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 creating new classes
  - Delay introduction of constructors and methods
  - Initial emphasize on object state and object references
  - Use visual debuggers to clarify object concepts, avoid common object
    misconceptions

Today's Lesson

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 and behavior.

- State represents relevant properties of an object (data)
- Behavior is the operations that access/modify object state

Object	State	Behavior
Mobile Phone	brand model is on volume	toggle on/off adjust volume send text
	date	schedule

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

Review: Storing `Random` Coin Flips in an `ArrayList`

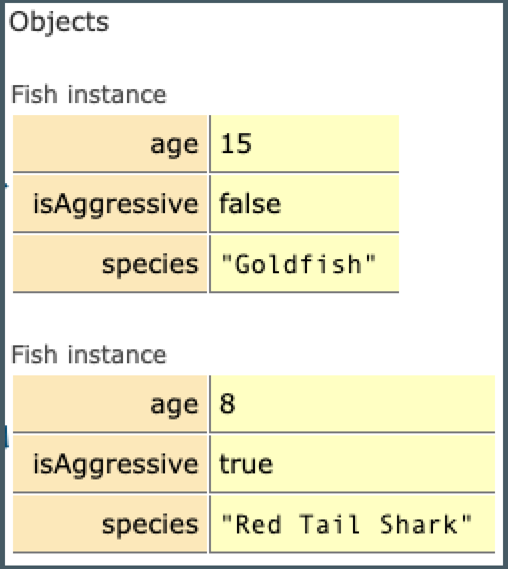
```java
public static void main(String[] args) {
  ArrayList<String> coinFlips = new ArrayList<String>();
  Random rand = new Random();
  int numHeads = 0;
  boolean heads = rand.nextBoolean();
  while (numHeads < 3) {
      if (heads) {
          numHeads++;
          coinFlips.add("Heads");
      }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

Defining a Java Class

- Template/blueprint for describing similar software objects.
- Define state (fields) and behavior (methods).

```
public class ClassName {

  //Field declarations

  //Method declarations

}
```

A class to model pet fish


Objects

Fish instance

age	15
isAggressive	false
species	"Goldfish"

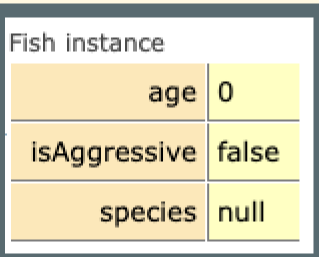
Fish instance

age	8
isAggressive	true
species	"Red Tail Shark"

```
public class Fish {

    //Field declarations
    int age;
    boolean isAggressive;
    String species;
```

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

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

Java Expression	Heap (dynamic memory)
`new Fish()`	

Fish instance

age	0
isAggressive	false
species	null

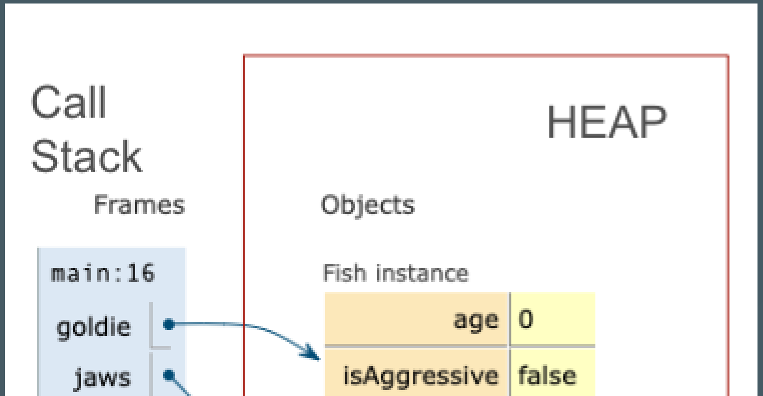
- Memory is allocated to store a value for each field
- Fields are initialize with default values based on data type: int 0

Reference Variable

A **reference variable**:

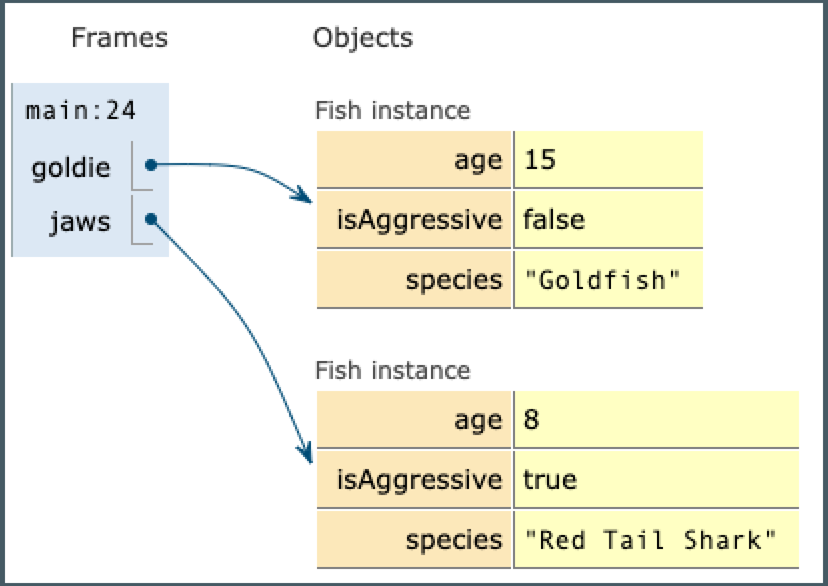
- Is declared with a reference data type (such as class **Fish**).
- Stores an object reference or `null`.

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



Accessing an object's field

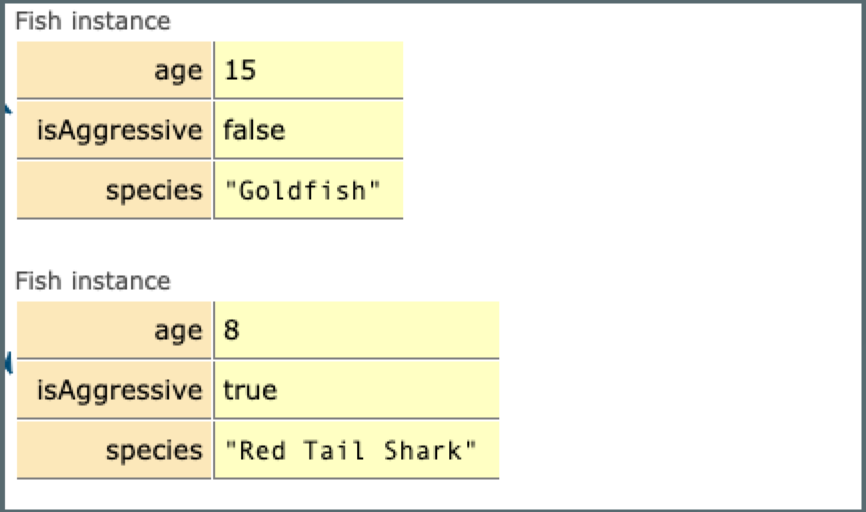
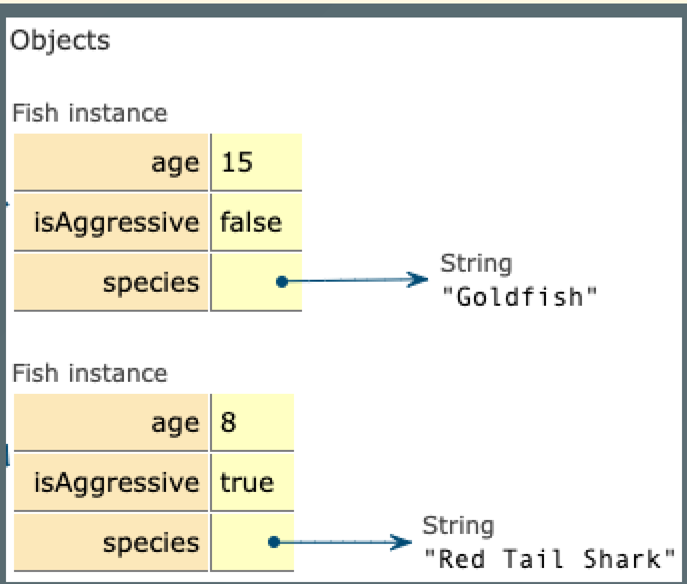
Suppose we'd like to update both fish as shown:



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

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
	

Fish instance

age	15
isAggressive	false
species	"Goldfish"

Fish instance

age	8
isAggressive	true
species	"Red Tail Shark"

Objects

Fish instance

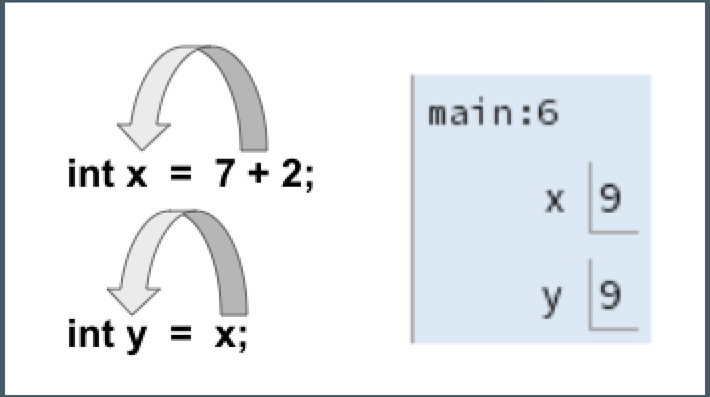
age	15
isAggressive	false
species	●

Fish instance

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;
```

CHALLENGE

Consider the following code:

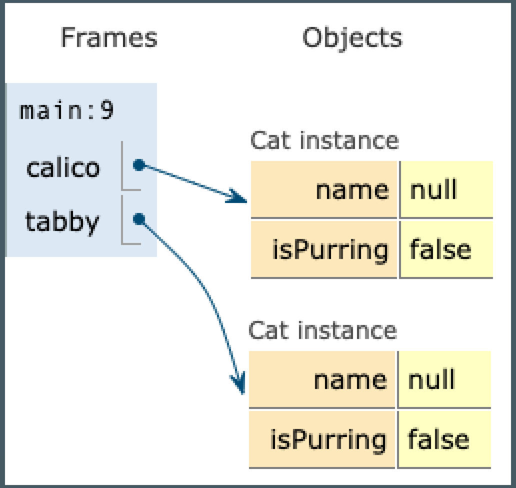
```
public class Cat {

    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);
```

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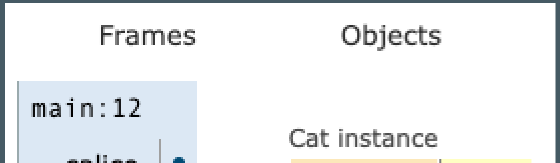
- Two primitive variables can store the same value.
- Two reference variables can reference the same object.

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

</summary>



Updating object state

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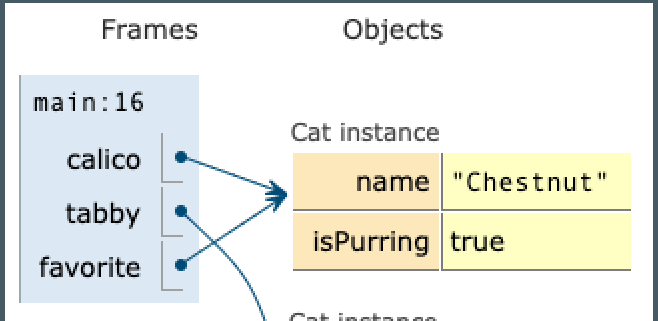
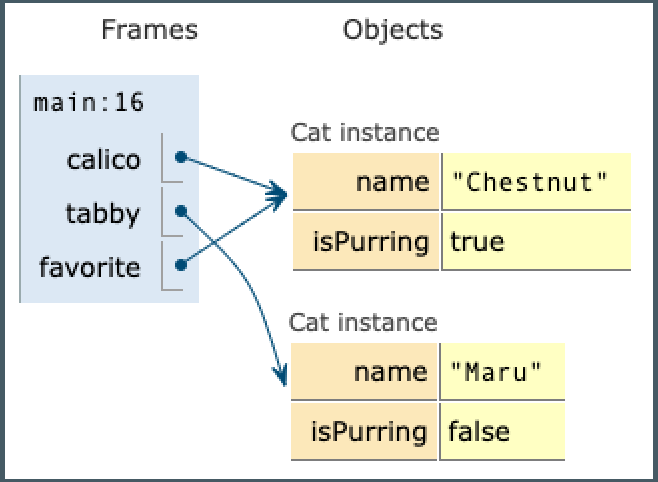
```
Cat calico = new Cat();
Cat tabby = new Cat();
Cat favorite = calico;

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

</summary>



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.