- Previous Lecture:
  - Selection sort, linear search, binary search
  - Array of objects
- Today's Lecture:
  - Searching in an array of objects
  - Inheritance—extending a class
- Reading:
  - Sec 7.1

Separate classes—each has its own members

```
class Dice {

 private int top;
 private int sides;

 public Dice(…) {…}
 public void roll() {…}
 public String toString(){…}
 public int getTop() {…}
 public int getSides() {…}
}
```

```
class TrickDice {

 private int top;
 private int sides;
 private int weightedSide;
 private int weight;

 public TrickDice(…) {…}
 public void roll() {…}
 public String toString(){…}
 public int getTop(){…}
 public int getSides() {…}
 public int getWSide() {…}
 public int getWeight() {…}
}
```

Can we get all the functionality of Dice in TrickDice without re-writing all the Dice components in class TrickDice?

```
class Dice {

 private int top;
 private int sides;

 public Dice(…) {…}
 public void roll() {…}
 public String toString(){…}
 public int getTop() {…}
 public int getSides() {…}
}
```

```
class TrickDice {

 //everything in class Dice
 //plus new/modified stuff
 //below

 private int weightedSide;
 private int weight;

 public TrickDice(…) {…}
 public void roll() {…}
 public String toString(){…}
 public int getWSide() {…}
 public int getWeight() {…}
}
```

Yes! Make TrickDice a subclass of Dice.

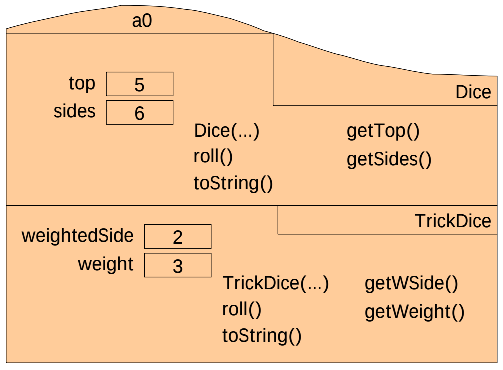
```
class Dice {

 private int top;
 private int sides;

 public Dice(…) {…}
 public void roll() {…}
 public String toString(){…}
 public int getTop() {…}
 public int getSides() {…}
}
```

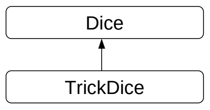
```
class TrickDice extends Dice
{
 private int weightedSide;
 private int weight;

 public TrickDice(…) {…}
 public void roll() {…}
 public String toString(){…}
 public int getWSide() {…}
 public int getWeight() {…}
}
```



Inheritance

Inheritance relationships are shown in a *class diagram*, with the arrow pointing to the parent class



An ***is-a*** relationship: the child ***is a*** more specific version of the parent

Single inheritance: one parent only

Inheritance

- Allows programmer to *derive* a class from an existing one
- Existing class is called the *parent class*, or *superclass*
- Derived class is called the *child class* or *subclass*
- The child class *inherits* the (public) members defined for the parent class
- Inherited trait can be *accessed as though it was **locally** declared (defined)*

Reserved word **`super`**

Invoke constructor of superclass

```
super(parameter-list);
```

`parameter-list` must match that in superclass' constructor

Which components get inherited?

- public components get inherited
- private components exist in object of child class, but cannot be directly accessed in child class $\Rightarrow$ we say they are not inherited
- Note the difference between inheritance and existence!

`protected` visibility (see Sec 7.2 for detail)

- Visibility modifiers control which members get inherited
- **`private`**
  - Not inherited, can be *accessed* by local class only
- **`public`**
  - Inherited, can be *accessed* by all classes
- **`protected`**
  - Inherited, can be *accessed* by subclasses
- *Access* : access as though declared locally
- All variables from a superclass *exist* in the subclass, but the **`private`** ones cannot be *accessed* directly

Important ideas in inheritance

- Single inheritance
- Keep common features as high in the hierarchy as reasonably possible
- Use the superclass' features as much as possible
- "Inherited" $\Rightarrow$ "can be accessed as though declared locally"
  (**`private`** variables from the superclass *exists* in the subclasses; they just cannot be *accessed* directly)
- Inherited features are continually passed down the line
- Use different hierarchies for different problems

Overriding methods

- Subclass can *override* definition of inherited method
- New method in subclass must have same signature as superclass (but has different method body)
- Which method gets used??
  The object that is used to invoke a method determines which version is used
- Method declared to be **`final`** cannot be overridden
- Do not confuse *overriding* with *overloading*!

```
/** A Dice (or Die) */
class Dice {

   private int top;    // top face
   private int sides;  // number of sides

   /** A Dice has numSides sides and the top face is random */
   public Dice(int numSides) {
     sides= numSides;
     roll();
   }

   /** top gets a random value in 1..sides */
   public void roll() {
     setTop(randInt(1,getSides())) ;
   }

   /** = random int in low..high */
   public static int randInt(int low, int high) {
     return (int) (Math.random()*(high-low+1))+low;
   }

   /** = Get top face */
   public int getTop() { return top; }

   /** = Get number of sides */
   public int getSides() { return sides; }

   /** Set top to faceValue  */
   public void setTop(int faceValue) { top= faceValue; }

   /** = String description of this Dice */
   public String toString() {
     return  getSides() + "-sided dice shows face " + getTop();
   }
} //class Dice
```

```
/** A TrickDice has one weightedSide such that the
 *  weightedSide appears weight times as often as other sides
 */
class TrickDice extends Dice {

  private int weightedSide;  //Weighted side appears more often
  private int weight;        //Weighted side appears weight times as often as other sides

  /** TrickDice has side s appearing with weight w */
  public TrickDice(int numFaces, int s, int w) {
    super(numFaces);
    weightedSide= s;
    weight= w;
  }

  /** = Get weighted side */
  public int getWSide() { return weightedSide; }

  /** = Get weight of weighted side */
  public int getWeight() { return weight; }

  /** top gets random value in 1..sides given trick property */
  public void roll() {
    int r= randInt(1,(getSides()+weight-1));
    if (r>getSides())
      setTop(weightedSide);
    else
      setTop(r);
  }

  /** = String description of this TrickDice */
  public String toString() { return "Tricky " + super.toString(); }
} //class TrickDice
```