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## Manipulating Pictures, Arrays, and Loops part 1

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## Learning Goals

- Understand at a conceptual and practical level
  - How to manipulate digital pictures?
  - What is an array?
  - How to get information from a picture object?
  - How to get and set information in a pixel object?
  - How to create and work with a color object?
  - How to import a class in a package?

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## Digital Pictures

- Represented by pixels
  - With a red, green, and blue value stored for each pixel
- Stored in .jpg (JPEG) files
  - International standard
  - With lossy compression
    - Lossy means not all data is stored
      - But what is lost isn't that important
    - Compression means made smaller
- Other formats for storing digital pictures are GIFF and BMP

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## Pictures have lots of Pixels

- How can we refer to each pixel?
  - pixel1, pixel2, pixel3, pixel4, pixel5, ...
- Do we really want to name each one?
  - There are  $640 \times 480 = 307,200$  pixels
- How do we deal with lots of data of the same type?
  - Use an array

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## What is an Array?

- Storage for a sequence of items
  - Of the same type
- You can access items by using an index
- The index starts at 0
  - The first item is at index 0
  - The last item is at index (length - 1)
- Arrays know their length (have a public length field)
  - `arrayObj.length`

0	1	2	3	4	5
3	7	9	2	1	5

0	1	2	3
8	3	2	6

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## Manipulating a Picture

- To manipulate a picture we need to manipulate the pixels that make up the picture
  - Change the red, green, or blue values at the pixel
- Pixel is a class that we created at Georgia Tech
  - Each pixel object has a red, green, and blue value

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## What Data does a Picture Object Have?

- A picture object has an array of pixel objects
  - That it read from the JPEG file
- It knows the picture width  
`pictureObj.getWidth()`
- It knows the picture height  
`pictureObj.getHeight()`
- It knows how to return an array of pixels  
`Pixel[] pixelArray = pictureObj.getPixels()`

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## Picture Exercise

- Create a picture in DrJava
  - get the pictures width, height, and number of pixels  

```
String fileName = FileChooser.pickAFile();
Picture pictureObj = new Picture(fileName);
int width = pictureObj.getWidth();
System.out.println("The picture width is " + width);
int height = pictureObj.getHeight();
System.out.println("The picture height is " + height);
Pixel[] pixelArray = pictureObj.getPixels();
System.out.println(pixelArray.length + " pixels");
```

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## Pixel Objects

- Each pixel has a red, green, and blue value
  - `getRed()`, `getGreen()`, `getBlue()`
  - `setRed(v)`, `setGreen(v)`, `setBlue(v)`
- Each pixel knows the location it was in the picture object
  - `getX()`, `getY()`
- You can also get and set the color at the pixel
  - `getColor()`, `setColor(color)`

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## Color Objects

- There is a class defined in Java that represents color
  - The Color class in the package `java.awt`
  - To use the class you must either
    - `import java.awt.Color;`
    - Use the full name `java.awt.Color`
- You can create a color object by giving the red, green, and blue values for it
  - `Color colorObj = new Color(255,10,125);`

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## Predefined Colors

- The Color class has defined class constants for many colors
  - `Color.red`, `Color.green`, `Color.blue`, `Color.black`, `Color.white`, `Color.yellow`, `Color.gray`, `Color.orange`, `Color.pink`, `Color.cyan`, `Color.magenta`
  - Or you can use all uppercase names
    - `Color.RED`, `Color.BLUE`, `Color.BLACK`, ...



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## Getting and Setting Pixel Colors

- To get a pixel's color as a color object  

```
Color color1 = pixelObj.getColor();
int red = color1.getRed();
int green = color1.getGreen();
int blue = color1.getBlue();
```
- To set a pixel's color using a new color object  

```
red = 20;
green = 30;
blue = 100;
Color color2 = new Color(red,green,blue);
pixelObj.setColor(color2);
```

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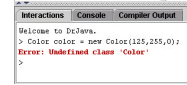
## Using Classes in Packages

- All classes in the Java language are in packages
  - You can use any class in java.lang
    - System, Math, Object
- For classes in other packages you need to import them
  - import java.awt.Color;
  - Import java.awt.\*; //import all classes in this package
    - To use the short name: Color
- Or use the fully qualified name
  - *packageName.ClassName*
  - java.awt.Color

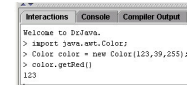
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## Undefined Class Error

- If you forget to import a class
  - Yet, you use the short name for the class
  - It won't compile
    - Undefined class error
- Undefined class errors mean
  - You need to import the class
  - Or you misspelled the class
  - Or used the wrong case



```
Interactions Console Compiler Output
Welcome to DrJava.
> Color color = new Color(125,255,0);
Error: Undefined class 'Color'
>
```



```
Interactions Console Compiler Output
Welcome to DrJava.
> import java.awt.Color;
> Color color = new Color(125,99,255);
> color.getRed();
125
```

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## Pixel Exercise

- In DrJava
  - Pick a file and create a picture object
  - Get the array of pixels from the picture object
  - Get the 1<sup>st</sup> pixel from the array of pixels
    - Pixel pixelObj = pixelArray[0]; // 0 is first one
  - Get the red, green, and blue value for this pixel
  - Get the x and y location of this pixel
  - Get the color of this pixel
    - Get the red, green, and blue values of the color

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## Changing Pixel Colors

- There are two ways to change the color of a pixel in a picture
  - Set the red, green, and blue values individually
    - pixelObj.setRed(value),
    - pixelObj.setGreen(value),
    - pixelObj.setBlue(value),
  - Or set the color
    - pixelObj.setColor(colorObj)
- But, you won't **see** any change in the picture
  - Until you ask it to repaint: pictureObj.repaint();

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## Changing a Color

- The Color class has methods for making a color object
  - Lighter
    - colorObj.brighter();
  - Darker
    - colorObj.darker();
- Example

```
> import java.awt.Color;
> Color testColor = new Color(168,131,105);
> System.out.println(testColor);
java.awt.Color[r=168,g=131,b=105]
> testColor = testColor.darker();
> System.out.println(testColor);
java.awt.Color[r=117,g=91,b=73]
> testColor = testColor.brighter();
> System.out.println(testColor);
java.awt.Color[r=167,g=130,b=104]
```

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## Rounding Errors

- Notice that when you made the color darker and then lighter the resulting color was slightly off of the original
  - The change is calculated in floating point
  - The result is stored in integer form
  - The decimal part is lost
- Rounding errors also occur because of the limited storage for floating point numbers
  - We can't store all the digits in some numbers

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## Summary

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- Pictures have pixels
  - You can change the picture by changing the color of the pixels
- Arrays let you store and retrieve values of the same type using an index
- You can ask a picture for it's width, height, and an array of pixels
- You can get and set the color of a pixel
- You will need to import classes that you wish to use that aren't in java.lang

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