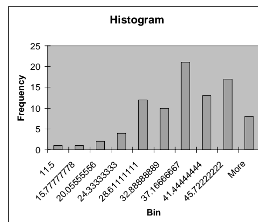
CS1004: Intro to CS in Java, Spring 2005

Lecture #16: Java conditionals/loops, cont'd.

Janak J Parekh
janak@cs.columbia.edu

Administrivia

- Midterms returned now
  - Weird distribution
  - Mean: 35.4 ± 8.4
  - What does this mean?
  - In-class extra credit
- HW#3 returned Thurs.
- HW#4 out



The Conditional Operator, redux

- (Another) Example:

```
System.out.println ("Your change is " + count +
   ((count == 1) ? "Dime" : "Dimes"));
```

- If `count` equals 1, then `"Dime"` is printed
- If `count` is anything other than 1, then `"Dimes"` is printed

The switch Statement

- The *switch statement* provides another way to decide which statement to execute next
- The `switch` statement evaluates an expression, then attempts to match the result to one of several possible *cases*
- Each case contains a value and a list of statements
- The flow of control transfers to statement associated with the first case value that matches

The switch Statement (II)

- The general syntax of a `switch` statement is:

switch and case are reserved words

```
switch ( expression )
{
   case value1 :
      statement-list1
   case value2 :
      statement-list2
   case value3 :
      statement-list3
   case  ...

}
```

If *expression* matches *value2*, control jumps to here

switch and break

- Often a *break statement* is used as the last statement in each case's statement list
  - A `break` statement causes control to transfer to the end of the `switch` statement
  - If a `break` statement is not used, the flow of control *will continue into the next case*
- Biggest common bug with switch, and a reason why I use it sparingly

switch Example

- An example of a switch statement:

```
switch (option) {
   case 'A':
      aCount++;
      break;
   case 'B':
      bCount++;
      break;
   case 'C':
      cCount++;
      break;
}
```

switch and default case

- A `switch` statement can have an optional *default case*
- The default case has no associated value and simply uses the reserved word `default`
- If the default case is present, control will transfer to it if no other case value matches
- If there is no default case, and no other value matches, control falls through to the statement after the switch

What can you switch on?

- The expression of a `switch` statement must result in an *integral type*, meaning an integer (`byte`, `short`, `int`, `long`) or a `char`
- It cannot be a `boolean` value or a floating point value (`float` or `double`)
- The implicit boolean condition in a `switch` statement is equality (==, not .equals())
- Common for things like menu systems ("Enter one of the above 5 options")

Comparing Data

- When comparing data using boolean expressions, it's important to understand the nuances of certain data types
- We've talked about these, but now let's formalize it

Comparing Float Values

- You should rarely use the equality operator (`==`) when comparing two floating point values (`float` or `double`)
- Two floating point values are equal only if their underlying binary representations match exactly
- Computations often result in slight differences that may be irrelevant
- In many situations, you might consider two floating point numbers to be "close enough" even if they aren't exactly equal

Comparing Float Values (II)

- To determine the equality of two floats, you may want to use the following technique:

```
if (Math.abs(f1 - f2) < TOLERANCE)
   System.out.println ("Essentially equal");
```

  - If the difference between the two floating point values is less than the tolerance, they are considered to be equal
  - The tolerance could be set to any appropriate level, such as 0.000001

Comparing Characters

- As we've discussed, Java character data is based on the Unicode character set
- Unicode establishes a particular numeric value for each character, and therefore an ordering
- We can use relational operators on character data based on this ordering
- For example, the character `'+'` is less than the character `'J'` because it comes before it in the Unicode character set
- Appendix C provides an overview of Unicode

Comparing Characters (II)

- In Unicode, the digit characters (0-9) are contiguous and in order
- Likewise, the uppercase letters (A-Z) and lowercase letters (a-z) are contiguous and in order

Characters	Unicode Values
0 – 9	48 through 57
A – Z	65 through 90
a – z	97 through 122

String equality

- Remember that in Java a character string is an object
- The `equals` method can be called with strings to determine if two strings contain exactly the same characters in the same order
- The `equals` method returns a boolean result

```
if (name1.equals(name2))
   System.out.println ("Same name");
```

String inequalities

- We cannot use the relational operators to compare strings
- The `String` class contains a method called `compareTo` to determine if one string comes before another
- A call to `name1.compareTo(name2)`
  - returns zero if `name1` and `name2` are equal (contain the same characters)
  - returns a negative value if `name1` is less than `name2`
  - returns a positive value if `name1` is greater than `name2`

compareTo example

```
if (name1.compareTo(name2) < 0)
   System.out.println (name1 + "comes first");
else
   if (name1.compareTo(name2) == 0)
      System.out.println ("Same name");
   else
      System.out.println (name2 + "comes first");
```

- Because comparing characters and strings is based on a character set, it is called a *lexicographic ordering*

Lexicographic Ordering

- Lexicographic ordering is not strictly alphabetical when uppercase and lowercase characters are mixed
- For example, the string `"Great"` comes before the string `"fantastic"` because all of the uppercase letters come before all of the lowercase letters in Unicode
- Also, short strings come before longer strings with the same prefix (lexicographically)
- Therefore `"book"` comes before `"bookcase"`

Comparing Objects

- The == operator *can* be applied to objects, as we mentioned before
- The `equals` method is also defined for all objects, but unless we redefine it when we write a class, it has the same semantics as the == operator
- It has been redefined in the `String` class to compare the characters in the two strings
- When you write a class, you can redefine the `equals` method to return true under whatever conditions are appropriate

Repetition Statements

- *Repetition statements* allow us to execute a statement multiple times, often referred to as *loops*
- Like conditional statements, they are controlled by boolean expressions
- Java has three kinds of repetition statements: *while*, *do*, and *for*
  - All are equivalent, but some are easier to use for certain cases

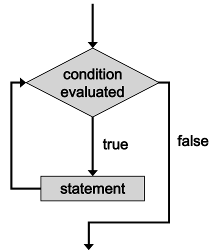
The while Statement

- A *while statement* has the following syntax:

```
while ( condition )
    statement;
```

- If the `condition` is true, the `statement` is executed
- Then the condition is evaluated again, and if it is still true, the statement is executed again
- The statement is executed repeatedly *until* the condition becomes false

Logic of a while Loop



Example

- An example of a while statement:

```
int count = 1;
while(count < 5) {
   System.out.println(count);
   count++;
}
```

- If the condition of a `while` loop is false initially, the statement is never executed
- Therefore, the body of a `while` loop will execute zero or more times

More complex example

- Maintain a *running sum*
  - A *sentinel value* is a special input value that represents the end of input
- *Input validation*
  - "While the user types an invalid value, reject and wait for a valid value."
- Example: calculate mean of exams
- Similar to *if* statements, *while* statements can be nested as well

Infinite Loops

- The body of a `while` loop eventually must make the condition false
- If not, it is called an *infinite loop*, which will execute until the user interrupts the program
- This is a common logical error
- You should always double check the logic of a program to ensure that your loops will terminate normally

Infinite Loops

- An example of an infinite loop:

```
int count = 1;
while(count <= 25) {
   System.out.println(count);
   count = count - 1;
}
```

- This loop will continue executing until interrupted or until an underflow error occurs

Nested Loops

- How many times will the string `"Here"` be printed?

```
count1 = 1;
while(count1 <= 10) {
   count2 = 1;
   while(count2 <= 20) {
      System.out.println("Here");
      count2++;
   }
   count1++;
}
```

break, version 2

- We saw `break` in the context of `switch`, but it can be used with `while` (and other loops) as well; for example,

```
while(true) {
      if(i > 10) break;
      else i++;
}
```

- What is this code equivalent to?
- Generally, you don't use break, but it's useful to have, especially if the while loop is very complex
- If you have nested loops, break only breaks out of the most immediate loop, not all of them
  - *return* can be used to break out of a bunch of loops, but avoid

The do Statement

- A *do statement* has the following syntax:

```
do {
   statement;
} while(condition);
```

- The `statement` is executed once initially, and then the `condition` is evaluated
- The statement is executed repeatedly until the condition becomes false

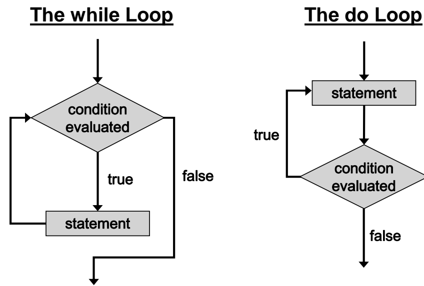
The do Statement

- An example of a `do` loop:

```
int count = 0;
do {
   count++;
   System.out.println(count);
} while (count < 5);
```

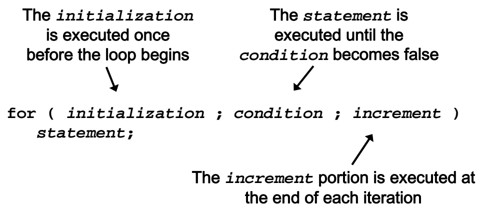
- The body of a `do` loop executes at least once
- What's the result of this code fragment?
- *do* is particularly useful for "interactive repetition"

Comparing while and do

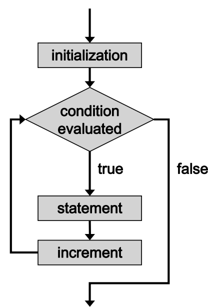


The for Statement

- A *for statement* has the following syntax:



Logic of a for loop



The for Statement

- A `for` loop is functionally equivalent to the following `while` loop structure:

```
initialization;
while(condition) {
   statement;
   increment;
}
```

The for Statement

- An example of a `for` loop:

```
for (int count=1; count < 5; count++)
   System.out.println (count);
```

- The initialization section can be used to declare a variable
- Like a `while` loop, the condition of a `for` loop is tested *prior* to executing the loop body
- Therefore, the body of a `for` loop will execute zero or more times

The for Statement

- The increment section can perform any calculation

```
for (int num=100; num > 0; num -= 5)
   System.out.println(num);
```

- A `for` loop is well suited for executing statements a specific number of times that can be calculated or determined in advance

The for Statement

- Each expression in the header of a `for` loop is optional
- If the initialization is left out, no initialization is performed
- If the condition is left out, it is always considered to be true, and therefore creates an infinite loop
- If the increment is left out, no increment operation is performed

Next time

- Finish *for*
- Start building more complex examples with loop constructs
- Think about how algorithms are created using conditions and loops