- Previous Lecture:
  - Intro to objects and classes (class `JFrame`)
  - Creating objects and calling their methods
- Today's Lecture:
  - OO thinking
  - Defining a class:
    - Instance variables and methods
    - Constructors
    - Method `toString`
- Reading: Sec 4.1, 4.2
- Announcements:
  - Section will be in the labs this week
  - You need your clicker today

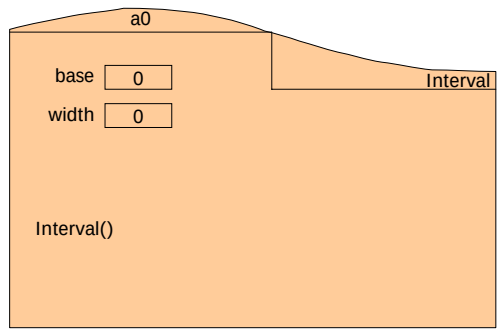
Class Definition

```
public class class-name {

   declaration (and initialization)

   constructor

   methods

}
```


Class definition: declarations

```
class Interval {
  private double base;  // low end
  private double width; // interval width
}
```

- *Declarations* in a class define ***fields*** (***instance variables***) of the class
- Each class is a *type*. Classes are *not* primitive types.



Declarations Revisited

- Syntax: *type name*;
- Examples:
```
int count;
double width;
Interval in1;
Interval in2;
```
- Instance variables have default initial values
  - `int` variables: `0`
  - Non-primitive (reference) variables: `null`

  Value `null` signifies that no object is referenced

Object instantiation

- An expression of the form

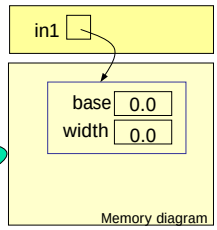
  `new` *class-name*`( )`

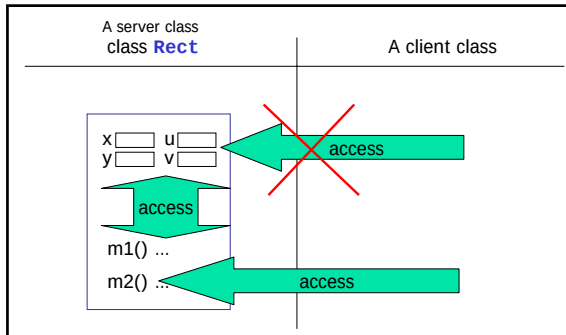
  computes a reference to a newly created object of the given class
- Examples:
```
Interval in1;           //declaration
in1 = new Interval();   //instantiation

//Combined declaration & instantiation
Interval in2 = new Interval();
```

Do not access fields directly

```
public class Client {
  public static void main(String[] args){

    Interval in1;
    in1= new Interval();
    System.out.println(
     in1.base+in1.width);
  }
}
```

base, width are private

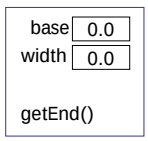




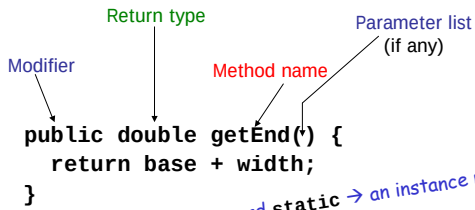
Data within objects should be protected: **private**
Provide only a set of methods for **public** access.

Class definition

```
class Interval {
  private double base;  // low end
  private double width; // interval width

  /* =Get right end of interval */
  public double getEnd() {
    return base + width;
  }
}
```



Instance method



The absence of the keyword **static** → an instance method
(There isn't a keyword "instance")

Methods

A method is a named, parameterized group of statements

```
modifier return-type method-name ( parameter-list ) {
    statement-list
}
```

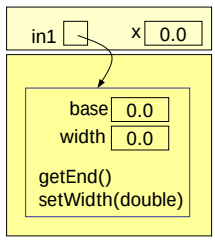
return-type **void** means nothing is returned from the method

There must be a **return** statement, unless return-type is **void**

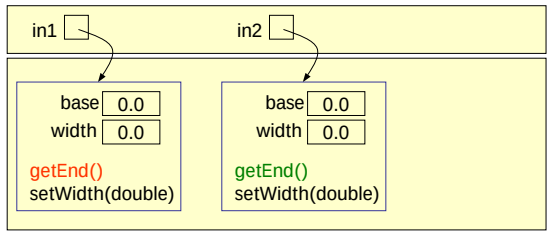

```
/* An Interval is [base, base+width] */
class Interval {
   private double base;  // low end
   private double width; // interval width

   /* =Get right end of interval */
   public double getEnd() {
     return base + width;
   }
   /* set width to w */
   public void setWidth(double w) {
     width= w;
   }
}
```

Calling an instance method

```
public class Client {
  public static void main(String[] args){

    Interval in1;
    in1= new Interval();
    double x;
    x= in1.getEnd();
    in1.setWidth(4);
  }
}
```




```
Interval in1= new Interval();
Interval in2= new Interval();
if ( in1.getEnd() > in2.getEnd() )
  System.out.println("blah...");
```



Constructor

- A *constructor* is used to create objects
- Each class has a default constructor
- You can define your own constructor:

modifier class-name **(** *parameter-list* **) {**
    statements-list
}

- Use **public** as the modifier for now
- an instance method that has *no* return type


```
class Interval {
  private double base;  // low end
  private double width; // interval width

  /* An Interval with base b, width w */
  public Interval(double b, double w) {
    base= b;
    width= w;
  }

  public double getEnd() {
    return base + width;
  }
}
```



```
class Interval {
  private double base;  // low end
  private double width; // interval width

  /* Default constructor */
  public Interval() {}




  public double getEnd() {
    return base + width;
  }
}
```

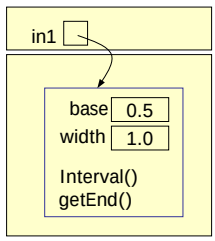

Constructor invocation

new ***class-name*** **(** *expression-list* **)**

- The value of above expression is a reference to a *new* object of the given *class-name*
- The defined (or default) constructor is invoked on the new object created by **new**

Creating an object

```
public class Client {
  public static void main(String[] args){

    Interval in1;
    in1= new Interval(
                0.5,1);


  }
}
```



Method `toString()`

- Every object has default method `toString`
- *Automatically* invoked by `print`, `println`

```
Interval a = new Interval(1,2);
System.out.println(a);
```

- Some default text will be printed unless you define a `toString` method

Method `toString()`

- Usually defined to give a *useful* description of an instance of a class
- E.g., useful description of an instance of `Interval` would be the mathematical notation for an Interval, e.g.,

  `[3,7.5]`

  for an `Interval` object with `base` 3 and `width` 4.5.


```
class Interval {
  private double base;  // low end
  private double width; // interval width

  public Interval(double b, double w){
    base= b;
    width= w;
  }

  /** =String description of Interval */
  public String toString() {
    return "[" + getBase() + "," + getEnd() +
           "]";
  }
}
```