Programming 1

Lecture 6 – OOP
Classes & Objects

Faculty of Information Technology
Hanoi University

Object-Oriented Programming

Why OOP?

- Model real-life objects in a meaningful way.
  - Objects which possess properties and behaviors
  - E.g. A certain dog has <u>yellow fur</u>, <u>blue eyes</u>… it can <u>run</u>, <u>bark</u> and <u>wiggle its tail</u>…
- A clear structure for the program.
  - Easier to maintain, modify and debug
  - “Don't Repeat Yourself” principle

Class vs. Instance

Class	**Puppy**	**Apple**
Instances		
		
		

Java Objects & Classes

- Object is a more general term than instance
  → In Java, object = instance
- You have encountered different objects
  – System.out -- a `PrintStream` object
  – "Hello, world" -- a `String` object
  – Scanner sc -- a `Scanner` object
- Each **object** belongs to a certain **class**
- An object has attributes and methods
  – **Defined in the class** to which it belongs

Why use objects?

- Why not just primitives?

```
// little baby alex
String nameAlex;
double weightAlex;

// little baby david
String nameDavid;
double weightDavid;
```

Why use objects?

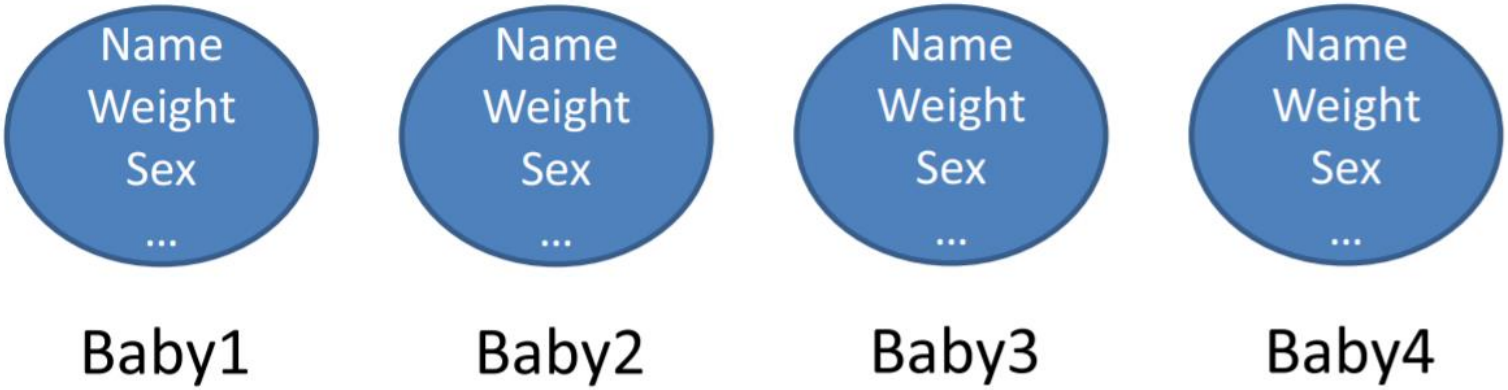
```
// little baby alex
String nameAlex;
double weightAlex;

// little baby david
String nameDavid;
double weightDavid;

// little baby david
String nameDavid2;
double weightDavid2;
```

Many babies?
Hard to manage

Why use objects?

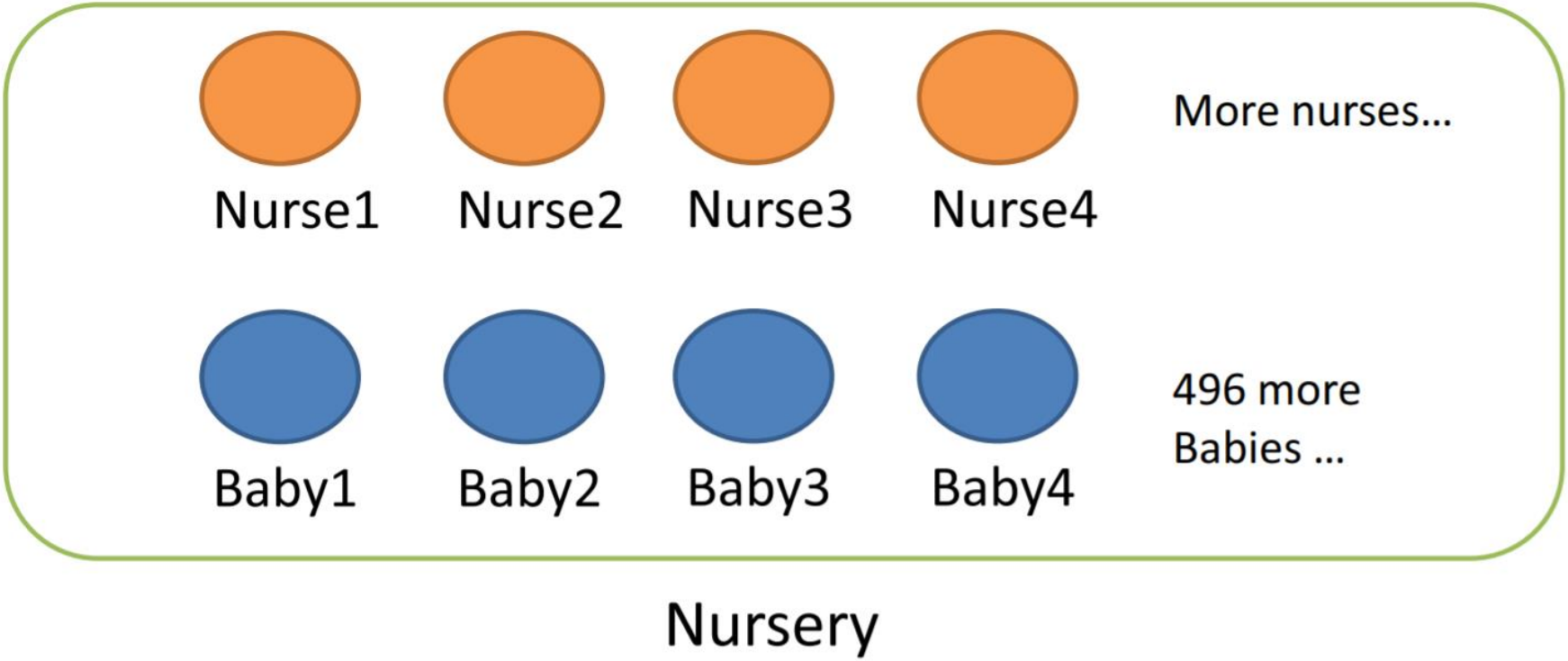
Managing many babies?
We can use arrays for *name*, *weight* & *sex*

...but objects are just better



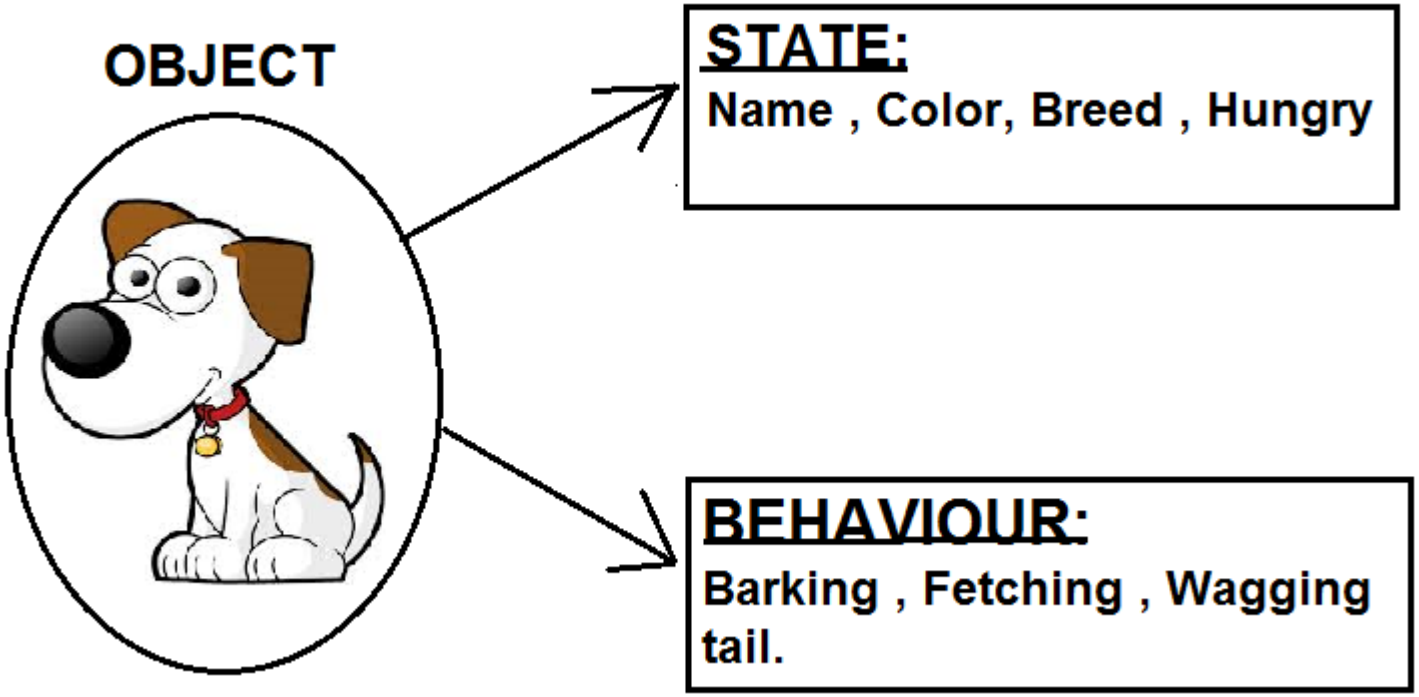
Why use objects?

Even better when we need to model relationships



Why use objects?

- Objects can also have behaviors



Why use objects?

- A program contains many objects which have different functions and interact with each other.

- Similarly, home appliances have different functions and all contribute to the operation of a household.

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Class -- Overview

```
public class Baby {
    String name;
    boolean isMale;
    double weight;
    double decibels;
    int numPoops = 0;

    public void poop() {
        numPoops += 1;
        System.out.println("Dear mother, " +
        "I have pooped. Ready the diaper.");
    }
}
```

Class Definition

Class -- Overview

```
Baby myBaby = new Baby();
```

Creating class Instance

Let’s declare a class

```
public class Baby {
```

fields

methods

```
}
```

Notes

- The *public* class `Baby` must be defined in the file `Baby.java`
- The *`main`* method is not part of the class definition.
  - It belongs to the *static* context.
  - The *`main`* method inside a class can be run.
  - Although being in the same class, the *`main`* method is not related to the non-static methods and attributes in any way.

Baby fields

- **Fields** or **attributes** are used to store data.

```
public class Baby {
    String name;
    double weight = 5.0;
    boolean isMale;
    int numPoops = 0;
}
```

Baby siblings?

```
public class Baby {
    String name;
    double weight = 5.0;
    boolean isMale;
    int numPoops = 0;
    Baby[] siblings;
}
```

- A class **attribute** can be any type
  - Primitives, class instances (including instances of the class itself)
  - Array of primitives, array of objects

How to store/modify data in object?

- Direct access
  - Requires fields to be *public* or *default*.
  - Does not work with *private* or *protected* fields.

```
Baby myBaby = new Baby();
myBaby.name = "Alex";
myBaby.isMale = true;
```

- Use a constructor
  - Need to define a suitable constructor in the class

```
// create a male baby named Alex
Baby myBaby = new Baby("Alex", true);
```

Constructors

```
public class Baby {
    public Baby () {
        // nothing
    }
    public Baby(String name, boolean isMale) {
        // some codes
    }
}

Baby b1 = new Baby();
Baby b2 = new Baby("Alex", true);
```

A constructor is invoked when an instance is created.

Constructors

- A constructor is like a method
- Constructor name is the same as class name
  - No return type – never returns anything
- Usually initialize fields
- All classes need at least one constructor
  - There can be more than one constructor.
  - There is a default constructor even if you don't write one.

```
public ClassName () {
    // default constructor
}
```

Baby constructor

```
public class Baby {
    String name;
    boolean isMale;
    public Baby(String n, boolean m) {
        name = n;
        isMale = m;
    }
}
```

Baby methods

```java
public class Baby {
    String name;
    public Baby(..) {...}

    public void sayHi() {
        System.out.println("Hi, my name is " + name);
    }

    public void eat(double food) {
        if (food >= 3) {
            System.out.println(name + " is full");
        } else {
            System.out.println(name + " is still hungry");
        }
    }
}
```

Baby class

```
public class Baby {
    // fields
    String name;
    double weight;
    boolean isMale;
    int numPoops;
    Baby[] siblings;

    // constructor(s)
    public Baby(…) {…}

    // methods
    public void sayHi() {…}
    public void eat(double food) {…}
}
```

Using Baby class

```
Baby mary = new Baby("Mary", false);
mary.sayHi();
mary.eat(1);

Baby tim = new Baby("Timmy", true);
tim.sayHi();
tim.eat(5);
```

```
Run:  Baby
C:\Users\Quan\.jdks\temurin-1.8.0_302\bin\java.exe ...
Hi, my name is Mary
Mary is still hungry
Hi, my name is Timmy
Timmy is full

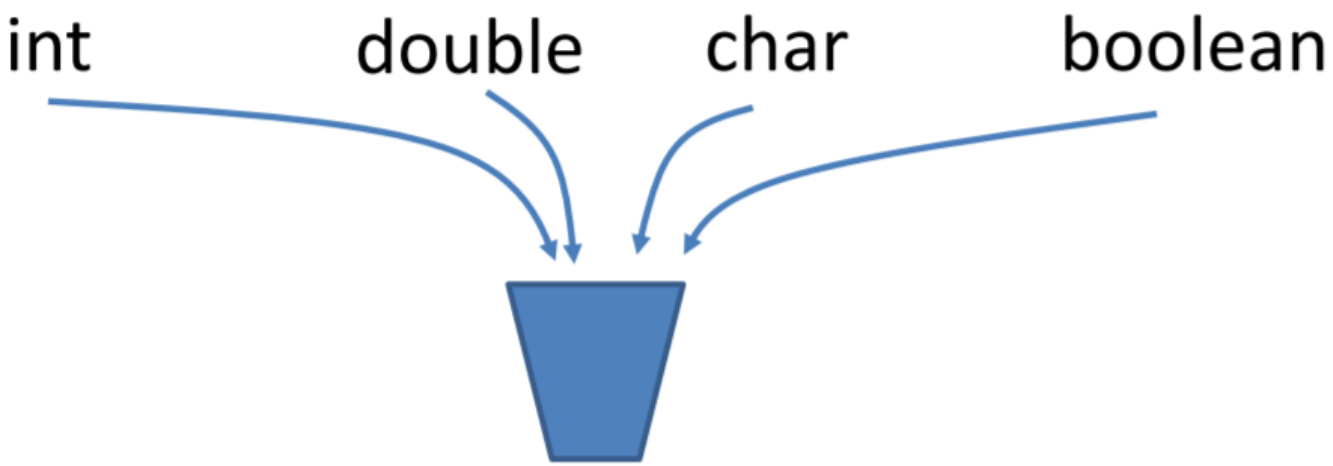
Process finished with exit code 0
```

Primitives vs References

- Primitive types are basic java types
  - `int, long, double, boolean, char, short, byte, float`
  - The actual values are stored in the variable
- Reference types are arrays and objects
  - `String, int[], Baby, …`
  - The variable only stores object's memory address

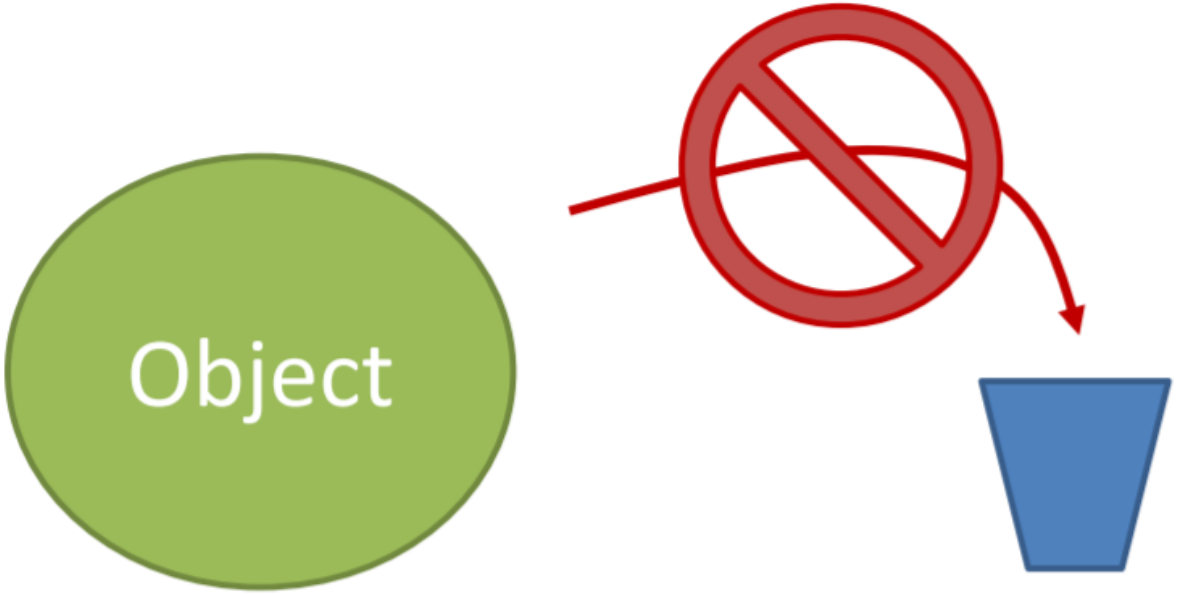
How Java stores primitives

- Variables are like fixed size cups
- Primitives are small enough that they just fit into the cup



How Java stores objects

- Objects are too big to fit in a variable
  - Stored somewhere else
  - Variable stores a number that locates the object



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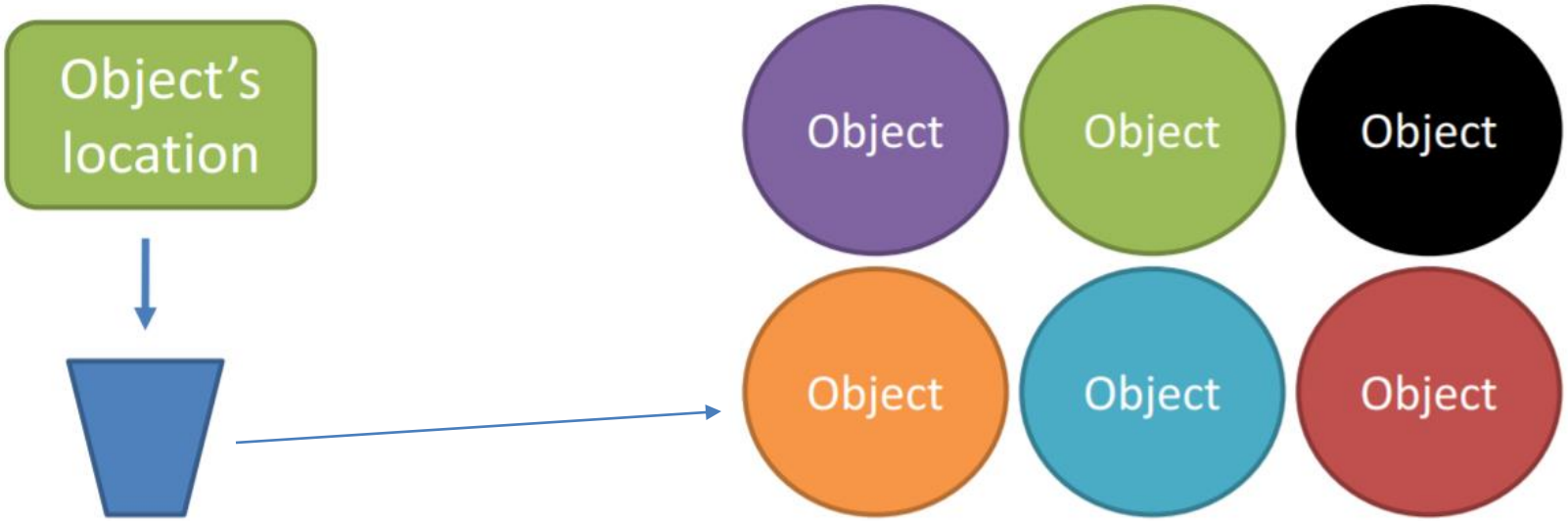

References

- The object's location is called a reference
  - All object variables are references, as opposed to primitive variables
- == only compares the references

```
Baby tim1 = new Baby("Timmy");
Baby tim2 = new Baby("Timmy");
// true or false?
boolean b = (tim1 == tim2);
```

References

```
Baby tim1 = new Baby("Timmy");
Baby tim2 = new Baby("Timmy");
// true or false?
boolean b = (tim1 == tim2);
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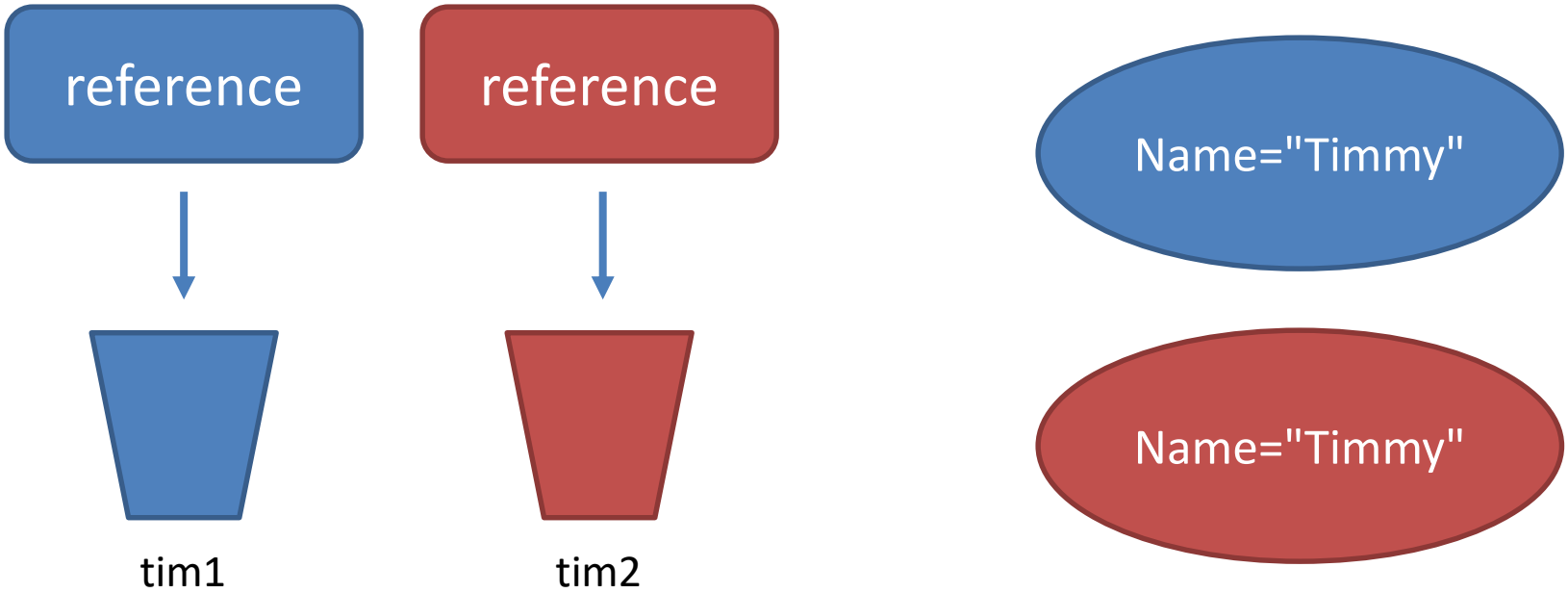
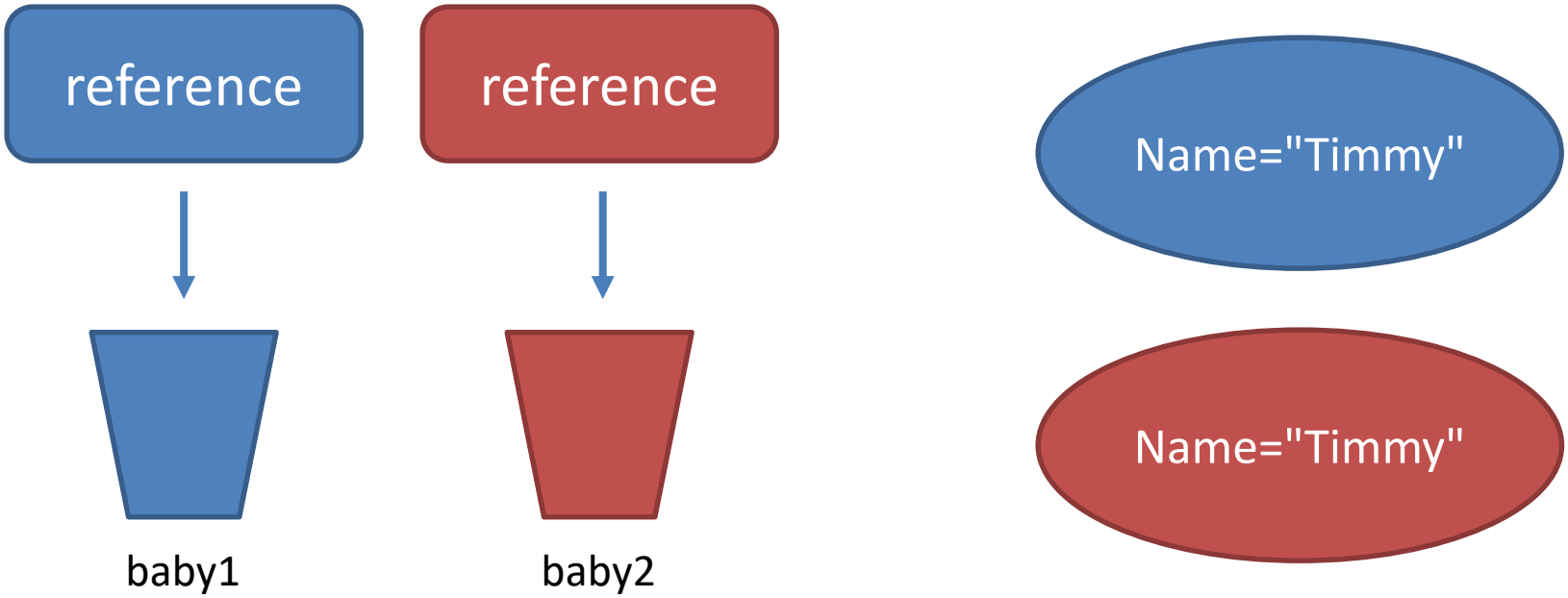


References

- Using = updates the reference.

```
baby1 = baby2;
```



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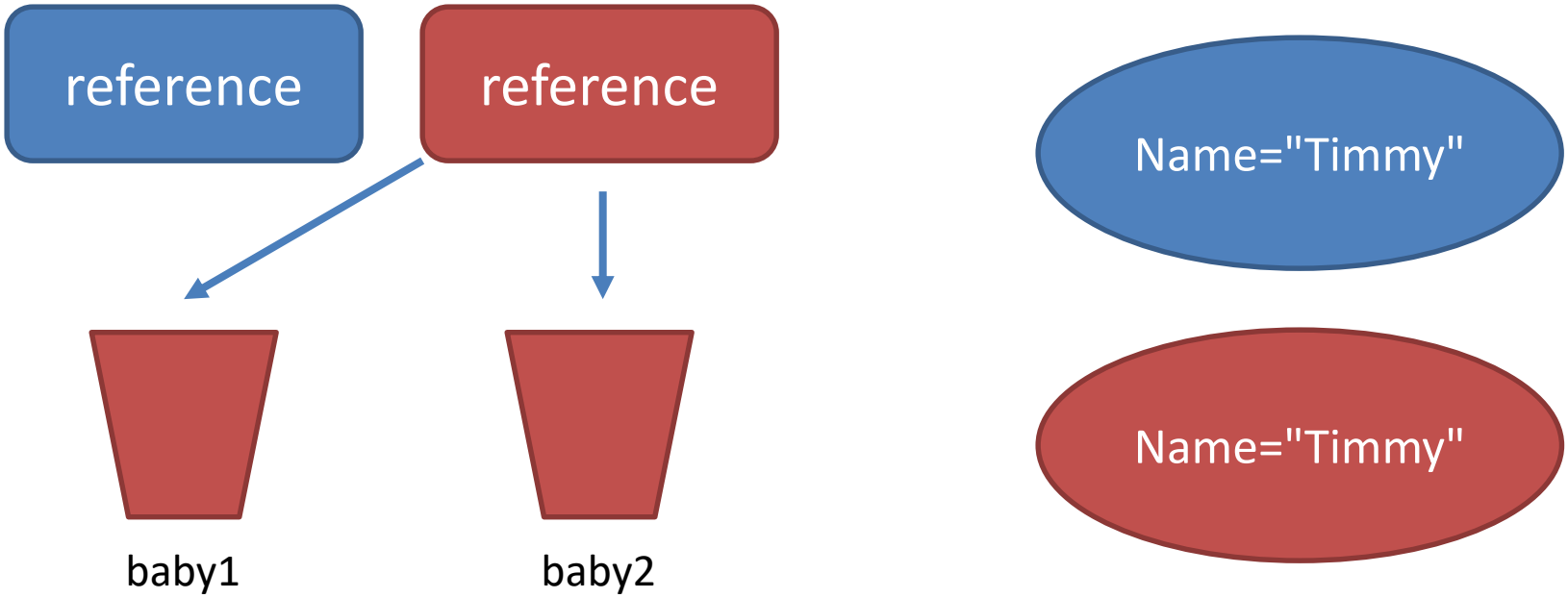

static keyword

- Applies to fields and methods
- `static` means the field/method
  - Belongs to the static context
  - Is defined for the entire class
  - Is not unique to each instance

static example

- Keep track of the number of babies that have been made

```
public class Baby {
    // fields
    static int babiesMade = 0;

    // constructor(s)
    public Baby(String n, boolean m) {
        name = n;
        isMale = m;
        babiesMade++;
    }

    // methods
}
```

BankAccount example

```java
public class BankAccount {
    double balance;
    int transactions;
    public BankAccount(double initial) {
        this.balance = initial;
        this.transactions = 1;
    }

    public void deposit(double amount) {
        balance += amount;
        transactions++;
    }

    public void withdraw(double amount) {
        balance -= amount;
        transactions++;
    }

    public void monthlyFee() {
        this.withdraw(10);
    }
}
```

this keyword

- You create a bank account:

```
BankAccount myAcc = new BankAccount(500);
```

- You withdraw $50:

```
myAcc.withdraw(50);
```

- Here, you specify the <u>method</u> to call and the <u>instance</u> to which the method belongs.

```
public void monthlyFee() {
    withdraw(10);
}
```

- What's the instance? → The current instance

this keyword

```
public void monthlyFee() {
    this.withdraw(10);
}
```

`this` keyword refers to the current instance.