Blue Pelican GridWorld

Teacher Manual

AP Computer Science
Case Study

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Chapter 2--BoxBug & SpiralBug

Modifying the methods of Bug
The Bug class is a very fundamental part of GridWorld. It should not be modified; rather, a new class is created extending the Bug class, and modifications are made in it by overriding the methods in the Bug superclass. One method that is very commonly overridden is the act( ) method.

Cleaning up our act( )
Recall from the last chapter (Getting Started), the Step button on the graphical interface to GridWorld. Each time it is clicked (and also on each iteration of Run), the act method of each object in the Grid is called. Below is the source code for the act method of the Bug class:

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

Notice how very simple this method is. It, in turn, uses three other methods of the Bug class:

- `canMove( )` … returns a boolean telling if it’s safe to move in the direction set for this object.
- `move( )` … move one space to the nearest of this object’s direction to horizontal, vertical, or at a 45 degree diagonal.
- `turn( )` … sets a new direction of 45 degrees clockwise from the current direction.

Notice that this code explains why when a Bug wants to move into the position of a Rock, another Bug, or is trying to move off the grid, it turns, instead. Also notice that with just a few changes, this is very fertile ground for modifying the behavior of the Bug.

BoxBug
The Bug class will now be extended to produce the BoxBug class. As its name suggests, BoxBug will travel in the shape of a box (square). The BoxBug will move along in its initial direction for a distance specified by the state variable (instance field) sideLength. It will then turn 90 clockwise and continue doing this unless it encounters an obstacle in which case it also turns 90 degrees clockwise and begins a new box.

![Fig 2-1. When testing the BoxBug class, the graphics should produce something like this for each BoxBug object on the Grid.](image-url)
It has already been suggested that we will have an integer state variable called \textit{sideLength} that determines the lengths of the sides of the square traced out by \textit{BoxBug}. A good feature for this new class to have would be for its constructor to initialize \textit{sideLength} as follows:

```java
public BoxBug(int length)
{
    sideLength = length;
    steps = 0;
}
```

Notice that there is now evidence of a second state variable, \textit{int steps}. For the sake of knowing when to turn 90 degrees, this variable keeps a tally of how many steps through which the \textit{BoxBug} has progressed. Also, notice that this constructor specifies how \textit{BoxBug} objects should be created:

```java
BoxBug myBoxBug = new BoxBug( len ); //int len specifies side length
```

So far, the new \textit{BoxBug} class appears as follows (notice \texttt{extends Bug}):

```java
import info.gridworld.actor.Bug;

public class BoxBug extends Bug
{
    //state variables
    private int sideLength;
    private int steps;

    //constructor
    public BoxBug(int length)
    {
        sideLength = length;
        steps = 0;
    }

    //...more code to come...
}
```

Finally, and most important of all, a modified \textit{act} method must be provided that overrides the \textit{act} method of the \textit{Bug} superclass. The requirements are that it keeps up with how far the \textit{BoxBug} has moved and then turns it 90 degrees clockwise.

\textbf{Project... BoxBug}

As a project, complete the \textit{BoxBug} class by providing code for the \textit{act} method so that the behavior of \textit{BoxBug} is as described: after turning 90 degrees be sure to reset \textit{steps} to 0 so the count can start over. To test this class, see the next section titled, \textbf{Testing with a new Runner class}. 
Testing with a new Runner class
(This discussion applies to testing a BoxBug class. A Runner class could be similarly created for any other modified type of Bug.)

Now that a BoxBug class has been created, how is it to be tested? First, create a new project: call it BoxBug and create the BoxBug class within it. The actual visual testing must be done with a BoxBugRunner class. This is not an AP tested class, but is necessary for the testing of BoxBug and to see it perform. Enter a second class into the project called BoxBugRunner as follows:

```java
import info.gridworld.actor.ActorWorld;
import info.gridworld.grid.Location;
import java.awt.Color;
public class BoxBugRunner
{
    public static void main( String args[] )
    {
        ActorWorld world = new ActorWorld( );
        BoxBug bug1 = new BoxBug(6);  //side of box = 6
        bug1.setColor(Color.ORANGE);

        BoxBug bug2 = new BoxBug(3);  //side of box = 3
        bug2.setColor(Color.GREEN);

        world.add (new Location(7, 8), bug1 );
        world.add (new Location(7, 5), bug2 );
        world.show( );
    }
}
```

Again this code is not part of the AP test. This is just a class we need to provide in order to test our BoxBug class with a graphical interface. One thing is; however, of importance if we wish to create other extensions of the Bug class. If for example, a spiral bug is created with a SpiralBug class, then the following two lines of code would replace the corresponding two lines in the BoxBugRunner class:

```java
SpiralBug bug1 = new SpiralBug(6);
SpiralBug bug2 = new SpiralBug(6);
```

This new class could be called the SpiralBugRunner class.

It should be noted that this runner class (either BoxBugRunner or SpiralBugRunner) will not compile unless the class (BoxBug or SpiralBug), upon which it is dependent, has already been compiled.
Project… *SpiralBug*

As a project, create a *SpiralBug* class by providing code for the `act` method so that it moves in a spiral. A key feature is to use most of the *BoxBug* class and increase the value of `sideLength` at the end of each turn. To test this class, see the previous section titled, **Testing with a new Runner class.** When testing, set an unbounded grid.

![SpiralBug class animation](image)

Fig 2-1. When testing the *SpiralBug* class, the graphics should produce something like this for each *SpiralBug* object on the grid.
**Project Key… BoxBug**

The complete class for *BoxBug*:

```java
import info.gridworld.actor.Bug;

public class BoxBug extends Bug {
    //state variables
    private int sideLength;
    private int steps;

    //constructor
    public BoxBug(int length) {
        sideLength = length;
        steps = 0;
    }

    public void act() {
        if((steps < sideLength) && (canMove())) {
            move();
            steps++;
        } else {
            turn();
            turn();
            steps = 0;
        }
    }
}
```

The official code for this class from the College Board is in Appendix D. The code for the superclass, *Bug*, is also given in Appendix D.

**Project Key… SpiralBug**

The complete class for *SpiralBug*:

```java
import info.gridworld.actor.Bug;
public class SpiralBug extends Bug {
    //state variables
    private int sideLength;
    private int steps;
```
//constructor
public SpiralBug(int length) {
    sideLength = length;
    steps = 0;
}

public void act() {
    if (steps < sideLength && (canMove( ))) {
        move( );
        steps++;
    } else {
        turn( );
        turn( );
        steps = 0;
        sideLength++;
    }
}

The complete class for SpiralBugRunner:

import info.gridworld.actor.ActorWorld;
import info.gridworld.grid.Location;
import java.awt.Color;
public class SpiralBugRunner {
    public static void main( String args[] ) {
        ActorWorld world = new ActorWorld( );
        SpiralBug bug1 = new SpiralBug(6); //side of box = 6
        bug1.setColor(Color.ORANGE);

        world.add (new Location(7, 8), bug1 );
        world.show( );
    }
}