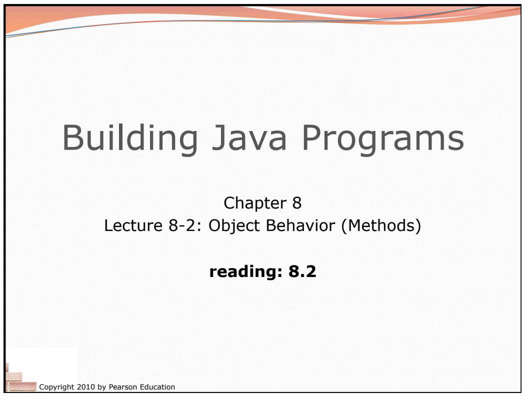
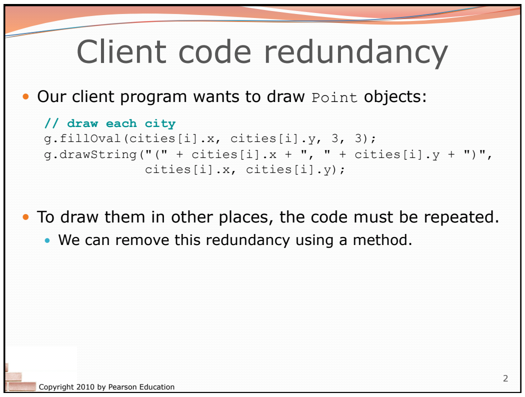


Building Java Programs

Chapter 8
Lecture 8-2: Object Behavior (Methods)

reading: 8.2

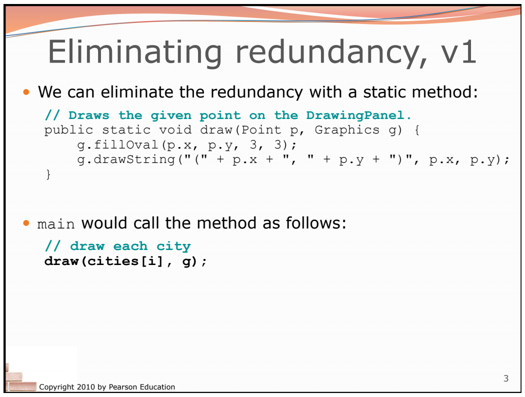


Client code redundancy

- Our client program wants to draw `Point` objects:

```
// draw each city
g.fillOval(cities[i].x, cities[i].y, 3, 3);
g.drawString("(" + cities[i].x + ", " + cities[i].y + ")",
             cities[i].x, cities[i].y);
```

- To draw them in other places, the code must be repeated.
  - We can remove this redundancy using a method.



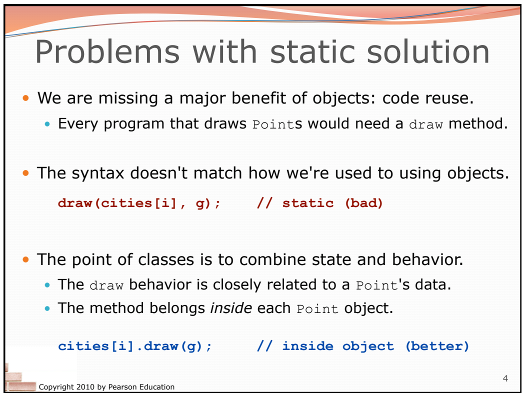
Eliminating redundancy, v1

- We can eliminate the redundancy with a static method:

```
// Draws the given point on the DrawingPanel.
public static void draw(Point p, Graphics g) {
    g.fillOval(p.x, p.y, 3, 3);
    g.drawString("(" + p.x + ", " + p.y + ")", p.x, p.y);
}
```

- `main` would call the method as follows:

```
// draw each city
draw(cities[i], g);
```



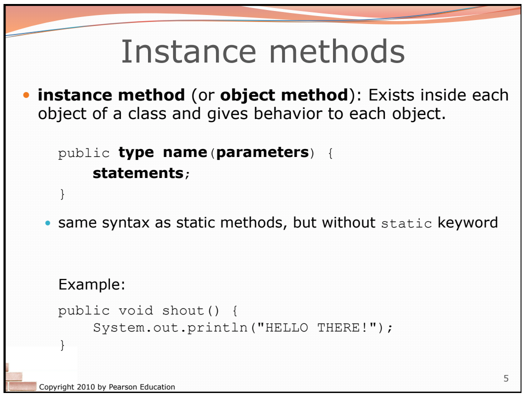
Problems with static solution

- We are missing a major benefit of objects: code reuse.
  - Every program that draws `Point`s would need a `draw` method.
- The syntax doesn't match how we're used to using objects.

```
draw(cities[i], g);    // static (bad)
```

- The point of classes is to combine state and behavior.
  - The `draw` behavior is closely related to a `Point`'s data.
  - The method belongs *inside* each `Point` object.

```
cities[i].draw(g);     // inside object (better)
```



Instance methods

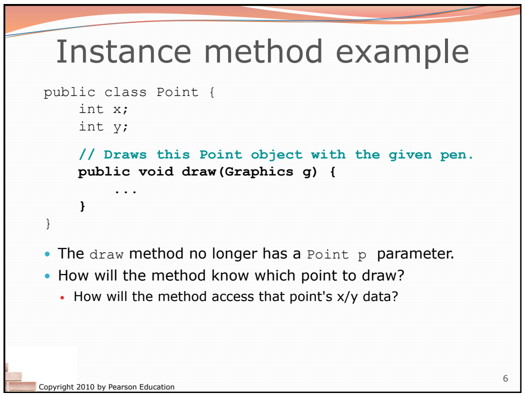
- **instance method** (or **object method**): Exists inside each object of a class and gives behavior to each object.

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

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

Example:

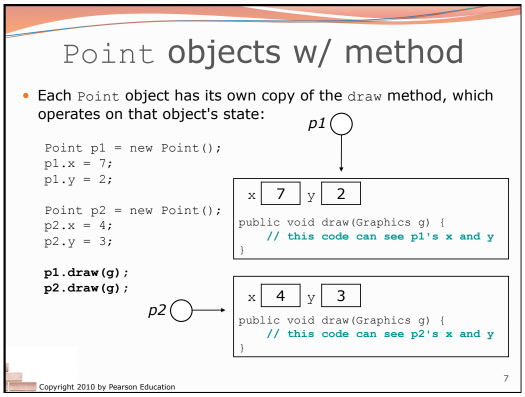
```
public void shout() {
    System.out.println("HELLO THERE!");
}
```



Instance method example

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

    // Draws this Point object with the given pen.
    public void draw(Graphics g) {
        ...
    }
}
```

- The `draw` method no longer has a `Point p` parameter.
- How will the method know which point to draw?
  - How will the method access that point's x/y data?



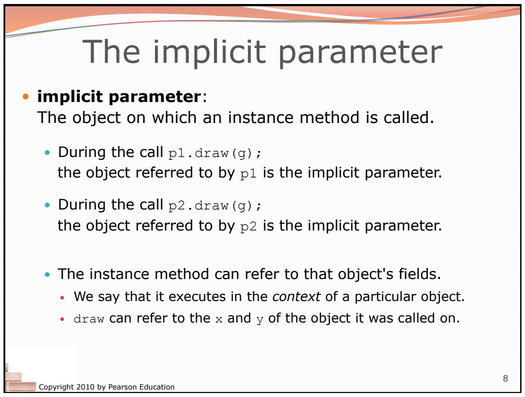
Point objects w/ method

- 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);
```

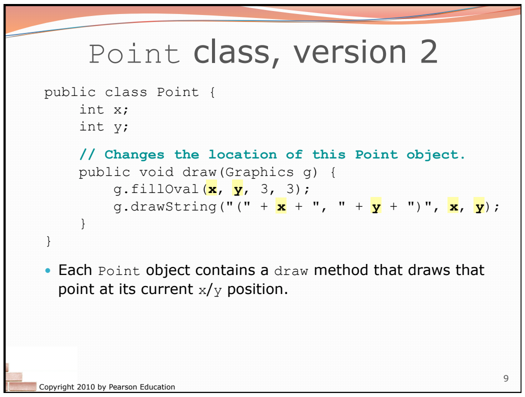
```
public void draw(Graphics g) {
    // this code can see p1's x and y
}
```

```
public void draw(Graphics g) {
    // this code can see p2's x and y
}
```



The implicit parameter

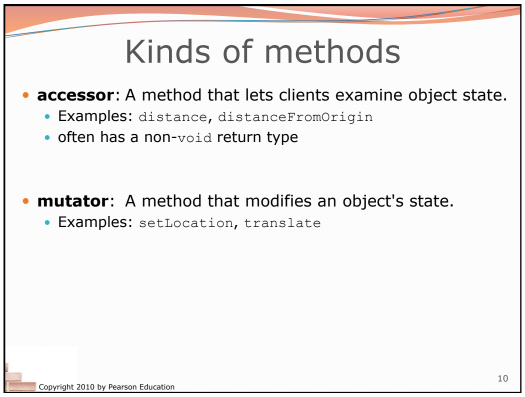
- **implicit parameter**:
  The object on which an instance method is called.
  - During the call p1.draw(g);
    the object referred to by p1 is the implicit parameter.
  - During the call p2.draw(g);
    the object referred to by p2 is the implicit parameter.
  - The instance method can refer to that 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.



Point class, version 2

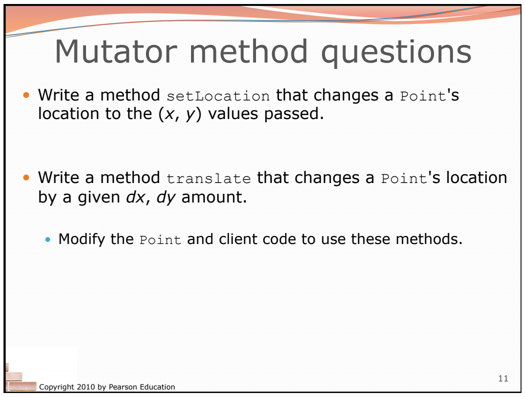
```
public class Point {
    int x;
    int y;

    // Changes the location of this Point object.
    public void draw(Graphics g) {
        g.fillOval(x, y, 3, 3);
        g.drawString("(" + x + ", " + y + ")", x, y);
    }
}
```

- Each Point object contains a draw method that draws that point at its current x/y position.



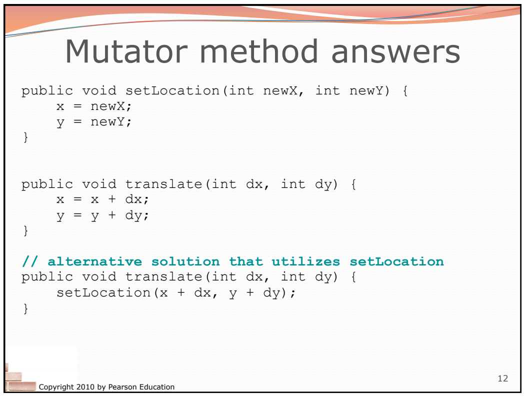
Kinds of methods

- **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



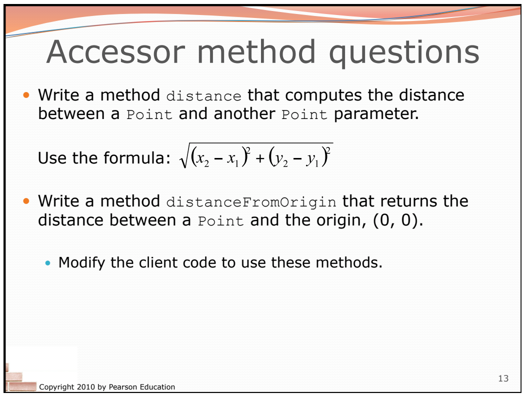
Mutator method questions

- 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);
}
```

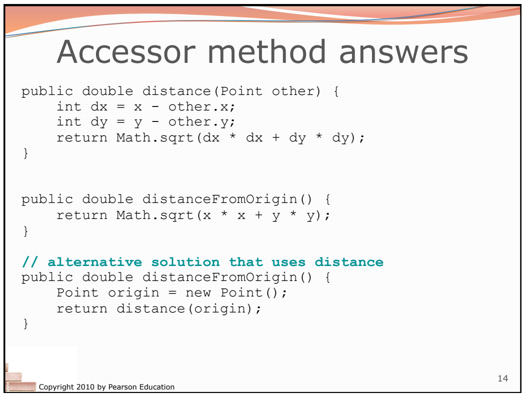


Accessor method questions

- Write a method `distance` that computes the distance between a `Point` and another `Point` parameter.

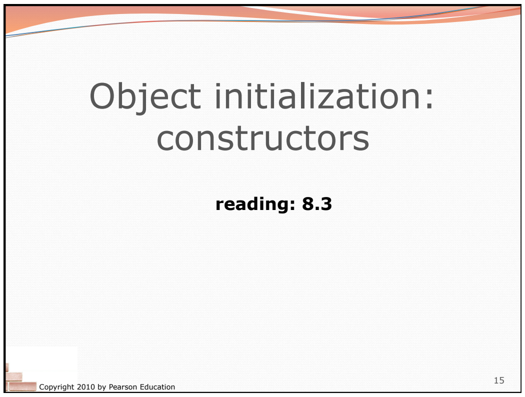
  Use the formula: $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

- Write a method `distanceFromOrigin` that returns the distance between a `Point` and the origin, (0, 0).
  - Modify the client code to use these methods.



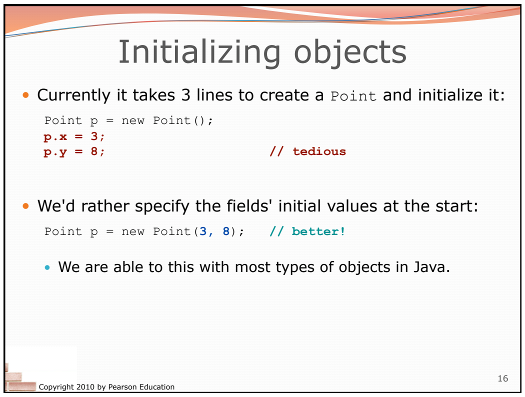
Accessor method answers

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

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

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



Object initialization: constructors

reading: 8.3



Initializing objects

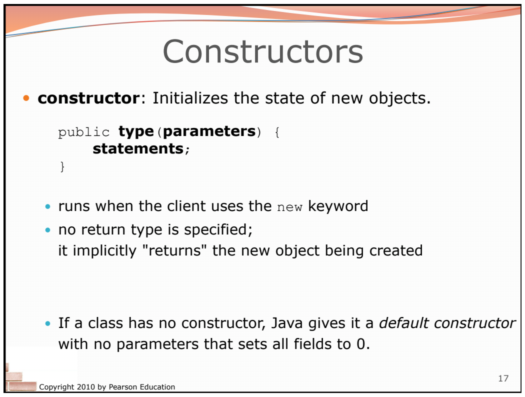
- Currently it takes 3 lines to create a `Point` and initialize it:

```
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);   // better!
```

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

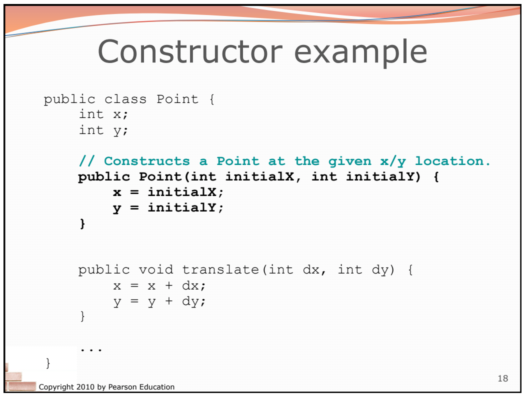


Constructors

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

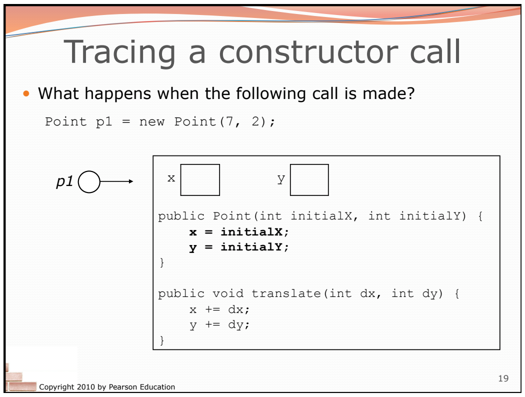
```
public type(parameters) {
    statements;
}
```

  - 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;
    }

    ...
}
```

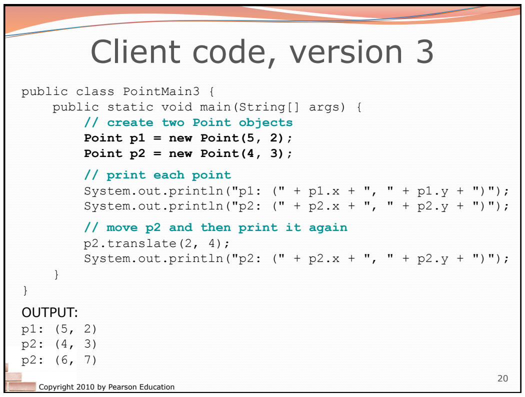


Tracing a constructor call

- 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;
}
```

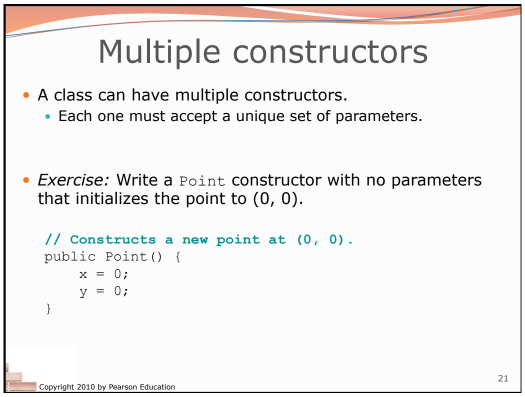


Client code, version 3

```
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)
```

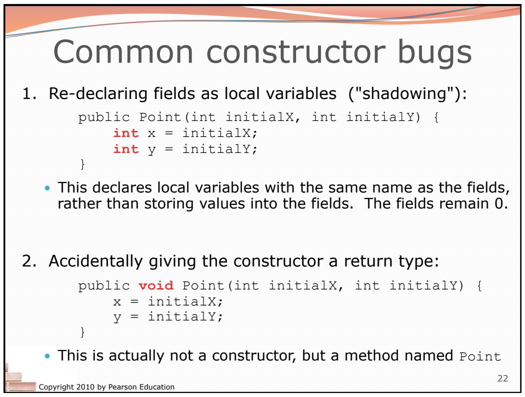


Multiple constructors

- 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;
}
```



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`