ArrayLists

Chapter 12.1 in Savitch

Using arrays to store data

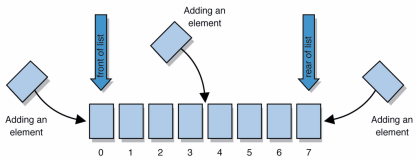
- Arrays: store multiple values of the same type.
- Conveniently refer to items by their index
- Need to know the size before declaring them:

```
int[] numbers = new int[100];
```

- We often need to store an unknown number of values.
  - Need to either count the values or resize as additional storage space is needed.

Lists

- **list**: a collection storing an ordered sequence of elements,
  each accessible by a 0-based index
  - a list has a **size** (number of elements that have been added)
  - elements can be added at any position



Exercise

- Let's write a class called `ArrayIntList` that implements a list using `int[]`
  - behavior:
    - `add(`**value**`)`, `add(`**index**`, `**value**`)`
    - `get(`**index**`)`, `set(`**index**`, `**value**`)`
    - `size()`
    - `remove(`**index**`)`
    - `indexOf(`**value**`)`
    - ...
  - The list's *size* will be the number of elements added to it so far

Using `ArrayIntList`

- construction

```
int[] numbers = new int[5];
ArrayIntList list = new ArrayIntList();
```

- storing a value

```
numbers[0] = 42;
list.add(42);
```

- retrieving a value

```
int n = numbers[0];
int n = list.get(0);
```

- searching for the value `27`

```
for (int i = 0; i < numbers.length; i++) {
    if (numbers[i] == 27) { ... }
}
if (list.indexOf(27) >= 0) { ... }
```

Pros/cons of `ArrayIntList`

- pro (benefits)
  - simple syntax
  - don't have to keep track of array size and capacity
  - has powerful methods (`indexOf`, `add`, `remove`, `toString`)
- con (drawbacks)
  - `ArrayIntList` only works for `int`s (arrays can be any type)
  - Need to learn

Java Collections and ArrayLists

- Java includes a large set of powerful collections classes.
- The most basic, `ArrayList`, is can store any type of Object.
- All collections are in the `java.util` package.

```
import java.util.ArrayList;
```

Type Parameters (Generics)

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

- When constructing an `ArrayList`, you can specify the type of elements it will contain between < and >.
  - We say that the `ArrayList` class accepts a *type parameter*, or that it is a *generic* class.

```
ArrayList<String> names = new ArrayList<String>();
names.add("Asa");
names.add("Nathan");
```

`ArrayList` methods

`add(`**value**`)`	appends value at end of list
`add(`**index**`, `**value**`)`	inserts given value at given index, shifting subsequent values 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 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` methods 2

`addAll(`**list**`)` `addAll(`**index**`, `**list**`)`	adds all elements from the given list at the end of this list inserts the list at the given index of this list
`contains(`**value**`)`	returns true if given value is found somewhere in this list
`containsAll(`**list**`)`	returns true if this list contains every element from given list
`equals(`**list**`)`	returns true if given other list contains the same elements
`remove(`**value**`)`	finds and removes the given value from this list
`removeAll(`**list**`)`	removes any elements found in the given list from this list
`retainAll(`**list**`)`	removes any elements *not* found in given list from this list
`subList(`**from**`, `**to**`)`	returns the sub-portion of the list between indexes **from** (inclusive) and **to** (exclusive)
`toArray()`	returns an array of the elements in this list

Iterating through an array list

- Suppose we want to look for a `value` in an ArrayList of Strings.

```
for (int i = 0; i < list.size(); i++) {
    if(value.equals(list.get(i)){
        //do something
    }
}
```

- Alternative:

```
for (String s : list) {
    if(value.equals(s)){
        //do something
    }
}
```

Note on generics in Java 7

In version 7 of Java, rather than doing:

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

You can save a few keystrokes:

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

Learning about classes

- The Java API Specification is a huge web page containing documentation about every Java class and its methods.
  - The link to the API Specs is on the course web site.

Modifying while looping

- Consider the following flawed pseudocode for removing elements that end with s from a list:

```
removeEndS(list) {
    for (int i = 0; i < list.size(); i++) {
        get element i;
        if it ends with an 's', remove it.
    }
}
```

  - What does the algorithm do wrong?

index	0	1	2	3	4	5
value	"she"	"sells"	"seashells"	"by"	"the"	"seashore"
size	6					

`ArrayList` of primitives?

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

```
// 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.

```
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 purpose is to hold a primitive value and to provide more functionality.
- Once you construct the list, use it with primitives as normal (autoboxing):

```
ArrayList<Double> grades = new ArrayList<Double>();
grades.add(3.2);
grades.add(2.7);
```

Wrapper classes - continued

- Autoboxing:

```
ArrayList<Double> grades = new ArrayList<Double>();
// Autoboxing: create Double from double 3.2
grades.add(3.2);
grades.add(2.7);
double sum = 0.0;
for (int i = 0; i < grades.size(); i++) {
   //AutoUNboxing from Double to double
   sum += grades.get(i);
}
...
```

Looking ahead: Interfaces

- A Java interface specifies which public methods are available to a user
- A class implements an interface if it provides all the methods in the interface
- Interfaces allow for a common behavior amongst classes, eg the Collection interface is implemented by many classes (LinkedList, ArrayList...)

Java Collections

- ArrayList belongs to Java's collections framework.
- Other classes have a very similar interface, so it will be easier to learn how to use those classes once you've learned ArrayLists