Building Java Programs

Chapter 8

Lecture 8-2: Object Behavior (Methods) and Constructors

reading: 8.2 - 8.3

Recall: Instance methods

- **instance method** (or **object method**): Exists inside each object of a class and gives behavior to each object.

```
public type name(parameters) {
    statements;
}
```

  - same syntax as static methods, but without `static` keyword

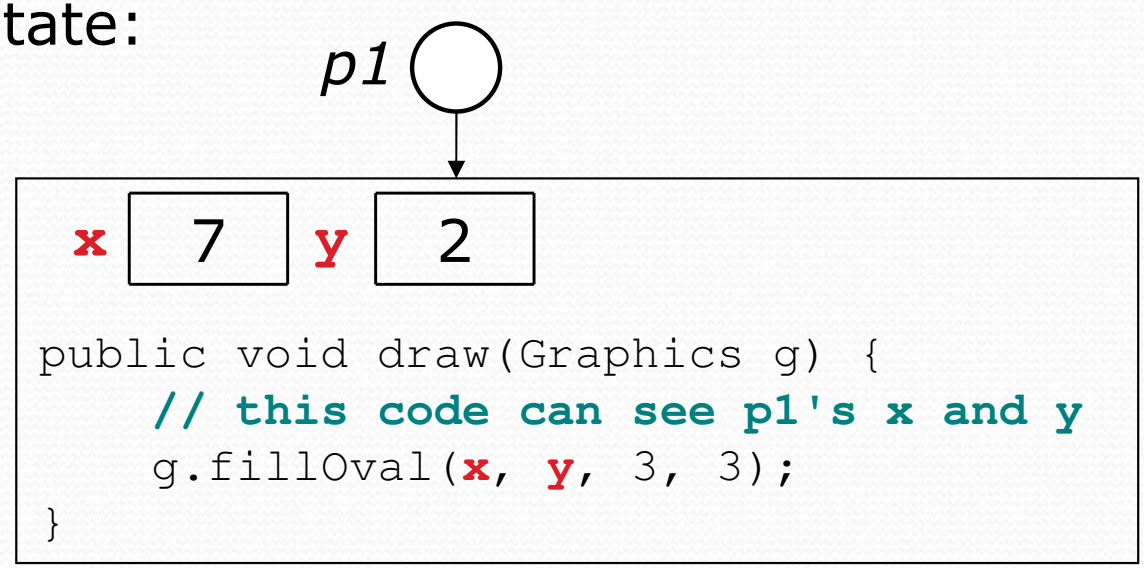
Example:

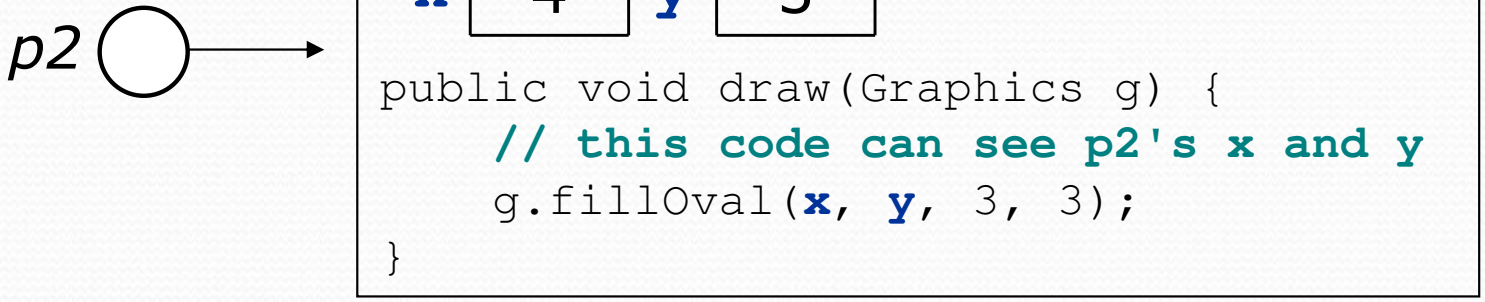
```
public void shout() {
    System.out.println("HELLO THERE!");
}
```

`Point` objects w/ method

- Each `Point` object has its own copy of the `draw` 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;

p1.draw(g);
p2.draw(g);
```





The implicit parameter

- **implicit parameter**:
  The object on which an instance method is called.
  - During the call `p1.draw(g);`
    the object referred to by `p1` is the implicit parameter.
  - During the call `p2.draw(g);`
    the object referred to by `p2` is the implicit parameter.
  - The instance method can refer to that object's fields.
    - We say that it executes in the *context* of a particular object.
    - `draw` can refer to the `x` and `y` of the object it was called on.

Kinds of methods

- **accessor**: A method that lets clients examine object state.
  - Examples: `distance`, `distanceFromOrigin`
  - often has a non-`void` return type

- **mutator**: A method that modifies an object's state.
  - Examples: `setLocation`, `translate`

Mutator method questions

- Write a method `setLocation` that changes a `Point`'s location to the (*x*, *y*) values passed.

- Write a method `translate` that changes a `Point`'s location by a given *dx*, *dy* amount.
  - Modify the `Point` and client code to use these methods.

Mutator method answers

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


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

// alternative solution that utilizes setLocation
public void translate(int dx, int dy) {
    setLocation(x + dx, y + dy);
}
```

Accessor method questions

- Write a method `distanceFromOrigin` that returns the distance between a `Point` and the origin, (0, 0).

  Use the formula: $\sqrt{x^2 + y^2}$

- Write a method `distance` to compute the distance between a `Point` and another `Point` passed as a parameter.

  Use the formula: $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

  - Modify the client code to use these methods.

Accessor method answers

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


public double distance(Point other) {
    int dx = x - other.x;
    int dy = y - other.y;
    return Math.sqrt(dx * dx + dy * dy);
}


// alternative distanceFromOrigin that uses distance
public double distanceFromOrigin() {
    Point origin = new Point();
    return distance(origin);
}
```

Printing objects

- By default, Java doesn't know how to print objects:

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


// better, but cumbersome;              p is (10, 7)
System.out.println("p is (" + p.x + ", " + p.y + ")");


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

The `toString` method

tells Java how to convert an object into a `String`

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

// the above code is really calling the following:
System.out.println("p1: " + p1.toString());
```

- Every class has a `toString`, even if it isn't in your code.
  - Default: class's name `@` object's memory address (base 16)

```
Point@9e8c34
```

`toString` syntax

```
public String toString() {
    code that returns a String representing this object;
}
```

- Method name, return, and parameters must match exactly.
- Example:

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

Object initialization: constructors

reading: 8.3

Initializing objects

- Currently it takes 3 lines to create a `Point` and initialize it:

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

- We'd rather specify the fields' initial values at the start:

```
Point p = new Point(3, 8);    // desired; doesn't work (yet)
```

  - We are able to this with most types of objects in Java.

Constructors

- **constructor**: Initializes the state of new objects.

```
public type(parameters) {
    statements;
}
```

  - runs when the client uses the `new` keyword
  - no return type is specified;
    it implicitly "returns" the new object being created

  - If a class has no constructor, Java gives it a *default constructor* with no parameters that sets all fields to 0.

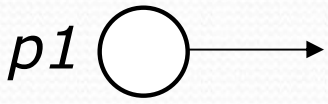
Constructor example

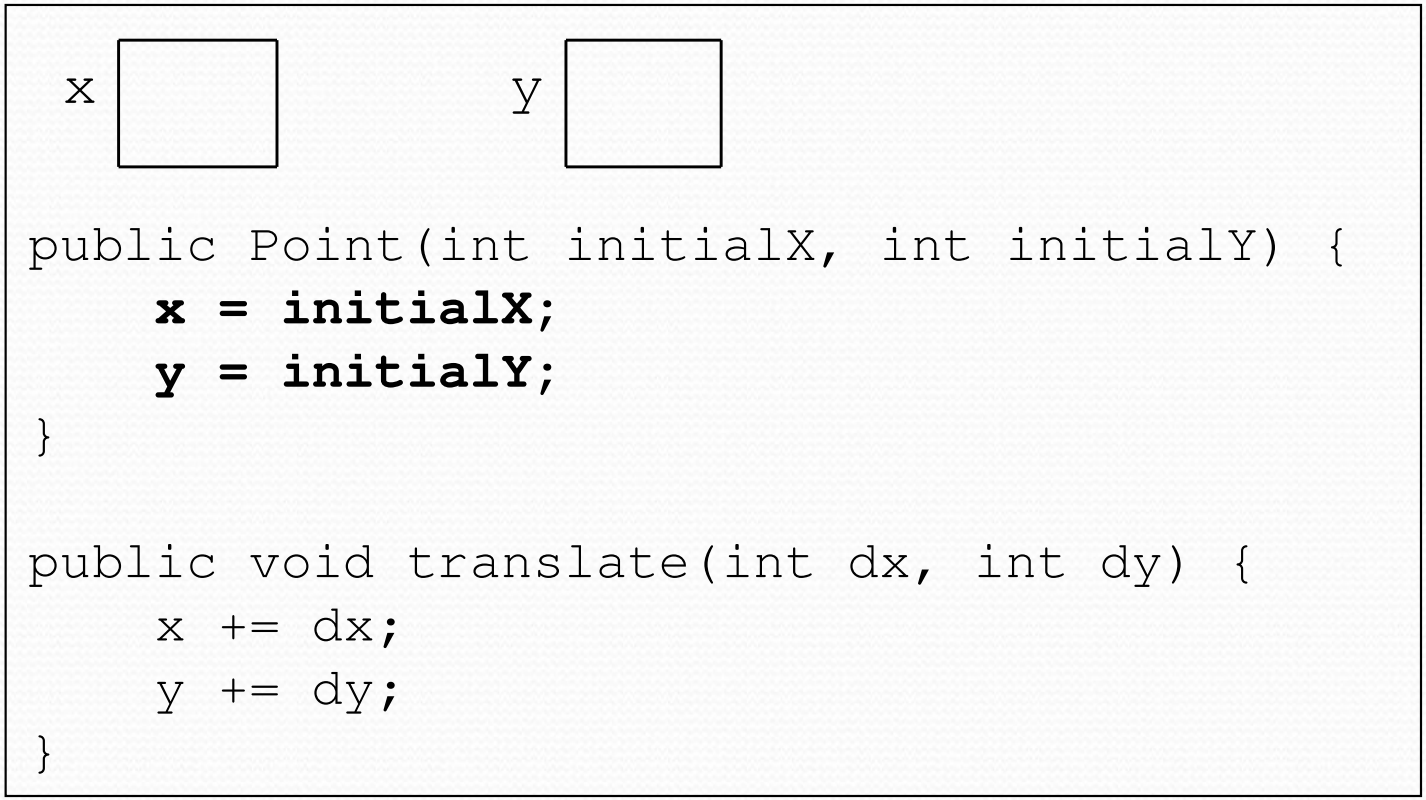
```
public class Point {
    int x;
    int y;

    // Constructs a Point at the given x/y location.
    public Point(int initialX, int initialY) {
        x = initialX;
        y = initialY;
    }


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

    ...
}
```

Tracing a constructor call

- 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;
}
```

Common constructor bugs

1. Re-declaring fields as local variables ("shadowing"):

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

   - This declares local variables with the same name as the fields, rather than storing values into the fields. The fields remain 0.

2. Accidentally giving the constructor a return type:

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

   - This is actually not a constructor, but a method named `Point`

Client code, version 3

```
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: (" + p1.x + ", " + p1.y + ")");
        System.out.println("p2: (" + p2.x + ", " + p2.y + ")");

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

OUTPUT:

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

Multiple constructors

- A class can have multiple constructors.
  - Each one must accept a unique set of parameters.

- *Exercise:* Write a `Point` constructor with no parameters that initializes the point to (0, 0).

```
// Constructs a new point at (0, 0).
public Point() {
    x = 0;
    y = 0;
}
```