GridWorld Case Study

Part 2: Bug Variations

Methods of the `Bug` Class

The `Bug` class provides three methods that specify how bugs move and turn.

`public boolean canMove()`
tests whether the bug can move forward into a location that is empty or contains a flower

`public void move()`
moves the bug forward, putting a flower into the location it previously occupied

`public void turn()`
turns the bug 45 degrees to the right without changing its location

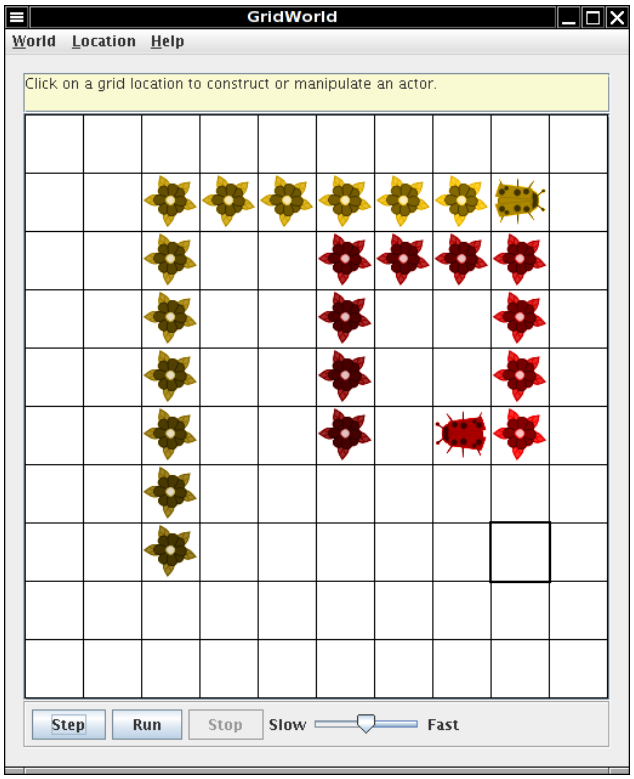
These methods are used in the bug's `act` method.

```
public void act()
{
   if (canMove())
      move();
   else
      turn();
}
```

The experiments in the previous section showed that the bug moves forward when it can. When the bug has a rock in front of it or is facing an edge of the grid, it cannot move, so it turns. However, it can step on a flower (which removes the flower from the grid). When the bug moves, it leaves a flower in its previous location. This behavior is determined by the `act` method and the three methods that the `act` method calls.

Extending the `Bug` Class

A new type of bug with different behavior can be created by extending the `Bug` class and overriding the `act` method. No new methods need to be added; the `act` method uses the three auxiliary methods from the `Bug` class listed above. A `BoxBug` moves in a square pattern. In order to keep track of its movement, the `BoxBug` class has two instance variables, `sideLength` and `steps`.



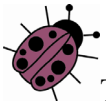
Do You Know? Set 2

The source code for the `BoxBug` class is in Appendix C.

1. What is the role of the instance variable `sideLength`?
2. What is the role of the instance variable `steps`?
3. Why is the `turn` method called *twice* when `steps` becomes equal to `sideLength`?
4. Why can the `move` method be called in the `BoxBug` class when there is no `move` method in the `BoxBug` code?
5. After a `BoxBug` is constructed, will the size of its square pattern always be the same? Why or why not?
6. Can the path a `BoxBug` travels ever change? Why or why not?
7. When will the value of `steps` be zero?

Runner Classes

In order to observe the behavior of one or more actors, a "runner" class is required. That class constructs an `ActorWorld` object, places actors into it, and shows the world. For the bug, this class is `BugRunner`. For the box bug, it is `BoxBugRunner`. In each of these runner classes, the overloaded `add` method is used to place actors (instances of classes such as `Bug`, `BoxBug`, `Rock`) into the grid of the `ActorWorld`. The `add` method with an `Actor` parameter and a `Location` parameter places an actor at a specified location. The `add` method with an `Actor` parameter but no `Location` parameter places an actor at a random location. When you write your own classes that extend `Bug`, you also need to create a similar runner class.

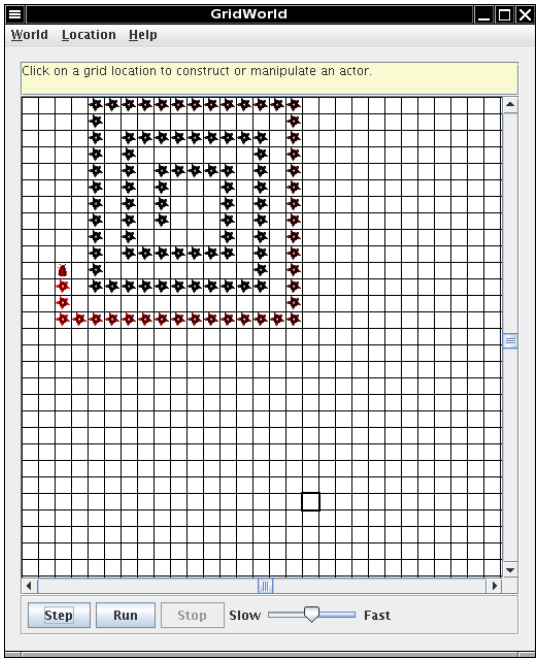


The source code for the `BoxBugRunner` class is at the end of this chapter.

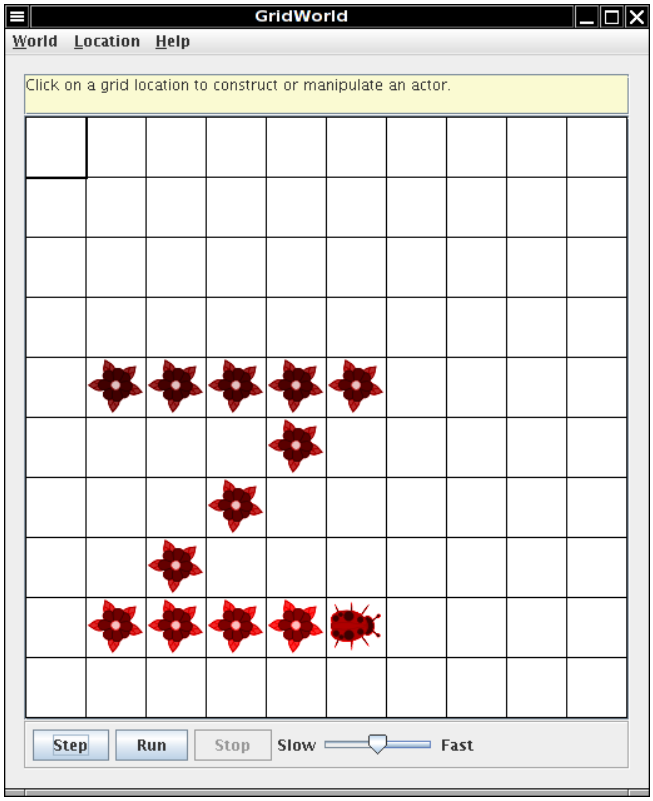
Exercises

In the following exercises, write a new class that extends the `Bug` class. Override the `act` method to define the new behavior.

1. Write a class `CircleBug` that is identical to `BoxBug`, except that in the `act` method the `turn` method is called once instead of twice. How is its behavior different from a `BoxBug`?
2. Write a class `SpiralBug` that drops flowers in a spiral pattern. Hint: Imitate `BoxBug`, but adjust the side length when the bug turns. You may want to use an `UnboundedGrid` to see the spiral pattern more clearly.



3. Write a class `ZBug` to implement bugs that move in a "Z" pattern, starting in the top left corner. After completing one "Z" pattern, a `ZBug` should stop moving. Supply the length of the "Z" as a parameter in the constructor. The following image shows a "Z" pattern of length 4. Hint: Notice that a `ZBug` needs to be facing east before beginning its "Z" pattern.



4. Write a class `DancingBug` that "dances" by making different turns before each move. The `DancingBug` constructor has an integer array as parameter. The integer entries in the array represent how many times the bug turns before it moves. For example, an array entry of 5 represents a turn of 225 degrees (recall one turn is 45 degrees). When a dancing bug acts, it should turn the number of times given by the current array entry, then act like a `Bug`. In the next move, it should use the next entry in the array. After carrying out the last turn in the array, it should start again with the initial array value so that the dancing bug continually repeats the same turning pattern.

The `DancingBugRunner` class should create an array and pass it as a parameter to the `DancingBug` constructor.

5. Study the code for the `BoxBugRunner` class. Summarize the steps you would use to add another `BoxBug` actor to the grid.

BoxBugRunner.java

```
import info.gridworld.actor.ActorWorld;
import info.gridworld.grid.Location;

import java.awt.Color;

/**
 * This class runs a world that contains box bugs.
 * This class is not tested on the AP CS A and AB exams.
 */
public class BoxBugRunner
{
  public static void main(String[] args)
  {
    ActorWorld world = new ActorWorld();
    BoxBug alice = new BoxBug(6);
    alice.setColor(Color.ORANGE);
    BoxBug bob = new BoxBug(3);
    world.add(new Location(7, 8), alice);
    world.add(new Location(5, 5), bob);
    world.show();
  }
}
```