CSE 143
Lecture 6

More `ArrayIntList`; Inheritance

reading: 15.1 - 15.2; 9.1, 9.3 - 9.4

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Finishing `ArrayIntList`

- Let's add the following features to `ArrayIntList`:
  - a constant for the default list capacity
  - better encapsulation and protection of implementation details
  - a better way to print list objects

Class constants

```
public static final type name = value;
```

- **class constant**: a global, unchangeable value in a class
  - used to store and give names to important values used in code
  - documents an important value; easier to find and change later

- classes will often store constants related to that type
  - `Math.PI`
  - `Integer.MAX_VALUE`, `Integer.MIN_VALUE`
  - `Color.GREEN`

```
// default array length for new ArrayIntLists
public static final int DEFAULT_CAPACITY = 10;
```

"Helper" methods

- Currently our list class has a few useful "helper" methods:
  - `public void checkResize()`
  - `public void checkIndex(int index, int min, int max)`
- We wrote them to help us implement other required methods.
- We don't want clients to call these methods; they are internal.
  - How can we stop clients from calling them?

A private method

```
private type name(type name, ..., type name) {
    statement(s);
}
```

- a **private method** can be seen/called only by its own class
  - encapsulated, similar to fields
  - your object can call the method on itself, but clients cannot call it
  - useful for "helper" methods that clients shouldn't directly touch

```
private void checkIndex(int index, int min, int max) {
    if (index < min || index > max) {
        throw new IndexOutOfBoundsException(index);
    }
}
```

Printing an `ArrayIntList`

- Currently our list class has a `print` method:

```
// 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`

```
ArrayIntList list = new ArrayIntList();
System.out.println("list is " + list);
```

- Syntax:

```
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:

```
ArrayIntList@9e8c34
```

toString solution

```
// 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;
    }
}
```

Exercise

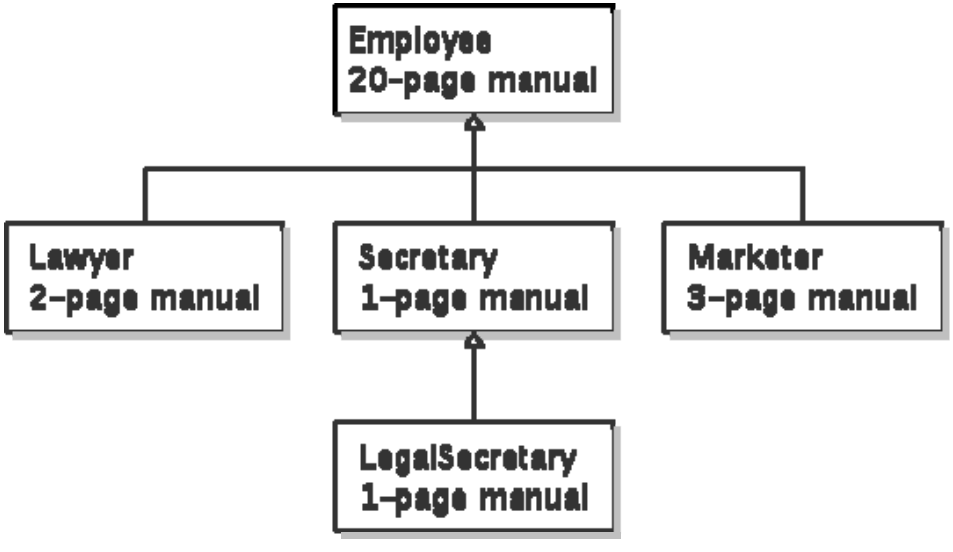
- Write a class called `StutterIntList`.
  - Its constructor accepts an integer *stretch* parameter.
  - Every time an integer is added, the list will actually add *stretch* number of copies of that integer.

- Example usage:

```
StutterIntList list = new StutterIntList(3);
list.add(7);      // [7, 7, 7]
list.add(-1);     // [7, 7, 7, -1, -1, -1]
list.add(2, 5);   // [7, 7, 5, 5, 5, 7, -1, -1, -1]
list.remove(4);   // [7, 7, 5, 5, 7, -1, -1, -1]
System.out.println(list.getStretch());   // 3
```

Inheritance

- **inheritance**: Forming new classes based on existing ones.
  - a way to share/**reuse code** between two or more classes
  - **superclass**: Parent class being extended.
  - **subclass**: Child class that inherits behavior from superclass.
    - gets a copy of every field and method from superclass



An `Employee` class

```
public class Employee {
    ...

    public int getHours() {
        return 40;              // works 40 hours / week
    }

    public double getSalary() {
        return 40000.0;         // $40,000.00 / year
    }

    public int getVacationDays() {
        return 10;              // 2 weeks' paid vacation
    }

    public String getVacationForm() {
        return "yellow";        // use the yellow form
    }
}
```

- Lawyers, Secretaries, etc. have similar behavior to the above.
  - How to implement those classes without redundancy?

Inheritance syntax

```
public class name extends superclass {
```

- Example:

```
public class Lawyer extends Employee {
    ...
}
```

- By extending `Employee`, each `Lawyer` object now:
  - receives a copy of each method from `Employee` automatically
  - can be treated as an `Employee` by client code

Overriding methods

- **override**: To replace a superclass's method by writing a new version of that method in a subclass.
  - No special syntax is required to override a method.
    Just write a new version of it in the subclass.

```
public class Lawyer extends Employee {
    // overrides getSalary method in Employee class;
    // give Lawyers a $5K raise
    public double getSalary() {
        return 45000.00;
    }
}
```

`super` keyword

- Subclasses can call overridden methods with `super`

  `super.`**method**`(`**parameters**`)`

  – Example:

```
public class Lawyer extends Employee {
    // give Lawyers a $5K raise (better)
    public double getSalary() {
        double baseSalary = super.getSalary();
        return baseSalary + 5000.00;
    }
}
```

  – This version makes sure that Lawyers always make $5K more than Employees, even if the Employee's salary changes.

Calling super constructor

`super(`**parameters**`);`

- Example:

```
public class Lawyer extends Employee {
    public Lawyer(String name) {
        super(name);  // calls Employee constructor
    }
    ...
}
```

- `super` allows a subclass constructor to call a superclass one.
- The `super` call must be the first statement in the constructor.
- Constructors are not inherited; If you extend a class, you must write all the constructors you want your subclass to have.

Exercise solution

```
public class StutterIntList extends ArrayIntList {
    private int stretch;

    public StutterIntList(int stretchFactor) {
        super();
        stretch = stretchFactor;
    }

    public StutterIntList(int stretchFactor, int capacity) {
        super(capacity);
        stretch = stretchFactor;
    }

    public void add(int value) {
        for (int i = 1; i <= stretch; i++) {
            super.add(value);
        }
    }

    public void add(int index, int value) {
        for (int i = 1; i <= stretch; i++) {
            super.add(index, value);
        }
    }

    public int getStretch() {
        return stretch;
    }
}
```

Subclasses and fields

```
public class Employee {
    private double salary;
    ...
}

public class Lawyer extends Employee {
    ...
    public void giveRaise(double amount) {
        salary += amount;   // error; salary is private
    }
}
```

- Inherited private fields/methods cannot be directly accessed by subclasses. *(The subclass has the field, but it can't touch it.)*
  - How can we allow a subclass to access/modify these fields?

Protected fields/methods

```
protected type name;    // field

protected type name(type name, ..., type name) {
    statement(s);       // method
}
```

- a **protected field** or **method** can be seen/called only by:
  - the class itself, and its subclasses
  - also by other classes in the same "package" (discussed later)
  - useful for allowing selective access to inner class implementation

```
public class Employee {
    protected double salary;
    ...
}
```