Inheritance and Interfaces

- Inheritance models an "is-a" relationship
  - A dog is a mammal, an ArrayList is a List, a square is a shape, ...
- Write general programs to understand the abstraction, advantages?

```java
void doShape(Shape s) {
    System.out.println(s.area());
    System.out.println(s.perimeter());
    s.expand(2.0);
}
```

- But a dog is also a quadruped, how can we deal with this?
Single inheritance in Java

- A class can extend only one class in Java
  - All classes extend Object --- it's the root of the inheritance hierarchy tree
  - Can extend something else (which extends Object), why?

- Why do we use inheritance in designing programs/systems?
  - Facilitate code-reuse (what does that mean?)
  - Ability to specialize and change behavior
    - If I could change how method \texttt{foo()} works, \texttt{bar()} is ok
  - Design methods to call ours, even before we implement
    - Hollywood principle: don't call us, ...
Multiple Interfaces

- Classes (and interfaces) can implement multiple interfaces
  - A dog is a mammal, a quadruped, a pet
  - How come canine is different?
  - What behavior do quadrupeds have? Pets have?

- An interface specifies the name (and signature) of methods
  - No implementation, no state/fields
  - Yes for constants

- In this course, by convention, we'll often use interfaces
  - Emphasize design before implementation
  - Use abstract/default classes for code reuse, state
Inheritance Example

```java
public class UtilRecord extends Record {
    // assumes Record's fields are protected, not private

    private String kind;

    public UtilRecord() {
        this("", "", 0, 0, "", "");
    }

    public UtilRecord(String a, String f, int s, int o, String e, String k) {
        super(a, f, s, o, e);
        kind = k;
    }

    /* etc */
```
Comparable and Comparator

- Both are interfaces, there is no default implementation
  - Contrast with `.equals()`, default implementation?
  - Contrast with `.toString()`, default?

- Where do we define a Comparator?
  - In its own `.java` file, nothing wrong with that
  - Private, used for implementation and not public behavior
    - Use a nested class, then decide on static or non-static
    - Non-static is part of an object, access inner fields

- How do we use the Comparator?
  - Sort, Sets, Maps (in the future)

- Does Hashing (future topic) have similar problems?
Comparable Example

```java
public class Record implements Comparable {
    public Record(String a, String f, int s, int o,
                   String e) {
        ...
    }

    public Record(Record rec) {
        ...
    }

    int compareTo(Record r) {
        // comparison code goes here
        // set n to neg # if <, 0 if ==, and pos # if >
        return n
    }
}
```
MVC: Model, View, Controller

- A model is the state and brains of a system
  - In a game it's all the pieces and where they are
  - In a spreadsheet it's the data and the formulae

- The view is how we look at the model
  - Spread sheet has graphs, charts, cells, text, ...
  - Game has board, number of opponents, hit-points, ...

- When the model changes, the views reflect the changes
  - The model tells the views how/if it has changed
  - Model sends information to views OR
  - View asks model for information