotate vertically as well (along Z-axis)
Space and network
Select the agents you want to place in the environment:
buildings
bombers
bombs
radar1
radar2
missiles
Space type: Continuous Discrete GIS
Air Defense System - Phase 4
1meters = 1px, X=1517, Y=786


Air Defense System : Simulation - AnyLogic Personal Learning Edition
x1
Running



Conclusion:

By following the four phases outlined in this practical, users can develop a comprehensive agent-based simulation model of a radar-based air defence system using AnyLogic. The model simulates the interactions between bombers, radars, missiles, bombs, and buildings in a continuous 3D space, providing insights into the effectiveness and performance of the air defence system in protecting ground facilities from aerial threats.