Manipulating Pictures

CS1316: Representing Structure and Behavior

Contents

- Miscellaneous Java details
- Writing a method
- Method parameters
  - Giving a method varying input values
- Function methods
  - Returning a value or object from a method
- Running a program
  - The static main method

Assignment

- *<Class> <variable> = <expression>;*
- *<variable> = <expression>;*
  - If the variable has already been declared.
    - You can't declare a variable twice.
  - ***Note***: In DrJava Interactions pane, variables will be declared for you.
- Style:
  - Capitalize your classnames
  - Lowercase everything else
    - But can use mixed case to breakUpCombinedWords

Java: Expressions and Indentation

- In Java, statements end with ";"
  - You can use as many lines as you want, insert spaces and returns almost whenever you want. The semicolon is the end of the statement.
- Indentation doesn't matter *at all*.
  - DrJava will indent for you, but just to make it easier to read.

Declaring a variable

- *<Classname> <variable>;*
- *<Classname> [] <variable>;*
- *<Classname> <variable> [];*
  - With the square brackets notation, you're declaring an *array*. (Turns out either way works.)
  - To *access* part of an array, you'll use square brackets, e.g.,
    myPicturesArray[5]

Expressions

- *new <Classname>(<maybe inputs>)*
  - Makes a new instance of the class
- *, /, +, -
- A shortcut:
  - *x = x + 1* is so common that it can be shortened to *x++*
  - *x=x+y* is so common that it can be shortened to *x += y*

Conditionals

- if (<logical-expression>)
  then-statement;
- Logical expressions are like you'd expect: <, >, <=, >=, ==
  - Logical "and" is &&
  - Logical "or" is ||
- BUT then-statement can be a *single* statement ***OR*** any number of statements {in curly braces}.

Conditional examples

- if (thisColor == myColor)
  setColor(thisPixel,newColor);
- if (thisColor == myColor)
  {setColor(thisPixel,newColor);}
- if (thisColor == myColor)
  {x = 12;
  setColor(thisPixel,newColor);}

You do *not* need these semi-colons to end the *if*, but they're not wrong

Need this one to end the statement *inside* the curly braces

A "Block"

- We call the curly braces and the code within it a *block*.
  - A block is considered a single statement.
- A Java statement (think "sentence") can end in a semi-colon *or* a right-curly-brace (think "----." or "¡---!" or "¿---?")

Iteration: While

- *while (<logical-expression>)*
  while-statement;
- You rarely will have only a single statement in a *while*, though.
- You'll almost always have a bunch of statements in a block.

Example while

```
> p
Picture, filename D:/cs1316/MediaSources/Swan.jpg height
   360 width 480
> Pixel [] mypixels = p.getPixels();
> int index = 0;
> while (index < mypixels.length)
   {mypixels[index].setRed(0);
    index++ };
Error: Invalid block statement
> while (index < mypixels.length)
   {mypixels[index].setRed(0);
    index++;};
```

Declaring an array of pixels

Need to have a semi-colon on the statements *inside* the block, too!

Side note: .length?

- Why .length not .length()?
  - *length* is an *instance variable* or *field* (different terms for same thing)
  - It's a variable that's known to the instances of the class.
    - Just as a method is a function known only to instances of the class.

Iteration: For

- *for (<initialization>; <continuing-condition>; <iterating-todo>)*
  statement;
- The *for* loop is unusual. It's *very* flexible, but that means it has lots of pieces to it:
  - <initialization> is a statement that gets executed *once* before the loop starts.
  - <continuing-condition> is a logical expression (e.g., <, >, ==) that is tested prior to each loop execution. The loop iterates only if the <continuing-condition is true>.
  - <iterating-todo> is a statement that gets executed at the end of each loop. It usually increments a variable.

Example: for

```
> for (int i=0; i < mypixels.length ; i++)
  { mypixels[i].setRed(0);};
```

- This is the same as the earlier *while* example, but shorter.
  - It sets up *i* equal to 0 to start.
  - It keeps going as long as *i* is less than the length of the pixels.
  - Each time through, it increments *i* by 1.
  - (Java oddity: *i* doesn't exist ***after*** the loop!)

Writing Programs in Java is Making Classes

- In Java, it's the objects that do and know things.
- So, the programming is all about defining what these objects do and know.
  - We define the variables that *all* objects of that class know at the top of the class *file.*
  - We define the *methods* for what the objects *do* inside the class file.

Picture.java

```
public class Picture {
  Definitions for data in each Picture object go here.

  Each method goes inside here.

}
```

Public?

- In Java, we can *control* what pieces of our programs other people have access to.
- Think about running a large organization.
  - You want those outside your organization accessing your company through pre-defined mechanisms: Press-releases, switchboard, technical support, salespeople.
  - You don't want them accessing your internal intercom, internal memoranda, boardroom meetings.
- In Java, you can declare what is *public* and what is *private* (or *protected* for just *related* classes)
- For now, we'll make all classes and method *public*, and it's probably best to make all data *private*.

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Example 1: DecreaseRed Our first picture method

```
/**
 * Method to decrease the red by half in the current picture
 */
public void decreaseRed()
{
  Pixel pixel = null; // the current pixel
  int redValue;       // the amount of red

  // get the array of pixels for this picture object
  Pixel[] pixels = this.getPixels();
  // start the index at 0
  int index = 0;

  // loop while the index is less than the length of the pixels array
  while (index < pixels.length)
  {
    // get the current pixel at this index
    pixel = pixels[index];
    // get the red value at the pixel
    redValue = pixel.getRed();
    // set the red value to half what it was
    redValue = (int) (redValue * 0.5);
   // set the red for this pixel to the new value
    pixel.setRed(redValue);
    // increment the index
    index++;
  }
}
```

What's this (int) stuff? It's called a *cast*. Try it without it and see what happens.

Using this method

```
> Picture mypicture = new
    Picture(FileChooser.pickA
    File());
> mypicture.decreaseRed();
> mypicture.show();
> mypicture.write("D:/cs1316/
    less-red-bridge.jpg");
```

More ways to comment

```
/**
 * Method to decrease the red by half in
 the current picture
 */
```

- Anything between /* and */ is ignored by Java.
- Just like //, but crossing multiple lines.

A method definition

```
public void decreaseRed()
 {
  // Skipping the insides for a minute.
}
```

- Void? We have to declare the *type* of whatever the method *returns*.
  - If nothing, we say that it returns *void*

Variables we'll need in this method

```
public void decreaseRed()
 {
   Pixel pixel = null; // the current pixel
   int redValue;       // the amount of red
```

- *pixel* and *redValue* are variables that are *local* to this method.
  - They don't exist anywhere else in the object or other method.
- *null* literally means "nothing."
  - If you want to put a blank value in an object variable, that's the value to use.
- Java is *case sensitive*
  - So you can have a variable *pixel* that holds an instance of class *Pixel*.
- *int* means "integer"

More data for the method

```
// get the array of pixels
 for this picture object
Pixel[] pixels =
this.getPixels();
// start the index at 0
int index = 0;
```

- *this*? *this* is how we refer to the picture (object) that is executing the method.
  - *mypicture* in the example
- *getPixels()* returns all the pixels in the object.

The loop for decreasing red

```
// loop while the index is less than the
    length of the pixels array
  while (index < pixels.length)
  {
    // get the current pixel at this index
    pixel = pixels[index];
    // get the red value at the pixel
    redValue = pixel.getRed();
    // set the red value to half what it
    was
    redValue = (int) (redValue * 0.5);
   // set the red for this pixel to the new
    value
    pixel.setRed(redValue);
    // increment the index
    index++;
  }
```

- All arrays know their *length*
  - This is a reference to a variable known only to the object
- We get the *pixel*, then get the pixel's red value.
- When we multiply by 0.5, we create a *float*
  - We say *(int)* to turn the value back into an integer to put in *redValue*.
- Then we set the pixel's red to the new *redValue*.
- Finally, we move to the next pixel by incrementing the index.

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Example 2: Decreasing red by an amount

```
/**
 * Method to decrease the red by an amount
 * @param amount the amount to change the red by
 */
public void decreaseRed(double amount)
{
  Pixel[] pixels = this.getPixels();
  Pixel p = null;
  int value = 0;

  // loop through all the pixels
  for (int i = 0; i < pixels.length; i++)
  {
    // get the current pixel
    p = pixels[i];
    // get the value
    value = p.getRed();
    // set the red value the passed amount time what it was
    p.setRed((int) (value * amount));
  }
}
```

A *double* is a floating point number.

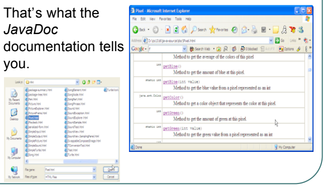
A lot shorter with a *for* loop!

Use it like this:

```
> mypicture.decreaseRed(0.5);
```

What do Pictures and Pixels know?

- That's the *JavaDoc* documentation tells you.



JavaDoc

- When comments are inserted in a particular format in Java classes and methods, documentation for that class and method can be *automatically* generated.
- This is called *JavaDoc*: Java Documentation.
- It's how Java users figure out what's available for them to use in other classes.
  - The *API:* Application Programming Interface
- "What is that format?" More on JavaDoc later.
- Not *all* of Picture, Sound, etc. are in JavaDoc.
  - You do need to read the Picture and Sound classes, too.

Inheritance

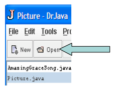
- "But hang on a minute! The class Picture doesn't actually know much at all!!"
- Right. *Picture **inherits*** from *SimplePicture*.

```
public class Picture extends SimplePicture
```

- That means that much of what *Picture* knows and can do comes form *SimplePicture*.
- We'll talk more about *"Why would you want to do that?"* later

Making our own methods

- Edit the .java file
- Stick your method at the bottom of the file.
  - *Inside* the final close curly brace "}" for the class.
  - Being sure to *declare* the method correctly.
- Save
- Click *Compile All*
  - Fix errors *when* they come up.



Yes, it's scary, but change Picture.java

- If you change some other file, Pictures won't know about your method.
- If you rename the file, it will no longer be a Picture class.
- You actually *have to* change the file we give you.
  - Don't worry. If you screw up, you can copy down a new one.
  - Also don't worry. The stuff that is easiest to screw up has been hidden away in SimplePicture.

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Example 3: Returning something

```
/**
 * Method to scale the picture by a factor, and return the result
 * @param scale factor to scale by (1.0 stays the same, 0.5 decreases each side by 0.5, 2.0 doubles each
    side)
 * @return the scaled picture
 */
public Picture scale(double factor)
{
  Pixel sourcePixel, targetPixel;
  Picture canvas = new Picture((int) (factor*this.getWidth())+1,
                               (int) (factor*this.getHeight())+1);
  // loop through the columns
  for (double sourceX = 0, targetX=0;
       sourceX < this.getWidth();
       sourceX+=(1/factor), targetX++)
  {
    // loop through the rows
    for (double sourceY=0, targetY=0;
         sourceY < this.getHeight();
         sourceY+=(1/factor), targetY++)
    {
      sourcePixel = this.getPixel((int) sourceX,(int) sourceY);
      targetPixel = canvas.getPixel((int) targetX, (int) targetY);
      targetPixel.setColor(sourcePixel.getColor());
    }
  }
  return canvas;
}
```

Returning a picture

```
public Picture scale(double factor)
```

- This scaling method returns a *new* instance of *Picture.*
  - It doesn't change the original!
  - That will turn out to be an advantage.
- This version takes a *factor* for how much to scale the target picture (*this*)

Declaring a new picture

```
Pixel sourcePixel, targetPixel;
  Picture canvas = new Picture((int)
  (factor*this.getWidth())+1,
                              (int) (factor*this.getHeight())+1);
```

- We need some pixels for copying things around.
- The canvas is the same size as *this*, but multiplied by the scaling *factor*, and adding one to avoid off-by-one errors.
  - The size of the *Picture **must*** be an *int* so we ***coerce*** it into that form.
- Note: We can create new *Picture* instances by passing in a filename ***OR*** a height and width!
  - It'll start out all-white (unlike in Python!)

Copying everything over

```
// loop through the columns
  for (double sourceX = 0, targetX=0;
       sourceX < this.getWidth();
       sourceX+=(1/factor), targetX++)
  {
   // loop through the rows
   for (double sourceY=0, targetY=0;
        sourceY < this.getHeight();
        sourceY+=(1/factor), targetY++)
   {
     sourcePixel = this.getPixel((int) sourceX,(int) sourceY);
     targetPixel = canvas.getPixel((int) targetX, (int) targetY);
     targetPixel.setColor(sourcePixel.getColor());
   }
  }
```

We can actually do multiple statements in initialization and incrementing of the *for* loop!

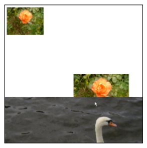
And return the new picture at the end

```
return canvas;
```

- Like in Python, anything you create in a method ***only*** exists inside that method.
- If you want it to get *outside* the ***context*** (or *scope*) of that method, you have to *return* it.

Why should we want to do that?

```
> Picture blank = new Picture(600,600);
> Picture swan = new
    Picture("D:/cs1316/MediaSources/swan.
    jpg");
> Picture rose = new
    Picture("D:/cs1316/MediaSources/rose.j
    pg");
> rose.scale(0.5).compose(blank,10,10);
> rose.scale(0.75).compose(blank,300,300);
> swan.scale(1.25).compose(blank,0,400);
> blank.show();
```



Manipulation without changing the original: Cascading methods

This returns a Picture—and *rose* is not changed!

This is a method that's understood by Pictures. Why, that's what *scale* returns!

```
rose.scale(0.5).compose(blank,10,10);
```

BTW, can use **explore**() as well as **show**() to see results or plan our compositions!

Some of the methods in Picture that are useful in cascades

```
public Picture scale(double factor)
public void chromakey(Picture target, Color
  bgcolor, int threshold,
                  int targetx, int targety)
public void bluescreen(Picture target,
                  int targetx, int targety)
public void compose(Picture target, int targetx,
  int targety)
public Picture flip()
```

How do you use all of those?

- If you were (say) to build a collage, you'd want to *use* these methods, but probably *not* in a method for Picture.
  - Individual picture objects shouldn't necessarily be responsible for assembling lots of pictures.
- In general: How do you build a program that simply *uses* other objects?

public static void main(String [] args)

- The answer isn't very object-oriented.
- You create a class with *one* method, with statements as if it were in the Interactions Pane.
  - It's a *main* method, and it uses the gobbledy-gook above.
  - It can be run from DrJava with a menu item *AND* from the Command prompt

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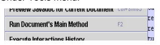
Example 4: MyPicture.java

```
public class MyPicture {

  public static void main(String args[]){

    Picture canvas = new Picture(600,600);
    Picture swan = new Picture("D:/cs1316/MediaSources/swan.jpg");
    Picture rose = new Picture("D:/cs1316/MediaSources/rose.jpg");
    Picture turtle = new Picture("D:/cs1316/MediaSources/turtle.jpg");

    swan.scale(0.5).compose(canvas,10,10);
    swan.scale(0.5).compose(canvas,350,350);
    swan.flip().scale(0.5).compose(canvas,10,350);
    swan.flip().scale(0.5).compose(canvas,350,10);
    rose.scale(0.25).compose(canvas,200,200);
    turtle.scale(2.0).compose(canvas,10,200);
    canvas.show();
  }
}
```

To run it

Under Tools menu:


Preview Javadoc for Current Document
Run Document's Main Method F2
Execute Interactions History

```
$ cd java-source
$ java MyPicture
```