Some background before I start the lesson...

- Initial lessons use existing classes (String, Arraylist, Random, Swing/Graphics)
  - practice reading APIs
  - practice instantiating objects
  - practice invoking static and instance methods
- Subsequent lesson on defining a new Java class
  - Delay introduction of constructors and methods
  - Initial emphasize on object state and object references
  - Use visual debuggers 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: What is an object?

Objects have state (properties/data) and behavior (operation that access/modify state)

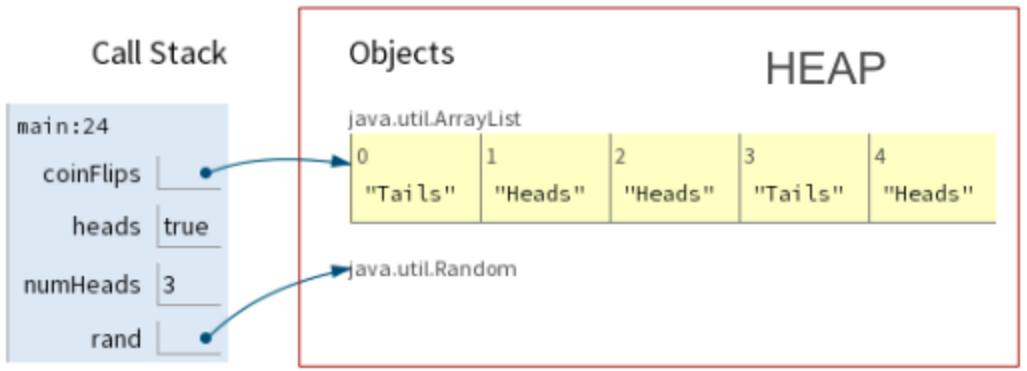
Object	State	Behavior
Mobile Phone	brand model is on volume	toggle on/off adjust volume send text
Zoom meeting	date time link	schedule cancel start

Review: Java Data Types

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

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

```
  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);
}
```



```
public class ClassName {

  //Field declarations

  //Method declarations

}
```

A class to model pet fish

Objects

Fish instance

age	15
isAggressive	false
species	"Goldfish"

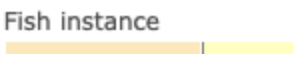
Fish instance

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)
	

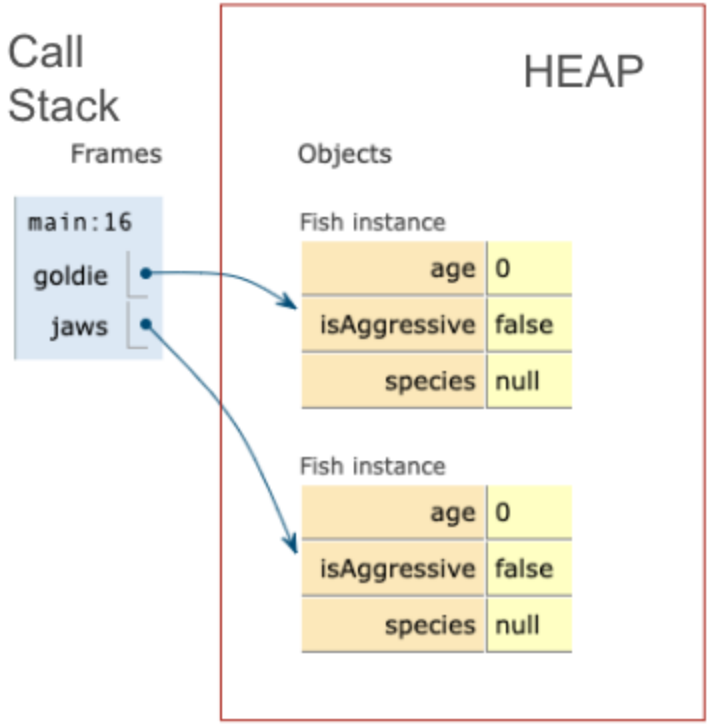
- Memory is allocated to store a value for each field
- Fields are initialize with default values based on data type: int 0, boolean false, String null
- Returns a reference to the new object

Reference Variable

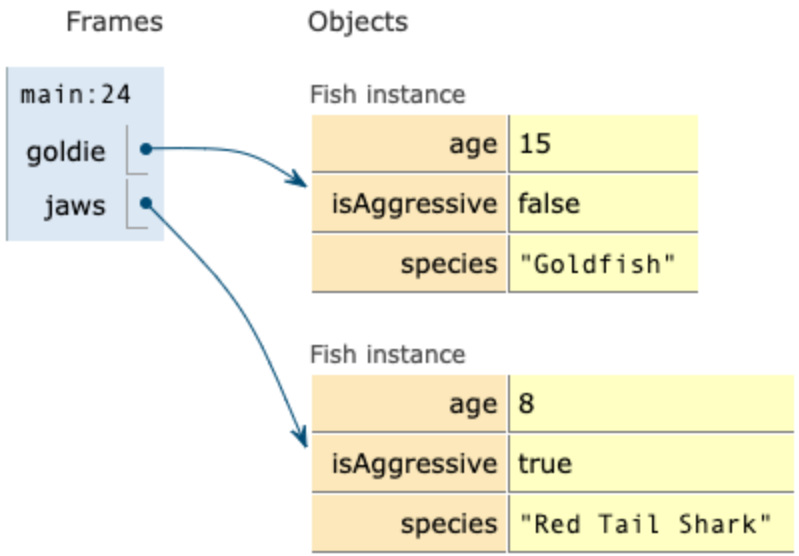
A **reference variable**:

- 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.

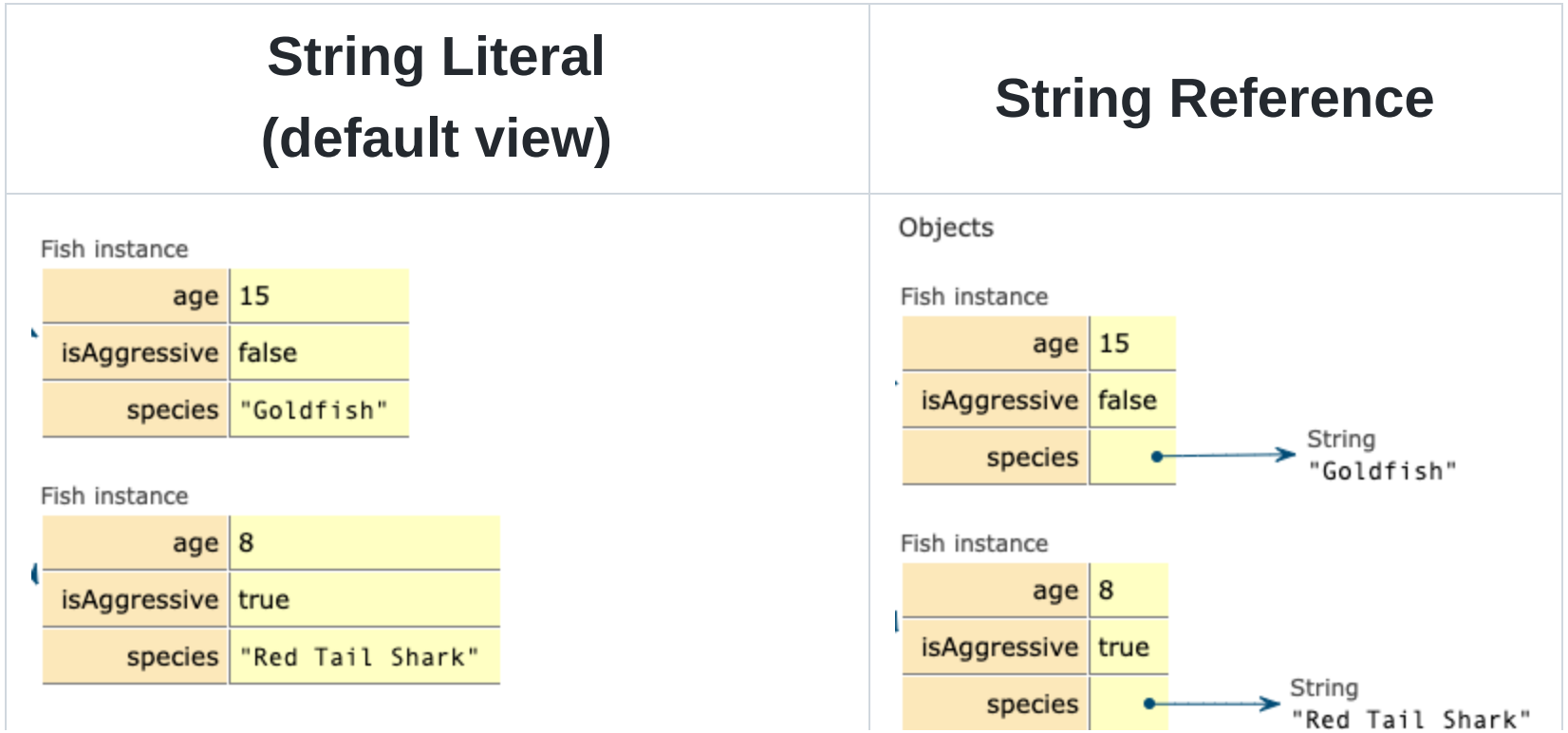
`objectReference.fieldName`

```
goldie.age = 15;
goldie.species = "Goldfish";

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

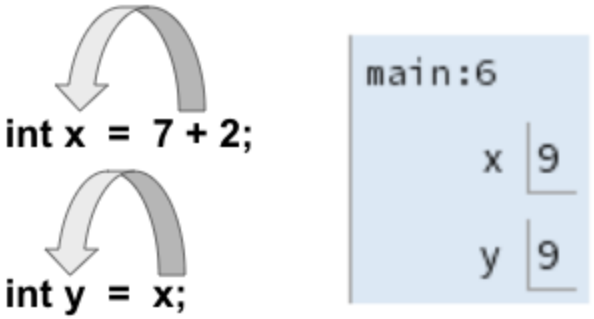
NOTE : `String` is a reference data type

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



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.



```
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

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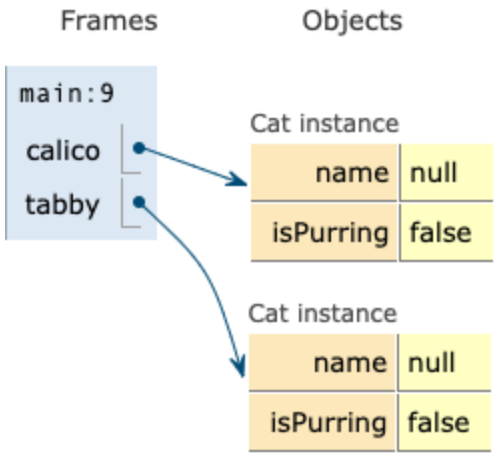
```
Cat calico = new Cat();
Cat tabby = new Cat();
```

</summary>



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Multiple variables can reference the same object

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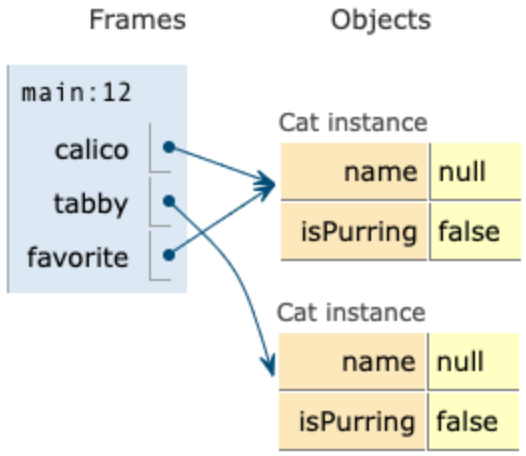
- Two primitive variables can store the same value.
- Two reference variables can reference the same object.

```
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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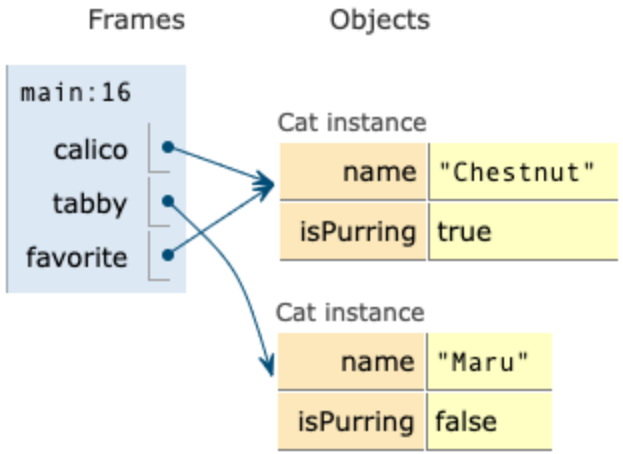

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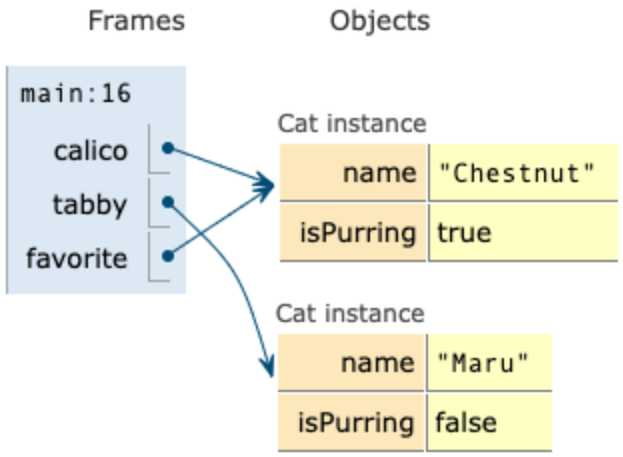
What get's printed?

```
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 unnecesary field assignments (consider default initialization).
- Step through with the debugger to confirm your code is correct.