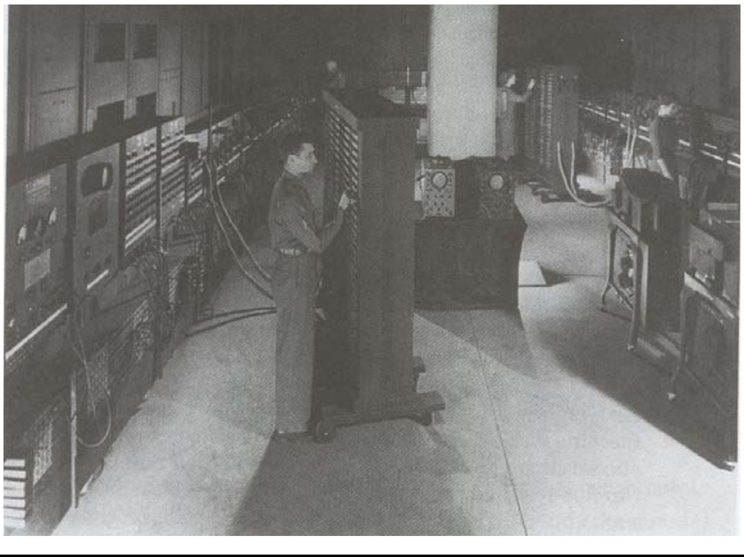
Introduction To Java Programming

You will study the process of creating Java programs and constructs for input, output, branching, looping, working with arrays as well some of the history behind Java's development.

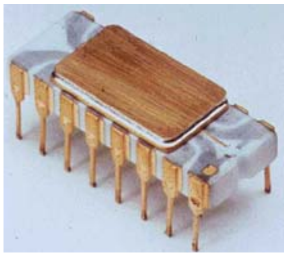
Java: History

•Computers of the past



Java: History (2)

•The invention of the microprocessor revolutionized computers


Intel microprocessor

Commodore Pet microcomputer

Java: History (3)

•It was believed that the logical next step for microprocessors was to have them run intelligent consumer electronics

AUTO CURTAIN
HOME ENTERTAINMENT
COMMUNICATION
MOODS
HOME AUTOMATION
GARAGE
AUTO SPRINKLERS
ON OFF
AUTO LIGHTING
HOME BACK UP SYSTEM
SECURITY
eCAM

Java History (4)

- Sun Microsystems funded an internal research project "Green" to investigate this opportunity.
  - Result: A programming language called "Oak"

Blatant advertisement: James Gosling was a graduate of the U of C Computer Science program.

Wav file from "The Simpsons" © Fox, Image from the website of Sun Microsystems

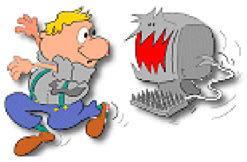
Java History (5)

- Problem: There was already a programming language called Oak.
- The "Green" team met at a local coffee shop to come up with another name...
  - Java!

JAVA

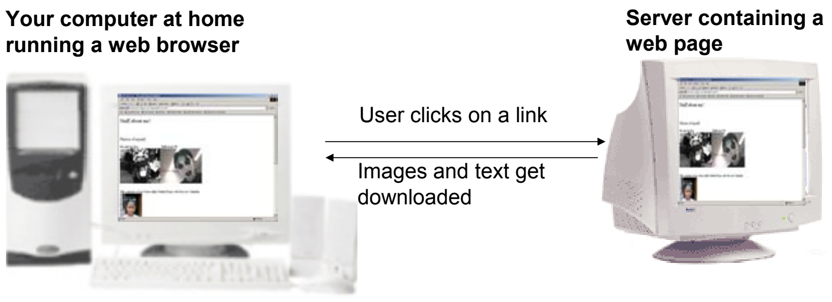
Java: History (6)

- The concept of intelligent devices didn't catch on.
- Project Green and work on the Java language was nearly canceled.



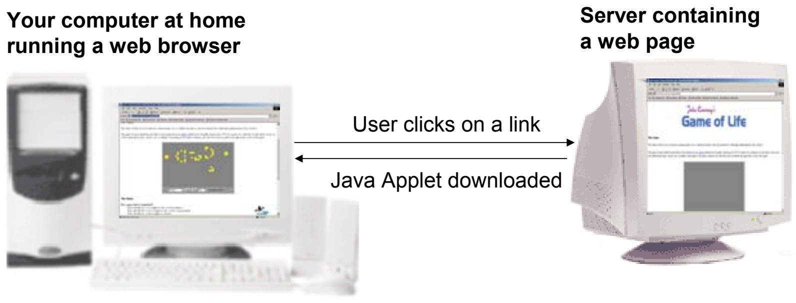
Java: History (7)

- The popularity of the Internet resulted in Sun's re-focusing of Java on computers.
- Prior to the advent of Java, web pages allowed you to download only text and images.


Your computer at home running a web browser
Server containing a web page
User clicks on a link
Images and text get downloaded

Java: History (8)

- Java enabled web browsers allowed for the downloading of programs (Applets).
- Java is still used in this context today:
  - Facebook
  - Hotmail

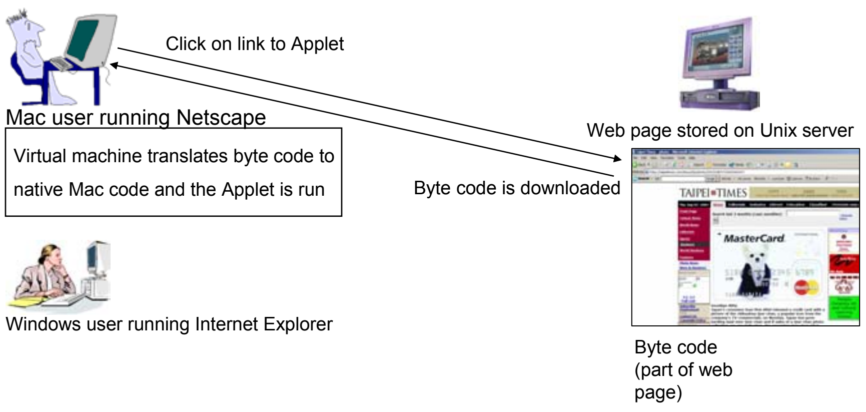

Your computer at home running a web browser
Server containing a web page
User clicks on a link
Java Applet downloaded
Game of Life

Java version of the Game of Life: http://www.bitstorm.org/gameoflife/

Online checkers: http://www.darkfish.com/checkers/index.html

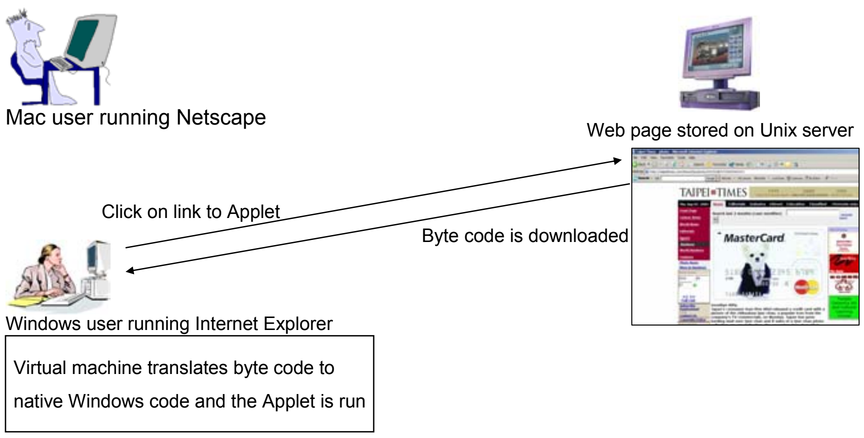
Java: Write Once, Run Anywhere

- Consequence of Java's history: platform-independence


Click on link to Applet
Mac user running Netscape
Virtual machine translates byte code to native Mac code and the Applet is run
Windows user running Internet Explorer
Web page stored on Unix server
Byte code is downloaded
Byte code (part of web page)
TAIPEI TIMES
MasterCard

Java: Write Once, Run Anywhere

- Consequence of Java's history: platform-independent


Mac user running Netscape
Web page stored on Unix server
Click on link to Applet
Byte code is downloaded
Windows user running Internet Explorer

Virtual machine translates byte code to native Windows code and the Applet is run

Java: Write Once, Run Anywhere (2)

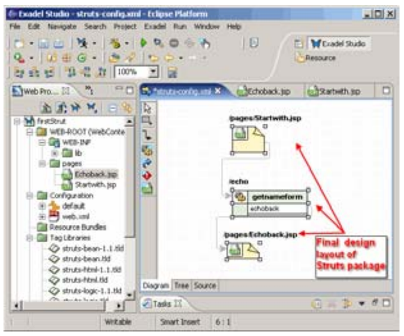
- But Java can also create standard (non-web based) programs

Dungeon Master (Java version)

http://www.cs.pitt.edu/~alandale/dmjava/

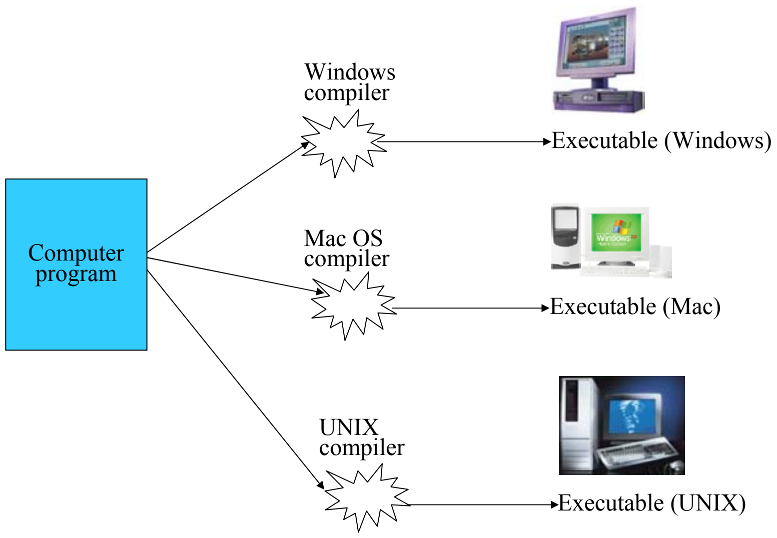
Java: Write Once, Run Anywhere (3)

- Java has been used by large and reputable companies to create serious stand-alone applications.
- Example:
  - Eclipse[1]: started as a programming environment created by IBM for developing Java programs. The program Eclipse was itself written in Java.

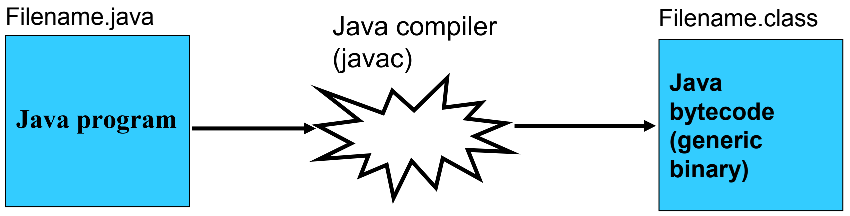


1 For more information: http://www.eclipse.org/downloads/

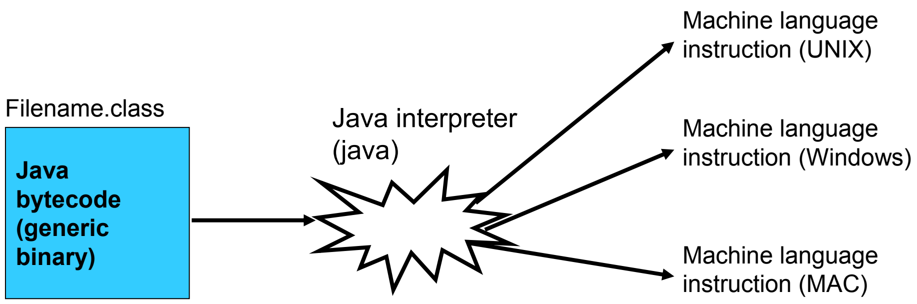
Compiled Programs With Different Operating Systems



A High Level View Of Translating/Executing Java Programs



A High Level View Of Translating/Executing Java Programs (2)


Filename.class
Java bytecode (generic binary)
Java interpreter (java)
Machine language instruction (UNIX)
Machine language instruction (Windows)
Machine language instruction (MAC)

Which Java?

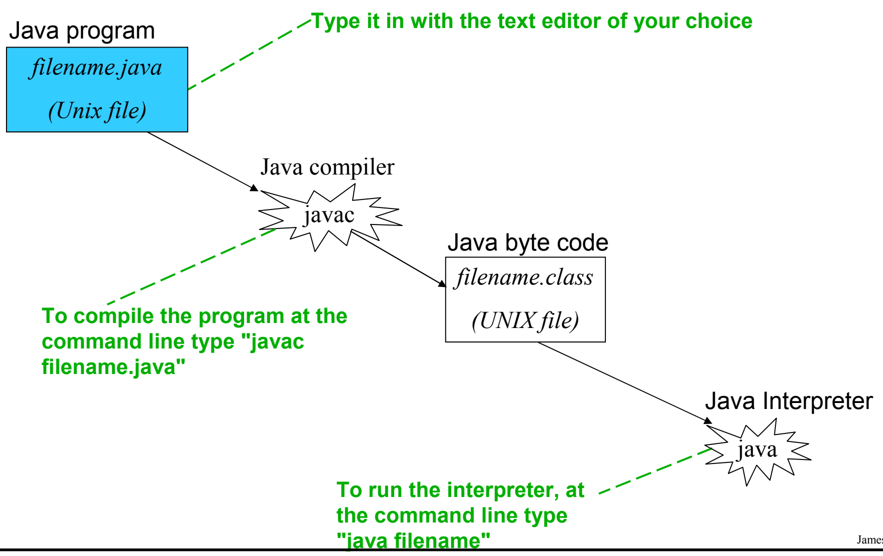
- Java 6 JDK (Java Development Kit), Standard Edition includes:
  - JDK (Java development kit) – for developing Java software (creating Java programs.
  - JRE (Java Runtime environment) – only good for running pre-created Java programs.
    - Java Plug-in – a special version of the JRE designed to run through web browsers.

http://java.sun.com/javase/downloads/index.jsp

Smallest Compilable And Executable Java Program

```
public class Smallest
{
   public static void main (String[] args)
   {
   }
}
```

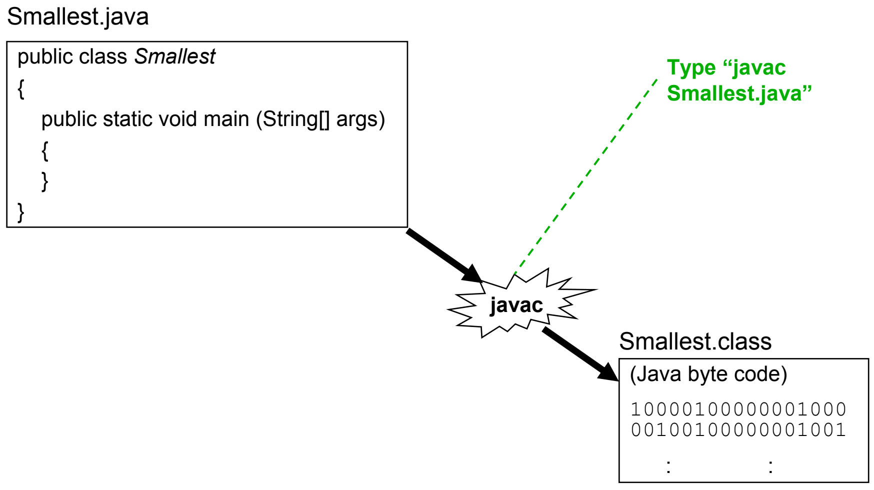
Creating, Compiling And Running Java Programs On The Computer Science Network


Java program
filename.java
(Unix file)
Type it in with the text editor of your choice
Java compiler
javac
To compile the program at the command line type "javac filename.java"
Java byte code
filename.class
(UNIX file)
Java Interpreter
java
To run the interpreter, at the command line type "java filename"

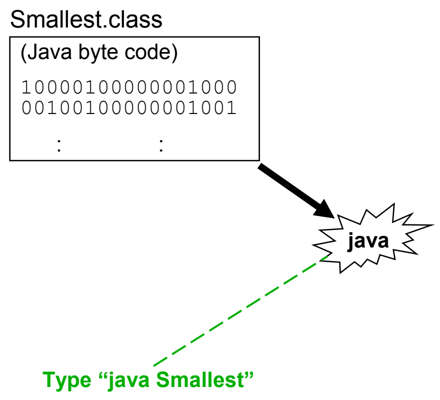
Compiling The Smallest Java Program

Smallest.java

```
public class Smallest
{
   public static void main (String[] args)
   {
   }
}
```



Running The Smallest Java Program



Documentation / Comments

Java

- Multi-line documentation
  - /* Start of documentation
  - */ End of documentation
- Documentation for a single line
  - //Everything until the end of the line is a comment

Java Output

- **Format:**

```
System.out.println(<string or variable name one> + <string or variable name two>..);
```

- **Examples** (Assumes a variable called 'num' has been declared.):

```
System.out.println("Good-night gracie!");
System.out.print(num);
System.out.println("num=" +num);
```

Output : Some Escape Sequences For Formatting

Escape sequence	**Description**
\t	Horizontal tab
\r	Carriage return
\n	New line
\”	Double quote
\\	Backslash

Declaring Variables

- **Format:**
  - It's the same structure that's used with 'C' variables.

Some Built-In Types Of Variables In Java

Type	**Description**
byte	8 bit signed integer
short	16 but signed integer
int	32 bit signed integer
long	64 bit signed integer
float	32 bit signed real number
double	64 bit signed real number
char	16 bit Unicode character
boolean	1 bit true or false value
String	A sequence of characters between double quotes ("")

Location Of Variable Declarations

```
public class <name of class>
{
   public static void main (String[] args)
   {
          // Local variable declarations occur here

          << Program statements >>
                 :            :

   }
}
```

Java Constants

Format:

final <*constant type*> <*CONSTANT NAME*> = <*value*>;

Example:

```
final int SIZE = 100;
```

Location Of Constant Declarations

```
public class <name of class>
{
   public static void main (String[] args)
   {
          // Local constant declarations occur here
          // Local variable declarations

          < Program statements >>
                        :           :

   }
}
```

James Tam

Java Keywords

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

James Tam

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
1	expression++ expression--	Post-increment Post-decrement	Right to left
2	++expression --expression + - ! ~ (type)	Pre-increment Pre-decrement Unary plus Unary minus Logical negation Bitwise complement Cast	Right to left

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
3	* / %	Multiplication Division Remainder/modulus	Left to right
4	+ -	Addition or String concatenation Subtraction	Left to right
5	<< >>	Left bitwise shift Right bitwise shift	Left to right

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
6	< <= > >=	Less than Less than, equal to Greater than Greater than, equal to	Left to right
7	= = !=	Equal to Not equal to	Left to right
8	&	Bitwise AND	Left to right
9	^	Bitwise exclusive OR	Left to right

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
10	|	Bitwise OR	Left to right
11	&&	Logical AND	Left to right
12	||	Logical OR	Left to right

Common Java Operators / Operator Precedence

Precedence level	Operator	Description	Associativity
13	=	Assignment	Right to left
	+=	Add, assignment	
	-=	Subtract, assignment	
	*=	Multiply, assignment	
	/=	Division, assignment	
	%=	Remainder, assignment	
	&=	Bitwise AND, assignment	
	^=	Bitwise XOR, assignment	
	|=	Bitwise OR, assignment	
	<<=	Left shift, assignment	
	>>=	Right shift, assignment	

Post/Pre Operators

```
public class Example1
{
   public static void main (String [] args)
   {
      int num = 5;
      System.out.println(num);
      num++;
      System.out.println(num);
      ++num;
      System.out.println(num);
      System.out.println(++num);
      System.out.println(num++);
   }
}
```

Getting Text Input

- You can use the pre-written methods (functions) in the Scanner class.
- **General structure**:

```
import java.util.Scanner;


main (String [] args)
{
    Scanner <name of scanner> = new Scanner (System.in);
    <variable> = <name of scanner> .<method> ();
}
```

Getting Text Input (2)

- **Example**:

```
import java.util.Scanner;

public class MyInput
{
    public static void main (String [] args)
    {
        String str1;
        int num1;
        char ch;
        Scanner in = new Scanner (System.in);
        System.out.print ("Type in an integer: ");
        num1 = in.nextInt ();
        System.out.print ("Type in a line: ");
        in.nextLine ();
        str1 = in.nextLine ();
        System.out.println ("num1:" +num1 +"\t str1:" + str1);
    }
}
```

Useful Methods Of Class Scanner[1]

- nextInt ()
- nextLong ()
- nextFloat ()
- nextDouble ()

1 Online documentation: http://java.sun.com/javase/6/docs/api/

Decision Making In Java

- Java decision making constructs
  - if
  - if, else
  - if, else-if
  - switch

Decision Making: Logical Operators

Logical Operation	C	Java
AND	&&	&&
OR	||	||
NOT	!	!

Decision Making: If

Format:

```
if (Boolean Expression)
   Body
```

Example:

```
if (x != y)
   System.out.println(“X and Y are not equal”);

if ((x > 0) && (y > 0))
{
    System.out.println("X and Y are positive");
}
```

Decision Making: If, Else

Format:

```
if (Boolean expression)
    Body of if
else
    Body of else
```

Example:

```
if (x < 0)
    System.out.println("X is negative");
else
    System.out.println("X is non-negative");
```

If, Else-If

Format:

```
if (Boolean expression)
    Body of if
else if (Boolean expression)
    Body of first else-if
        :       :     :
else if (Boolean expression)
    Body of last else-if
else
    Body of else
```

If, Else-If (2)

Example:

```
if (gpa == 4)
{
    System.out.println("A");
}
else if (gpa == 3)
{
    System.out.println("B");
}
else if (gpa == 2)
{
    System.out.println("C");
}
```

If, Else-If (2)

```
else if (gpa == 1)
{
        System.out.println("D");
 }
 else
 {
        System.out.println("Invalid gpa");
 }
```

Alternative To Multiple Else-If's: Switch (2)

Format (character-based switch):

```
switch (character variable name)
{
   case '<character value>':
       Body
       break;

   case '<character value>':
       Body
       break;
          :
  default:
      Body
}
```

1 The type of variablein the brackets can be a byte, char, short, int or long

Alternative To Multiple Else-If's: Switch (2)

Format (integer based switch):

```
switch (integer variable name)
{
   case <integer value>:
       Body
       break;

   case <integer value>:
       Body
       break;
          :
  default:
      Body
}
```

1 The type of variablein the brackets can be a byte, char, short, int or long

Loops

Java Pre-test loops

- For
- While

Java Post-test loop

- Do-while

While Loops

Format:

```
while (Expression)
   Body
```

Example:

```
int i = 1;
while (i <= 1000000)
{
     System.out.println("How much do I love thee?");
     System.out.println("Let me count the ways: ", + i);
     i = i + 1;
}
```

For Loops

Format:

```
for (initialization; Boolean expression; update control)
    Body
```

Example:

```
for (i = 1; i <= 1000000; i++)
{
     System.out.println("How much do I love thee?");
     System.out.println("Let me count the ways: " + i);
}
```

Do-While Loops

Format:

```
do
    Body
while (Boolean expression);
```

Example:

```
 char ch = 'A';
 do
{
     System.out.println(ch);
     ch++;
 }
 while (ch != 'K');
```

Many Pre-Created Classes Have Been Created

- Rule of thumb: Before writing new program code to implement the features of your program you should check to see if a class has already been written that has methods that already implement those features.
- The Java API is Sun Microsystems's collection of pre-built Java classes:
  - http://java.sun.com/javase/6/docs/api/

Arrays

- Java arrays are very similar to arrays in C:
  - Indexed from 0 to (size – 1).
  - They must be homogeneous (each element contains the same type of information).
- However they differ in one very important fashion:
  - Java arrays always involve the dynamic allocation of memory (similar to using 'malloc' or 'alloc' in 'C').
  - An array variable is not actually an array but instead it is a reference to an array.
    - A reference is similar to a pointer and contains a memory address but unlike a pointer low level operations such as "address of"/& and "de-referencing" of the pointer using the '*' aren't possible. De-referencing is automatically done as needed depending upon the context.

Arrays (2)

- This also means that while the size of the array in 'C' must generally be determined when the program is written (at compile time a constant determines the size) with Java arrays the size can be determined at runtime (the value stored in a variable can determine the size).

Arrays (3)

•**Format** (declaring a reference to an array):
<*Type in each element*> [] <*array name*>;

•**Example** (declaring a reference to an array):

```
int [] arr;
```

Arrays (4)

•**Format** (creating an array by allocating memory):

<*array name*> = new <*Type in each element*> [<*array size*>];

•**Example** (declaring a reference to an array):

```
arr  = new int [4];
```

Of course the two steps could be combined into one step:

```
int [] arr = new int [4];
```

Arrays (5)

•The complete program can be found in UNIX under:

/home/courses/219/examples/java_intro/MyArray.java

```
Scanner in = new Scanner (System.in);
int [] arr;
int size;
int i;
System.out.print ("Type in the size of the array: ");
size = in.nextInt ();
arr = new int [size];
for (i =0; i < size; i++)
{
  arr[i] = i;
  System.out.print(arr[i] + " ");
}
System.out.println();
```

Arrays: Null References

```
int [] arr = null;
arr[0] = 1;
```

NullPointerException

After This Section You Should Now Know

- How Java was developed and the impact of it's roots on the language
- The basic structure required in creating a simple Java program as well as how to compile and run programs
- How to document a Java program
- How to perform text based input and output in Java
- The declaration of constants and variables
- What are the common Java operators and how they work
- The structure and syntax of decision making and looping constructs
- How to declare and manipulate arrays