Review Repetition Structure

Write a program to receive an non-negative integer and display 0,1,2 to the input.

1) Use while loop
2) Use for loop

Write a program to receive an non-negative integer and display 1,2,3 to the input.

1) Use while loop
2) Use for loop

Write a program to receive an non-negative integer and display 2,4,6 to the input.

1) Use while loop
2) Use for loop

Write a program to receive an non-negative integer and display 1,3,5 to the input.

1) Use while loop
2) Use for loop

Write a program to receive an non-negative integer and display the integer divisor of the input.

1) Use while loop
2) Use for loop

Array


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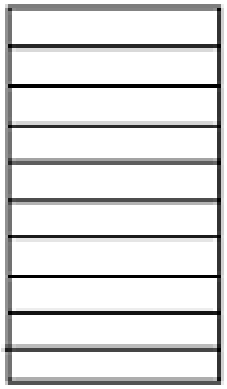
Arrays
One name for many data

- An *array* is a named sequence of contiguous memory locations capable of holding a *collection* of data of the same type.
- Unlike the variables of previous programs, an array can store *more than one* value.
- An array can store a list of thousands or even millions of data

A variable in contrast to an array

a variable: storage for one value



an array: contiguous memory storage for many values.

Array Declaration

- `type[] name:`
  - type is a *data type* such a int, char, double or boolean
  - name is a valid Java identifier that provides a name to an array

- `int[] myArray` and `double[] yourArray`:
  - The variables myArray and yourArray are *reference* variables.
  - A *reference* variable does not hold an integer, a floating point number, a character or a boolean value.
  - A reference variable holds *a memory address*.

Array Declaration

- Java provides two types of variable primitive and reference:
  - A primitive variable stores a *single* value of type byte, short, int, long, float, double, boolean, or char.
  - A reference variable holds a memory address or reference.

- Each of the two variables `myArray` and `yourArray`, when assigned a value, holds
  - a memory address
    - the address of the *first* cell of a block of storage locations

Array Instantiation

- The references `myArray` and `yourArray` are *uninitialized*.
- A declaration does not *create* an array.
- Once an array reference is declared
  - memory for the array must be allocated.

Array Instantiation

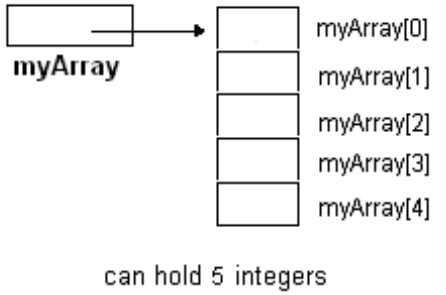
- An array is created or instantiated via the new operator:

```
type[] name;              // declaration
name = new type[size];          // array instantiation
       or
type[] name = new type[size]  // declaration and
             // instantiation
```

- type is a data type
- size is a positive integer or any expression that evaluates, or is automatically converted, to a positive integer.
- The integer size indicates the *length* of the array, i.e., the number of cells in the array.

Array Instantiation

- The values held in an array must all be the *same data type*.
- When an array is created, each cell is automatically given a *unique name* .
- The names of the cells of the array referenced by `myArray` are `myArray[0], myArray[1], myArray[2], myArray[3], and myArray[4]`
- In this case, the array is indexed from 0 to 4
- The first index of every array is 0.



Array Instantiation

- When an array is instantiated, each memory cell is initialized with the "*zero value*" of its data type.

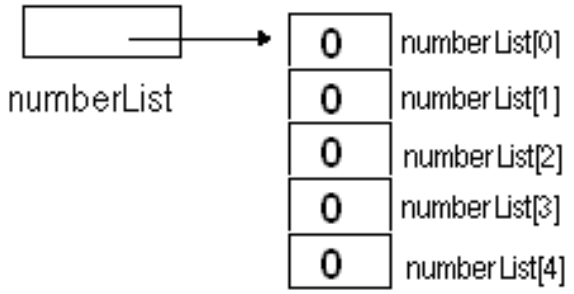
- Thus every cell of an array of `int` or `char` data is initialized to *0* and all cells of an array of `doubles` are set to *0.0*.

- Each cell of a `boolean` array is initialized to `false`.

Array Instantiation

```
int [] numberList;
numberList = new double[5];
```

- **********
- numberList refers to an array of 5 integers
- Each array cell is initialized to 0



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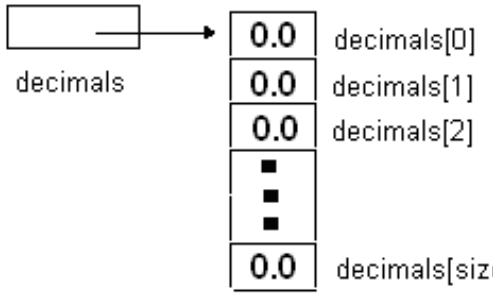
Array Instantiation

```
System.out.println("Enter array size:  ");
int size = input.nextInt();
double [] decimals;
decimals = new double[size];
**********
```

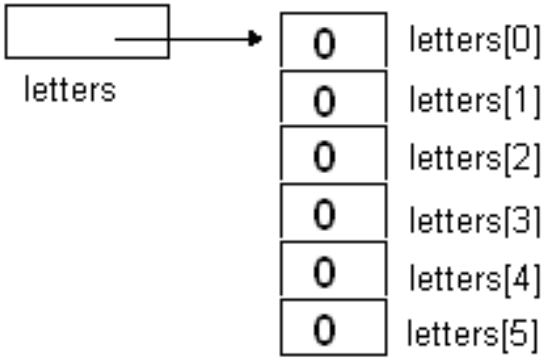
- The length of the array (size) is supplied at runtime
  The name decimals refers to an array of d
- Each memory cell is initialized to 0.0.



Array Instantiation

```
int x = 3;
char [] letters = new char[2*x];
```

- **********
- letters refers to an array of char data.
- Each memory cell is i



Array Instantiation

- Once an array is created, its length is *fixed*.
- The length of an array cannot be *altered*.
- If variable `x` refers to an array, then `x.length` gives the number of memory cells allocated to the array.

Using an Array

- You can use array variables in assignment statements or any expression.
- The statement:

```
int[] numbers = new int[5]
```

- declares and instantiates an array named numbers such that:
  - numbers is indexed from 0 to 4.
  - numbers is capable of storing 5 integers in locations numbers[0], numbers[1], numbers[2], numbers[3], and numbers[4].
  - numbers.length has the value 5.
  - the initial value stored in each cell of numbers is 0.

Using an Array

- Each memory cell is a variable:

```
numbers[0] = input.nextInt();                // reads a value into numbers[0]

numbers[1] = 213 + numbers[1];               // adds 213 to numbers[1]

System.out.println(5*numbers[1] + 3*numbers[0]);
```

Using an Array

Program statement:

- Write a program that prompts for 10 integers and displays those same numbers in reverse order. For example, if you enter the numbers:

0 11 2 33 4 55 6 77 8 99

the program's output is:

99 8 77 6 55 4 33 2 11 0

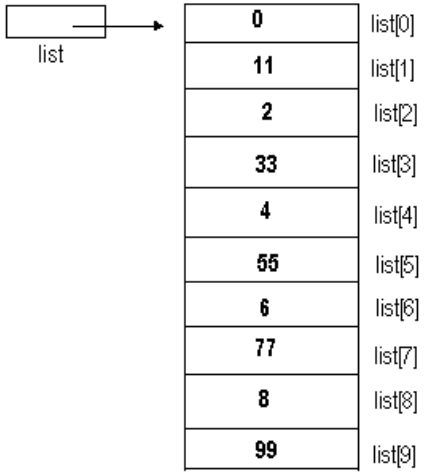
Solution

- The following application stores 10 integers in an array named list.
- The array consists of 10 memory cells that are named list[0], list[1]...list[9]. The user supplies 10 numbers.
- The numbers are stored in these 10 cells and finally, the numbers are displayed in reverse order.

```
1. import java.util.*;
2. public class ReverseList
3. {
4.     public static void main(String[] args)
5.     {
6.         Scanner input = new Scanner(System.in);
7.         int [] list;    // declare list an array variable
8.         list = new int[10]; //instantiate or create an array named list
9.         System.out.print("Enter 10 integers: ");
10.         // read values into list[0], list[1],..,list[9]
11.         for (int i= 0; i < 10; i++)
12.             list[i] = input.nextInt();
13.         System.out.print("List in reverse : ");
14.         //print values stored in list[9], list[8], … , list[0]
15.         for (int i= 9; i >= 0; i--)
16.             System.out.print(list[i] + " ");
17.         System.out.println();
18.     }
19.}
```

Discussion

- The program prompts for 10 integers. After the data is entered (lines 11-12):



- The array list holds 10 integers.
- The individual memory cells are designated list[0], list[1], list[2], ... , list[8], and list[9]

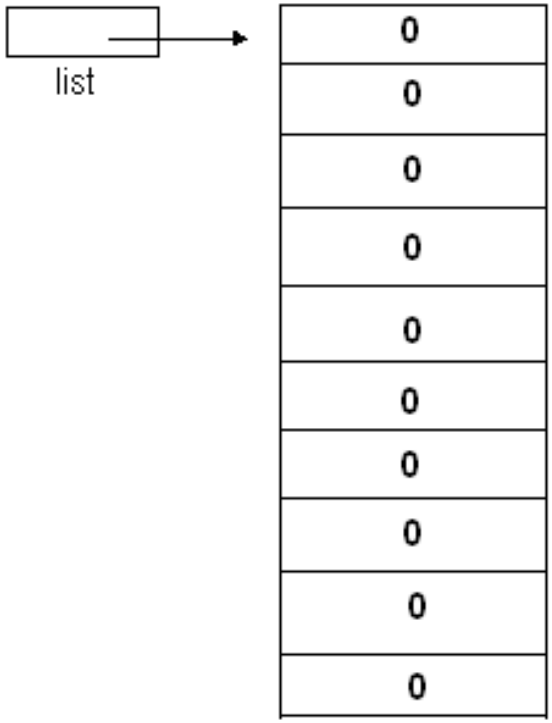
Discussion

- Line 7: `int [] list;`
  Line 7 is an array declaration as indicated by the square brackets [].
- Like any variable, list must be *declared* before its use.
- The statement on line 7 declares that list is a reference variable
- The declaration does not assign a value to list.
- No memory has been *allocated* yet; no array *exists* yet.
-

Discussion

- `Line 8: list = new int[10];`
- The segment `new int[10]` *allocates* a block of memory large enough to store ten integers
  - returnsthe starting address of this memory chunk.
- The new operator *creates or instantiates* a new array.
- The operator reserves a *consecutive* block of storage locations in memory
  - return the starting address of the block. All are initialized to 0:

list

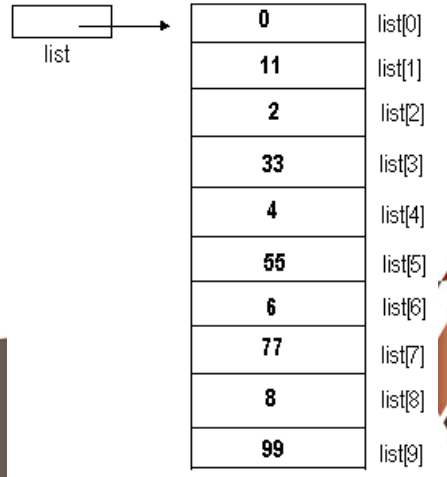


Discussion

- Lines 11 and 12:

```
for (int i= 0; i < 10; i++)
    list[i] = input.nextInt();
```

Lines 11 and 12 comprise a for loop that accepts interactive input and stores the values in list[0], list[1], list[2], list[3], list[4], list[5], list[6], list[7], list[8], and list[9].



Discussion

- Lines 15 and 16:

```
for (int i= 9; i >= 0; i--)
System.out.print(list[i] + " ");
```

  - The for loop prints the array items in reverse.: list[9], list[8], …, and list[0].

Activity

- Group of two or three people
- Write source code to create this array

1.1
2.2
3.2
4.5
5.4

Array Initialization

- Java provides a convenient form of array initialization.
- The following code segment declares and explicitly initializes an array of characters:

```
char letters[] = {'a', 'b', 'c'};
```

- The new operator is not *explicitly* used.
- This initialization of letters is equivalent to:

```
char letters[] ;
letters = new char[3];
letters[0] = 'a';
letters[1] = 'b';
letters[2] = 'c';
```

-
- .

Array Initialization

- Similarly:

```
int squares = {0,1,4,9,16,25,36,49,64,81,100};
```

is shorthand for:

```
int squares = new int[11];
for (int i= 0; i<11; i++ )
squares[i] = i*i;
```

- Explicit method of array initialization is *convenient*
  - only when the size of the array is not particularly large

The = Operator

- The assignment operator (=) can be used with array references, but such use can lead to some unexpected results and subtle bugs:

```
int [] a = {5,4,3,2,1};
int [] b = new int[5];  // initialized to 0's
b = a;
a[0] = 100;
System.out.println(" a[0] is " + a[0]+
                   " and b[0] is " +b[0]);
```

-

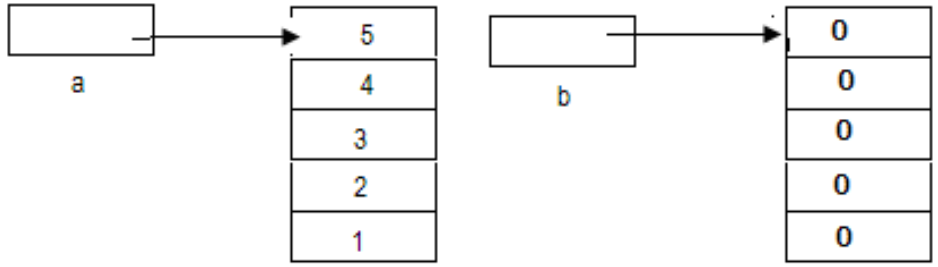
Output:

a[0] is 100 and b[0] is 100

- Both a[0] and b[0] are 100.
- a and b are both *references*, i.e., a and b each holds a *single address*.

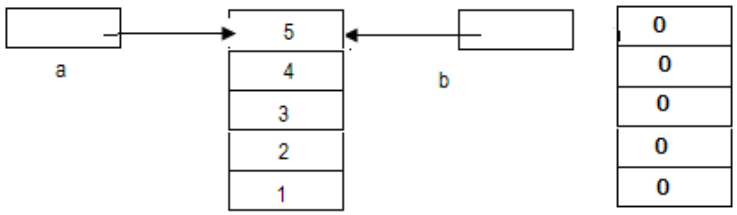
The = Operator

```
int a = {5,4,3,2,1}
int b = new int[5]
```



The = Operator

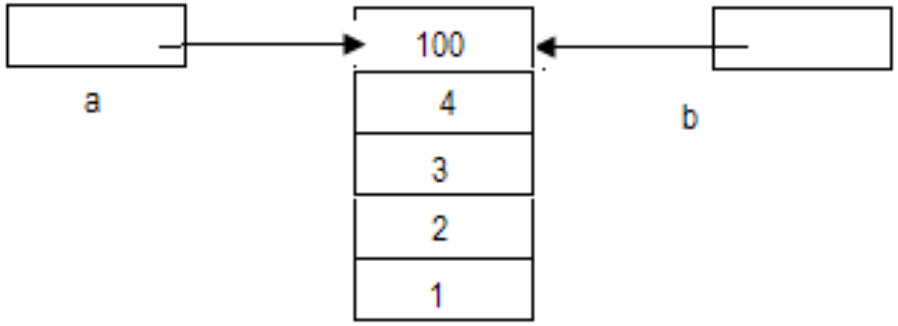
```
b = a
```



After the assignment b=a

The = Operator

```
B[0] = 100;
```



After executing the assignment b=a, the references a and b both refer to the same memory and any changes to a[i] affect b[i].

The == Operator

- The == operator does not *compare* the contents of the arrays; the == operator compares references.

```
int[]  a = {5,4,3,2,1};
int[]  b = {5,4,3,2,1};
int[]  c = a;
```

- The expression `a == b` is false because a and b hold different references
- `a == c` evaluates to true.

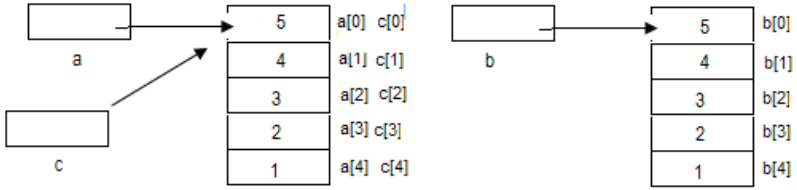


Figure 7.13 Comparing array references

Example

- Create a program to read 5 integers from user and display the highest value, the lowest value and the average of the list.

Example

- Create a program to read 10 doubles from user. Then, the inputs two doubles. The second input will replace the first value in the list.

Example

- Create a program to receive 2 sequences of 5 integers. Display both of them and copy the first set to the second sequence and display them.

Example

- Create a program to receive a sequence of 10 doubles. Then, receive an double and display if the input is in the list or not.

Example

- Create a program to receive a sequence of 10 doubles. Then, receive an double and display the number of value that is larger than or equal to the input.

Example

- Create a program to receive the list of 5 student's weight and display who is the highest.

Example

- Create a program to random 10 non-negative integer and sort the array from the lowest to the largest.