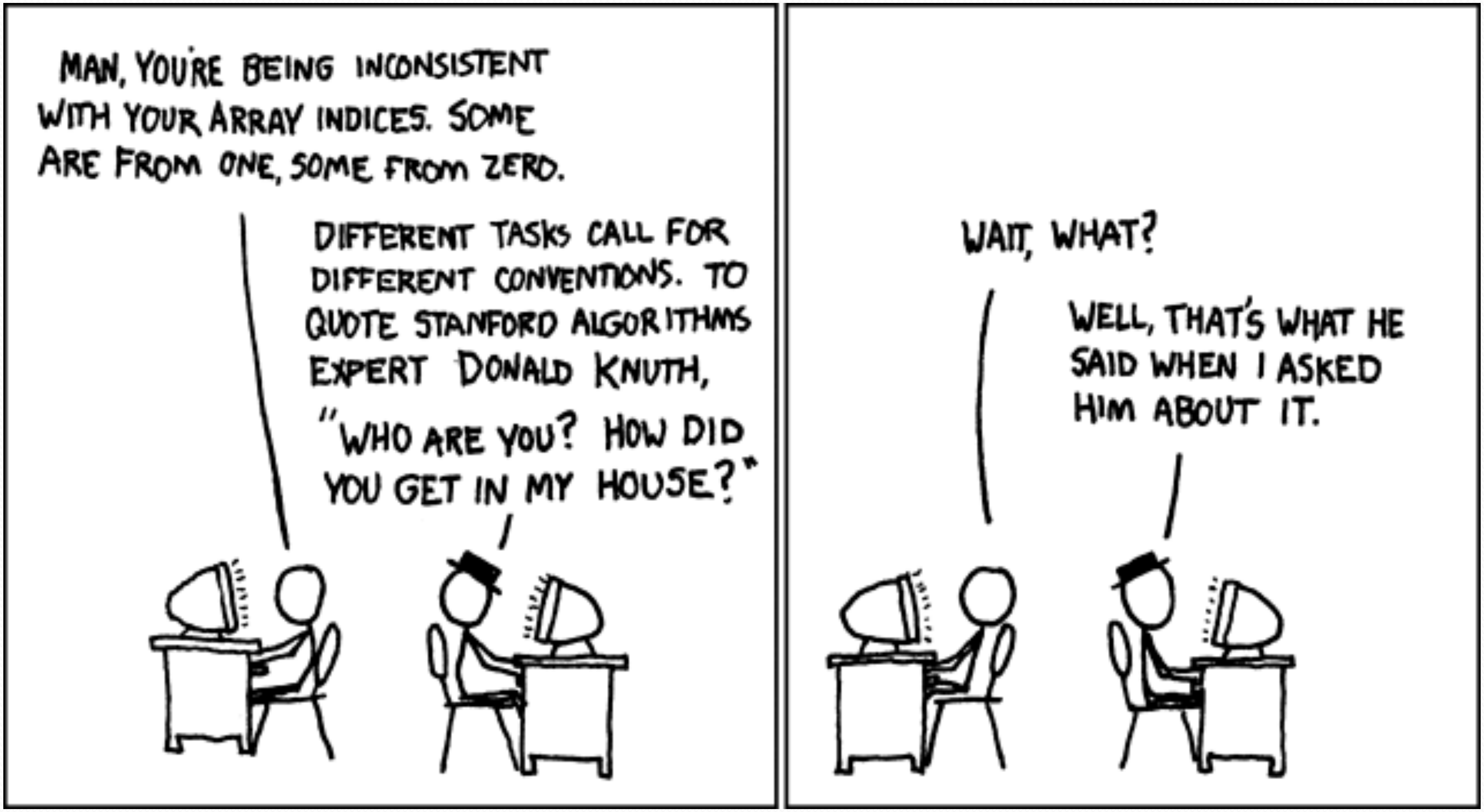
Building Java Programs

Chapter 10

Lecture 10-1: `ArrayList`

reading: 10.1


MAN, YOU'RE BEING INCONSISTENT WITH YOUR ARRAY INDICES. SOME ARE FROM ONE, SOME FROM ZERO.
DIFFERENT TASKS CALL FOR DIFFERENT CONVENTIONS. TO QUOTE STANFORD ALGORITHMS EXPERT DONALD KNUTH, "WHO ARE YOU? HOW DID YOU GET IN MY HOUSE?"
WAIT, WHAT?
WELL, THAT'S WHAT HE SAID WHEN I ASKED HIM ABOUT IT.

Words exercise

- Write code to read a file and display its words in reverse order.

- A solution that uses an array:

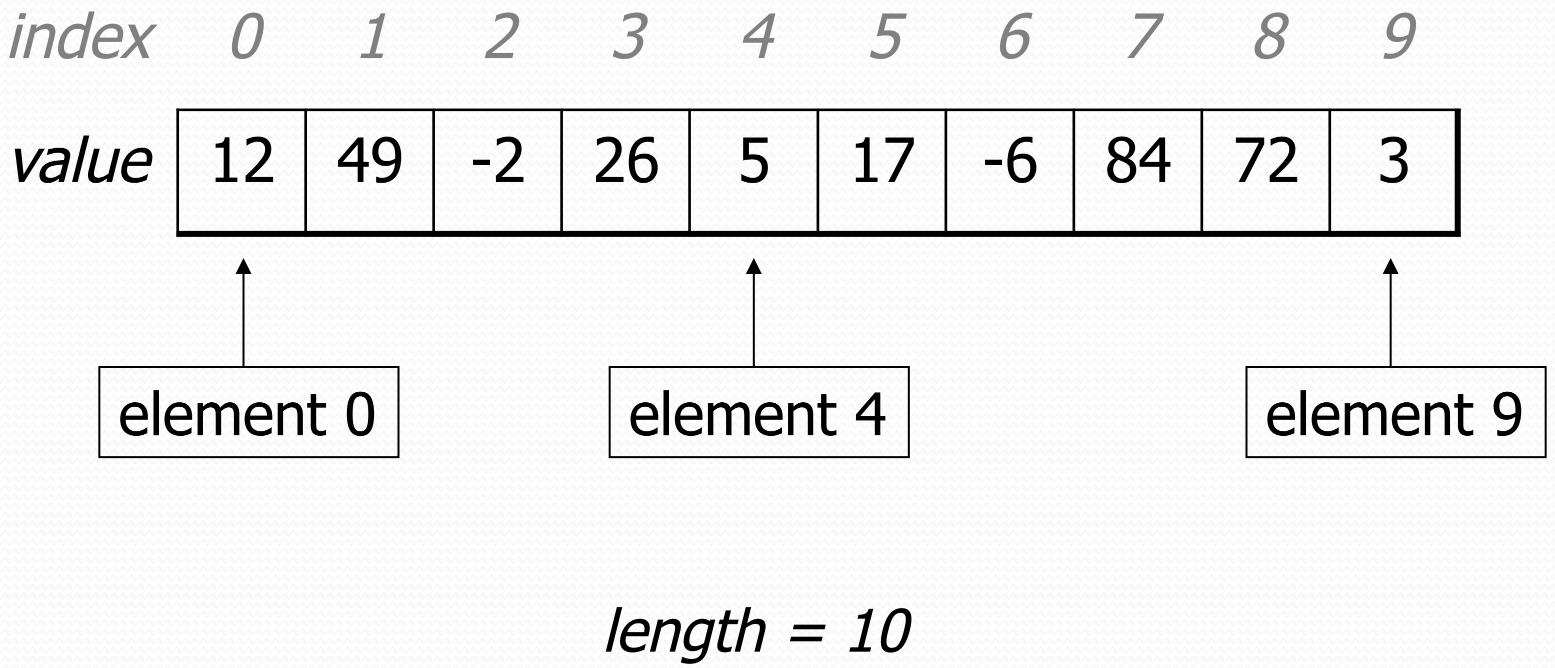
```
String[] allWords = new String[1000];
int wordCount = 0;

Scanner input = new Scanner(new File("words.txt"));
while (input.hasNext()) {
    String word = input.next();
    allWords[wordCount] = word;
    wordCount++;
}
```

- What's wrong with this?

Recall: Arrays (7.1)

- **array**: object that stores many values of the same type.
  - **element**: One value in an array.
  - **index**: 0-based integer to access an element from an array.
  - **length**: Number of elements in the array.



index 0 1 2 3 4 5 6 7 8 9
value 12 49 -2 26 5 17 -6 84 72 3
element 0
element 4
element 9
length = 10

Array Limitations

- Fixed-size
- Adding or removing from middle is hard
- Not much built-in functionality (need Arrays class)

List Abstraction

- Like an array that resizes to fit its contents.

- When a list is created, it is initially empty.

```
[]
```

- Use `add` methods to add to different locations in list

```
[hello, ABC, goodbye, okay]
```

  - The list object keeps track of the element values that have been added to it, their order, indexes, and its total size.
  - You can add, remove, get, set, ... any index at any time.

Collections

- **collection**: an object that stores data; a.k.a. "data structure"
  - the objects stored are called **elements**
  - some collections maintain an ordering; some allow duplicates
  - typical operations: *add*, *remove*, *clear*, *contains* (search), *size*

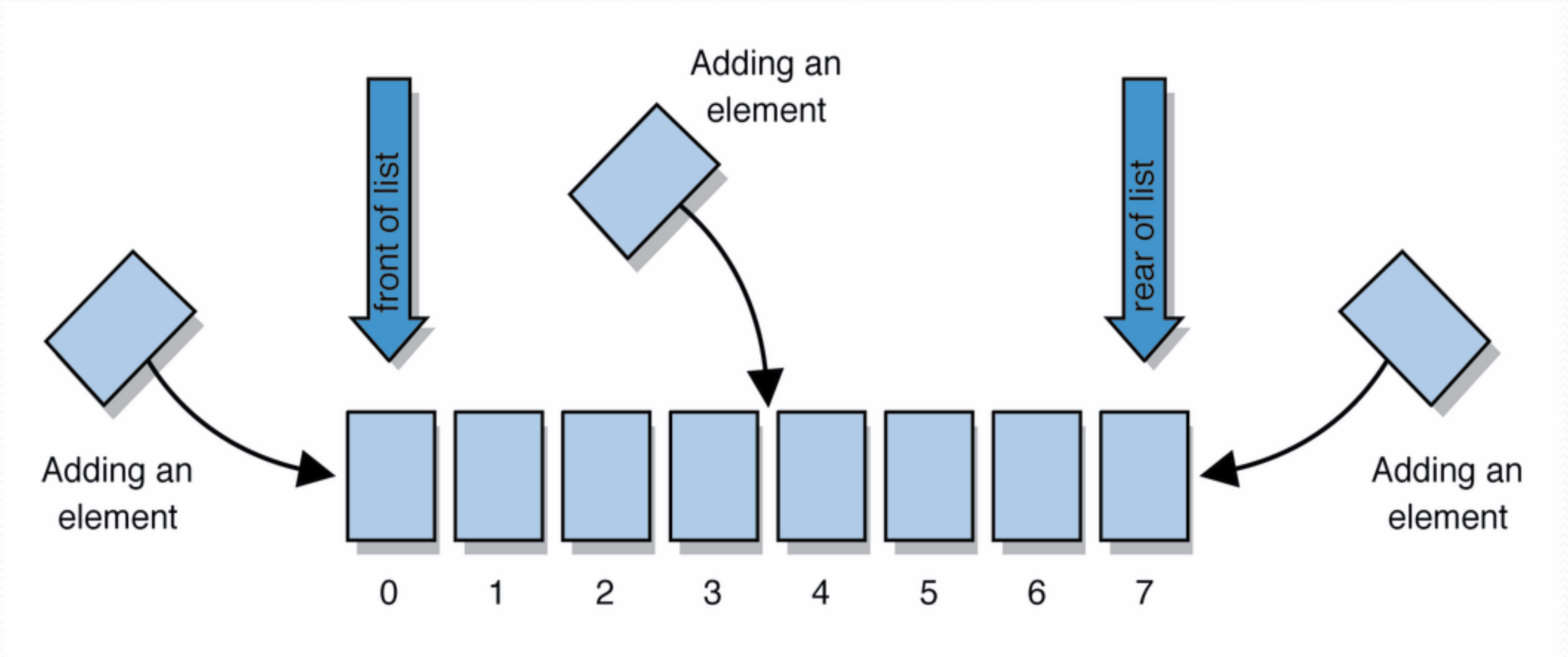
  - examples found in the Java class libraries:
    (covered in CSE 143!)
    - `ArrayList`, `LinkedList`, `HashMap`, `TreeSet`, `PriorityQueue`

  - all collections are in the `java.util` package

```
import java.util.*;
```

Lists

- **list**: a collection of elements with 0-based **indexes**
  - elements can be added to the front, back, or elsewhere
  - a list has a **size** (number of elements that have been added)
  - in Java, a list can be represented as an **`ArrayList`** object



Type parameters (generics)

`ArrayList<`**`Type`**`> `**`name`**` = new ArrayList<`**`Type`**`>();`

- When constructing an `ArrayList`, you must specify the type of its elements in `< >`
  - This is called a *type parameter* ; `ArrayList` is a *generic* class.
  - Allows the `ArrayList` class to store lists of different types.
  - Arrays use a similar idea with **Type**`[]`

```
ArrayList<String> names = new ArrayList<String>();
names.add("Marty Stepp");
names.add("Stuart Reges");
```

`ArrayList` methods (10.1)*

`add(`**value**`)`	appends value at end of list
`add(`**index**`,` **value**`)`	inserts given value just before the given index, shifting subsequent values to the right
`clear()`	removes all elements of the list
`indexOf(`**value**`)`	returns first index where given value is found in list (-1 if not found)
`get(`**index**`)`	returns the value at given index
`remove(`**index**`)`	removes/returns value at given index, shifting subsequent values to the left
`set(`**index**`,` **value**`)`	replaces value at given index with given value
`size()`	returns the number of elements in list
`toString()`	returns a string representation of the list such as `"[3, 42, -7, 15]"`

ArrayList vs. array

- construction

```
String[] names = new String[5];
ArrayList<String> list = new ArrayList<String>();
```

- storing a value

```
names[0] = "Jessica";
list.add("Jessica");
```

- retrieving a value

```
String s = names[0];
String s = list.get(0);
```

ArrayList vs. array

```
String[] names = new String[5];               // construct
names[0] = "Jessica";                         // store
String s = names[0];                          // retrieve
for (int i = 0; i < names.length; i++) {
    if (names[i].startsWith("B")) { ... }
}                                             // iterate
```

```
ArrayList<String> list = new ArrayList<String>();
list.add("Jessica");                          // store
String s = list.get(0);                       // retrieve
for (int i = 0; i < list.size(); i++) {
    if (list.get(i).startsWith("B")) { ... }
}                                             // iterate
```

ArrayList as param/return

```
public static void name(ArrayList<Type> name) {// param
public static ArrayList<Type> name(params)      //
return
```

- Example:

```
// Returns count of plural words in the given list.
public static int countPlural(ArrayList<String> list) {
    int count = 0;
    for (int i = 0; i < list.size(); i++) {
        String str = list.get(i);
        if (str.endsWith("s")) {
            count++;
        }
    }
    return count;
}
```

Words exercise, revisited

- Write a program that reads a file and displays the words of that file as a list.
  - Then display the words in reverse order.
  - Then display them with all plurals (ending in "s") capitalized.
  - Then display them with all plural words removed.

Exercise solution (partial)

```
ArrayList<String> allWords = new ArrayList<String>();
Scanner input = new Scanner(new File("words.txt"));
while (input.hasNext()) {
    String word = input.next();
    allWords.add(word);
}

// display in reverse order
for (int i = allWords.size() - 1; i >= 0; i--) {
    System.out.println(allWords.get(i));
}

// remove all plural words
for (int i = 0; i < allWords.size(); i++) {
    String word = allWords.get(i);
    if (word.endsWith("s")) {
        allWords.remove(i);
        i--;
    }
}
```

`ArrayList` of primitives?

- The type you specify when creating an `ArrayList` must be an object type; it cannot be a primitive type.

```
// illegal -- int cannot be a type parameter
ArrayList<int> list = new ArrayList<int>();
```

- But we can still use `ArrayList` with primitive types by using special classes called *wrapper* classes in their place.

```
// creates a list of ints
ArrayList<Integer> list = new ArrayList<Integer>();
```

Wrapper classes

Primitive Type	Wrapper Type
`int`	`Integer`
`double`	`Double`
`char`	`Character`
`boolean`	`Boolean`

- A wrapper is an object whose sole purpose is to hold a primitive value.

- Once you construct the list, use it with primitives as normal:

```
ArrayList<Double> grades = new ArrayList<Double>();
grades.add(3.2);
grades.add(2.7);
...
double myGrade = grades.get(0);
```