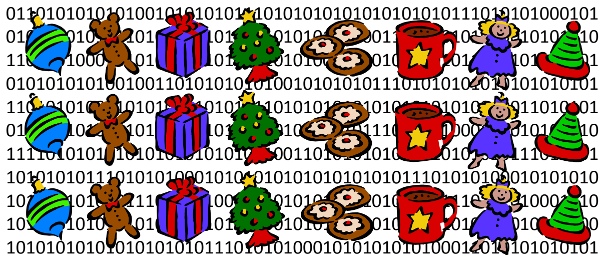
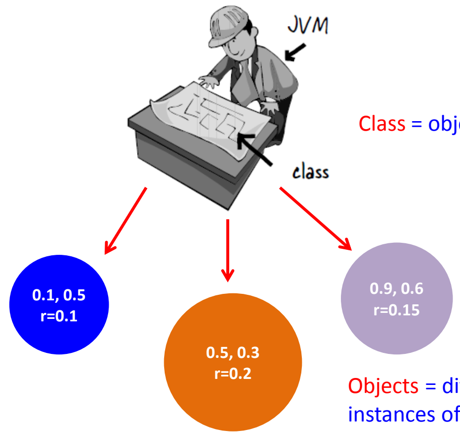
Objects, primitives and references



Overview

- Objects revisited
  - Instance variables
  - Instance methods
  - Declaring and creating
- Primitives variables
  - Different size bit patterns in memory
- Reference variables
  - Remote control to an object
  - Of aliases and orphans

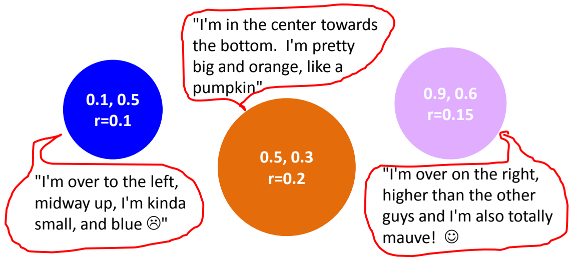
Classes and objects



Class = object blueprint

Objects = different instances of a class

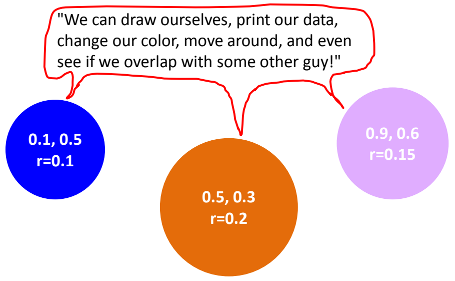
Hey objects, what do you know?


"I'm in the center towards the bottom. I'm pretty big and orange, like a pumpkin"
0.1, 0.5 r=0.1
0.9, 0.6 r=0.15
0.5, 0.3 r=0.2
"I'm over to the left, midway up, I'm kinda small, and blue ☹"
"I'm over on the right, higher than the other guys and I'm also totally mauve! ☺"

```
public class Ball
{
   private double posX   = 0.0;
   private double posY   = 0.0;
   private double radius = 0.0;
   private Color  color  = new Color(0.88f, 0.68f, 1.0f);
}
```

Instance variables = what an object knows

Hey objects, what can you do?


"We can draw ourselves, print our data, change our color, move around, and even see if we overlap with some other guy!"
0.1, 0.5 r=0.1
0.5, 0.3 r=0.2
0.9, 0.6 r=0.15

```
public void draw()                                    {...}
public String toString()                              {...}
public void setColor(double r, double g, double b)    {...}
public void move(double deltaX, double deltaY)        {...}
public boolean overlap(Ball other)                    {...}
```

Instance methods = what an object can do

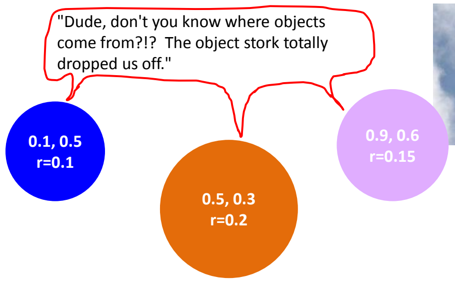
Bonus move method

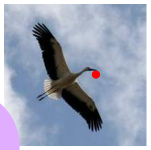
```
import java.awt.*;

public class Ball
{
   private double posX   = 0.0;
   private double posY   = 0.0;
   private double radius = 0.0;
   private Color  color  = new Color(0.88f, 0.68f, 1.0f);

   public void move(double deltaX, double deltaY)
   {
      posX   += deltaX;
      posY   += deltaY;
   }
   ...
}
```

Hey objects, where did you come from?


"Dude, don't you know where objects come from?!? The object stork totally dropped us off."
0.1, 0.5 r=0.1
0.5, 0.3 r=0.2
0.9, 0.6 r=0.15

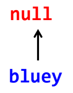


```
public Ball(double x, double y, double r)
{
   posX   = x;
   posY   = y;
   radius = r;
}
```

Constructor = the object stork

An object soap opera

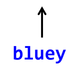
```
public class BallSoapOpera
{
   public static void main(String [] args)
   {
      Ball bluey;
   }
}
```



"Cruel cruel world. I'm a variable, but I have no purpose in life. I'm so worthless, a sad empty vessel..."

An object soap opera

```
public class BallSoapOpera
{
   public static void main(String [] args)
   {
      Ball bluey;
      bluey = new Ball(0.1, 0.5, 0.1);
   }
}
```



"Yay thank you object stork. At long last, I'm finally a real Ball! Though I seem to be invisible."

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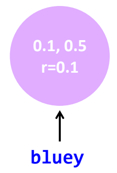
An object soap opera

```
public class BallSoapOpera
{
   public static void main(String [] args)
   {
      Ball bluey;
      bluey = new Ball(0.1, 0.5, 0.1);
      bluey.draw();
   }
}
```



"That's great! Now everybody can see me. But my color is a little girly…"

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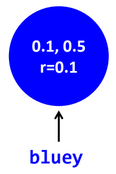
An object soap opera

```
public class BallSoapOpera
{
   public static void main(String [] args)
   {
      Ball bluey;
      bluey = new Ball(0.1, 0.5, 0.1);
      bluey.setColor(0.0, 0.0, 1.0);
      bluey.draw();
   }
}
```



" Awh that's better, a nice manly blue, just like I like it!"

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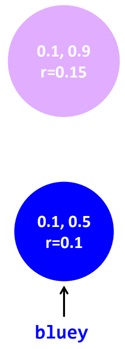
An object soap opera

```
public class BallSoapOpera
{
   public static void main(String [] args)
   {
      Ball bluey;
      bluey = new Ball(0.1, 0.5, 0.1);
      bluey.setColor(0.0, 0.0, 1.0);
      bluey.draw();

      Ball mauevy = new Ball(0.1, 0.9, 0.15);
      mauevy.draw();
   }
}
```



"Well hello there, what's your name beautiful? Why don't you come over here?"

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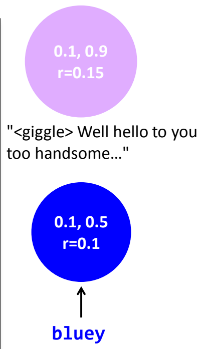
An object soap opera

```
public class BallSoapOpera
{
   public static void main(String [] args)
   {
      Ball bluey;
      bluey = new Ball(0.1, 0.5, 0.1);
      bluey.setColor(0.0, 0.0, 1.0);
      bluey.draw();

      Ball mauevy = new Ball(0.1, 0.9, 0.15);
      mauevy.draw();

      while (!mauevy.overlap(bluey))
      {
         mauevy.move(0.0, -0.01);
         mauevy.draw();
      }
   }
}
```



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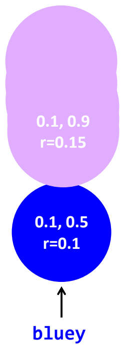
An object soap opera

```
public class BallSoapOpera
{
   public static void main(String [] args)
   {
      Ball bluey;
      bluey = new Ball(0.1, 0.5, 0.1);
      bluey.setColor(0.0, 0.0, 1.0);
      bluey.draw();

      Ball mauevy = new Ball(0.1, 0.9, 0.15);
      mauevy.draw();

      while (!mauevy.overlap(bluey))
      {
         mauevy.move(0.0, -0.01);
         mauevy.draw();
      }
   }
}
```



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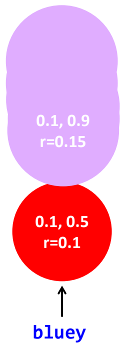
An object soap opera

```
public class BallSoapOpera
{
   public static void main(String [] args)
   {
      Ball bluey;
      bluey = new Ball(0.1, 0.5, 0.1);
      bluey.setColor(0.0, 0.0, 1.0);
      bluey.draw();

      Ball mauevy = new Ball(0.1, 0.9, 0.15);
      mauevy.draw();

      while (!mauevy.overlap(bluey))
      {
         mauevy.move(0.0, -0.01);
         mauevy.draw();
      }
      bluey.setColor(1.0, 0.0, 0.0);
      bluey.draw();
   }
}
```



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Declaring a variable

- All variables must have a type
  - Primitive types: hold fundamental values
    - integers, booleans, floating-point values
    - type name is all lowercase
    - `int, double, boolean, char, byte, short, long, float`
  - Object reference types: refer to an object
    - may contain several values
    - type name starts in uppercase
    - e.g. `String, Color, Ball, Dog, Giraffe, ...`

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Primitive type sizes

- Primitive types
  - Just a block of memory in your computer
  - Size of block measured in bits (number of 0s or 1s)
  - Integers:

type	bits	example
byte	8	0110 1110
short	16	0110 1110 1101 1101
int	32	0101 1001 0000 0001 0111 1101 0110 0010
long	64	1101 0011 1001 0001 1101 0101 1010 0101 0111 1010 0011 1010 1011 1100 1111 1111

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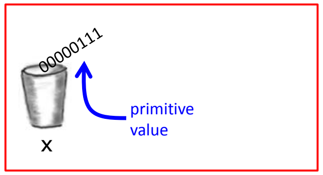
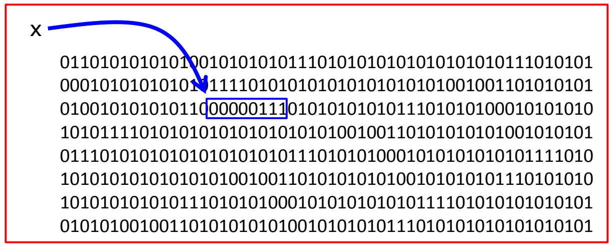
Creating a primitive variable

```
byte x = 7;
```





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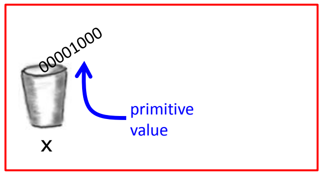
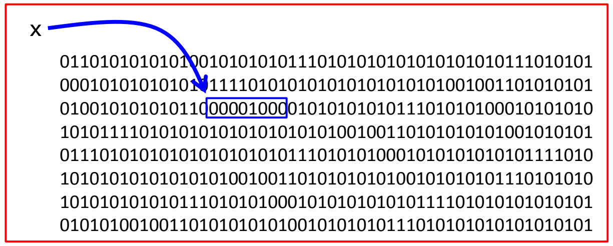
Creating a primitive variable

```
byte x = 7;
x = x + 1;
```





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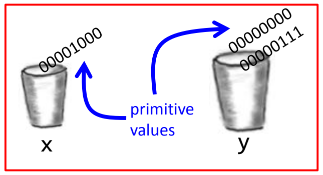
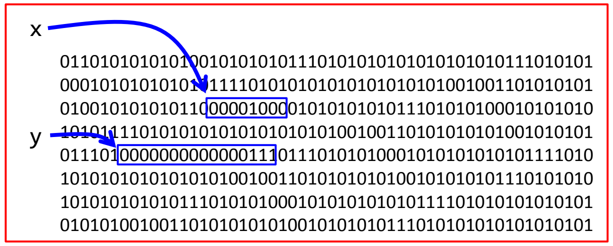
Creating a primitive variable

```
byte x = 7;
x = x + 1;

short y = 7;
```





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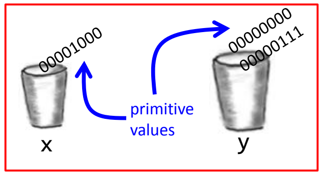
You can't put a big cup into a small one

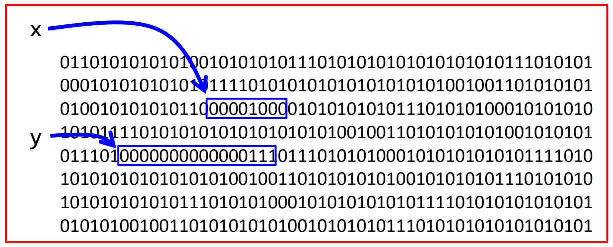
You may know 7 can fit in a byte, but compiler doesn't!

```
byte x = 7;
x = x + 1;

short y = 7;

x = y;
```

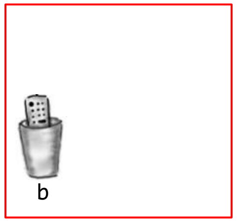


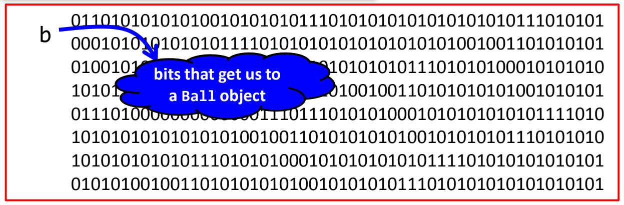


Declaring a reference variable

```
Ball b;
```

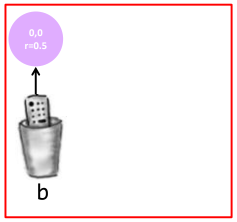
Currently b is equal to `null`. References variables always need to be use new to create an actual object.

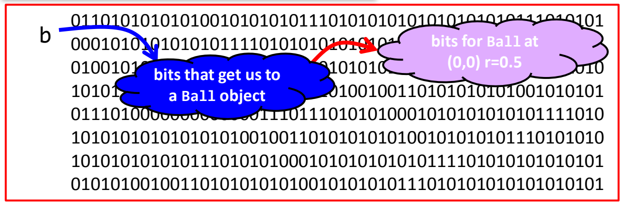




Creating a reference variable

```
Ball b = new Ball(0.0, 0.0, 0.5);
```

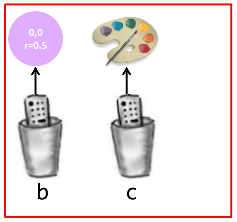


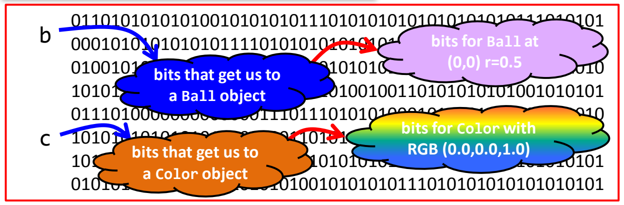

b
bits that get us to a Ball object
bits for Ball at (0,0) r=0.5

Creating a reference variable

```
Ball b = new Ball(0.0, 0.0, 0.5);

Color c = new Color(0.0f, 0.0f, 1.0f);
```




b
bits that get us to a Ball object
bits for Ball at (0,0) r=0.5
c
bits that get us to a Color object
bits for Color with RGB (0.0,0.0,1.0)

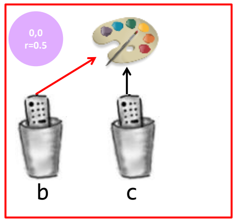
References variables can't switch types

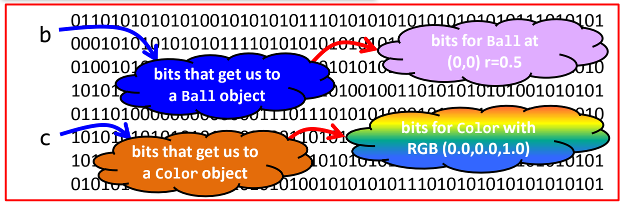
```
Ball b = new Ball(0.0, 0.0, 0.5);

Color c = new Color(0.0f, 0.0f, 1.0f);

b = c;
```

You can't put a Color object into a Ball reference variable!




b
c
bits that get us to a Ball object
bits for Ball at (0,0) r=0.5
bits that get us to a Color object
bits for Color with RGB (0.0,0.0,1.0)

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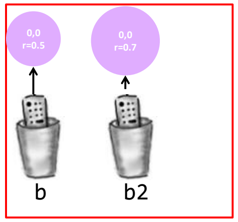
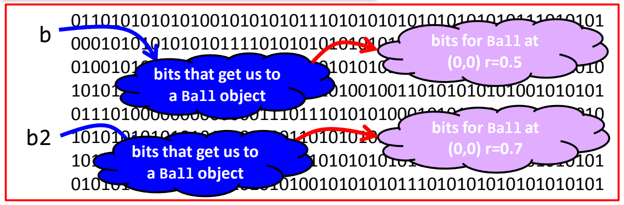
Two references of same type

```
Ball b = new Ball(0.0, 0.0, 0.5);
Ball b2 = new Ball(0.0, 0.0, 0.7);
```




b
b2
bits that get us to a Ball object
bits for Ball at (0,0) r=0.5
bits that get us to a Ball object
bits for Ball at (0,0) r=0.7

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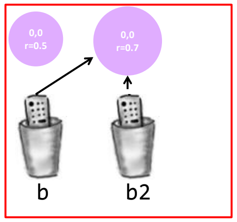
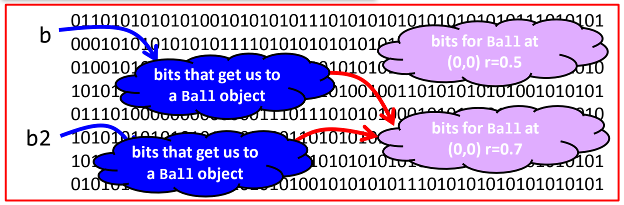
Two references of same type

```
Ball b = new Ball(0.0, 0.0, 0.5);
Ball b2 = new Ball(0.0, 0.0, 0.7);

b = b2;
```




b
b2
bits that get us to a Ball object
bits for Ball at (0,0) r=0.5
bits that get us to a Ball object
bits for Ball at (0,0) r=0.7

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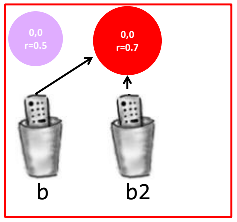
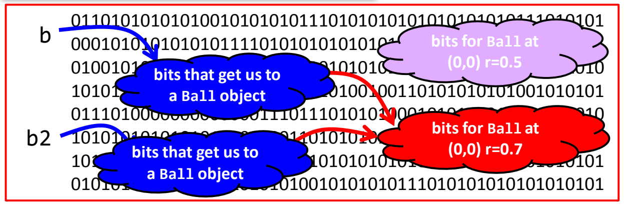
Two names: one object

```
Ball b = new Ball(0.0, 0.0, 0.5);
Ball b2 = new Ball(0.0, 0.0, 0.7);

b = b2;
b.setColor(1.0, 0.0, 0.0);
```




b
b2
bits that get us to a Ball object
bits for Ball at (0,0) r=0.5
bits that get us to a Ball object
bits for Ball at (0,0) r=0.7

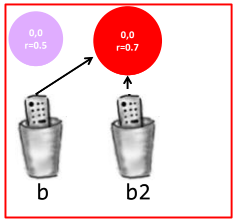
28

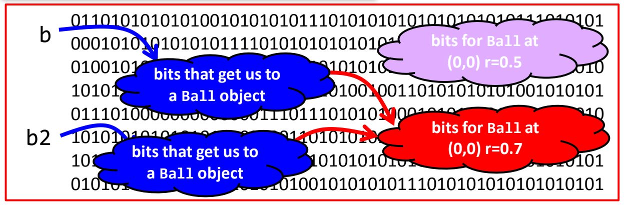
Two names: one object

```
Ball b = new Ball(0.0, 0.0, 0.5);
Ball b2 = new Ball(0.0, 0.0, 0.7);

b = b2;
b2.setColor(1.0, 0.0, 0.0);
```

Currently b and b2 are just aliases, different names for controlling the same object. Calling a method on b is same as calling the same method on b2.



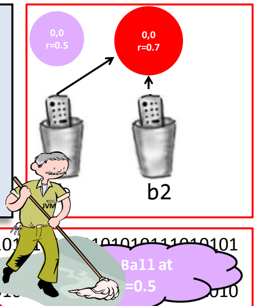

b
b2
bits that get us to a Ball object
bits that get us to a Ball object
bits for Ball at (0,0) r=0.5
bits for Ball at (0,0) r=0.7

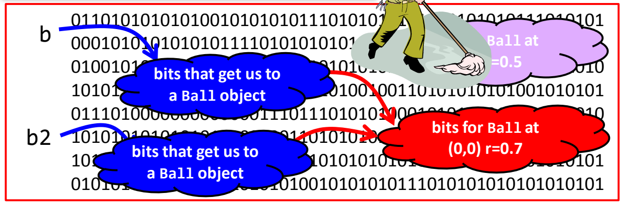
Orphaned objects

```
Ball b = new Ball(0.0, 0.0, 0.5);
Ball b2 = new Ball(0.0, 0.0, 0.7);

b = b2;
b2.setColor(1.0, 0.0, 0.0);
```

The Ball object at (0,0) r=0.5 has become an orphan (no one can control it anymore). The Java garbage collector eventually frees up the memory.




b
b2
bits that get us to a Ball object
bits that get us to a Ball object
Ball at =0.5
bits for Ball at (0,0) r=0.7

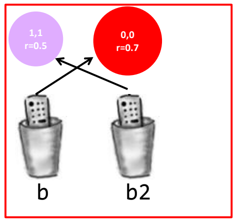
Reference variables can be reprogrammed

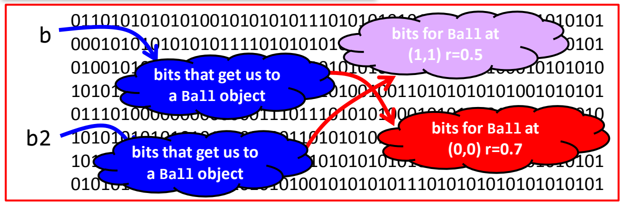
```
Ball b = new Ball(0.0, 0.0, 0.5);
Ball b2 = new Ball(0.0, 0.0, 0.7);

b = b2;
b2.setColor(1.0, 0.0, 0.0);

b2 = new Ball(1.0, 1.0, 0.5);
```

b2 now refers to a brand new Ball object at a new location (1,1). b2 forgets how to control Ball at (0,0). But b still can.




b
b2
bits that get us to a Ball object
bits that get us to a Ball object
bits for Ball at (1,1) r=0.5
bits for Ball at (0,0) r=0.7

Alias bug'o'rama

- Instance variables have a name
  - So do parameters to methods
  - So do local variables
  - Be careful: Java lets you use the same name!

```
public class Ball
{
   private double posX   = 0.0;
   private double posY   = 0.0;
   private double radius = 0.0;

   public Ball(double x, double y, double r)
   {
      posX   = x;
      posY   = y;
      radius = r;
   }
   ...
}
```

This class works just fine.

The instance variables and the parameters to the constructor method Ball() all use different names.

No confusion!

Alias bug'o'rama

- Local variables
  - If same name as instance variable → Java uses the local variable

```
public class Ball
{
   private double posX   = 0.0;
   private double posY   = 0.0;
   private double radius = 0.0;

   public Ball(double x, double y, double r)
   {
      double posX   = x;
      double posY   = y;
      double radius = r;
   }
   ...
}
```

This will compile and run, but the instance variables will all remain 0.0.

In the `Ball()` constructor, posX means the local variable not the instance variable.

Alias bug'o'rama

- Parameter to method
  - If same name as instance variable → Java uses the parameter variable

```
public class Ball
{
   private double posX   = 0.0;
   private double posY   = 0.0;
   private double radius = 0.0;

   public Ball(double posX, double posY, double radius)
   {
      posX   = posX;
      posY   = posY;
      radius = radius;
   }
   ...
}
```

This will compile and run, but the instance variables will all remain 0.0.

In the `Ball()` constructor, posX means the parameter variable not the instance variable.

`this` to the rescue

- `this`
  - Refers to the instance of the object running the method
  - Use instance variable instead of local variable

```
public class Ball
{
   private double posX   = 0.0;
   private double posY   = 0.0;
   private double radius = 0.0;

   public Ball(double posX, double posY, double radius)
   {
      this.posX   = posX;
      this.posY   = posY;
      this.radius = radius;
   }
   ...
}
```

This works just fine. Using this allows you to have the same parameter variables names as your instance variables (if you want).

Multiple `main()` methods

- Every Java class can have a `main()`
  - `java MyClass` → runs `main()` in `MyClass.java`
  - Often used to test and debug a class

```
public class Ball
{
   ...
   public static void main(String [] args)
   {
      Ball a = new Ball(0.5, 0.5, 0.2);
      Ball b = new Ball(0.5, 0.5, 0.2);
      System.out.println("a = " + a);
      System.out.println("b = " + b);
      System.out.println("a overlaps b = " + a.overlap(b));
      a.move(0.5, 0.0);
      System.out.println("a = " + a);
      System.out.println("a overlaps b = " + a.overlap(b));
      a.draw();
      b.draw();
   }
   ...
}
```

Quiz

- Classes and objects

Class =

Object =

Instance variables =

Instance methods =

Constructor =

Summary

- Classes and objects

Class = object blueprint

Object = instances of a class

Instance variables = what an object knows

Instance methods = what an object can do

Constructor = object stork

- Primitive and reference variables
  - Aliased objects, orphaned objects
- Alias bugs
- Every class can have `main()`