

Programming Fundamentals 2

Introduction to ArrayList

Produced Dr. Siobhán Drohan
by: Mairead Meagher



Waterford Institute *of* Technology
INSTITIÚID TEICNEOLAÍOCHTA PHORT LÁIRGE

Department of Computing and Mathematics
<http://www.wit.ie/>

Topic list

- Grouping Objects
 - Developing a basic personal notebook project using Collections e.g. ArrayList
- Indexing within Collections
 - Retrieval and removal of objects
- Generic classes e.g. ArrayList
- Iteration
 - Using the for each loop
 - Using the while loop
- Coding ShopV3.0 that stores an ArrayList of Products.

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.

Primitive Arrays

- Primitive arrays can store groups of objects.
- However, the size of the array is fixed when it is created.
- This means that:
 - We have to maintain a variable that tells us how many objects have actually been added to the primitive array e.g. `int total`;
 - If our array is full, we cannot add any more additional items.
- We need a way of grouping objects that can grow/shrink according to our needs.

Example: 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.

Java class libraries

- Many useful classes.
- We don't have to write everything from scratch.
- Java calls its libraries, *packages*.

Back to the notebook:

- 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;

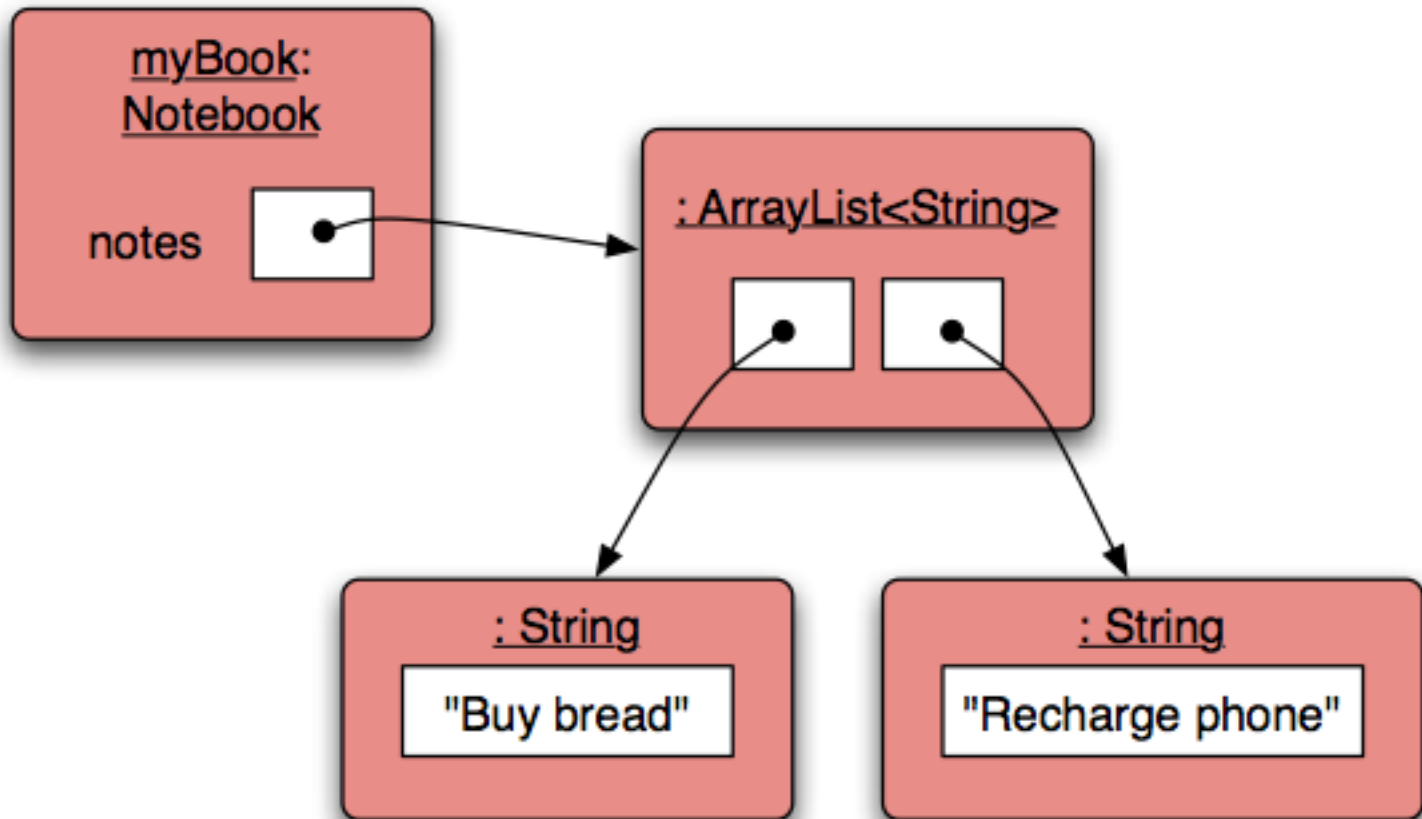
    // Perform any initialization required for the notebook.
    public Notebook()
    {
        notes = new ArrayList<String>();
    }

}
```

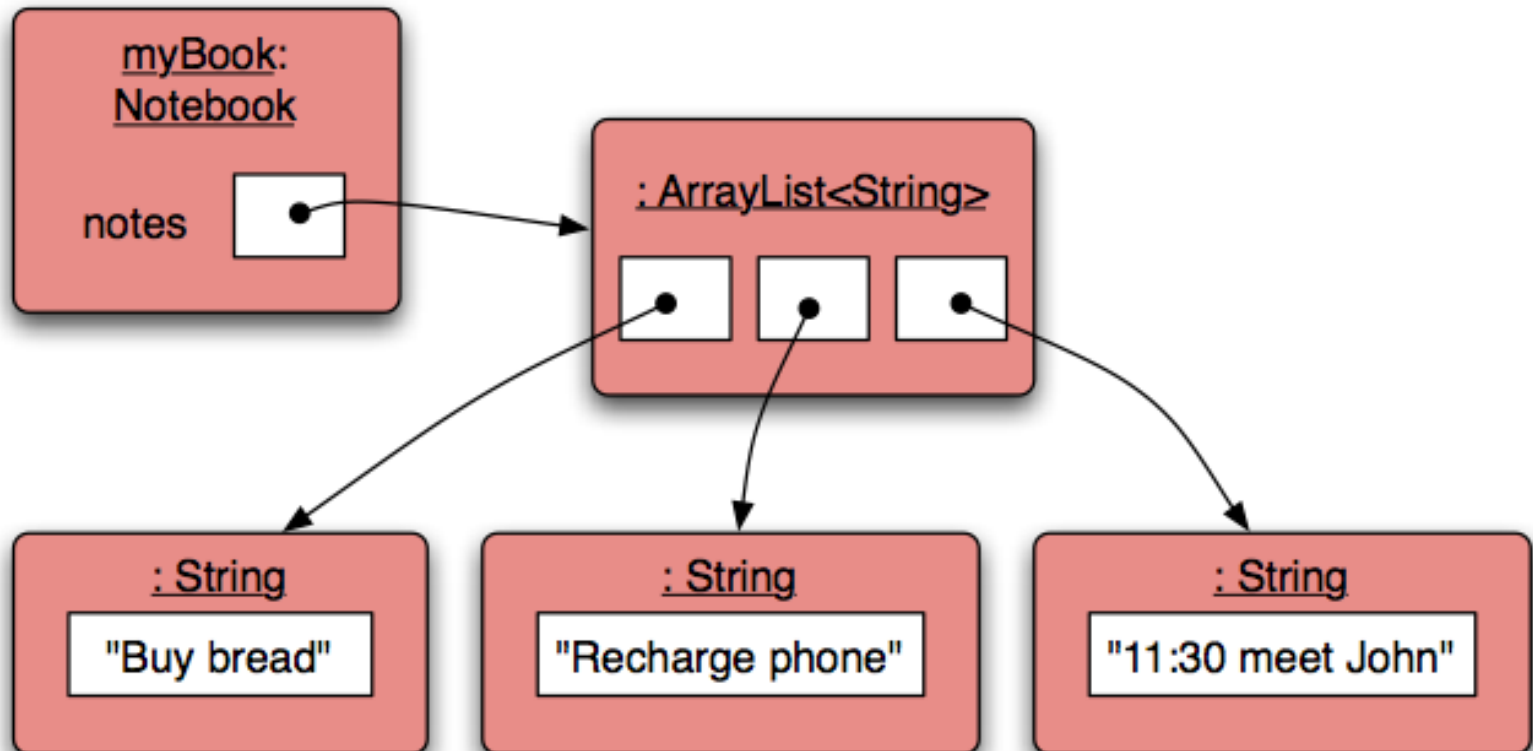
Collections

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

Object structures with collections



Adding a third note



Features of the collection

- It increases its capacity as necessary.
- It keeps a private count (`size()` accessor).
- It 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?

```
import java.util.ArrayList;

public class Notebook
{
    private ArrayList<String> notes;

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

    public void storeNote(String note){
        notes.add(note);
    }

    public int numberOfNotes(){
        return notes.size();
    }
}
```

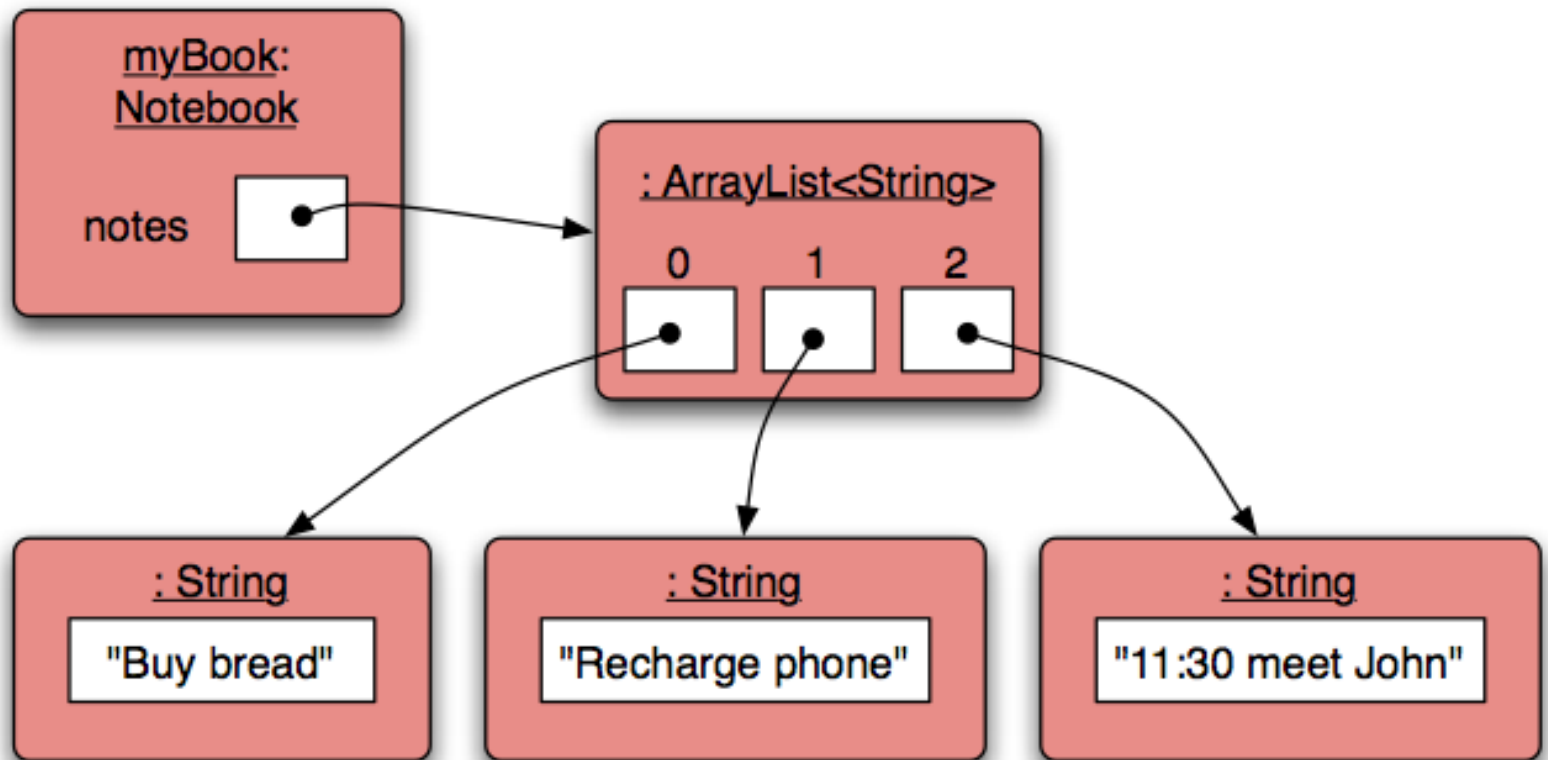
Adding a new note

Returning the
number of notes

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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

A blue rounded rectangle containing the text "Index validity checks". Three blue arrows originate from this box: one points to the condition `if(noteNumber < 0)`, another points to the condition `else if(noteNumber < numberOfNotes())`, and the third points to the `else` block.

Retrieve and
print the note

A red rounded rectangle containing the text "Retrieve and print the note". A red arrow points from this box to the line `System.out.println(notes.get(noteNumber));` in the code block.

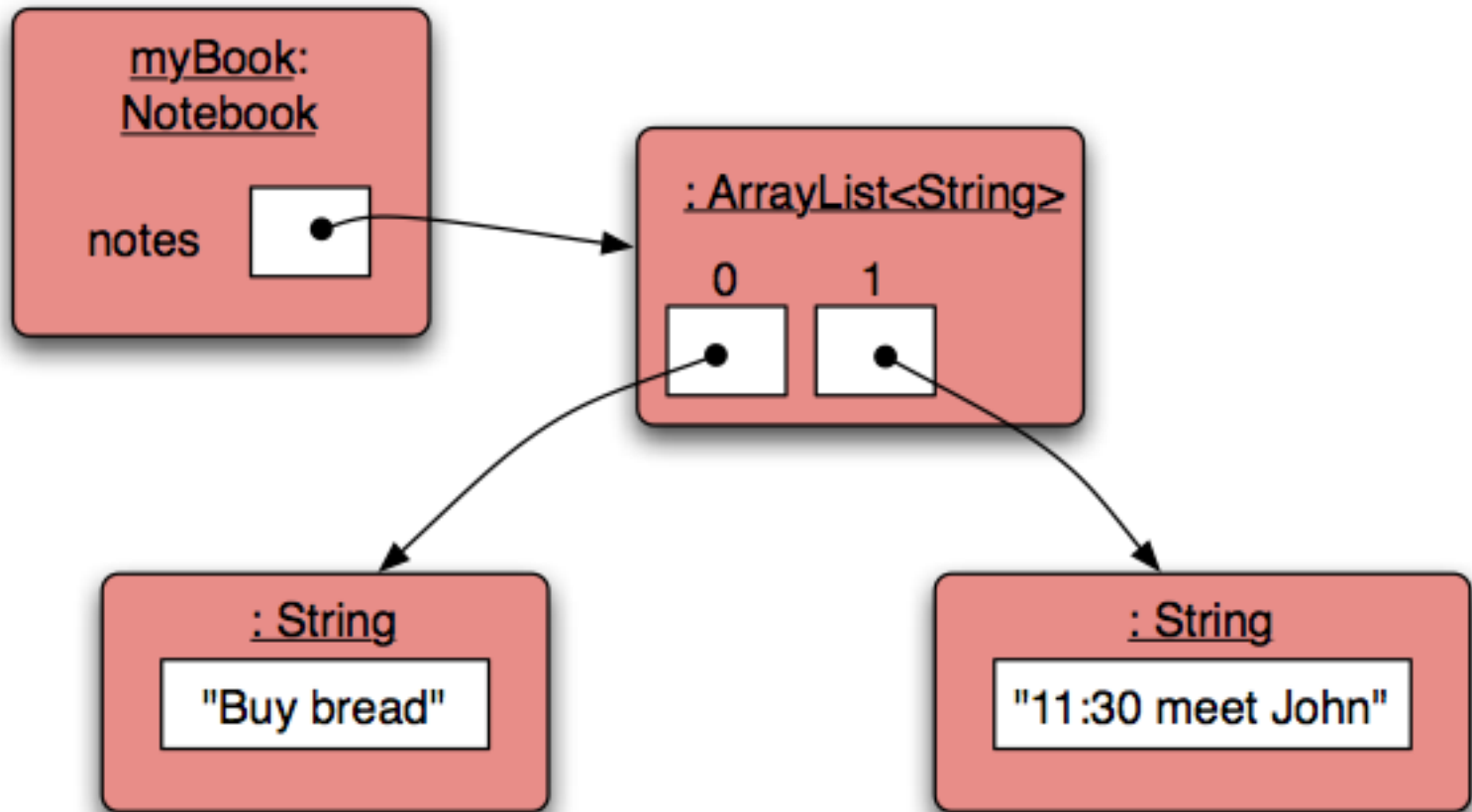
Removing an object

```
public void removeNote(int noteNumber)
{
    if(noteNumber < 0) {
        // This is not a valid note number, so do nothing.
    }
    else if(noteNumber < numberOfNotes()) {
        // This is a valid note number.
        notes.remove(noteNumber);
    }
    else {
        // This is not a valid note number, so do nothing.
    }
}
```

Index
validity
checks

Delete the note at
the specific index

Removal may affect numbering



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Generic classes

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

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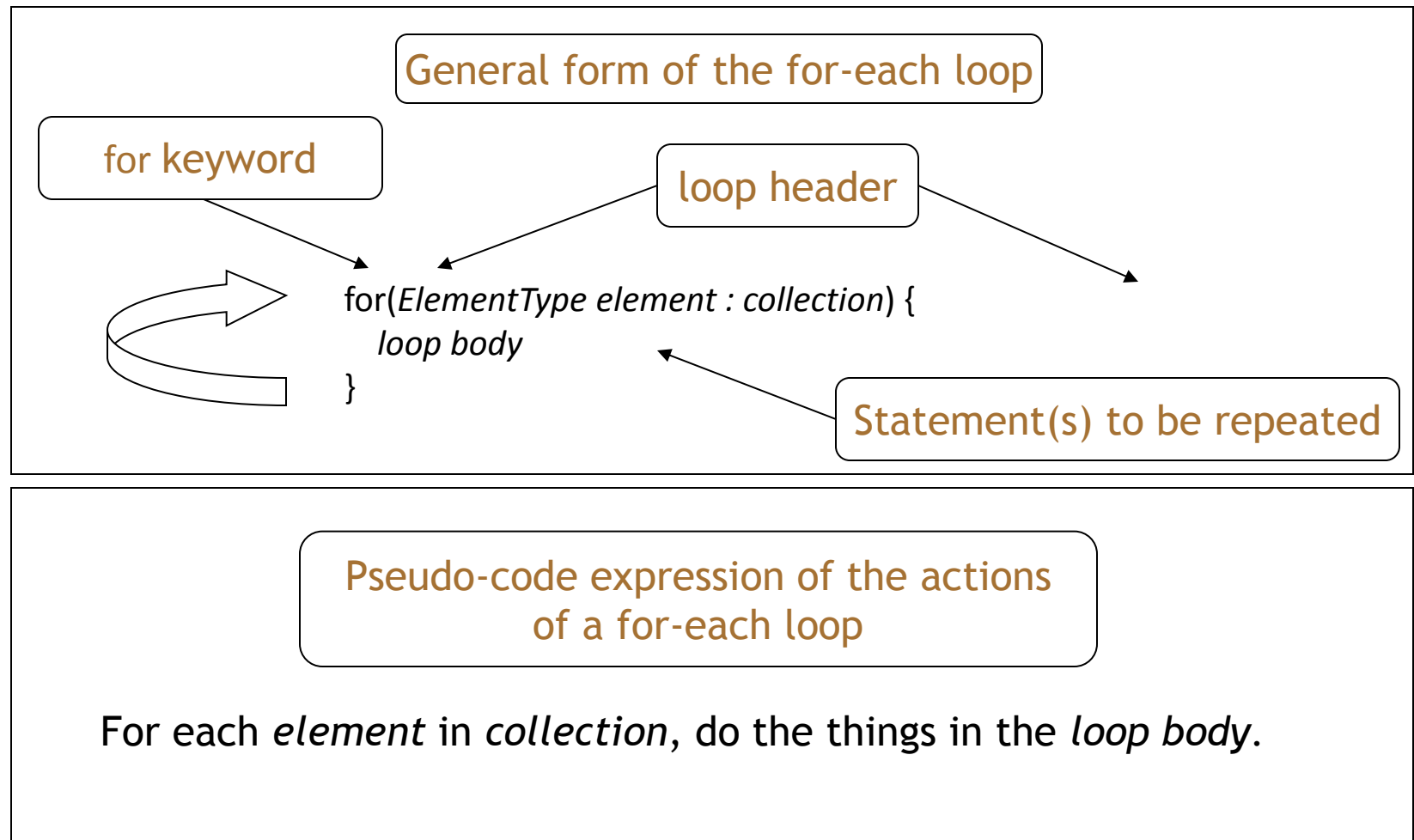
Processing a whole collection (iteration)

- 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.
 - We will start with its *for-each loop*.

Iteration fundamentals

- We often want to repeat some actions over and over
 - e.g., print all the notes in the notebook.
- 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.

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*

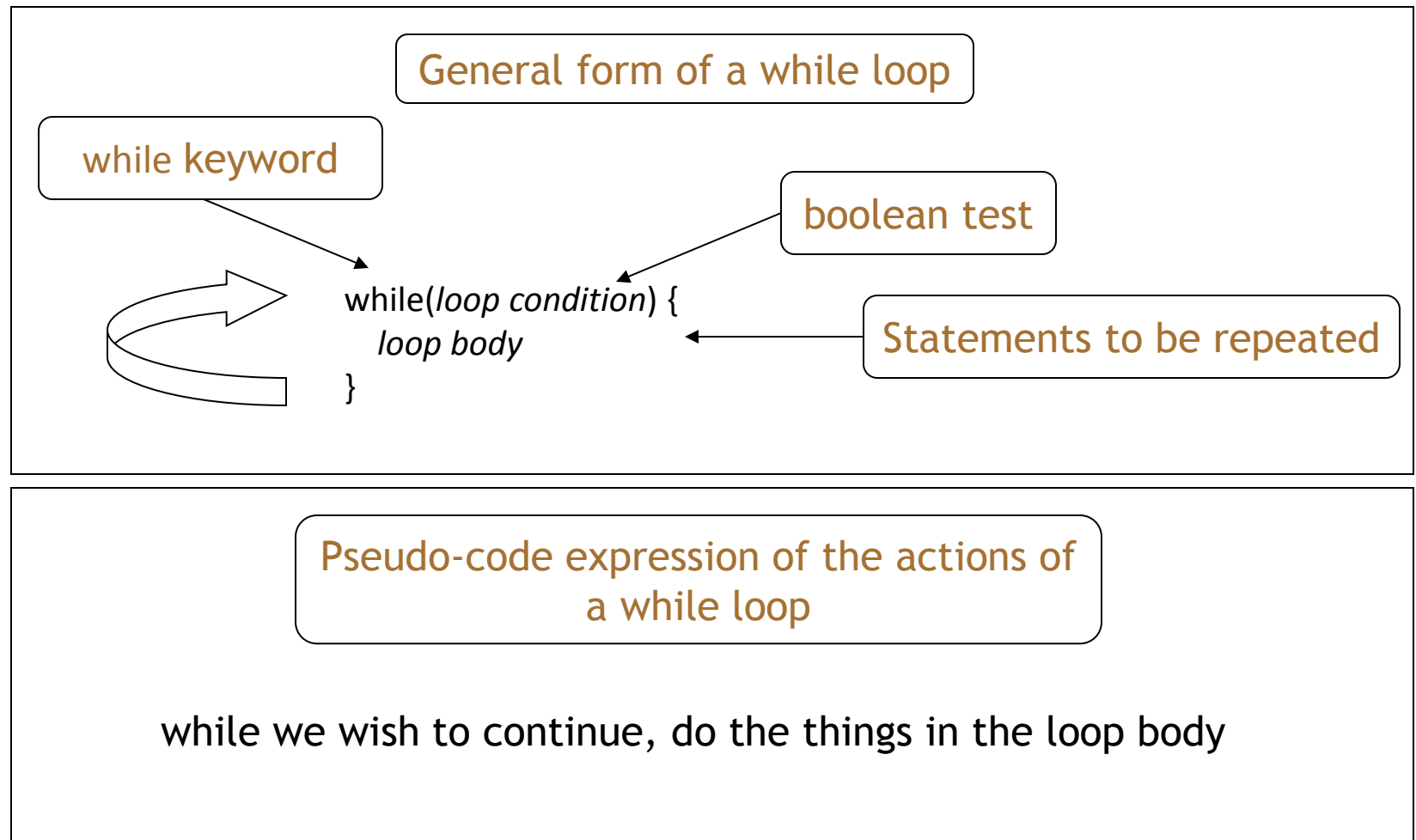
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The while loop

- A for-each loop repeats the loop body **for each** object in a collection.
- Sometimes we require more variation than this.
- We can use a boolean condition to decide whether or not to keep going.
- A while loop provides this control.

While loop pseudo code



while loop for iterating over a collection

```
/**
 * List all notes in the notebook.
 */
public void listNotes()
{
    int index = 0;
    while(index < notes.size()) {
        System.out.println(notes.get(index));
        index++;
    }
}
```

Increment
index by 1

while the value of *index* is less than the size of the collection,
print the next note, and then increment *index*

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*.



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