CSE 143
Lecture 3

More `ArrayList`;
object-oriented programming

reading: 10.1; 8.1 - 8.7

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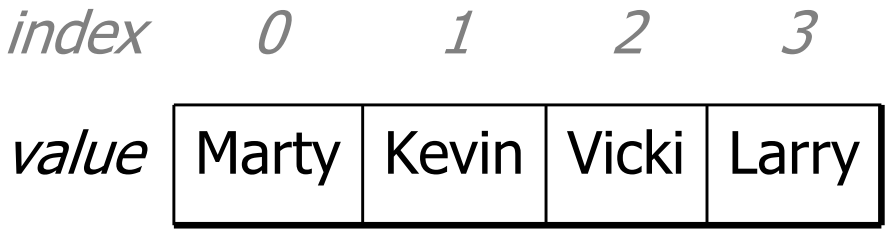
Out-of-bounds

- Legal indexes are between **0** and the **list's size() - 1**.
  - Reading or writing any index outside this range will cause an `IndexOutOfBoundsException`.

```
ArrayList<String> names = new ArrayList<String>();
names.add("Marty");    names.add("Kevin");
names.add("Vicki");    names.add("Larry");
System.out.println(names.get(0));          // okay
System.out.println(names.get(3));          // okay
System.out.println(names.get(-1));         // exception
names.add(9, "Aimee");                     // exception
```



ArrayList "mystery"

```
ArrayList<Integer> list = new ArrayList<Integer>();
for (int i = 1; i <= 10; i++) {
    list.add(10 * i);   // [10, 20, 30, 40, ..., 100]
}
```

- What is the output of the following code?

```
for (int i = 0; i < list.size(); i++) {
    list.remove(i);
}
System.out.println(list);
```

- Answer:

```
[20, 40, 60, 80, 100]
```

ArrayList "mystery" 2

```
ArrayList<Integer> list = new ArrayList<Integer>();
for (int i = 1; i <= 5; i++) {
    list.add(2 * i);   // [2, 4, 6, 8, 10]
}
```

- What is the output of the following code?

```
int size = list.size();
for (int i = 0; i < size; i++) {
    list.add(i, 42);   // add 42 at index i
}
System.out.println(list);
```

- Answer:

```
[42, 42, 42, 42, 42, 2, 4, 6, 8, 10]
```

ArrayList as parameter

```
public static void name(ArrayList<Type> name) {
```

- Example:

```
// Removes all plural words from the given list.
public static void removePlural(ArrayList<String> list) {
    for (int i = 0; i < list.size(); i++) {
        String str = list.get(i);
        if (str.endsWith("s")) {
            list.remove(i);
            i--;
        }
    }
}
```

- You can also return a list:

```
public static ArrayList<Type> methodName(params)
```

Exercise

- Write a method `addStars` that accepts an array list of strings as a parameter and places a `*` after each element.
  - Example: if an array list named `list` initially stores:

    ```
    [the, quick, brown, fox]
    ```

  - Then the call of `addStars(list);` makes it store:

    ```
    [the, *, quick, *, brown, *, fox, *]
    ```

- Write a method `removeStars` that accepts an array list of strings, assuming that every other element is a `*`, and removes the stars (undoing what was done by `addStars` above).

Exercise solution

```
public static void addStars(ArrayList<String> list) {
    for (int i = 0; i < list.size(); i += 2) {
        list.add(i, "*");
    }
}


public static void removeStars(ArrayList<String> list) {
    for (int i = 0; i < list.size(); i++) {
        list.remove(i);
    }
}
```

Exercise

- Write a method `intersect` that accepts two sorted array lists of integers as parameters and returns a new list that contains only the elements that are found in both lists.
  - Example: if lists named `list1` and `list2` initially store:

    `[1, 4, 8, 9, 11, 15, 17, 28, 41, 59]`

    `[4, 7, 11, 17, 19, 20, 23, 28, 37, 59, 81]`

  - Then the call of `intersect(list1, list2)` returns the list:

    `[4, 11, 17, 28, 59]`

Other Exercises

- Write a method `reverse` that reverses the order of the elements in an `ArrayList` of strings.

- Write a method `capitalizePlurals` that accepts an `ArrayList` of strings and replaces every word ending with an "s" with its uppercased version.

- Write a method `removePlurals` that accepts an `ArrayList` of strings and removes every word in the list ending with an "s", case-insensitively.

Object-Oriented Programming

reading: 8.1 - 8.7

Classes and objects

- **class**: A program entity that represents either:
  1. A program / module, or
  2. A template for a new type of objects.

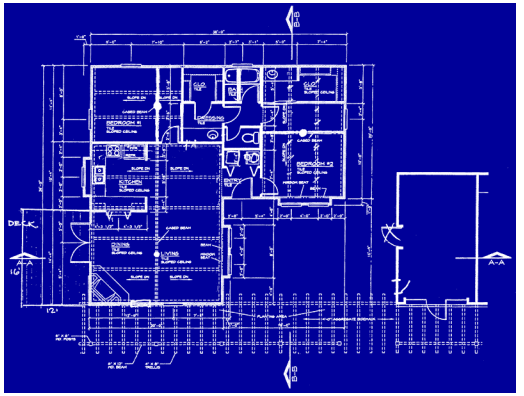
- **object**: An entity that combines **state** and **behavior**.
  - **object-oriented programming (OOP)**: Programs that perform their behavior as interactions between objects.
  - **abstraction**: Separation between concepts and details. Objects provide abstraction in programming.

Blueprint analogy

iPod blueprint

state:
- current song
- volume
- battery life

behavior:
- power on/off
- change station/song
- change volume
- choose random song



creates

iPod #1

state:
- song = "1,000,000 Miles"
- volume = 17
- battery life = 2.5 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

iPod #2

state:
- song = "Letting You"
- volume = 9
- battery life = 3.41 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

iPod #3

state:
- song = "Discipline"
- volume = 24
- battery life = 1.8 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

Clients of objects

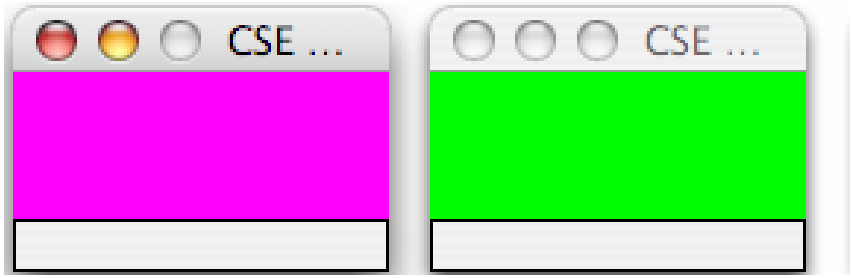
- **client program**: A program that uses objects.
  - Example: `Bomb` is a client of `DrawingPanel` and `Graphics`.

`Bomb.java` (client program)

```
public class Bomb {
    main(String[] args) {
        new DrawingPanel(...)
        new DrawingPanel(...)
        ...
    }
}
```

`DrawingPanel.java` (class)

```
public class DrawingPanel {
    ...
}
```



Fields

- **field**: A variable inside an object that is part of its state.
  - Each object has *its own copy* of each field.

- Declaration syntax:

```
private type name;
```

  - Example:

```
public class Point {
    private int x;
    private int y;

    ...
}
```

Instance methods

- **instance method** (or **object method**): A method inside each object of a class that gives behavior to each object.

```
public type name(parameters) {
    statements;
}
```

  - same syntax as static methods, but without `static` keyword

  Example:

```
public void translate(int dx, int dy) {
    x = x + dx;
    y = y + dy;
}
```

The implicit parameter

- **implicit parameter**:
  The object on which an instance method is being called.
  - If we have a `Point` object `p1` and call `p1.translate(5, 3);` the object referred to by `p1` is the implicit parameter.
  - If we have a `Point` object `p2` and call `p2.translate(4, 1);` the object referred to by `p2` is the implicit parameter.
  - The instance method can refer to that object's fields.
    - We say that it executes in the *context* of a particular object.
    - `translate` can refer to the `x` and `y` of the object it was called on.

Constructors

- **constructor**: Initializes the state of new objects.

```
public type(parameters) {
    statements;
}
```

  - runs when the client uses the `new` keyword
  - no return type is specified; implicitly "returns" the new object

```
public class Point {
    private int x;
    private int y;

    public Point(int initialX, int initialY) {
        x = initialX;
        y = initialY;
    }
```

BankAccount exercise

- Suppose we have a class `BankAccount` with the methods:

```
public BankAccount(int id)
public void deposit(double amount)
public void withdraw(double amount)
public double getBalance()
public int getID()
```

- How would we make each account object keep a log of all deposit/withdrawal transactions?
  - Desired: a `printLog` method that shows all transactions so far.

```
Deposit of $7.84
Withdrawal of $2.53
Deposit of $6.19
```

Objects storing collections

- An object can have an array, list, or other collection as a field.

```
public class Course {
    private double[] grades;
    private ArrayList<String> studentNames;

    public Course() {
        grades = new double[4];
        studentNames = new ArrayList<String>();
        ...
    }
```

- Now each object stores a collection of data inside it.