More on Classes

Encapsulation

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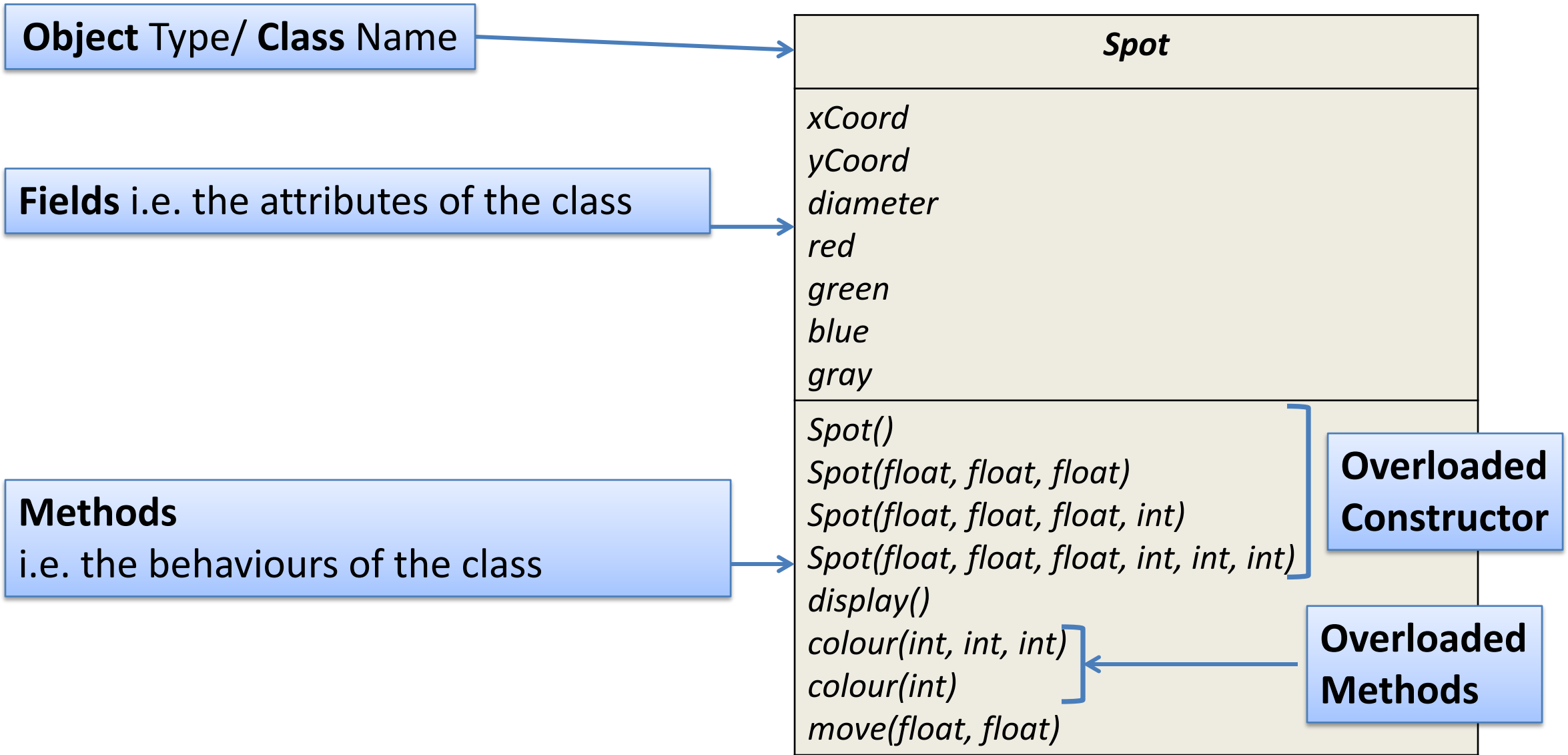
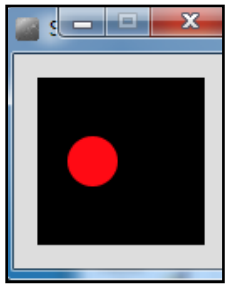
Topics list

1. Recap: Version 6.1
2. Our design smells!
3. **Encapsulation**
4. Refactoring Spot:
   - **Access Modifiers**
   - **Accessors and Mutators**
   - **Validation**

Class Diagram for Spot Version 6.1



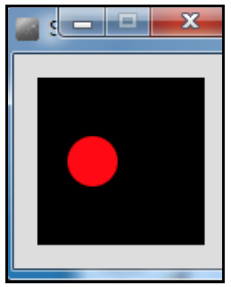
Spot Class – Version 6.1



```
class Spot{
  float xCoord, yCoord;
  float diameter;
  int red, green, blue;

 Spot()
  {
  }

 Spot (float xCoord, float yCoord, float diameter)
 {
    this.xCoord = xCoord;
    this.yCoord = yCoord;
    this.diameter = diameter;
  }

  // colour methods…
  // display method…
  // move method…
}
```

Source: Reas & Fry (2014)

Spot Class – Version 6.1



```
class Spot{
// fields and constructors…

 void display ()
  {
    ellipse(xCoord, yCoord, diameter, diameter);
  }

 void colour (int red, int green, int blue)
  {
    this.red = red;
    this.green = green;
    this.blue = blue;
    fill (red, green, blue);
  }

  void colour (int gray){
    this.gray = gray;
    fill (this.gray);
  }
}
```

Source: Reas & Fry (2014)

Spot Class – **Version 7.0**

```
Spot sp;

void setup()
{
  size (100,100);
  noStroke();
  sp = new Spot(33, 50, 30);
}

void draw()
{
  background(0);
  sp.colour(255, 0, 0);
  sp.diameter = 30000;
  sp.display();
}
```

```
class Spot{
  float xCoord, yCoord;
  float diameter;
  int red, green, blue;

  // constructors…
 void display(){
    ellipse(xCoord, yCoord, diameter, diameter);
  }

 void colour(int red, int green, int blue)
  {
    this.red = red;
    this.green = green;
    this.blue = blue;
    fill (red, green, blue);
  }
  //move methods…
}
```

Source: Reas & Fry (2014)

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4. Refactoring Spot:
   - **Access Modifiers**
   - **Accessors and Mutators**
   - **Validation**

Our Our design smells!

- We can directly access the diameter field
  (and all other fields) in the Spot class
  from another class,
  and set it to a value that is completely preposterous!

- Also, when we directly access a field in a class,
  we are applying a "**behaviour**" to that field
  i.e. resizing the circle.
  - But, aren't **methods** supposed to be the "behaviour" for a class???

Our Our design smells!

- Our design violates one of the basic principles of object-oriented design:

Encapsulation!

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Encapsulation

- **Encapsulation** (data hiding)
  is a fundamental Object Oriented concept.

- How to achieve encapsulation?
  1. ***wrap*** the data (fields) and code acting on the data (methods) together as single unit.
  2. ***hide*** the fields from other classes.
  3. ***access*** the fields **only** through the methods of their current class.

http://www.tutorialspoint.com/java/java_encapsulation.htm

Encapsulation in Java – **steps 1-3**

Encapsulation Step	Approach in Java

1. **Wrap** the data (fields)
and code acting on the data (methods)
together as single unit.
	public class *ClassName*
	{
	Fields
	Constructors
	Methods
	}

2. **Hide** the fields from other classes.	**Declare the fields of a class as private**.
3. **Access** the fields **only** through the methods of their current class.	**Provide public set**ter **and get**ter methods to modify and view the fields values.

http://www.tutorialspoint.com/java/java_encapsulation.htm

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Refactoring Spot: **Access Modifiers**

- **Java** provides a number of access modifiers to set access levels for classes, fields, methods and constructors.

- The four access levels are:
  - Visible to the package, the default. No modifiers needed.
  - **Visible to the class only (private).**
  - **Visible to the world (public).**
  - Visible to the package and all subclasses (protected).

In Processing, we will focus on **public** and **private**.

http://www.tutorialspoint.com/java/java_modifier_types.htm

Refactoring Spot 7.0: **Access Modifiers**

```
public class Spot{
  float xCoord, yCoord;
  float diameter;
  int red, green, blue;

  Spot()
  {
  }

  // other constructor
  void display(){
     ellipse(xCoord, yCoord, diameter, diameter);
  }
  // move method…
  // colour methods…
}
```

Filename: Spot

Encapsulation step 1 is complete;

all fields, constructors and methods
are all in a single unit, called **Spot**.

We just changed the class access level to **public**

…by adding the keyword **public** in front of class

*(with nothing in front of **class** the default is **package**).*

The four access levels are:

– Visible to the package, the default. No modifiers needed.
– **Visible to the class only (private).**
– **Visible to the world (public).**
– Visible to the package and all subclasses (protected).

In Processing, we will focus on **public** and **private**.

Refactoring Spot 7.0: Access Modifiers

```
public class Spot{
   float xCoord, yCoord;
   float diameter;
   int red, green, blue;

   Spot()
   {
   }

   // other constructor
   void display(){
      ellipse(xCoord, yCoord, diameter, diameter);
   }
   // move method…
   // colour methods…
}
```

However, as the default access level is **package**
→ our methods and fields are all **package** level access.

Problem: this breaks **Encapsulation step 2**
i.e. the fields of a class should be **private**.

Refactoring Spot 7.0: Access Modifiers

```
public class Spot{
  private float xCoord, yCoord;
  private float diameter;
  private int red, green, blue;

  Spot()
  {
  }

  // other constructor
  void display(){
     ellipse(xCoord, yCoord, diameter, diameter);
  }
  // move method…
  // colour methods…
}
```

To fix **Encapsulation step 2**,
we **declare all the fields** with **private** access.

Refactoring Spot 7.0: Access Modifiers

```
public class Spot{
   private float xCoord, yCoord;
   private float diameter;
   private int red, green, blue;
   //constructors…
   //display method…
   // move method…
   // colour methods…
}
```

The **private** fields are not viewable or updatable outside the class **Spot**. Other classes don't know these exist.

SOLUTION? Put a high fence around my garden, now it is safe! But waite, I can no longer access my own garden.

http://www.evinw.com/w/

Topics list

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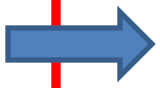
4. Refactoring Spot:
   - **Access Modifiers**
   - **Accessors and Mutators (getters & setters)**
   - **Validation**



Refactoring Spot 7.0: **Setters and Getters**

SOLUTION: Hire a **private** guard and give him **rules** on who is able to access the garden. Anyone wanting to use the garden must get permission from guard. garden is now **safe** and **accessible**.

Encapsulation Step 3:
Provide <u>public</u> setter and getter methods to modify and view the fields values.

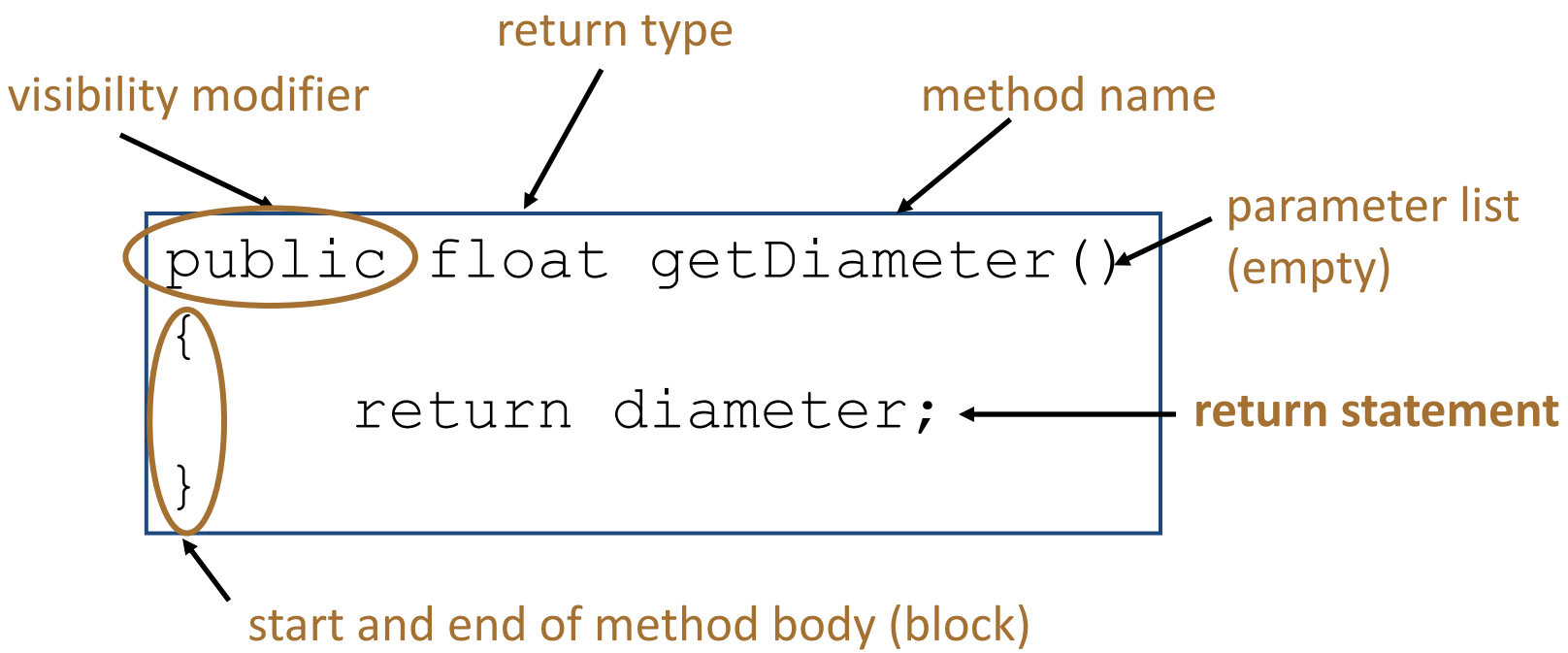
http://www.evinw.com/w/

Getters (Accessor Methods)

- **Accessor** methods
  - return information about the **state** of an object
  - i.e. the values stored in the fields.

- A '**get**ter' method
  - is a specific type of **accessor** method and typically:
    - **contains a return statement**
      (as the last executable statement in the method).
    - defines a **return type**.
    - **does NOT change the object state**.

Getters

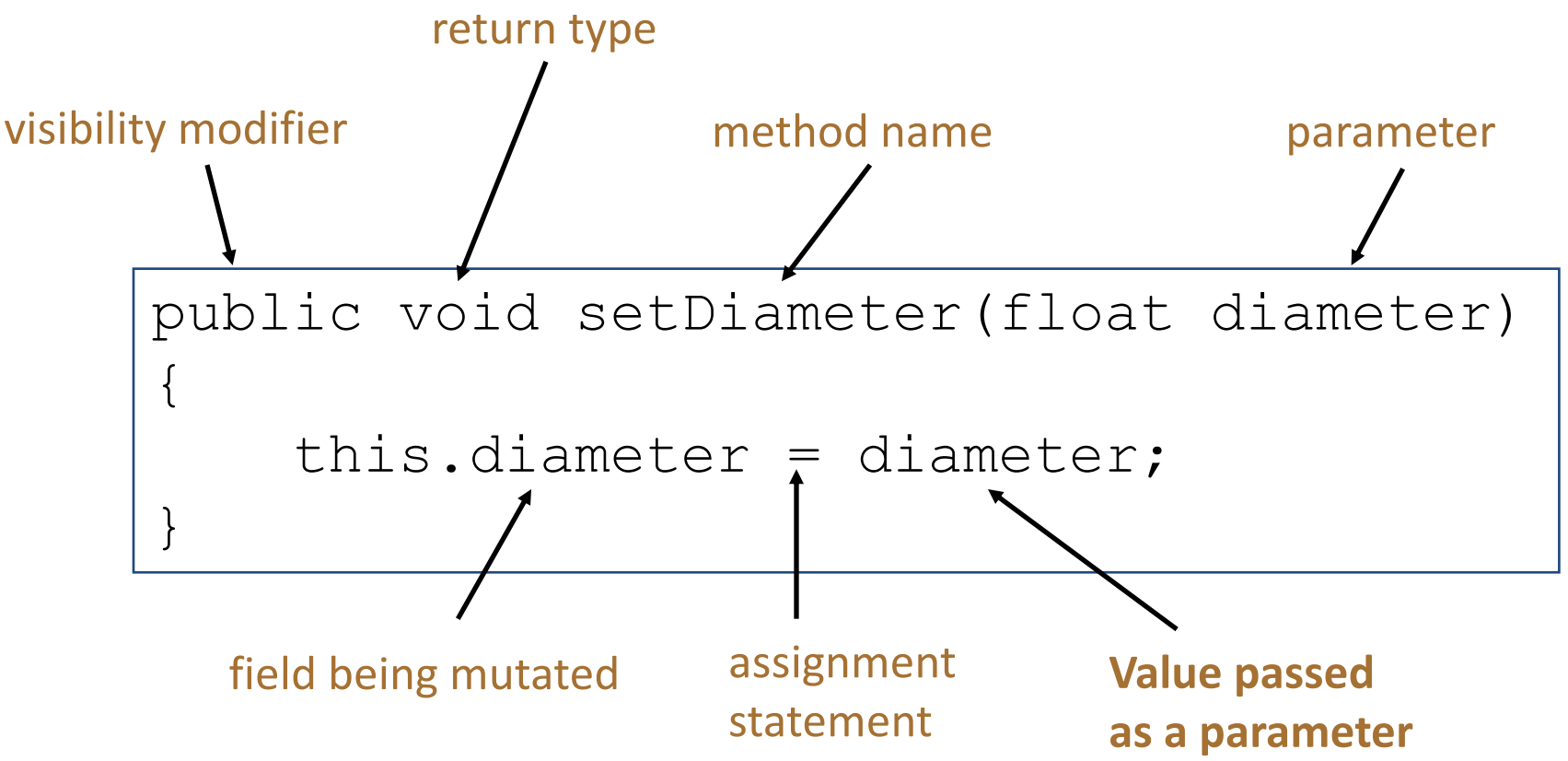

return type
visibility modifier
method name
parameter list
(empty)
public float getDiameter()
{
return diameter;
}
return statement
start and end of method body (block)

Setters (Mutator methods)

- **Mutator** methods
  - change (i.e. mutate!) an object's state.

- A '**set**ter' method
  - is a specific type of **mutator** method and typically:
    - contains an **assignment statement**
    - takes in a **parameter**
    - **changes the object state**.

Setters


return type
visibility modifier
method name
parameter
public void setDiameter(float diameter)
{
this.diameter = diameter;
}
field being mutated
assignment statement
Value passed as a parameter

Getters/Setters

- For each instance field in a class, you are normally asked to write:
  - A **get**ter
    - Return statement
  - A **set**ter
    - Assignment statement

Refactoring Spot 7.0: **Get**ters

```
public class Spot{
  private float xCoord, yCoord;
  private float diameter;
  private int red, green, blue;

  //constructors…
  //display method…
  // move method…
  // colour methods…

  public float getDiameter(){
    return diameter;
  }
```

```
public float getXCoord(){
    return xCoord;
  }

public float getYCoord(){
   return yCoord;
  }

  public int getRed(){
   return red;
  }
```

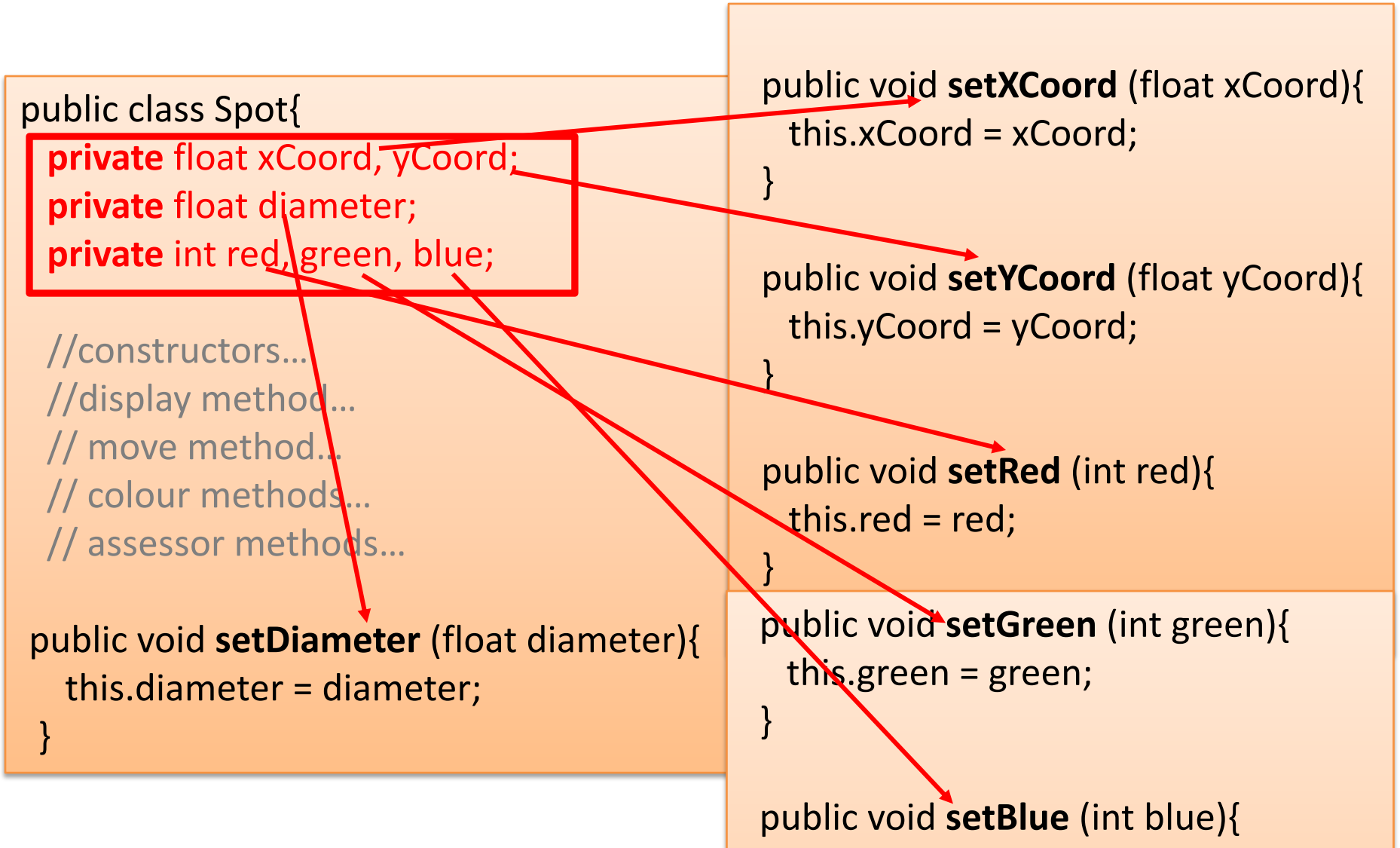
```
  public int getGreen(){
    return green;
  }

  public int getBlue(){
    return blue;
  }

  public int getGray(){
    return gray;
  }

} //end Spot class
```

Refactoring Spot 7.0: **Set**ters



Spot Class – Version 7.0

```
Spot sp;

void setup()
{
  size (100,100);
  noStroke();
  sp = new Spot(33, 50, 30);
}

void draw()
{
  background(0);
  sp.colour(255, 0, 0);
  sp.diameter = 30000;
  sp.display();
}
```

```
class Spot{
  float xCoord, yCoord;
  float diameter;
  int red, green, blue;

  // constructors…
  // display method…
  // colour methods…
  // move methods…
}
```

Before refactoring,
we directly accessed the diameter field…
this broke Encapsulation rules.

Source: Reas & Fry (2014)

Refactoring Spot 7.0 – getters and setters

```
Spot sp;

void setup()
{
  size (100,100);
  noStroke();
  sp = new Spot(33, 50, 30);
}

void draw()
{
  background(0);
  sp.colour(255, 0, 0);
  sp.setDiameter(30000);
  sp.display();
}
```

```
class Spot{
    private float xCoord, yCoord;
    private float diameter;
    private int red, green, blue;

  // constructors…
  // display method…
  // colour methods…
  // move methods…
  //getter methods…
  //setter methods…
  public void setDiameter (float diameter) {
      this.diameter = diameter;
  }
}
```

Now we update via the appropriate setter

Review – Encapsulation steps

We have:

- Wrapped the fields & methods into a single unit
- Hidden our fields (they are **private**)
- Implemented **getter** and **setter** methods
  - to view/update the fields.

Enforced the Encapsulation rules

Encapsulation Step
1. **Wrap** the data (fields) and code acting on the data (methods) together as single unit.
2. **Hide** the fields from other classes.
3. **Access** the fields only through the methods of their current class.

But Our Design Still Smells!

BECAUSE

While we can no longer directly access the field/property,

we can still set the field values
to undesirable values by passing in a parameter …
e.g. 30000

→ We need **validation**!

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   - **Validation**

Improving the constructor

```
Spot(float xCoord, float yCoord, float diameter)
{
  this.xCoord = xCoord;
  this.yCoord = yCoord;
  this.diameter = diameter;
}
```

Current constructor with **no** validation.

Improving the **constructor**

```
Spot(float xCoord, float yCoord, float diameter)
{
   this.xCoord = xCoord;
   this.yCoord = yCoord;
   if ((diameter >= 20) && (diameter <= 50)){
      this.diameter = diameter;
   }
   else{
      this.diameter = 20;
   }
}
```

Updated constructor **with** some **validation**.

Note: in the constructor,
you typically set the field to a default value
if invalid data was entered.

Improving the **setter** / mutator

```
public void setDiameter (float diameter){
    if ((diameter >= 20) && (diameter <= 50)){
        this.diameter = diameter;
    }
}
```

Note: The validation done at constructor level must be **repeated at setter level** for that field

→ **data integrity**!

However, in setter methods,

you typically do not update the field's value if invalid data was entered (no "else" branch).

Summary - Encapsulation (data hiding)

- Hide fields
  - Access them only through methods of the class
    e.g. **get**ters & **set**ters
- Make the
  - **class public**
  - and the **fields private**
- 4 Access Levels
  (2 for processing)
  - package
  - **private**
  - **public**
  - Protected
- Accessors
  - **get**
- Mutators
  - **set**
- Write a getter & setter for each each field
- **Validation**
  - Test min / max values
  - in **constructor**
    - Apply default if value fails
  - in **setter**
    - Ignore the update if value fails

Summary continued

Encapsulation – Steps

1. Wrap Fields & Methods in single file
2. Hide the fields from other classes using private
3. Access only through getter & setters
4. Apply validation in constructors & setters

Questions?

References

- Reas, C. & Fry, B. (2014) Processing – A Programming Handbook for Visual Designers and Artists, 2nd Edition, MIT Press, London.