

We pause our study of Java to create a small game in the Greenfoot Integrated Development Environment. This will consist of moving crabs around on the beach.

I suggest that you change your folder structure as follows.

World	Contains all source files for the class
Jdk	Contains all projects written with JDK
P1_Hello	
P2_Geometry	
...	
P11_Arrays	
BlueJ	Contains all projects written with BlueJ
Greenfoot	Contains all projects written with Greenfoot
P12_CrabWorld	
Netbeans	Contains all projects written with Netbeans

Program 1. Create a program in which crabs move around on the beach.

(a) Create the Scenario

1. Open the Greenfoot programming environment. Select **Scenario/New Scenario**. Name the scenario **CrabWorld**.
2. Go to the web site <http://plbailey79.github.io/portal> and download **PCScix10_CrabPrereqs.zip**. Install the images and sounds into the appropriate places of the **CrabWorld** project folder.
3. Right click the **World** tab. Select **New subclass**. Name it **CrabWorld**. Select a background image and push the **Ok** button.
4. Right click the **Actor** tab. Select **New subclass**. Name it **Crab**. Select an image and push the **Ok** button.
Compile and Run.
(N.B. there used to be a compile button, but Greenfoot 3.0 compiles automatically.)
5. Right click on the **Crab** tab. Select **New Crab** and place the crab in the world. **Save the world.**
Compile and Run.
Pause. Insert several more crabs into the world. **Run.**
6. Questions:
 - (a) What is the relationship between **World** and **CrabWorld**?
 - (b) What is the relationship between **Actor** and **Crab**?
 - (c) What is the relationship between **CrabWorld** and **Crab**?
 - (d) What does **Compile** do? What do **Run**, **Pause**, and **Reset** do?

(b) Assign Behavior

1. Right click the **Crab** tab and select **Open editor**.
2. Find the line of code which says **// Add your action code here**.
3. Replace this with **move(3);**
Compile. Place a crab into the world. **Run**
4. Questions:
 - (a) What does the 3 do in **move(3)**?
 - (b) Where is the **move** method defined?

(c) Make Motion Continuous

1. In the Crab's act method, after the line containing `move`, insert this code:

```
    if (getX() <= 1 ||
        getX() >= getWorld().getWidth() - 1 ||
        getY() <= 1 ||
        getY() >= getWorld().getHeight() - 1)
    {
        turn(7);
    }
```

2. **Compile.** Insert a crab into the world. **Run.**
Pause. Insert several more crabs into the world. **Run.**
3. Questions:
 - (a) What do `getX` and `getY` do?
 - (b) Where are the methods `getX`, `getY`, and `turn` defined?

(d) Drunken Crab

1. In the Crab's act method, after the line containing `move`, insert this code:

```
    if (Greenfoot.getRandomNumber(100) < _%ageProbabilty_)
    {
        turn(Greenfoot.getRandomNumber(_#degrees_));
    }
```

Compile. Insert a crab into the world. **Run.**

2. Note that the crab always turns in one direction. Correct this.
3. **Compile.** Insert a crab into the world. **Run.**
Pause. Insert several more crabs into the world. **Run.**
4. Questions:
 - (a) Where is the `getRandomNumber` method defined? Can we see it?
 - (b) Is a positive turn clockwise or counterclockwise?

(e) Refactoring Methods

Create new methods, cut code from the `act` method, and paste into the new methods.

1. Cut and paste to create a `atWorldsEdge` method after the `act` method:

```
public boolean atWorldsEdge()
{
    return
        (getX() <= 1 ||
         getX() >= getWorld().getWidth() - 1 ||
         getY() <= 1 ||
         getY() >= getWorld().getHeight() - 1);
}
```

2. Cut and paste to create a `ricochet` method after the `act` method:

```
public void ricochet()
{
    if (atWorldsEdge())
    {
        turn(7);
    }
}
```

3. Cut and paste to create a `stagger` method after the `act` method:

```
public void stagger()
{
    if (Greenfoot.getRandomNumber(100) < 10)
    {
        turn(Greenfoot.getRandomNumber(30) - 15);
    }
}
```

4. Modify the `act` method to use the new `ricochet` and `stagger` methods.

5. **Compile.** Insert a crab into the world. **Run.**

Pause. Insert several more crabs into the world. **Run.**

6. Questions:

- (a) What is the point of this exercise?

(f) Feed the Crabs

1. Create a subclass of the `Actor` class, and call it `Worm`. Assign the worm image to this class.
2. The worm does not act. Instead, when a crab is close to a worm, it eats it. Create the following `eat` method in `Crab` class:

```
public void eat()
{
    Actor worm;
    worm = getOneObjectAtOffset(0, 0, Worm.class);
    if (worm != null)
    {
        World world;
        world = getWorld();
        world.removeObject(worm);
    }
}
```

3. Invoke the `Crab.eat` method from the `Crab.act` method.
4. Place many worms and a few crabs in the world, and **Run**. Then **Pause**, **Reset**.
5. Place many worms and a few crabs in the world, **Save the World**, and **Run**. Then **Pause**, **Reset**.
6. Find the `slurp.wav` file and place it in the `sounds` directory of your scenario. Add this line of code at the bottom of the `eat` method: `Greenfoot.playSound("slurp.wav");` and **Run**.
7. Questions:
 - (a) What does `getOneObjectAtOffset` do? What does “offset” probably mean? What do the parameters `(0, 0, Worm.class)` do?
 - (b) What does `getWorld` do?
 - (c) What does **Save the World** do?

(g) Control Your Crab

1. Add this `control` method to the `Crab` class:

```
public void control()
{
    if (Greenfoot.isKeyDown("left"))
    {
        turn(-3);
    }
    if (Greenfoot.isKeyDown("right"))
    {
        turn(3);
    }
}
```

2. Modify the crab's `act` method to invoke the `control` method. **Compile and Run.**
3. Modify the `control` method to accept input for forward motion if the `up` key is pressed and backward motion if the `down` key is pressed. **Compile and Run.**
4. Comment out the `move`, `ricochet` and `stagger` calls from the `act` method.
5. Open the `CrabWorld` class in the editor. Modify the `prepare` method so that there is only one crab. **Compile and Run.**
6. Questions:
 - (a) What class contains the `isKeyDown` method, and why?
 - (b) What other methods are in this class might be useful in the game?

(h) Anteating Crabs

1. Create a subclass of `Actor` called `Ant`.
2. Add `move(2)`, `stagger()`, and `ricochet()` to the `Ant.act` method.
Place lots of ants into the world and save the world. **Compile and Run**
3. Modify the `Crab` class so that a crab can eat ants if he catches them. Since the crab still eats worms, there are at least two ways to make this modification: copying the `eat` class to make an `eatAnts` class, or making a parameter such as `eat(Class cls)`. Of course, the sound of eating an ant should be a crunch instead of a slurp.

Program 2. We continue improving our Crab game by adding an antagonist - lobsters that eat crabs!

(a) Refactor to Create an Animal Class

1. Create a subclass of `Actor` and call it `Animal`. This class does not need an image.
2. Copy the `stagger`, `ricochet`, `control`, and `atWorldsEdge` methods into the `Animal` class.
3. Modify the `Crab` class to inherit from `Animal`, and remove the `stagger`, `ricochet`, `control`, and `atWorldsEdge` methods from the `Crab` class.
4. Repeat the above step for the `Ant` class.
`Compile` and `Run`.

(b) Create a Lobster Class

1. Create a subclass of `Animal` called `Lobster`, and assign an image to it.
2. Modify the `Lobster`'s `act` method to move, stagger, and ricochet. It should move a little faster than a crab.
3. Modify the `Lobster` to eat crabs. `Compile`. Put some lobsters in the world. `Run`.

(c) End of Game - Loosing

1. Create a subclass of Actor and call it `Message`; it does not need an image.
2. Edit the source code of the `Message` class to be:

```
import greenfoot.*;

public class Message extends Actor
{
    private int width;
    private int height;
    private String msgTxt;

    public Message(int width, int height, String msgTxt)
    {
        this.width = width;
        this.height = height;
        this.msgTxt = msgTxt;
        updateImage();
    }

    public void updateImage()
    {
        GreenfootImage image = new GreenfootImage(width, height);
        image.setColor(Color.CYAN);
        image.fill();
        GreenfootImage txtImg = new GreenfootImage(
            msgTxt,
            36,
            Color.YELLOW,
            Color.BLUE);
        image.drawImage(
            txtImg,
            (image.getWidth() - txtImg.getWidth()) / 2,
            (image.getHeight() - txtImg.getHeight()) / 2);
        setImage(image);
    }
}
```

3. Insert the following method into the `CrabWorld` class:

```
public void act()
{
    if (getObjects(Crab.class).isEmpty())
    {
        addObject(
            new Message(getWidth() / 3, getHeight() / 3, "GAME OVER"),
            getWidth() / 2,
            getHeight() / 2);
        Greenfoot.playSound("gameover.wav");
        Greenfoot.stop();
        return;
    }
}
```

(d) End of Game - Winning (Keeping Score)

1. Add an instance variable to the Crab class by inserting this line of code after the opening brace of the class:

```
private int score = 0;
```

2. Modify the `eat` method(s) to store 1 points for each worm and 2 points for each ant eaten.
3. Modify the game to end with an appropriate message and/or sound when the crab reaches 25 points.

(e) Showing the Score

1. Create a new subclass of `Actor` and call it `Counter`, using the `counter.png` image. Place a `Counter` object in the lower left corner of the world and Save the World.
2. Edit the source code of `Counter` class to be:

```
import greenfoot.*;

public class Counter extends Actor
{
    private static final Color transparent = new Color(0, 0, 0, 0);
    private GreenfootImage background;
    private int value;

    public Counter()
    {
        background = getImage();
        value = 0;
        updateImage();
    }

    public int getValue()
    {
        return value;
    }

    public void setValue(int newValue)
    {
        value = newValue;
        updateImage();
    }

    private void updateImage()
    {
        GreenfootImage image = new GreenfootImage(background);
        GreenfootImage text = new GreenfootImage(
            "" + value,
            22,
            Color.BLACK,
            transparent);
        image.drawImage(
            text,
            (image.getWidth() - text.getWidth())/2,
            (image.getHeight() - text.getHeight())/2);
        setImage(image);
    }
}
```

3. Modify the `Crab` class to find the `Counter` object in its world, and invoke that counter's `setValue` method to update the score.

(f) Cleaning up the code: Go through all your classes and make any necessary updates to make sure you are following the our proper conventions:

- All class names should be capitalized.
- All variable and method names should start with lower case.
- Class, variable, or method names which consist of more than one word should capitalize the all words following the first word. For example, `deadend` should be `DeadEnd` if it is a class, or `deadEnd` if it is a variable.
- Following the Allman brace placement and indentation style. According to Wikipedia, *This style puts the brace associated with a control statement on the next line, indented to the same level as the control statement. Statements within the braces are indented to the next level.* For example:

```
// Do it this way.
if (x == y)
{
    something();
    somethingmore();
}
else
{
    somethingelse();
}
```

Don't use the K & R style, which puts braces on the same line with the control statement:

```
// Don't do it this way:
if (x == y) {
    something();
    somethingmore();
} else {
    somethingelse();
}
```

The AP Computer Science exam uses the Allman style.