COMP 250

Lecture 6

Objects & Classes 1:

.

`String`, wrapper classes, `Math`,

defining our own classes, constructors

`this`

Jan. 19, 2022

Java comes with many built-in *classes*:

- `String`
- *Wrapper classes* such as:
  - `Boolean`
  - `Byte`
  - `Character`
  - `Integer`
  - ….
- `Math`

We can also define our own classes.

Classes are “reference types” rather than “primitive types”.

(Other reference types include arrays – see last lecture.)

`String` Examples

We can make a string object in different ways, e.g.:

```
String  s  =  "Hello" ;
String  s1  =  new String("Hello") ;     // allowed but unnecessary
```

This is similar to how there are different ways to make arrays.

`String` Examples

There are several methods associated with strings.

We call the methods using the dot notation as follows:

```
String  s  =  "Hello" ;
```

```
int  m = s.length();
```

Then `m` would have the value 5.

```
char  c = s.charAt(1);
```

Then `c` would have the value `'e';`

```
String  s  =  "Hello" ;

int  m;

char  c;
```

```
m = s.indexOf('o');
```
m is 4.

```
m = s.indexOf('p');
```
m is -1 (indicating 'not found')

```
c = s.charAt(8);
```
Produces a runtime error
StringIndexOutOfBoundsException

String concatenation

```
String  s0  =  “Hello”  ;
String  s1  =  “ there” ;
```

The following expressions (and more) each produce the string “Hello there”.

```
“Hello” + “ there”

s0 + s1

s0.concat(s1)

“Hello”.concat(“ there”)
```

Compare Strings using `equals()`

```
String  s0  =  "Hello"  ;
String  s1  =  "Hello"  ;

boolean  b  =  s0.equals( s1 );      //  true
```

The `equals()` method goes through each character of the two strings and verifies that they are the same.

A common mistake made by Java programmers to compare strings using the "==" operator instead of `equals()`. See next slide(s).

ASIDE: *why* not compare Strings using `==` operator ?

As we will see, when the "==" operator compares objects, it checks if two *objects* are the same.

So, you might expect the following expressions to evaluate to `false` i.e. the left and right side are *different (but equal)* strings.

```
"surprise" == "surprise"          // evaluates to true

"sur" + "prise" == "surprise"     // evaluates to true
```

The reason the first result is true is that the Java *compiler* creates a list of constants that the program will need, and it only makes one copy of each constant.
For the second example, the compiler does the concatenation `"sur" + "prise"` in advance, so again there is just one string `"surprise"`.

ASIDE: *why* not compare Strings using == operator ?

Consider a different example in which a string is computed at run time.

```
String s = "sur";
```

`s + "prise" == "surprise"` evaluates to `false`

The reason is that there are two String objects created *at runtime*.

`(s + "prise").equals("surprise")` evaluates to `true` which is what we want.

Bottom line: it is always safer to use equals when comparing strings.

```
String  name  =  "Suzanne Fortier" ;
        name = name.toUpperCase();
```

The second line assigns `name` the string "`SUZANNE FORTIER`"

A common mistake is to write just

```
        name.toUpperCase()
```

and assume that this changes the string that `name` references. It doesn't. Rather, a new (upper case) string is created *and returned*. You need to write that returned string somewhere.

Strings are “immutable”

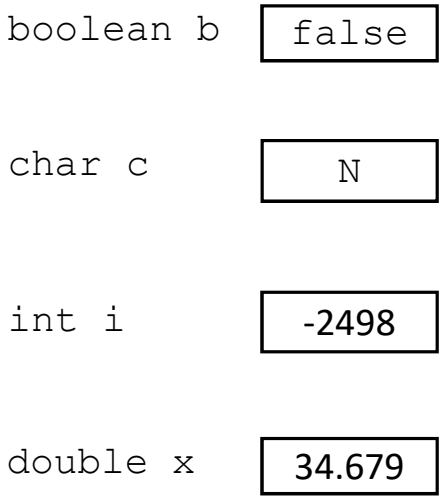
String objects cannot be changed.

```
String s = "cats";
s.charAt(0) = 'r';        // compile-time error!
```

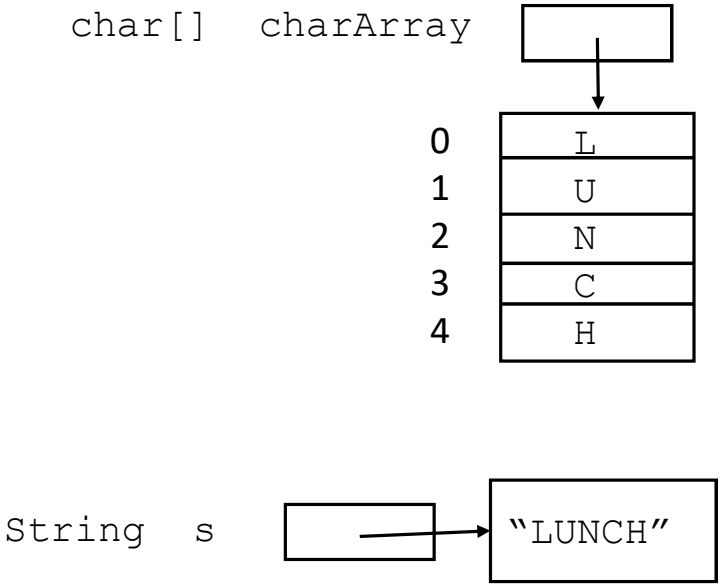
You cannot use the `charAt` method in this way.

There is no `String` method that allows us to set the value of a particular character.
Rather, one would have to make a new string.
(There are various `String` methods that can help you do that. Details omitted here.)

Primitive types



Reference types (so far...)



Let's look at more examples of reference types.

Wrapper classes

Primitive Type	Wrapper Class
`byte`	`Byte`
`short`	`Short`
`int`	`Integer`
`long`	`Long`
`float`	`Float`
`double`	`Double`
`boolean`	`Boolean`
`char`	`Character`

How do we use these?

One way we use wrapper classes is to define constants:

`Byte.MAX_VALUE` has value $2^7 - 1$

`Short.MAX_VALUE` has value $2^{15} - 1$

`Integer.MAX_VALUE` has value $2^{31} - 1$

`Long.MAX_VALUE` has value $2^{63} - 1$

`Float.MAX_VALUE` and `Double.MAX_VALUE` have the largest (finite) values that you can represent with a `float` or `double`, respectively.

Use `MIN_VALUE` instead of `MAX_VALUE` to get the smallest negative values.

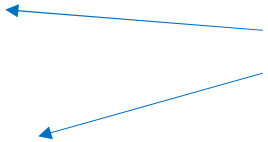
Another way we use wrapper classes is to convert from a String to a number:

To convert from a `String` to an `int`, use:

```
int i = Integer.parseInt("54");
```

To convert from a `String` to an `Integer`, use:

```
Integer j = Integer.valueOf("54");
```



The names of these methods don't clarify at all what is the difference between them!

I can't think of better name for them. Calling them "convertToPrimitiveInt()" and "convertToWrapperInteger()" would have been awkward :/.

To convert from a `String` to a `double`, use:

```
double z = Double.parseDouble("2.7");
```

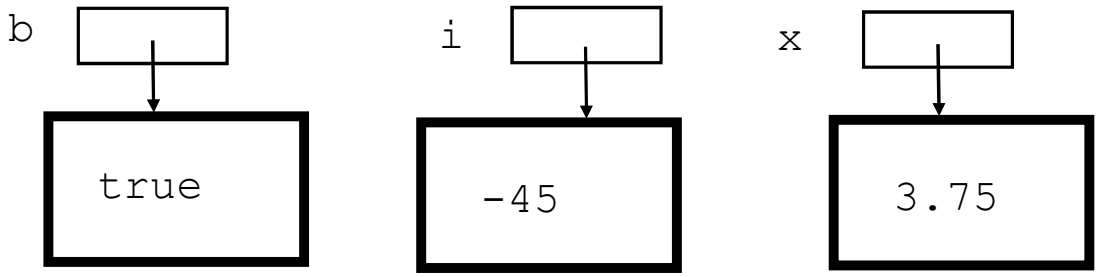
To convert from a `String` to a `Double`, use:

```
Double y = Double.valueOf("2.7");
```

Initializing a wrapper class variable

```
Boolean  b =   new Boolean(true)     Boolean.valueOf(true);
Integer  i  =  new Integer( -45 )    Integer.valueOf(-45);
Double   x  =  new Double( 3.75 );   Double.valueOf(3.75);
```

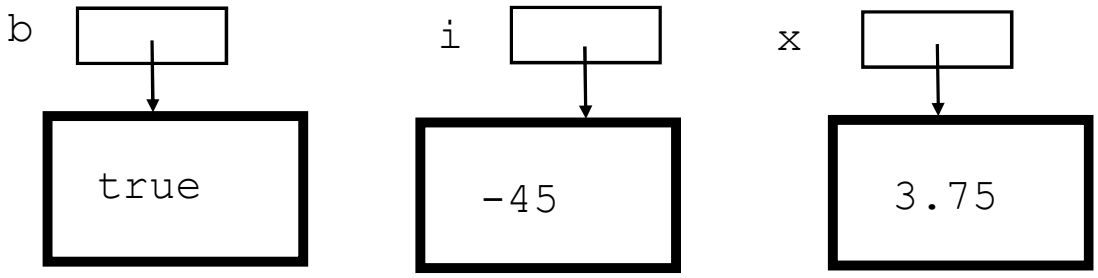
The wrapper classes constructors were “deprecated” as of Java 8.



Autoboxing and Unboxing ("wrapper")

Alternatively, we can write:

```
Boolean   b   =   true;
Integer   i   =   -45;
Double    x   =   3.75;
```



The compiler replaces this code with what I wrote on the previous slide.
This is called *autoboxing*. (It is reminiscent of casting but it is not the same thing.)

Going in the opposite direction is called *unboxing*.

```
boolean   b1   =   b;
integer   i1   =   i;
double    x1   =   x;
```

Check out fields & methods for wrapper classes at the Java API e.g. `Integer`

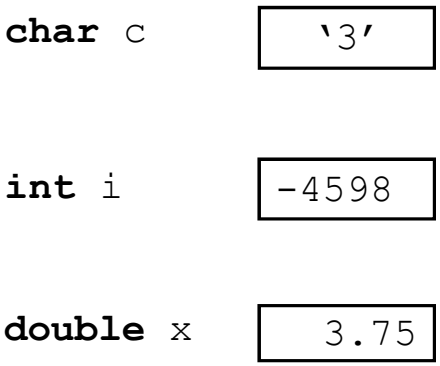
Method Summary

All Methods | **Static Methods** | **Instance Methods** | **Concrete Methods**

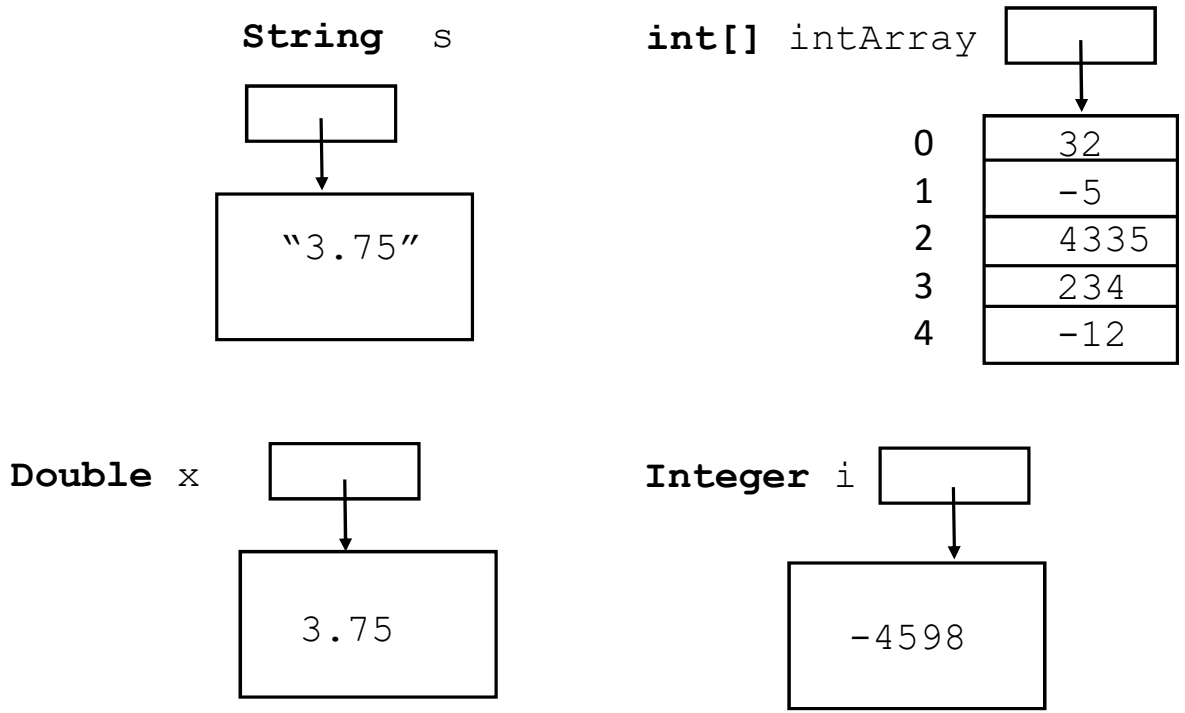
Modifier and Type	Method and Description
`static int`	**`bitCount`**`(int i)` Returns the number of one-bits in the two's complement binary representation of the specified `int` value.
`byte`	**`byteValue`**`()` Returns the value of this `Integer` as a `byte` after a narrowing primitive conversion.
`static int`	**`compare`**`(int x, int y)` Compares two `int` values numerically.
`int`	**`compareTo`**`(Integer anotherInteger)` Compares two `Integer` objects numerically.
`static int`	**`compareUnsigned`**`(int x, int y)` Compares two `int` values numerically treating the values as unsigned.
`static Integer`	**`decode`**`(String nm)` Decodes a `String` into an `Integer`.
`static int`	**`divideUnsigned`**`(int dividend, int divisor)` Returns the unsigned quotient of dividing the first argument by the second where each argument and the result is interpreted as an unsigned value.
`double`	**`doubleValue`**`()` Returns the value of this `Integer` as a `double` after a widening primitive conversion.
`boolean`	**`equals`**`(Object obj)` Compares this object to the specified object.
`float`	**`floatValue`**`()` Returns the value of this `Integer` as a `float` after a widening primitive conversion.

Big Picture Brief Summary

Primitive types



Reference types

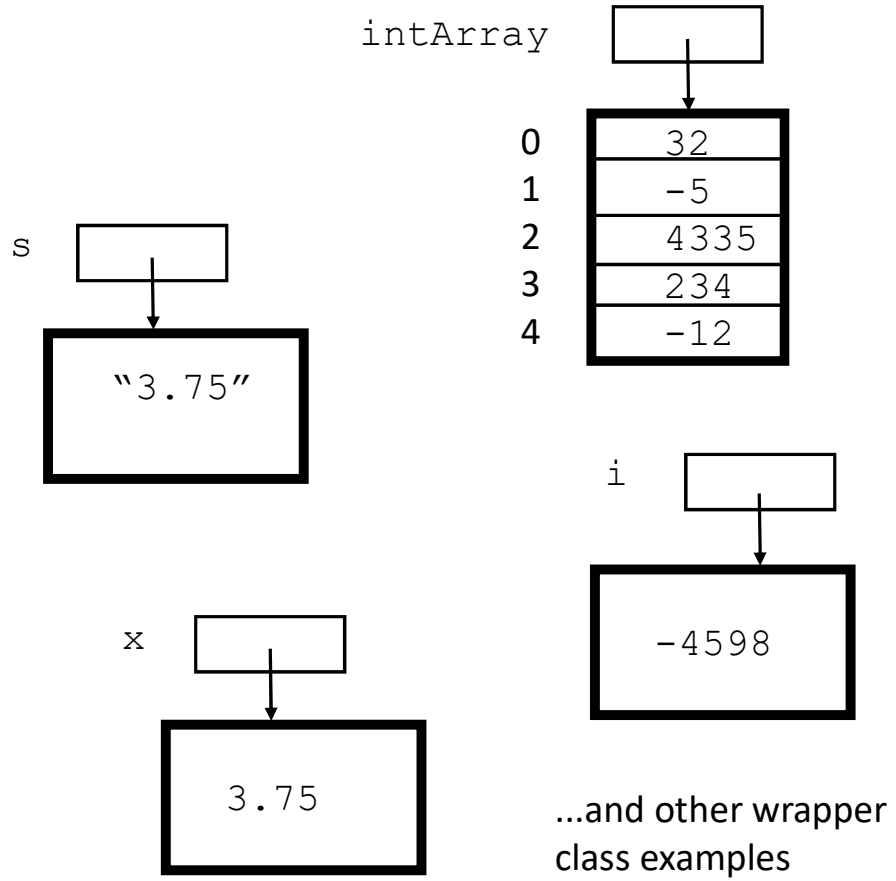


...and other wrapper class examples

Reference variables and objects

The arrows are *references to "objects"*.

The value of a reference variable can be thought of as the address of an object in memory. That's what we mean by the arrow. (More generally, it is some id or number that uniquely identifies the object.)



...and other wrapper class examples

COMP 250

Lecture 6

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Jan. 19, 2022

Math

- `Math.PI` is the value π ← this is a field, not a method

Suppose that we declare a variable `double x;`

- `Math.sqrt(x)` returns the value $\sqrt{x}$.
- `Math.random( )` returns a random number in (0,1).
- `Math.log(x)` returns the value $log_e x$ or $ln(x)$.
- `Math.log10(x)` returns the value $log_{10} x$. (There is no method for taking log to a given base b.)
- `Math.sin(x)` returns the value $sin(x)$.

As we saw in lecture 4, Java has many pre-defined reference types, or “classes”.

They are organized into packages.

Examples of packages from the “standard Java library”:

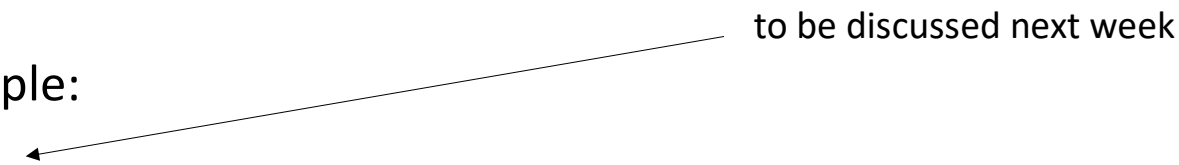
```
java.awt
java.util
java.lang
```

Defining your own class

```
class  ClassName {

   // field declarations

   // method declarations
}
```



Example:

```
public class HelloWorld {

   public static void main ( String[] args ) {
      System.out.println("Hello, World!");
  }
}
```

Java naming conventions

Class names begin with an upper case letter (`String, Integer, Math, …`).

Constants should be all upper case, e.g. `Math.PI`

Variables, methods, package names (and some other things) begin with a lower case character.

e.g. `Integer j = Integer.valueOf("54");`

Constructors

```
class  ClassName {

   // field declarations     FEB 12:  MENTION THEY ARE
                                      INITIALIZED.

   // method declarations

   ClassName( ){  //  constructor methods have no return type
                  //  their method name is same as class name

       //   instructions in constructor method
    }

}
```

No-argument Constructor

```
class Point2D {
   int      x;
   int      y;

   Point2D(){ };

   //  methods  for operating on a point  e.g  moving it

}
```

A constructor with no arguments is called a “no-argument constructor”.
It could have an empty body, or it could have instructions in the body such a print statement, or it might assign default values to the fields, e.g. `x = 5;` ...

Default Constructor

```
class Point2D {
   int      x;
   int      y;

   //  Point2D(){ };
}
```

The compiler would essentially create this method.

If you don't explicitly define any constructor for your class, then the compiler makes a "default constructor" for you, namely a no-argument constructor.

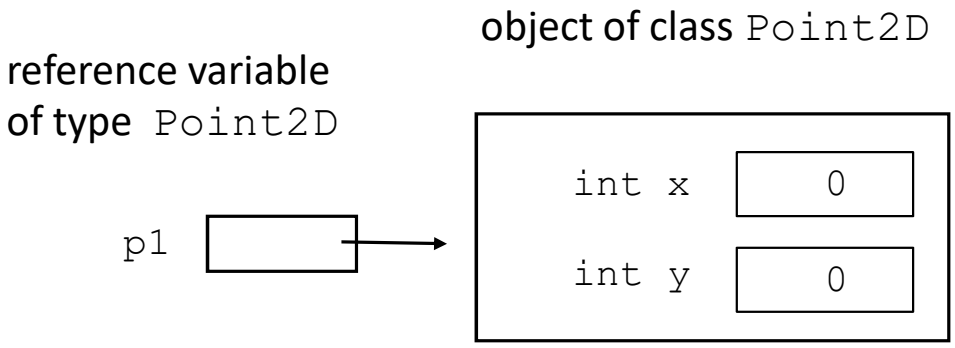
The no-argument and default constructors both initialize the fields to a default value of 0, 0.0, '\u0000', `false`, or `null` depending on the type.

`new` keyword

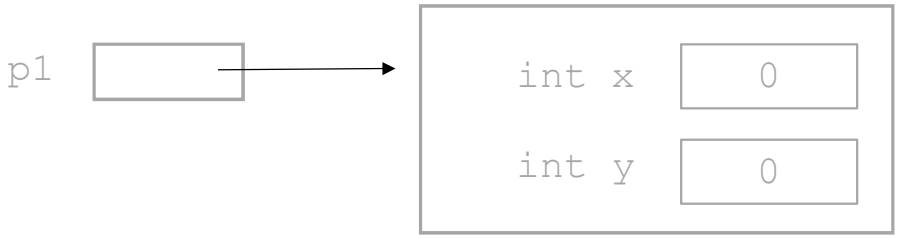
To create (construct) an object, use the `new` keyword and a constructor method which has the name of the object's class (except for wrapper classes – see earlier).

Some method might have the following instruction:

```
Point2D   p1  =  new  Point2D();
```

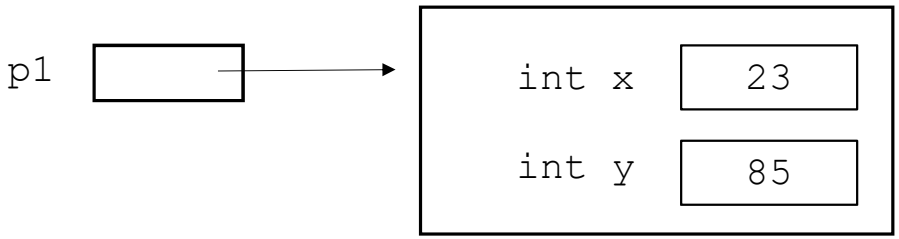


```
Point2D  p1 =  new Point2D();
```



The method can then change the values in the object's `x` and `y` fields :

```
p1.x  = 23;
p1.y  = 85;
```



Constructors with arguments

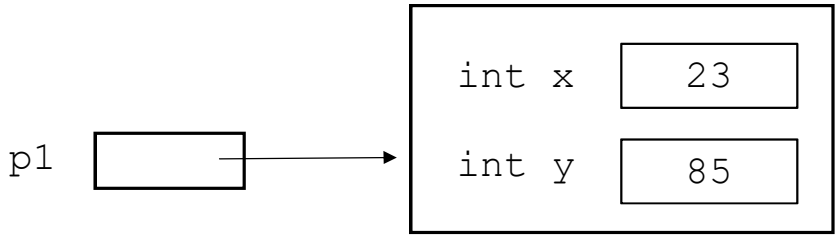
We can define constructors that have arguments, for example, that assign values to the fields of the object.

```
class Point2D {
   int      x;
   int      y;

   Point2D(int x0, int y0){
         x = x0;
         y = y0;
   }
}
```

We can call this constructor as follows:

```
Point2D p1 = new Point2D(23, 85);
```



Non-default constructors & “overloading”

```
class Point2D {
   int      x;
   int      y;

   Point2D(){ };    // “no argument” constructor

   Point2D(int x0, int y0}{
         x = x0;
         y = y0;
     }
}
```

If we define a (non-default) constructor that has some parameter(s), and if we also want to have a no-argument constructor, then we must explicitly define the no-argument constructor. Otherwise, the no-argument constructor won’t exist.

```
class Point2D {
    int     x;
    int     y;

    Point2D(int x0, int y0}{
       x = x0;
       y = y0;
    }

    void  moveTo(int  x0,  int  y0){
       x  =  x0;
       y  =  y0;
    }

    void  moveBy(int  deltaX,  int deltaY){
       x  =  x + deltaX;
       y  =  y + deltaY;
    }
}
```

other method declarations

keyword `this`

```
class Point2D {
     int   x;
     int   y;

     Point2D(int x, int y}{
          this.x = x;
          this.y = y;
     }

     void  moveTo(int  x,  int  y){
        this.x  =  x;
        this.y  =  y;
     }

     void  moveBy(int  deltaX,  int deltaY){
        this.x  +=  deltaX;
        this.y  +=  deltaY;
     }
}
```

`this` refers to the `Point2D` object being constructed.

`this` refers to the `Point2D` object that is calling ("invoking") the method.

'`this`' allows having variable names that are the same as the field name, making the code easier to read.

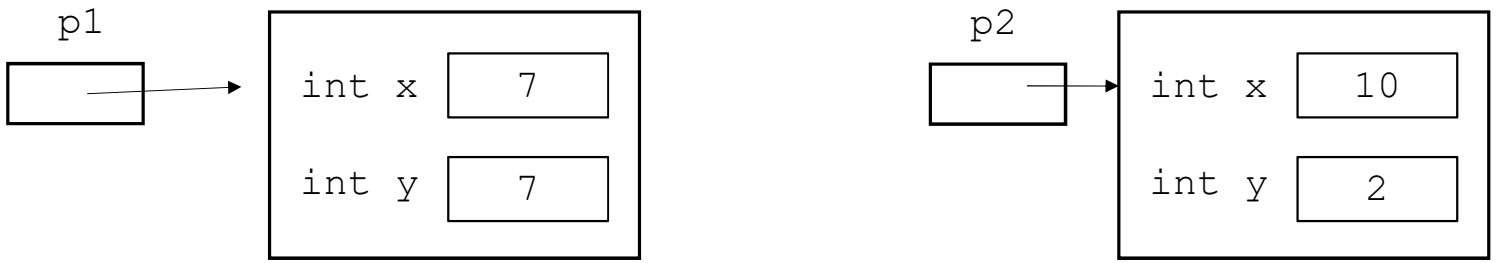
Example

```
public class  AnotherClass {

   public static void main ( String[] args ) {

      Point2D   p1 = new Point2D(3, 4};
      p1.moveTo( 7, 7 );


      Point2D   p2 = new Point2D(8, 2};
      p2.moveBy( 2, 0 );
   }
}
```



Coming up…

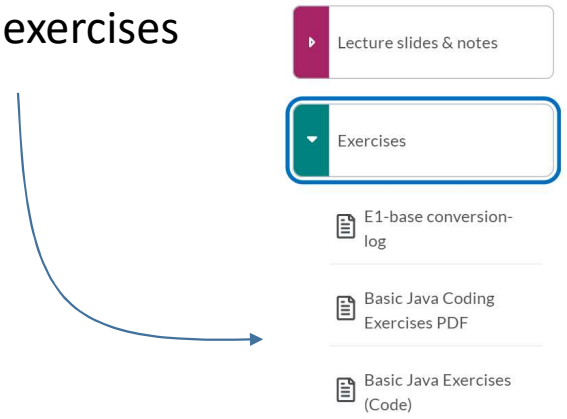
Lectures

Fri. Jan. 21 objects & classes 2

aliasing, static, scope, ...

Homework (TODO)

Basic Java coding exercises (with solutions)



Assignment 1 to be posted Fri. Jan. 28 (2 weeks).