Data Structures & Algorithms

Lecture 3

January 30

Introduction to Java

Announcements

Objects

- Variables made up from the primitive types (int, short, long, float, double, char, and boolean) are special.
- Variables made of any other types are called objects.
A primitive type variable can be thought of as a name for a location in memory that will hold data of the specified type.

```java
int payrollSum = 27416;
```

An example of an object would be a variable of type String.

- String is not a primitive type.
- Rather than actually being a location in memory that stores the data, the object variable is a reference to the data making up the object.
  - It’s a pointer to the data.

When we declare a String object:

```java
String firstName;
```

Java creates a reference to a string.

- Basically this will point to some string data stored elsewhere in memory.

```
firstName
```

(Java)

Unless we have initially assigned some string to the variable, it doesn’t point anywhere.

- That is, it is a null pointer.
Objects

• Suppose we assign it a string:
  \[ \text{firstName} = "\text{Ali}"; \]
• Then the variable references (points to) the location in memory with the string data in it.

Objects

• Later, we can assign it a different string:
  \[ \text{firstName} = "\text{Alexandra}"; \]
• The variable references (points to) the location in memory with the new string data in it.

Objects

• Java will eventually clear out old data that no variables are referencing.
• This is known as garbage collection.

Objects

• More than one variable may refer to the same data.
  \[ \text{String otherName;} \]
  \[ \text{otherName} = \text{firstName}; \]
Allowed Types in Java

• The type for a variable declaration can be
  – A primitive type: int, double, char, or boolean
  – The name of a Class
    • in the Java language
      – String, JFrame, BufferedImage, etc.
    • the name of a class you or someone else created
      – Turtle, Picture, Sound,FileChooser

Object and Primitive Variables

• Primitive variables allocate space based on their size
  – The contents of the space is set to the variable’s value

  ```
  int a = 3
  a
  ```

• Object type variables cause space allocation for a reference to an object
  – The contents of the space is a way to calculate the address of the object
  – Or null if it isn’t referring to an object yet.

  ```
  String str = "Hi";
  str
  ```

Memory Exercise

• Draw the memory used for the following:

  ```
  int x = 2;
  int y = 7;
  int z = x + y;
  ```

• Draw the memory used for the following:

  ```
  String fullName;
  String firstName = "James";
  String lastName = "Clark";
  fullName = firstName + lastName;
  ```

Creating Objects

• A class is like a factory that creates objects of that class.

• We ask a class to create an object by using the keyword:
  ```
  new ClassName
  ```

• We also ask the class to initialize the object.
  – And pass data to help initialize it.
Objects

- Objects are very important in Java.
  - We will return to them again.
  - And again.
  - And again...

Java is Case Sensitive

- Some programming languages are case sensitive.
- Upper and lower case letters are treated as distinct from one another.
  - Meaning that `variableName` isn’t the same as `VariableName`
  - Or `double` isn’t the same as `Double`
  - Or `string` isn’t the same as `String`

Java is Case Sensitive

- In Java `int` and `float` are all lowercase.
- Class names start with an uppercase letter.
  - So `String` and `System` are the names of classes.
- Class names define objects.
  - That is describe their characteristics.
  - More on this later...

Java Naming Conventions

- In Java only `Class` names start with an uppercase letter:
  - `System`, `BufferedImage`, `Picture`
- All other names start with lowercase letters but use uppercase for the first letter of each additional word:
  - `picture`, `fileName`, `thisIsALongName`
Identifying Classes Exercise

- Which of these are primitive types, and which are the names of classes?
  - int
  - Picture
  - char
  - Double
  - Math
  - double
  - Integer
  - String

Semicolon

- Java programs are made up of *statements*.
  - Like sentences in English
  - Java statements end in a semicolon, not a period.
    - e.g. `int sum = 0;`

Period

- A period is used as a kind of separator.
- The period is used to send a message to an object
  - `System.out.println()`
  - `out.println()` is sending the `println()` message to the `out` object.
- Or access data in the object
  - `System.out.println()`
  - `System.out` is a way to access the class variable called `out` in the `System` class.

Semicolon

- In DrJava, if you put a statement in the interactions pane -
  - Without a semicolon, it prints the result of that statement.
  - With a semicolon, it does not print the result of that statement.
- You can always use
  - `System.out.println();`
to force output.
  - This is more like how a real Java program will work.
Messages Always Have Parenthesis

- You can tell that `System.out.println()` is sending a message.
  - Because of the ()
- Messages always have ()
  - Even if they are empty.
  - That is, even if there are no parameters (arguments).
- If you are sending data with a message it goes inside the parentheses:
  - Separated by commas
  - For example,
    `Math.min(3,4);`

Summary

- Computers can do math and make logical comparisons.
- Computers can execute billions of instructions per second.
- Computers keep getting faster, smaller, and cheaper.
- Java has typical math and relational operators
- You can print out things using `System.out.println(value)`

What is Media Computation?

- Processing
  - picture elements
  - sound fragments
  - movie frames
  - Text files and HTML pages
- The speed and storage capacity of modern computers make this possible
  - Even for beginning students just learning to program.
How Does Color Vision Work?

• Our eyes and brain work together to make sense of what we see.

• The rods allow us to see black, white, and shades of gray.

• The cones in our eyes are what allow us to see in color.
  – Our cones are sensitive to red, green, and blue light.
  – All other colors are combinations of these three.

Red, Green and Blue Light

• White light is a combination of red, green, and blue
  – Full intensity red, green, and blue combined

• Black is the absence of all light
  – No red, green or blue light

• All other colors are combinations
  – Of red, green, and blue
  – Of different intensities

Color Exercise

• Start DrJava
  – In the interactions pane type `ColorChooser.pickAColor();`
  – Click on the RGB tab and move the sliders to change the intensity of red, green, and blue
  – Make white, black, red, blue, green, yellow, violet, and orange
How do Digital Cameras Work?

• There are red, green, and blue filters that capture the amount of each color at a position
  – A part of a grid
• There are many positions
  – Picture element or pixels
  – 640 x 480 is low resolution
  – 1600 x 1200 is high resolution
• The more pixels the better the picture
  – The higher the resolution
  – You can enlarge the picture without it looking grainy

How do Computer Displays Work?

• A display has pixels (picture elements).
• Each pixel has a red, green, and blue component.
• Combinations of red, green, and blue give the resulting color:
  – Black is
    • 0 red,
    • 0 green and
    • 0 blue
  – White is
    • 255 red,
    • 255 green,
    • 255 blue

Pictures are made up of Pixels

• Digital cameras record light as pixels.
• Monitors display images using pixels.
• Our limited vision acuity helps us to see the discrete pixels as a smooth image.
  – If we blow up the picture we can see the pixels.

Digital Pictures

• They capture the intensity of the red, green, and blue colors at each pixel
• Stored as a group of numbers
  – 8 bits for red, 8 bits for green, 8 bits for blue
  – Need nearly 1 million bytes to store a 640 x 480 picture
  – Need 3 million bytes to store an image from a 1 megapixel (million pixels) camera
• Displayed as red, green, and blue colors on the computer display
  – Lots of them close together
  – Our brain sees a smooth color image
Digital Pictures

- Represented as an array of pixels
  - With a red, green, and blue value stored for each pixel
- Stored in (JPEG) files
  - International standard
  - With lossy compression
    - Lossy means not all data is stored
    - But what is lost isn’t usually that important
    - Compression means made smaller
  - The file names have a .jpg extension.
- Other formats for storing digital pictures include GIFF, TIFF, PNG and BMP.

Pictures have large numbers of Pixels

- How can we refer to each pixel?
  - As - pixel1, pixel2, pixel3, pixel4, pixel5, ...
- Do we really want to individually name each one?
  - A 640 x 480 image = 307,200 pixels.

Pictures have large numbers of Pixels

- How do we deal with lots of data of the same type?
  - Use an array.

What is an Array?

- Storage for a sequence (or list) 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
They have a public length field `arrayObj.length`
Notice this is a field, not a method.
That is, no “()”