ArrayLists

Using arrays to store data

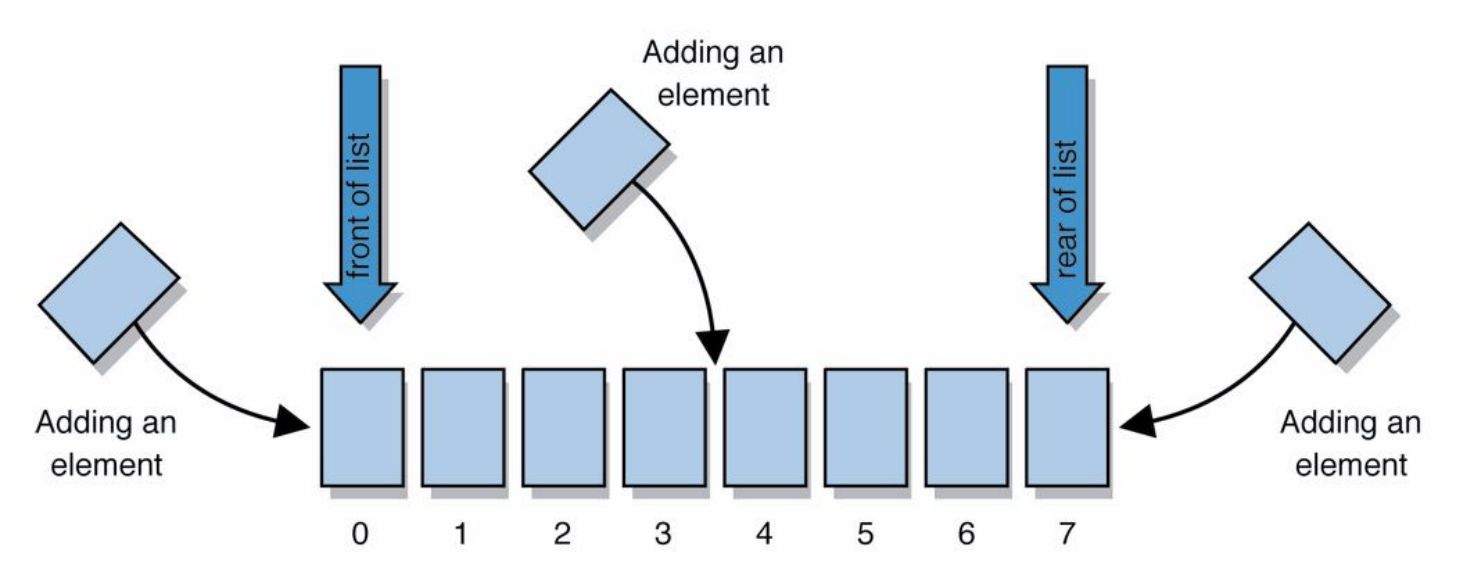
- Arrays: store multiple values of the same type.
- Conveniently refer to items by their index
- Need to know the size before declaring them:

```
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



`ArrayIntList`

- Let's consider the methods of a class called `ArrayIntList` that represents 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

ArrayIntList

- construction

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

- storing a given value: retrieving a value

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

- searching for a given value

```
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 how to use the class

Java Collections and ArrayLists

- Java includes a large set of powerful classes that provide functionality for storing and accessing collections of objects
- The most basic, `ArrayList`, 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

Learning about classes

- The Java API specification website contains detailed documentation of every Java class and its methods.

https://docs.oracle.com/javase/8/docs/api/

java.text.spi
java.time
java.time.chrono
java.time.format
java.time.temporal
java.time.zone
java.util
java.util.concurrent
java.util.concurrent.atomic
java.util.concurrent.locks
java.util.function
java.util.jar
java.util.logging

AppletStub
ApplicationException
Arc2D
Arc2D.Double
Arc2D.Float
Area
AreaAveragingScaleFilter
ARG_IN
ARG_INOUT
ARG_OUT
ArithmeticException
Array
Array
ArrayBlockingQueue
ArrayDeque
ArrayIndexOutOfBoundsException
ArrayList
Arrays
ArrayStoreException
ArrayType
ArrayType
AssertionError
AsyncBoxView
AsyncHandler
AsynchronousByteChannel
AsynchronousChannel
AsynchronousChannelGroup
AsynchronousChannelProvider

Constructors

Constructor and Description
`ArrayList()` Constructs an empty list with an initial capacity of ten.
`ArrayList(Collection<? extends E> c)` Constructs a list containing the elements of the specified collection, in the order they are returned by the collection's iterator.
`ArrayList(int initialCapacity)` Constructs an empty list with the specified initial capacity.

Method Summary

All Methods | **Instance Methods** | **Concrete Methods**

Modifier and Type	Method and Description
boolean	`add(E e)` Appends the specified element to the end of this list.
void	`add(int index, E element)` Inserts the specified element at the specified position in this list.
boolean	`addAll(Collection<? extends E> c)` Appends all of the elements in the specified collection to the end of this list, in the order that they are returned by the specified collection's Iterator.
boolean	`addAll(int index, Collection<? extends E> c)` Inserts all of the elements in the specified collection into this list, starting at the specified position.
void	`clear()` Removes all of the elements from this list.
Object	`clone()` Returns a shallow copy of this `ArrayList` instance.

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 and above

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<>();
```

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: Example

- Every java primitive has a class dedicated to it.

```
Example:

int x = 3;
Integer y = new Integer(5);

int z = x + y;

int z  = x + y.intValue();  // convert wrapper to primitive

// can also construct an Integer from a string:

y = new Integer("5");
```

ArrayLists of wrapper type objects

Primitive Type	Wrapper Type
int	Integer
double	Double
char	Character
boolean	Boolean
float	Float

- 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);
```

ArrayLists of wrapper type objects

- 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);
}
...
```

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 ArrayList

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 common behavior amongst classes. Example: the List interface is implemented by several Collections classes (LinkedList, ArrayList, Vector, Stack)