Objects and Classes

Object-Oriented Programming

Outline

- Classes vs. objects
- Designing a class
- Methods and instance variables
- Encapsulation & information hiding

- Readings:
  - HFJ: Ch. 2, 3, 4.
  - GT: Ch. 3, 4.

Java program

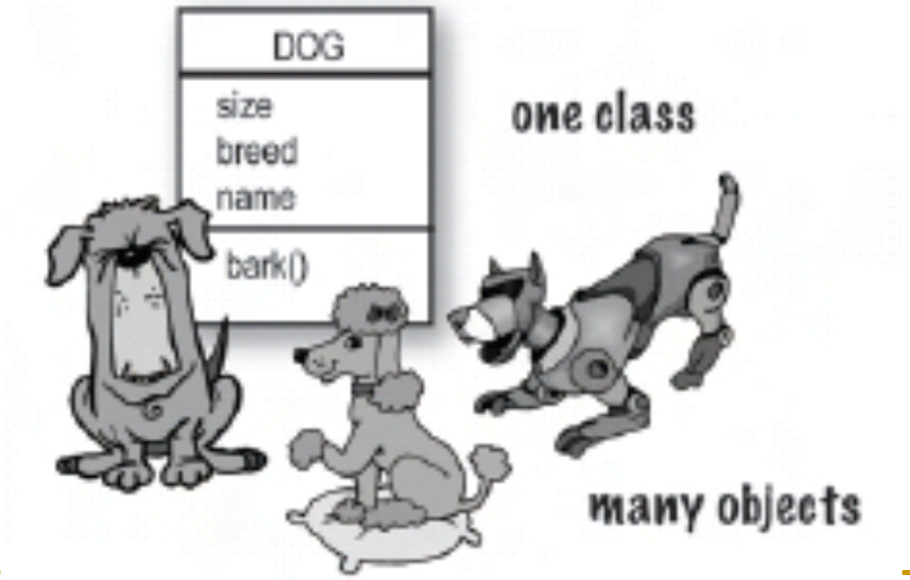
```
public class Greeting {
  public void greet() {
    System.out.print("Hi there!");
  }
}
```

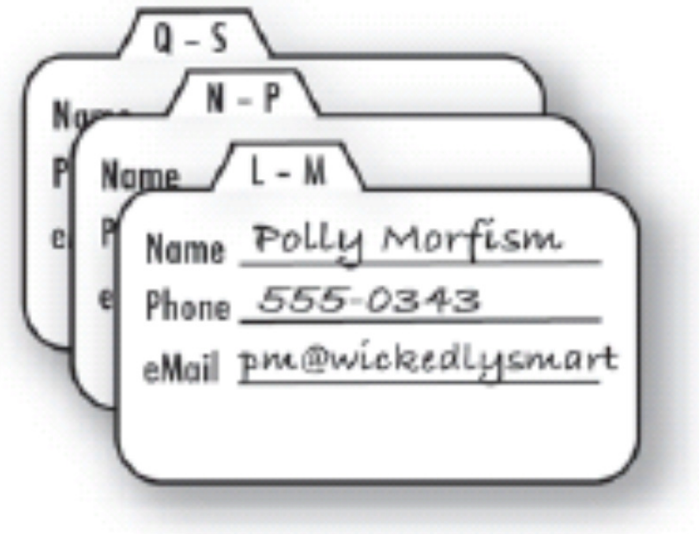
```
public class TestGreeting {
  public static void main(String[] args) {
    Greeting gr = new Greeting();
    gr.greet();
  }
}
```

- A Java program, at run-time, is a collection of objects. They do things (their methods) and ask other objects to do things (calling methods of others).
- A Java program, when we write it, is a collection of classes
- A Java library contains predefined classes that we can use in our programs

Classes vs. objects

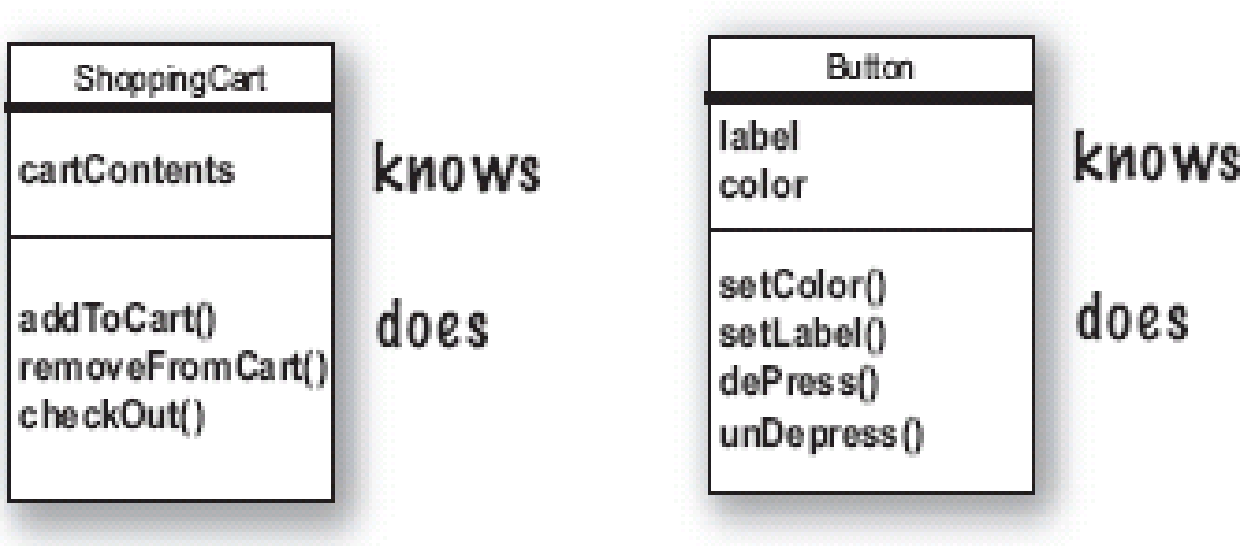
- A class is a blueprint/template that is used to construct objects.
- Each object is *instantiated* from a class. That object is called an *instance* of the class.



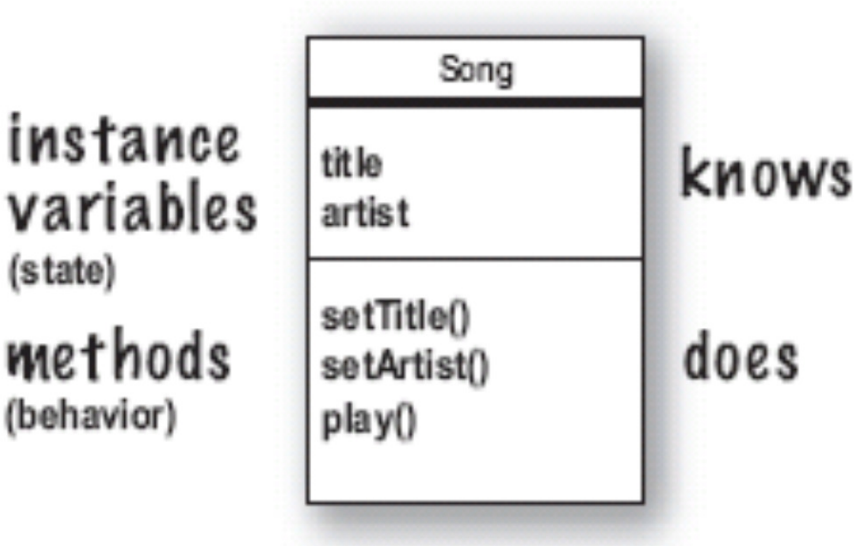


Designing a class

- When you design a class, think about the objects that will be created from that class
  - things the object **knows** about itself
  - things the object **does**



Designing a class



- things the object knows about itself

  → **instance variables**

  the object's instance variables represent its *state*

- things the object can do

  → **methods**

  the object's methods represent its *behavior*

Writing a class

1. Write the class

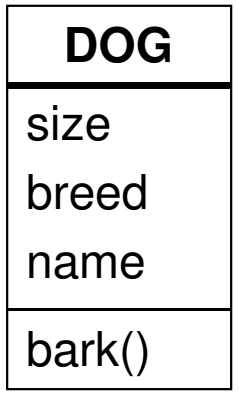
instance variables

a method

```
class Dog {

  int size;
  String breed;
  String name;

  void bark() {
    System.out.println("Ruff! Ruff!");
  }
}
```



Writing a class

2. Write a tester (TestDrive) class

with code to test the Dog class

dot notation (.) gives access to an object's instance variables and methods

```
public class DogTestDrive {
  public static void main(String [] args) {
    Dog d = new Dog();
    d.name = "Bruno";
    d.bark();
  }
}
```

make a Dog object

set the name of the Dog

call its bark() method

Information hiding is not here yet.

Writing a class

Instance variables/methods belong to an object.

Thus, when accessing them, you MUST specify **which object** they belong to.

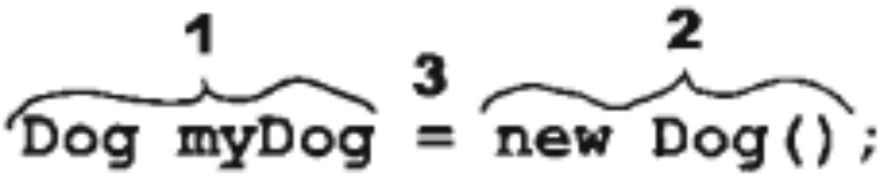
dot notation (.) and ***the object reference***

```
public class DogTestDrive {
  public static void main(String [] args) {
    Dog d = new Dog();
    d.name = "Bruno";
    d.bark();
  }
}
```

access 'name' of ***the Dog***

call ***its*** *bark() method*

Object references



3 steps of object declaration, creation and assignment:

1. Declare a reference variable

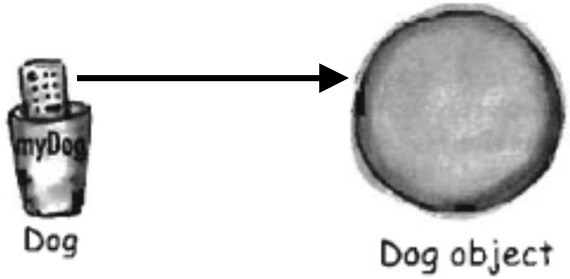
```
Dog myDog = new Dog();
```

2. Create an object

```
Dog myDog = new Dog();
```

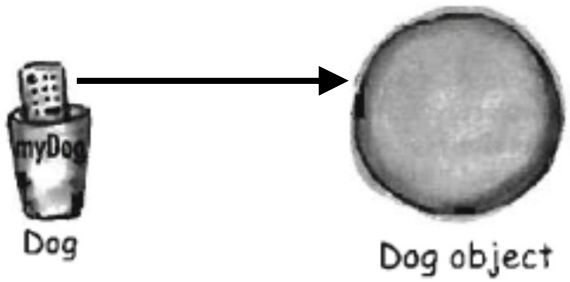
3. Link the object and the reference

```
Dog myDog = new Dog();
```



Object references

```
Dog myDog = new Dog();
```



Remember: **References are not objects!**

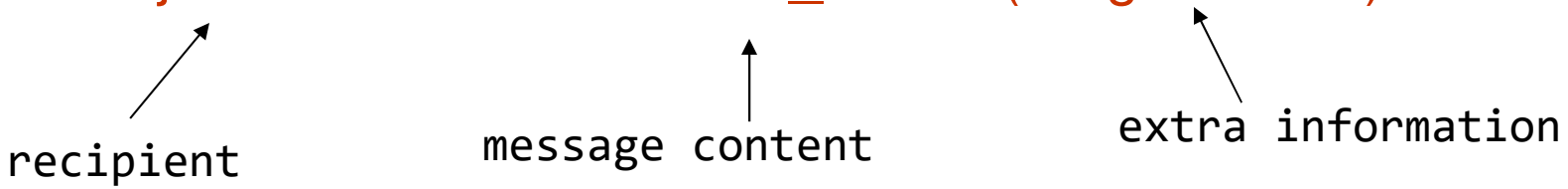
Messaging between objects

- Sending a message to an object is actually calling a method of the object.

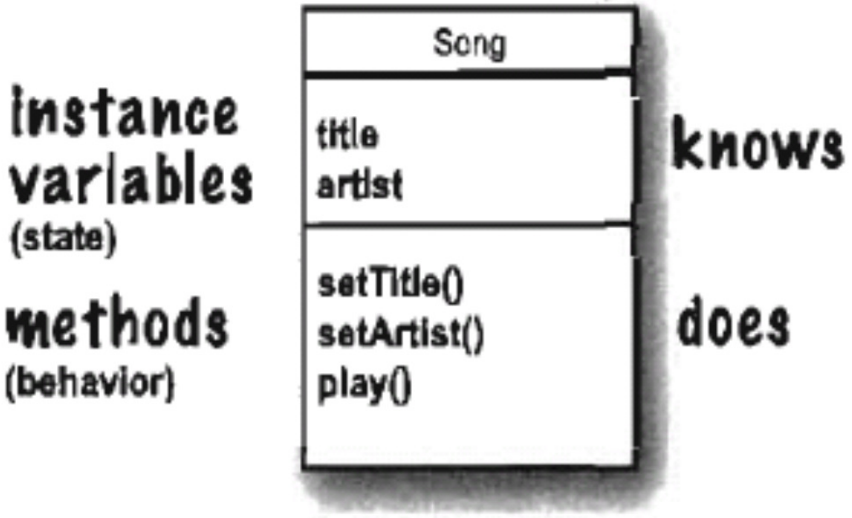
```
d.bark()
```

- Syntax:

<object reference>.<method_name>(<arguments>)



Methods – How objects behave



- Objects have
  - state (instance variables)
  - behavior (methods)
- A method can use instance variables' value and change the object's state.
- A method can use instance variables so that objects of the same type can behave differently

State affects behavior, behavior affects state

```
class Dog {

  int size;
  String breed;
  String name;

  void bark() {
    if (size > 14)
      System.out.println("Ruff! Ruff!");
    else
      System.out.println("Yip! Yip!");
  }

  void getBigger() {
    size += 5;
  }
}
```

State affects behavior.

Dogs of different sizes behave differently.

method changes state

DOG
size breed name
bark() getBigger()

State affects behavior, behavior affects state

```
class DogTestDrive {

  public static void main (String[] args) {

    Dog one = new Dog();
    one.size = 7;
    Dog two = new Dog();
    two.size = 13;

    two.bark();
    two.getBigger();
    two.bark () ;

    one.bark();
  }
}
```

State affects behavior, behavior affects state

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class DogTestDrive {

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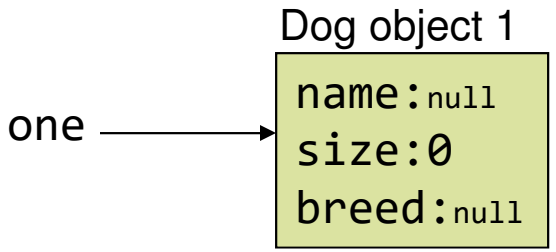


```
%> java DogTestDrive
```

State affects behavior, behavior affects state

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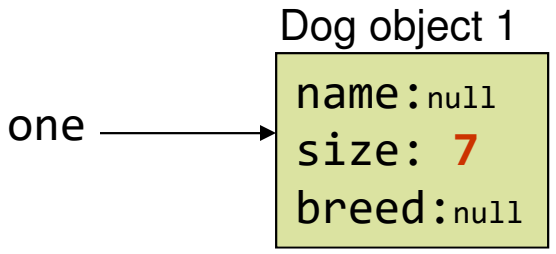


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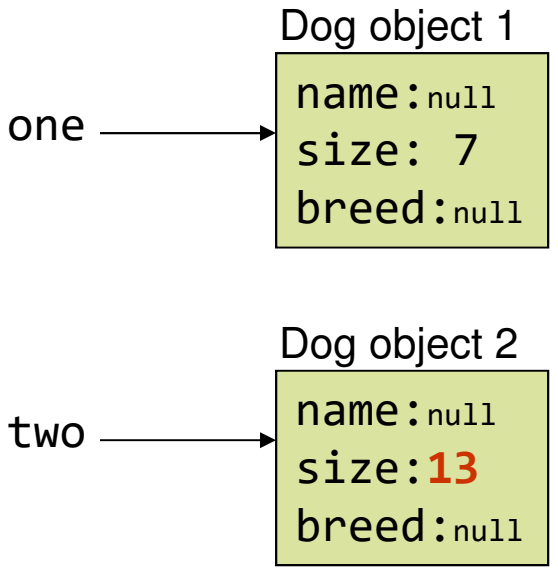


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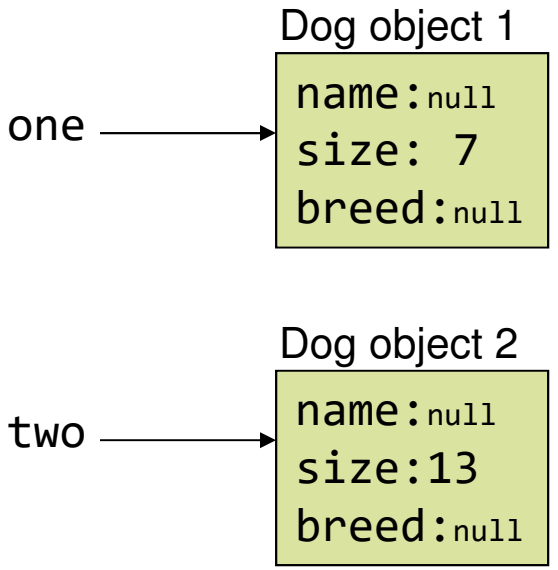


```
%> java DogTestDrive

Yip! Yip!
```

State affects behavior, behavior affects state

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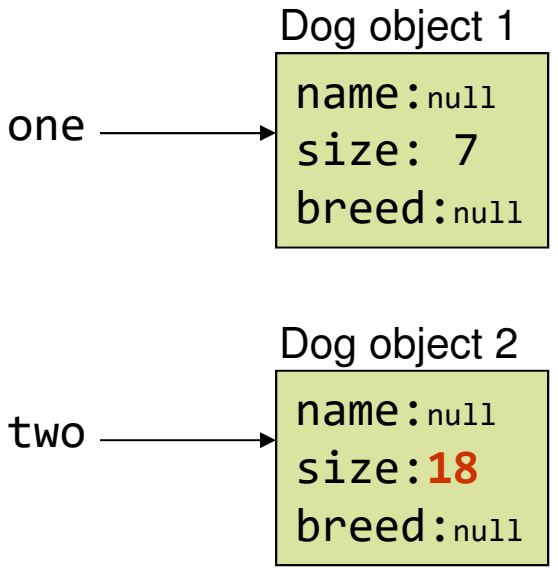


```
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Yip! Yip!
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State affects behavior, behavior affects state

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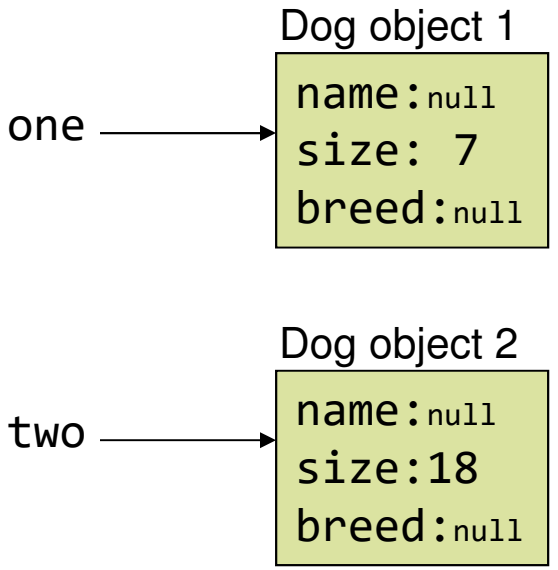


```
%> java DogTestDrive
Yip! Yip!
Ruff! Ruff!
```

State affects behavior, behavior affects state

```
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    Dog one = new Dog();
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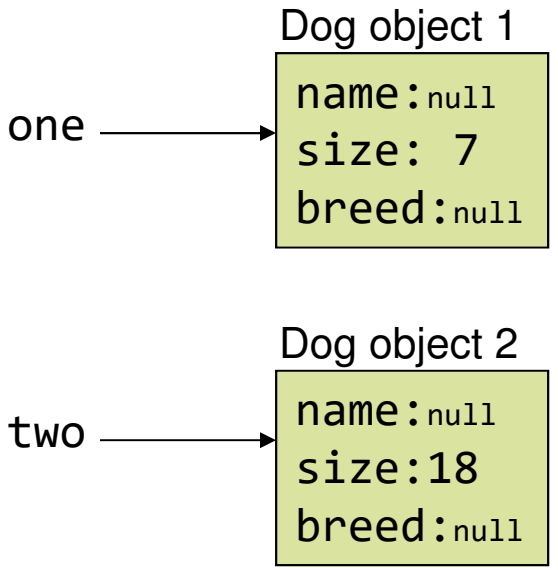


```
%> java DogTestDrive
Yip! Yip!
Ruff! Ruff!
Yip! Yip!
%>
```

Compare

`size, breed` vs. **`dog`**

- syntax?
- meanings?

```
class Dog {
  int size;
  String breed;
  ...
  void getBigger() {
    size += 5;
  }
}
```

```
public class DogTestDrive {
  public static void main(String [] a
    Dog dog = new Dog();
    dog.name = "Bruno";
    dog.bark();
  }
}
```

Instance variables vs. local variables

Instance variables

- belong to an object
- declared inside a class but NOT within a method
- have default values (0, 0.0, false, null…)

```
class Dog {
  int size;
  String breed;
  ...
  void getBigger() {
    size += 5;
  }
}
```

Local variables

- belong to a method
- declared within a method
- MUST be initialized before use

```
public class DogTestDrive {
  public static void main(String [
    Dog dog = new Dog();
    dog.name = "Bruno";
    dog.bark();
  }
}
```

Encapsulation / information hiding

```
class Dog {
  int size;
  String breed;
  String name;
```

```
Dog d = new Dog();
d.size = -1;
```

- What is wrong with this code?
  - It allows for a supernatural dog
  - Object's data is exposed.
- Exposed instance variables can lead to invalid states of object
- What to do about it?
  - write set methods (*setters*) for instance variables
  - hide the instance variables to force other code to use the set methods instead of accessing them directly.

Information hiding. Rule of thumb

- Mark instance variables **private.**
- Make getters and setters and mark them **public.**

- Don't forget to check data validity in setters.

```
class Dog {
  private int size;

  public void setSize(int s) {
    if (s > 0) size = s;
  }

  public int getSize() {
    return size;
  }
  ...
```

Class access control

Access modifiers:

- `public` : Accessible anywhere by anyone
- `private` : Only accessible within the current class
- `protected` : Accessible only to the class itself and to its subclasses or other classes in the same "package"
- default (no keyword): accessible within the current package

Implementation vs. Interface

- DogTestDrive: a “client” of Dog
- Implementation
  - Data structures and code that implement the object features (instant variables and methods)
  - Usually more involved and may have complex inner workings
  - Clients don’t need to know
- Interface
  - The controls exposed to the “client” by the implementation
  - The knobs on the black box

Encapsulation / information hiding

"Don't expose internal data structures!"

- Objects hold data and code
  - Neither is exposed to the end user or "client" modules.
- Interface vs. implementation
  - A cat's look vs. its internal organs
  - A TV's screen & buttons vs. the stuff inside the box
- Complexity is hidden inside the object
  - Make life easier for clients
  - More modular approach
    - Implementation changes in one component doesn't affect others
  - Less error-prone