CSSE 220

Types, Loops, Strings, Arrays and ArrayLists

Check out ArrayListPractice from SVN

Quick Review: What are Types?

- All variables in Java have a “type”
- Describes the data that can be stored in a variable
  - String – text only
  - short/int/long – whole numbers only
  - float/double – numbers with decimals
  - boolean – true or false
  - char – a single text character
- Classes – Class names are also types, let you define your own, more complex, types

Strings

- String myString = “hello”;
- String otherString = new String(“hello2”);

- Java’s way of storing text data
- Has many handy functions like substring, charAt, etc. that you will slowly learn
- But how do you find out about these cool functions?

Java API Documentation

- What's an API?
  - Application Programming Interface

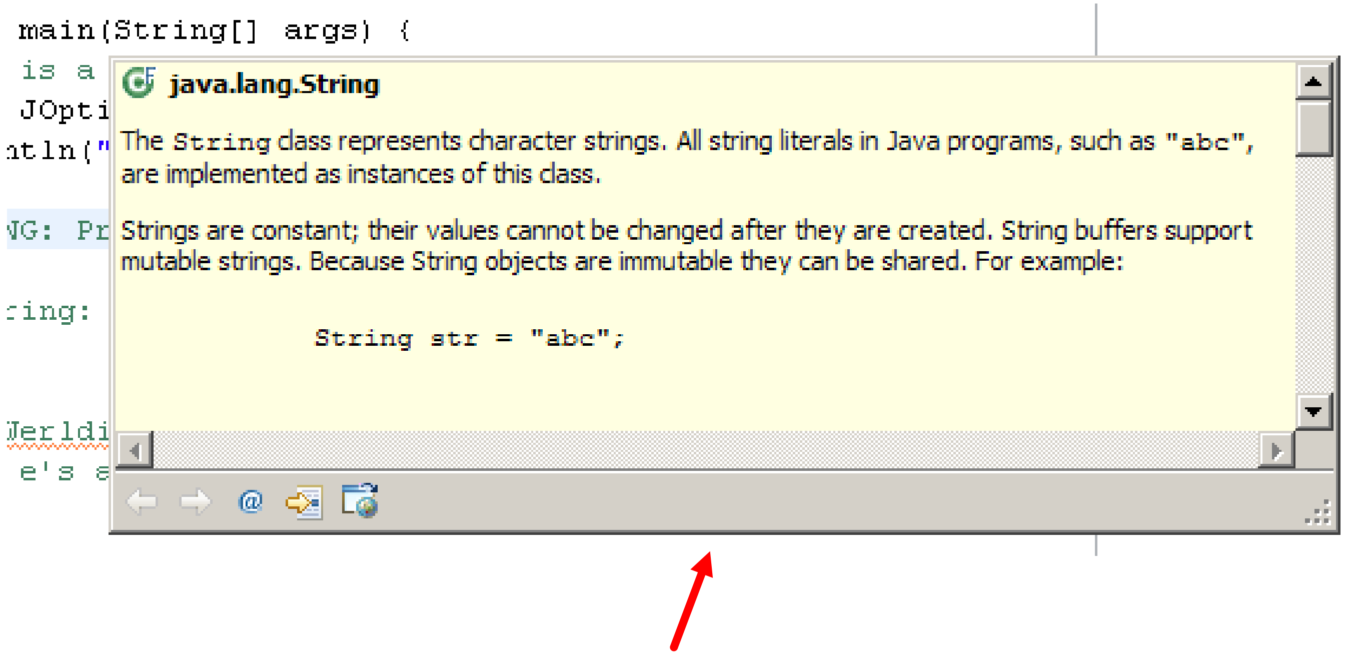
- The Java API on-line
  - Google for: java api documentation 7
  - Or go to: http://download.oracle.com/javase/7/docs/api/
  - Also hopefully on your computer at C:\Program Files\Java\jdk1.7.0_9\docs\api\index.html

You need the 7 (or 8) to get the current version of Java

Note: Your version may be something other than 7.0_9.
We recommend that you bookmark this page in your browser, so you can refer to it quickly, with or without an internet connection.

Java Documentation in Eclipse

- Setting up Java API documentation in Eclipse
  - Should be done already,
- Using the API documentation in Eclipse
  - Hover text
  - Open external documentation (Shift-F2)



java.lang.String

The `String` class represents character strings. All string literals in Java programs, such as `"abc"`, are implemented as instances of this class.

Strings are constant; their values cannot be changed after they are created. String buffers support mutable strings. Because String objects are immutable they can be shared. For example:

```
String str = "abc";
```

Exercise

- If you haven’t, finish work on StringProbs.java

Review Loops: while & for Loops

- While loop syntax: Similar to Python

```
while (condition) {
  statements
}
```

- For loop syntax: Different from Python

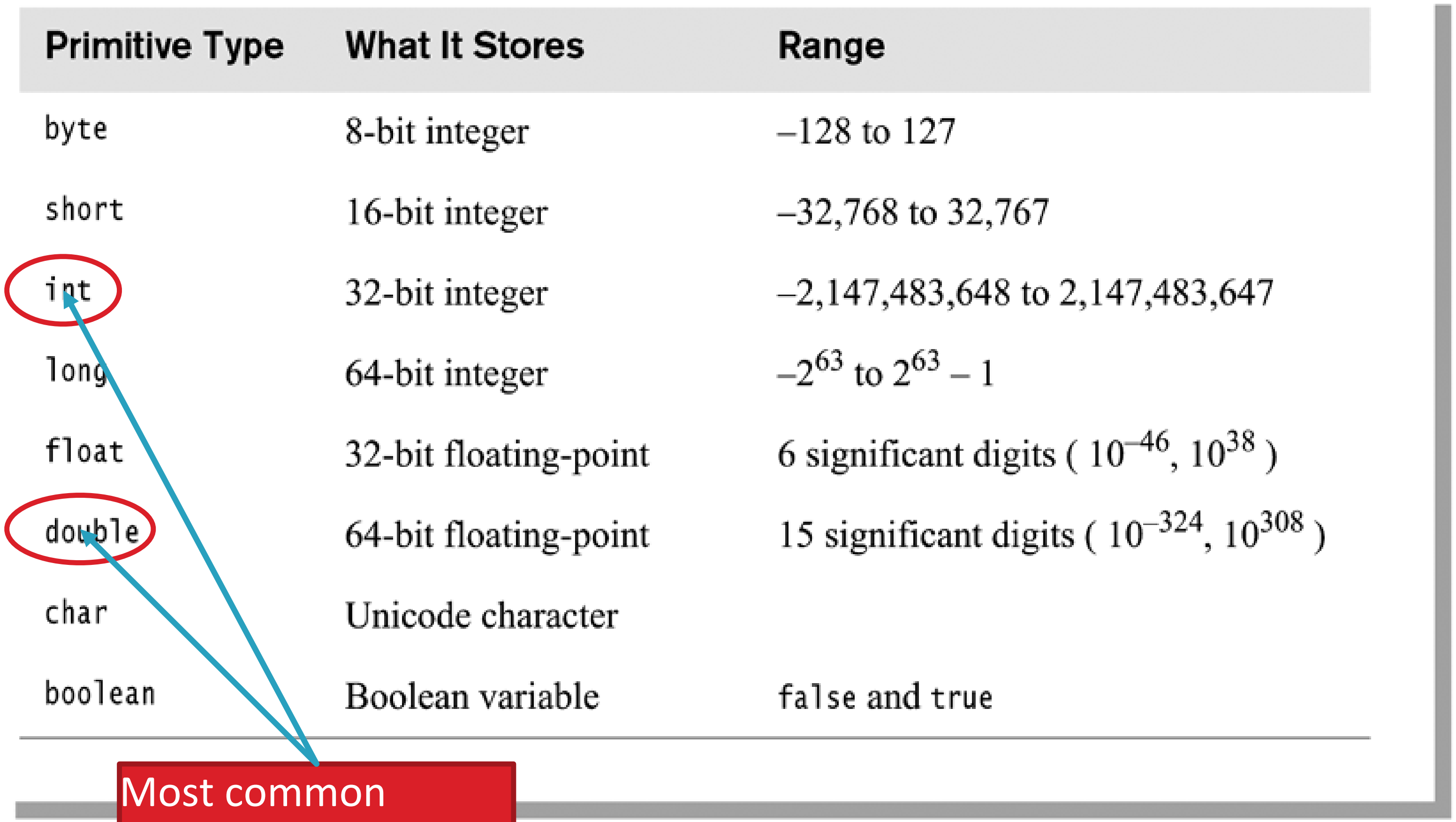
```
for (initialization ; condition ; update) {
     statements
}
```

In both cases, curly braces optional if only one statement in body; but be careful!

Let’s practice some loops

- Go to http://codingbat.com/java/Warmup-2
- We’ll do countXX together
- Then you do doubleX, stringBits, and (if you have time) stringSplosion

Primitive types



Primitive Type	What It Stores	Range
`byte`	8-bit integer	–128 to 127
`short`	16-bit integer	–32,768 to 32,767
`int`	32-bit integer	–2,147,483,648 to 2,147,483,647
`long`	64-bit integer	-2^{63} to $2^{63} - 1$
`float`	32-bit floating-point	6 significant digits (10^{-46}, 10^{38})
`double`	64-bit floating-point	15 significant digits (10^{-324}, 10^{308})
`char`	Unicode character	
`boolean`	Boolean variable	`false` and `true`

figure 1.2

The eight primitive types in Java

Most common number types in Java code

Gotcha!!!

- int vs. double:
  - int num1 = 1
  - double result = num1 / 2;
  - //what is result??

- How do we fix this?

Java Loop Examples

- Look at `Investment.java`, `InvestmentTest.java` and `InvestmentRunner.java`
  - Practice using a single while loop
  - Study and run the code, then answer quiz questions

- Do the Rates exercise in the Rates.java file
  - You'll practice using a single for loop in that exercise
  - Hint: in printf's format string, use %% to display a single %

Sentinel Values: A Loop and a Half

- Sentinel value—a special input value not part of the data, used to indicate end of data set
  - `Enter a quiz score, or Q to quit:`
- A loop and a half—a loop where the test for termination comes in the middle of the loop
- Examples… (on next slide)

Two Loop-and-a-half Patterns

```
// Pattern 1

boolean done = false;
while (!done) {
   // do some work

   if (condition) {
      done = true;
   } else {
      // do more work
   }
}
```

The variable *done* here is called a *flag*

```
// Pattern 2

while (true) {
   // do some work

   if (condition) {
      break;
   }

   // do more work
}
```

Arrays- What, When, Why, & How?

- What
  - A special **type** used to hold a set number of items of a specified type
- When
  - Use when you need to store multiple items of the same type
  - Number of items is known and will not change

Arrays- What, When, Why, & How?

- Why
  - Avoids things like int1, int2, int3, int4
  - Avoids repetitive code and frequent updates
- How
  - Type[] arr = new Type[num]; ← Creates a new array of type Type stored in variable arr
  - An array of 5 Strings (stored in the variable fiveStrings) would look like this:
    - String[] fiveStrings = new String[5];

Array Examples Handout

- Form groups of 2
- Look at the Array Examples Handout
- Study how arrays are used and answer the questions in the quiz
  - FIRST PAGE OF QUIZ ONLY

Go to http://codingbat.com/java/Array-2

- Work in your groups to solve fizArray3, bigDiff, shiftLeft
- When you finish all 3, call me over to take a look
- If you finish early, try zeroFront

Array Types

- Group a collection of objects under a single name
- Elements are referred to by their **position**, or ***index***, in the collection (0, 1, 2, …)
- Syntax for declaring: `ElementType[] name`
- Declaration examples:
  - A local variable: `double[ ] averages;`
  - Parameters: `public int max(int[] values) {…}`
  - A field: `private Investment[] mutualFunds;`

Allocating Arrays

- Syntax for allocating:

  `new` *`ElementType[length]`*

- Creates space to hold values
- Sets values to defaults
  - `0` for number types
  - `false` for boolean type
  - `null` for object types
- Examples:
  - `double[] polls = new double[50];`
  - `int[] elecVotes = new int[50];`
  - `Dog[] dogs = new Dog[50];`

Don't forget this step!

This does NOT construct any **Dogs**. It just allocates space for referring to **Dogs** (all the **Dogs** start out as *null*)

Reading and Writing Array Elements

- Reading:
  - `double exp = polls[42] * elecVotes[42];`

Reads the element with index 42.

Sets the value in slot 37.

- Writing:
  - `elecVotes[37] = 11;`

- Index numbers run from 0 to array length – 1
- Getting array length: `elecVotes.length`

No parentheses, array length is (like) a field

Arrays: Comparison Shopping

Arrays…	**Java**	**Python lists**
have fixed length	***yes***	***no***
are initialized to default values	***yes***	***n/a***
track their own length	***yes***	***yes***
trying to access "out of bounds" stops program before worse things happen	***yes***	***yes***

ArrayList- What, When, Why, & How?

- What
  - A class in a Java library used to hold a collection of items of a specified type
  - Allows variable number of items
  - Fast random access
- When
  - Use when you need to store multiple items of the same type
  - Number of items is not known/will change

ArrayList- What, When, Why, & How?

- Why
  - Fast random access
  - Allows length changes, cannot do this with an array
- How

  -
    ```
    ArrayList<Type> arl = new
    ArrayList<Type>();
    ```
    - Creates a new ArrayList of type Type stored in variable arl

ArrayList Examples Handout

- Look at the ArrayList section of the examples handout
- Study how arrayLists are used and answer the questions in the quiz
- Then solve the 3 problems in ArrayListPractice (you downloaded it from SVN)
- When you finish, call me over to take a look

What if we don’t know how many elements there will be?

- **ArrayLists** to the rescue
- Example:

Element type

- `ArrayList<State> states = new ArrayList<State>();`

Variable type

Constructs new, empty list

Adds new element to end of list

- `states.add(new State(“Indiana”, 11, .484, .497));`

- `ArrayList` is a *generic class*
  - Type in <brackets> is called a *type parameter*

ArrayList Gotchas

- Type parameter can't be a primitive type
  - Not: `ArrayList<int> runs;`
  - But: `ArrayList<Integer> runs;`

- Use ***get*** method to read elements
  - Not: `runs[12]`
  - But: `runs.get(12)`

- Use **`size()`** not **`length`**
  - Not: `runs.length`
  - But: `runs.size()`

Lots of Ways to Add to List

- Add to end:
  - `victories.add(new WorldSeries(2011));`
- Overwrite existing element:
  - `victories.set(0,new WorldSeries(1907));`
- Insert in the middle:
  - `victories.add(1, new WorldSeries(1908));`
  - Pushes elements at indexes 1 and higher up one

- Can also remove:
  - `victories.remove(victories.size() - 1)`

So, what's the deal with primitive types?

- Problem:
  - ArrayList's only hold objects
  - Primitive types aren't objects
- Solution:
  - *Wrapper classes*—instances are used to "turn" primitive types into objects
  - Primitive value is stored in a field inside the object

Primitive	Wrapper
byte	***Byte***
boolean	***Boolean***
char	***Character***
double	***Double***
float	***Float***
int	***Integer***
long	***Long***
short	***Short***

Auto-boxing Makes Wrappers Easy

- Auto-boxing: automatically enclosing a primitive type in a wrapper object when needed
- Example:
  - You write: `Integer m = 6;`
  - Java does: `Integer m = new Integer(6);`

  - You write: `Integer answer = m * 7;`
  - Java does:
    ```
    int temp = m.intValue() * 7;
    Integer answer = new Integer(temp);
    ```

Auto-boxing Lets Us Use ArrayLists with Primitive Types

- Just have to remember to use wrapper class for list element type

- Example:

  -
    ```
    ArrayList<Integer> runs =
          new ArrayList<Integer>();
    runs.add(9); // 9 is auto-boxed
    ```

  -
    ```
    int r = runs.get(0); // result is
    unboxed
    ```

Enhanced For Loop and Arrays

- Old school

```
double scores[] = …
double sum = 0.0;
for (int i=0; i < scores.length; i++) {
    sum += scores[i];
}
```

- New, whiz-bang, enhanced for loop

```
double scores[] = …
double sum = 0.0;
for (double score : scores) {
    sum += score;
}
```

Say “in”

- No index variable **(easy, but limited in 2 respects)**
- Gives a name (**score** here) to each element

Enhanced For and ArrayList's

```
ArrayList<State> states = …
int total = 0;
for (State state : states) {
      total += state.getElectoralVotes();
}
```

Work Time

- Finish all the in-class material exercises if you haven’t yet
- Work on TwelveProblems