# Java Fundamentals

CSE 413, Autumn 2002

Programming Languages

http://www.cs.washington.edu/education/courses/413/02au/

# Readings and References

- Reading
  - » Chapter 3, Fundamental Programming Structures in Java, *Core Java Volume 1*, by Horstmann and Cornell

- Other References
  - » "Language Basics", Java tutorial
  - » http://java.sun.com/docs/books/tutorial/java/nutsandbolts/index.html

# Java Primitive Data Types

| | |
|---|---|
| **`boolean`** | true or false |
| **`char`** | '\u0000' to '\uFFFF' 16 bits (ISO Unicode) |
| **`byte`** | -128 to +127 |
| **`short`** | -32,768 to +32,767 |
| **`int`** | -2,147,483,648 to +2,147,483,647 |
| **`long`** | -9,223,372,036,854,775,808 to<br>+ 9,223,372,036,854,775,807 |

# Java Primitive Data Types

| | |
|---|---|
| `float` | -3.40292347E+38 to<br>+3.40292347E+38<br><br>(IEEE 754 floating point) |
| `double` | -1.79769313486231570E+308 to<br>+1.79769313486231570E+308<br><br>(IEEE 754 floating point) |

# Object Wrappers for Primitive Types

Each primitive data type has an object "wrapper" with related functionality

- `Boolean`
- `Byte`
- `Character`
- `Short`
- `Integer`
- `Long`
- `Float`
- `Double`

# Accessing Values In Wrappers

Integer.intValue()

```
Integer i = new Integer( 5 );
int j = i.intValue();
```

j is now primitive int  with value 5

There are also useful general purpose functions defined in the wrapper classes

```
static int parseInt(String s, int radix)
static String toString(int i, int radix)
etc
```

# Java Operators are Much Like C/C++

- Arithmetic +, -, *, /, %
- Preincrement and postincrement (++, --)
- Assignment (=, +=, -=., etc.)
- Relational comparison operators (==,<,>,<=,>=)
- Boolean logical operators (!, &&, ||)
- Bitwise operators (~,&,|,^)
- Shift operators (>>, <<,>>>)
- No programmer-defined operator overloading (java does overload + for string concatenation)

# Integer division and remainder

- Recall this
  - » value = quotient * divisor + remainder
- The division operator is /

```
int x = 7;
int y = x / 2;
```

  - » `y` will have the value 3 at this point
- The remainder operator is %

```
int rem = x % 2;
```

  - » `rem` will have the value 1 at this point since 7-(3*2) is equal to 1

# increment and decrement

- ++ and -- operators allow you to concisely indicate that you want to *use* and *increment or decrement* a variable's value
- pre-increment : ++i
  - » the value of i is incremented before being used in the expression
- post-increment: i++
  - » the value of i is incremented after being used in the expression
- in a statement by itself, makes no difference
  - » there is no expression of interest, just increment the value

```
Blob b = new Blob(count++,color,x,y);
```

# Assignment Operators

- Sets a value or expression to a new value
- Simple uses

```
int a = 10;
```

- Compound +=, *= in form of *x op= y,* is short hand for *x = x op y*

```
a += 10;
a = a + 10; // equivalent
```

# Relational operators

- Relational operators: boolean result
  - » < less than
  - » > greater than
  - » <= less than or equal
  - » >= greater than or equal
  - » == equivalence

# Boolean Logical Operators

- Used to group, join and change boolean results of relationals
- && logical AND
- || logical OR
- ! logical NOT

# Bitwise Operators

- Integers types only, produce int or long
- ~ bitwise not (reverses bits)
- & bitwise and
- | bitwise or
- ^ bitwise exclusive or

```
char aChar = 'c'; // 99 = 0x63 = 110 0011
int mask = 0xF;
int z = (aChar & mask);
```

# Shift Operators

- Integers types only, produce int or long
- << (left shift): shifts bits to left
- >> (signed right shift): shifts bits to right, keeps the sign (+ value fills with zeros; - value fills with ones)
- >>> (unsigned right shift): shifts bits to right, fills with zeros regardless of sign

# Identifiers

- Variable, method, class, or label
- Keywords and reserved words not allowed
- Must begin with a letter, dollar($), or underscore(_)
- Subsequent letters, $, _, or digits
- foobar  // valid
- 3_node  // invalid

# Java Keywords

| | | | | |
|---|---|---|---|---|
| abstract | boolean | break | byte | case |
| catch | char | class | continue | default |
| do | double | else | extends | false |
| final | finally | float | for | if |
| implements | import | instanceof | int | interface |
| long | native | new | null | package |
| private | protected | public | return | short |
| static | super | switch | synchronized | this |
| throw | throws | transient | true | try |
| void | volatile | while | | |

Keywords that are reserved but not used in Java

| | |
|---|---|
| const | goto |

# Literals - boolean, char, String

- true or false
  - » `boolean isBig = true;`
  - » `boolean isLittle = false;`
- character in an enclosing single quotes
  - » `char c = 'w';`
- Unicode
  - » `char c1 = '\u4567';`
- String
  - » `String s = "hi there";`

# Literals - Integer types

- Expressed in decimal, octal, or hexadecimal
  - » 28 = decimal
  - » 034 = octal
  - » 0x1c = hexadecimal
- Default is 32 bits, to get a long specify a suffix of L
  - » 4555L

# Literals - floating-point

- floating-point numeric value
- decimal point  16.55
- scientific notation, E or e:  4.33E+44
- 32-bit float, suffix F or f :  1.82F
- 64-bit double, suffix D or d:  12345d
- Default without F or D is 64-bit double

# Sequence and Grouping

```
//Simple sequence

statement1;
statement2;

//Grouped -- can replace a single
//statement anywhere

{
   statement1;
   statement2;
}
```

# The `if` statement

```
if (condition) {
    this block is executed if the condition is true
} else {
    this block is executed if the condition is false
}
```

- The condition is a logical expression that is evaluated to be **`true`** or **`false`**, depending on the values in the expression and the operators

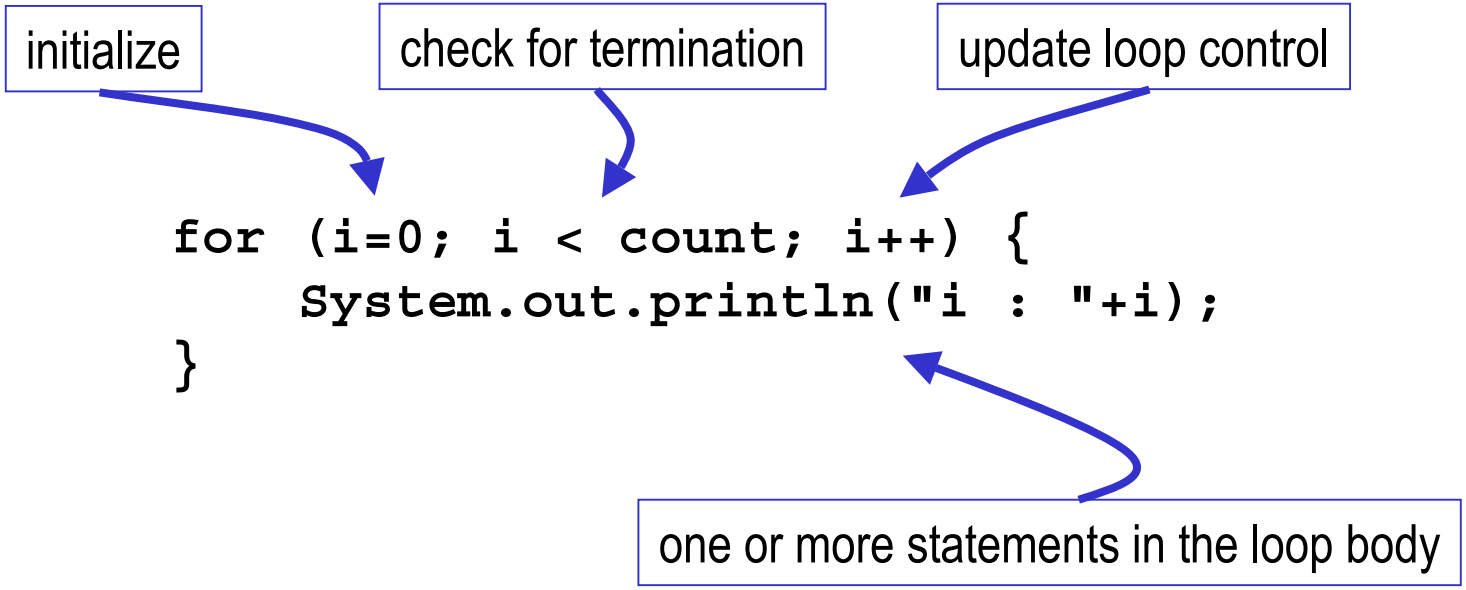
# `switch` statement

```
switch (integral type) {

   case value1 : {
      statement1;
      break; //Break out of switch
   }
   case value2 : {
      statement2;
      break;
   }
   default : {
      statement3;
   }

}
```

there are lots of limitations and potential bugs in using this, so be careful!

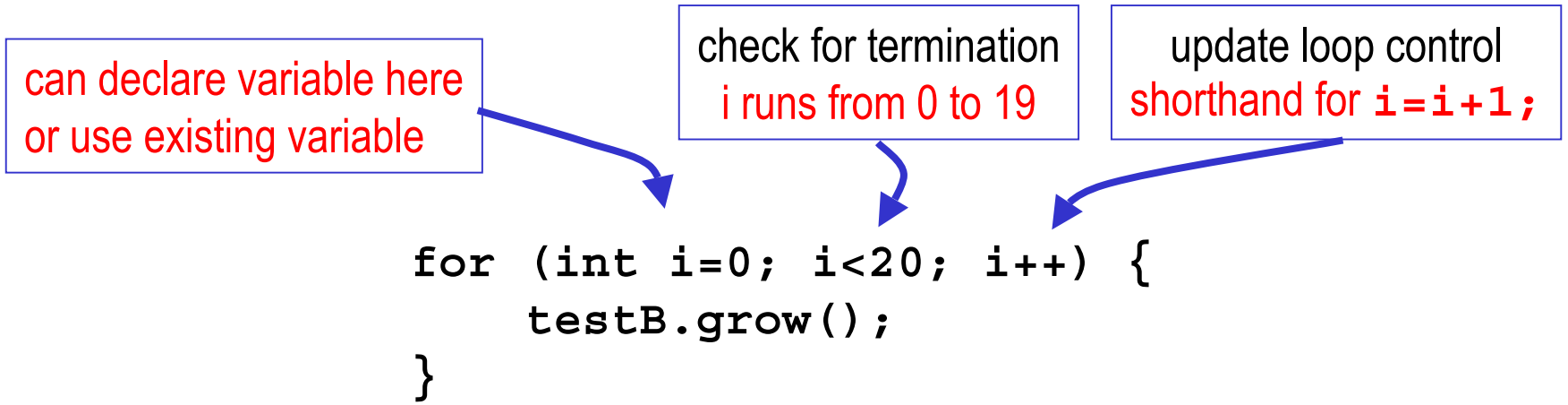
# The `for` loop

- A counting loop is usually implemented with `for`
  - » The `for` statement is defined in section 14.13 of the Java Language Specification



# `for` example

- a counting loop implemented with **`for`**




`Looper.java`

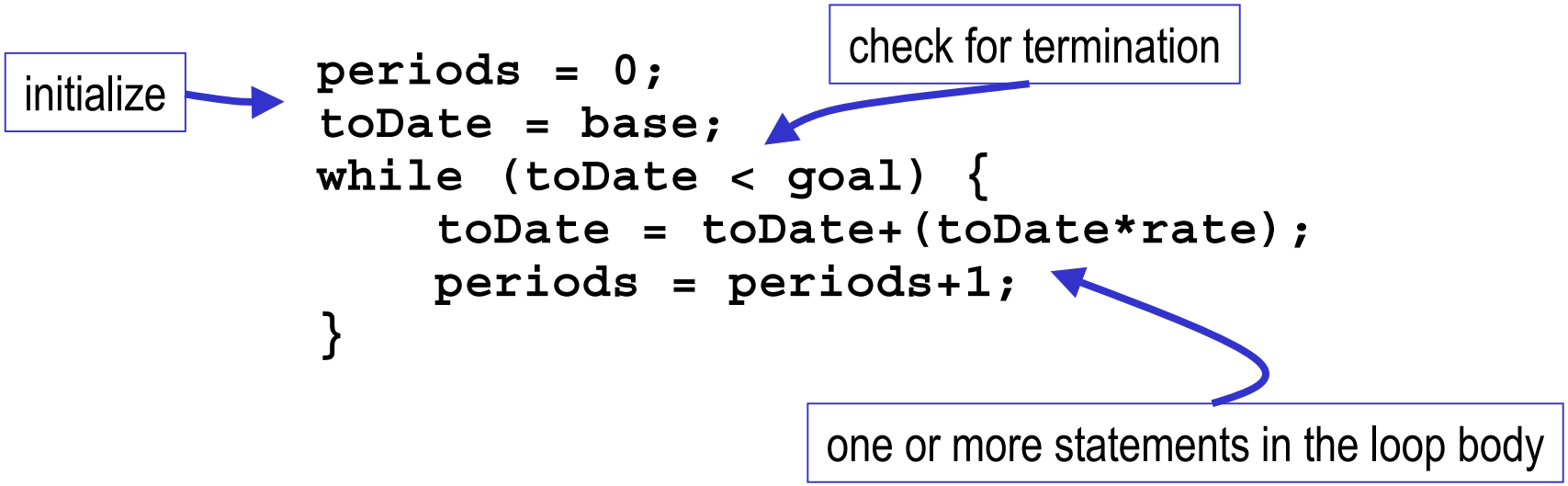
# limited life of a loop control variable

- The scope of a local variable declared in the ForInit part of a for statement includes all of the following:
  - » Its own initializer
  - » Any further declarators to the right in the ForInit part of the for statement
  - » The Expression and ForUpdate parts of the for statement
  - » The contained Statement

from Java Language Specification, section 6.3

# The **`while`** loop

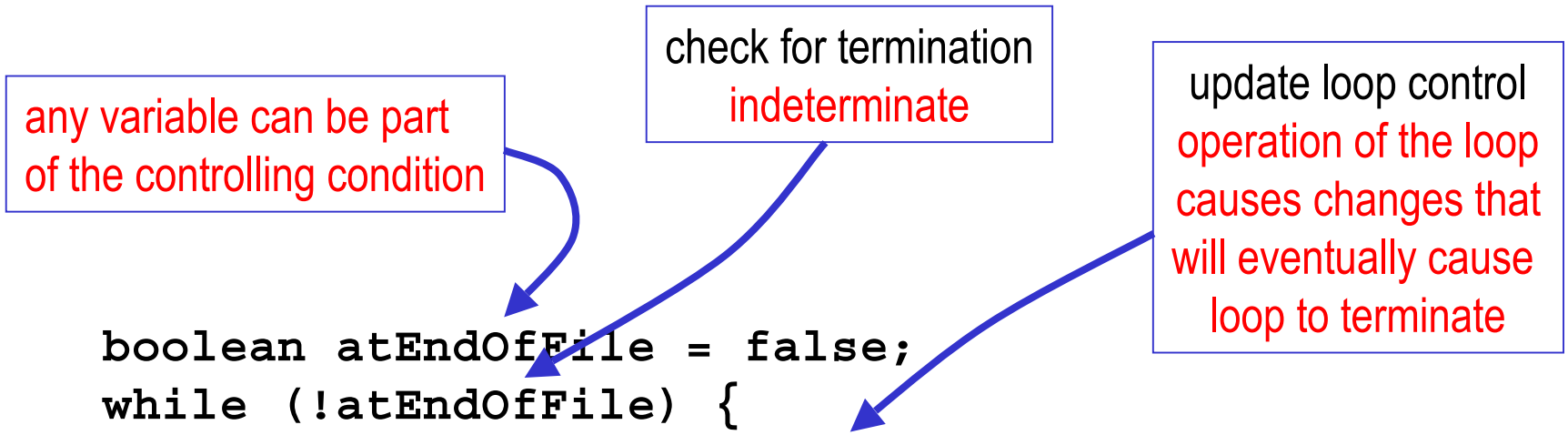
- condition loop is usually implemented with **`while`**
  - » The **`while`** statement is defined in section 14.11 of the Java Language Specification




Note: reaching a limit by counting is satisfying a condition.
**`for`** loops can be rewritten as **`while`** loops, and vice versa

# `while` example

- a condition loop implemented with **`while`**




```
boolean atEndOfFile = false;
while (!atEndOfFile) {
    read another line and set atEndOfFile if appropriate
    process the new line if needed
}
```

`Looper.java`

# body of loop may not execute at all

- Notice that depending on the values of the control variables, it is quite possible that the body of the loop will not execute at all in both **`for`** and **`while`**

```
goal = 75;
...
periods = 0;
toDate = 100;
while (toDate < goal) {
    toDate += toDate*rate;
    periods++;
}
```

check for termination
**`toDate`** is already greater than **`goal`**,
and so the entire loop is skipped

# Early terminaton of the loop statement

- A loop is often used to look at all the elements of a list one after another
  - » all the Animals in a PetSet
  - » all the Shapes in a Car
- Sometimes we want to
  - » exit the loop statement early if we find some particular element or condition while we are looping
  - » ie, get out of the loop statement (for, while) entirely

# break - jump to loop exit

```
public void snack() {
  for (int i=0; i<theBunch.size(); i++) {
    if (remainingFood <= 0) {
      System.out.println("No food left, so no more snacks.");
      break;
    }
    Animal pet = (Animal)theBunch.get(i);
    double s = Math.min(remainingFood,pet.getMealSize());
    pet.eat(s);
    remainingFood -= s;
  }
  // the break statement takes us here, out of the loop entirely
}
```

# Early cycling of the loop

- Sometimes we want to
  - » Stop processing the item we are looking at right now and go on to the next one
- The loop statement (for, while) is still the controlling structure, but we just want to go to the next iteration of the loop

# continue - jump to loop end

```
public void dine() {
  for (int i=0; i<theBunch.size(); i++) {
    Animal pet = (Animal)theBunch.get(i);
    double s = 2*pet.getMealSize();
    if (remainingFood < s) {
      System.out.println("Not enough food for "+pet+
        "'s dinner, so we'll skip to next animal.");
      continue;
    }
    pet.eat(s);
    remainingFood -= s;
    // continue takes us here, the end of this loop
  }
}
```

# Short-Circuit Operators

- With && and ||, only as much of the logical expression as needed is evaluated
- Example:

```
int i=1;
if (false && (++i == 2))
   System.out.println(i); // doesn't print
if (true || (++i == 2))
   System.out.println(i); // prints 1
```

- Don't use increment operator in places where it might not get executed (as in this example)

# boolean expressions and variables

- If you find yourself doing something like this

```
if (pageNumber == lastPage) {
  allDone = true;
} else {
  allDone = false;
}
```

- there is an easier way

```
allDone = (pageNumber == lastPage);
```

boolean variable

boolean expression

# conditional operator (3 operands)

- If you find yourself doing something like this

```
if (score < 0) {
  color = Color.red;
} else {
  color = Color.black;
}
```

- there is an easier way

```
color = (score < 0) ? Color.red : Color.black;
```

variable

boolean expression

use this value if expression is true

use this value if expression is false

# Appendix

# Positional Notation

- Each column in a number represents an additional power of the base number
- in base ten
  - » $1=1*10^0$, $30=3*10^1$, $200=2*10^2$
- in base sixteen
  - » $1=1*16^0$, $30=3*16^1$,$200=2*16^2$
  - » we use A,B,C,D,E,F to represent the numbers between $9_{16}$ and $10_{16}$

# Binary, Hex, and Decimal

| $2^8=256_{10}$ | $2^7=128_{10}$ | $2^6=64_{10}$ | $2^5=32_{10}$ | $2^4=16_{10}$ | $2^3=8_{10}$ | $2^2=4_{10}$ | $2^1=2_{10}$ | $2^0=1_{10}$ | $Hex_{16}$ | $Decimal_{10}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1 | 1 | 3 | 3 |
| | | | | | 1 | 0 | 0 | 1 | 9 | 9 |
| | | | | | 1 | 0 | 1 | 0 | A | 10 |
| | | | | | 1 | 1 | 1 | 1 | F | 15 |
| | | | | 1 | 0 | 0 | 0 | 0 | 10 | 16 |
| | | | | 1 | 1 | 1 | 1 | 1 | 1F | 31 |
| | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7F | 127 |
| | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | FF | 255 |

# Binary, Hex, and Decimal

| $Binary_2$ | $16^4=65536_{10}$ | $16^3=4096_{10}$ | $16^2=256_{10}$ | $16^1=16_{10}$ | $16^0=1_{10}$ | $Decimal_{10}$ |
|---|---|---|---|---|---|---|
| 11 | | | | | 3 | 3 |
| 1001 | | | | | 9 | 9 |
| 1010 | | | | | A | 10 |
| 1111 | | | | | F | 15 |
| 1 0000 | | | | 1 | 0 | 16 |
| 1 1111 | | | | 1 | F | 31 |
| 111 1111 | | | | 7 | F | 127 |
| 1111 1111 | | | | F | F | 255 |

# Binary, Hex, and Decimal

| $Binary_2$ | $Hex_{16}$ | $10^3=1000_{10}$ | $10^2=100_{10}$ | $10^1=10_{10}$ | $10^0=1_{10}$ |
|---|---|---|---|---|---|
| 11 | 3 | | | | 3 |
| 1001 | 9 | | | | 9 |
| 1010 | A | | | 1 | 0 |
| 1111 | F | | | 1 | 5 |
| 1 0000 | 10 | | | 1 | 6 |
| 1 1111 | 1F | | | 3 | 1 |
| 111 1111 | 7F | | 1 | 2 | 7 |
| 1111 1111 | FF | | 2 | 5 | 5 |