Building Java Programs

Chapter 15
Lecture 15-1: Implementing `ArrayIntList`

reading: 15.1 - 15.3
Could you explain loops to me, Bob? How do they work?

What?

I said: “I don’t understand how loops work.”

Could you repeat that?

I said... I don't bloody understand how loops wo-*

Oh, I see what you did there. Were you talking to me?
Recall: classes and objects

• **class**: A program entity that represents:
  • A complete program or module, or
  • A template for a type of objects.
  • (*ArrayList* is a class that defines a type.)

• **object**: An entity that combines **state** and **behavior**.
  
  – **object-oriented programming (OOP)**: Programs that perform their behavior as interactions between objects.

  – **abstraction**: Separation between concepts and details. Objects provide abstraction in programming.
Elements of a class

public class BankAccount {
    private String name; // fields:
    private int id; // data encapsulated
    private double balance; // inside each object

    public BankAccount(String name, int id) {
        this.name = name; // constructor:
        this.id = id; // initializes
        this.balance = 0.0; // new objects
    }

    public void deposit(double amount) {
        this.balance += amount; // instance method:
    }
    ... // each object's behavior
}

"implicit parameter": object on which a method was called
### ArrayList implementation

- **What is an ArrayList's behavior?**
  - add, remove, indexOf, etc

- **What is an ArrayList's state?**
  - Many elements of the same type
  - For example, unfilled array

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`size` 5
ArrayIntList implementation

- Simpler than ArrayList<E>
  - No generics (only stores ints)
  - Fewer methods: `add(value)`, `add(index, value)`, `get(index)`, `set(index, value)`, `size()`, `isEmpty()`, `remove(index)`, `indexOf(value)`, `contains(value)`, `toString()`,

- Fields?
  - `int[]`
  - `int` to keep track of the number of elements added
  - The default capacity (array length) will be 10
Implementing `add`

- How do we add to the end of a list?

```java
public void add(int value) {
    list[size] = value;  // just put the element
    size++;              // in the last slot,  
}                       // and increase the size
```

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- `list.add(42);`

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Printing an `ArrayIntList`

- Let's add a method that allows clients to print a list's elements.

- You may be tempted to write a `print` method:
  ```java
  // client code
  ArrayIntList list = new ArrayIntList();
  ...
  list.print();
  ```

- Why is this a bad idea? What would be better?
The `toString` method

- Tells Java how to convert an object into a `String`
  ```java
  ArrayIntList list = new ArrayIntList();
  System.out.println("list is " + list);
  // ("list is " + list.toString());
  ```

- **Syntax:**
  ```java
  public String toString() {
    code that returns a suitable String;
  }
  ```

- Every class has a `toString`, even if it isn't in your code.
  - The default is the class's name and a hex (base-16) number:
    ```java
    ArrayIntList@9e8c34
    ```
/\* Returns a String representation of the list. \*/
public String toString() {
    if (size == 0) {
        return "[]";
    } else {
        String result = "[" + elementData[0];
        for (int i = 1; i < size; i++) {
            result += ", " + elementData[i];
        }
        result += "]";
        return result;
    }
}
Implementing \texttt{add} \#2

• How do we add to the middle or end of the list?
  • must \textit{shift} elements to make room for the value (see book 7.4)

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• \texttt{list.add(3, 42);} // insert 42 at index 3

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• Note: The order in which you traverse the array matters!
public void add(int index, int value) {
    for (int i = size; i > index; i--) {
        list[i] = list[i - 1];
    }
    list[index] = value;
    size++;
}

• list.add(3, 42);

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Other methods

- Let's implement the following methods in our list:
  - `get(index)`
    Returns the element value at a given index.
  - `set(index, value)`
    Sets the list to store the given value at the given index.
  - `size()`
    Returns the number of elements in the list.
  - `isEmpty()`
    Returns `true` if the list contains no elements; else `false`. (Why write this if we already have the `size` method?)
Implementing remove

• Again, we need to shift elements in the array
  • this time, it's a left-shift
  • in what order should we process the elements? 
  • what indexes should we process?

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• `list.remove(2);` // delete 9 from index 2

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Implementing `remove` code

```java
public void remove(int index) {
    for (int i = index; i < size; i++) {
        list[i] = list[i + 1];
    }
    size--;
    list[size] = 0;    // optional (why?)
}
```

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