

## A1: Introduction to digital pictures and color

If you look at an advertisement for a digital camera, it will tell you how many *megapixels* the camera can record. What is a megapixel? A digital camera has sensors that record color at millions of points arranged in rows and columns (Figure 1). Each point is a *pixel* or *picture (abbreviated **pix**) element*. A *megapixel* is one million pixels. A 16.2 megapixel camera can store the color at over 16 million pixels. That's a lot of pixels! Do you really need all of them? If you are sending a small version of your picture to a friend's phone, then just a few megapixels will be plenty. But, if you are printing a huge poster from a picture or you want to zoom in on part of the picture, then more pixels will give you more detail.

How is the color of a pixel recorded? It can be represented using the RGB (Red, Green, Blue) color model, which stores values for red, green, and blue, each ranging from 0 to 255. You can make yellow by combining red and green. That probably sounds strange, but combining pixels isn't the same as mixing paint to make a color. The computer uses light to display color, not paint. Tilt the bottom of a CD in white light and you will see lots of colors. The CD acts as a prism and lets you see all the colors in white light. The RGB color model sometimes also stores an alpha value as well as the red, green, and blue values. The alpha value indicates how transparent or opaque the color is. A color that is transparent will let you see some of the color beneath it.

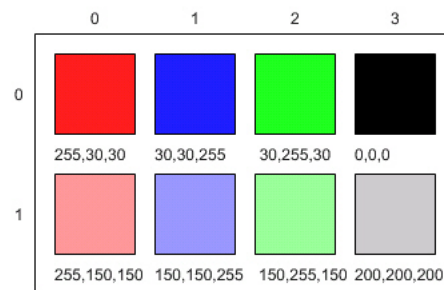


Figure 1: RGB values and the resulting colors displayed in rows and columns

How does the computer represent the values from 0 to 255? A decimal number uses the digits 0 to 9 and powers of 10 to represent values. The decimal number 325 means 5 ones ( $10^0$ ) plus 2 tens ( $10^1$ ) plus 3 hundreds ( $10^2$ ) for a total of three hundred and twenty-five. Computers use *binary numbers*, which use the digits 0 and 1 and powers of 2 to represent values using groups of bits. A *bit* is a **binary digit**, which can be either 0 or 1. A group of 8 bits is called a *byte*. The binary number 110 means 0 ones ( $2^0$ ) plus 1 two ( $2^1$ ) plus 1 four ( $2^2$ ), for a total of 6.

### Questions

1. How many bits does it take to represent the values from 0 to 255?
2. How many bytes does it take to represent a color in the RGB color model?
3. How many pixels are in a picture that is 640 pixels wide and 480 pixels high?

## A2: Picking a color

Run the `main` method in `ColorChooser.java`. This will pop up a window (Figure 2) asking you to pick a color. Click on the RGB tab and move the sliders to make different colors.

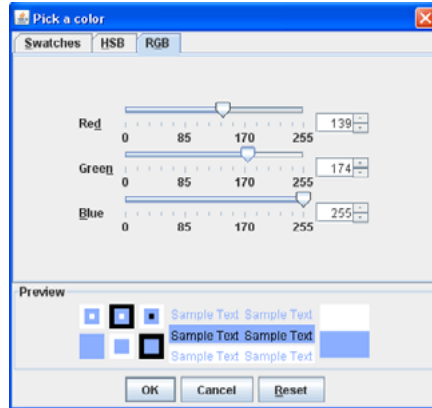


Figure 2: The Color Chooser (This is the version from Java 6.)

When you click the OK button, the red, green, and blue values for the color you picked will be displayed as shown below. The `Color` class has a `toString` method that displays the class name followed by the red, green, and blue values. The `toString` method is automatically called when you print an object.

```
java.awt.Color[r=139,g=174,b=255]
```

Java represents color using the `java.awt.Color` class. This is the *full name* for the `Color` class, which includes the *package* name of `java.awt` followed by a period and then the class name `Color`. Java groups related classes into *packages*. The *awt* stands for Abstract Windowing Toolkit, which is the package that contains the original Graphical User Interface (GUI) classes developed for Java. You can use just the short name for a class, like `Color`, as long as you include an import statement at the beginning of a class source file, as shown below. The `Picture` class contains the following import statement.

```
import java.awt.Color;
```

Use the `ColorChooser` class (run the `main` method) to answer the following questions.

### Questions

1. How can you make pink?
2. How can you make yellow?
3. How can you make purple?
4. How can you make white?