Objects and Containers

Weng Kai
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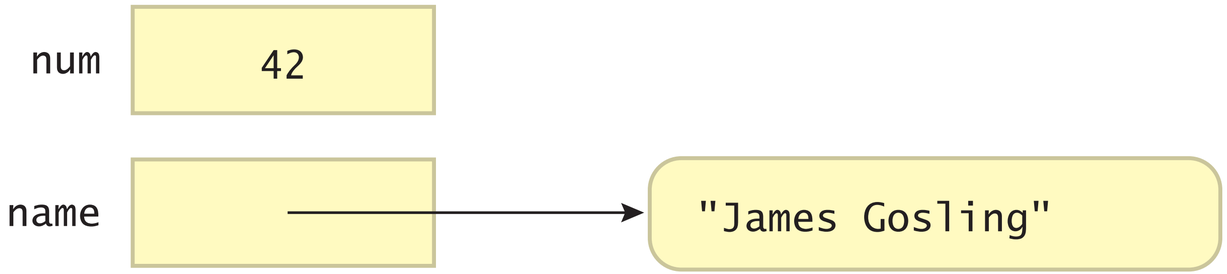
Primitive Data Types

Type	Storage	Min Value	Max Value
`byte`	8 bits	–128	127
`short`	16 bits	–32,768	32,767
`int`	32 bits	–2,147,483,648	2,147,483,647
`long`	64 bits	–9,223,372,036,854,775,808	9,223,372,036,854,775,807
`float`	32 bits	Approximately –3.4E+38 with 7 significant digits	Approximately 3.4E+38 with 7 significant digits
`double`	64 bits	Approximately –1.7E+308 with 15 significant digits	Approximately 1.7E+308 with 15 significant digits

Creating Objects

```
int num = 42;
String name =  = new String("James Gosling");
```

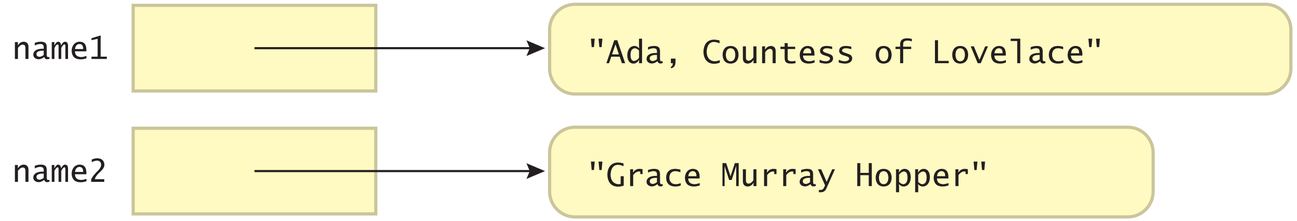
- The first declaration creates a variable that holds an integer value.
- The second declaration creates a String variable that holds a reference to a String object. An object variable doesn't hold an object itself.

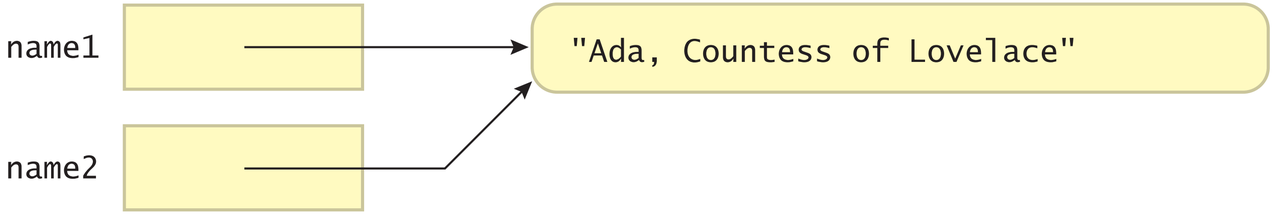


Object Variables

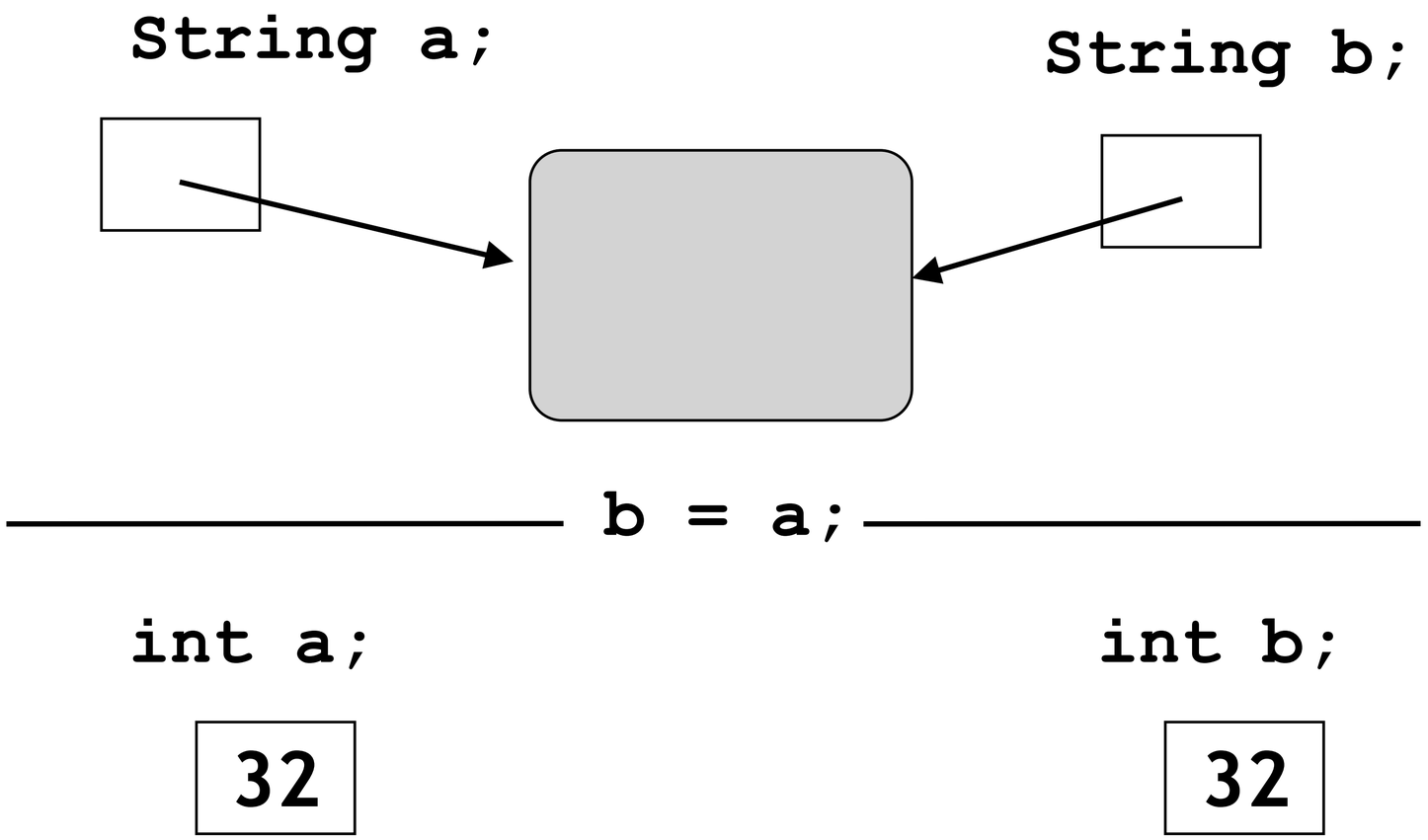
- Object variables are managers to objects.

```
String name1 = "Ada, Countess of Lovelace";
String name2 = "Grace Murray Hopper";
name2 = name1;
```





Primitive types vs. object types



To Compare Two Strings

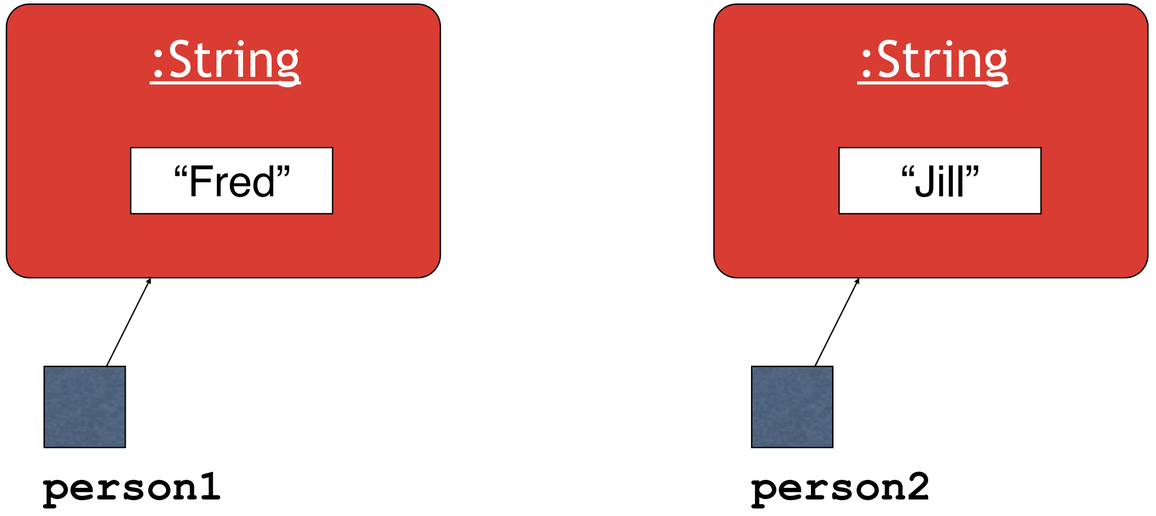
```
if(input == "bye") {
    ...
}
```

Same one?

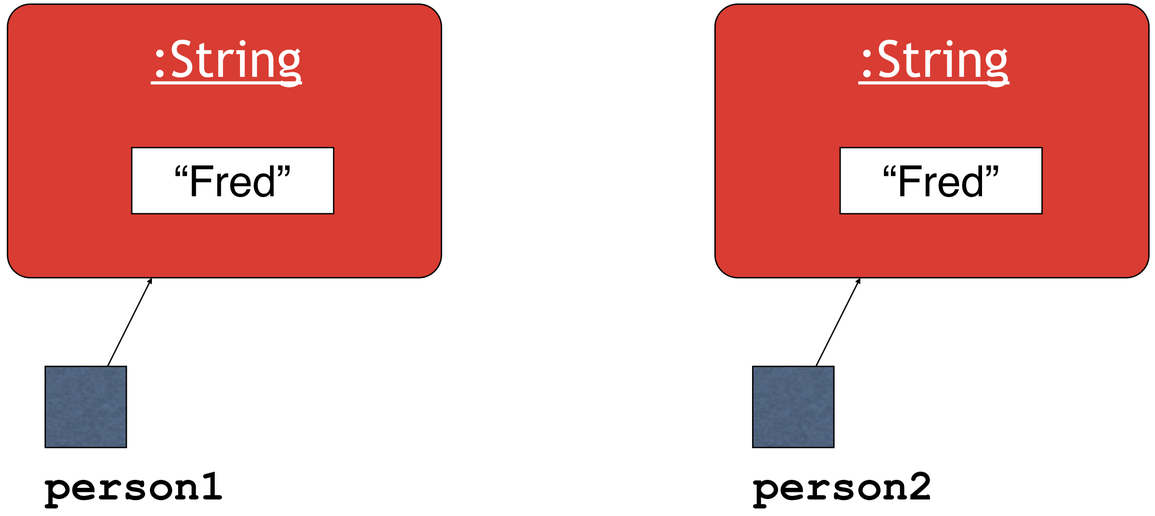
```
if(input.equals("bye")) {
    ...
}
```

Same Content?

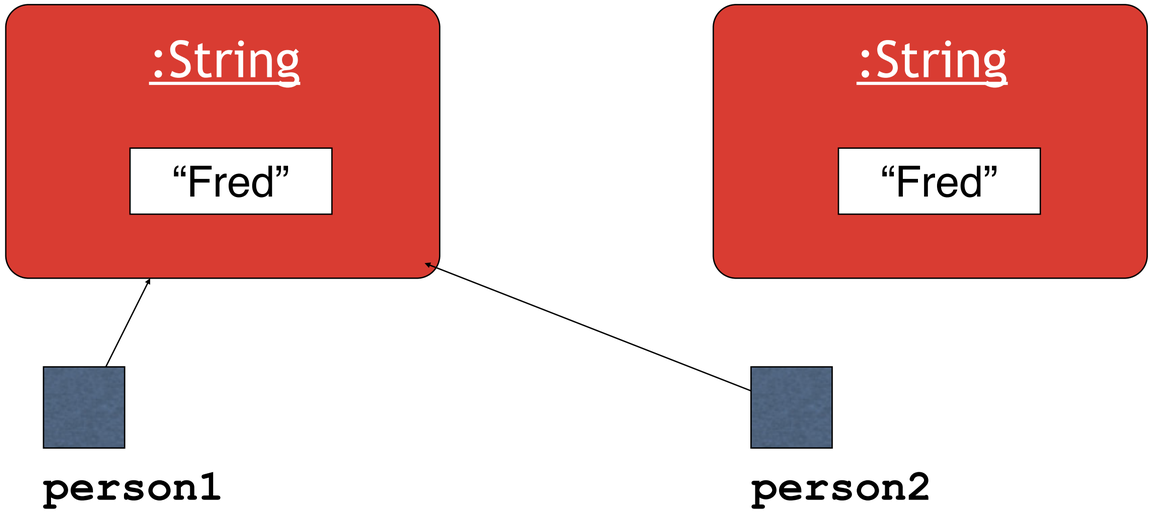
- String should be compared by .equals()




```
person1 == person2 ?
```



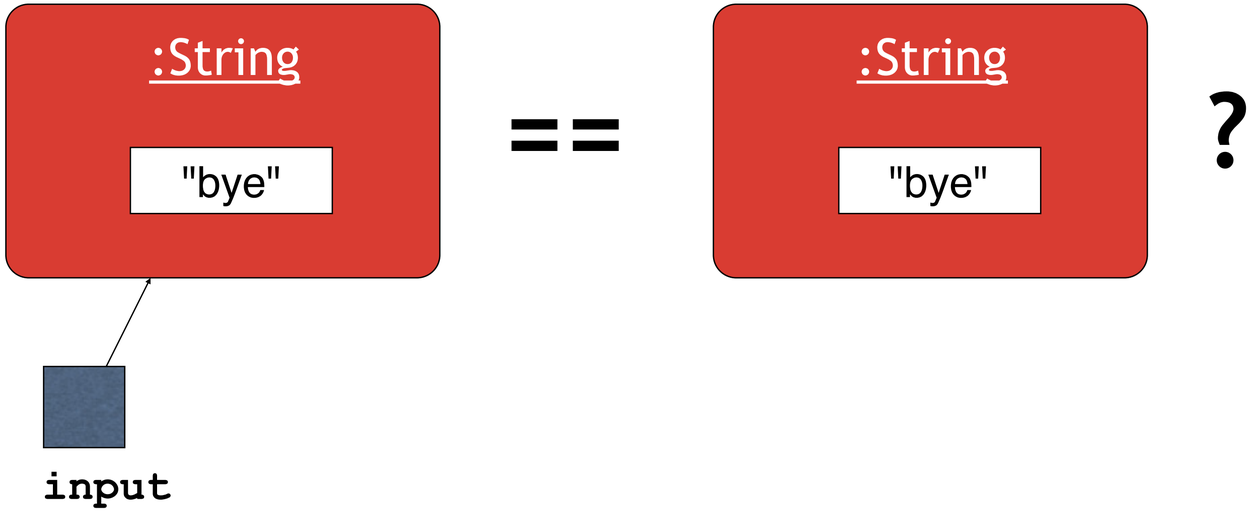

```
person1 == person2 ?
```




```
person1 == person2 ?
```

```
String input = in.next();
if(input == "bye") {
    ...
}
```

== for the same one



String Methods

```
int count = name.length();
```

- After an object has been instantiated, we use the dot operator to access its methods.

String Methods (1)

- String (String str)
  - Constructor: creates a new string object with the same characters as str.
- int length ()
  - Returns the number of characters in this string.
- int compareTo (String str)
  - Returns an integer indicating if this string is lexically before (a negative return value), equal to (a zero return value), or lexically after (a positive return value), the string str.
- boolean equals (String str)
  - Returns true if this string contains the same characters as str (including case) and false otherwise.
- boolean equalsIgnoreCase (String str)
  - Returns true if this string contains the same characters as str (without regard to case) and false otherwise.

String Methods (2)

- char charAt (int index)
  - Returns the character at the specified index.
- String concat (String str)
  - Returns a new string consisting of this string concatenated with str.
- String replace (char oldChar, char newChar)
  - Returns a new string that is identical with this string except that every occurrence of oldChar is replaced by newChar.
- String substring (int offset, int endIndex)
  - Returns a new string that is a subset of this string starting at index offset and extending through endIndex-1.

String Methods (3)

- String toLowerCase ()
  - Returns a new string identical to this string except all uppercase letters are converted to their lowercase equivalent.
- String toUpperCase ()
  - Returns a new string identical to this string except all lowercase letters are converted to their uppercase equivalent.
- String trim()
  - Returns a new string without the space before or after the string.

String Object is Immutable

- All methods can not alter the string but generate a new string object
- Assign a new string literal to a string variable is to make the variable manage the new string object

```
String s = "";
for ( int i=0; i<100; i++ ) {
    s += i;
}
```

- This code segment will create and destroy string object 100 times!

StringBuffer

```
StringBuffer sb = new StringBuffer();
for ( int i=0; i<100; i++ ) {
    sb.append(i);
}
String s = sb.toString();
```

Lab 1

- PTA 7-1, 7-2

array

- Consider the case where a programmer needs to keep track of a number of people within an organization. So far, our initial attempt will be to create a specific variable for each user. This might look like,

```
int name1 = 101;

int name2 = 232;

int name3 = 231;
```

the array way

```
int[] names = new int[4];
names[0] = 101;
names[1] = 232;
names[2] = 231;
names[3] = 0;
```

array

- An array is a special type of collection that can store a fixed number of elements.

```
int[] a;

int a[];
```

array

- Array is a data structure which hold multiple variables of the same data type
  - All elements are in the same type

a[0]	a[1]	a[2]	a[3]	a[4]	a[5]	a[6]	a[7]	a[8]	a[9]

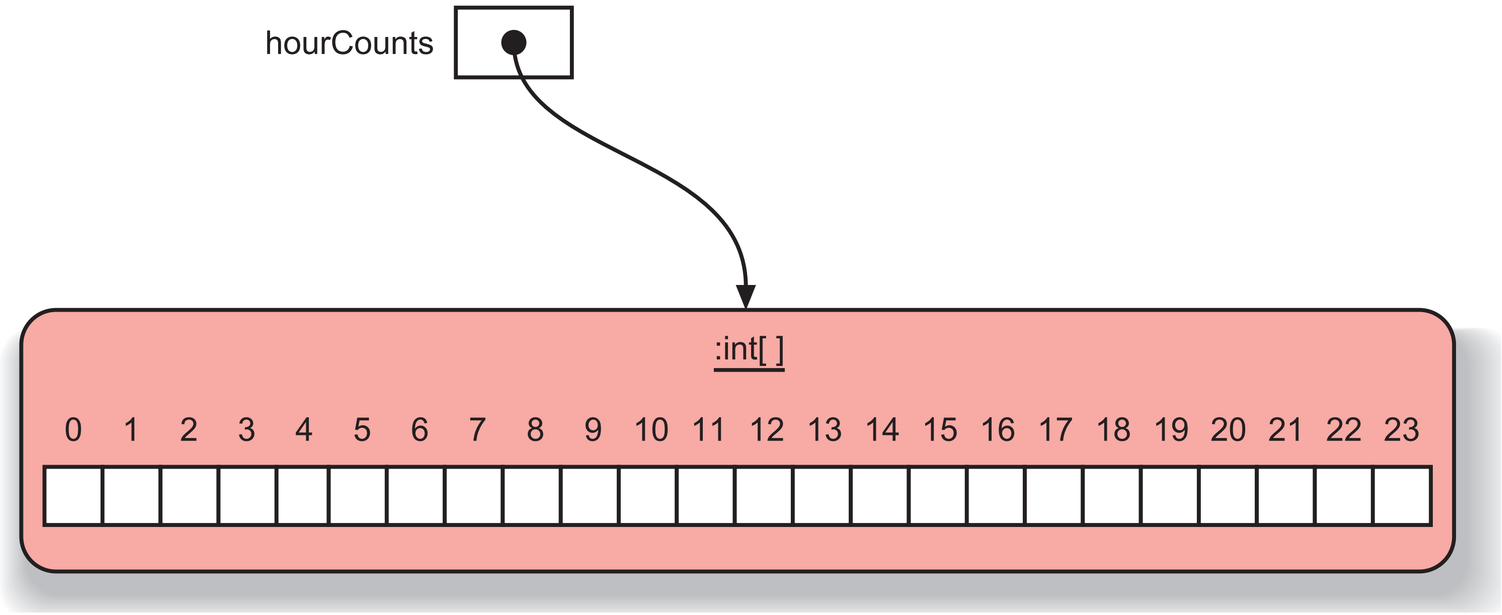
to define an array

- <type>[] <name>= new <type>[number_of_elements];
  - int[] grades= new int[100];
  - float[] averages = new int[20];

- *number_of_elements* must be an integer

create array object

- hourCounts = new int[24];



int[] a= new int[10]

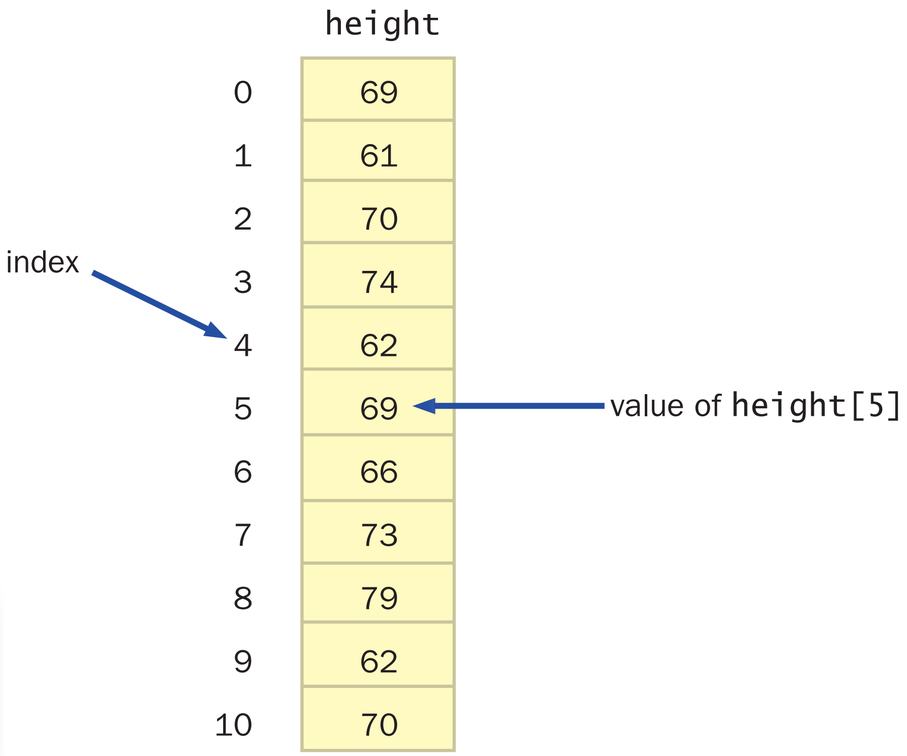
- An array of int
- 10 elements: a[0],a[1],…,a[9]

a[0]	a[1]	a[2]	a[3]	a[4]	a[5]	a[6]	a[7]	a[8]	a[9]

- Each element is an int variable
- To be right or left value:
  - a[2] = a[1]+6;

element of an array

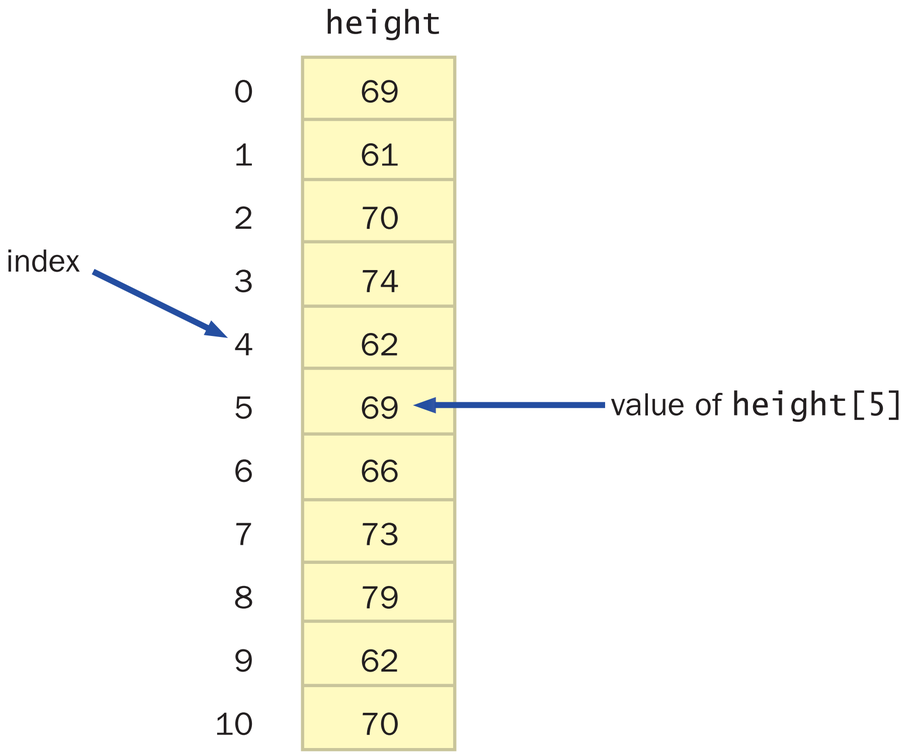
- each element is a variable of the type
- index or subscript starts from 0
  - grades[0]
  - grades[99]
  - average[5]



KEY CONCEPT

An array of size N is indexed from 0 to N–1.

Question



- Based on the array shown in Figure 8.1, what are each of the following?

1. height[1]
2. height[2] + height[5]
3. height[2 + 5]
4. the value stored at index 8
5. the fourth value
6. height.length

length

- every array has an internal member length which tells the size of the array
  - the number of elements

Valid Subscript Values

- The compiler does check to see if you use a valid subscript, wherever it is used as right or left value.
- It causes problems once the program runs, possibly corrupting data or code, possibly causing the program to abort.
- It is Java's responsibility to make sure that your program uses only valid subscript values, in the run-time.

KEY CONCEPT

Bounds checking ensures that an index used to refer to an array element is in range.

```
for ( i=0; i<100; ++i )
    sum += grade[i];
```

better to be:

```
for ( i=0; i<grade.length; ++i )
    sum += grade[i];
```

```java
public class ArrayLength {
    public static void main(String[] args) {
      int[] a = new int[(int)(Math.random()*10)];
      for ( int i=0; i<a.length; ++i )
        a[i] = (int)(Math.random()*100);
      for ( int i=0; i<a.length; ++i )
        System.out.println(a[i]);
    }
  }
}
```

initializer Lists

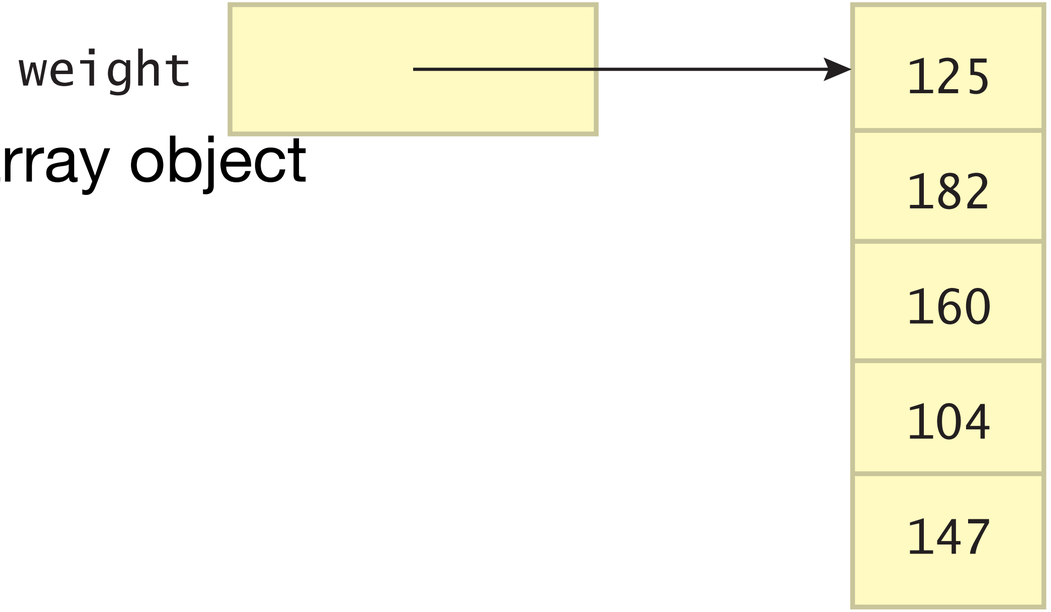
- int[] a = {1,2,3,4,5};

for-each

```
for ( <type> <variable>: <array> ) {
    variable...
}
```

```
public class ForArray {
  public static void main(String[] args) {
    int[] array = new int[(int)(Math.random()*10)+1];
    for ( int i=0; i<array.length; ++i )
      array[i] = (int)(Math.random()*100);
    for ( int value: array )
      System.out.println(value);
  }
}
```

Array Variable

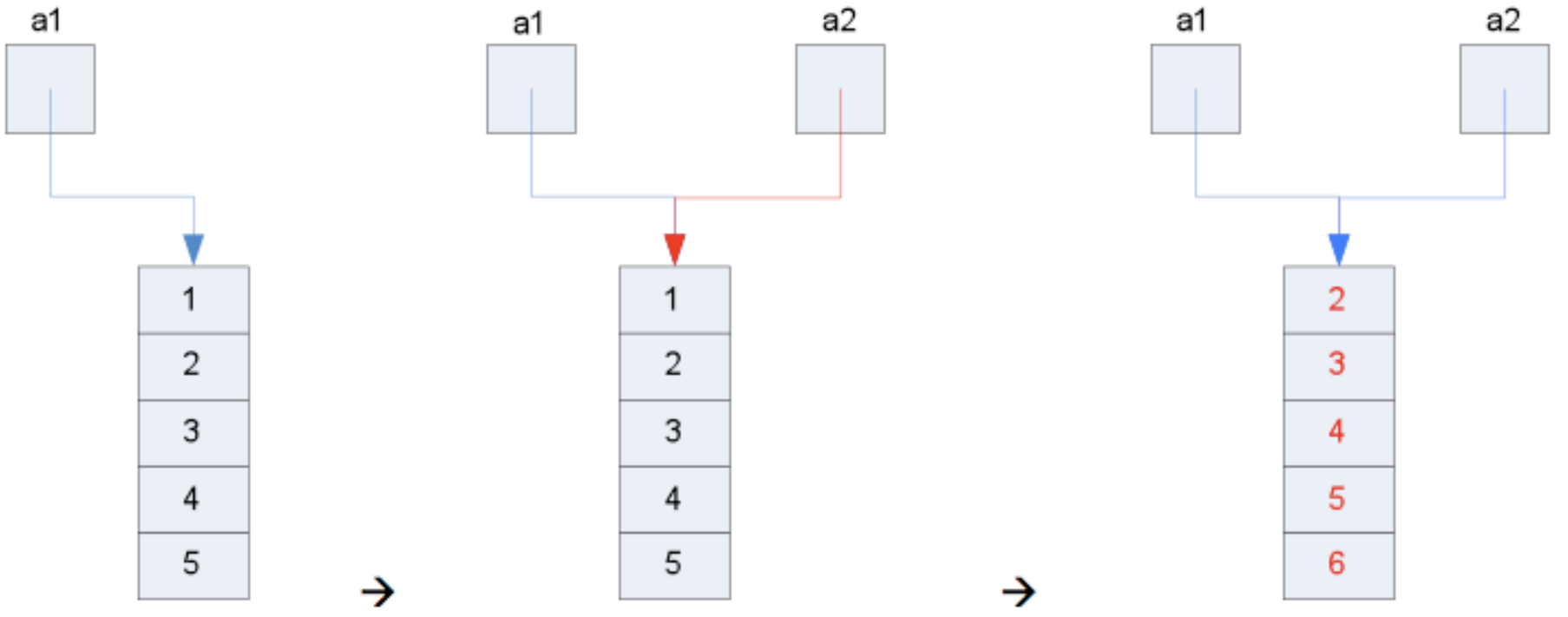


- Array variable is the manager to an array object

assignment of two arrays

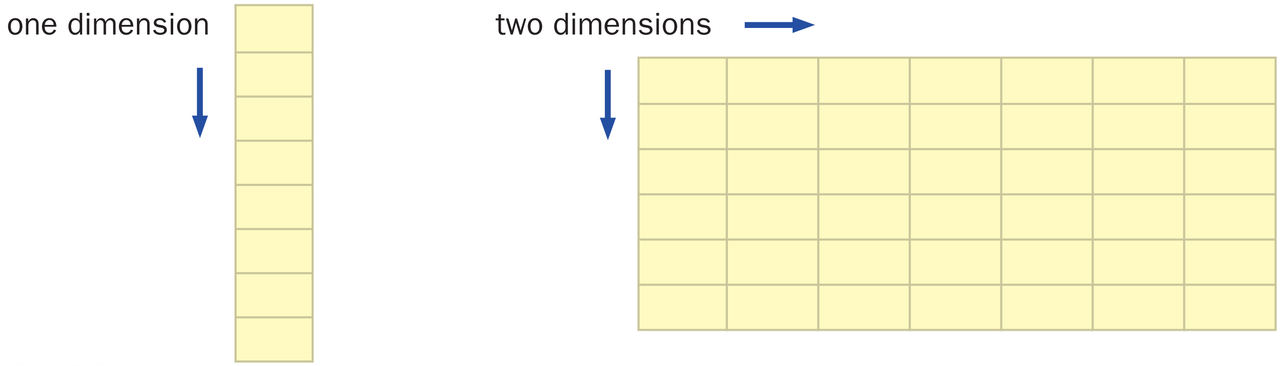
- int[] a = new int[10];
- a[0] = 5;
- int[] b = a;
- b[0] = 16;
- System.out.println(a[0]);

```
public class ArrayAssignment {
  public static void main(String[] args) {
    int[] a1 = {1,2,3,4,5};
    int[] a2 = a1;
    for ( int i=0; i<a2.length; ++i )
      a2[i] ++;
    for ( int v : a1 )
      System.out.println(v);
  }
}
```


a1
1
2
3
4
5
a1
a2
1
2
3
4
5
a1
a2
2
3
4
5
6

matrix

- array of arrays
  - int[][] a = new int[3][4];
    - defines a two dimensional array
    - a is an array of int[3];



```java
public class TwoDArray
{
   //-----------------------------------------------------------------
   // Creates a 2D array of integers, fills it with increasing
   // integer values, then prints them out.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      int[][] table = new int[5][10];
      // Load the table with values
      for (int row=0; row < table.length; row++)
         for (int col=0; col < table[row].length; col++)
            table[row][col] = row * 10 + col;
      // Print the table
      for (int row=0; row < table.length; row++)
      {
         for (int col=0; col < table[row].length; col++)
            System.out.print(table[row][col] + "\t");
         System.out.println();
      }
    }
}
```

Lab 2

- PTA 7-3, 7-4

Container

A personal notebook

- It allows notes to be stored.
- It has no limit on the number of notes it can store.
- It will show individual notes.
- It will tell us how many notes it is currently storing.

Collection

- Collection objects are objects that can store an arbitrary number of other objects.

library classes

- Libraries typically contain many hundreds or thousands of different classes.
- Java calls its libraries packages.
  - import
- Notebook class uses ArrayList class in the java.util package

NoteBook.java

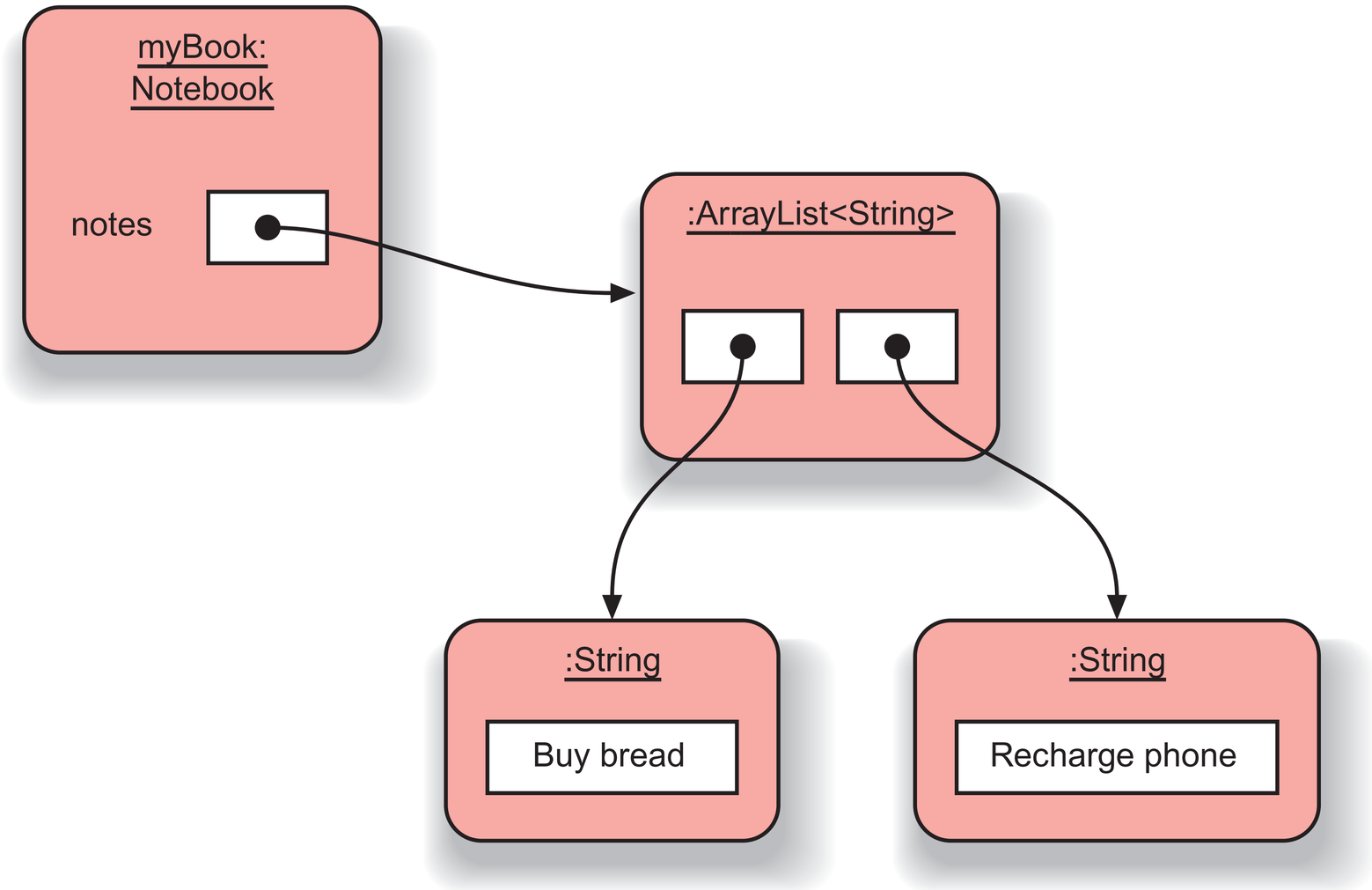
```
import java.util.ArrayList;

public class Notebook
{
   private ArrayList<String> notes;

   public Notebook()  {
      notes = new ArrayList<String>();
   }
}
```

generic classes

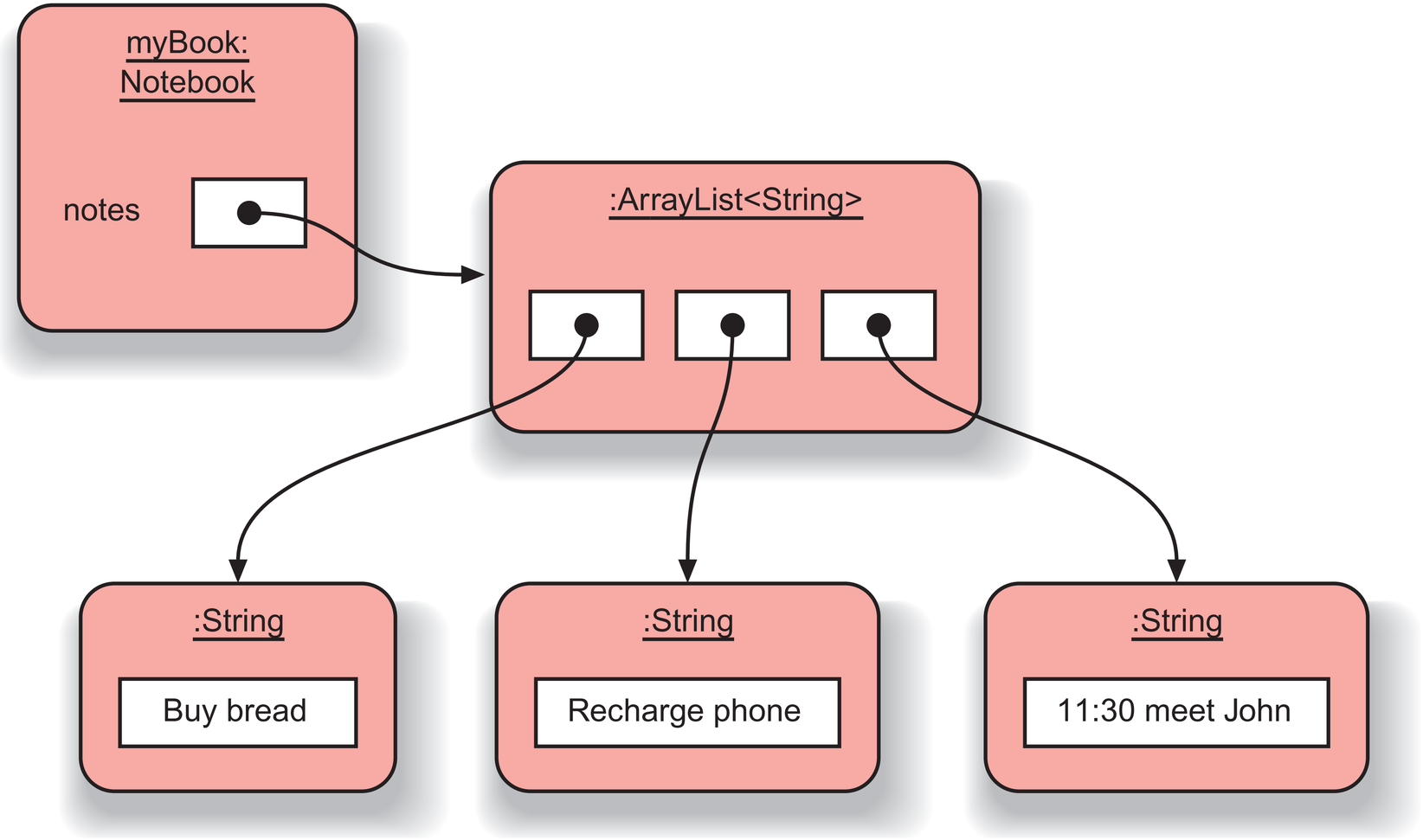
```
private ArrayList<String> notes;
```

- Have to specify two types: the type of the collection itself (here: ArrayList) and the type of the elements that we plan to store in the collection (here: String)

Object structure



Object structure



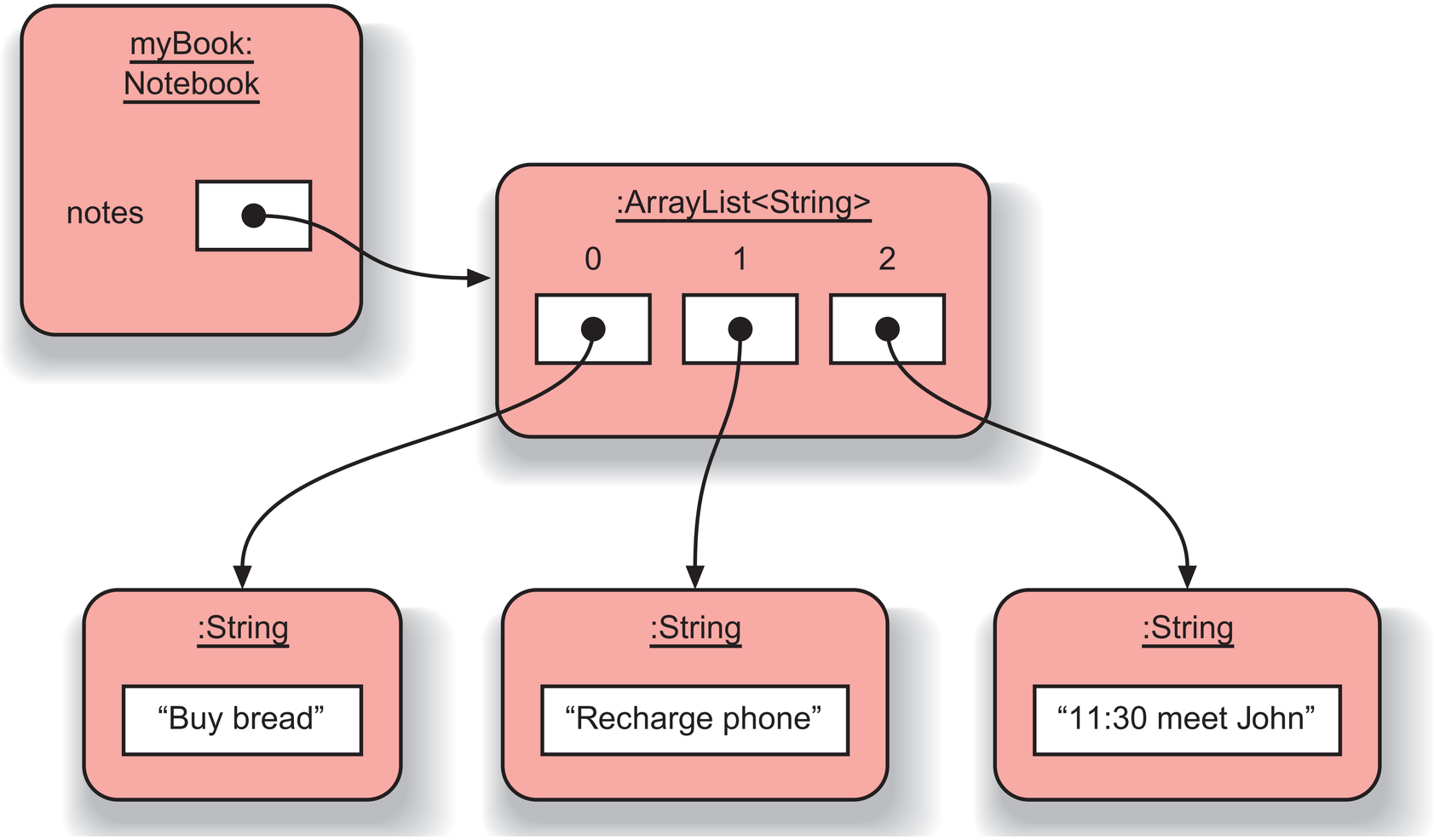
ArrayList

- It is able to increase its internal capacity as required: as more items are added, it simply makes enough room for them.
- It keeps its own private count of how many items it is currently storing. Its size method returns the number of objects currently stored in it.
- It maintains the order of items you insert into it. You can later retrieve them in the same order.

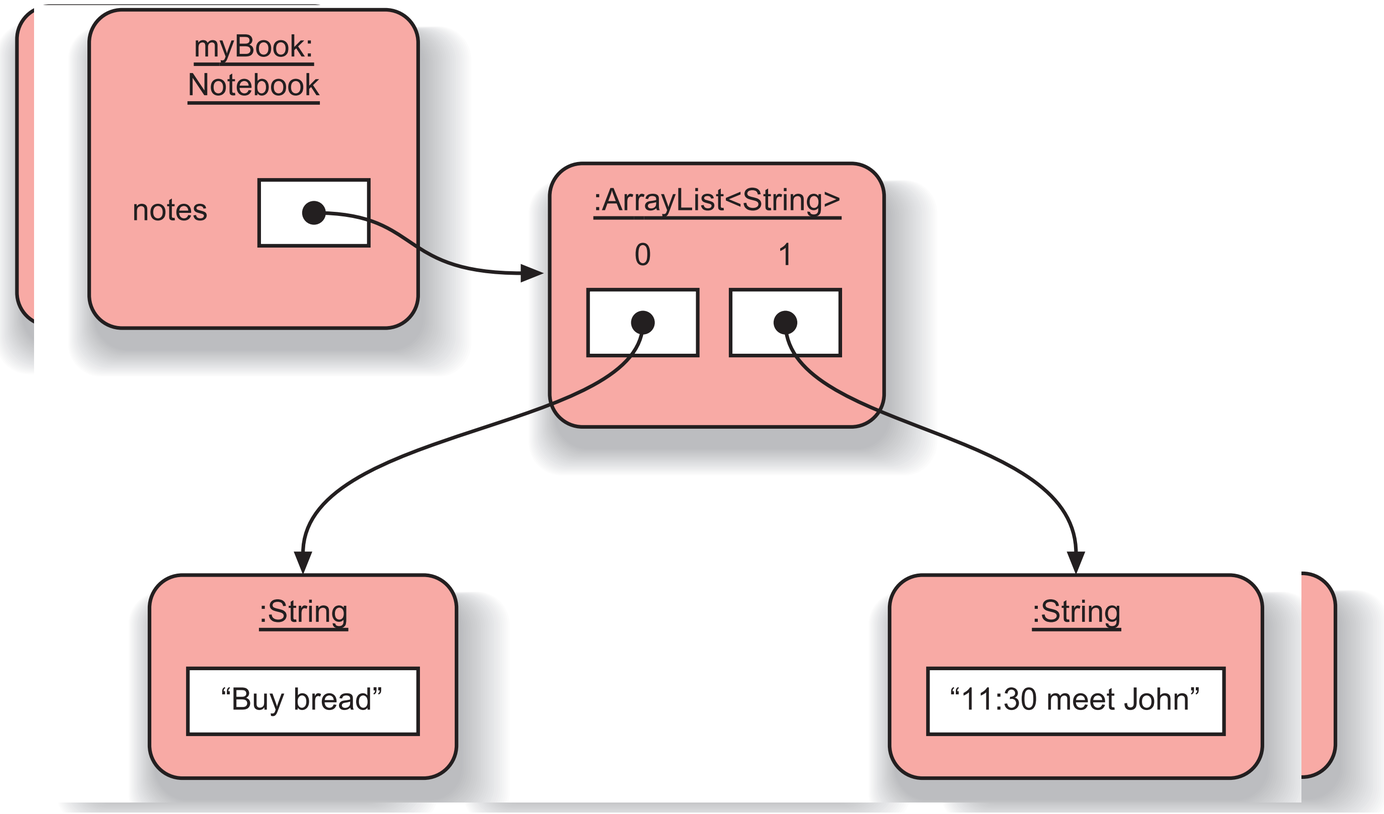
put in

- `public boolean add(E o);`
- `public void add(int index, E element);`

index


myBook:
Notebook
notes
:ArrayList<String>
0
1
2
:String
“Buy bread”
:String
“Recharge phone”
:String
“11:30 meet John”

Removing



- `public boolean remove(Object o);`
- `public E remove(int index);`

Processing a whole collection

- for-each loop

```
for (ElementType element : collection) {
    loop body
}
```

```
public voidlistNotes() {
    for(String note : notes) {
        System.out.println(note);
    }
}
```

while loop

```
int index = 0;
while(index < notes.size()) {
    System.out.println(notes.get(index));
    index++;
}
```

```
public E get(int index);
```

while loop

```
int index = 0;
boolean found = false;
while (index < notes.size() && !found) {
   String note = notes.get(index);
   if (note.contains(searchString)) {
         found = true;
   } else {
         index++;
   }
}
```

Iterator

- An iterator is an object that provides functionality to iterate over all elements of a collection.

```
public void listNotes() {
   Iterator<String> it = notes.iterator();
   while (it.hasNext()) {
      System.out.println(it.next());
   }
}
```

How an iterator acts

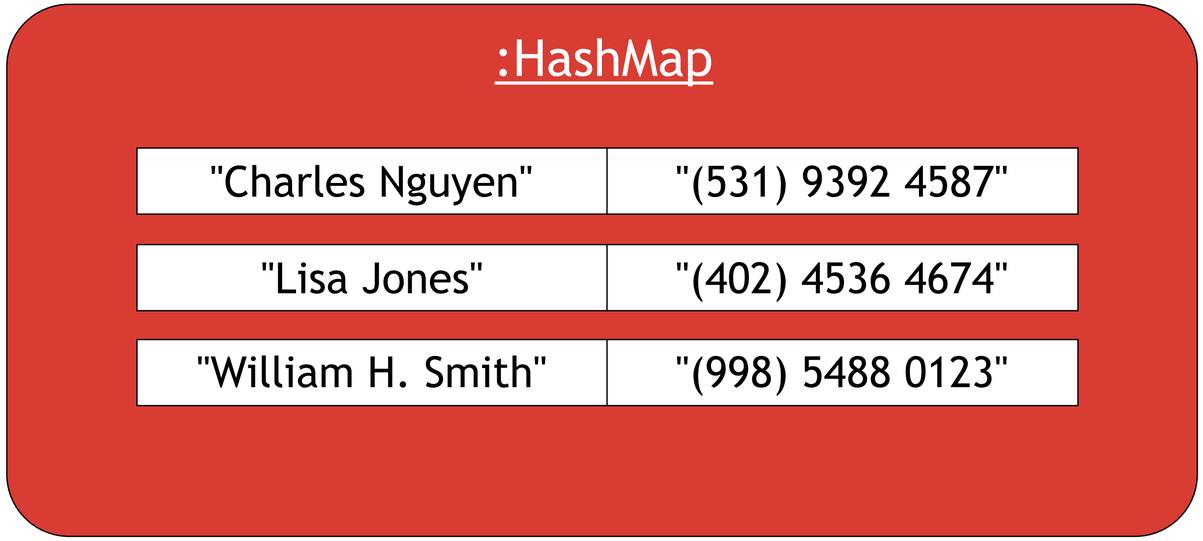
1. Ask a container to hand you an **Iterator** using a method called **iterator( )**. This **Iterator** will be ready to return the first element in the sequence on your first call to its **next( )** method.
2. Get the next object in the sequence with **next( )**.
3. See if there *are* any more objects in the sequence with **hasNext( )**.
4. Remove the last element returned by the iterator with **remove( )**.

Maps

- Maps are collections that contain pairs of values.
- Pairs consist of a <u>key</u> and a <u>value</u>.
- Lookup works by supplying a key, and retrieving a value.
- An example: a telephone book.

Using maps

- A map with Strings as keys and values



Using maps

```
HashMap <String, String> phoneBook = new HashMap<String, String>();

phoneBook.put("Charles Nguyen", "(531) 9392 4587");

phoneBook.put("Lisa Jones", "(402) 4536 4674");

phoneBook.put("William H. Smith", "(998) 5488 0123");

String phoneNumber = phoneBook.get("Lisa Jones");

System.out.println(phoneNumber);
```

Using sets

```
import java.util.HashSet;
import java.util.Iterator;
...
HashSet<String> mySet = new HashSet<String>();
mySet.add("one");
mySet.add("two");
mySet.add("three");
Iterator<String> it = mySet.iterator();
while(it.hasNext()) {
    call it.next() to get the next object
    do something with that object
}
```

Compare this to ArrayList code!

Lab 3

- A score data processing program reads two types of text lines
  - <sid> <name>, as 3190101234,Kim
  - <sid> <course initials> <mark>, as 3190101234,Java,95
- And prints a table of the marks as:
  - sid, name, <course name1>, <course name2>…,average
  - 3190101234, Kim, 95, ,95
  - 3190101235, John, , 86, 86