

Grouping objects

Collections and iterators

The requirement to group objects

- Many applications involve collections of objects:
 - Personal organizers.
 - Library catalogs.
 - Student-record system.
- The number of items to be stored varies.
 - Items added.
 - Items deleted.

Fixed-size collections

- Sometimes the maximum collection size can be pre-determined.
- Programming languages usually offer a special **fixed-size collection** type: an *array*.
- Java arrays can store **objects** or **primitive-type** values.
- Arrays use a special syntax.

Fixed-size collections

Examples:

- `int[] numbers;`
- `String[] stories;`
- `Point[] coordinates;`
- `Circle[] balls;`

Fixed-size collections

Examples:

```
int[] myIntArray = new int[3];
```

```
int[] myIntArray = {1,2,3};
```

```
int[] myIntArray = new int[]{1,2,3};
```

```
String[] myStringArray = new String[3];
```

```
String[] myStringArray = {"a","b","c"};
```

```
String[] myStringArray = new String[]{"a","b","c"};
```

```
String[] myStringArray;
```

```
myStringArray = new String[]{"a","b","c"};
```

The *weblog-analyzer* project

- Web server records details of each access.
- Supports webmaster's tasks.
 - Most popular pages.
 - Busiest periods.
 - How much data is being delivered.
 - Broken references.
- Analyze accesses by hour.

The *weblog-analyzer* project

- Apache access log
 - 192.168.2.20 - - [28/Jul/2019:10:27:10 -0300]
"GET /cgi-bin/try/ HTTP/1.0" 200 3395
 - 127.0.0.1 - - [28/Jul/2019:10:27:32 -0300]
"GET /hidden/ HTTP/1.0" 404 7218

Creating an array object

```
public class LogAnalyzer {
```

```
    private int[] hourCounts;  
    private LogfileReader reader;
```

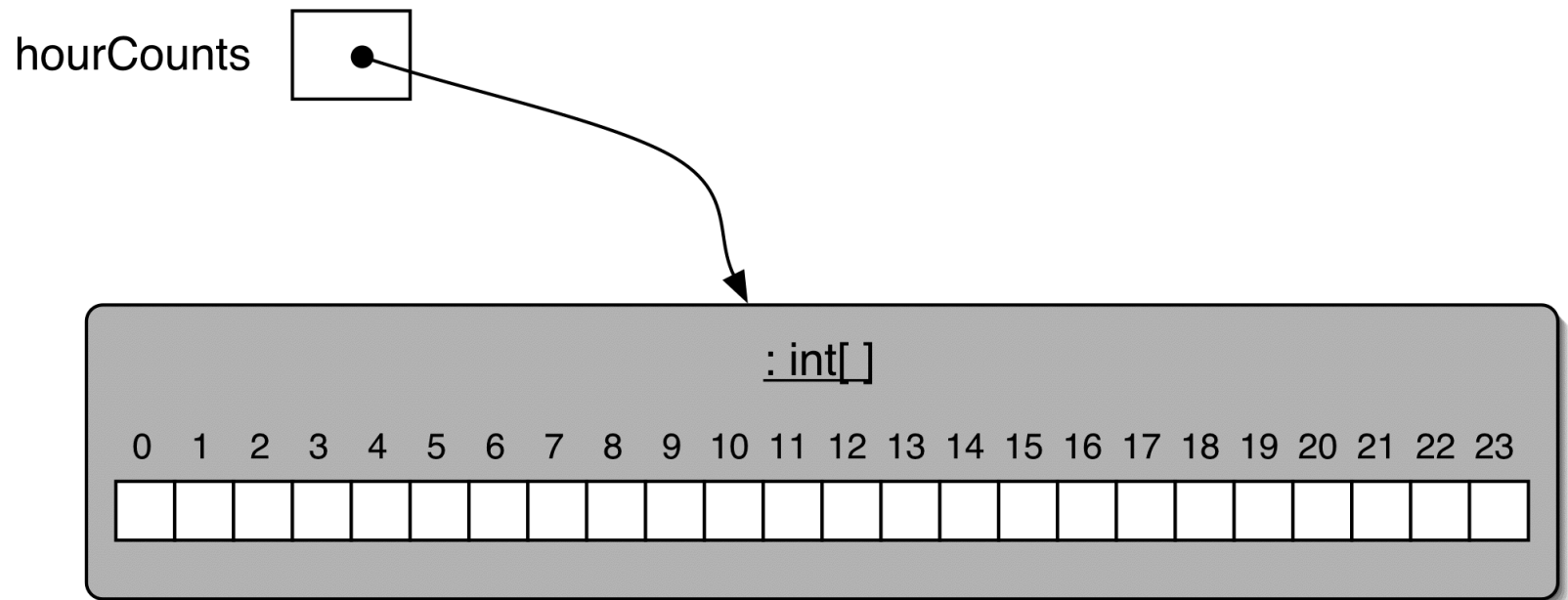
← Array variable declaration

```
    public LogAnalyzer() {  
        hourCounts = new int[24];  
        reader = new LogfileReader();  
    }  
    ...
```

← Array object creation

```
}
```


The hourCounts array



Using an array

- Square-bracket notation is used to access an array element: `hourCounts[...]`
- Elements are used like ordinary variables.
 - On the left of an assignment:
 - `hourCounts[hour] = ...;`
 - In an expression:
 - `adjusted = hourCounts[hour] - 3;`
 - `hourCounts[hour]++;`

Variable-size collections

- But sometimes the maximum collection size cannot be determined!
- Java has us covered here as well 😊

A personal notebook

- Notes may be stored.
- Individual notes can be viewed.
- There is no limit to the number of notes.
- It will tell how many notes are stored.
- Explore the *notebook1* project.

Class libraries

- Collections of **useful classes**.
- We don't have to write everything from scratch.
- Java calls its libraries, *packages*.
- Grouping objects is a recurring requirement.
 - The `java.util` package contains classes for doing this.

```

import java.util.ArrayList;

/**
 * ...
 */
public class Notebook {
    // Storage for an arbitrary number of notes.
    private ArrayList<String> notes;

    /**
     * Perform any initialization required for the
     * notebook.
     */
    public Notebook() {
        notes = new ArrayList<String>();
    }

    ...
}

```

Collections

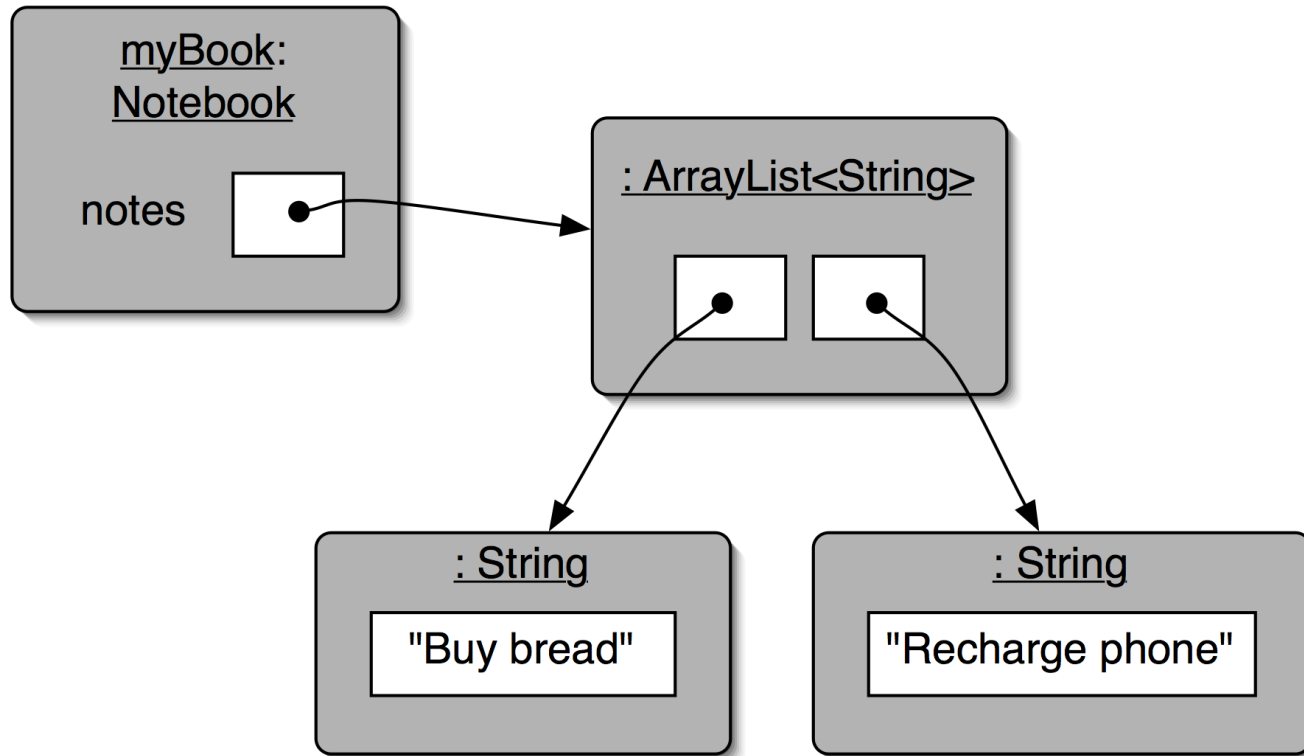
ArrayList<String> notes;

- We specify:
 - the **type of collection**: ArrayList
 - the **type of objects** it will contain: <String>
- We say, “ArrayList of String”.

Generic classes

- Collections are known as *parameterized* or *generic* types.
- The type parameter says what we want a list of:
 - `ArrayList<Person>`
 - `ArrayList<TicketMachine>`
 - etc.
- `ArrayList` implements list functionality:
 - `add`, `get`, `size`, etc.

Object structures with collections



Features of the collection

- It **increases its capacity** as necessary.
- It keeps a **private count** (`size()` accessor).
- ArrayList keeps the **objects in order**.
- **Details** of how all this is done **are hidden**.
 - Does that matter? Does not knowing how prevent us from using it?

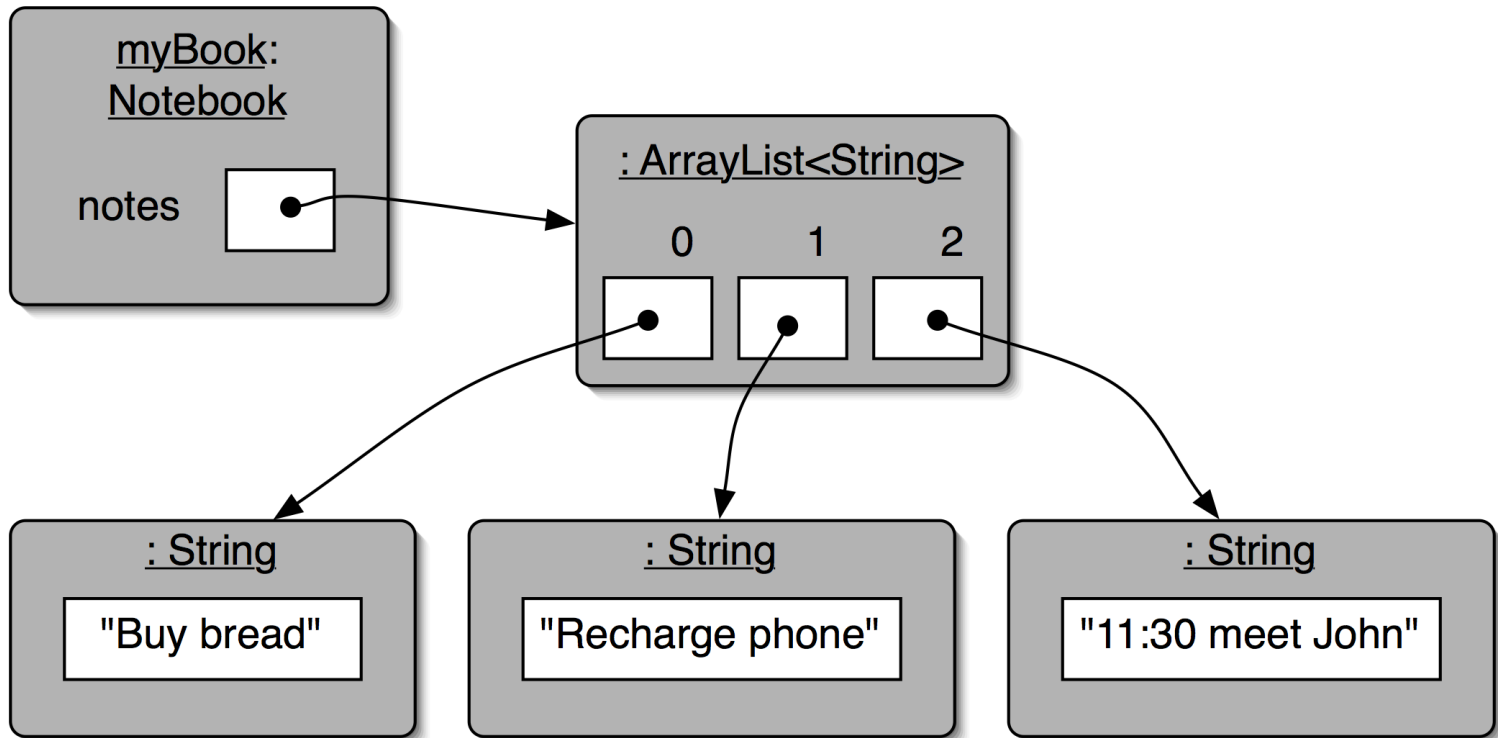
Using the collection

```
public class Notebook {  
    private ArrayList<String> notes;  
    ...  
    public void storeNote(String note) {  
        notes.add(note);  
    }  
    public int numberOfNotes() {  
        return notes.size();  
    }  
    ...  
}
```

Adding a new note

Returning the number of notes
(*delegation*)

Adding a third note + Index numbering



Retrieving an object

```
public void showNote(int noteNumber)
{
    if(noteNumber < 0) {
        // This is not a valid note number.
    }
    else if(noteNumber < numberOfNotes()) {
        System.out.println(notes.get(noteNumber));
    }
    else {
        // This is not a valid note number.
    }
}
```

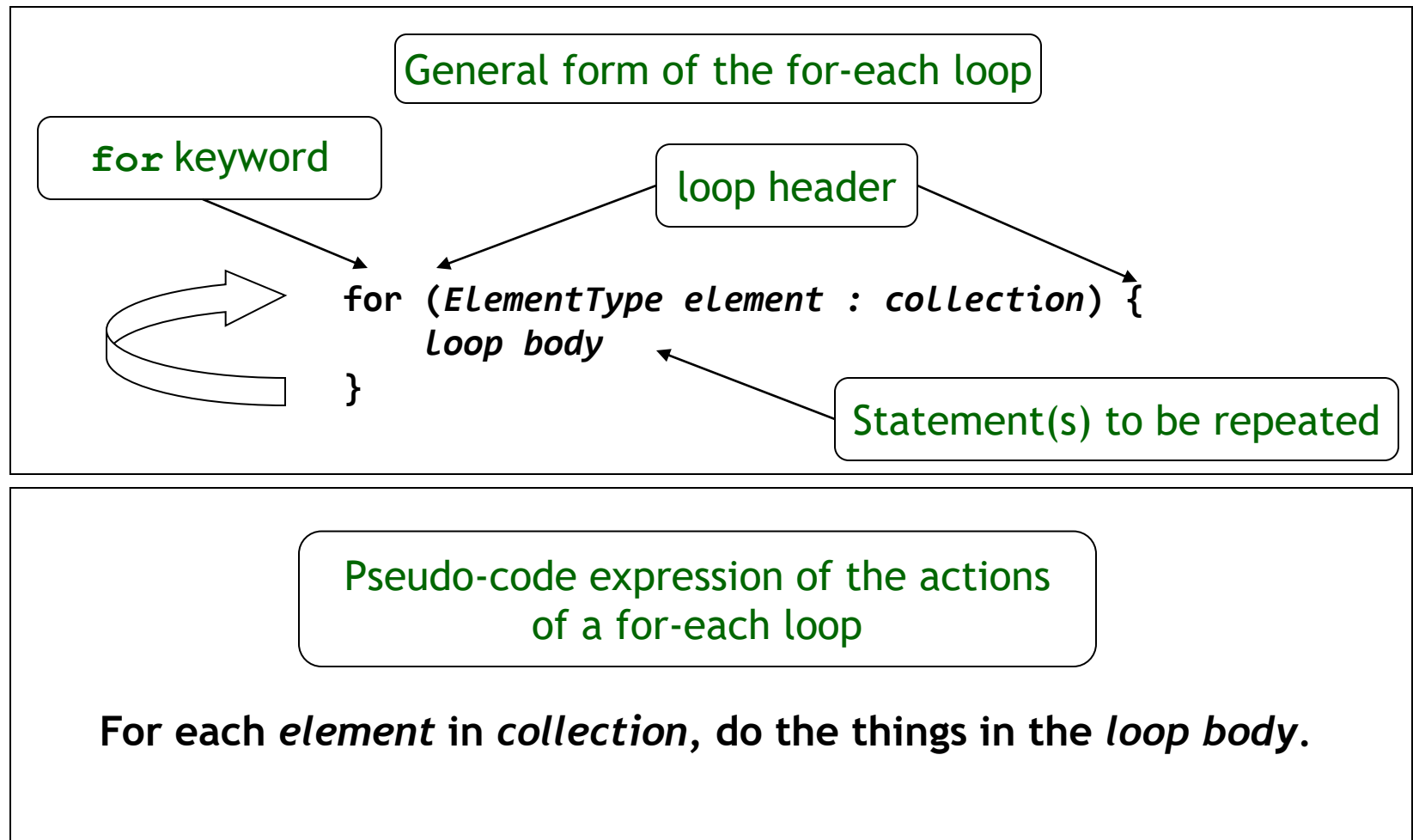
Index validity checks

Retrieve and print the note

Iteration

- We often want to **perform some actions an arbitrary number of times**.
 - E.g., print all the notes in the notebook. How many are there?
- Most programming languages include ***loop statements*** to make this possible.
- Java has several sorts of loop statement.
 - One is ***for-each*** loop.

For-each loop pseudo code



A Java example

```
/**
 * List all notes in the notebook.
 */
public void listNotes() {
    for (String note : notes) {
        System.out.println(note);
    }
}
```

for each *note* in *notes*, print out *note*

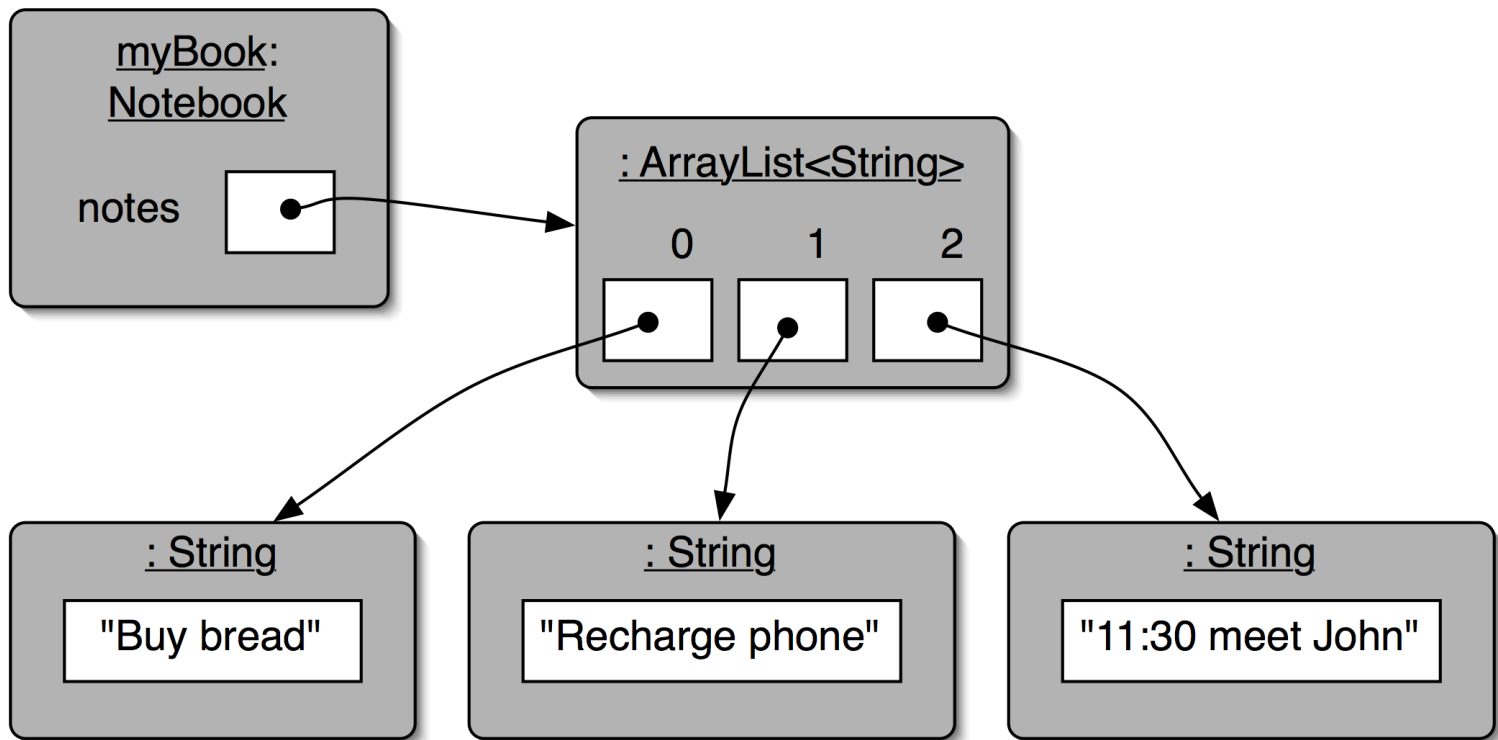
for-each versus while

- for-each:
 - easier to write.
 - safer: it is guaranteed to stop.
- while:
 - we don't *have* to process the whole collection.
 - doesn't even have to be used with a collection.
 - take care: could be an *infinite loop*.

Searching a collection

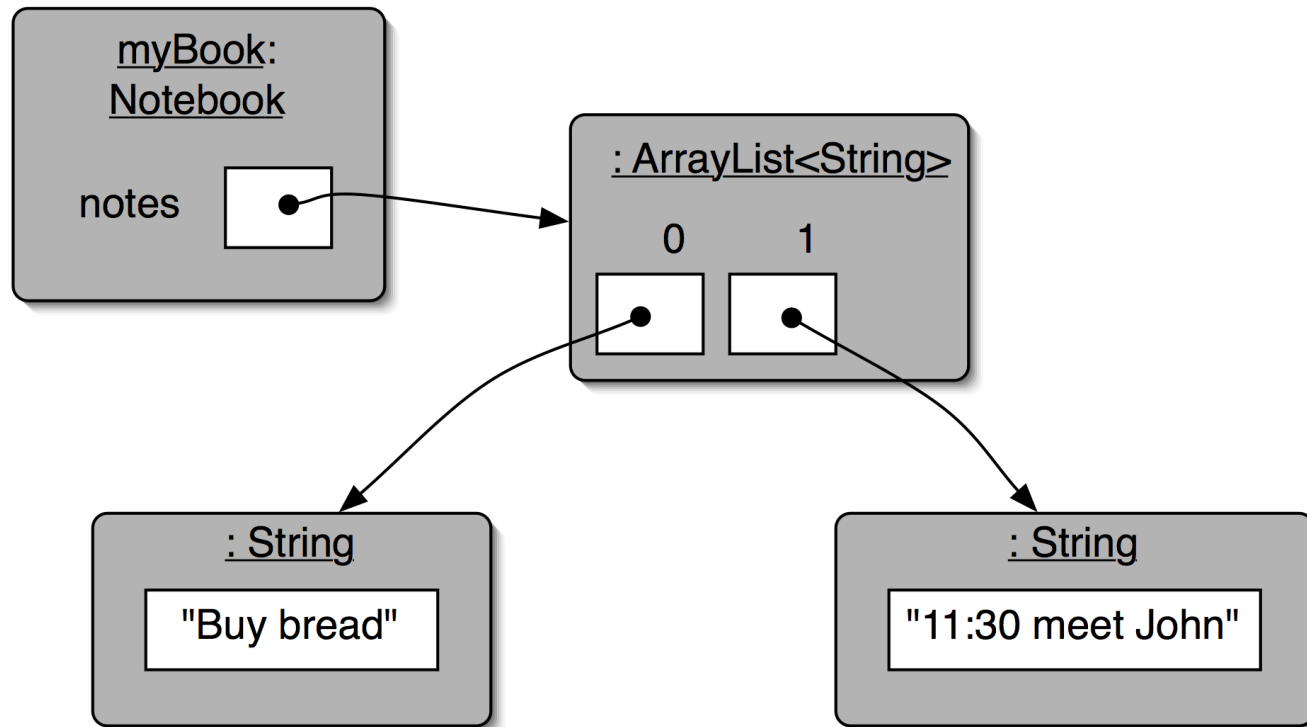
```
int index = 0;
boolean found = false;
while (index < notes.size()) {
    String note = notes.get(index);
    if (note.contains(searchString)) {
        found = true;
        // We don't need to keep looking.
        break;
    }
    else {
        index++;
    }
}
// Either we found it, or we searched the whole
// collection.
```

Index numbering



Removal may affect numbering

```
notes.remove(1);
```



Iteration fundamentals

- We often want to **repeat** some actions over and over.
- **Loops** provide us with a way to control how many times we **repeat those actions**.
- With **collections**, we often want to repeat things **once for every object** in a particular collection.

Using an Iterator object

`java.util.Iterator`

returns an `Iterator` object

```
Iterator<ElementType> it = myCollection.iterator();  
while (it.hasNext()) {  
    call it.next() to get the next object  
    do something with that object  
}
```

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

Using an Iterator object

```
for (String note : notes) {  
    System.out.println(note);  
    if (note.contains("Second")) {  
        notes.remove("Second object.");  
    }  
}
```



```
Iterator<String> it = notes.iterator();  
while (it.hasNext()) {  
    String note = it.next();  
    if (note.contains("Second")) {  
        it.remove();  
    }  
}
```

Index versus Iterator

- Ways to iterate over a collection:
 - for-each loop.
 - Use if we want to process every element.
 - while loop.
 - Use if we might want to stop part way through.
 - Use for repetition that doesn't involve a collection.
 - Iterator object.
 - Use if we might want to stop part way through.
 - Often used with collections where indexed access is not very efficient, or impossible.
 - Can be used to remove objects from collection while iterating.

Review

- **Arrays** are appropriate where a **fixed-size** collection is required.
- Arrays use special syntax.
- For loops offer an alternative to while loops when the **number of repetitions** is known.
- For loops are used when an **index variable** is required.

Review

- **Collections** allow an **arbitrary number** of objects to be stored.
- **Class libraries** usually contain **tried-and-tested** collection classes.
- Java's class libraries are called ***packages***.
- We have used the `ArrayList` class from the `java.util` **package**.

ArrayList Review

- Items may be **added** and **removed**.
- Each item has an **index**.
- **Index** values **may change** if items are removed (or further items added).
- The main `ArrayList` methods are `add`, `get`, `remove` and `size`.
- `ArrayList` is a parameterized or generic type.