UNIVERSITY OF WASHINGTON

Building Java Programs

Chapter 8: Classes

Chapter outline

Lecture 21

- **objects, classes, object-oriented programming**
- **object fields**
  - **instance methods**

Lecture 22

  - constructors
  - encapsulation
- preconditions, postconditions, and invariants

Lecture 23

- special methods: `toString` and `equals`
- the keyword `this`

Classes, types, and objects

- **class**:
  1. A file that can be run as a program, containing static methods and global constants.
  2. A template for a type of objects.

- We can write Java classes that are not programs in themselves, but instead define of new types of objects.
  - We can use these objects in our programs if we so desire.

- Why would we want to do this?

Objects and "OOP"

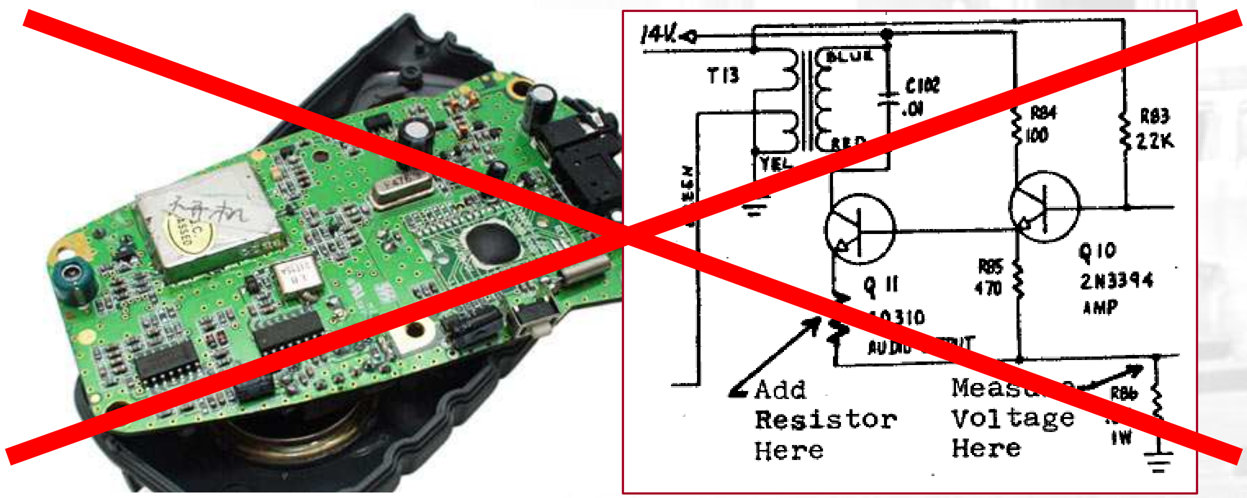
- **object**: An encapsulation of data and behavior.
- **object-oriented programming (OOP)**: Writing programs that perform most of their useful behavior through interactions with objects.

- So far, we have interacted with objects such as:
  - `String`
  - `Point`
  - `Scanner`
  - `DrawingPanel`
  - `Graphics`
  - `Color`
  - `Random`
  - `File`
  - `PrintStream`

Abstraction

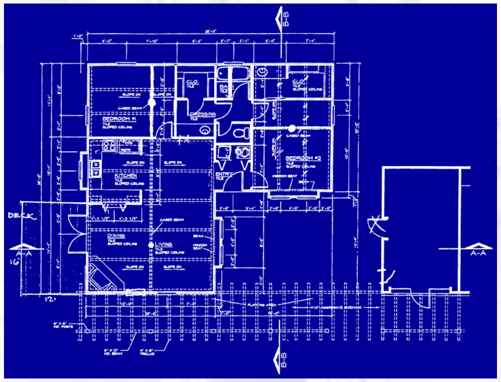
- **abstraction**: A distancing between ideas and details.
  - The objects in Java provide a level of abstraction, because we can use them without knowing how they work.

- You use abstraction every day when interacting with technological objects such as a portable music player.
  - You understand its external behavior (volume knobs/buttons, station/song wheel, etc.)
  - You DON'T understand its inner workings.



Factory/blueprint analogy

- In real life, a factory can create many similar objects.
  - This is also like following a blueprint.



Music player factory
state: # of players made
behavior: directions on how to build a music player

creates

Music player #1
state:
station/song,
volume, battery life
behavior:
power on/off
change station/song
change volume
choose random song

Music player #2
state:
station/song,
volume, battery life
behavior:
power on/off
change station/song
change volume
choose random song

Music player #3
state:
station/song,
volume, battery life
behavior:
power on/off
change station/song
change volume
choose random song

Recall: Point objects

- Java has a class of objects named `Point`.
  - To use `Point`, you must write: `import java.awt.*;`
- Constructing a `Point` object, general syntax:

```
Point <name> = new Point(<x>, <y>);
Point <name> = new Point();  // the origin, (0, 0)
```

  - Example:

```
Point p1 = new Point(5, -2);
Point p2 = new Point();  // 0, 0
```

- `Point` objects are useful for several reasons:
  - They store two values, an (x, y) pair, in a single variable.
  - They have useful methods we can call in our programs.

Recall: Point data/methods

- Data stored in each `Point` object:

Field name	Description
`x`	the point's x-coordinate
`y`	the point's y-coordinate

- Useful methods of each `Point` object:

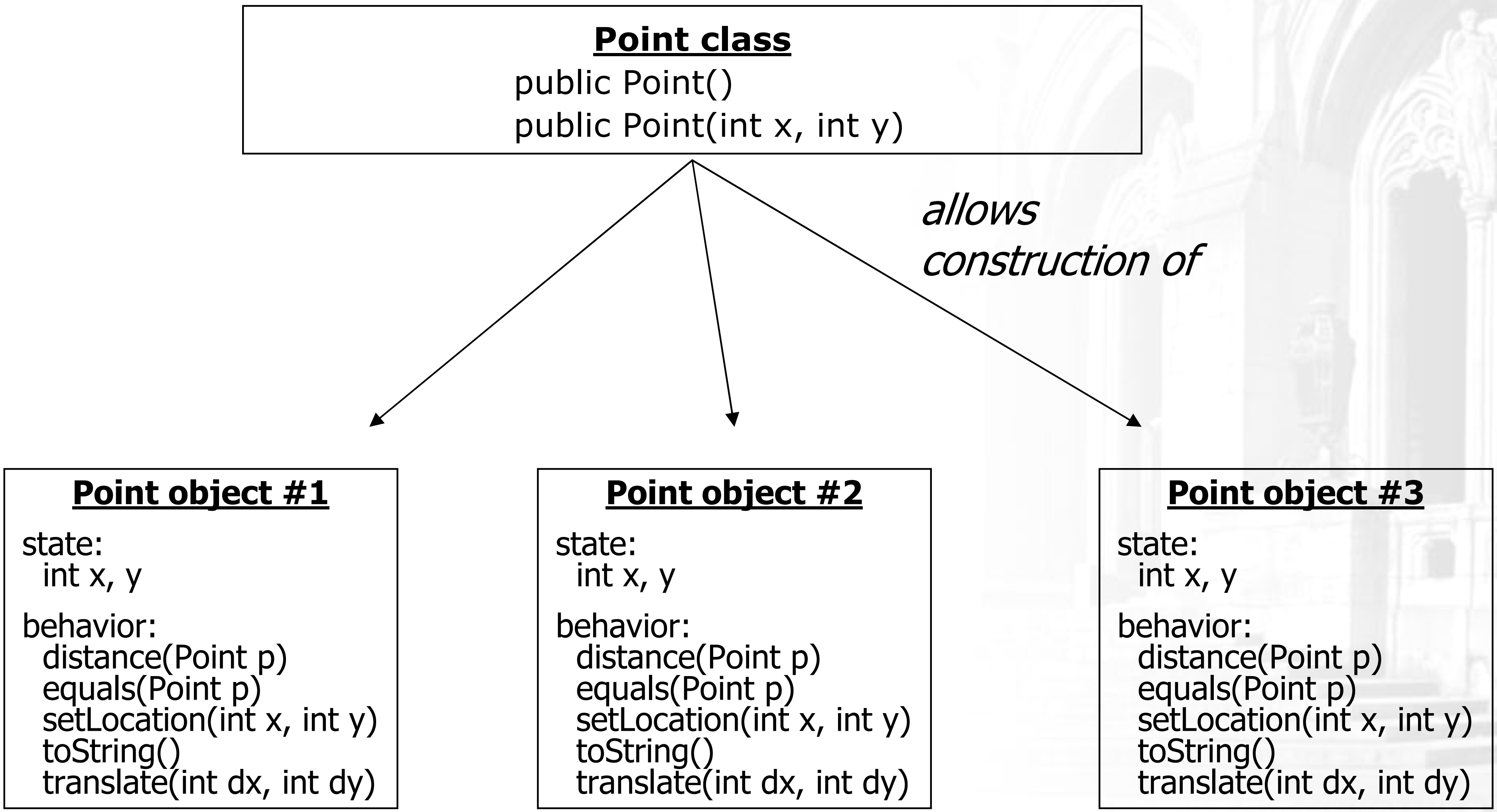
Method name	Description
`distance(`*p*`)`	how far away the point is from point *p*
`setLocation(`*x*`, `*y*`)`	sets the point's x and y to the given values
`translate(`*dx*`, `*dy*`)`	adjusts the point's x and y by the given amounts

  - `Point` objects can also be printed using `println` statements:

```
Point p = new Point(5, -2);
System.out.println(p);    // java.awt.Point[x=5,y=-2]
```

A Point class

- The `Point` class might look something like this:
  - Each object contains its own data and methods.
  - The class has the instructions for how to construct individual objects.



Object state: fields

- suggested reading: 8.2

Point class, version 1

- The following code creates a new class of objects named `Point`.

```
public class Point {
    int x;
    int y;
}
```

  - We'd save this code into a file named `Point.java`.

  - Each object contains two pieces of data:
    - an `int` named `x`,
    - an `int` named `y`.
  - `Point` objects (so far) do not contain any behavior.

Fields

- **field**: A variable inside an object that represents part of the internal state of the object.
  - Each object will have *its own copy* of the data fields we declare.

- Declaring a field, general syntax:

  <type> <name> ;

  or, to declare a field and give it an initial value:

  <type> <name> = ***<value>*** ;

  - Examples:

```
public class Student {
    String name;    // each student object has a
    double gpa;     // name and gpa data field
}
```

Accessing fields

- Code in another class can access your object's fields (for now).
- Accessing a data field, general syntax:

  <variable name>* . *<field name>

- Modifying a data field, general syntax:

  <variable name>* . *<field name> = ***<value>*** ;

- Examples:

```
System.out.println("the x-coord is " + p1.x);    // access
p2.y = 13;                                        // modify
```

  - Later in this chapter, we'll learn about *encapsulation*, which will change the way we access the data inside objects.

Client code

- **client code**: Code that uses an object.
- The following code (stored in `PointMain.java`) uses our `Point` class.

```
public class PointMain {
    public static void main(String[] args) {
        // create two Point objects
        Point p1 = new Point();
        p1.x = 5;
        p1.y = 2;
        Point p2 = new Point();
        p2.x = 4;
        p2.y = 3;

        // print each point
        System.out.println("p1 is (" + p1.x + ", " + p1.y + ")");
        System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");

        // move p2 and then print it again
        p2.x += 2;
        p2.y += 4;
        System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");
    }
}
```

OUTPUT:

```
p1 is (5, 2)
p2 is (4, 3)
p2 is (6, 7)
```

Client code question

- Write a client program that uses our new `Point` class to produce the following output:

```
p1 is (7, 2)
p1's distance from origin = 7.280109889280518
p2 is (4, 3)
p2's distance from origin = 5.0
p1 is (18, 8)
p2 is (5, 10)
```

  - Recall that the formula to compute distance between two points (x_1, y_1) and (x_2, y_2) is:

$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Object behavior: instance methods

- suggested reading: 8.3

Client code redundancy

- Our client program had code such as the following to translate a `Point` object's location.

```
// move p2 and then print it again
p2.x += 2;
p2.y += 4;
System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");
```

- If we translate several points, the above code would be redundantly repeated several times in the client program.

Eliminating redundancy, v1

- We could eliminate the redundancy with a static method in the client for translating point coordinates:

```
// Shifts the location of the given point.
public static void translate(Point p, int dx, int dy) {
    p.x += dx;
    p.y += dy;
}
```

  - Why doesn't the method need to return the modified point?

- The client would call the method as follows:

```
// move p2 and then print it again
translate(p2, 2, 4);
System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");
```

Classes with behavior

- The static method solution isn't a good idea:
  - The call syntax doesn't match the way we're used to interacting with objects.

    ```
    translate(p2, 2, 4);
    ```

  - The whole point of writing classes is to put related state and behavior together. This behavior is closely related to the x/y data of the `Point` object, so it belongs in the `Point` class.

- The objects we've used contain behavior inside them.
  - When we wanted to use that behavior, we called a method of the object using the dot notation.

    ```
    // move p2 and then print it again
    p2.translate(2, 4);
    System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");
    ```

- In this section, we'll see how to add methods to our `Point` objects.

Instance methods

- **instance method**: a method (without the `static` keyword) that defines the behavior for each object.
  - The object can refer to its own fields or methods as necessary.

- Declaring an object's method, general syntax:

```
public <type> <name> ( <parameter(s)> ) {
    <statement(s)> ;
}
```

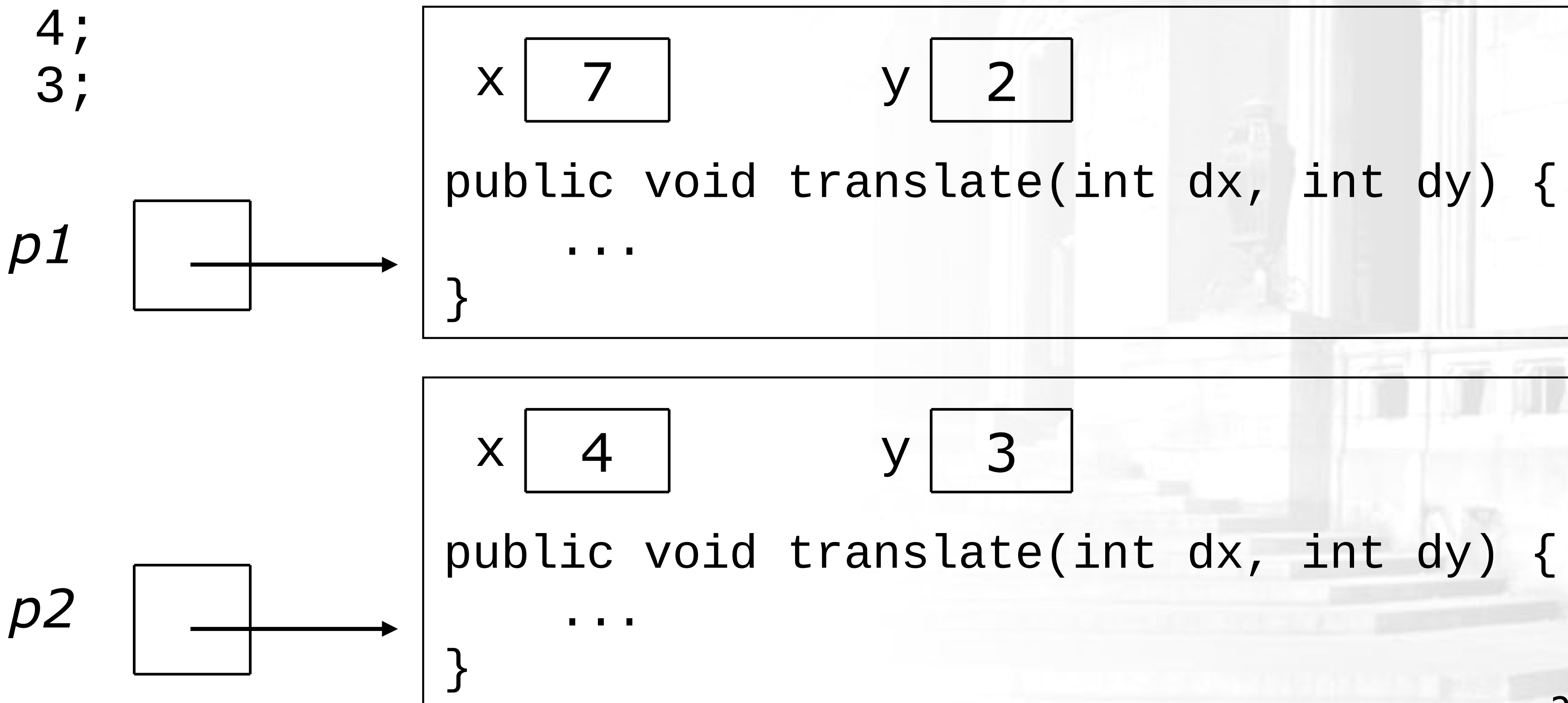
  - Example (this code appears inside the `Point` class):

```
public void translate(int dx, int dy) {
    ...
}
```

Point object diagrams

- Think of each `Point` object as having its own copy of the `translate` method, which operates on that object's state:

```
Point p1 = new Point();
p1.x = 7;
p1.y = 2;

Point p2 = new Point();
p2.x = 4;
p2.y = 3;
```



The implicit parameter

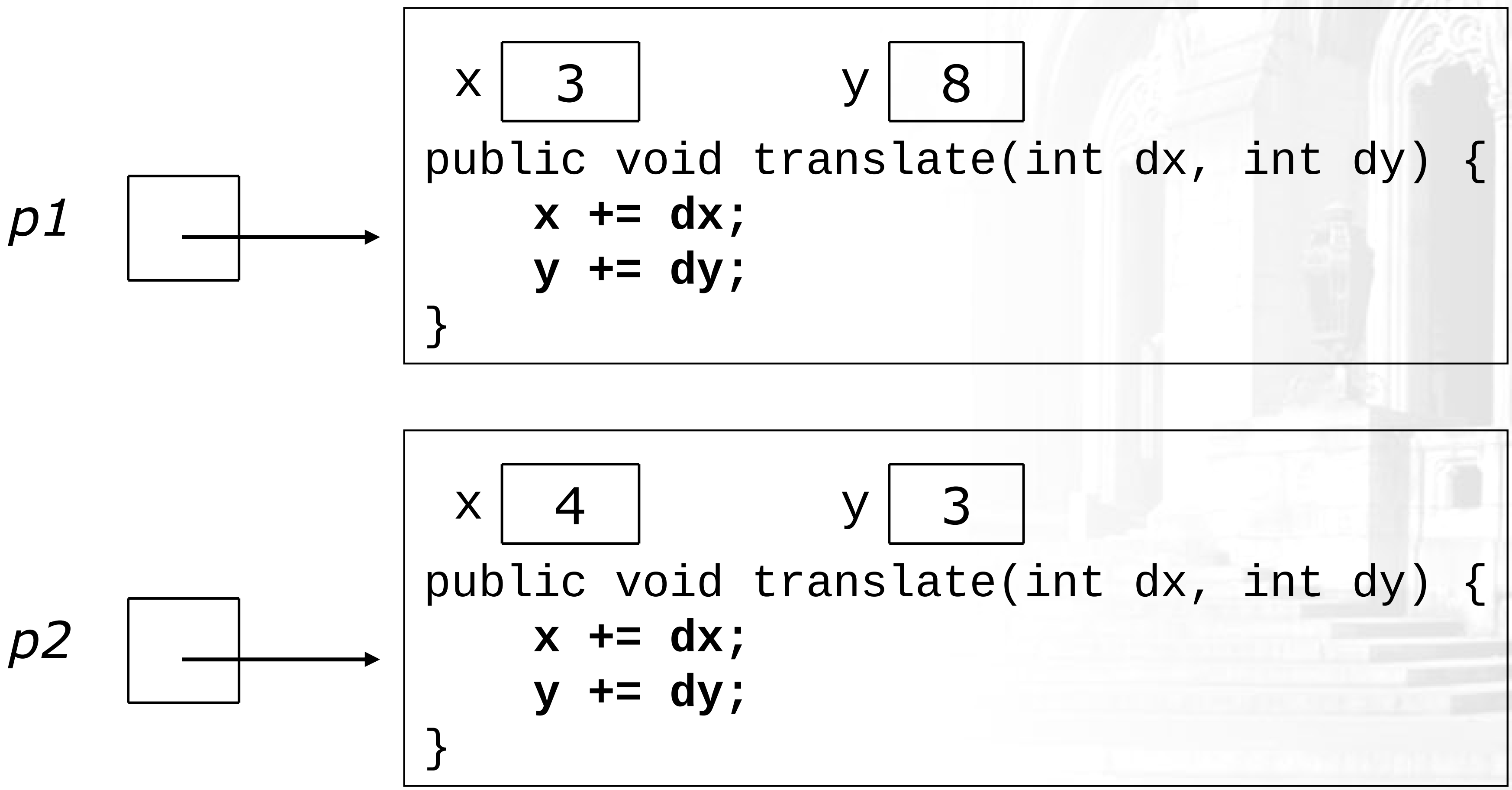
- **implicit parameter**: The object on which an instance method is called.
  - Each instance method call happens on a particular object:
    - During the call `p1.translate(11, 6);` , the object referred to by `p1` is the implicit parameter.
    - During the call `p2.translate(1, 7);` , the object referred to by `p2` is the implicit parameter.
  - The instance method can refer to that object's fields. (We sometimes say that instance method code operates in the *context* of a particular object on each call.)
- Therefore the complete `translate` method should be:

```
public void translate(int dx, int dy) {
    x += dx;
    y += dy;
}
```

Tracing instance method calls

- What happens when the following calls are made?

```
p1.translate(11, 6);

p2.translate(1, 7);
```



Point class, version 2

- This second version of `Point` gives a method named `translate` to each `Point` object:

```
public class Point {
    int x;
    int y;

    // Changes the location of this Point object.
    public void translate(int dx, int dy) {
        x += dx;
        y += dy;
    }
}
```

  - Each `Point` object now contains one method of behavior, which modifies its x and y coordinates by the given parameter values.

Instance method questions

- Write an instance method named `distanceFromOrigin` that computes and returns the distance between the current `Point` object and the origin, (0, 0).

  Use the following formula:

  $$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

- Write an instance method named `distance` that accepts a `Point` as a parameter and computes the distance between it and the current `Point`. Use the same formula above.

- Write an instance method named `setLocation` that accepts `x` and `y` values as parameters and changes the `Point`'s location to be those values.
  - You may wish to refactor the rest of your `Point` class to use this method.

- Modify the client code to use these new methods as appropriate.

Accessors and mutators

Two common categories of instance methods:

- **accessor**: A method that provides access to information about an object.
  - Generally the information comes from (or is computed using) the object's state stored in its fields.
  - The `distanceFromOrigin` and `distance` methods are examples of accessors.

- **mutator**: A method that modifies the state of an object in some way.
  - Sometimes the modification is based on parameters that are passed to the mutator method, such as the `translate` method with parameters for dx and dy.
  - The `translate` and `setLocation` methods are examples of mutators.

Client code, version 2

- The following client code (stored in `PointMain2.java`) uses our modified `Point` class:

```
public class PointMain2 {
    public static void main(String[] args) {
        // create two Point objects
        Point p1 = new Point();
        p1.x = 5;
        p1.y = 2;
        Point p2 = new Point();
        p2.x = 4;
        p2.y = 3;

        // print each point
        System.out.println("p1 is (" + p1.x + ", " + p1.y + ")");
        System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");

        // move p2 and then print it again
        p2.translate(2, 4);
        System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");
    }
}
```

OUTPUT:

```
p1 is (5, 2)
p2 is (4, 3)
p2 is (6, 7)
```

Client code question

- Recall our client program that produces this output:

```
p1 is (7, 2)
p1's distance from origin = 7.280109889280518
p2 is (4, 3)
p2's distance from origin = 5.0
p1 is (18, 8)
p2 is (5, 10)
```

- Modify the program to use our new instance methods. Also add the following output to the program:

```
distance from p1 to p2 = 3.1622776601683795
```

Lecture outline

<u>Lecture 21</u>

- objects, classes, and object-oriented programming
- object fields
  - instance methods

<u>Lecture 22</u>

  - **constructors**
  - **encapsulation**
- **preconditions, postconditions, and invariants**

<u>Lecture 23</u>

- special methods: `toString` and `equals`
- the keyword `this`

Object initialization: constructors

- suggested reading: 8.4

Initializing objects

- It is tedious to have to construct an object and assign values to all of its data fields manually.

```
Point p = new Point();
p.x = 3;
p.y = 8;                            // tedious
```

- We'd rather be able to pass in the fields' values as parameters, as we did with Java's built-in `Point` class.

```
Point p = new Point(3, 8);  // better!
```

- To do this, we need to learn about a special type of method called a *constructor*.

Constructors

- **constructor**: A special method that initializes the state of new objects as they are created.
  - Constructors may accept parameters to initialize the object.
  - A constructor doesn't specify a return type (not even `void`) because it implicitly returns a new `Point` object.

  - Constructor syntax:

```
public <type> ( <parameter(s)> ) {
    <statement(s)> ;
}
```

- Example:

```
public Point(int initialX, int initialY) {
    ...
}
```

Point class, version 3

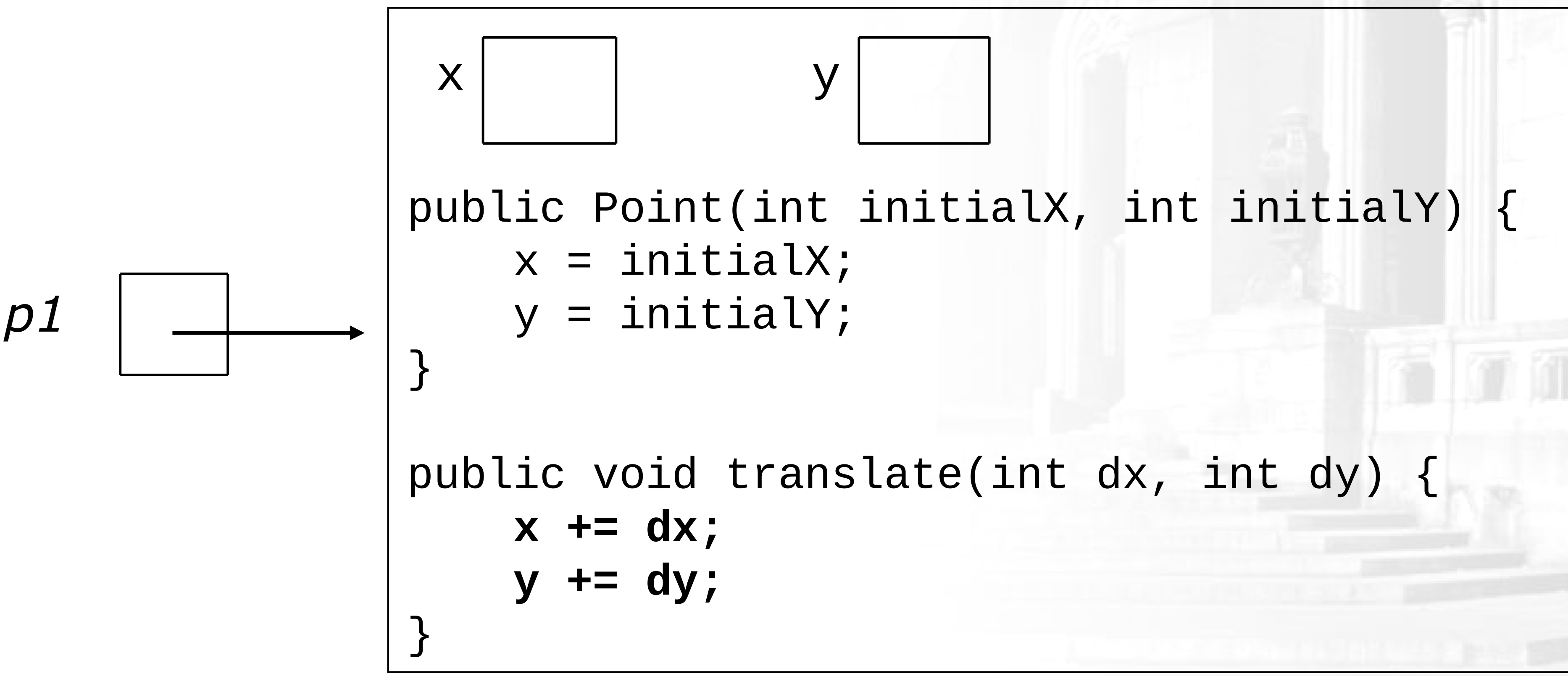
- This third version of the Point class provides a constructor to initialize Point objects:

```
public class Point {
    int x;
    int y;

    public Point(int initialX, int initialY) {
        x = initialX;
        y = initialY;
    }

    public void translate(int dx, int dy) {
        x += dx;
        y += dy;
    }
}
```

Tracing constructor calls

- What happens when the following call is made?

```
Point p1 = new Point(7, 2);
```




```
public Point(int initialX, int initialY) {
    x = initialX;
    y = initialY;
}

public void translate(int dx, int dy) {
    x += dx;
    y += dy;
}
```

Client code, version 3

- The following client code (stored in `PointMain3.java`) uses our `Point` constructor:

```
public class PointMain3 {
    public static void main(String[] args) {
        // create two Point objects
        Point p1 = new Point(5, 2);
        Point p2 = new Point(4, 3);

        // print each point
        System.out.println("p1 is (" + p1.x + ", " + p1.y + ")");
        System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");

        // move p2 and then print it again
        p2.translate(2, 4);
        System.out.println("p2 is (" + p2.x + ", " + p2.y + ")");
    }
}
```

OUTPUT:

```
p1 is (5, 2)
p2 is (4, 3)
p2 is (6, 7)
```

Client code question

- Recall our client program that produces this output:

```
p1 is (7, 2)
p1's distance from origin = 7.280109889280518
p2 is (4, 3)
p2's distance from origin = 5.0
p1 is (18, 8)
p2 is (5, 10)
```

- Modify the program to use our new constructor.

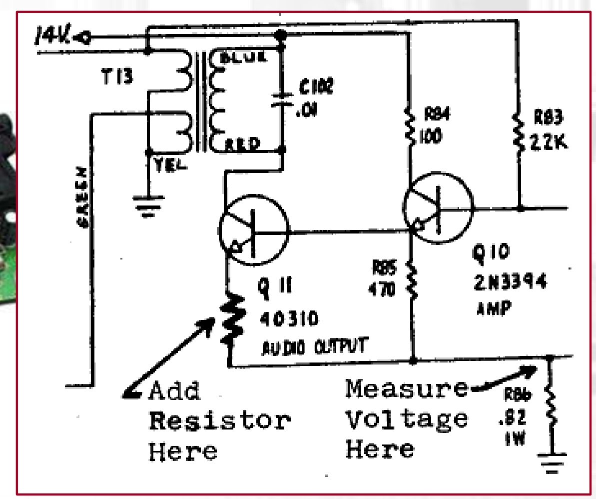
Encapsulation

- suggested reading: 8.5

Encapsulation

- **encapsulation**: Hiding the implementation details of an object from the clients of the object.
  - Specifically, this means protecting the object's fields from modification by clients.

- Encapsulating objects provides *abstraction*, because we can use them without knowing how they work. The object has:
  - an external view (its behavior)
  - an internal view (the state that accomplishes the behavior)



Implementing encapsulation

- Fields can be declared *private* to indicate that no code outside their own class can change them.
  - Declaring a private field, general syntax:
    ```
    private <type> <name> ;
    ```
  - Examples:
    ```
    private int x;
    private String name;
    ```
- Once fields are private, client code cannot directly access them. The client receives an error such as:

```
PointMain.java:11: x has private access in Point
System.out.println("p1 is (" + p1.x + ", " + p1.y + ")");
                                 ^
```

Encapsulation and accessors

- Once fields are private, we often provide accessor methods to examine their values:

```
public int getX() {
    return x;
}
```

  - This gives clients "read-only" access to the object's fields.

- If so desired, we can also provide mutator methods:

```
public void setX(int newX) {
    x = newX;
}
```

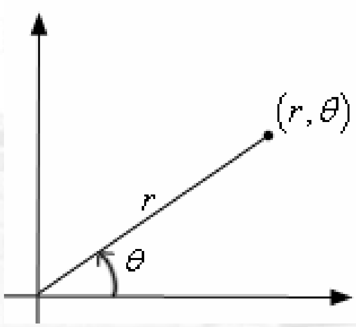
  - Question: Is there any difference between a public field and a private field with a `get` and `set` method?

Benefits of encapsulation

- Encapsulation helps provide a clean layer of abstraction between an object and its clients.

- Encapsulation protects an object from unwanted access by clients.
  - For example, perhaps we write a program to manage users' bank accounts. We don't want a malicious client program to be able to arbitrarily change a `BankAccount` object's balance.

- Encapsulation allows the class author to change the internal representation later if necessary.
  - For example, if so desired, the `Point` class could be rewritten to use polar coordinates (a radius r and an angle θ from the origin), but the external view could remain the same.



Point class, version 4

```
// A Point object represents an (x, y) location.
public class Point {
    private int x;
    private int y;

    public Point(int initialX, int initialY) {
        x = initialX;
        y = initialY;
    }

    public double distanceFromOrigin() {
        return Math.sqrt(x * x + y * y);
    }

    public int getX() {
        return x;
    }

    public int getY() {
        return y;
    }

    public void setLocation(int newX, int newY) {
        x = newX;
        y = newY;
    }

    public void translate(int dx, int dy) {
        x += dx;
        y += dy;
    }
}
```

Preconditions, postconditions, and invariants

- suggested reading: 8.6

Pre/postconditions

- **precondition**: Something that you expect / assume to be true when your method is called.
- **postcondition**: Something you promise to be true when your method exits.
  - Pre/postconditions are often documented as comments on method headers.
  - Example:

```
// Sets this Point's location to be the given (x, y).
// Precondition: newX >= 0 && newY >= 0
// Postcondition: x >= 0 && y >= 0
public void setLocation(int newX, int newY) {
    x = newX;
    y = newY;
}
```

Class invariants

- **class invariant**: An assertion about an object's state that is true throughout the lifetime of the object.
  - An invariant can be thought of as a postcondition on every constructor and mutator method of a class.
  - Example: "No BankAccount object's balance can be negative."
  - Example: "The speed of a SpaceShip object must be ≤ 10."
- Example: Suppose we want to ensure that all `Point` objects' x and y coordinates are never negative.
  - We must ensure that a client cannot construct a `Point` object with a negative x or y value.
  - We must ensure that a client cannot move an existing `Point` object to a negative (x, y) location.

Violated preconditions

- What if your precondition is not met?
  - Sometimes the client passes an invalid value to your method.
  - Example:

```
Point pt = new Point(5, 17);
Scanner console = new Scanner(System.in);
System.out.print("Type the coordinates: ");
int x = console.nextInt();  // what if the user types
int y = console.nextInt();  // a negative number?
pt.setLocation(x, y);
```

  - How can we prevent the client from misusing our object in this way?

Dealing with violations

- One way to deal with this problem would be to return out of the method if negative values are encountered.
  - However, it is not possible to do something similar in the constructor, and the client doesn't expect this behavior.

- A more common solution is to have your object *throw an exception*.

- **exception**: A Java object that represents an error.
  - When a precondition of your method has been violated, you can generate ("throw") an exception in your code.
  - This will cause the client program to halt. (That'll show 'em!)

Throwing exceptions example

- Throwing an exception, general syntax:

  `throw new` ***<exception type>*** `();`

  or, `throw new` ***<exception type>*** `("`***<message>***`");`

  - The ***<message>*** will be shown on the console when the program crashes.

- Example:

```
// Sets this Point's location to be the given (x, y).
// Throws an exception if newX or newY is negative.
// Postcondition: x >= 0 && y >= 0
public void setLocation(int newX, int newY) {
    if (newX < 0 || newY < 0) {
        throw new IllegalArgumentException();
    }

    x = newX;
    y = newY;
}
```

Encapsulation and invariants

Encapsulation helps you enforce invariants.

- Ensure that no `Point` is constructed with negative x or y:

```
public Point(int initialX, int initialY) {
    if (initialX < 0 || initialY < 0) {
        throw new IllegalArgumentException();
    }
    x = initialX;
    y = initialY;
}
```

- Ensure that no `Point` can be moved to a negative x or y:

```
public void translate(int dx, int dy) {
    if (x + dx < 0 || y + dy < 0) {
        throw new IllegalArgumentException();
    }
    x += dx;
    y += dy;
}
```

- Other methods require similar modifications.

Lecture outline

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- objects, classes, and object-oriented programming
- object fields
  - instance methods

<u>Lecture 22</u>

  - constructors
  - encapsulation
- preconditions, postconditions, and invariants

<u>Lecture 23</u>

- **special methods: `toString` and `equals`**
- **the keyword `this`**

Special instance methods: `toString` and `equals`

- suggested reading: 8.6

Problem: object printability

- By default, Java doesn't know how to print the state of your objects, so it prints a strange result:

```
Point p = new Point(10, 7);
System.out.println("p is " + p);  // p is Point@9e8c34
```

- We can instead print a more complex string that shows the object's state, but this is cumbersome.

```
System.out.println("(" + p.x + ", " + p.y + ")");
```

- We'd like to be able to print the object itself and have something meaningful appear.

```
// desired behavior:
System.out.println("p is " + p);  // p is (10, 7)
```

The toString method

- The special method `toString` tells Java how to convert your object into a `String` as needed.
  - The `toString` method is called when your object is printed or concatenated with a `String`.

```
Point p1 = new Point(7, 2);
System.out.println("p1 is " + p1);
```

  - If you prefer, you can write the `.toString()` explicitly.

```
System.out.println("p1 is " + p1.toString());
```

- Every class contains a `toString` method, even if it isn't written in your class's code.
  - The default `toString` behavior is to return the class's name followed by a hexadecimal (base-16) number:

```
Point@9e8c34
```

toString method syntax

- You can replace the default behavior by defining an appropriate `toString` method in your class.
  - Example: The `Point` class in `java.awt` has a `toString` method that converts a `Point` into a `String` such as:
    `"java.awt.Point[x=7,y=2]"`
- The `toString` method, general syntax:

```
public String toString() {
    <statement(s) that return an appropriate String> ;
}
```

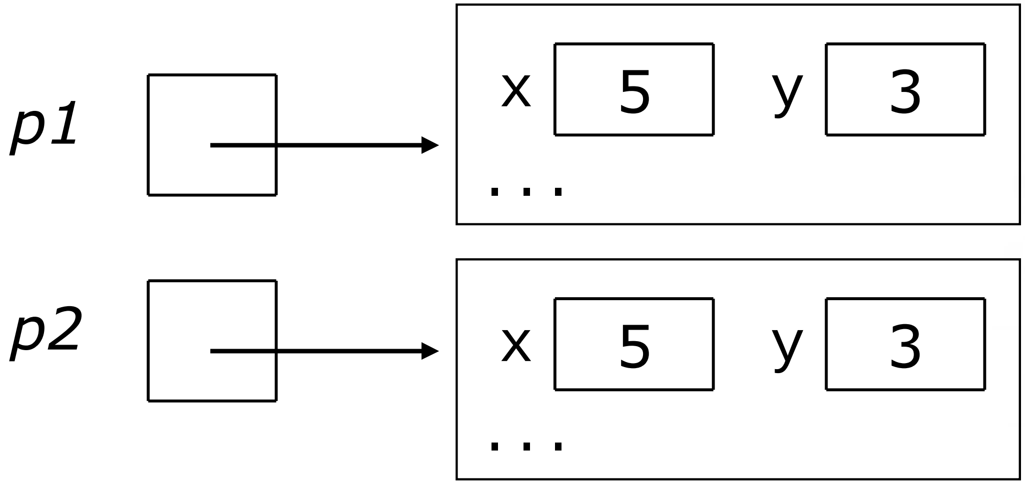
  - The method must have this exact name and signature.
- Example:

```
// Returns a String representing this Point.
public String toString() {
    return "(" + x + ", " + y + ")";
}
```

Recall: comparing objects

- The == operator does not work well with objects.
  - == compares references to objects and only evaluates to `true` if two variables refer to the same object.
    - It doesn't tell us whether two objects have the same state.
  - Example:

```
Point p1 = new Point(5, 3);
Point p2 = new Point(5, 3);
if (p1 == p2) {  // false
    System.out.println("equal");
}
```



The equals method

- The `equals` method compares the state of objects.
  - When we write our own new classes of objects, Java doesn't know how to compare their state.
  - The default `equals` behavior acts just like the == operator.

```
if (p1.equals(p2)) {  // still false
    System.out.println("equal");
}
```

- We can replace this default behavior by writing an `equals` method.
  - The method will actually compare the state of the two objects and return `true` for cases like the above.

Initial flawed equals method

- You might think that the following is a valid implementation of the `equals` method:

```
public boolean equals(Point other) {
    if (x == other.x && y == other.y) {
        return true;
    } else {
        return false;
    }
}
```

  - However, it has several flaws that we should correct.

- One initial flaw: the body can be shortened to:

```
    return x == other.x && y == other.y;
```

equals and the Object class

- A proper equals method does not accept a parameter of type Point.
  - It should be legal to compare Point objects to any other type of objects, such as:

```
Point p = new Point(7, 2);
if (p.equals("hello")) {   // false
    ...
}
```

- The equals method, general syntax:

```
public boolean equals(Object <name>) {
    <statement(s) that return a boolean value> ;
}
```

  - The parameter to a proper equals method must be of type Object (which means that any object of any type can be passed as the parameter).

Another flawed version

- You might think that the following is a valid implementation of the `equals` method:

```
public boolean equals(Object o) {
    if (x == o.x && y == o.y) {
        return true;
    } else {
        return false;
    }
}
```

- However, it does not compile.

```
Point.java:36: cannot find symbol
symbol  : variable x
location: class java.lang.Object
if (x == o.x && y == o.y) {
          ^
```

Type-casting objects

- The object that is passed to `equals` can be cast from `Object` into your class's type.
  - Example:

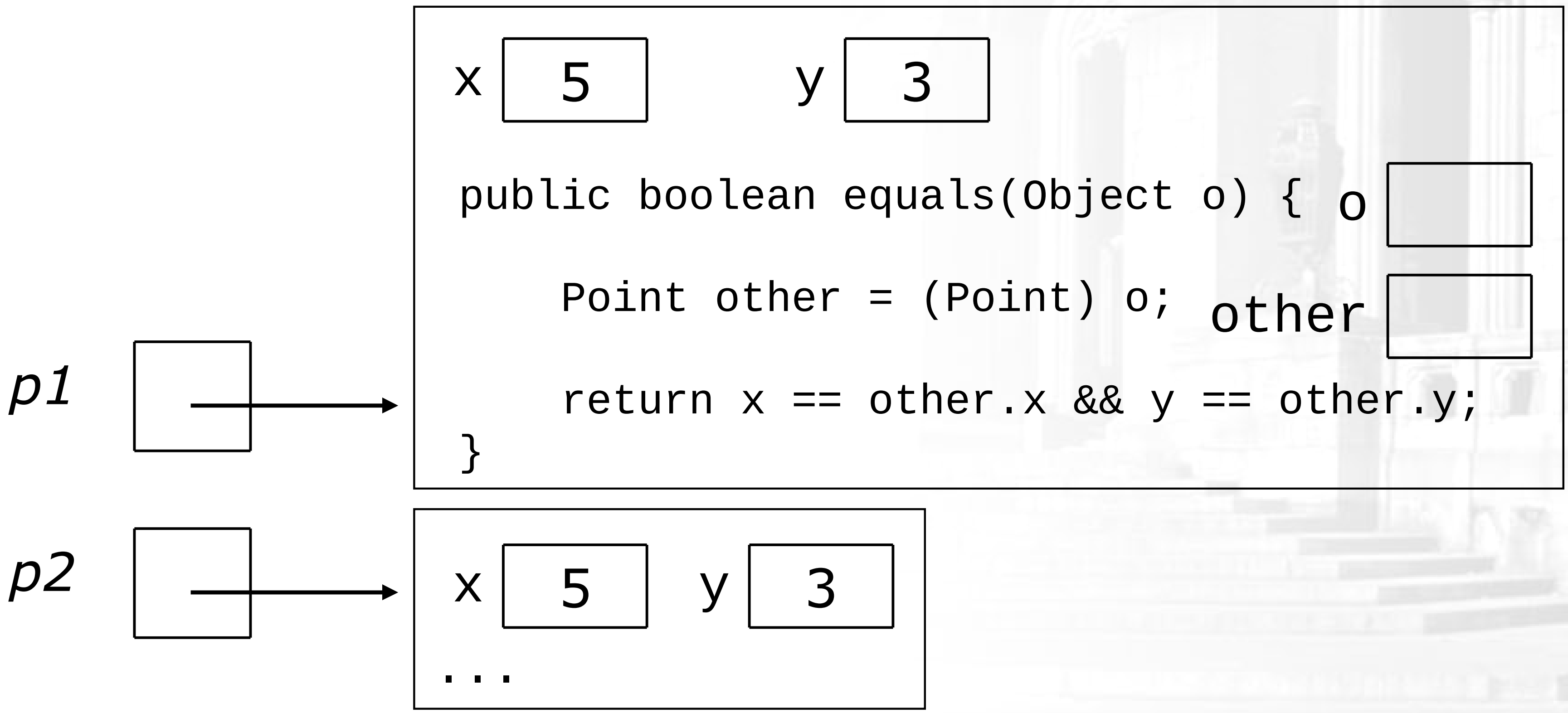
```
public boolean equals(Object o) {
    Point other = (Point) o;
    return x == other.x && y == other.y;
}
```

- Type-casting with objects behaves differently than casting primitive values.
  - We are really casting a reference of type `Object` into a reference of type `Point`.
  - We're promising the compiler that `o` refers to a `Point` object.

Casting objects diagram

- Client code:

```
Point p1 = new Point(5, 3);
Point p2 = new Point(5, 3);
if (p1.equals(p2)) {
    System.out.println("equal");
}
```



Comparing different types

- Our `equals` code still is not complete.
  - When we compare `Point` objects to any other type of objects,

```
Point p = new Point(7, 2);
if (p.equals("hello")) {   // false
    ...
}
```

  - Currently the code crashes with the following exception:

```
Exception in thread "main"
java.lang.ClassCastException: java.lang.String
        at Point.equals(Point.java:25)
        at PointMain.main(PointMain.java:25)
```

  - The culprit is the following line that contains the type-cast:

```
public boolean equals(Object o) {
    Point other = (Point) o;
```

The instanceof keyword

- We can use a keyword called `instanceof` to ask whether a variable refers to an object of a given type.
  - The `instanceof` keyword, general syntax:

    <variable> `instanceof` ***<type>***

  - The above is a `boolean` expression that can be used as the test in an `if` statement.

  - Examples:

```
String s = "hello";
Point p =
    new Point(7, 2);
```

expression	result
`s instanceof Point`	`false`
`s instanceof String`	`true`
`p instanceof Point`	`true`
`p instanceof String`	`false`
`null instanceof String`	`false`

Final version of equals method

- This version of the `equals` method allows us to correctly compare `Point` objects against any other type of object:

```
// Returns whether o refers to a Point object with
// the same (x, y) coordinates as this Point object.
public boolean equals(Object o) {
    if (o instanceof Point) {
        Point other = (Point) o;
        return x == other.x && y == other.y;
    } else {
        return false;
    }
}
```

The keyword `this`

- suggested reading: 8.7

Using the keyword this

- The this keyword is a reference to the implicit parameter (the object on which an instance method or constructor is being called).

- Usage of the this keyword, general syntax:
  - To refer to a field:
    this.***<field name>***

  - To refer to a method:
    this.***<method name>***(***<parameters>***);

  - To call a constructor from another constructor:
    this(***<parameters>***);

Variable shadowing

- **shadowed variable**: A field that is "covered up" by a local variable or parameter with the same name.
  - Normally it is illegal to have two variables in the same scope with the same name, but in this case it is allowed.
  - To avoid shadowing, we named our `setLocation` parameters `newX` and `newY`:

```
public void setLocation(int newX, int newY) {
    if (newX < 0 || newY < 0) {
        throw new IllegalArgumentException();
    }
    x = newX;
    y = newY;
}
```

Avoiding shadowing with this

- The `this` keyword lets us use the same names and still avoid shadowing:

```
public void setLocation(int x, int y) {
    if (x < 0 || y < 0) {
        throw new IllegalArgumentException();
    }
    this.x = x;
    this.y = y;
}
```

  - When `this.` is not seen, the parameter is used.
  - When `this.` is seen, the field is used.

Multiple constructors

- It is legal to have more than one constructor in a class.
  - The constructors must accept different parameters.

```
public class Point {
    private int x;
    private int y;

    public Point() {
        x = 0;
        y = 0;
    }

    public Point(int initialX, int initialY) {
        x = initialX;
        y = initialY;
    }

    ...
}
```

Multiple constructors w/ this

- To avoid redundant code, one constructor may call another using the `this` keyword.
  - We can also use the `this.` field syntax so that the constructor parameters' names can match the field names.

```
public class Point {
    private int x;
    private int y;

    public Point() {
        this(0, 0);   // calls the (x, y) constructor
    }

    public Point(int x, int y) {
        this.x = x;
        this.y = y;
    }

    ...
```