DATA STRUCTURES & ALGORITHMS

LECTURE 3

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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.

Unless we have initially assigned some string to the variable, it doesn't point anywhere.
- That is, it is a null pointer.
• Suppose we assign it a string:
  ```java
  firstName = "Ali";
  ```
• Then the variable references (points to) the location in memory with the string data in it.
  ```java
  String firstName = "Ali";
  ```

• Later, we can assign it a different string:
  ```java
  firstName = "Alexandra";
  ```
• The variable references (points to) the location in memory with the new string data in it.
  ```java
  String firstName = "Alexandra";
  ```

• Java will eventually clear out old data that no variables are referencing.
• This is known as **garbage collection**.
  ```java
  String latestEmployeeFName;
  latestEmployeeFName = 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

  ```java
  int a = 3
  a
  3
  ```

• 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.

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

MEMORY EXERCISE

• Draw the memory used for the following:
  ```java
  int x = 2;
  int y = 7;
  int z = x + y;
  ```

• Draw the memory used for the following:
  ```java
  String fullName;
  String firstName = "James";
  String lastName = "Clark";
  fullName = firstName + lastName;
  ```

CREATING OBJECTS

• Remember that a class is a factory that creates objects of that class.
• We ask a class to create an object by using the keyword:
  ```java
  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 primitive types are all lowercase
  - `double`, `float`, `int`, `char`, etc.
- 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 PARENTHESES

• 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.

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

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 pixel) 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 “()”