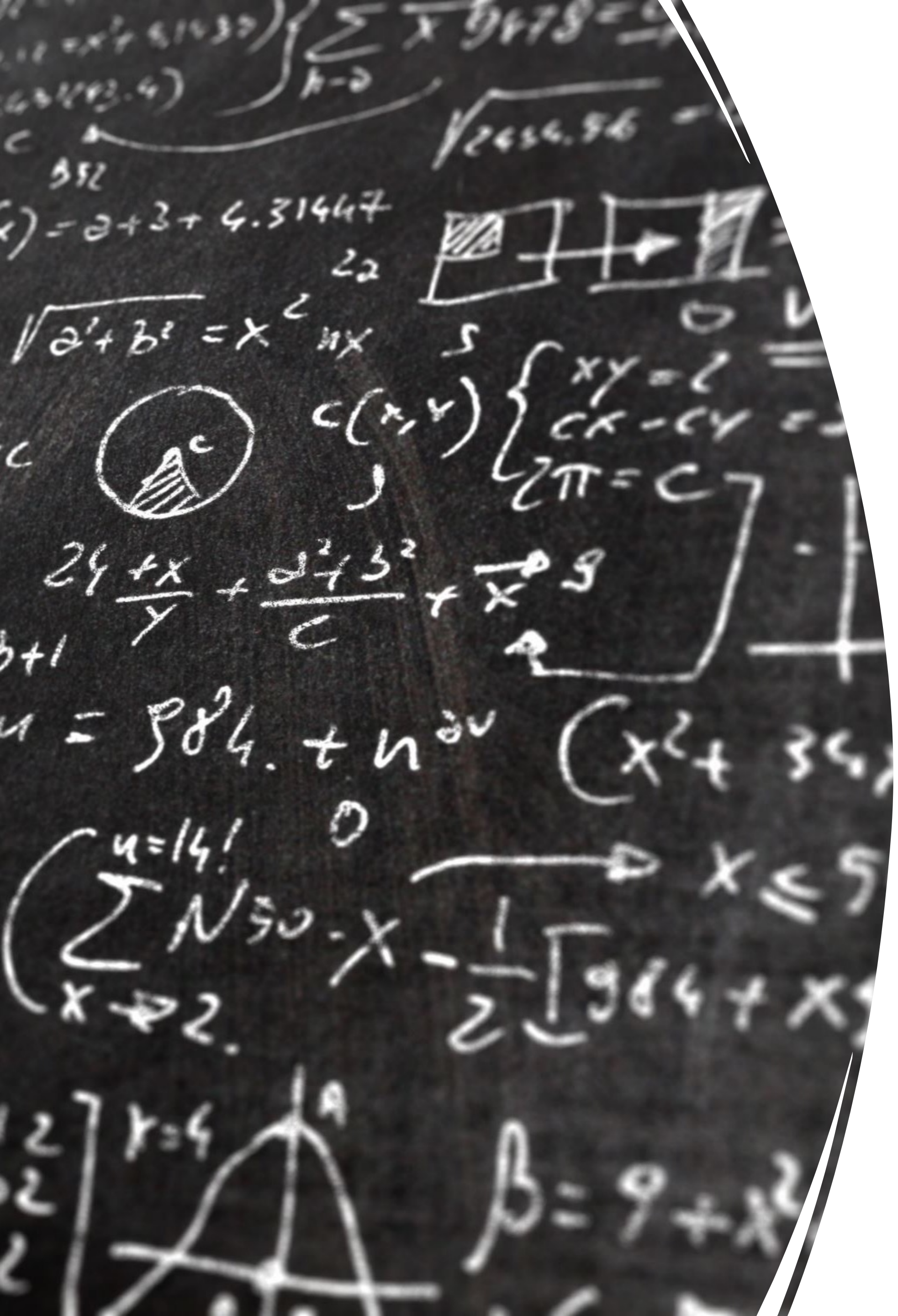


CS 113 – Computer Science I

Lecture 12 – Objects

Adam Poliak

10/25/2022

Announcements

- Assignment 06
    - Due Thursday 10/27

- Sharing code

- Mid-semester feedback

Object-oriented programming (OOP)

Method for designing programs in terms of objects

Recall: Top-down design

- the “nouns” in your feature list correspond to classes/data
- the “verbs” correspond to methods

Using objects: some special methods

The **constructor method** is called when you do a `new`

accesors (aka getters)
return the values of instance variables

mutators (aka setters)
set the values of instance variables

toString()
returns a string representation of an object

Defining classes

By defining our own classes, we can create our own data types

A class definition contains

- the data contained by the new type (**instance variables**)

- the operations supported by the new type (**instance methods**)

Example: Defining a class `Point`

What data should it have?

- X-coordinate
- y-coordinate
- Name
- color

What operations should it support?

this

`this` is a special keyword that refers to the object inside an instance method

Analogy:

Visualizing programs with objects

```
class Point {
  public double x = -1.0;
  public double y = -1.0;

  public Point() {
    this.x = 0;
    this.y = 0;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void add(Point p) {
     this.x = this.x + p.getX();
     this.y = this.y + p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(3, 5);

    p.add(p2);
  }
}
```

Draw a stack diagram

Exercise: Draw a stack diagram for the following program

```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
     this.x = this.x - p.getX();
     this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Draw a stack diagram

Function Stack:

Created objects

Exercise: Draw a stack diagram for the following program

```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
     this.x = this.x - p.getX();
     this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Exercise: Draw a stack diagram for the following program

```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
     this.x = this.x - p.getX();
     this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Draw a stack diagram

Function Stack:

Created objects

Main:

Exercise: Draw a stack diagram for the following program

```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
     this.x = this.x - p.getX();
     this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Exercise: Draw a stack diagram for the following program

```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
    this.x = this.x - p.getX();
    this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Draw a stack diagram

Function Stack:

Point():

Main:

Created objects

Draw a stack diagram

Function Stack:

Point():

- **this**

Main:

Created objects

Exercise: Draw a stack diagram for the following program

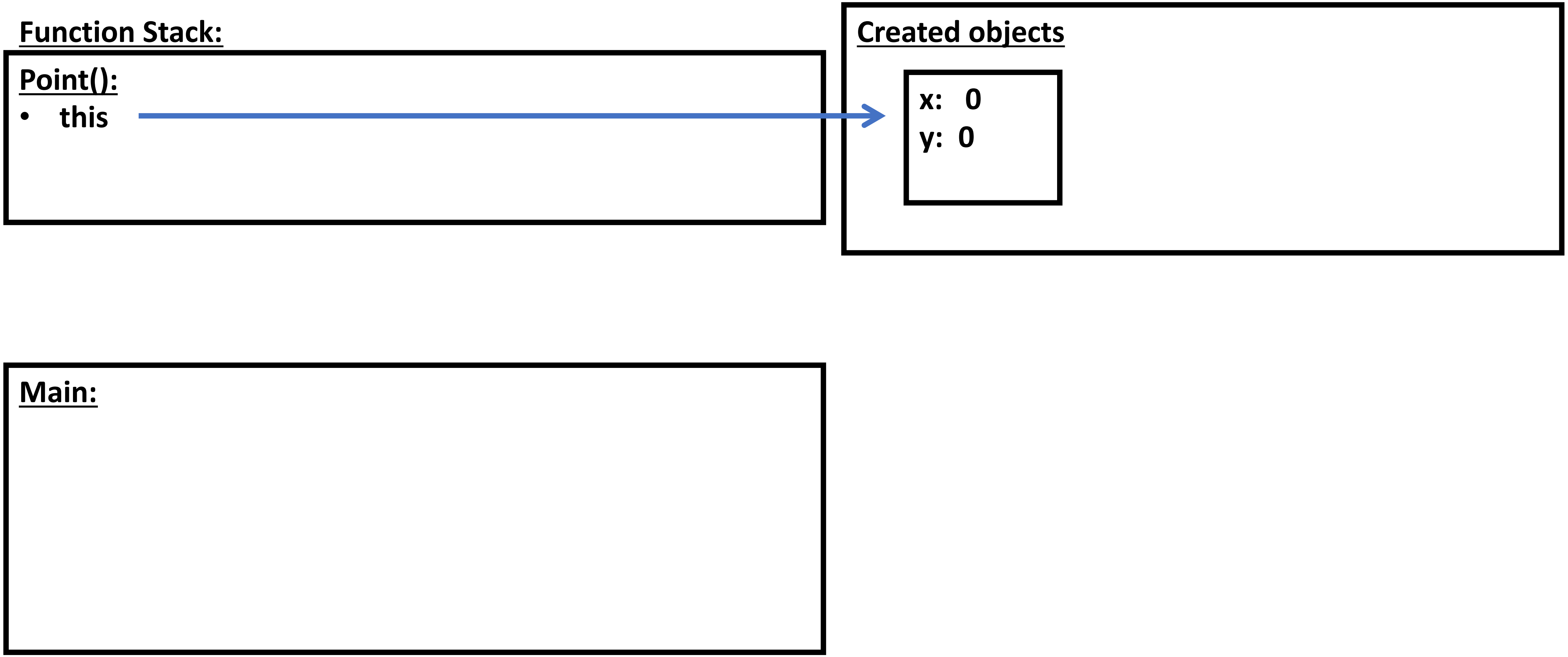
```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
    this.x = this.x - p.getX();
    this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

     add(p2);
  }
}
```

Draw a stack diagram



Function Stack:

Point():

- this

Created objects

x: 0
y: 0

Main:

Exercise: Draw a stack diagram for the following program

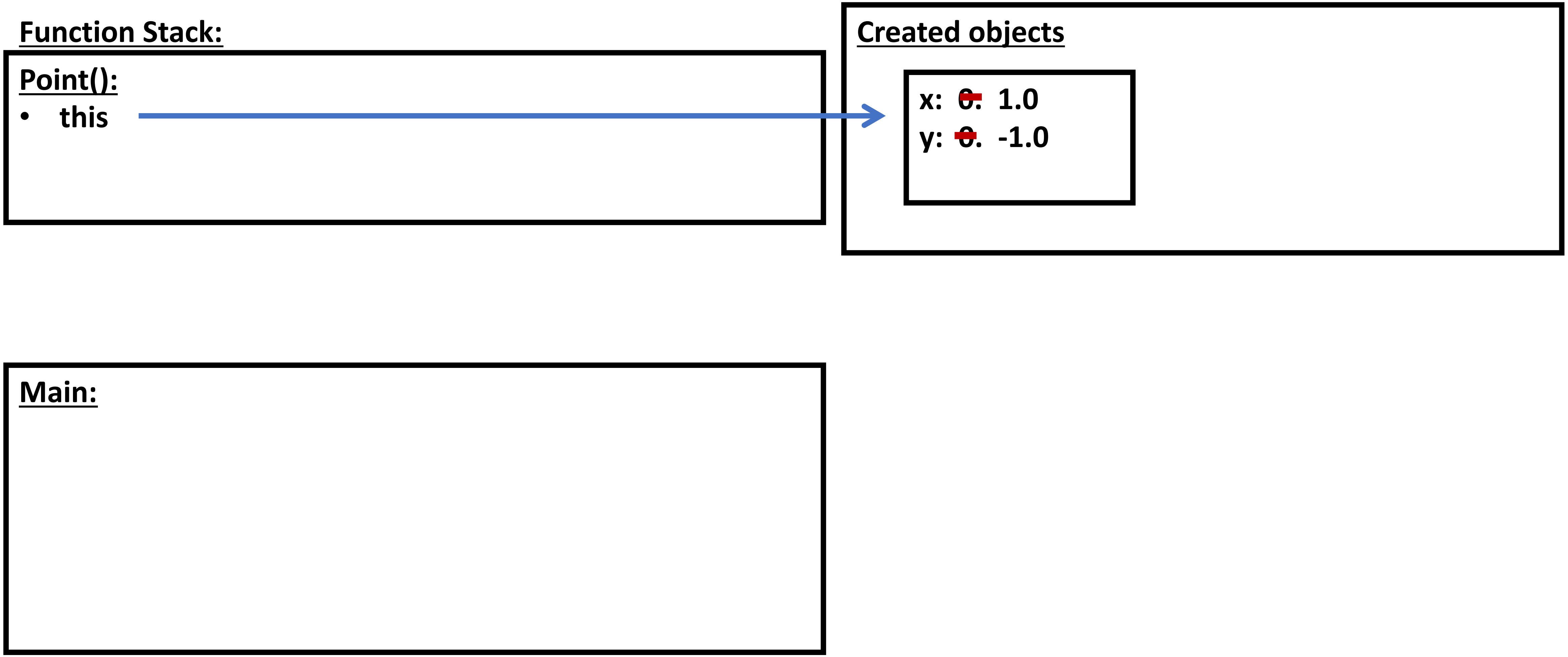
```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
    this.x = this.x - p.getX();
    this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Draw a stack diagram



Function Stack:

Point():

- this

Created objects

x: ~~0.~~ 1.0

y: ~~0.~~ -1.0

Main:

Exercise: Draw a stack diagram for the following program

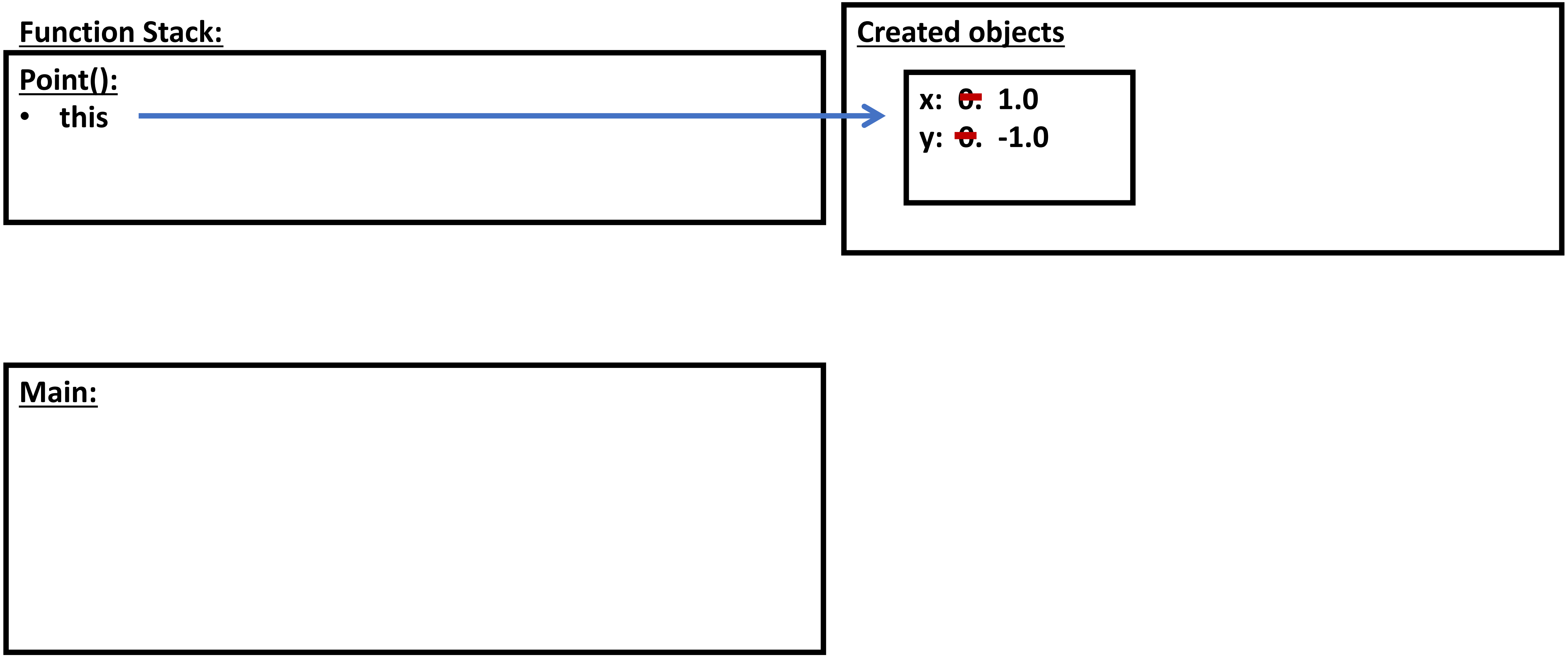
```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
     this.x = this.x - p.getX();
     this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Draw a stack diagram



Function Stack:

Point():

- this

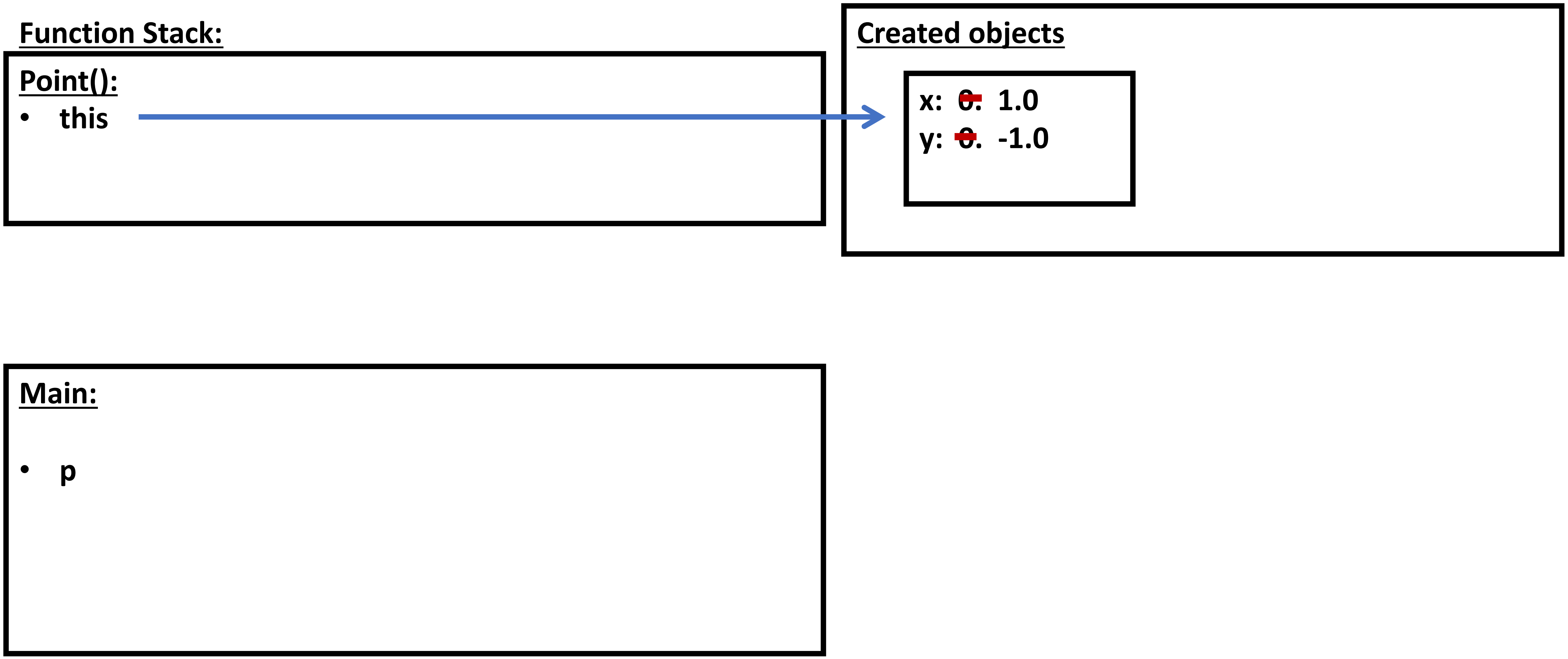
Created objects

x: ~~0.~~ 1.0

y: ~~0.~~ -1.0

Main:

Draw a stack diagram



Function Stack:

Point():

- this

Created objects

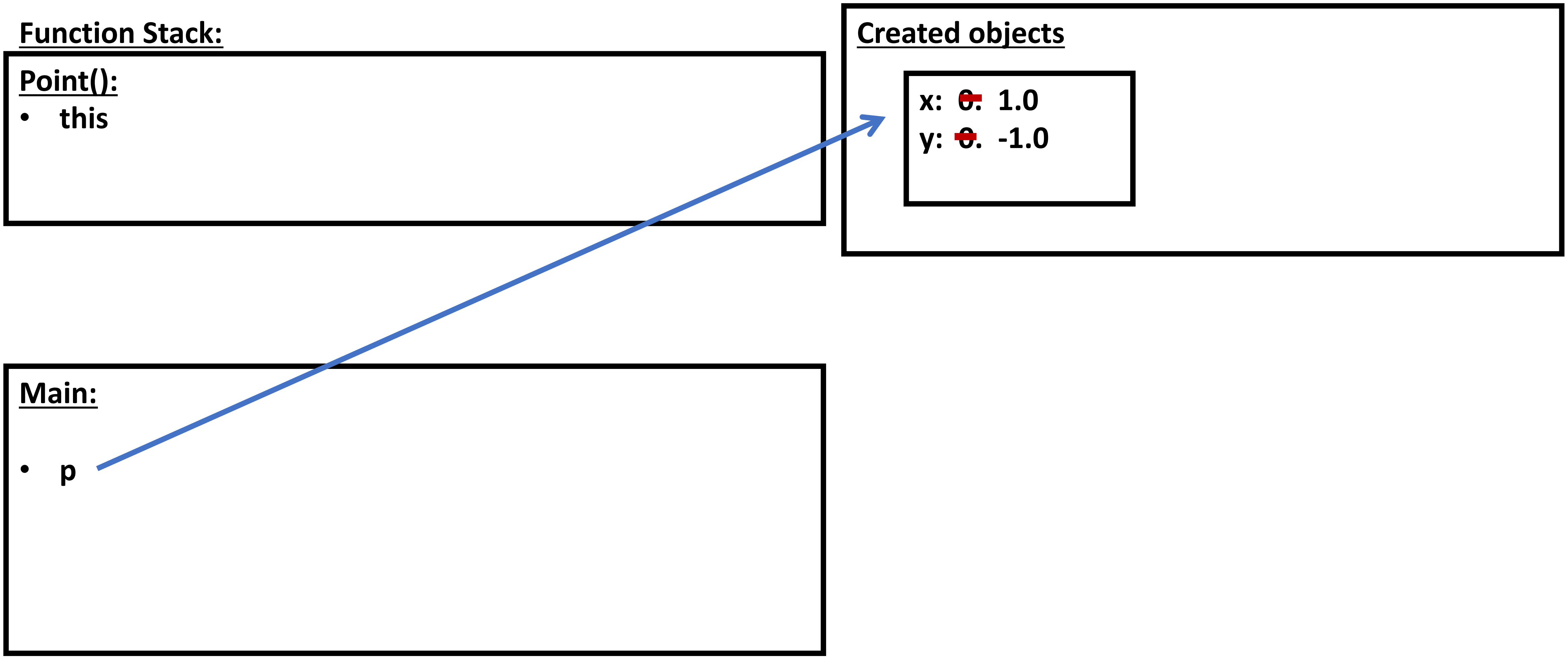
x: ~~0.~~ 1.0

y: ~~0.~~ -1.0

Main:

- p

Draw a stack diagram



Function Stack:

Point():

- **this**

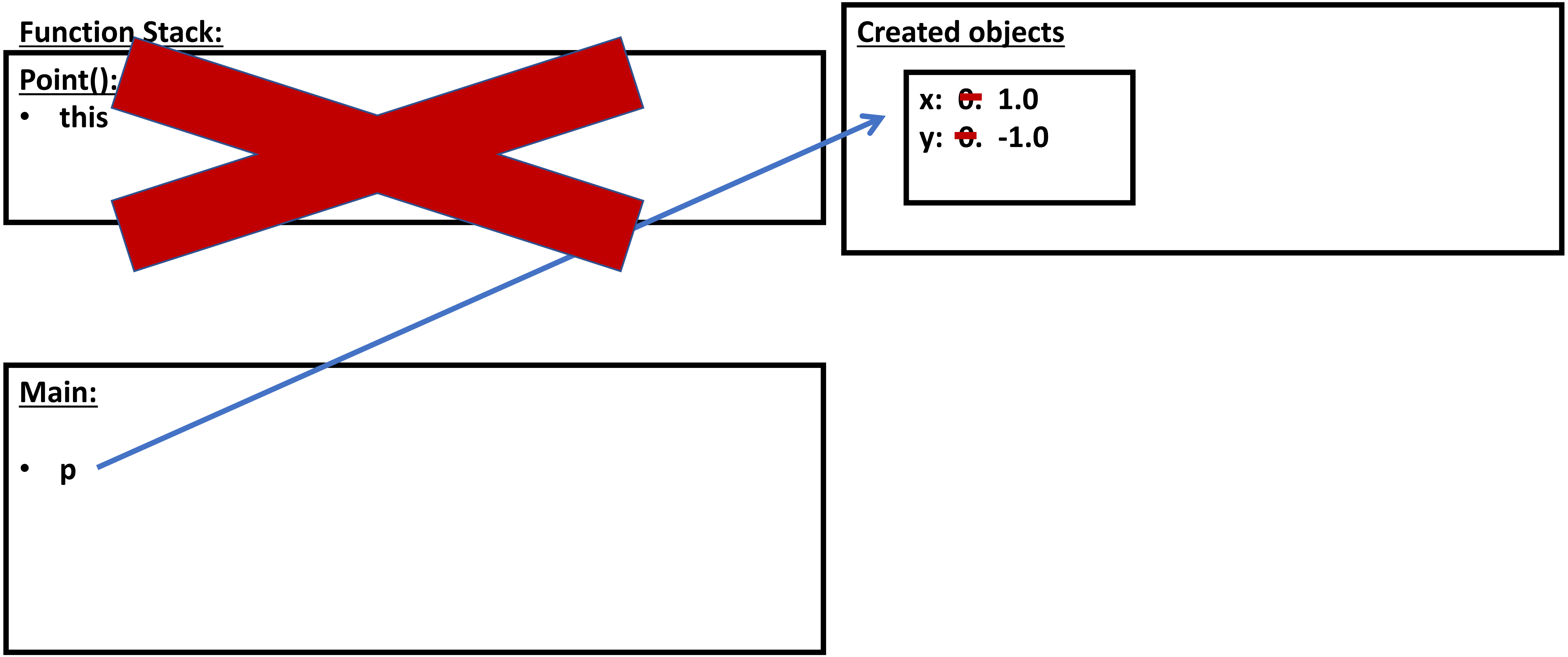
Created objects

x: ~~0.~~ 1.0
y: ~~0.~~ -1.0

Main:

- **p**

Draw a stack diagram



Function Stack:

Point():

- this

Main:

- p

Created objects

x: ~~0.~~ 1.0
y: ~~0.~~ -1.0

Exercise: Draw a stack diagram for the following program

```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
    this.x = this.x - p.getX();
    this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Exercise: Draw a stack diagram for the following program

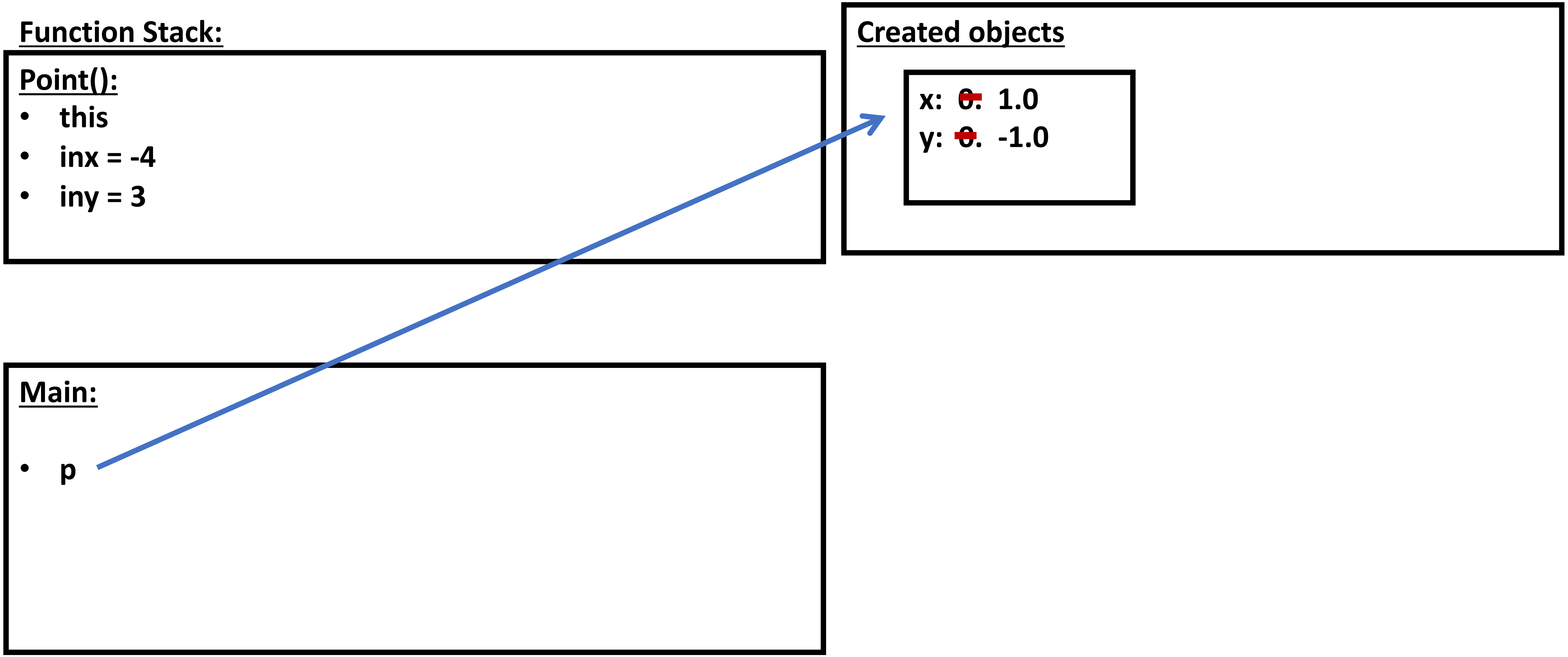
```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
     this.x = this.x - p.getX();
     this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(p2);
  }
}
```

Draw a stack diagram



Function Stack:

Point():

- this
- inx = -4
- iny = 3

Main:

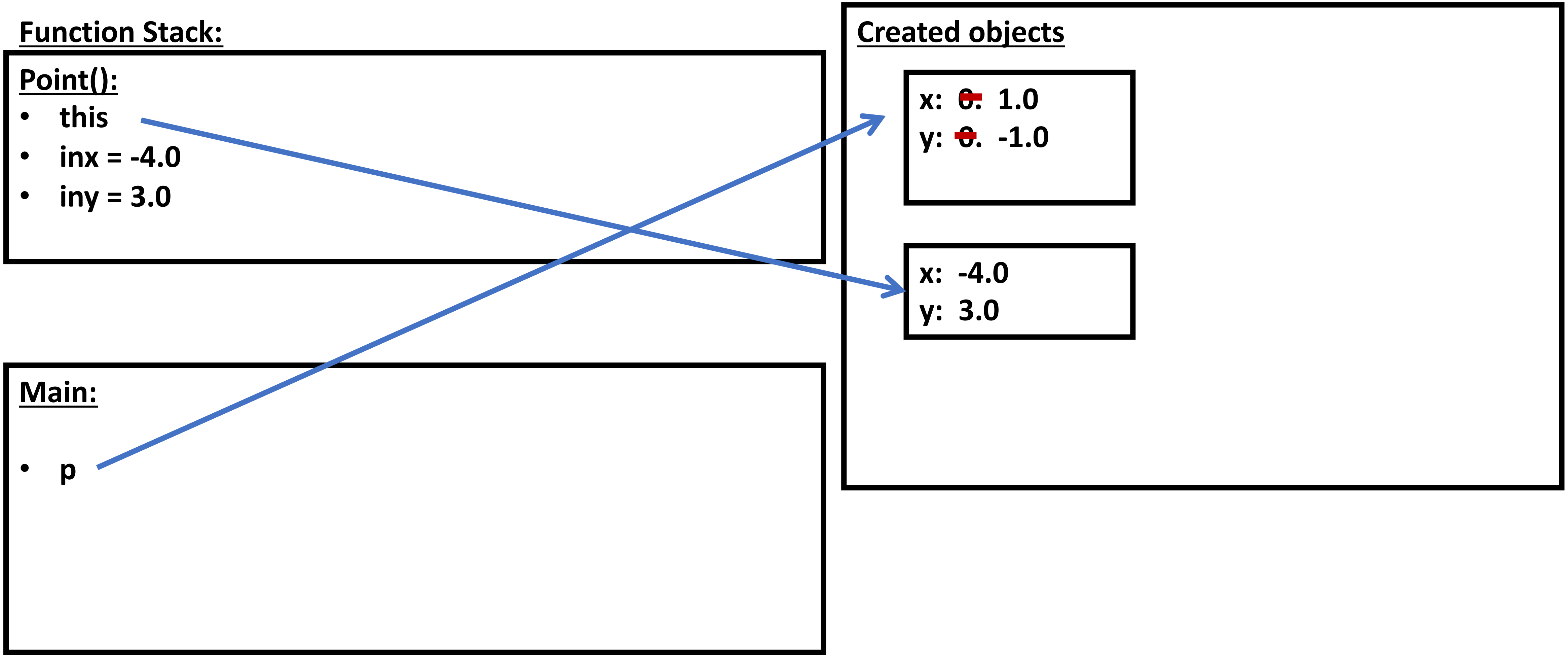
- p

Created objects

x: ~~0.~~ 1.0

y: ~~0.~~ -1.0

Draw a stack diagram



Function Stack:

Point():

- this
- inx = -4.0
- iny = 3.0

Main:

- p

Created objects

x: ~~0.~~ 1.0
y: ~~0.~~ -1.0

x: -4.0
y: 3.0

Exercise: Draw a stack diagram for the following program

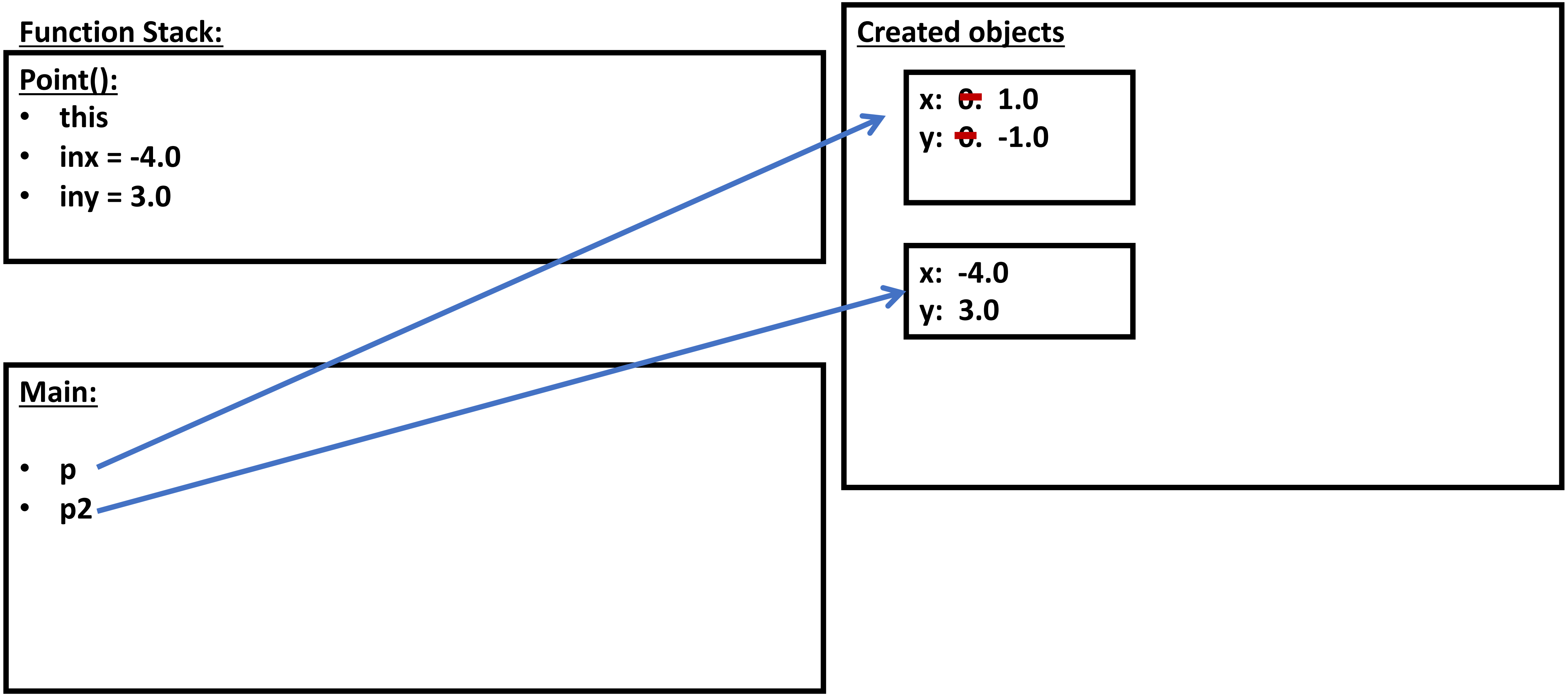
```
class Point {
  public double x = 0.0;
  public double y = 0.0;

  public Point() {
    this.x = 1;
    this.y = 1;
  }
  public Point(double inx, double iny) {
    this.x = inx;
    this.y = iny;
  }
 public void sub(Point p) {
    this.x = this.x - p.getX();
    this.y = this.y - p.getY();
  }
```

```
  public static void main(String[] args) {
    Point p = new Point();
    Point p2 = new Point(-4, 3);

    p.add(
  }
}
```

Draw a stack diagram



Function Stack:

Point():

- this
- inx = -4.0
- iny = 3.0

Main:

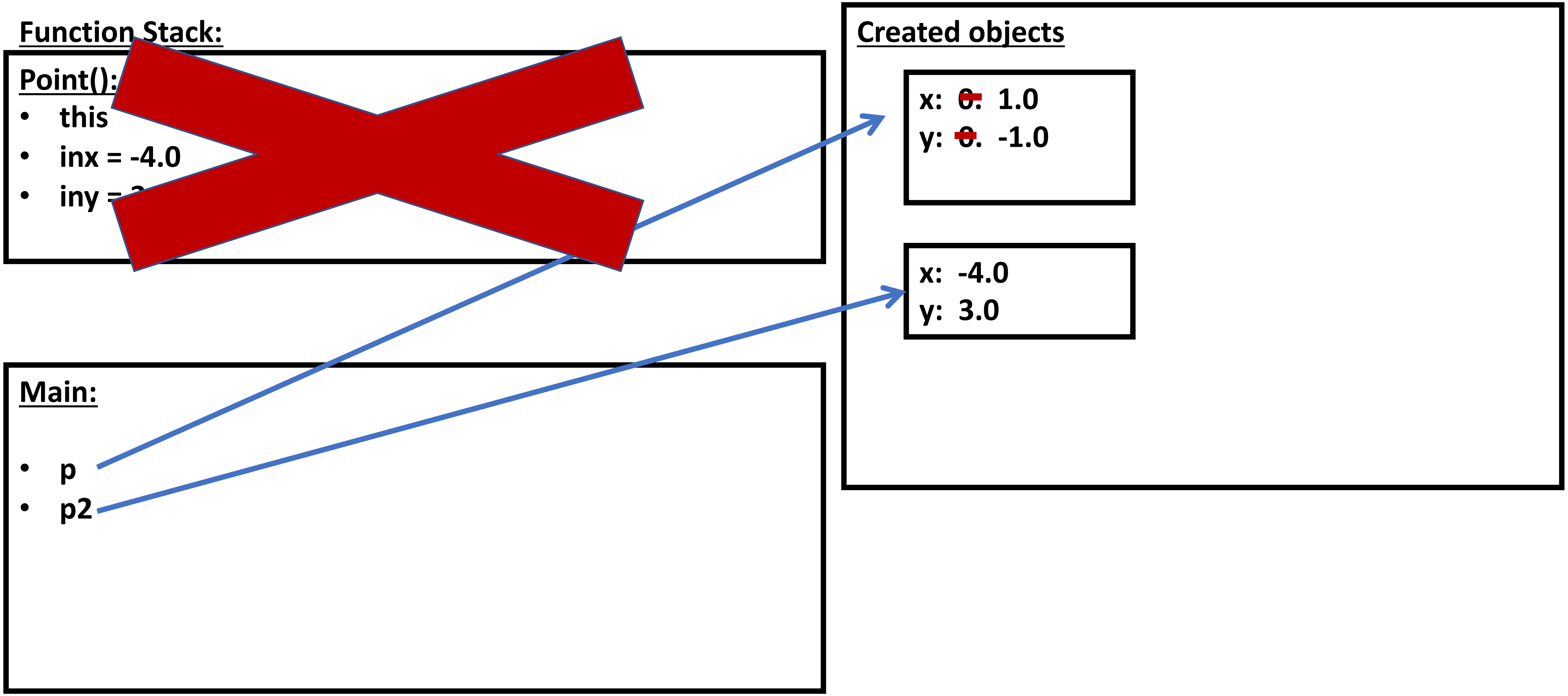
- p
- p2

Created objects

x: ~~0.~~ 1.0
y: ~~0.~~ -1.0

x: -4.0
y: 3.0

Draw a stack diagram



Function Stack:

Point():

- this
- inx = -4.0
- iny = 3

Main:

- p
- p2

Created objects

x: ~~0.~~ 1.0
y: ~~0.~~ -1.0

x: -4.0
y: 3.0

Example: Add using a static method

- Make a new static function called “add” that takes in two points, adds their x and y coordinates, and returns a new point

Exercise: Objects and Arrays

Arrays can store objects just like any other type (such as ints, Strings, etc.)

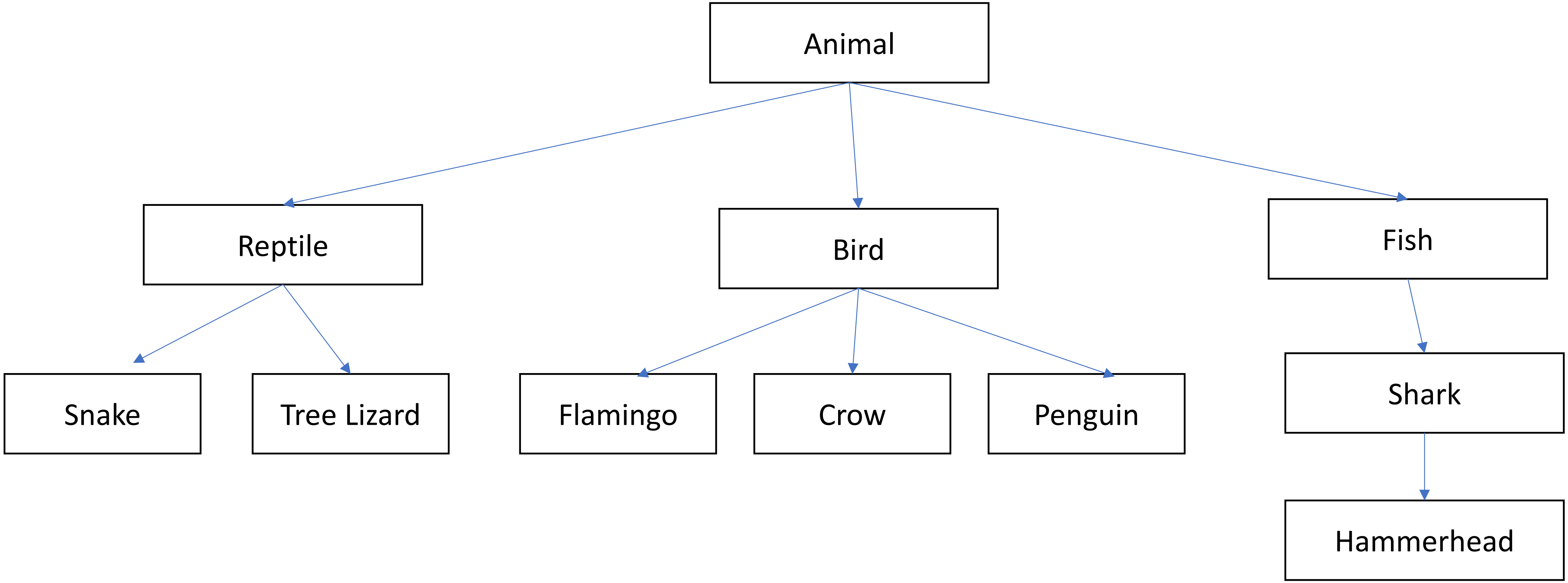
Write a program that asks the user for a number of points and stores them in an array.

Exercise: Draw a stack diagram for the previous program

Access modifiers

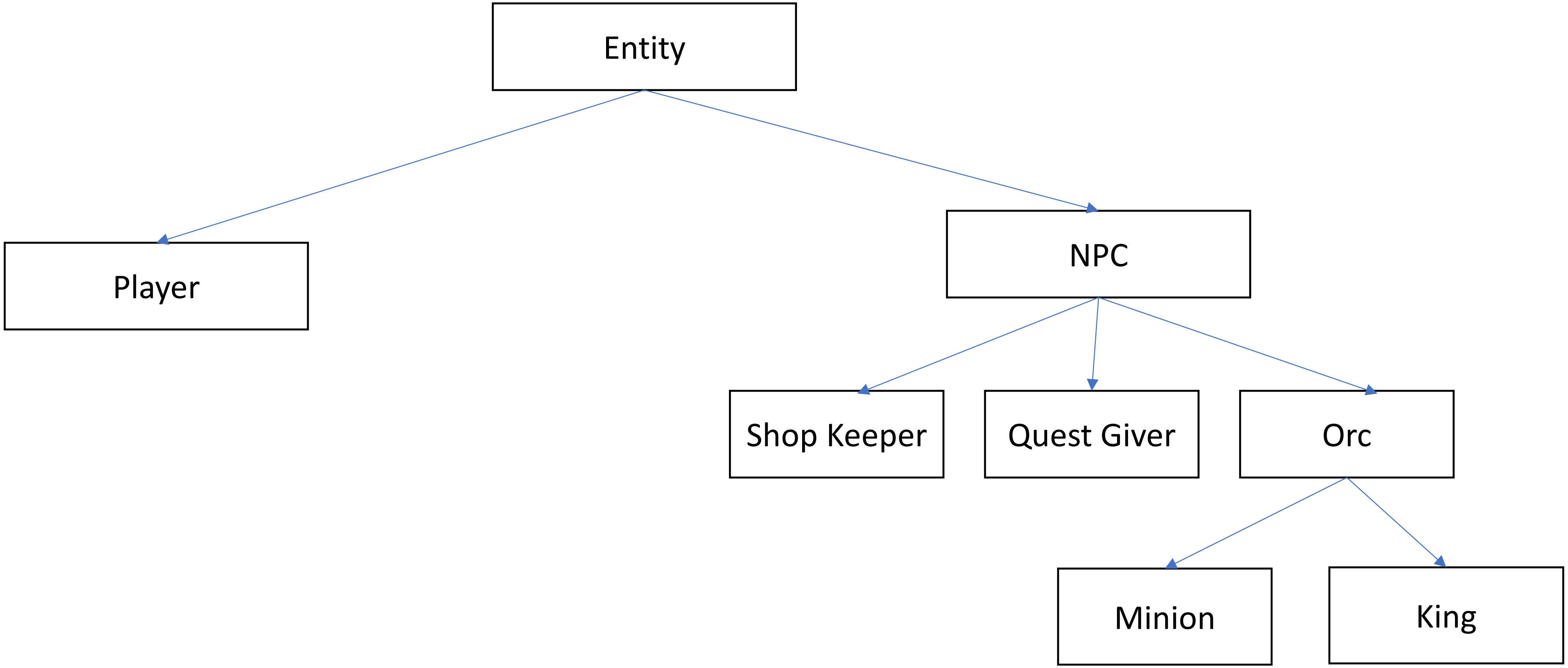
Class inheritance

Inheritance: feature for organizing classes into hierarchies



Inheritance: subclasses refine behavior/state

Inheritance



Polymorphism

Polymorphism: Demo

```
public class Zoo {
   public static void main(String[] args) {
      Animal animal1 = new Animal();
      animal1.locomote();

      Animal animal2 = new Reptile();
      animal2.locomote();
   }
}
```

```
public class Animal {
   public Animal() {
   }
   public void locomote() {
      System.out.println("I am moving!");
   }
}
```

```
public class Reptile extends Animal {
   public Reptile() {
   }
   public void locomote() {
      System.out.println("I am walking!");
   }
}
```

Exercise: What is the output of this program?

```
public class Zoo {
    public static void main(String[] args) {
        Animal animal1 = new Animal();
        animal1.locomote();

        Animal animal2 = new Fish();
        animal2.locomote();
    }
}
```

```
public class Animal {
    public Animal() {
    }
    public void locomote() {
        System.out.println("I am moving!");
    }
}
```

```
public class Fish extends Animal {
  public Fish() {
  }
  public void locomote() {
    System.out.println("I am swimming!");
  }
}
```

Exercise: Implement a Bird animal

OOP Example & Design: Vending machine

OOP Design: Vending machine

Defining the snack class

```
public class Snack {
    private int mQuantity;
    private double mCost;
    private String mName;

    public Snack(String name, int quantity, double cost) {
        mQuantity = quantity;
        mCost = cost;
        mName = name;
    }
    public String getName() {
        return mName;
    }

    public void buy() {
       if (mQuantity > 0) {
           mQuantity--;
       }
    }
}
```

Testing the Snack class

```
public static void main(String args[])
{
    Snack snack = new Snack("Slurm", 10, 1.5);
    System.out.println("Snack: "+snack.getName());
}
```

Objects: Stack diagrams revisited

```
public static void main(String[] args) {
        double userCash = 8.0;
        Snack soda = new Snack("Tang", 10, 1.5); // call constructor
        soda.buy();
}
```

Exercise: draw a stack diagram for this program

Exercise: Define a class BankAccount

BankAccount should have the following data:

- Name
- Amount

BankAccount should have the following operations:

- currentBalance() // returns current amount in the bank account
- withdraw(float amt) // withdraw the given amount from the account
- deposit(float amt) // deposit the given amount to the account