Objects First With Java
A Practical Introduction Using BlueJ

Grouping objects

Collections and iterators

Concepts covered so far

- Abstraction
- Modularization
- Classes define types
- Class and object diagrams
- Object references
- Primitive types
- Object types
- Object creation
- Overloading
- Internal/external method call

Main concepts to be covered

- Collections
- Loops
- Iterators
- Arrays

The requirement to group objects

- Many applications involve objects grouped into collections:
  - Personal organizers (objects: notes).
  - Library catalogs (objects: files).
  - Student-record system (objects: records).
- The number of items to be stored varies.
  - Items added (new appointments or books).
  - Items deleted (students leave university or appointments are cancelled).

Possibilities so far?

- Define one class:
  - A field for each note / book / student.
  - Drawback: Possible number of entries is fixed, not variable!
- Again, define one class:
  - Create objects (instances of the class) for new notes / books / students.
  - Drawback: Objects are not grouped at all, just living individually!
- Hence: need for more flexibility!

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 us how many notes are currently stored.
- Example: *notebook1* project

Class libraries, library classes

- Libraries are collections of a large number of predefined useful classes.
- Java has many of such libraries.
- We don't have to write everything from scratch ☺.
- Java calls its libraries *packages*.
- No differences in using such library classes.
- Grouping objects is a recurring requirement.
  - The `java.util` package contains classes for doing this.
  - One example is the `ArrayList` class used in the following.
  - `ArrayList` is a *collection class*.
  - Collections can store an arbitrary number of elements, each element being another object.

```
import java.util.ArrayList;

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

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

    ...
}
```

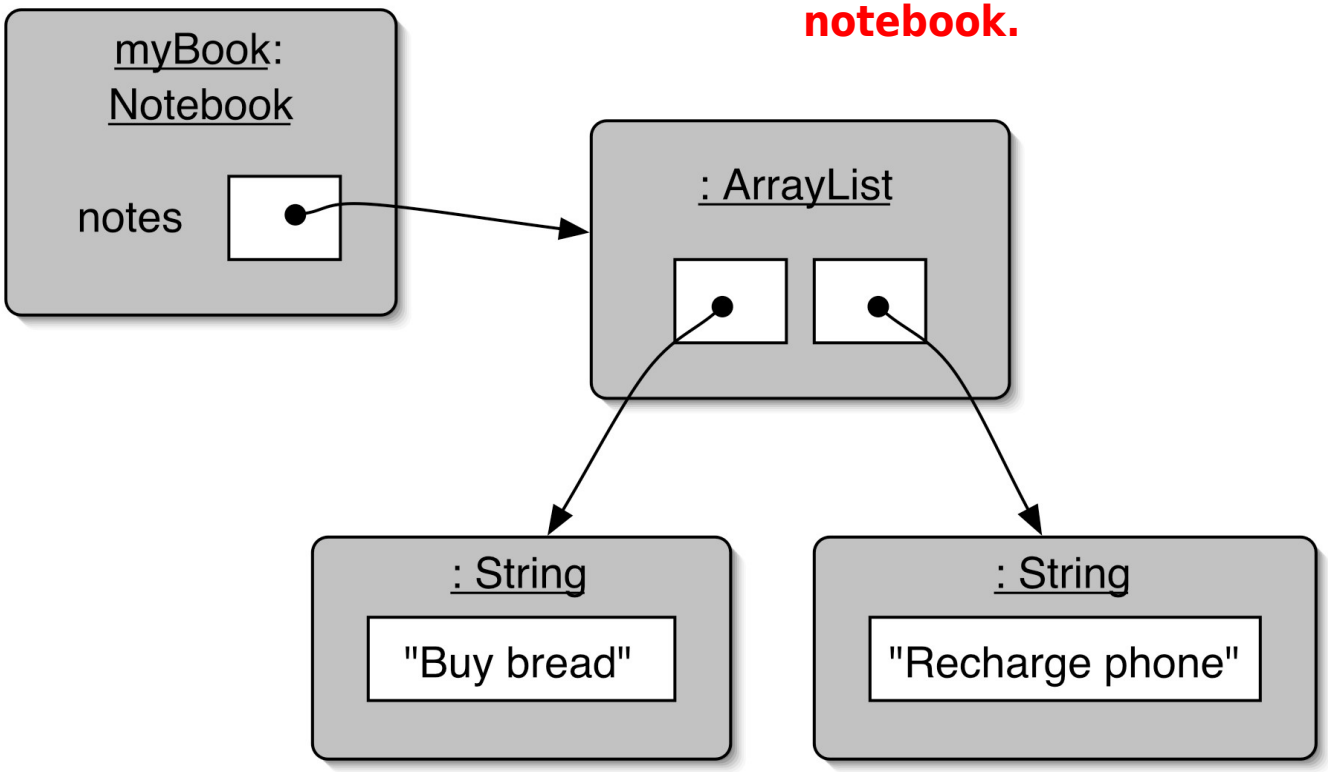
Import: from a library!
(to be placed before class defs.)

Once imported, `ArrayList` can be used as usual.

Constructor: initialize!

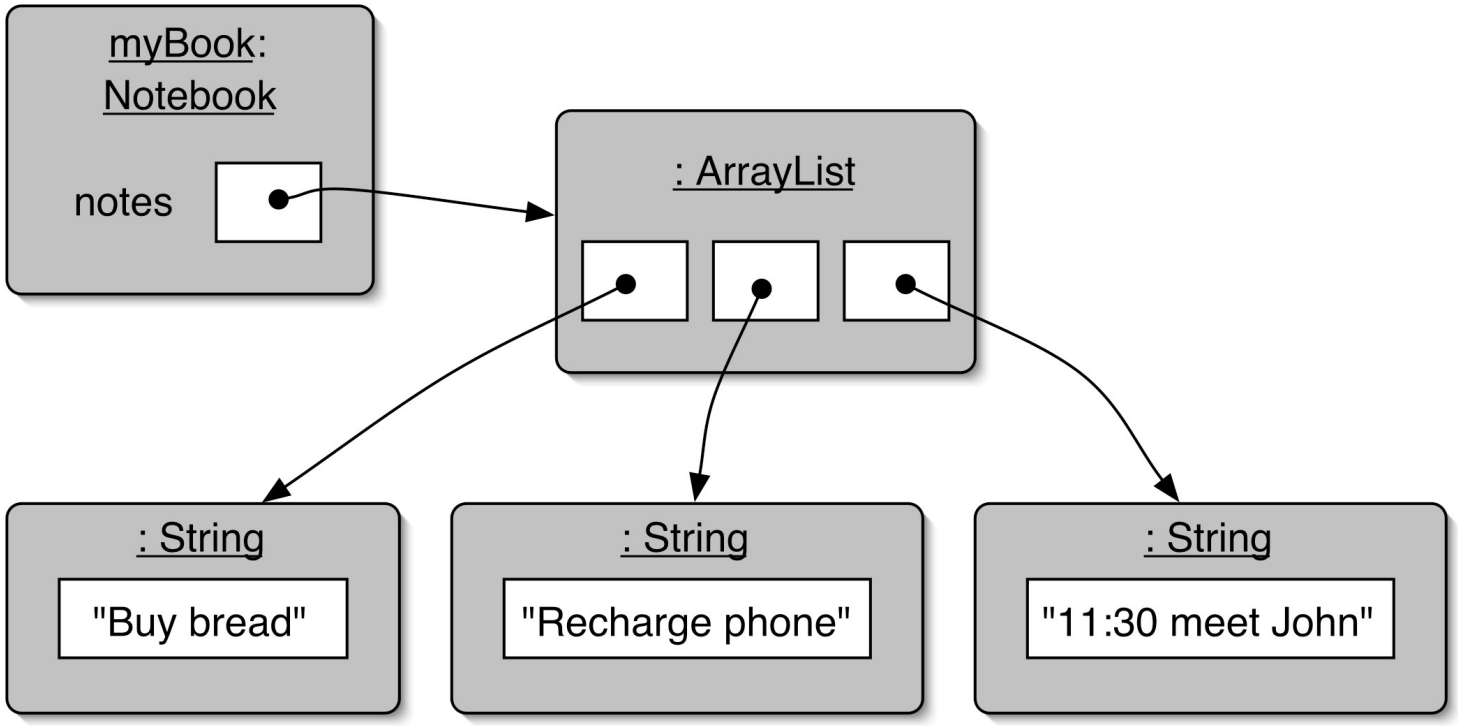
Object structures with collections

At present, two notes in the notebook.



Adding a third note

Then, a third one is added.



Features of the collection

- It increases its capacity as necessary (i.e. no memory problems).
- It keeps a private count (`size()` accessor method).
- It keeps the objects in the order they have been inserted.
- Details of how all this is done are hidden.
  - Does that matter? Must we know details? Does not knowing how prevent us from using it?
  - Advantage: Someone else did work, we just need to know how to use `ArrayList`.

Using the collection

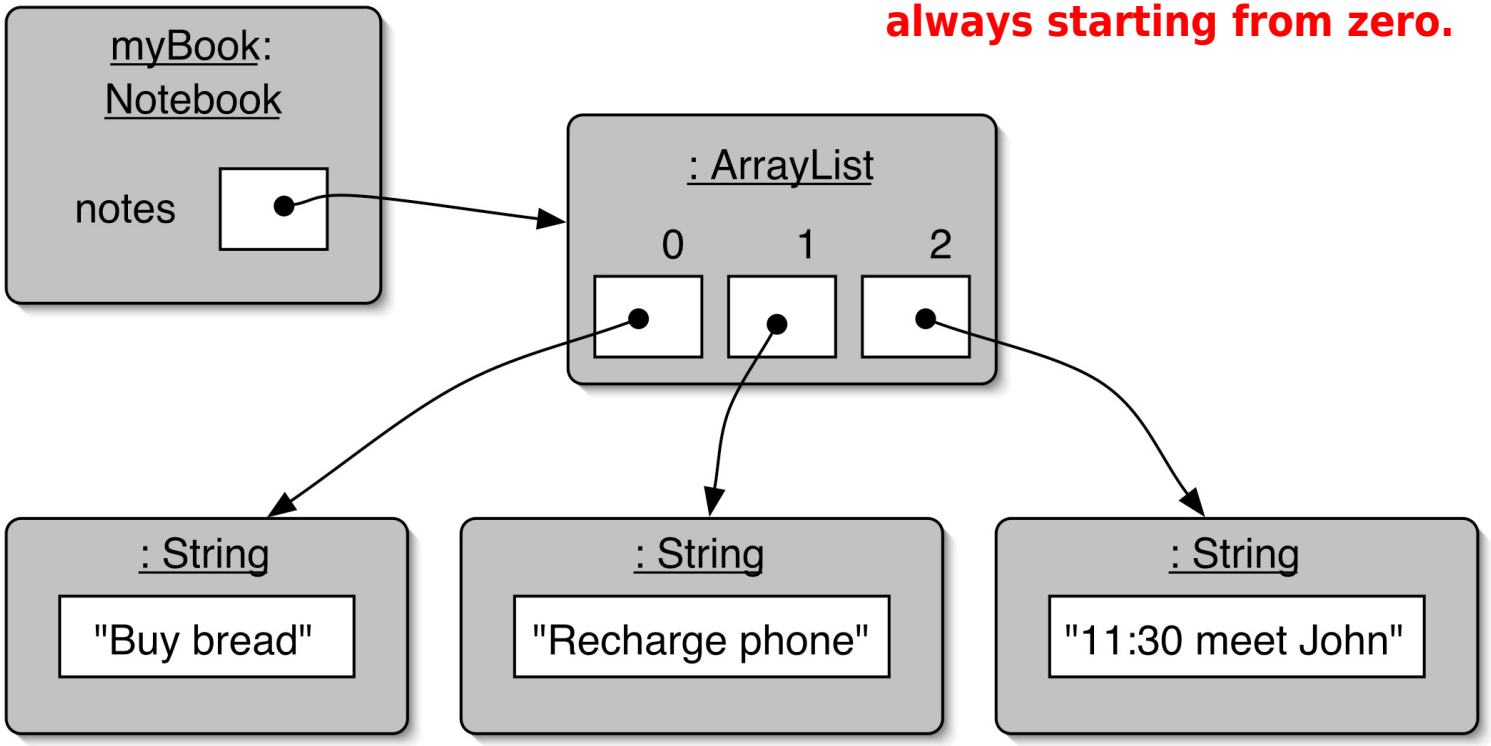
```
public class Notebook
{
    private ArrayList notes;
    ...

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

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

    ...
}
```

Adding a new note

Returning the number of notes (*delegation* to `ArrayList`).

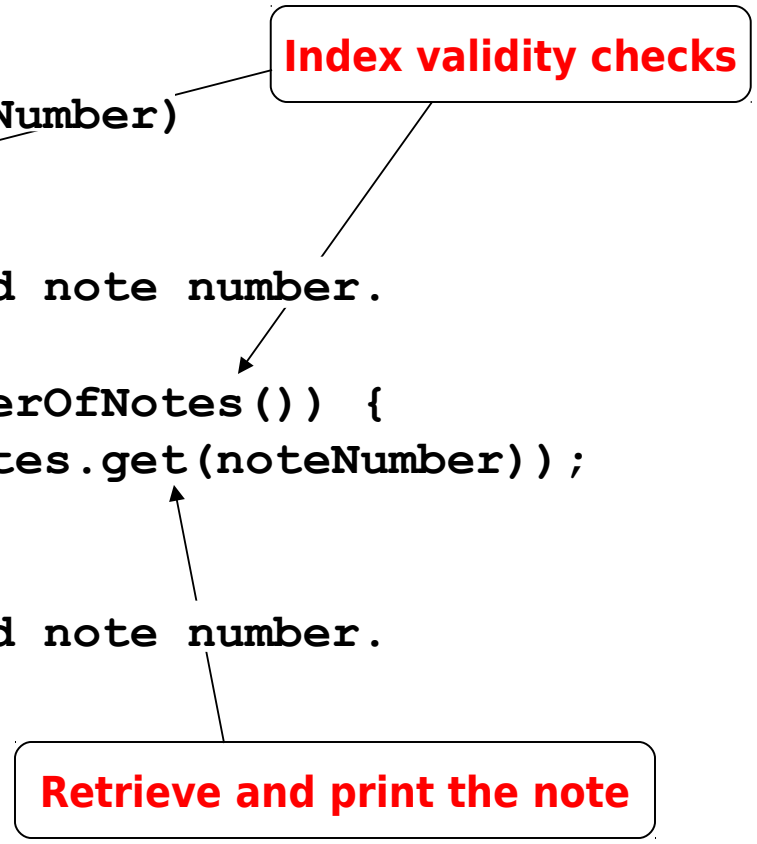
Index numbering

Implicit numbering (index), always starting from zero.

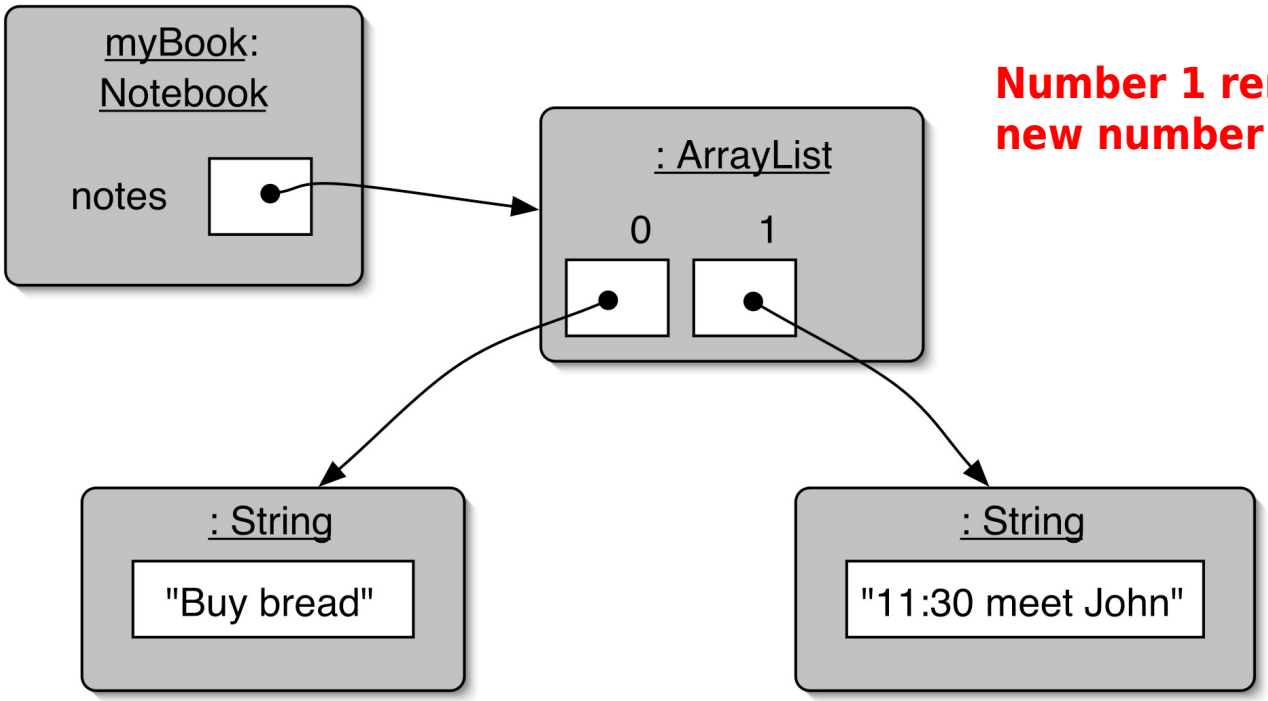


Retrieving an object

```
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.
    }
}
```



Removal may affect numbering



Number 1 removed – new number 1!

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.

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`.

Documentation of Java packages

- Java API Documentation
  - http://download.oracle.com/javase/7/docs/api/
- List of packages
  - List of interfaces and classes
    - Description of each class
      - Field, Constructors, and Methods summary
- Example: `java.util` -> `ArrayList`

Iteration

- *Iteration* means doing something several times, where the number of times may vary due to circumstances.
- 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 three sorts of loop statement:
  - We will focus on its *while loop*.

A Java example

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

Increment by one:
equivalent to

```
index += 1;
index = index+1;
```

Iterating over a collection: an alternative way

import java.util.Iterator

Returns an Iterator object

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

Attention: Iterator, iterator!

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

Iterator offers 2 methods: next, hasNext

The *auction* project

- The *auction* project provides further illustration of collections and iteration.
- Two further points to follow up:
  - The `null` value – reference to "no object".
  - Casting. Used to store the result of `get` into a variable (of a specific type):
    - `String message = (String) notes.get(0);`

Review

- Loop statements allow a block of statements to be repeated.
- A Java while loop allows the repetition to be controlled by a boolean expression.
- Collection classes have special `Iterator` objects that simplify iteration over the whole collection.

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 (collections can store objects only).
- Arrays use a special syntax (different from method concept for historical reasons).
- Access to arrays is typically more efficient.

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

- Log files contain line records:
  - `year month day hour minute`
  - `2011 11 15 10 55`
- Classes:
  - `LogAnalyzer`, `LogReader`, `LogEntry` and `LoglineTokenizer`

Creating an array object

```
public class LogAnalyzer
{
    private int[] hourCounts;
    private LogfileReader reader;

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

Array variable declaration - no creation of an array yet!

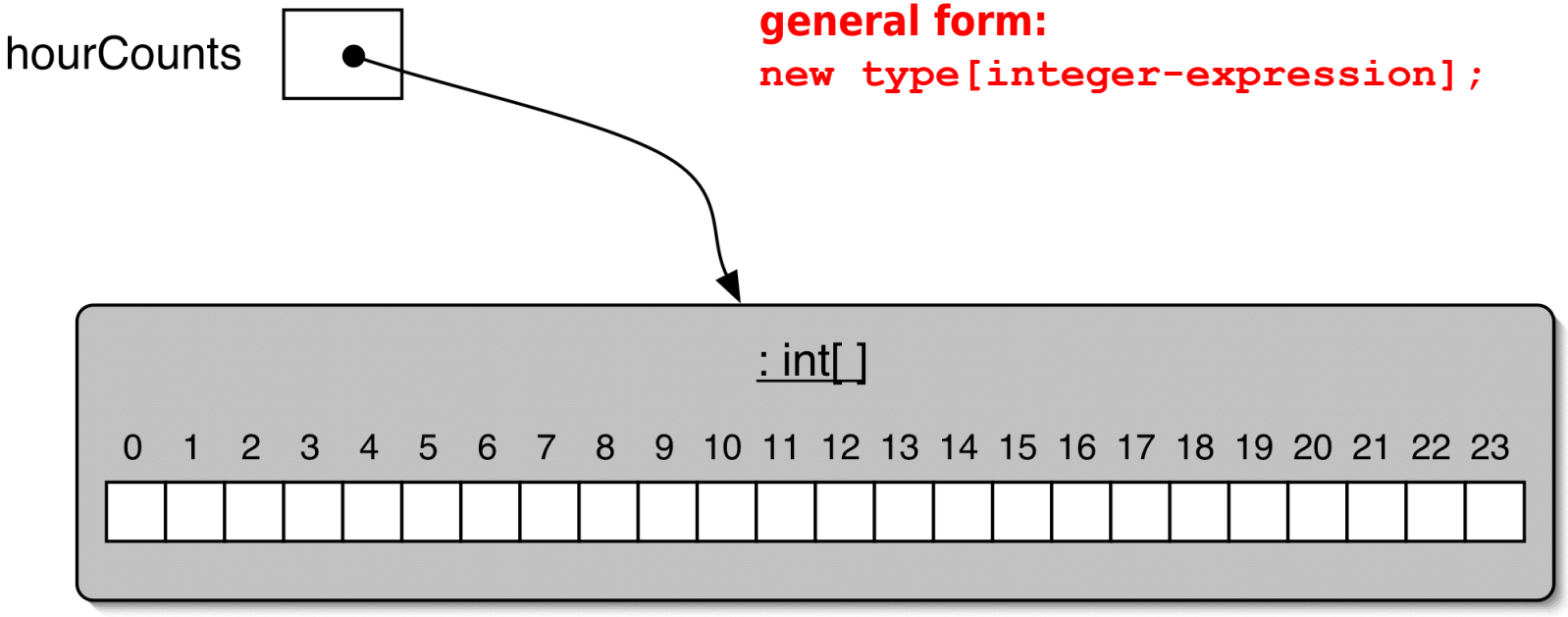
Array object creation

The `hourCounts` array

```
hourCounts = new int[24];
```

general form:

```
new type[integer-expression];
```



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]++;`
- Array indices always start at zero.

A Java `for` loop example using an array

for loop version

```
for(int hour = 0; hour < hourCounts.length; hour++) {
    System.out.println(hour + ": " + hourCounts[hour]);
}
```

while loop version

```
int hour = 0;
while(hour < hourCounts.length) {
    System.out.println(hour + ": " + hourCounts[hour]);
    hour++;
}
```

Review

- Arrays are appropriate where a fixed-size collection is required.
- Arrays use special syntax.
- Classical for loop usage to iterate over arrays.

Concepts covered today

- collection
- array
- index
- iterator
- while loop
- for loop
- import statement
- library
- package
- cast