Swarmfest ‘99 Tutorial

Session II: Simplebug demo

Benedikt Stefansson

<benedikt at ucla.edu>

revised version 0.3

by YABUKI Taro for Java

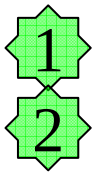
Second session

- Tutorial: Simplebug
  - Start: From non-OO to OO to Swarm
  - Adding GUI: Probes, raster image, graphs
  - Creating and controlling full experiment run
- Topics covered:
  - Managing objects
  - Swarms, activity library, probes, GUI

Chapters in Simplebug tutorial

• simpleCBug	Simple non-OO code
• simpleObjCBug	Bug is now Java class
• simpleObjCBug2	Adds grid holding food
• simpleSwarmBug	Adds a ModelSwarm
• simpleSwarmBug2	Many bugs...
• simpleSwarmBug3	Reads parameters from file
• simpleObserverBug	Adds ObserverSwarm & GUI
• simpleObserverBug2	Adds more sophisticated GUI
• simpleExperBug	Runs multiple experiments

Bug in non-OO



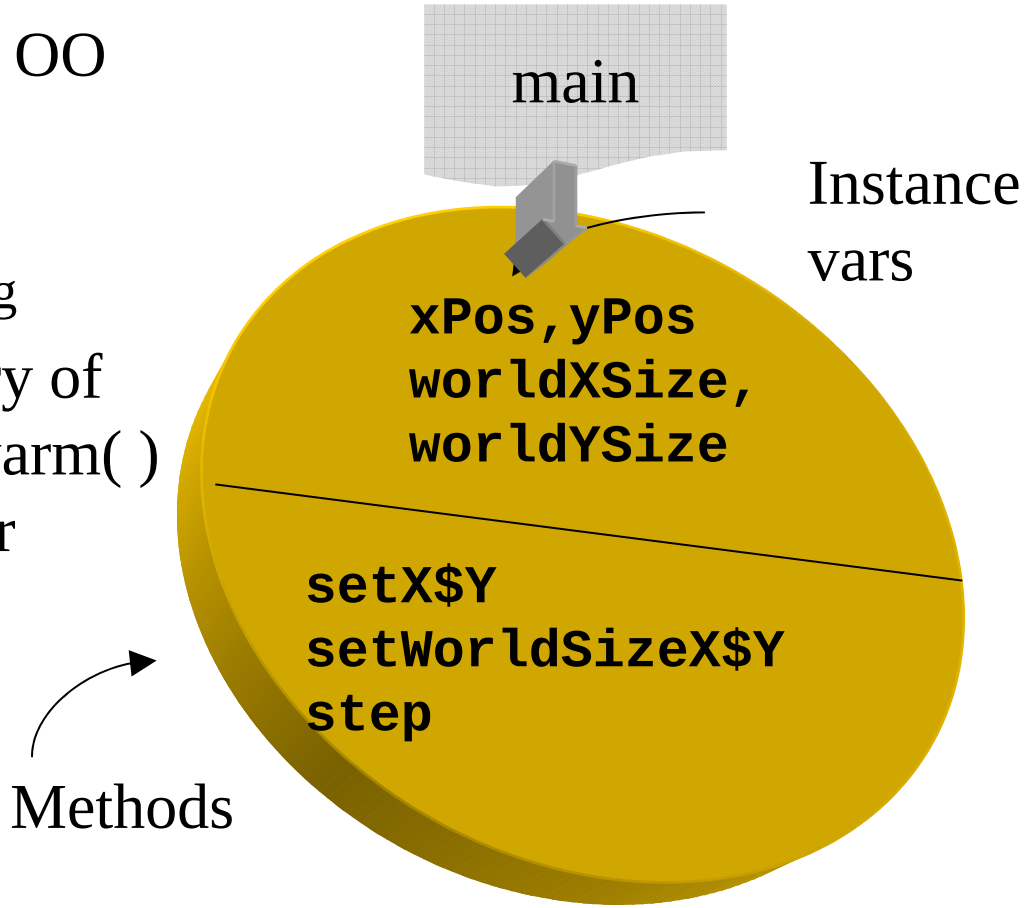

```
import swarm.*;
public class simpleCBug{
  public static void main(String[] args){
    int worldXSize = 80;                                    // Maximum X value
    int worldYSize = 80;                                    // Maximum Y value
    int xPos = 40;                                 // Bug's starting position
    int yPos = 40;
    int i;

    Globals.env.initSwarm("bug", "0.1", "t_yabuki at nifty dot com", args);

    System.out.println("I started at X = " + xPos + " Y = " + yPos + "¥n");

    for(i = 0; i < 100; i++) {
      // Random movement in X and Y (possibly 0)

      xPos = xPos + Globals.env.uniformIntRand.getIntegerWithMin$withMax(-1,1);
      yPos = yPos + Globals.env.uniformIntRand.getIntegerWithMin$withMax(-1,1);

      // Take move modulo maximum coordinate values

      xPos = (xPos+ worldXSize) % worldXSize;
      yPos = (yPos + worldYSize) % worldYSize;

      System.out.println("I moved to X = " + xPos + " Y = " + yPos);
    }
  }
}
```

Bug in non-OO explanations

1. Importing package gives us access to random number obj etc.
2. Each Java program must have main function, which can take an argument:
   - args: value of command line args
3. initSwarm() function checks command line args and revs up Swarm engine
4. The program uses default random number distributions to choose new location for bug

Bug in OO

- The simplest version of an OO program
  - A main( ) function
  - One class, one instance: Bug
- main( ) imports base library of Swarm and fires up initSwarm( ) which gives us libraries for memory allocation etc.



Bug in OO: The bug as object

- Inheriting from the SwarmObjectImpl class Bug knows these tricks:
  - construction: Allocate memory
  - drop: Deallocate and die

- First instruct class to create instance of itself. Associate instance with aBug

```
Bug aBug=new
   Bug(Globals.env.globalZone);
```

- Then set parameters in the instance, aBug

```
aBug.setX$Y(xPos,yPos);
aBug.setWorldXSize$Y(worldXSize,w
   orldYSize);
```

Typical create phase

Allocate memory etc.

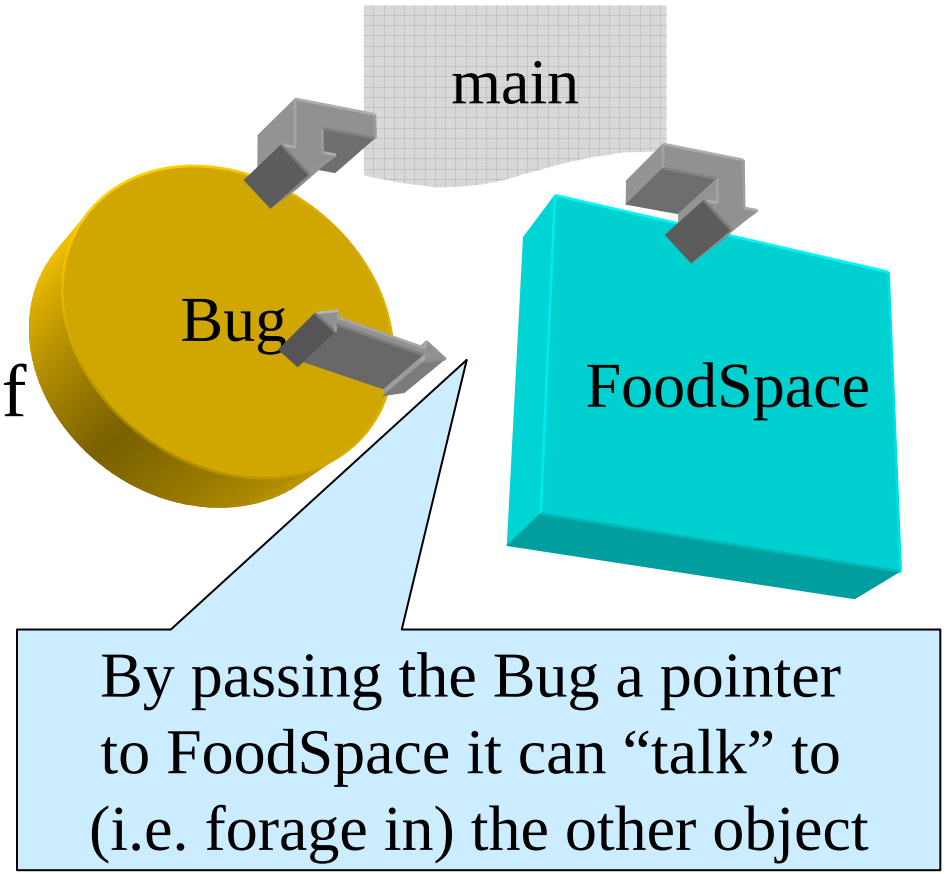
```
Bug aBug =new Bug(Globals.env.globalZone);
```

Set all necessary parameters

```
aBug.setWorldSizeX$Y(xsize,ysize);
aBug.setFoodSpace(foodSpace);
aBug.setX$Y(xPos,yPos);
```

Bug in OO II: The FoodSpace

- Here create a world for the bug to roam around in and eat
- The world is defined in FoodSpace, a subclass of Discrete2dImpl
- Discrete2d manages a lattice of integer values



The FoodSpace class

- By subclassing from Discrete2dImpl FoodSpace inherits several Ivars and about 16 methods to store and retrieve values in 2d space
- The only addition is a method to fill space with “food”

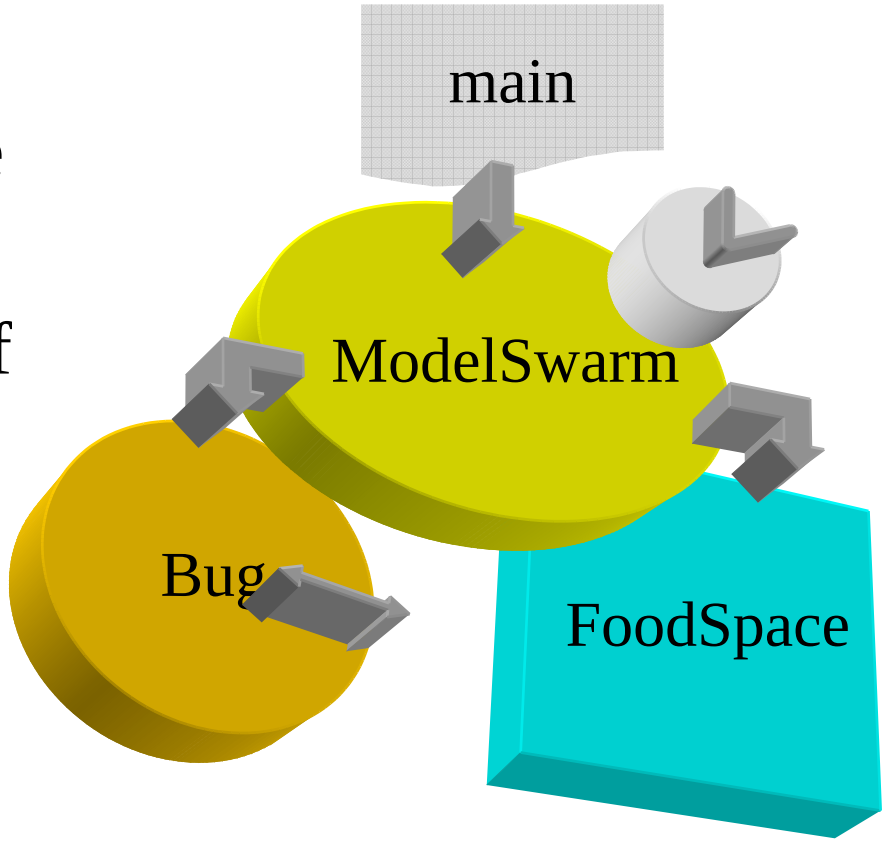
Inherited method

```
public Object seedFoodW    rob
  (double seedProb){
  int x,y;
  int xsize,ysize;
  xsize=this.getSizeX();
  ysize=this.getSizeY();
  for (y = 0; y < ysize; y++)
    for (x = 0; x < xsize; x++)
      if (Globals.env.uniformDblRand
      .getDoubleWithMin$withMax
      (0.0,1.0)<=seedProb)
        this.putVa    $atX$Y(1,x,y);

  return this;
}
```

Inherited method

Bug in Swarm: The ModelSwarm

- An instance of the Swarm class can manage a model world
- Facilitates the creation of agents and interaction model
- Model can have many Swarms, often nested



Creating a Swarm

I. construction
  - Initialize memory and parameters

II. buildObjects
  - Build all the agents and objects in the model

III. buildActions
  - Define order and timing of events

IV. activate
  - Merge into top level swarm or start Swarm running

Step I: Initializing

1 2

```
public ModelSwarm(Zone aZone){
```

3

```
   super(aZone);
```

4

```
   worldXSize = 80;
   worldYSize = 80;
   seedProb = 0.1;
   xPos = 40;
   yPos = 40;
}
```

Details on constructional method

1. This is a constructor. It can’t return a value or object.

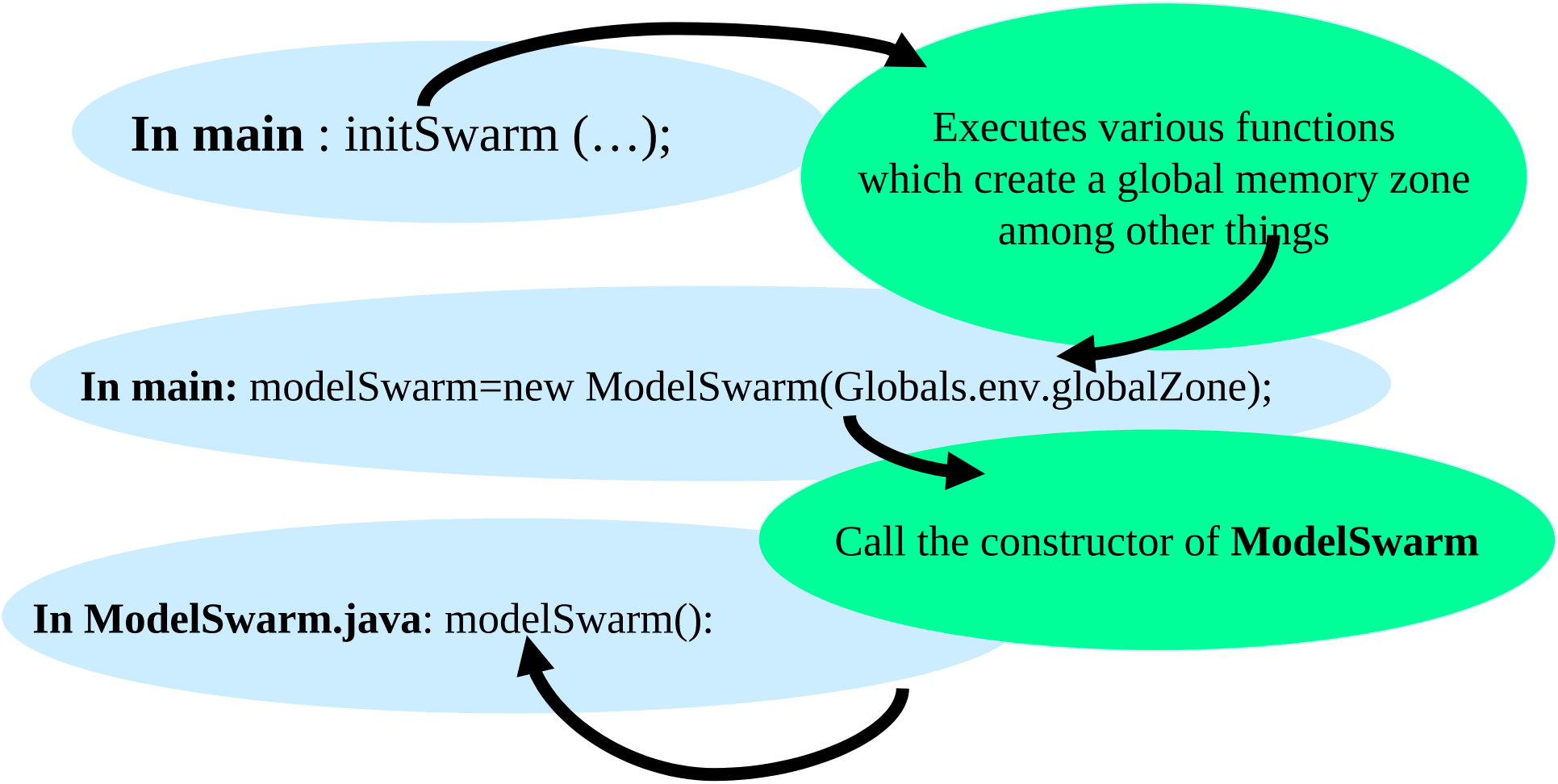
3. super
   - Executes a constructor of the super class of obj (SwarmImpl). It allocates memory.

4. varName=val
   - It is same to “this.varName=val”. The name of itself can be omitted.

2 Memory zones

- The interface swarm.defobj.Drop provides facilities to drop an object - deallocate memory
- Each object is created in a memory zone
- Effectively this means that the underlying mechanism provides enough memory for the instance, its variables and methods.
- The zone also keeps track of all objects created in it and allows you to reclaim memory simply by dropping a zone. It will signals to all objects in it to destroy themselves

Where did that zone come from?



Step II: Building the agents

```
public Object buildObjects(){
  foodSpace =new FoodSpace
    (Globals.env.globalZone,worldXSize,worldYSize);
  foodSpace.seedFoodWithProb(seedProb);

  Bug aBug =new Bug(Globals.env.globalZone);
  aBug.setWorldSizeX$Y(worldXSize,worldYSize);
  aBug.setFoodSpace(foodSpace);
  aBug.setX$Y(xPos,yPos);

  return this;
}
```

Details on the buildObjects phase

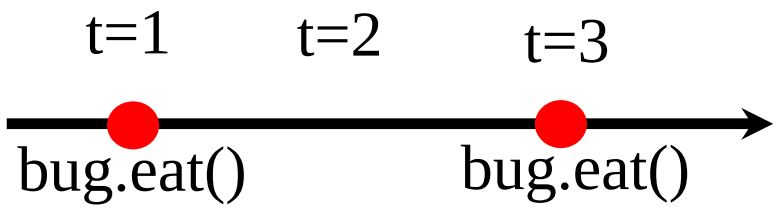
- The purpose of this method is to create each instance of objects needed at the start of simulation, and then to pass parameters to the objects
- It is good OO protocol to provide setX: methods for each parameter X we want to set, as in: `aBug.setFoodSpace(foodSpace)`

Step III: Building schedules

```
public Object buildActions(){
  modelSchedule=new ScheduleImpl(this,1);
  try {
    modelSchedule.at$createActionTo$message
      (0,aBug,new Selector(Class.forName("Bug"),
      "step",false));
  } catch (Exception e){
    System.exit(1);
  }
  return this;
}
```

Schedules

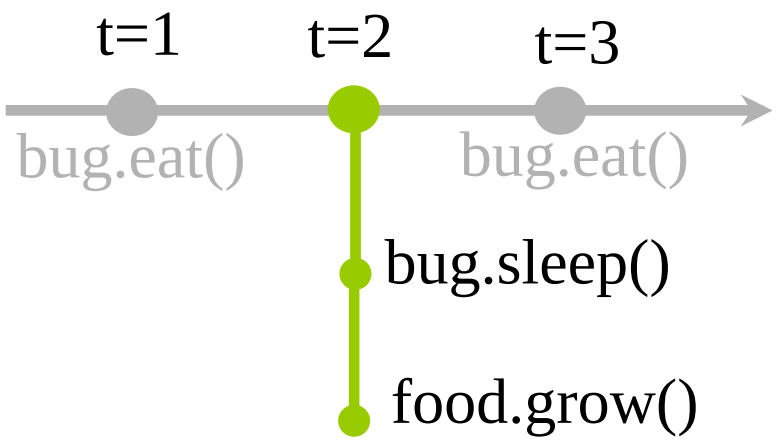
- Schedules define event in terms of:
  1. – Time of first invocation
  2. – Target object
  3. – Method to call
  4. – Repeat interval



modelSchedule.at$
createActionTo$
message(t,agent, method)
1 2 3

ActivityGroups

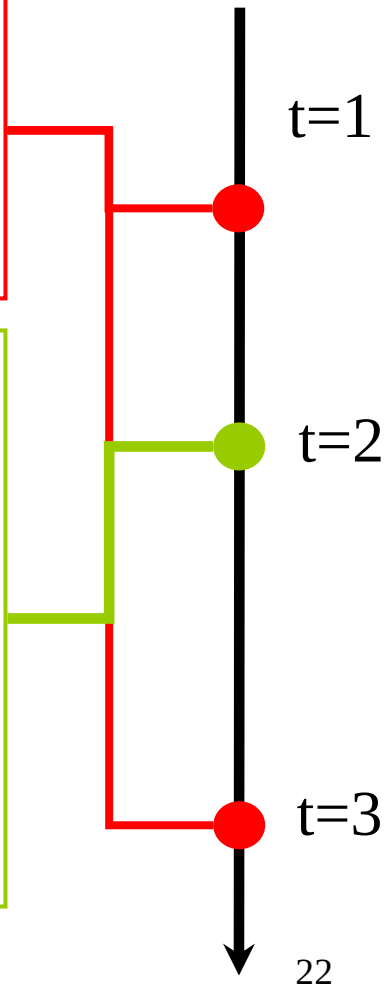
- ActivityGroups group together events at same timestep
- Schedule then “executes” group



Implementation

```
schedule1=new ScheduleImpl(this,2);
schedule1.at$createActionTo$message
  (0,bug,new Selector(Class.forName("Bug"),"eat",false));
```

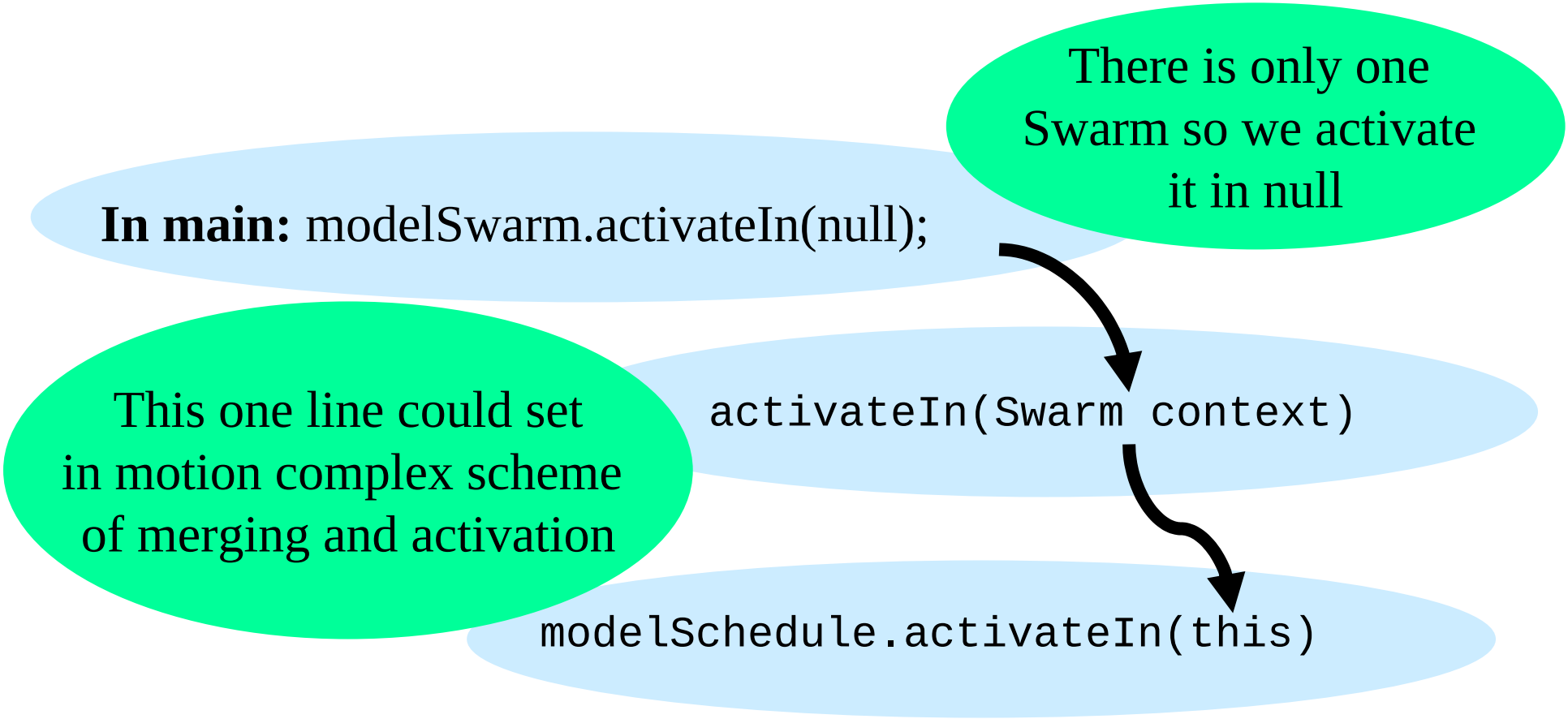
```
actionGroup=new ActionGroupImpl(this);
actionGroup.createActionTo$message
    (bug,new Selector(Class.forName("Bug"),"sleep",false));
actionGroup.createActionTo$message
    (bug,new Selector(Class.forName("Food"),"grow",false));
schedule2=new ScheduleImpl(this,1);
schedule2.at$createAction(2,modelActions);
```



Step IV: Activating the Swarm

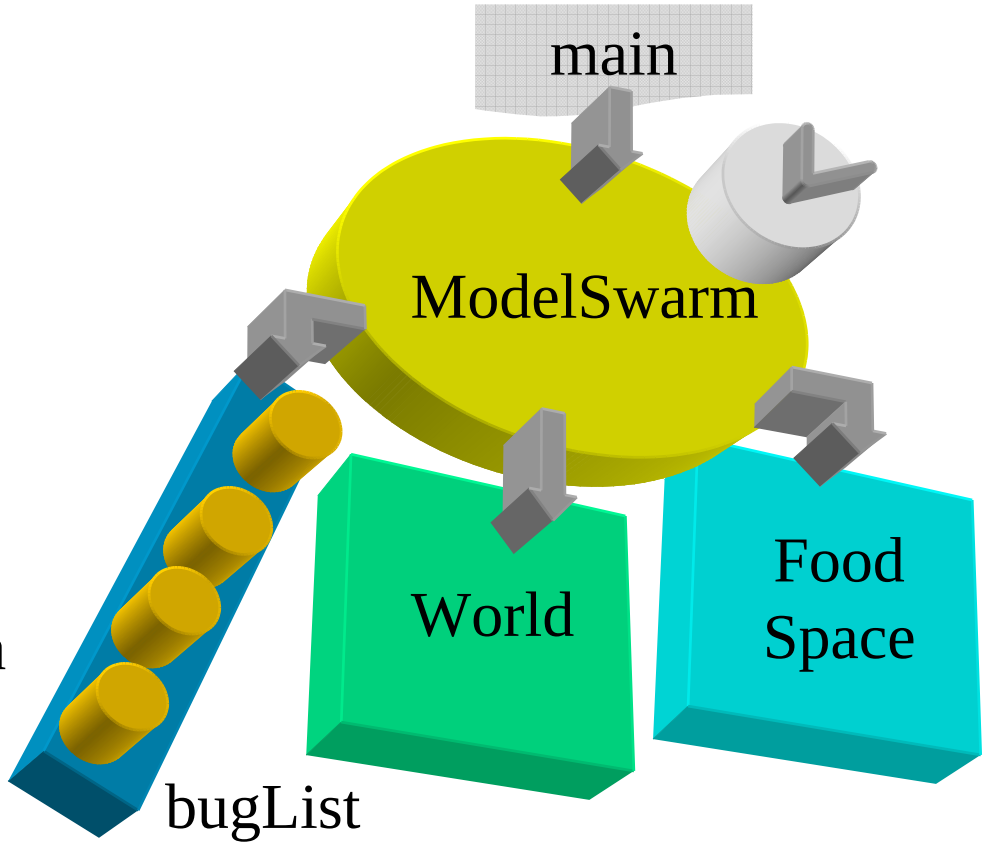
```
public Activity activateIn(Swarm context){

 super.activateIn(context);

 modelSchedule.activateIn(this);

 return getActivity();

}
```

Activation of schedule(s)



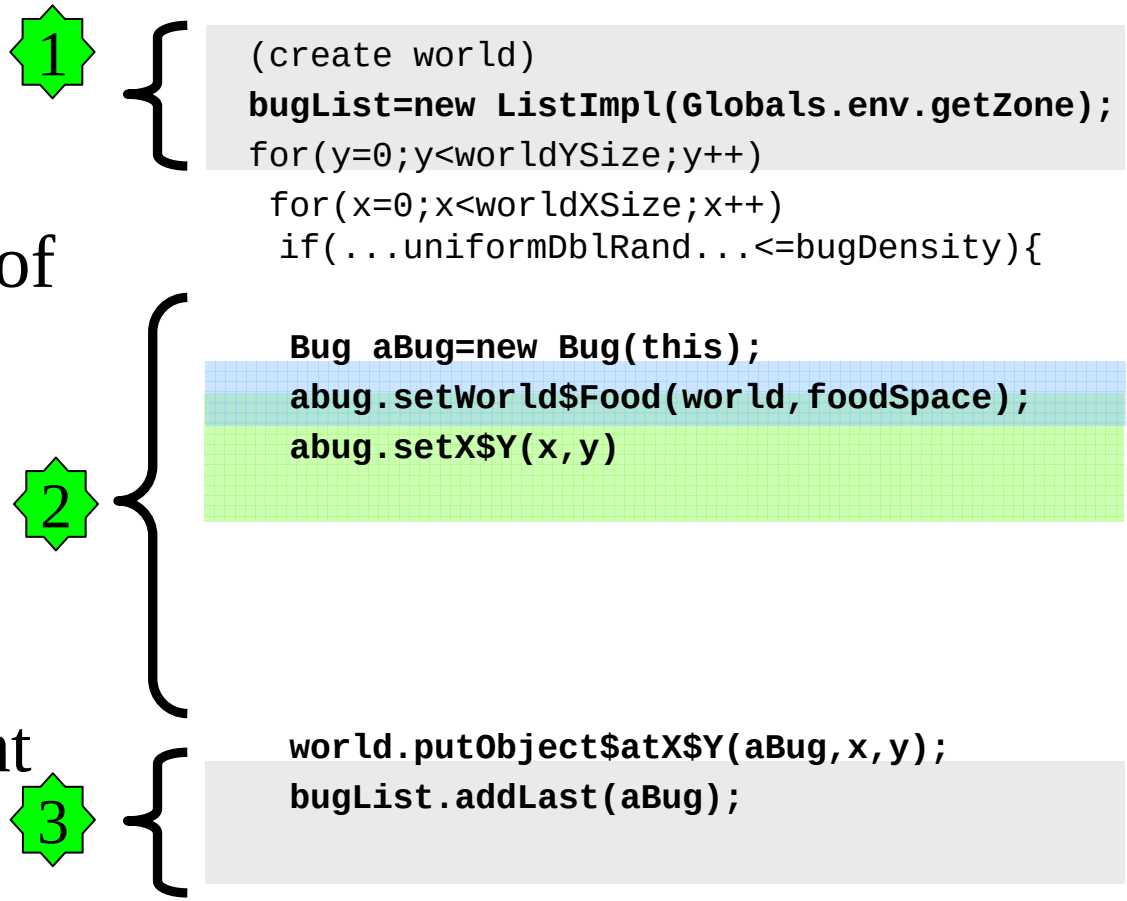
Bug in Swarm II: More bugs

- To manage more than one bug add
  - World, a Grid2d instance that enforces one bug per location
  - bugList, to keep track of bugs as a collection



Creating a population of agents

- Create collection objects (Grid2d, List) to keep track of agents
- In for loop create each instance & initialize
- Then put each agent on list,grid



Activity and collections

- We now have a collection of agents - bugs
- Schedule now takes as target the collection object - a List instance
- The collection object passes on the message to each bug

```
public Object buildActions(){
  modelActions=new
   ActionGroupImpl(this);
  modelActions.createActionForEach
   $message(bugList,new Selector
   (Class.forName("Bug"),"step",
   false));
  modelActions.createActionTo
   $message(reportBug,new Selector
   (Class.forName("Bug"),"report",
   false));

  modelSchedule=new ScheduleImpl(this,1);
  modelSchedule.at$createAction
  (0,modelActions);

  return this;
}
```

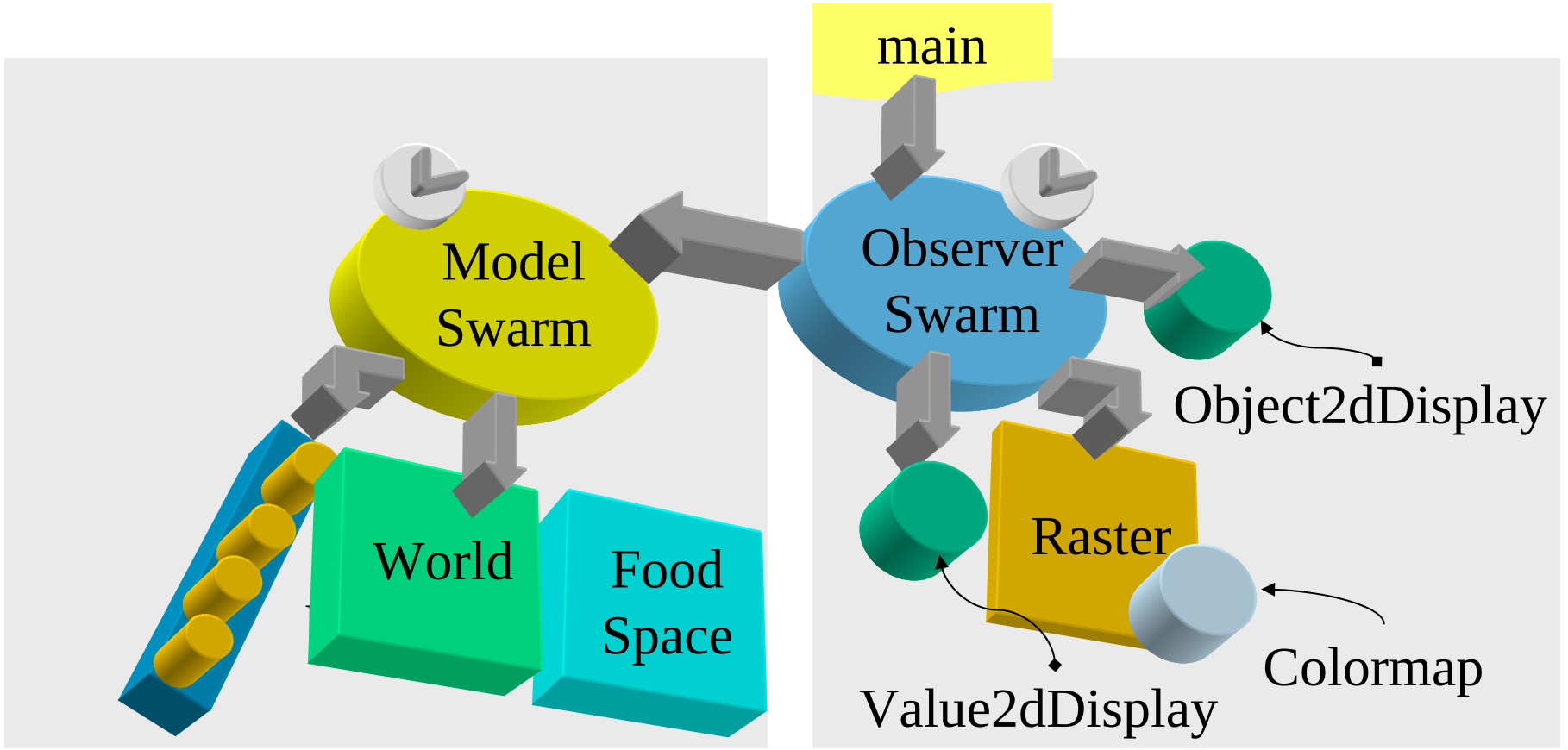
Bug in Swarm III: Loading state

- lispAppArchiver
  - Reads values of ivars from file
- Any instance vars not mentioned in .scm unchanged
- Instance vars must be public to be set by lispAppArchiver

- The bug.scm file:

```
(list(cons'modelSwarm
 (make-instance
  'ModelSwarm
  #:worldXSize 80
  #:worldYSize 80
  #:seedProb 0.9
  #:bugDensity 0.01)))
```

Bug with Observer: Adding GUI



Creating an ObserverSwarm

- constructor
  - Initialize memory and parameters
- buildObjects
  - Build ModelSwarm
  - Build graphs, rasters and probes
- buildActions
  - Define order and timing of GUI events
- activate

Step I: Initializing

```
public observerSwarm(Zone aZone){
  super(aZone);

  displayFrequency = 1;
}
```

Step II: Creating objects

```
public Object buildObjects(){
  super.buildObjects();

  modelSwarm=new ModelSwarm(this);
  getControlPanel().setStateStopped();
  modelSwarm.buildObjects();

  (create Colormap)
  (create Raster)
  (create foodDisplay)
  (create bugDisplay)
  return this;
}
```

Boldfaced items are only placeholders

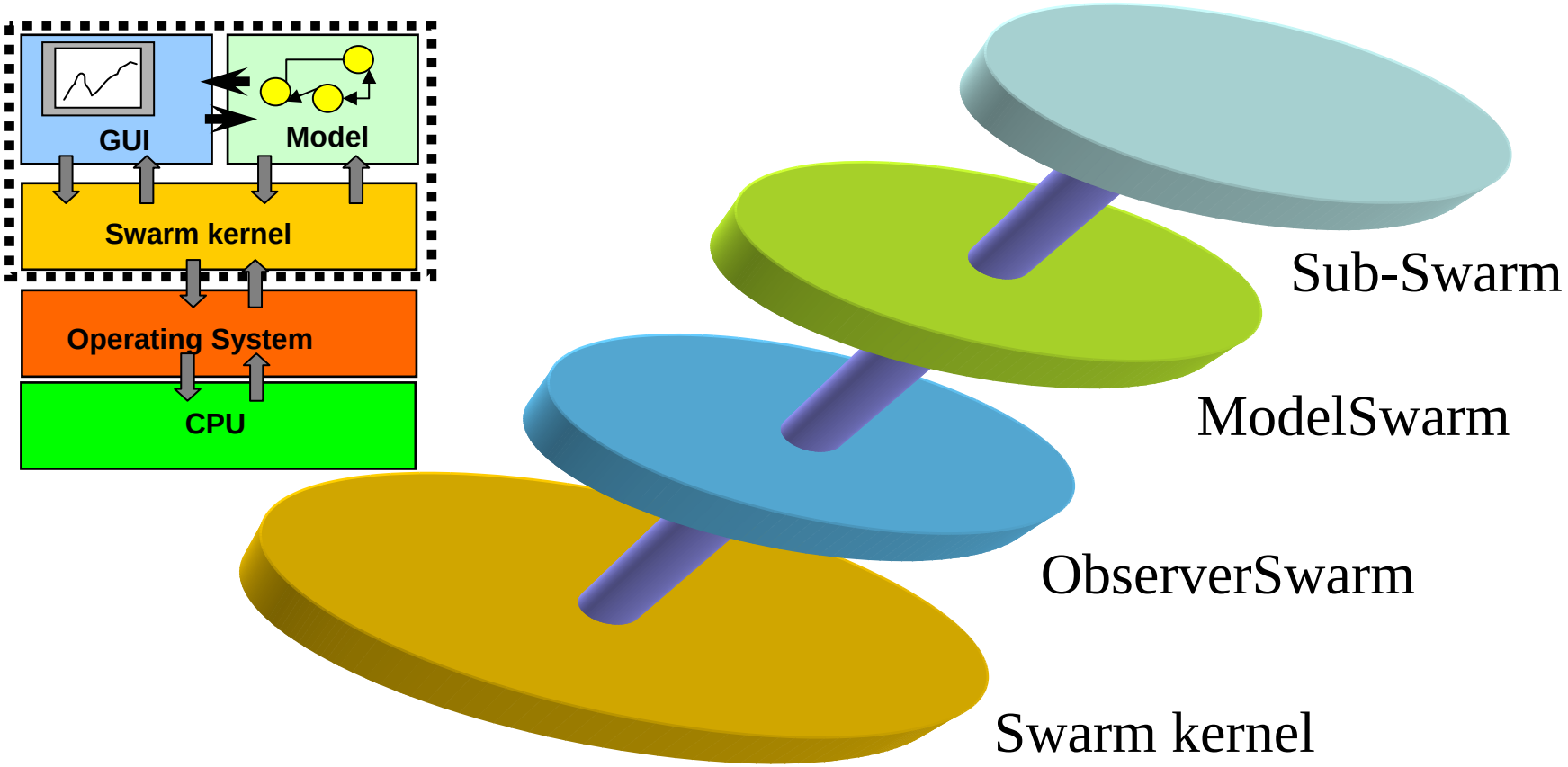
Step III: Building schedules

```
public Object buildActions(){
 super.buildActions();
 modelSwarm.buildActions();
 (create ActionGroup)
   (create foodDisplay action)
   (create bugDisplay action)
   (create worldRaster action)
   (create GUI update action)

 (create Schedule)
    (create action to ActionGroup)
return this;}
```

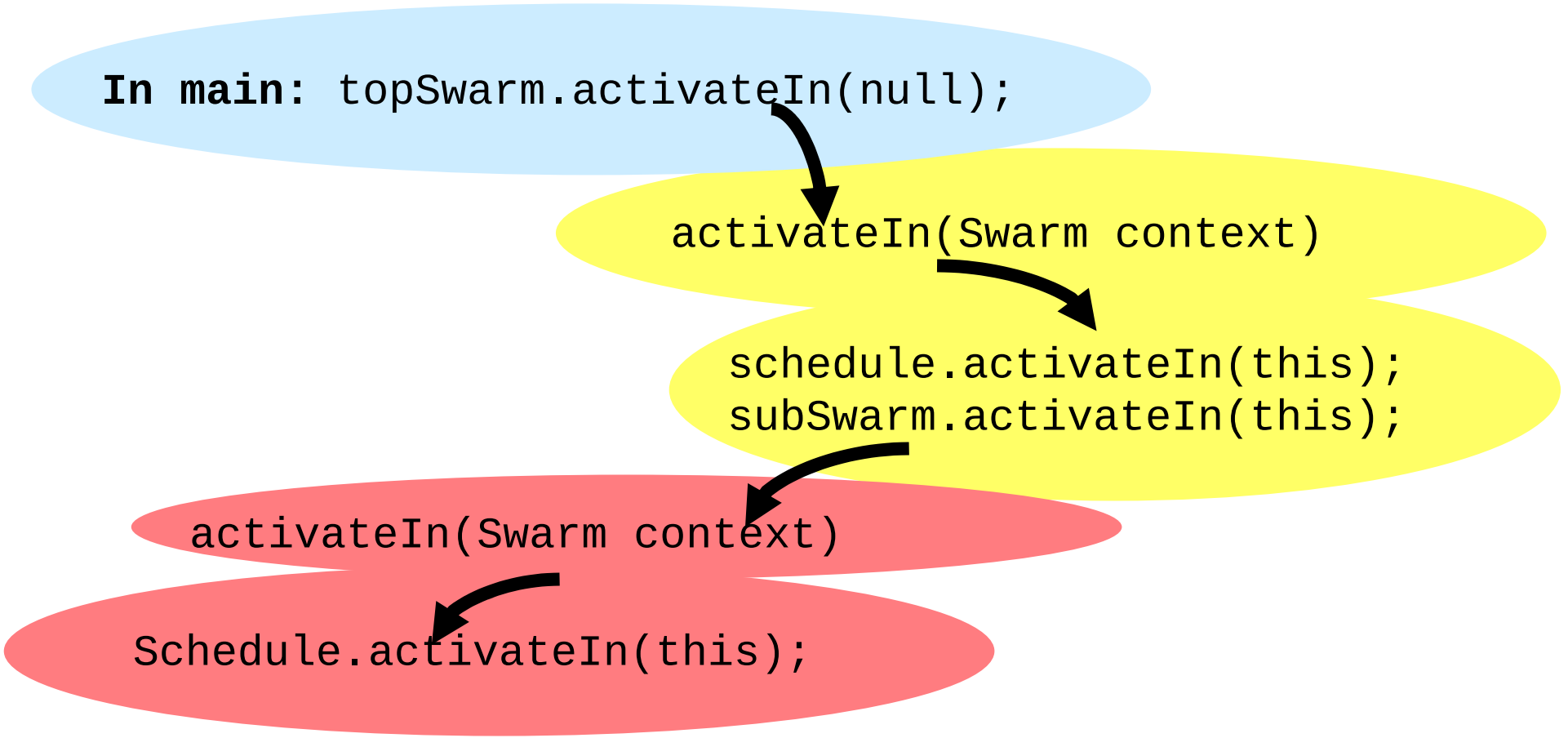
Step IV: Activating the Swarms

```
public Activity activateIn(Swarm context){
  super.activateIn(context);

  modelSwarm.activateIn(this);
  displaySchedule.activateIn(this);

  return getSwarmActivity();
}
```

Integration of Swarm activities

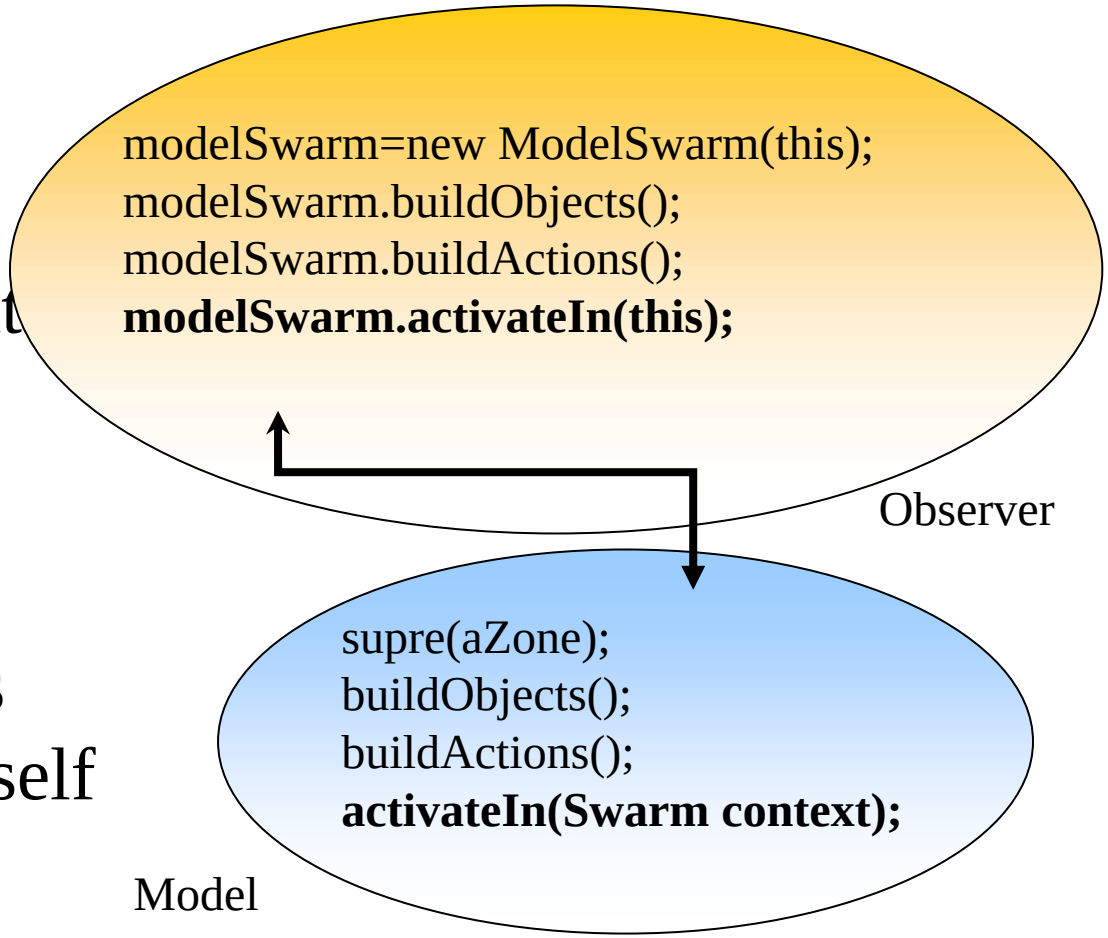


Multilevel activation



Merging two Swarms

- main( ) creates ObserverSwarm
- ObserverSwarm creat ModelSwarm as a subswarm in own memory zone
- ModelSwarm creates agents and activates self in ObserverSwarm

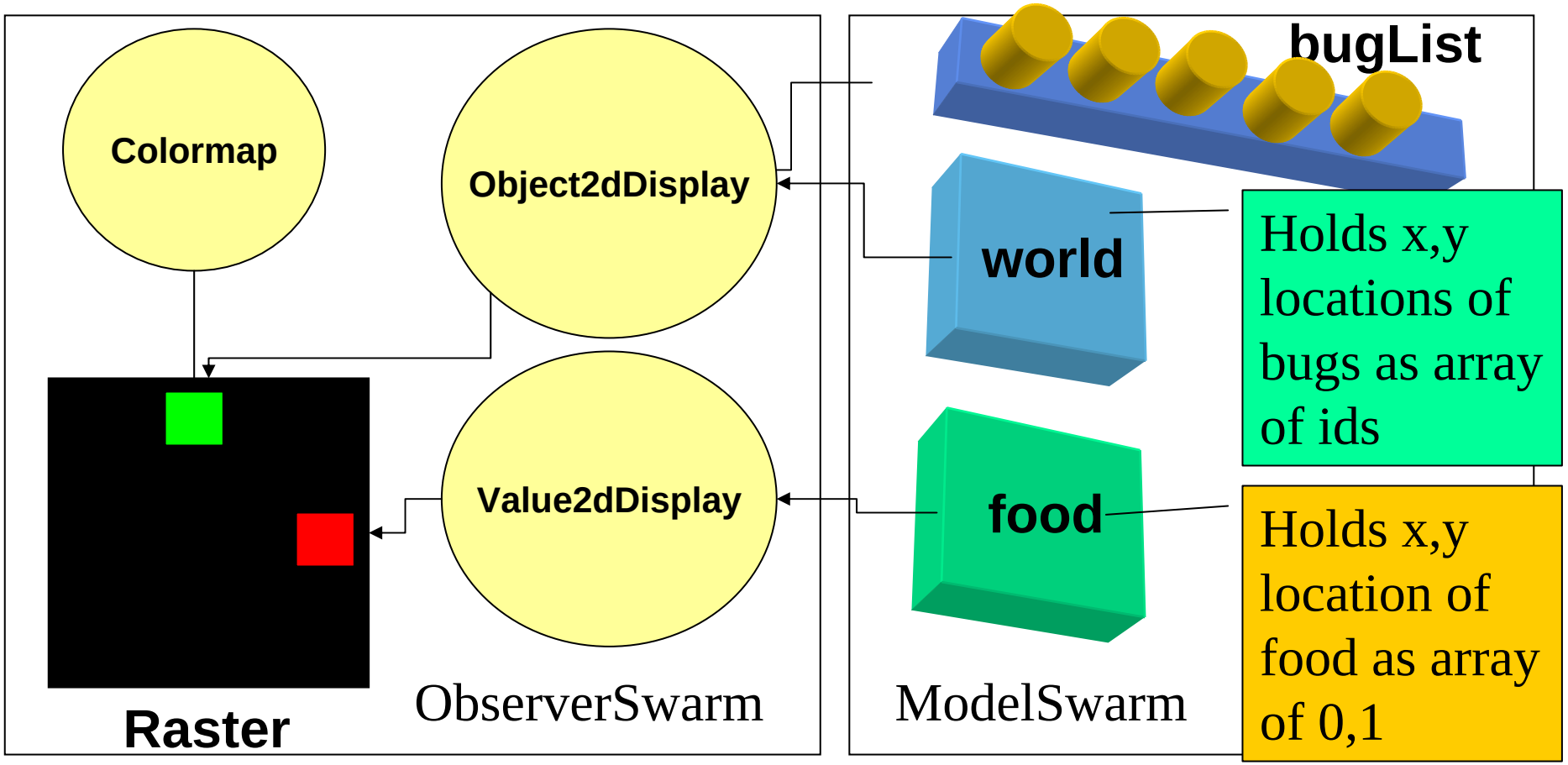


Managing the Raster display

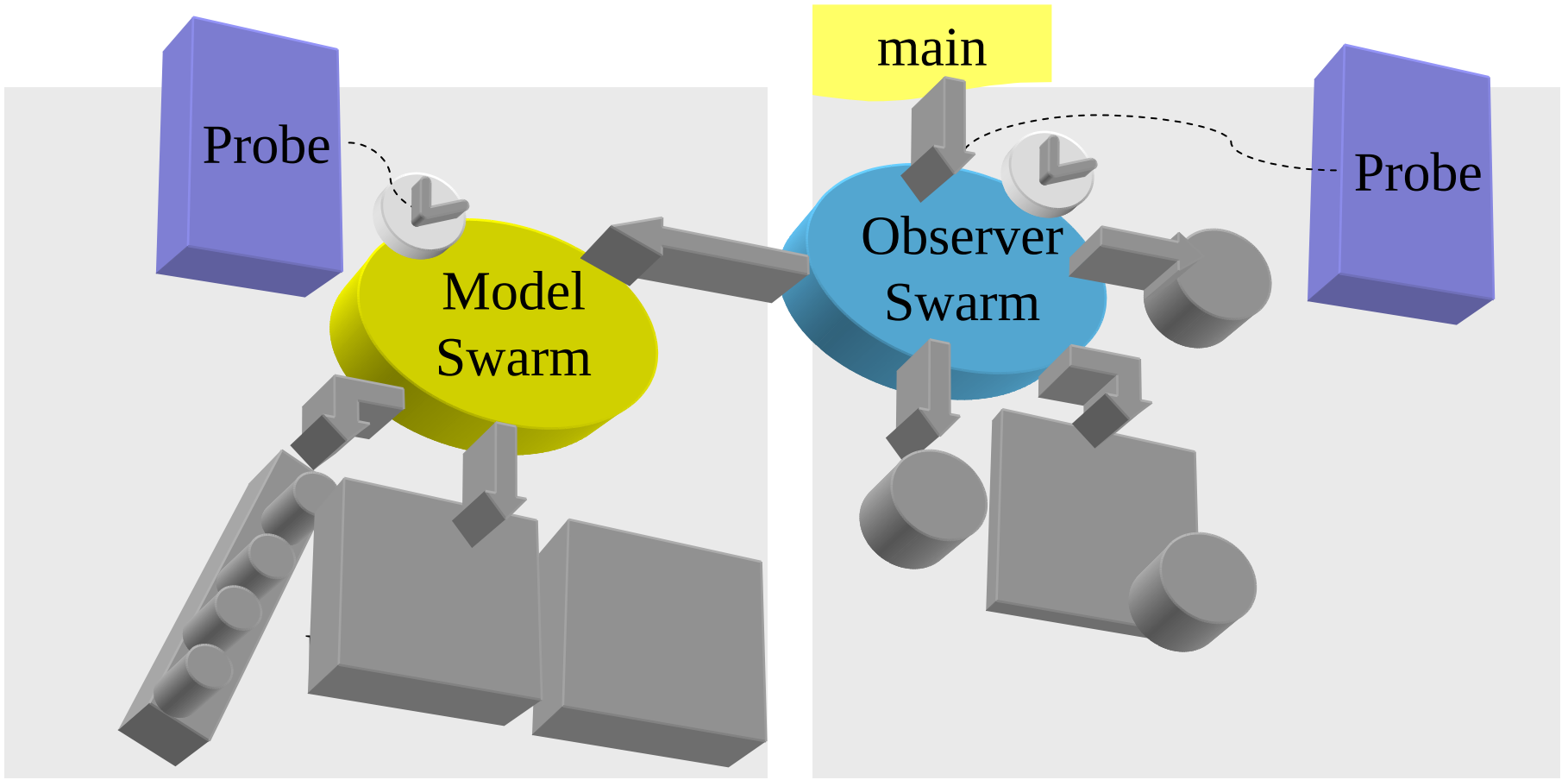
- ZoomRaster displays data from lattice
- We will display the food distribution from FoodSpace and ask bugs to draw location
- In addition to ZoomRaster need the 3 classes to the right:

- ColorMap:
  - Associates a number with a color in palette
- Value2dDisplay:
  - Maps array of x,y int data to raster
- Object2dDisplay:
  - Feeds data from agents & captures mouseclick

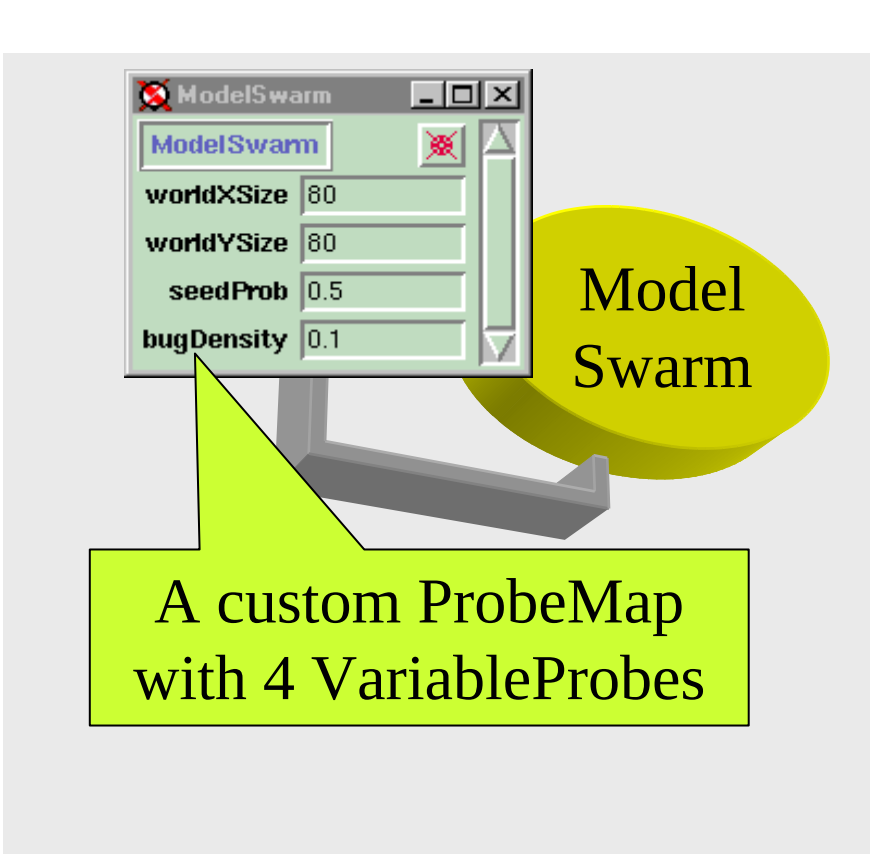
What do these new objects do?

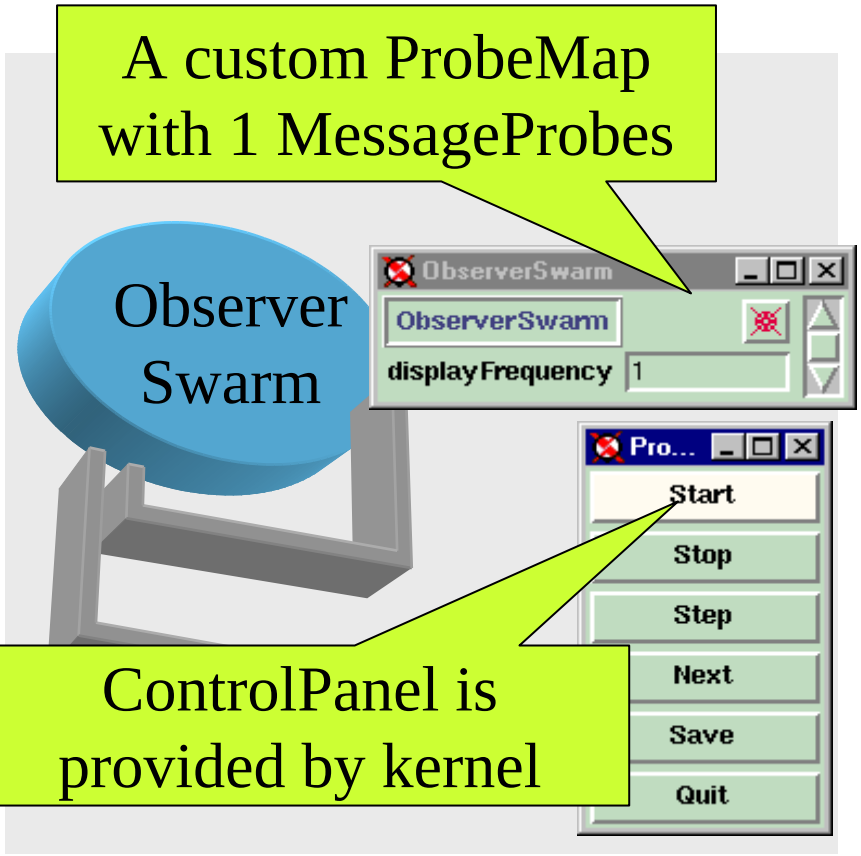


Bug with Observer II: Add probes



How the probes come in...



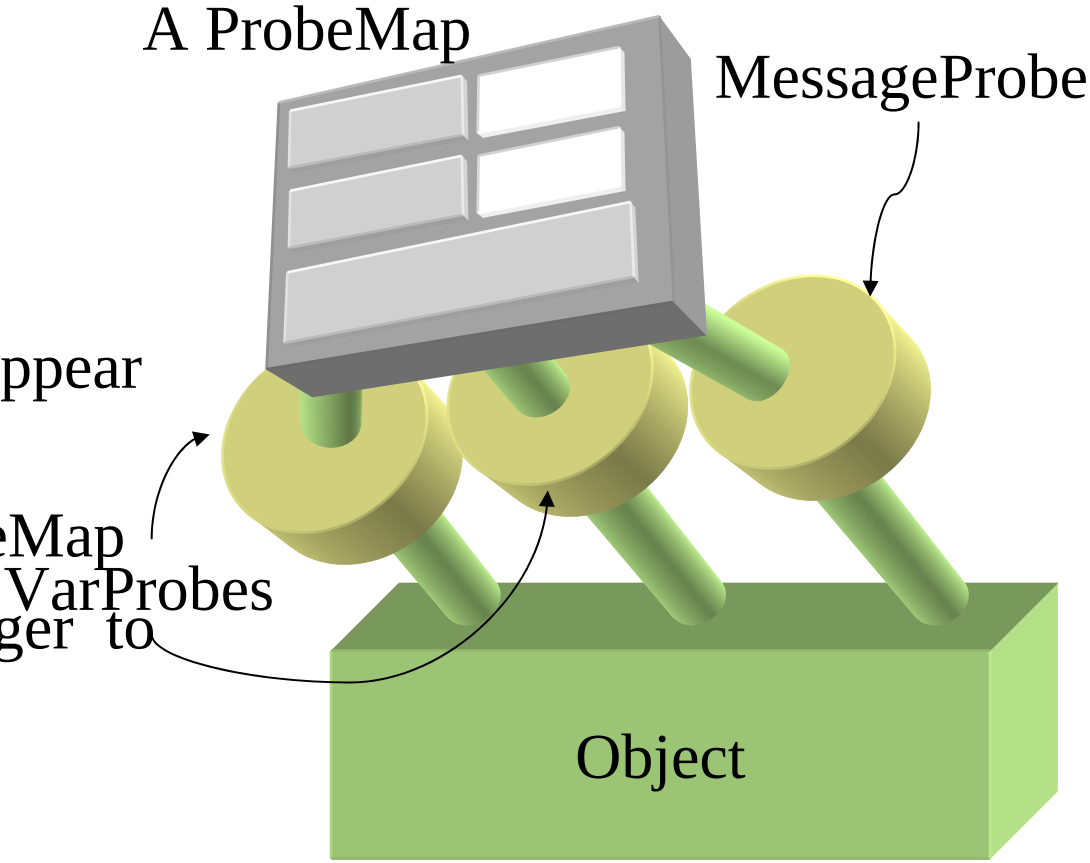


Brief overview of probes

- Two major uses for probes
  - To interface with an object
  - To create a GUI to an object
- Interface with an object of two types
  - VarProbe: Probes an instance variable
  - MessageProbe: Probes a method
- GUI utilities:
  - ProbeMap: Collection of Var and MessageProbes

Creating graphic probe to object

1. Check out instance of EmtpyProbeMap
2. Attach VarProbe or MessageProbe to each variable or message to appear on GUI
3. Put each probe on ProbeMap
   - Ask probeDisplayManager to
4. create actual widget



Creating ModelSwarm's probe

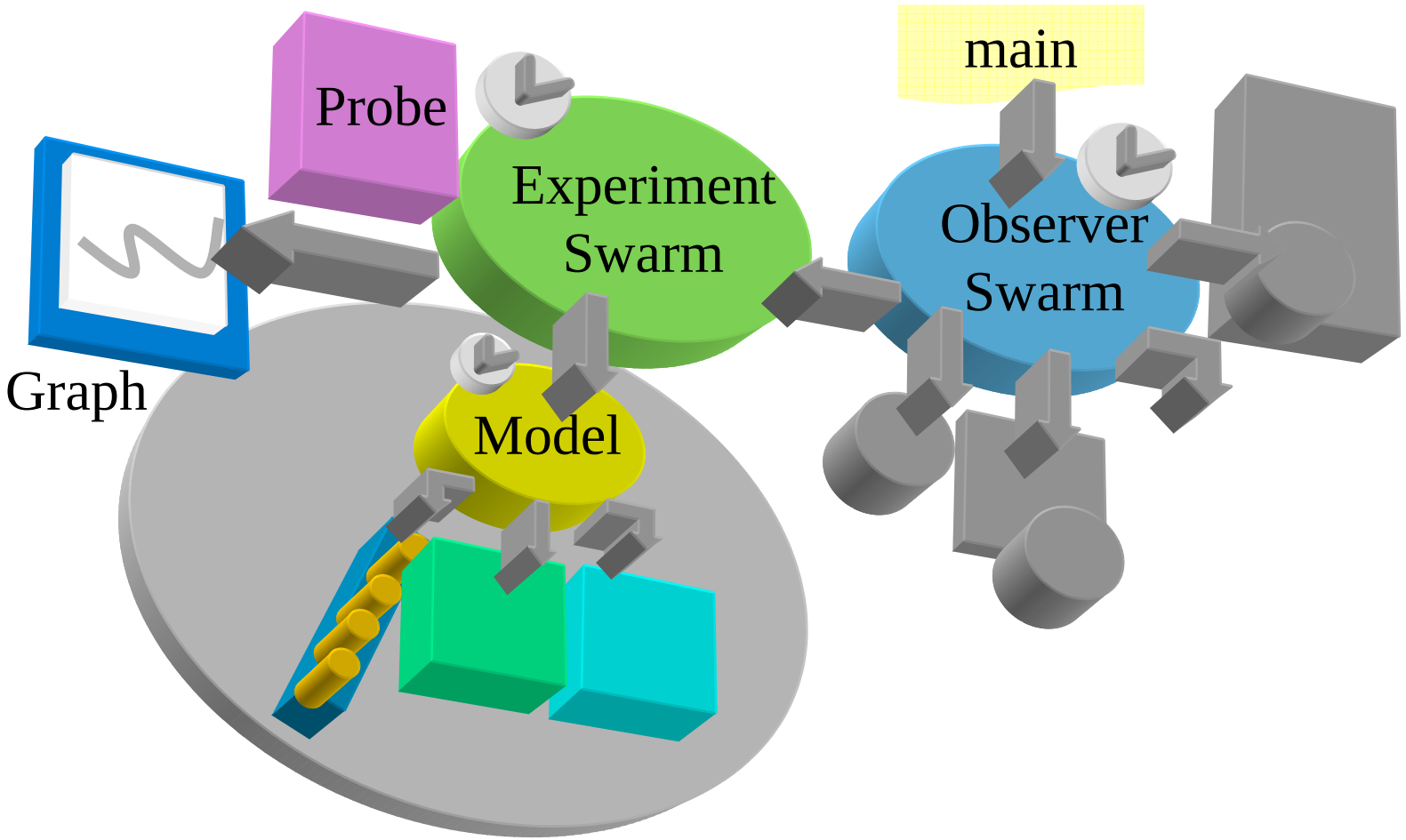
1.
```
EmptyProbeMap probeMap=new
  EmptyProbeMapImpl(aZone,this.getClass());
```

2.
```
probeMap.addProbe(Globals.env.probeLibrary.
  getProbeForVariable$inClass
  ("worldXSize",this.getClass()));
```

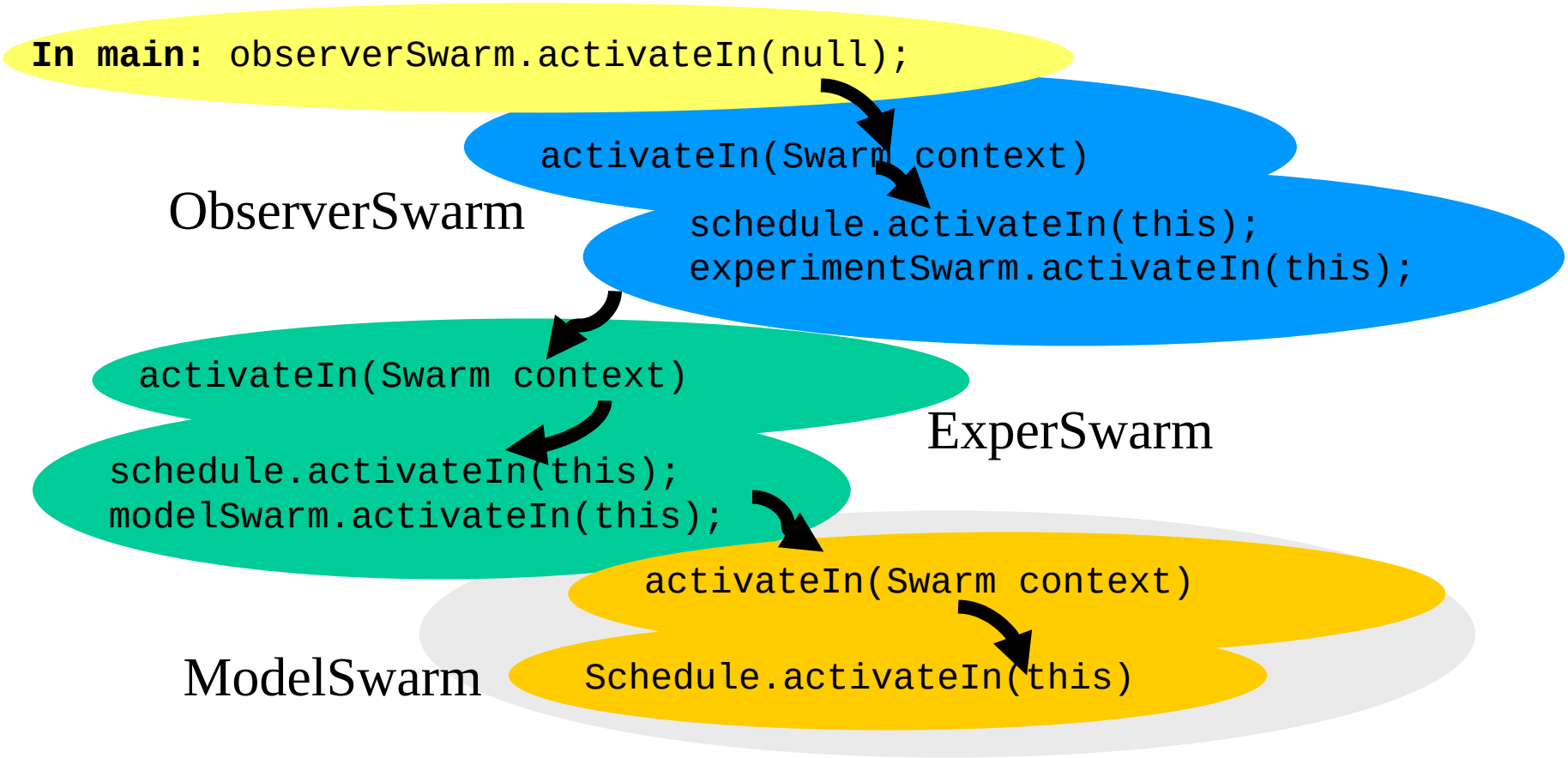
3.
```
Globals.env.probeLibrary.setProbeMap$For
  (probeMap,this.getClass());
```

4.
```
(then call Globals.env.createArchivedProbeDisplay
  (modelSwarm,"modelSwarm") in Observer)
```

Final frontier: Experiment Bug

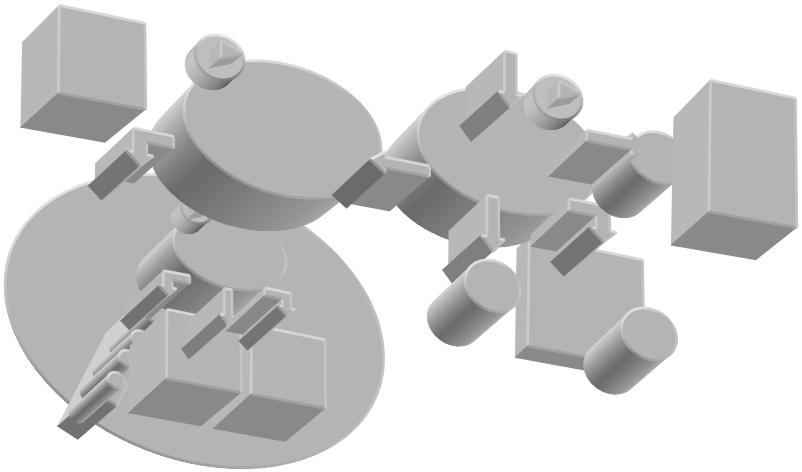


Multilevel activation

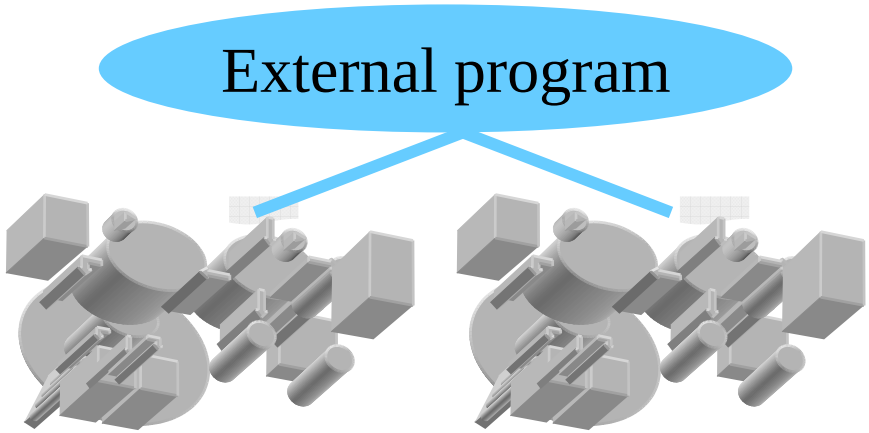


Two approaches to experiments

- Use Swarm to control experiment runs



- Use external program to execute Swarms



Two approaches: Pros and cons

- Use Swarm to control experiment runs
- Pros:
  - All processing is done within Swarm framework
  - Can use GUI interactively
- Cons
  - Sequential - can't parallelize in present form

- Use external program to execute Swarms
- Pros:
  - Can do "poor mans" paralellization on multiprocessor machines
- Cons:
  - Requires knowledge of tools outside Swarm framework