

Unit 2: Using Objects

Objects: Instances of Classes

Adapted from:

- 1) Building Java Programs: A Back to Basics Approach
by Stuart Reges and Marty Stepp
- 2) Runestone CSAwesome Curriculum

Expressions

In this unit, you will learn to use **objects** (variables of a **class** or **reference type**) that have been designed by other programmers.

Later on, in Unit 5, you will learn to create your own classes and objects.

A **class** in programming defines a new abstract data type. A class is the formal implementation, or blueprint, of the attributes and behaviors of an object.

When you create **objects or instances of a class** in coding, you create new variables or objects of that class data type.

Expressions

class: A program entity that represents a template for a new type of objects.

object or instance: An entity that combines attributes(data) and behavior(methods).

- **object-oriented programming (OOP):** Programs that perform their behavior as interactions between objects. Java is object-oriented.

The `Car` **class** is a template for creating `Car` **objects**.

Classes and objects

Example:

The Ipod **class** provides the template or blueprint for the **attributes(data)** and **behavior(methods)** of an ipod **object**.

Its attributes or data can include the current song, current volume and battery life.

Its behavior or methods can include change song, change volume, turn on/off, etc...

Two different Ipod objects can have different attributes/data. However, their template share the same implementation/code.

Blueprint analogy

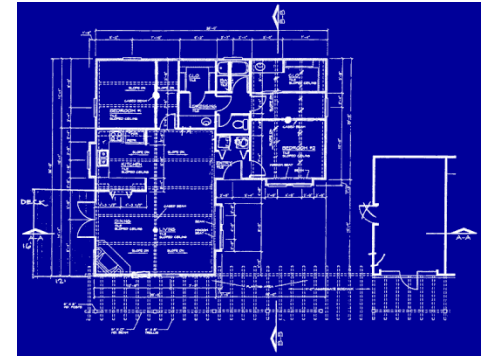
iPod blueprint

attributes:

current song
volume
battery life

behavior:

power on/off
change station/song
change volume
choose random song



creates

iPod #1

attributes:

song = "Uptown Funk"
volume = 17
battery life = 2.5 hrs

behavior:

power on/off
change station/song
change volume
choose random song



iPod #2

attributes:

song = "You make me
wanna"
volume = 9
battery life = 3.41 hrs

behavior:

power on/off
change station/song
change volume
choose random song



iPod #3

attributes:

song = "Trumpets"
volume = 24
battery life = 1.8 hrs

behavior:

power on/off
change station/song
change volume
choose random song



More Examples

Suppose you are writing an arcade game. What are some useful classes and their corresponding objects?

Example:

The **Character** Class represents characters in the game.

Attributes/Data: String name, int numberOfLives, boolean isAlien.

Behavior/Methods: shoot(), runLeft(), runRight(), jump().

Objects:

```
Character player1, player2; //declaring objects of type Character  
Character enemy1, enemy2;
```

More Examples

Your game might have more than one classes.

Classes: Character, Boss, MysteryBox, Obstacle.

Objects:

Boss level1, level2;

MysteryBox yellow; // give player 3 extra lives

MysteryBox red; // give player 100 coins

Obstacle wall; //immovable

Obstacle poison; // kills player

Sprite

Soon, we will use the Processing IDE(www.processing.org) to help us write arcade games.

In games, a **sprite** is an object that represents a character in a game.

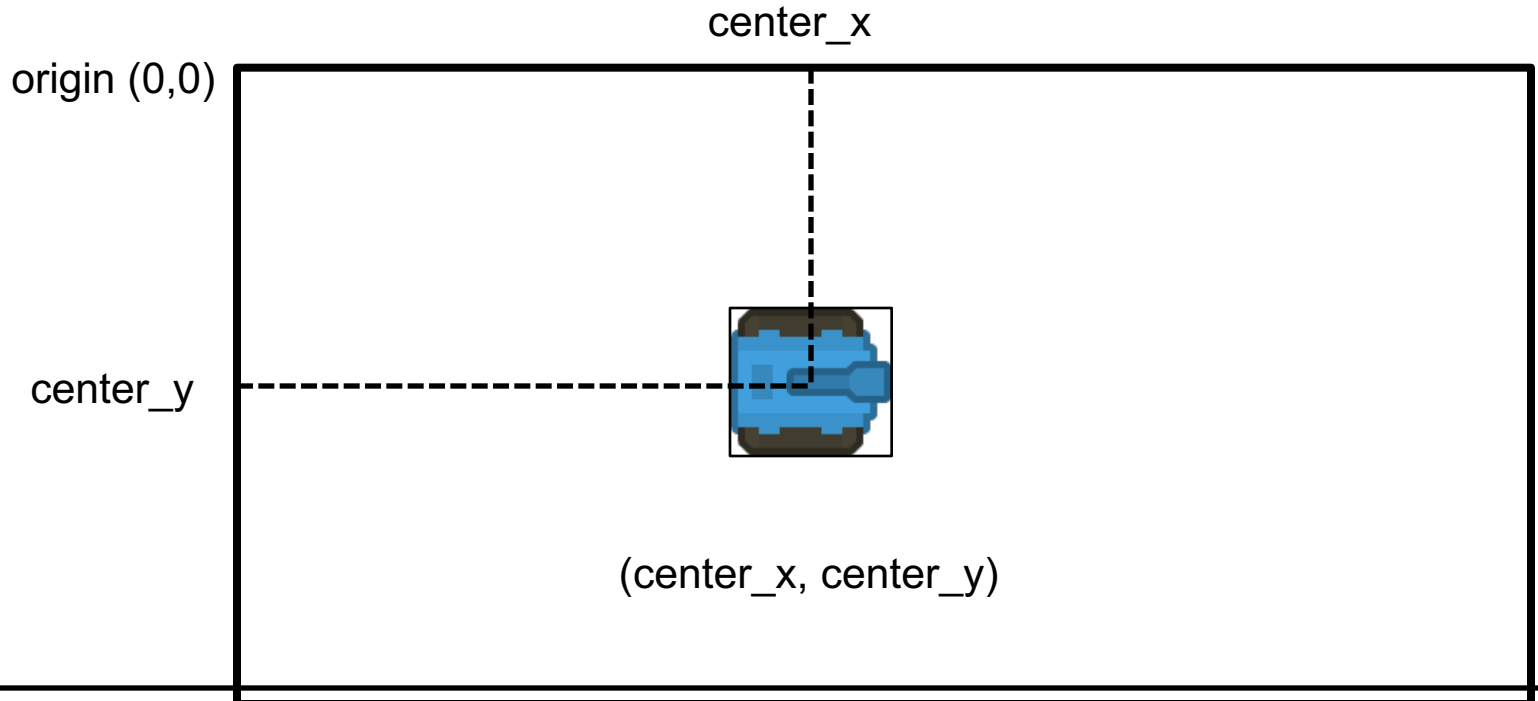
It usually consists of an image(or set of images) of a character moving and interacting with other sprites in the game.

Let's look at an example of a Sprite class that we will expand later into a full arcade game.

Sprite

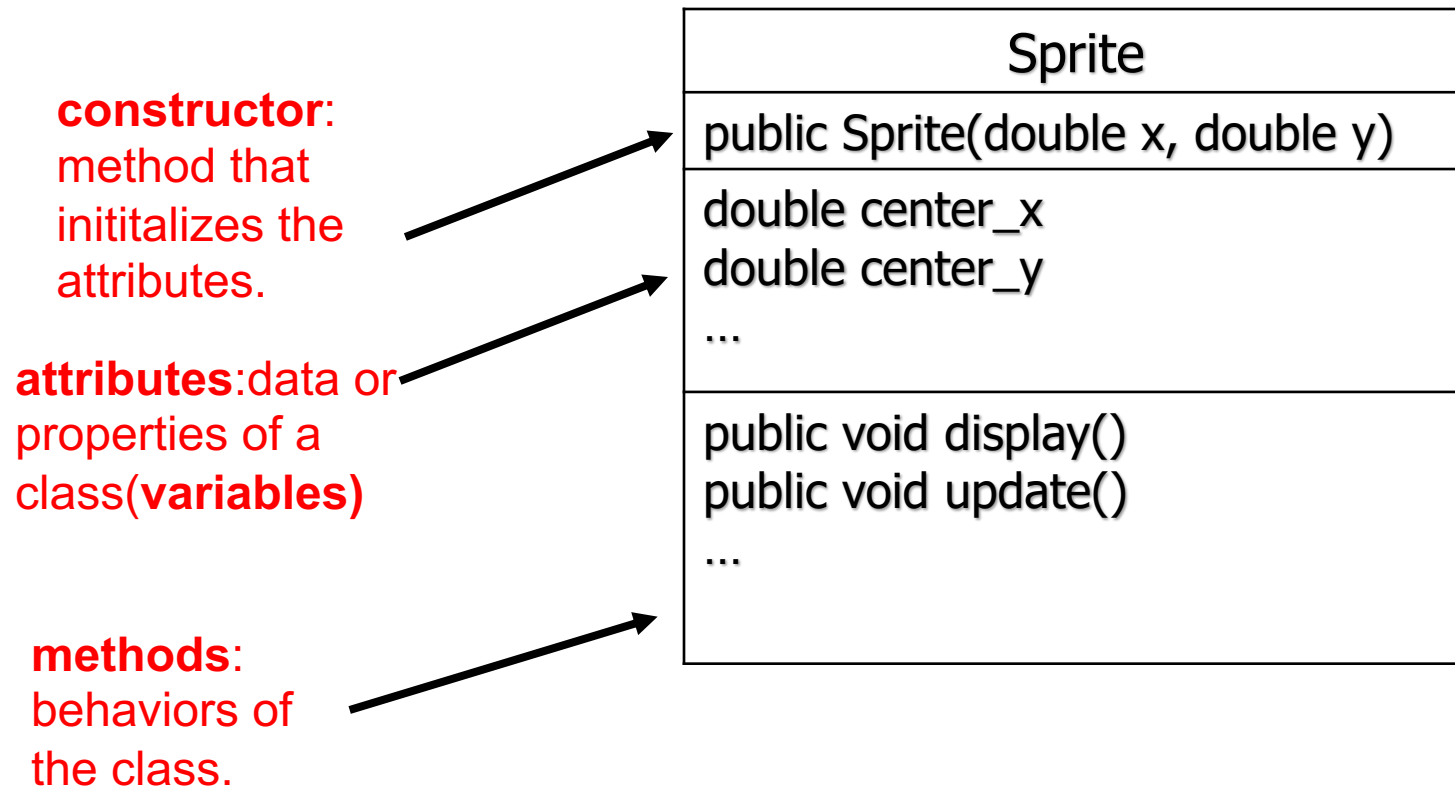
Sprite's attributes can include many properties: the image(.png or .jpg) of the sprite, the width and height of the image, and position on the screen given by `center_x` and `center_y` instance variables.

To keep things simple, for now, we focus on just two attributes: `center_x` and `center_y`.



Class Diagram

The image below represents a **class diagram** of the Sprite class. The class diagram allows us to preview the contents of the class.



Constructor

The **constructor** of a class is a method that allows us to initialize the attributes(variables) of an object when it is first created.

Constructors always have the same name as the class and are used with the keyword **new**.

signature: name of constructor and its parameter list.

An object variable is created using the keyword new followed by a call to a constructor.

Sprite
public Sprite(double x, double y)
double center_x double center_y ...
public void display() public void update() ...

Constructor

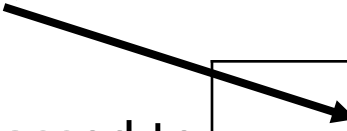
Consider the line of code used to create a Sprite object called player:

```
Sprite player = new Sprite(30.0, 50.0);
```

arguments or parameters:
data that
methods need
to do its job.

The **actual parameters** (30.0, 50.0) is passed to the **formal parameters** (double x, double y) of the constructors. The actual parameters passed to a constructor must be compatible with the types identified in the formal parameter list.

In code not shown here, the variables x and y are then used to initialize the attributes center_x and center_y.



Sprite
public Sprite(double x, double y)
double center_x double center_y ...
...

Multiple Objects

We can create multiple objects using the constructor.

```
public class ConstructorExample
{
    public static void main(String[] args){
        Sprite player1 = new Sprite(30, 50);
        Sprite player2 = new Sprite(10, 40);
    }
}
```

Note that in this example, player1 and player2 are two different objects or instances of the same class, each with its own copy of instance variables and methods.

We can access the attributes of an object by using the **dot notation** as shown in the next example.

Accessing attributes

We can **access** the attributes of an object by using the **dot notation**.

```
public class ConstructorExample{  
    public static void main(String[] args){  
        Sprite player1 = new Sprite(30, 50);  
        Sprite player2 = new Sprite(10, 40);  
        System.out.println(player1.center_x) // 30  
        System.out.println(player1.center_y) // 50  
        System.out.println(player2.center_x) // 10  
        System.out.println(player2.center_y) // 40  
  
    }  
}
```

modifying attributes

We can **modify** the attributes of an object by using the **dot notation**.

```
public class ConstructorExample{  
    public static void main(String[] args){  
        Sprite player1 = new Sprite(30, 50);  
        Sprite player2 = new Sprite(10, 40);  
        System.out.println(player1.center_x) // 30  
        System.out.println(player1.center_y) // 50  
        System.out.println(player2.center_x) // 10  
        System.out.println(player2.center_y) // 40  
        player1.center_x = 100;  
        System.out.println(player1.center_x) // 100  
    }  
}
```

Overloaded constructors

constructors are said to be **overloaded** when there are multiple constructors with the same name but a different signature.

Note on the right, the Sprite class has two constructors: one that has no parameter and one that has parameters.

Usually, the constructor that has no parameter (sometimes called the default constructor) initializes the object to some default values, for example, zeroes.

Sprite
<code>public Sprite()</code> <code>public Sprite(double x, double y)</code>
<code>double center_x</code> <code>double center_y</code> ...
...

overloaded constructors

We can call different constructors to initialize our objects.

```
public class ConstructorExample{  
    public static void main(String[] args){  
        Sprite player1 = new Sprite();  
        Sprite player2 = new Sprite(10, 40);  
        System.out.println(player1.center_x) // 0  
        System.out.println(player1.center_y) // 0  
        System.out.println(player2.center_x) // 10  
        System.out.println(player2.center_y) // 40  
  
    }  
}
```

Primitive vs. Reference Type

The memory associated with a variable of a **primitive type**(**int**, **double**, **boolean**) holds an actual primitive value.

```
int x = 3; // x is a variable of a primitive type  
          // the memory associated with x actually holds the value 3
```

```
int y = x;
```



Here we have two different integers in memory both of which has the value 3.



Primitive vs. Reference Type

While the memory associated with a variable of a **reference type** holds an object **reference value**. This value is the **memory address** of the referenced object.

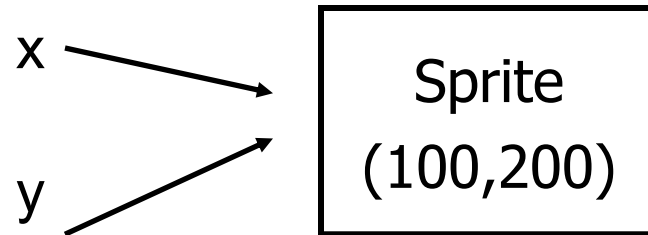
```
Sprite x = new Sprite(100, 200);
```

```
// player1 is a variable of a reference type
```

```
// the value of player1 is actually an address in memory of this
```

```
// Sprite object not the actual object itself.
```

```
Sprite y = x;
```



Note that this is similar to the previous slide example. But in this case, both `x` and `y` stores the **same address in memory** therefore both refer to the **same object**.

More Examples

// x, y and isPrime are variables of primitive type(Unit 1).

```
int x = 3;
```

```
double y = 2.5;
```

```
boolean isPrime = false;
```

// player1, player2 are variables of a reference type

```
Sprite player1 = new Sprite(100, 200);
```

```
Sprite player2 = new Sprite();
```

Null

The keyword **null** is a special value used to indicate that a reference is not associated with any object. Accessing an instance variable of a null reference will result in a `NullPointerException`.

```
// player1 points to the address or location in memory for the  
// Sprite object
```

```
Sprite player1 = new Sprite(100, 200);
```

```
Sprite player2 = null; // player2 is initialized to null since it is not  
                       // yet associated with any object.
```

```
System.out.println(player2.center_x) // NullPointerException
```

Example Implementation

Although we will write the Sprite class later in Unit 5. It is instructive to see the implementation of this very simple class to understand the structure of a class.

Note that there are two .java files. The main method is in Main.java(sometimes call the driver class) and the Sprite object class is in Sprite.java.

Main.java

```
public class Main{
    public static void main(String[] args){
        Sprite player1 = new Sprite();
        Sprite player2 = new Sprite(10, 40);
    }
}
```

**creating the
objects by
calling one of
the constructors**

Sprite.java

```
public class Sprite{
    double center_x;
    double center_y;
    public Sprite(){
        center_x = 0;
        center_y = 0;
    }
    public Sprite(double x, double y){
        center_x = x;
        center_y = y;
    }
}
```

**declaring the
instance
variables**

**overloaded
constructors**

**initializing
the instance
variables**

References

1) Building Java Programs: A Back to Basics Approach by Stuart Reges and Marty Stepp

2) Runestone CSAwesome Curriculum:

<https://runestone.academy/runestone/books/published/csawesome/index.html>

For more tutorials/lecture notes in Java, Python, game programming, artificial intelligence with neural networks:

<https://longbaonguyen.github.io>