Smalltalk Programming
Lesson 18

In the last lesson you made code changes to give an enemy the ability to move and use the Morphic animation system. You also made code changes to prevent the enemy from moving off the game screen. However, you were left with a problem to consider – how to move the enemy left instead of right?

Every time the method `move` executes it will not know which direction your enemy is moving or wants to move – your `move` method will only have the ability to find out where the enemy is on the game screen. You need something that remembers information before and after the `move` method executes. With this something, your method can then know which direction it needs to move the enemy towards.

This situation is where an *instance variable* will be useful. If you remember, you declared the instance variable `ship` in your `ShooterGame` class. The `ship` instance variable allows easy access to the `Ship` instance. For this situation, you will use an instance variable to remember the *direction* of your enemy. Because your method needs to know the direction that the enemy is going, the name *direction* for your instance variable will work very nicely.

1. Add the *direction* instance variable in the `Enemy` class. Make the following change below and save it.

```
RectangleMorph subclass: #Enemy
   instanceVariableNames: 'direction'
   classVariableNames: ''
   poolDictionaries: ''
   category: 'ShooterGame'
```

2. All `Enemy` instances now have the *direction* instance variable. This instance variable can be used to remember which direction the enemy is heading.

3. Now that the *direction* instance variable provides the ability to remember which direction an enemy instance is moving, you will need to give it a starting value. This starting value will let the enemy instance know which direction it should start with.

4. In order to start a new enemy instance in a direction, the `Enemy>>initialize` method would be a great place to set the starting direction. Make the following changes to `Enemy>>initialize` and then save the changes.

initialize

```
   super initialize.
   self color: Color green.
   self borderColor: Color honeydew.
   self extent: 32 @ 32.
   direction := 10
```

5. The value for *direction* will now be used to let the enemy know to move right when it starts.

6. Now that an enemy instance can know whether it is moving right or left, you can make the code changes to `Enemy>>move` so it can move the enemy right or left.

```
move

    self x: self x + direction.
    (self right > owner right)
        ifTrue: [direction := -10].
    (self left < owner left)
        ifTrue: [direction := 10].
    owner changed
```

7. Look at each line of code. Can you figure out what each line of code is doing? How is the newly declared *direction* instance variable being used in this method?

8. Because your currently running enemy instance was created *before* the direction instance variable was declared, your enemy does not have an assigned direction value. Its value will be *nil*. The value *nil* means "nothing." Your enemy cannot use "nothing" for a direction. So, you have a few options if you want to send the `move` method to your running enemy. Choose and follow one of the options below:

1. You can delete your current enemy and create a new enemy. The new enemy will initialize with a direction value and can begin to move using that value. But what is the fun in this? Why not see how long you can keep your game running while building it? If you choose this option you will want to:
    1. Delete your current enemy. In an explore morph window run the "self delete." expression on your current enemy. Remember to select the enemy first.
    2. Create a new enemy. This step is like steps 6 and 7 in Lesson 16. In an explore morph window, select ShooterGame and then run "self initializeEnemies.". Remember to select ShooterGame first.
2. You can use the explore morph window to set the *direction* value on your currently running enemy. In an explore morph window, select ShooterGame and then run "do it" on "direction := 10.". Remember to select ShooterGame first.

3. You can use the debugger on your enemy. If you would like to see how this can be done, go to the **Advanced Solution** below. What you learn there will help you understand the debugger better, which is a powerful tool worth getting to know.

9. In an explore morph window, run "self move." on enemy instance. Remember to select the enemy first.

10. Test your code changes by running the expression "self move." on your enemy object in an explore morph window.

11. What do you notice about your enemy with your new code?

12. You might have noticed that your enemy will go out of bounds just a little bit. You can fix this by making the following changes to `Enemy>>move`.

move

```
self x: self x + direction.
(self right > owner right)
   ifTrue: [direction := -10.
      self x: self x + direction].
(self left < owner left)
   ifTrue: [direction := 10.
      self x: self x + direction].
owner changed
```

13. Go ahead and enable stepping for your enemy morph. In an explore morph window run the "self startStepping." expression on your current enemy. Remember to select the enemy first.

14. What else needs to be done for your shooter game?

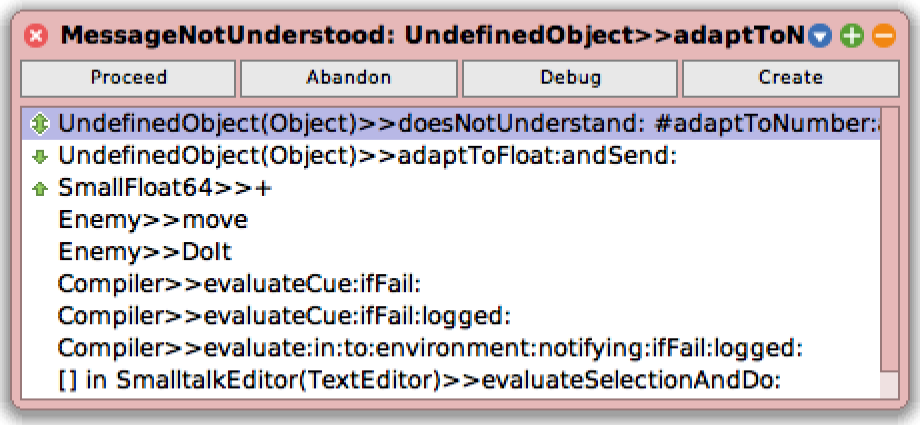
15. Save and Quit your Smalltalk image.

Advanced Solution

Congratulations on selecting the advanced solution! Your effort here will help you to understand and use the Smalltalk debugger even better.

1. In an explore morph window, run "self move." on your enemy instance. Remember to select the enemy first.

2. A predebugger window like the one in Figure 1 below will be displayed. The error message says that there is an undefined object (UndefinedObject). Press the "Debug" button to proceed to the debugger (or press any key).

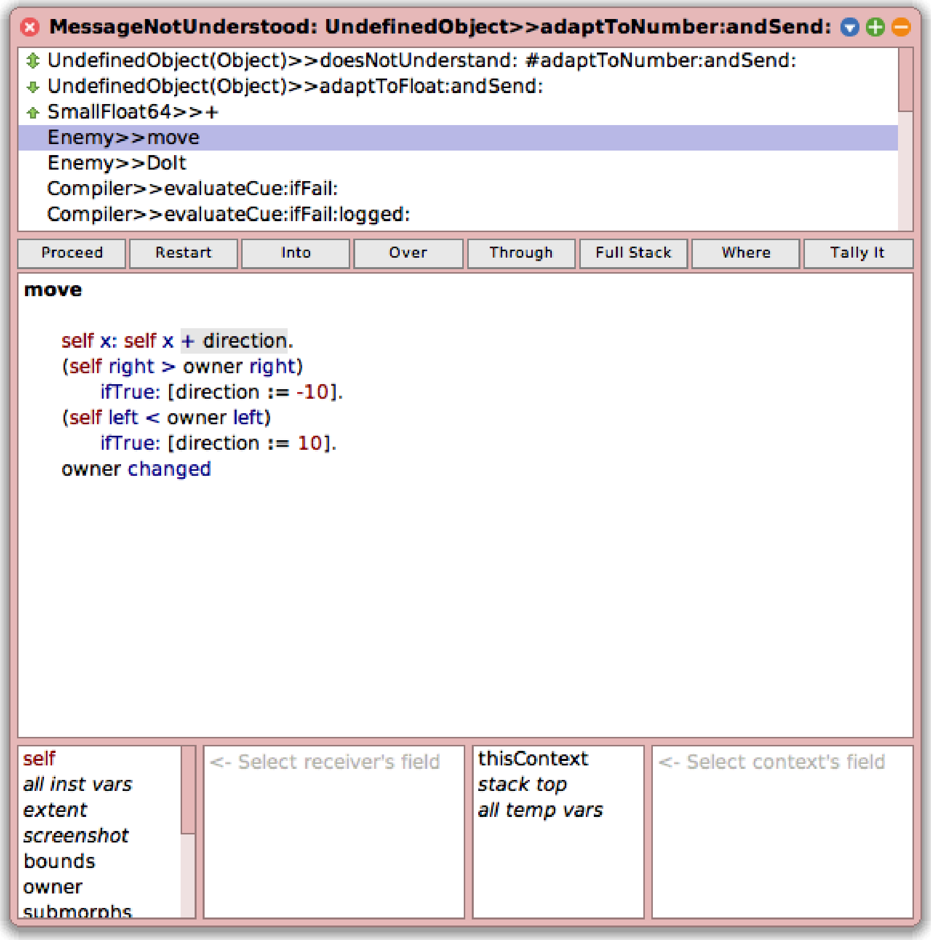

MessageNotUnderstood: UndefinedObject>>adaptToN

```
UndefinedObject(Object)>>doesNotUnderstand: #adaptToNumber:
UndefinedObject(Object)>>adaptToFloat:andSend:
SmallFloat64>>+
Enemy>>move
Enemy>>DoIt
Compiler>>evaluateCue:ifFail:
Compiler>>evaluateCue:ifFail:logged:
Compiler>>evaluate:in:to:environment:notifying:ifFail:logged:
[] in SmalltalkEditor(TextEditor)>>evaluateSelectionAndDo:
```

Figure 1: UndefinedObject error

3. The debugger will now be displayed. The last 3 lines in the execution stack show that a numeric operation was attempted on an object that is undefined. Selecting any of the lines will show, in the middle pane, the Smalltalk code being executed in that method, with the part that triggered the error highlighted. Select "Enemy>>move" in the stack to see where in your method the error was triggered.

4. The debugger window will look like the one below in Figure 2. The error was triggered in Enemy>>move with "+ direction." Because you recently made a change with the *direction* instance variable, it would be a good thing to look at first.



MessageNotUnderstood: UndefinedObject>>adaptToNumber:andSend:

```
UndefinedObject(Object)>>doesNotUnderstand: #adaptToNumber:andSend:
UndefinedObject(Object)>>adaptToFloat:andSend:
SmallFloat64>>+
Enemy>>move
Enemy>>DoIt
Compiler>>evaluateCue:ifFail:
Compiler>>evaluateCue:ifFail:logged:
```

```
move

    self x: self x + direction.
    (self right > owner right)
        ifTrue: [direction := -10].
    (self left < owner left)
        ifTrue: [direction := 10].
    owner changed
```

Figure 2: Enemy>>move error occurrence

5. The 4 panes below the middle pane allow you to inspect various aspects of the objects in the middle method pane.

1. The 2 bottom left panes work like the explore morph window does on a selected object. The object selected here is an instance of Enemy. The left pane shows instance variables for the Enemy instance. The right pane works like the explore morph workspace pane.
2. The 2 bottom right panes work similar to the 2 bottom left panes, except here, the left pane shows temporary variables. The right pane here also works like the explore morph workspace pane.

6. All of these panes can be used to run, inspect, and change values to see how your code works. Remember, method code in the middle pane can be changed, but be careful not to change methods that are not yours (Smalltalk methods for example). Otherwise you could crash or break something with your Squeak image without the ability to fix it.

7. Select the *direction* instance variable in the bottom left pane, like Figure 3 below. The pane on the right shows its value. This is the problem. Our method is attempting to add nil as the value of *direction*, but nil cannot be used like a number.

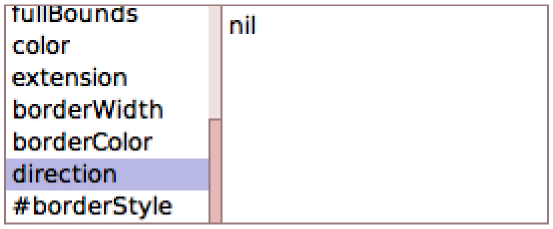


Figure 3: direction instance variable with the value of nil

8. Replace nil with the value “10” and save the value by choosing “accept” or pressing Ctrl-s.

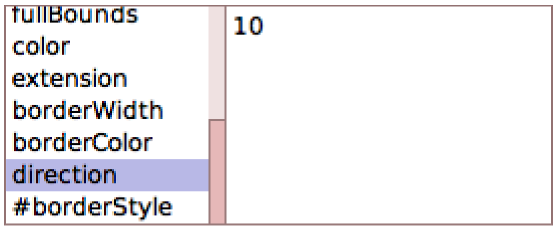


Figure 4: direction instance variable with the value of 10

9. In the debugger press the “Restart” button. This will restart the use of the selected method. In this case it is `Enemy>>move`.

10. Now press the “Proceed” button. This will remove the debugger window, execute `Enemy>>move`, and move your enemy.

11. Congratulations for taking the advanced solution!