Data Types, Variables and Arrays (Chapter 3 of Schilit)

Object Oriented Programming BS (CS/SE) II

By

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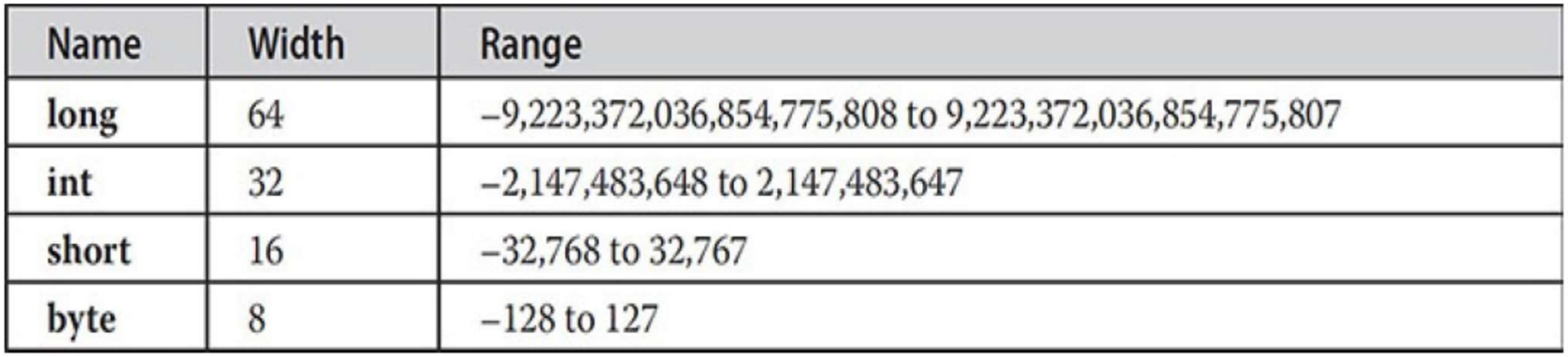
Java is Strongly Typed Language

- Compiler is the Boss
  - Every Declaration must have a data type

Primitive Types

- Integer
  - byte → short → int → long
- Floating point numbers
  - float → double
- Character
  - char
- Boolean
  - boolean

Integer

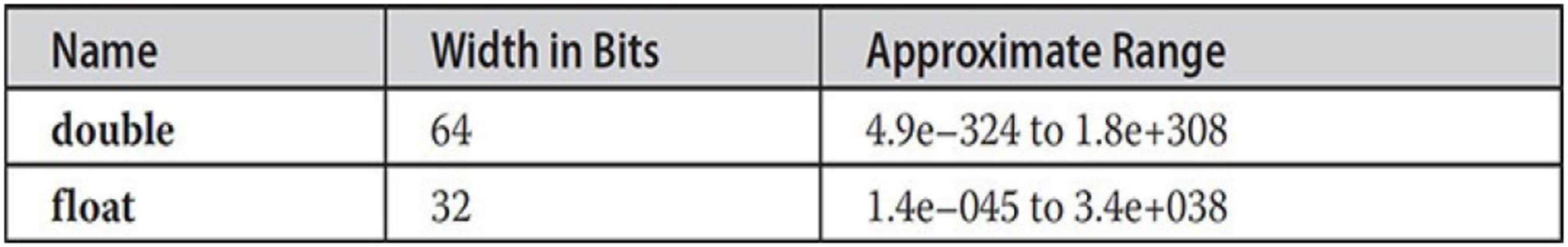


Name	Width	Range
long	64	–9,223,372,036,854,775,808 to 9,223,372,036,854,775,807
int	32	–2,147,483,648 to 2,147,483,647
short	16	–32,768 to 32,767
byte	8	–128 to 127

Code: “LightTravel”

- How many mile light travels in 1000 days? Remember it travels 186000 miles/second

Floating Point Type



Name	Width in Bits	Approximate Range
double	64	4.9e–324 to 1.8e+308
float	32	1.4e–045 to 3.4e+038

Code: FloatingValues

- Input bowling speed in miles and return km.

Character

- char var1=‘G’;
- char var2=‘O’;
- char var3=‘O’;
- char var4=‘D’;
- Print them using single print statement
- Concatenation?
- Storing inside a string variable?

One possible Solution

```
str = String.valueOf(a)+String.valueOf(b)+String.valueOf(c);
```

Try it with your name

Boolean

- boolean b1=true/false;

- Take an integer number as input from user
- If the number is multiple of 2, set the flag variable to True
- Now If the flag is True print Multiple of 2 otherwise print not a multiple of 2

Memory

- All the primitive types get memory from stack

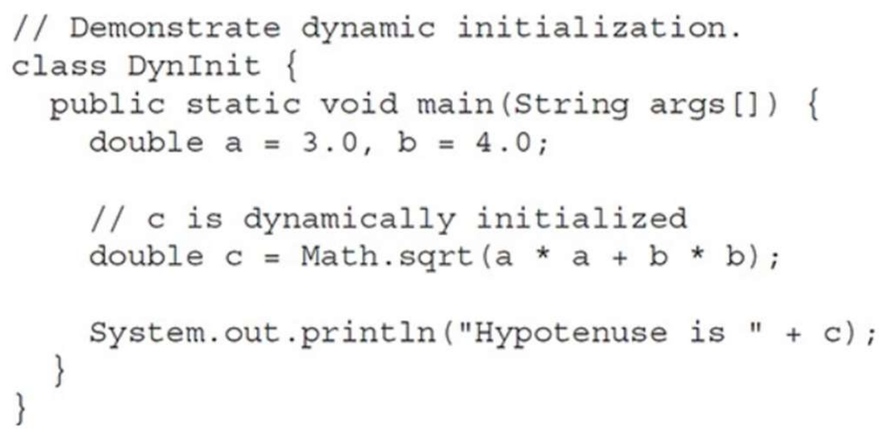
Declaring Variables

- Declaring a variable is for:
  - Setting the identifier
  - Type of value
  - Initial value that it takes
  - Exp: int a;   , char c;   , boolean b;

Declare a variable and print it without assigning any values

Dynamic Initialization

- Use of Math class
- Values are not always assigned as a constant, there could be a method call etc



```
// Demonstrate dynamic initialization.
class DynInit {
  public static void main(String args[]) {
    double a = 3.0, b = 4.0;

    // c is dynamically initialized
    double c = Math.sqrt(a * a + b * b);

    System.out.println("Hypotenuse is " + c);
  }
}
```

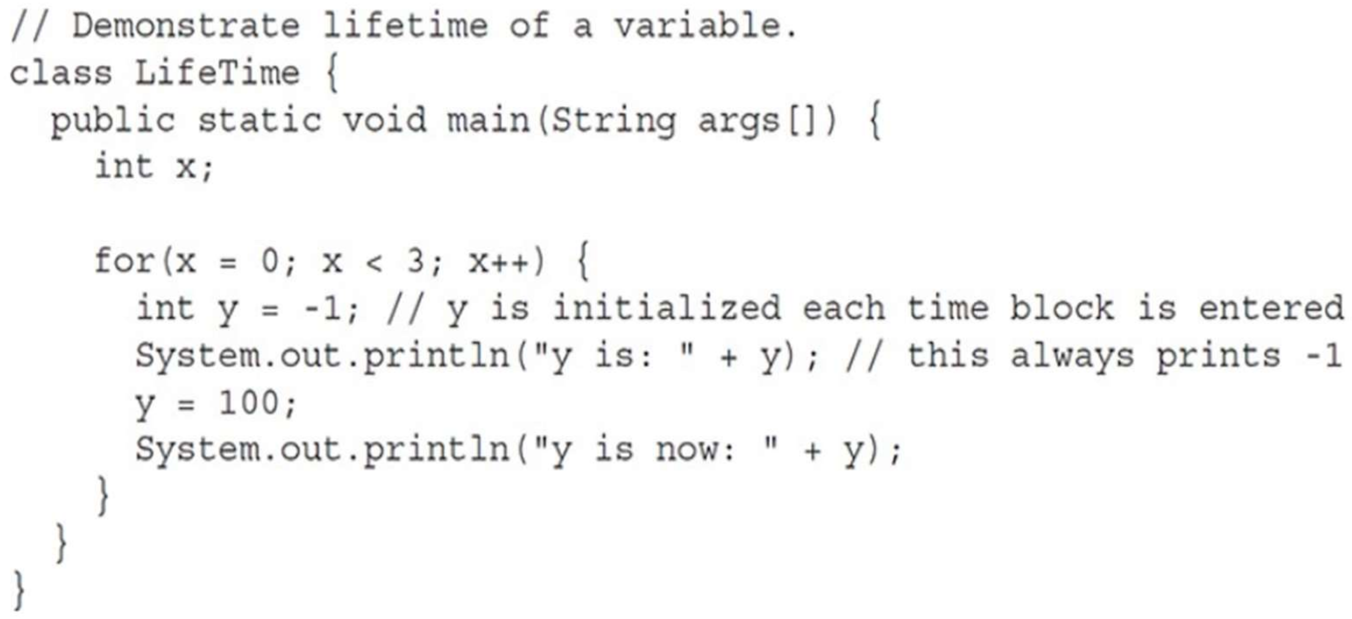
Scope and lifetime of a variable

- Scope defines the visibility of your variable along with its lifetime
- A block defines a new scope
- Method’s scope is within curly braces:
  - Defining a variable inside method limits its scope to outside world
  - Concept of Local Variable

Scope

```
// Demonstrate block scope.
class Scope {
  public static void main(String args[]) {
    int x; // known to all code within main

    x = 10;
    if(x == 10) { // start new scope
      int y = 20; // known only to this block

      // x and y both known here.
      System.out.println("x and y: " + x + " " + y);
      x = y * 2;
    }
    // y = 100; // Error! y not known here

    // x is still known here.
    System.out.println("x is " + x);
  }
}
```

Lifetime



```
// Demonstrate lifetime of a variable.
class LifeTime {
  public static void main(String args[]) {
    int x;

    for(x = 0; x < 3; x++) {
      int y = -1; // y is initialized each time block is entered
      System.out.println("y is: " + y); // this always prints -1
      y = 100;
      System.out.println("y is now: " + y);
    }
  }
}
```

Same name issue

```
// This program will not compile
class ScopeErr {
  public static void main(String args[]) {
    int bar = 1;
    {               // creates a new scope
      int bar = 2;  // Compile-time error - bar already defined!
    }
  }
}
```

Arrays

- Grouping of related(homogenous) data
- Each element is accessed:
  - Via Index (starting from zero)

Array Declaration

type var-name[ ];

```
int month_days[];
```

Allocation of memory with new

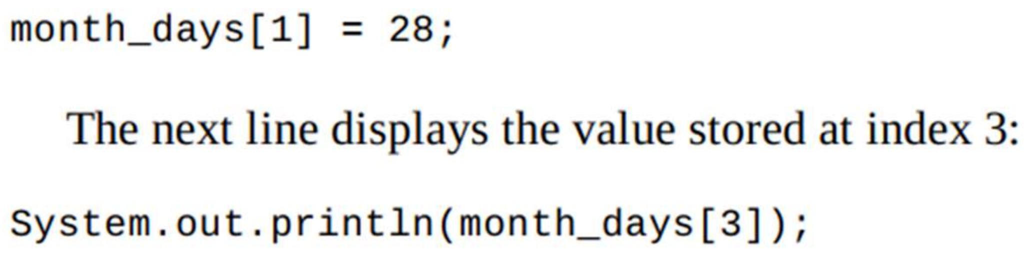
array-var = new *type* [*size*];

```
month_days = new int[12];
```

Access without assigning values to array elements

- Numeric data types with a zero value
- Boolean with false
- Reference types with null values

Assigning and printing values

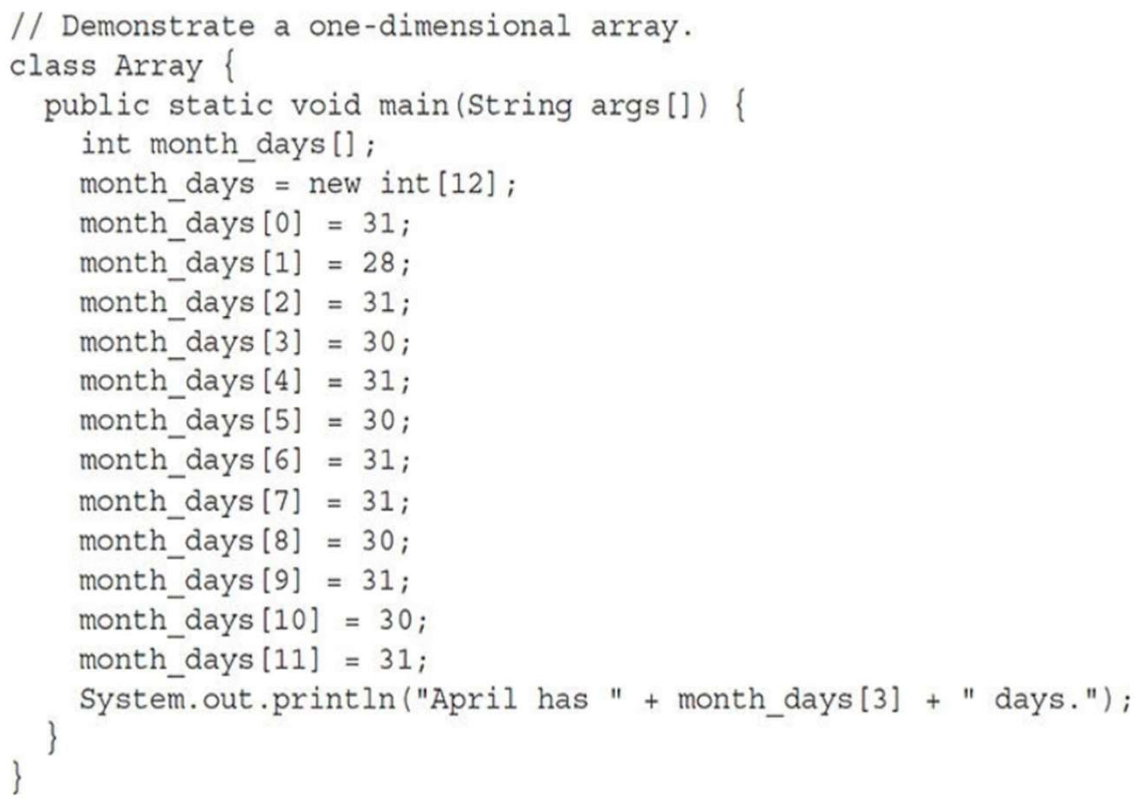


```
month_days[1] = 28;
```

The next line displays the value stored at index 3:

```
System.out.println(month_days[3]);
```

Putting it all to gather



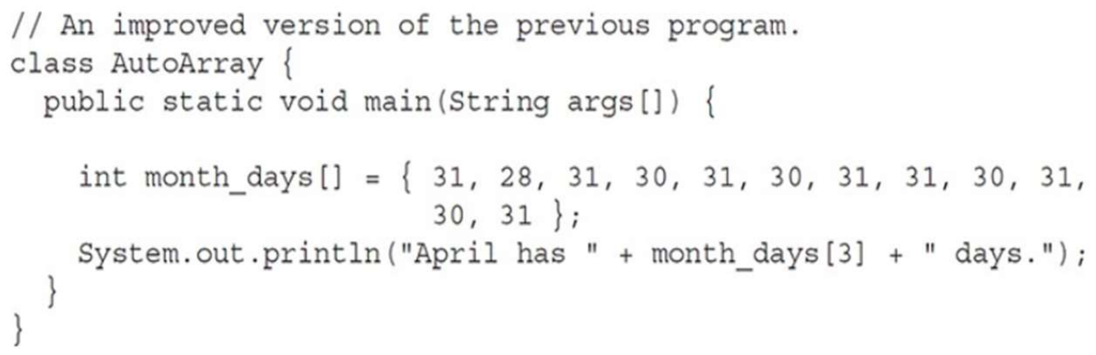
```
// Demonstrate a one-dimensional array.
class Array {
  public static void main(String args[]) {
    int month_days[];
    month_days = new int[12];
    month_days[0] = 31;
    month_days[1] = 28;
    month_days[2] = 31;
    month_days[3] = 30;
    month_days[4] = 31;
    month_days[5] = 30;
    month_days[6] = 31;
    month_days[7] = 31;
    month_days[8] = 30;
    month_days[9] = 31;
    month_days[10] = 30;
    month_days[11] = 31;
    System.out.println("April has " + month_days[3] + " days.");
  }
}
```

Combine declaration and allocation

```
int month_days[] = new int[12];
```

Array Initializer

- List of comma separated values, surrounded by curly braces
- Array size auto decided, according to number of elements



```java
// An improved version of the previous program.
class AutoArray {
  public static void main(String args[]) {

    int month_days[] = { 31, 28, 31, 30, 31, 30, 31, 31, 30, 31,
                         30, 31 };
    System.out.println("April has " + month_days[3] + " days.");
  }
}
```

Write array program to store months in year

Write Average Program using array of 5 elements, using array Initializer and new keyword

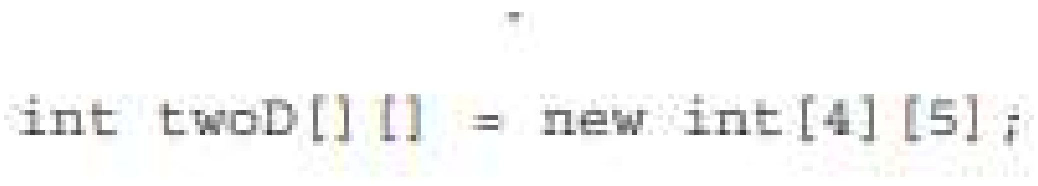
Arrays Task

- Write a program using arrays:
  - Create student_names array which holds names of any 5 students, the names will be input by the user
  - Create student_marks array which holds marks of those 5 students, again input by the user
  - Print it in following format

Name	Marks
Ali	50
Ahmed	60

Multidimensional Arrays

- Array of Arrays
- Normally we will stick to 2D Array

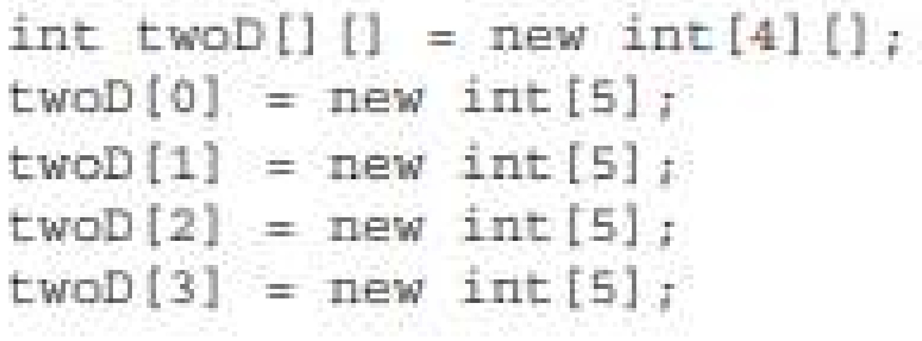


```
int twoD[][] = new int[4][5];
```

Code Demonstration

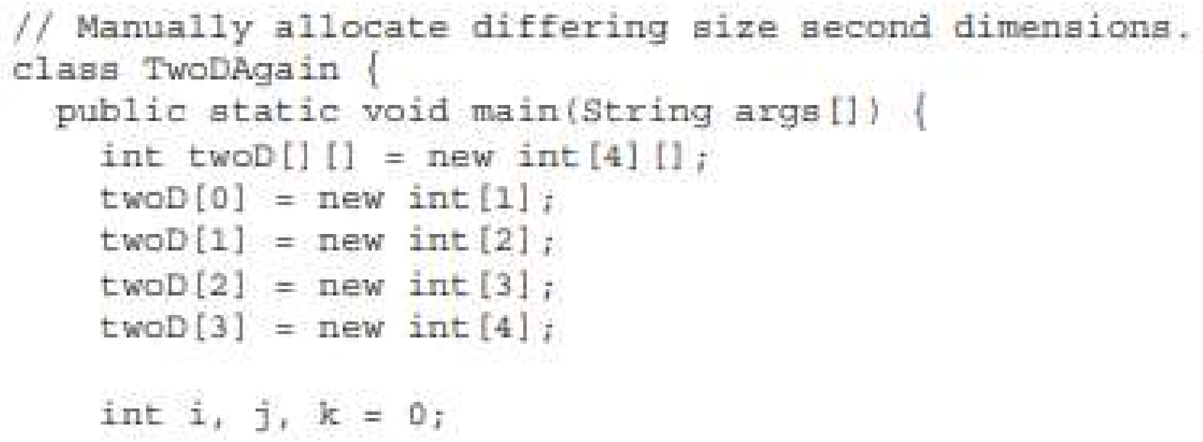
```
// Demonstrate a two-dimensional array.
class TwoDArray {
  public static void main(String args[]) {
    int twoD[][]= new int[4][5];
    int i, j, k = 0;

    for(i=0; i<4; i++)
      for(j=0; j<5; j++) {
        twoD[i][j] = k;
        k++;

     }

    for(i=0; i<4; i++) {
      for(j=0; j<5; j++)
        System.out.print(twoD[i][j] + " ");
      System.out.println();
    }
  }
}
```

Allocate second Dimension Manually



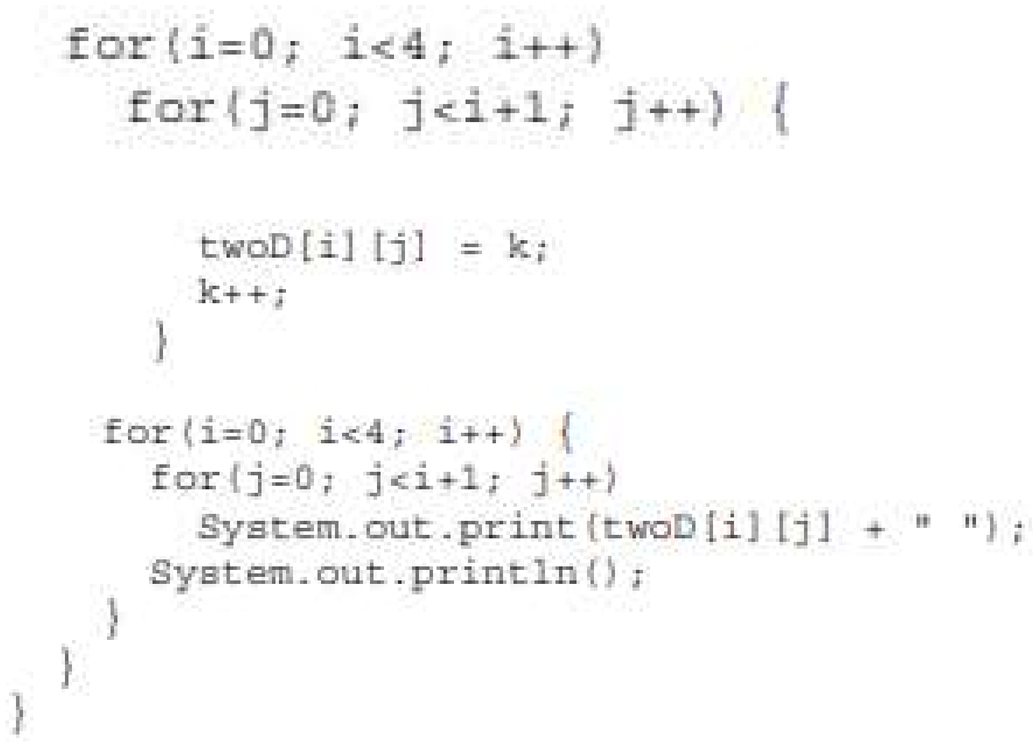
```
int twoD[][] = new int[4][];
twoD[0] = new int[5];
twoD[1] = new int[5];
twoD[2] = new int[5];
twoD[3] = new int[5];
```

Example



```
// Manually allocate differing size second dimensions.
class TwoDAgain {
  public static void main(String args[]) {
    int twoD[][] = new int[4][];
    twoD[0] = new int[1];
    twoD[1] = new int[2];
    twoD[2] = new int[3];
    twoD[3] = new int[4];

    int i, j, k = 0;
```

Example contd.

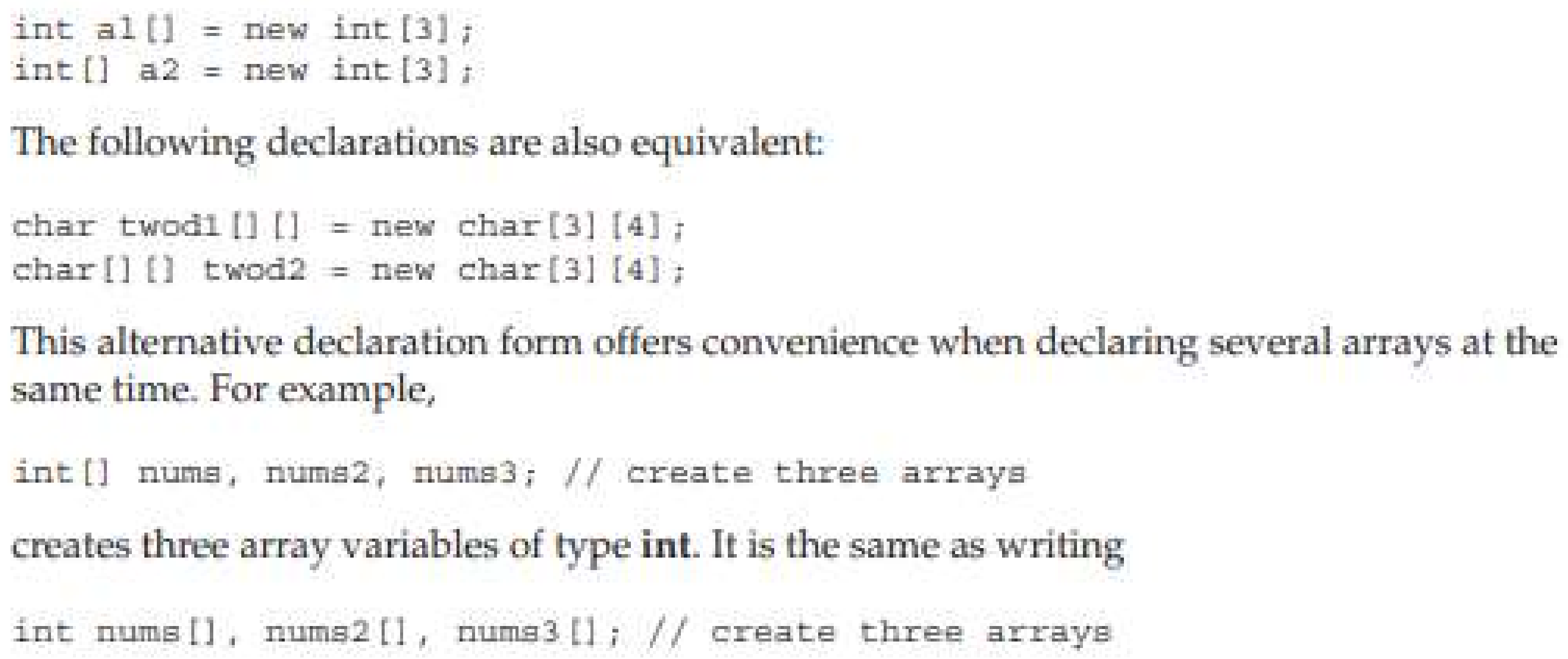


```
  for(i=0; i<4; i++)
    for(j=0; j<i+1; j++) {

        twoD[i][j] = k;
        k++;
      }

    for(i=0; i<4; i++) {
      for(j=0; j<i+1; j++)
        System.out.print(twoD[i][j] + " ");
      System.out.println();
    }
  }
}
```

Type this code

```
// Demonstrate a three-dimensional array.
class ThreeDMatrix {
  public static void main(String args[]) {
    int threeD[][][] = new int[3][4][5];
    int i, j, k;

    for(i=0; i<3; i++)
      for(j=0; j<4; j++)
        for(k=0; k<5; k++)
          threeD[i][j][k] = i * j * k;

    for(i=0; i<3; i++) {
      for(j=0; j<4; j++) {
        for(k=0; k<5; k++)
          System.out.print(threeD[i][j][k] + " ");
        System.out.println();
      }
      System.out.println();
    }
  }
}
```

Alternatives



```
int a1[] = new int[3];
int[] a2 = new int[3];
```

The following declarations are also equivalent:

```
char twod1[][] = new char[3][4];
char[][] twod2 = new char[3][4];
```

This alternative declaration form offers convenience when declaring several arrays at the same time. For example,

```
int[] nums, nums2, nums3; // create three arrays
```

creates three array variables of type **int**. It is the same as writing

```
int nums[], nums2[], nums3[]; // create three arrays
```

Arrays

- Declaration
- Initialization
- Multi Dimensional Arrays

Strings

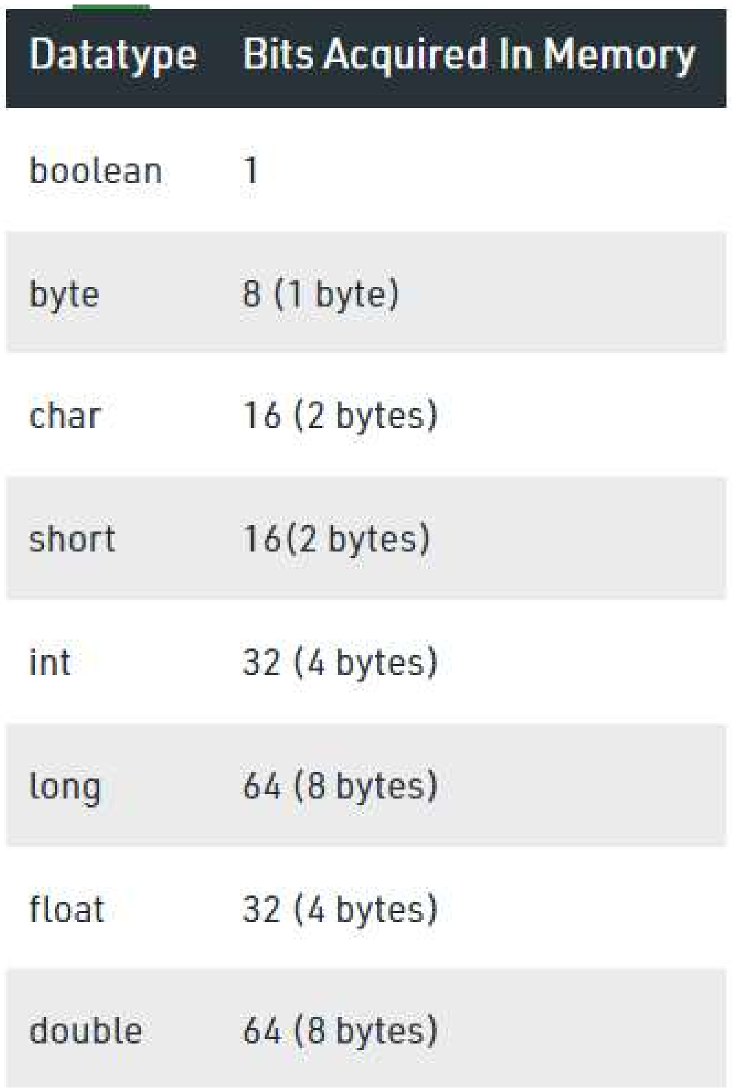
- Not a primitive type
- Rather it is an object in java

Copying Arrays

- Copying One Array to Other
- = operator
- Loop to copy

Type conversion

- You assign a value of one data type to another:
  - Two types might not be compatible or might be
- If Data types are compatible:
  - Java will perform the conversion automatically known as Automatic Type Conversion
- If not then they need to be cast or converted explicitly.
  - For example, assigning an int value to a long variable.



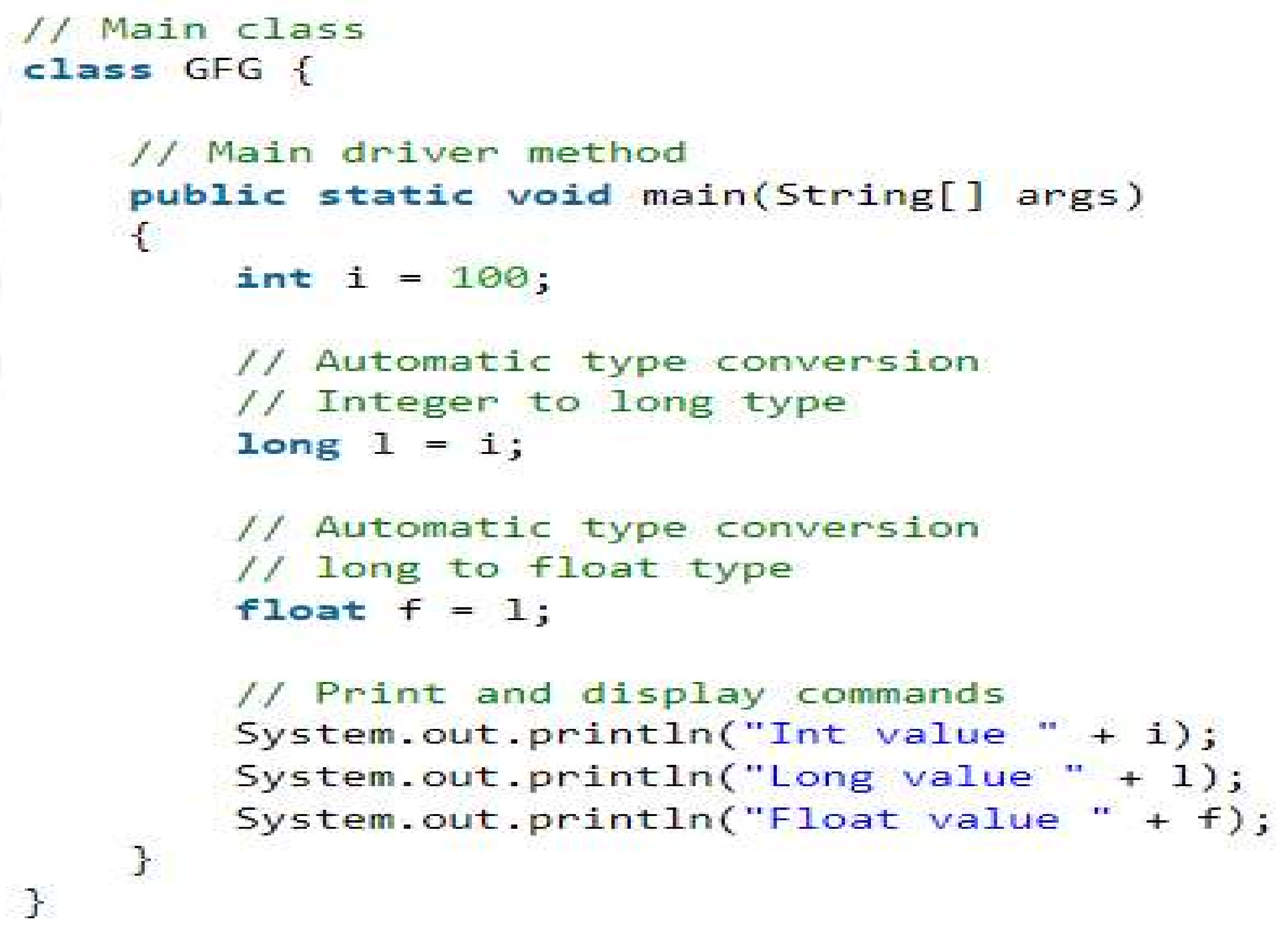
Datatype	Bits Acquired In Memory
boolean	1
byte	8 (1 byte)
char	16 (2 bytes)
short	16(2 bytes)
int	32 (4 bytes)
long	64 (8 bytes)
float	32 (4 bytes)
double	64 (8 bytes)

Widening or Automatic Type Conversion

- Automatically done by Java
- When:
  - Two Data Types are compatible
    - Like numeric types
    - Numeric to boolen or char is incompatible
  - Assign the value of smaller dtype to bigger dtype

Byte –> Short –> Int –> Long – > Float –> Double

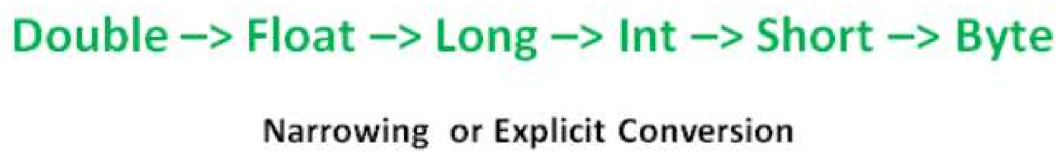
Widening or Automatic Conversion



```java
// Main class
class GFG {

    // Main driver method
    public static void main(String[] args)
    {
        int i = 100;

        // Automatic type conversion
        // Integer to long type
        long l = i;

        // Automatic type conversion
        // long to float type
        float f = l;

        // Print and display commands
        System.out.println("Int value " + i);
        System.out.println("Long value " + l);
        System.out.println("Float value " + f);
    }
}
```

Narrowing or Explicit conversion

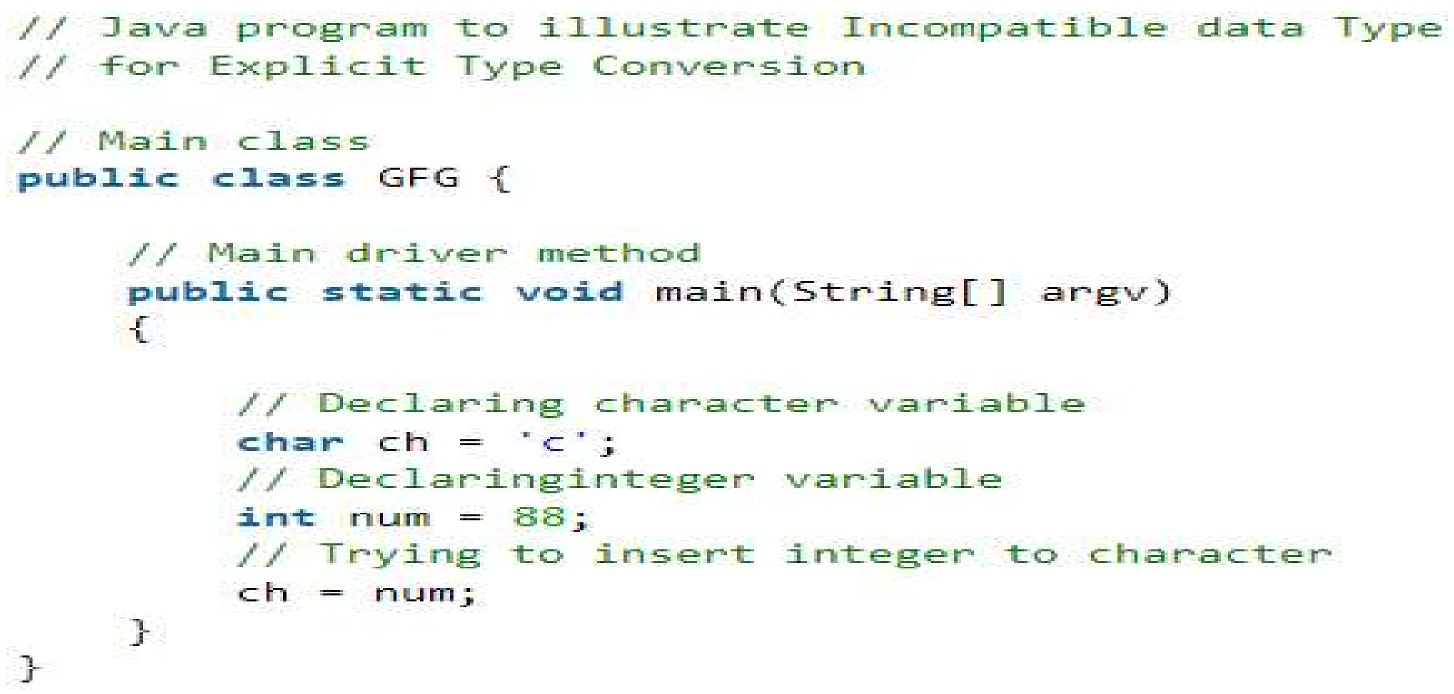
- Larger data type to Smaller Data type:
    - Useful for incompatible types



Double –> Float –> Long –> Int –> Short –> Byte

Narrowing or Explicit Conversion

Error (int 4 bytes, char 2 bytes)



```
// Java program to illustrate Incompatible data Type
// for Explicit Type Conversion

// Main class
public class GFG {

    // Main driver method
    public static void main(String[] argv)
    {

        // Declaring character variable
        char ch = 'c';
        // Declaringinteger variable
        int num = 88;
        // Trying to insert integer to character
        ch = num;
    }
}
```

```java
// Main class
public class GFG {

    // Main driver method
    public static void main(String[] args)
    {

        // Double datatype
        double d = 100.04;

        // Explicit type casting by forcefully getting
        // data from long datatype to integer type
        long l = (long)d;

        // Explicit type casting
        int i = (int)l;
```