Building Java Programs

Chapter 10

Lecture 21: `ArrayList`

reading: 10.1

End of CSE142: Where to go from here

Courses at UW

- **CSE 143 – Computer Programming II**
  - More object-oriented programming
  - Basic data structures (Stacks, Queues, Trees, etc.)
  - Recursive Algorithms
- **CSE 154 – Web programming**
  - HTML, CSS, Javascript, PHP, MySQL
- **CSE 373 – Data Structures and Algorithms**
  - After CSE 143
  - More advanced data structures and algorithms

Some Programs at UW

- **CSE (Computer Science and Engineering)**
  - List of research areas: https://www.cs.washington.edu/research/
- **iSchool (Information School)**
  - "Information schools are interested in the relationship between information, technology, and people."
  - https://ischool.uw.edu/about
- **HCDE (Human Centered Design and Engineering)**
  - "Study Human Computer Interaction (HCI), User Experience (UX) Research and Design, Interaction Design and Prototyping, and Sociotechnical Systems"
  - http://www.hcde.washington.edu/
- **Engineering (Mechanical, Electrical, etc.)**
- **Sciences (Physics, Biology, etc.)**
- **Math (Statistics, Discrete Math, etc.)**

Online Tutorials

- Web programming
  - w3schools: http://www.w3schools.com/
    - Try HTML, javascript, css, jQuery
- Code Academy
  - https://www.codecademy.com/learn
  - Try Python or Ruby in "Language Skills"
- Khan Academy
  - https://www.khanacademy.org/computing/computer-programming
  - Try "Intro to SQL"
- Many more…

Words exercise

- Write code to read a file and display its words in reverse order.
- A solution that uses an array:

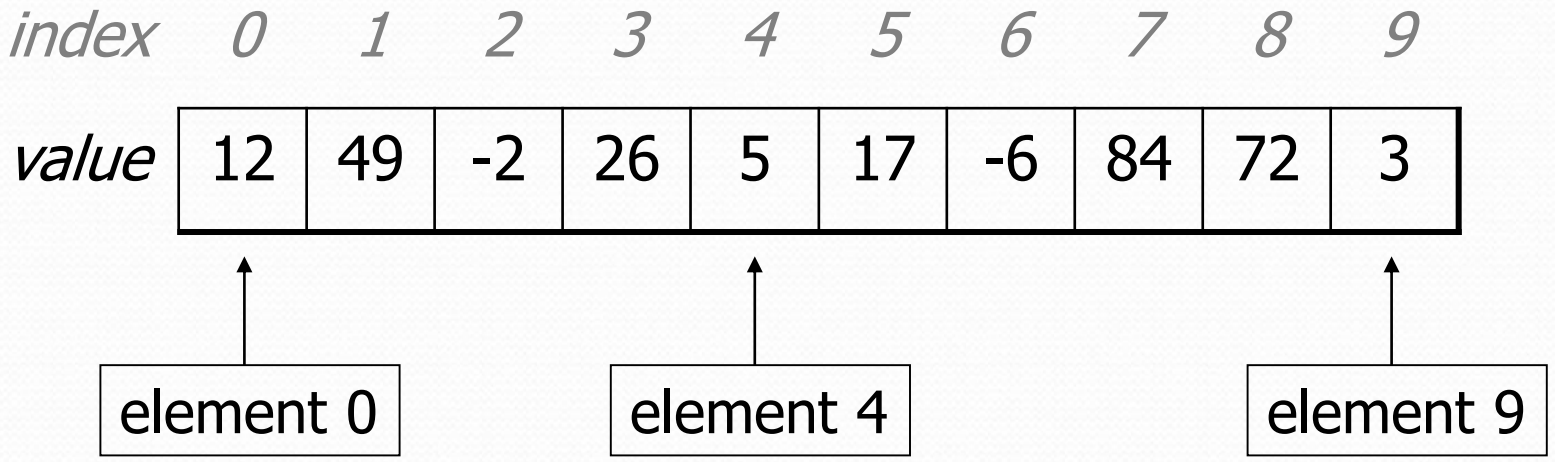
```
String[] allWords = new String[1000];
int wordCount = 0;

Scanner input = new Scanner(new File("words.txt"));
while (input.hasNext()) {
    String word = input.next();
    allWords[wordCount] = word;
    wordCount++;
}
for(int i = allWords.length - 1; i >= 0; i++) {
    System.out.print(allwords[i] + " ");
}
```

- 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.



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]
```

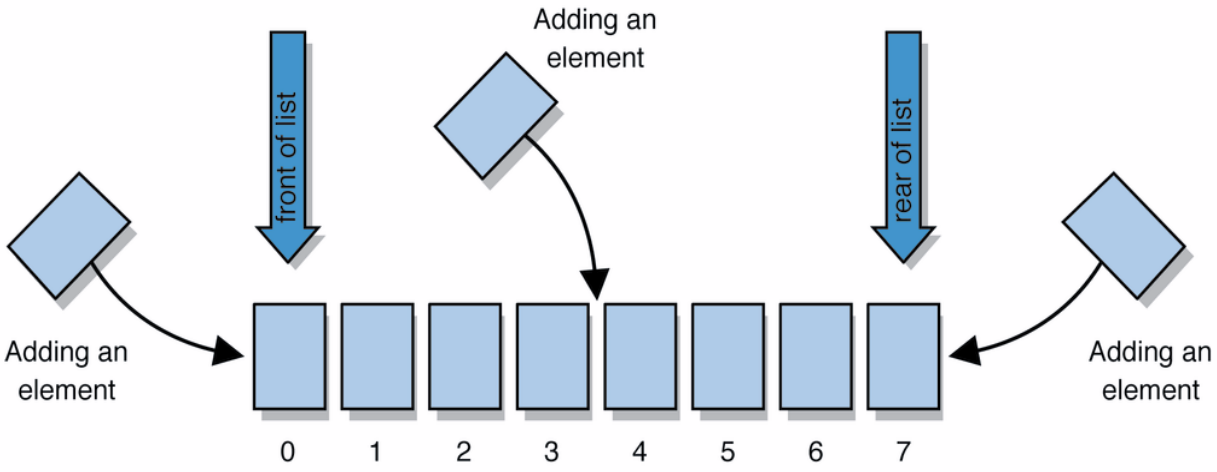
  - The list object keeps track of the element values that have been added to it, their order, indexes, and its total size.
  - You can add, remove, get, set, ... any index at any time.

Collections and lists

- **collection**: an object that stores data ("**elements**")

```
import java.util.*;   // to use Java's collections
```

- **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);
```