

Some background before I start the lesson...

- Initial lessons use existing classes (String, ArrayList, Random)
 - practice reading APIs
 - practice instantiating objects
 - practice invoking static and instance methods
- Today's Lesson: Defining a new Java class
 - Delay introduction of constructors
 - Initial emphasize on object state and object references
 - Visual debugger to clarify object concepts, avoid common misconceptions

Today's Lesson - Defining a new Java class

We've seen how to use existing Java core and utility classes (String, ArrayList, etc.) to solve some interesting problems.

Today we'll see how to define a **new** class to model some real world objects.

Review

Objects have state (properties/attributes) and behavior (operations that access/modify state)

Object	State	Behavior
Mobile Phone	brand model is on volume	toggle on/off adjust volume send text
Zoom meeting	date time link	schedule cancel start

Review

Java Data Types		
Primitive Types	byte, short, int, long, float, double, boolean, char	Variable stores a primitive value
Reference Types (non-primitive)	String, ArrayList, Random, JButton, JFrame, ...	Variable stores an object reference

- Primitive types are predefined in Java.
- Reference types can be defined by the programmer.

Review

Random and ArrayList

```
public static void main(String[] args) {  
    ArrayList<String> coinFlips = new ArrayList<String>();  
    Random rand = new Random();  
    int numHeads = 0;  
    boolean heads = rand.nextBoolean();  
  
    while (numHeads < 3) {  
        if (heads) {  
            numHeads++;  
            coinFlips.add("Heads");  
        }  
        else {  
            coinFlips.add("Tails");  
        }  
        heads = rand.nextBoolean();  
    }  
  
    System.out.println("Total coin flips:" + coinFlips.size());  
    System.out.println(coinFlips);  
}
```



- Primitive variables (`numHeads`, `heads`) store primitive data value.
- Reference variables (`coinFlips`, `rand`) store reference to object in the heap.

```
public class ClassName {  
    //Field declarations  
    //Method declarations  
}
```

A class to model pet fish

Objects

Fish instance

age	15
isAggressive	false
species	"Goldfish"

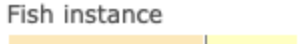
Fish instance

age	8
isAggressive	true
species	"Red Tail Shark"

```
public class Fish {
```

Creating a new class instance (i.e. object)

```
public class Fish {  
    int age;  
    boolean isAggressive;  
    String species;  
}
```

Java Expression	Heap (dynamic memory)
	

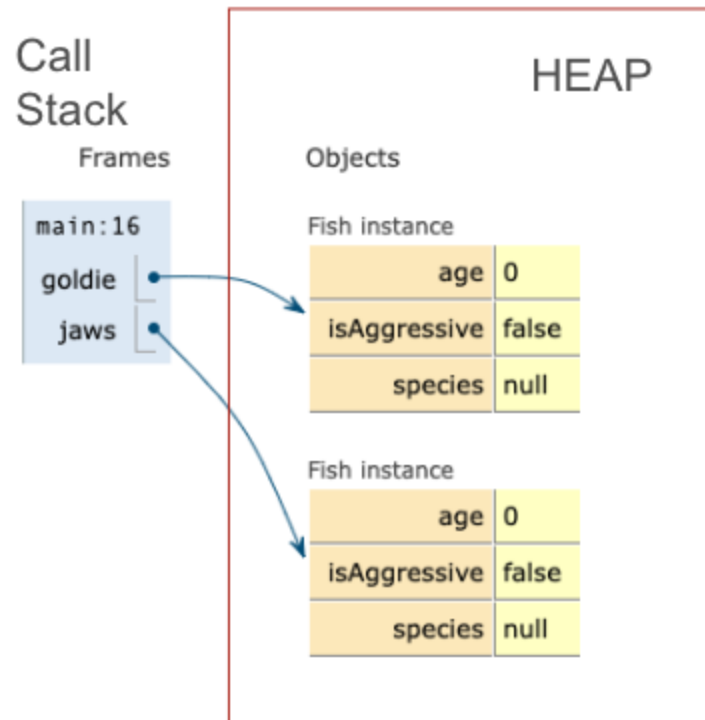
- Memory is allocated to store a value for each field
- Fields are initialize with default values based on data type: int 0, boolean false, String null
- Returns a reference to the new object

Reference variable

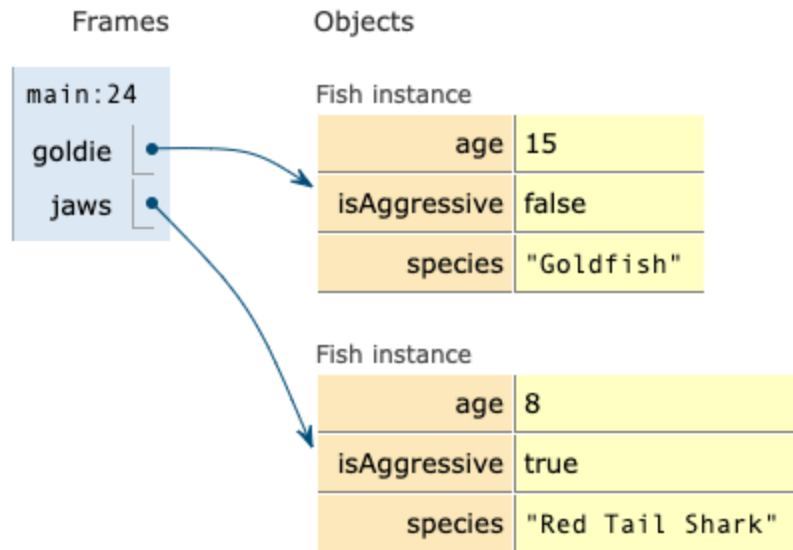
A reference variable:

- Is declared with a reference data type (such as class **Fish**).
- Stores an object reference or `null`.

```
Fish goldie = new Fish();  
Fish jaws = new Fish();
```



Suppose we'd like to update both fish as shown:



- Each fish instance has it's own variable named **age**.
- **Dot notation** is used to access a field through a reference.

```
objectReference.fieldName
```

```
goldie.age = 15;  
goldie.species = "Goldfish";  
  
jaws.age = 8;  
jaws.species= "Red Tail Shark";  
jaws.isAggressive = true;
```

NOTE : **String** is a reference data type

The species variable actually stores a reference to a separate **String** object.


String Literal (default view)	String Reference																								
<p>Fish instance</p> <table><tr><td>age</td><td>15</td></tr><tr><td>isAggressive</td><td>false</td></tr><tr><td>species</td><td>"Goldfish"</td></tr></table> <p>Fish instance</p> <table><tr><td>age</td><td>8</td></tr><tr><td>isAggressive</td><td>true</td></tr><tr><td>species</td><td>"Red Tail Shark"</td></tr></table>	age	15	isAggressive	false	species	"Goldfish"	age	8	isAggressive	true	species	"Red Tail Shark"	<p>Objects</p> <p>Fish instance</p> <table><tr><td>age</td><td>15</td></tr><tr><td>isAggressive</td><td>false</td></tr><tr><td>species</td><td></td></tr></table> <p>String "Goldfish"</p> <p>Fish instance</p> <table><tr><td>age</td><td>8</td></tr><tr><td>isAggressive</td><td>true</td></tr><tr><td>species</td><td></td></tr></table> <p>String "Red Tail Shark"</p>	age	15	isAggressive	false	species		age	8	isAggressive	true	species	
age	15																								
isAggressive	false																								
species	"Goldfish"																								
age	8																								
isAggressive	true																								
species	"Red Tail Shark"																								
age	15																								
isAggressive	false																								
species																									
age	8																								
isAggressive	true																								
species																									

Recall how an assignment statement works

The value of the expression on the right hand side is copied into the variable on the left hand side.



`int x = 7 + 2;`



`int y = x;`

```
main:6
    x | 9
    y | 9
```

```

public class Cat {

    String name;
    boolean isPurring;

    public static void main(String[] args) {
        Cat calico = new Cat();
        Cat tabby = new Cat();
        Cat favorite = calico;

        tabby.name = "Maru";
        calico.name= "Chestnut";
        favorite.isPurring = true;

        System.out.printf("calico: %s %b%n", calico.name, calico.isPurring);
        System.out.printf("tabby %s %b%n", tabby.name, tabby.isPurring);
        System.out.printf("favorite: %s %b%n", favorite.name, favorite.isPurring);
    }
}

```

- Sketch out the heap and stack frame.
- What gets printed? Debug to confirm your answer.

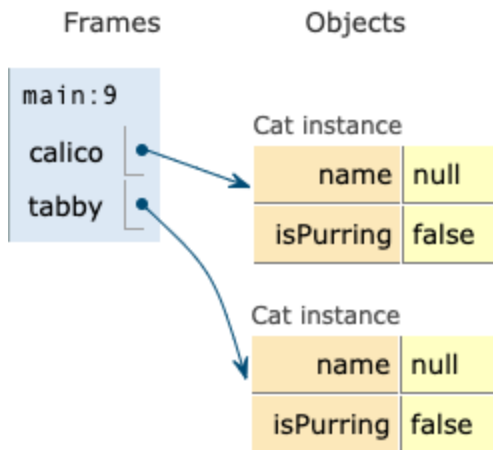


`new Cat()` creates an instance

<details> <summary>

```
Cat calico = new Cat();  
Cat tabby = new Cat();
```

</summary>



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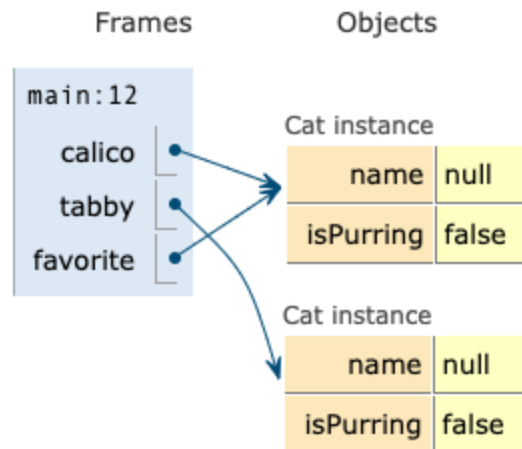
Multiple variables can reference the same object

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- Two primitive variables can store the same value.
- Two reference variables can reference the same object.

```
Cat calico = new Cat();  
Cat tabby = new Cat();  
Cat favorite = calico
```

</summary>



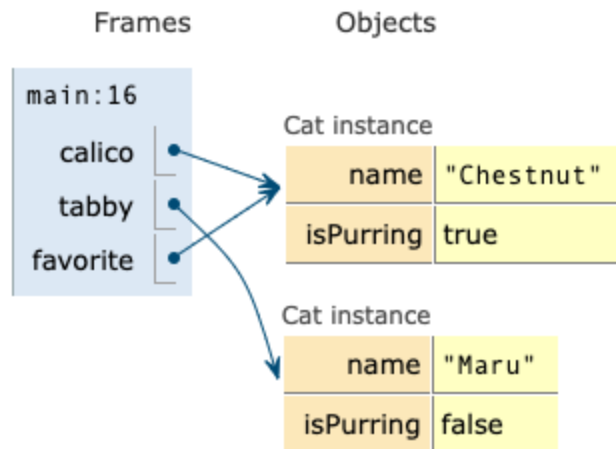
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Updating object state

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```
Cat calico = new Cat();  
Cat tabby = new Cat();  
Cat favorite = calico;  
  
tabby.name = "Maru";  
calico.name= "Chestnut";  
favorite.isPurring = true;
```

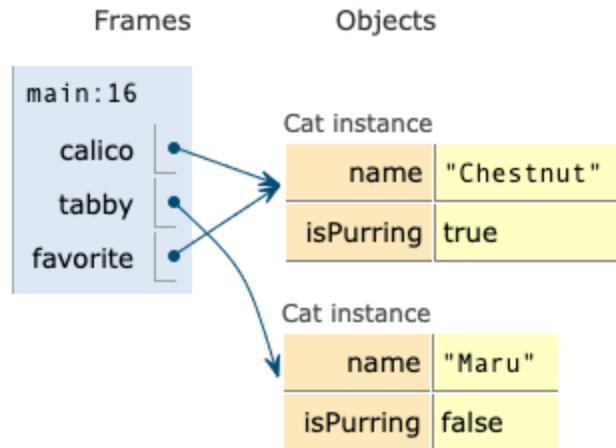
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What get's printed?

```
System.out.printf("calico: %s %b\n", calico.name, calico.isPurring);  
System.out.printf("tabby %s %b\n", tabby.name, tabby.isPurring);  
System.out.printf("favorite: %s %b\n", favorite.name, favorite.isPurring);
```



```
calico: Chestnut true  
tabby: Maru false  
favorite: Chestnut true
```


CHALLENGE

- Implement a class named `Hamster` with fields to store a name, weight in ounces, and whether they are friendly.
- Implement a `main` method to instantiate two hamster and update their state as shown.
 - do not write unnecessary field assignments (consider default initialization).
- Step through with the debugger to confirm your code is correct.

