Lecture 2: Classes and objects. Inheritances

Outline

- Object oriented programming
- Defining Classes
- Using Classes
- References vs Values
- Inheritances

Object oriented programming

- Represent the real world

Baby

Object oriented programming

- Represent the real world

Baby

Name

Sex

Weight

Decibels

poops so far

Object Oriented Programming

- Objects group together
  - Primitives (int, double, char, etc..)
  - Objects (String, etc…)

Baby

```
String name
boolean isMale
double weight
double decibels
int numPoops
```

Why use classes?

- Why not just primitives?

```
// little baby alex
String nameAlex;
double weightAlex;
// little baby david
String nameDavid;
double weightDavid;
```

Why use classes?

- Why not just primitives?

```
// little baby alex
String nameAlex;
double weightAlex;
// little baby david
String nameDavid;
double weightDavid;
// little baby david
String nameDavid2;
double weightDavid2;
```

David2?
Terrible ☹

Why use classes?

- Why not just primitives?

```
// little baby alex
String nameAlex;
double weightAlex;
// little baby david
String nameDavid;
double weightDavid;
// little baby david
String nameDavid2;
double weightDavid2;
```

David2?
Terrible ☹

500 Babies? That Sucks!

Why use classes?

Baby1

Why use classes?

Baby1

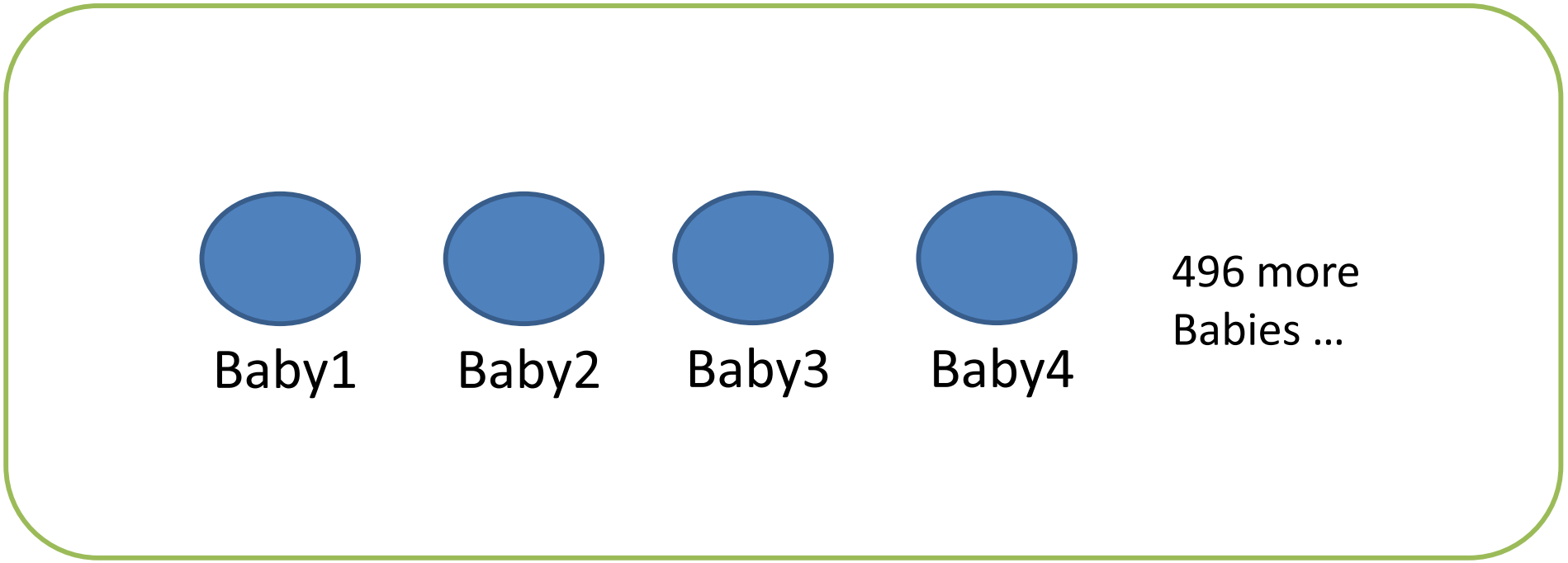
Baby2

Baby3

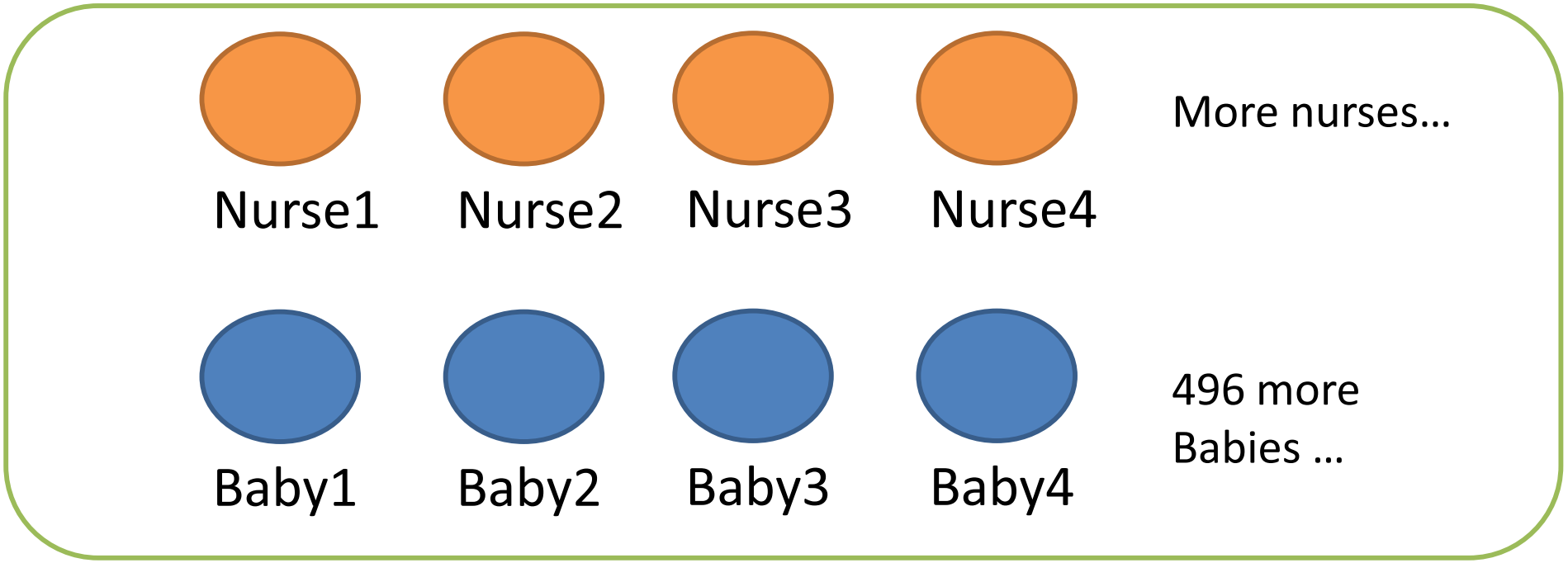
Baby4

496 more Babies …

Why use classes?

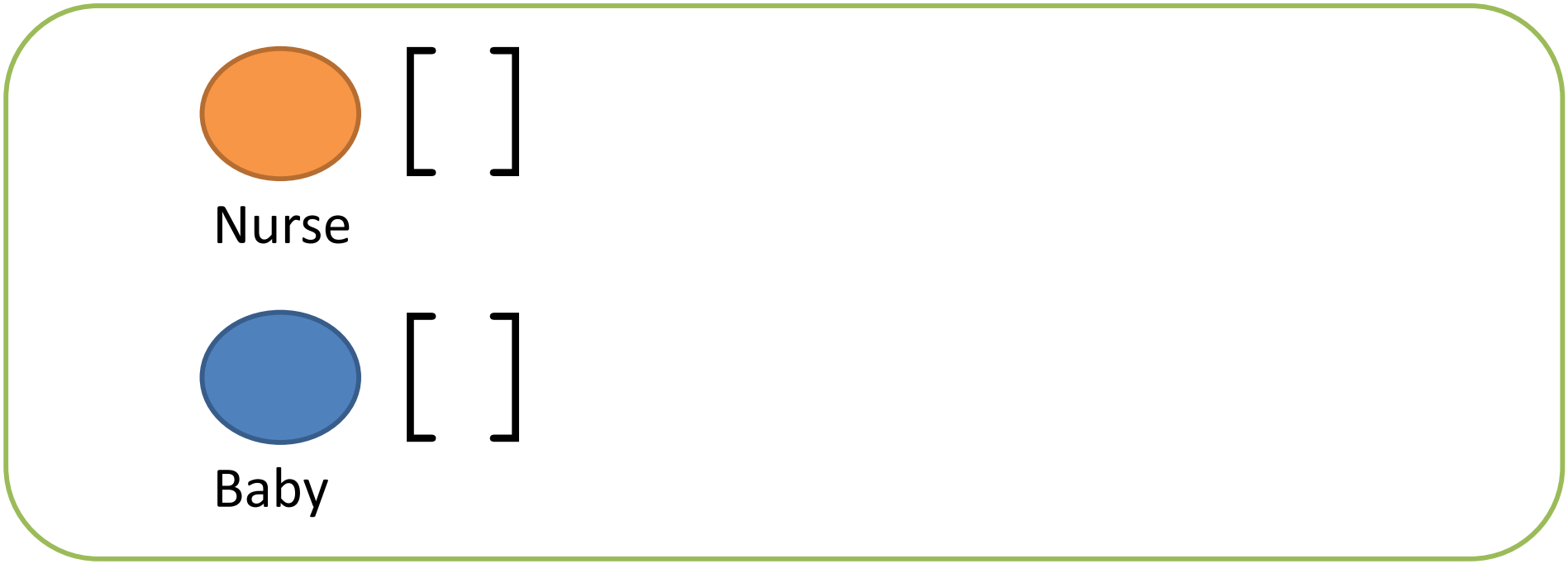


Why use classes?

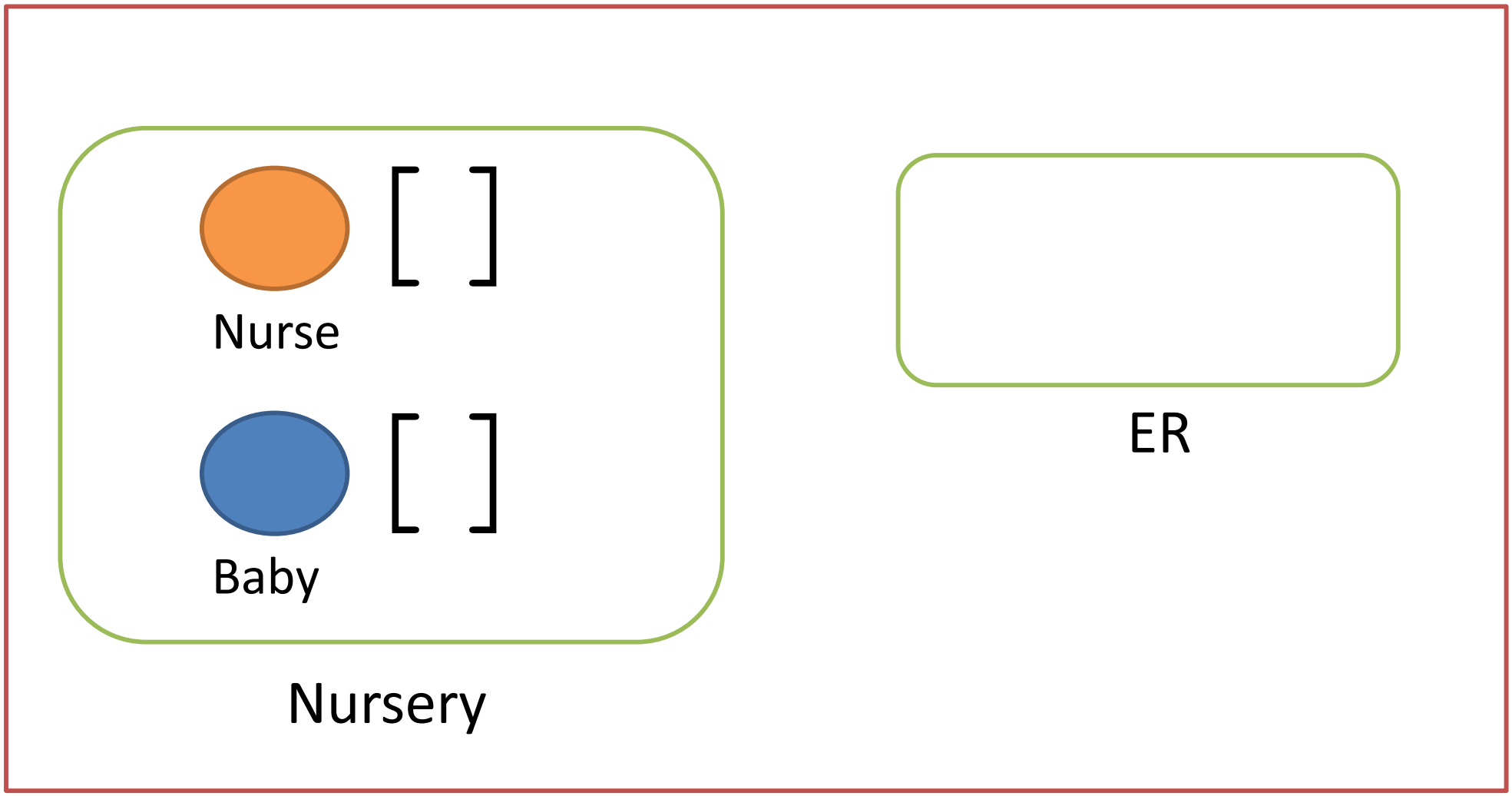


Nursery

Why use classes?



Why use classes?



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Class - overview

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

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

Class Definition

Class - overview

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

Class

Instance

Let’s declare a baby!

```
public class Baby {

}
```

Let’s declare a baby!

```
public class Baby {

}
```

fields

methods

Note

- Class names are Capitalized
- 1 Class = 1 file
- Having a `main` method means the class can be run

Baby fields

```
public class Baby {

    TYPE var_name;
    TYPE var_name = some_value;



}
```

Baby fields

```
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;
   XXXXX  YYYYY;


}
```

Baby Siblings?

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

}
```

Ok, let's make this baby!

```
Baby ourBaby = new Baby();
```

But what about it's name? it's sex?

Constructors

```
public class CLASSNAME{
    CLASSNAME ( ) {
    }

    CLASSNAME ([ARGUMENTS]) {
    }
}
```

```
CLASSNAME obj1 = new CLASSNAME();
CLASSNAME obj2 = new CLASSNAME([ARGUMENTS])
```

Constructors

- Constructor name == the class name
- No return type – never returns anything
- Usually initialize fields
- All classes need at least one constructor
  - If you don't write one, defaults to

```
CLASSNAME () {
}
```

Baby constructor

```
public class Baby {
    String name;
    boolean isMale;
    Baby(String myname, boolean maleBaby){
          name = myname;
          isMale = maleBaby;
    }
}
```

Baby methods

```
public class Baby {
    String name = "Slim Shady";
    ...
    void sayHi() {
        System.out.println(
        "Hi, my name is.. " + name);
    }
}
```

Baby methods

```
public class Baby {
    String weight = 5.0;

    void eat(double foodWeight) {
        if (foodWeight >= 0 &&
            foodWeight < weight) {
             weight = weight + foodWeight;
        }
    }

}
```

Baby class

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

    void sayHi() {…}
    void eat(double foodWeight) {…}
}
```

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Classes and Instances

```
// class Definition
public class Baby {…}


// class Instances
Baby shiloh = new Baby("Shiloh Jolie-Pitt", true);
Baby knox   = new Baby("Knox Jolie-Pitt",   true);
```

Accessing fields

- Object.FIELDNAME

```
Baby shiloh = new Baby("Shiloh Jolie-Pitt",
                       true)
System.out.println(shiloh.name);
System.out.println(shiloh.numPoops);
```

Calling Methods

- Object.METHODNAME([ARGUMENTS])

```
Baby shiloh = new Baby("Shiloh Jolie-Pitt",
                       true)
shiloh.sayHi();     // "Hi, my name is ..."
shiloh.eat(1);
```

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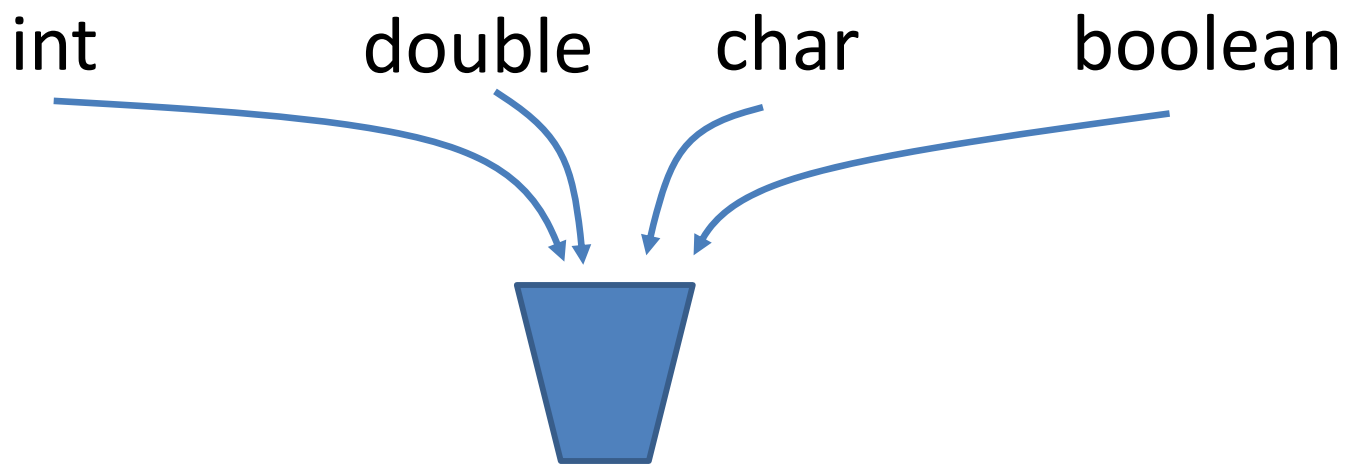
Primitives vs References

- 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, …

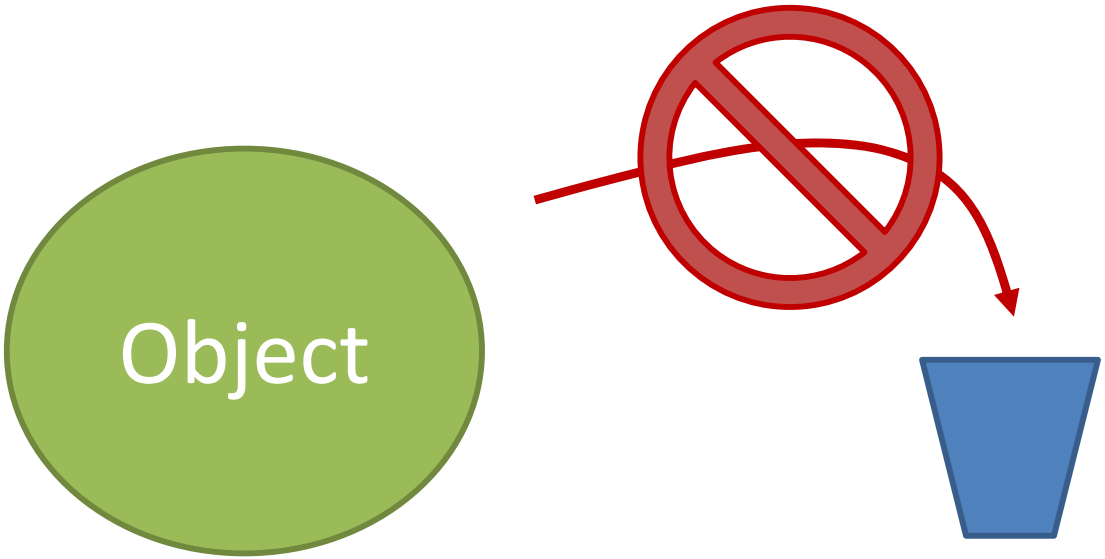
How java stores primitives

- 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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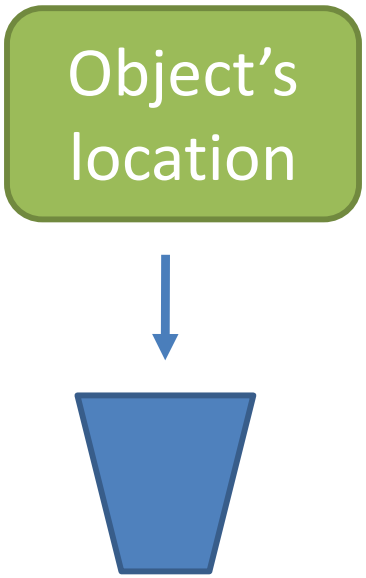
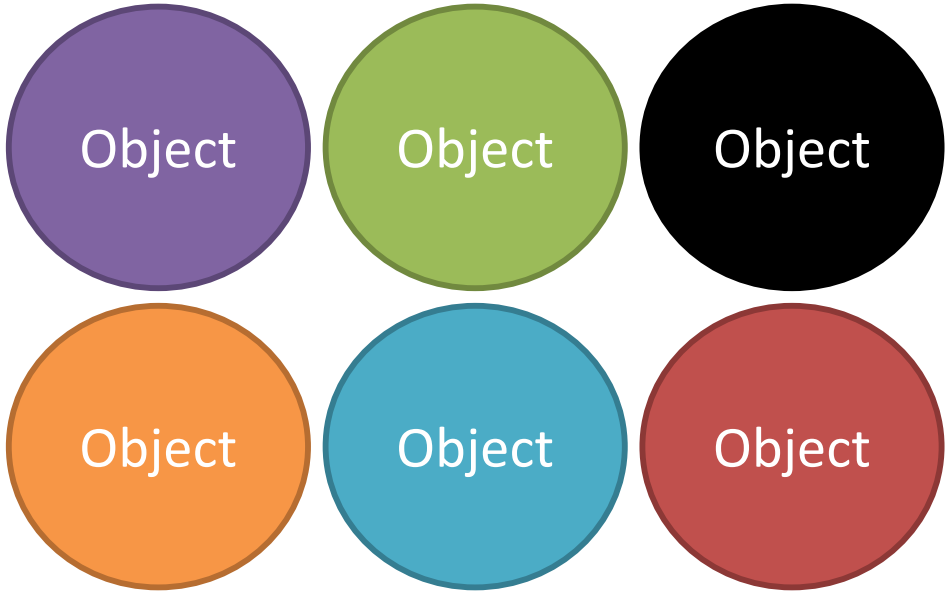




References

- The object's location is called a reference
- == compares the references

```
Baby shiloh1 = new Baby("shiloh");
Baby shiloh2 = new Baby("shiloh");
```

Does `shiloh1 == shiloh2`?

References

- The object's location is called a reference
- == compares the references

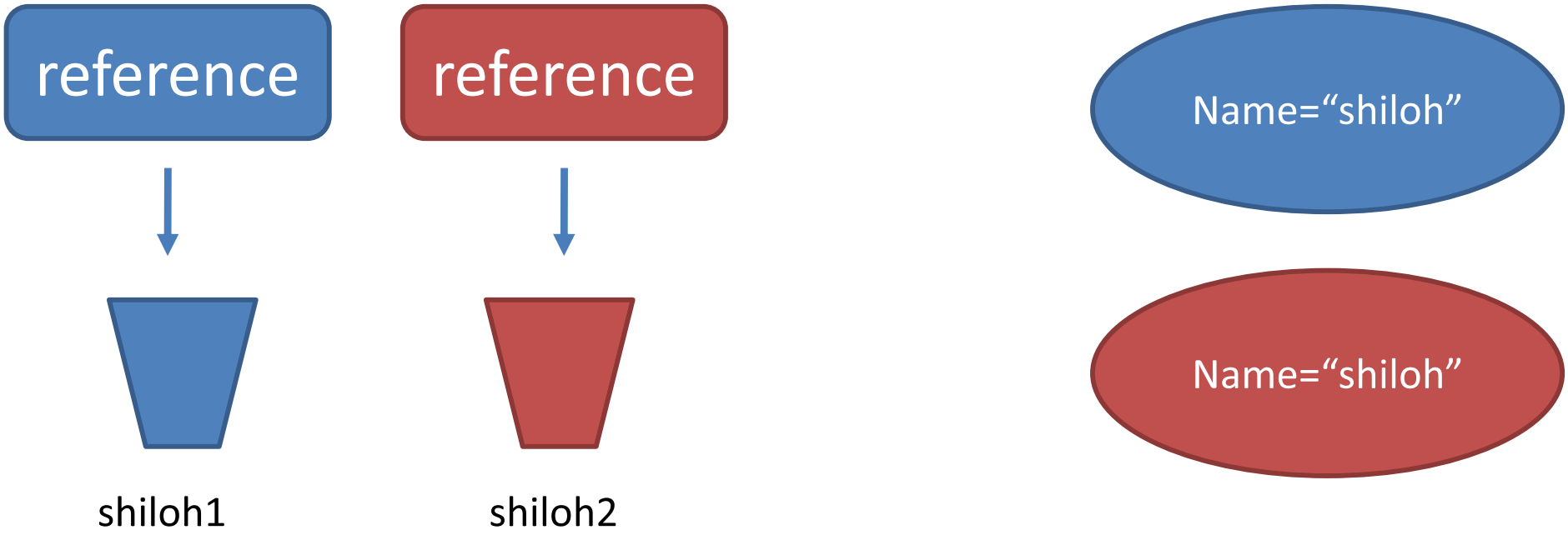
```
Baby shiloh1 = new Baby("shiloh");
Baby shiloh2 = new Baby("shiloh");
```

Does `shiloh1 == shiloh2`?

no

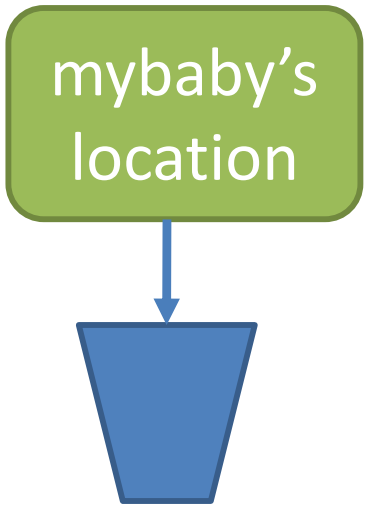
References

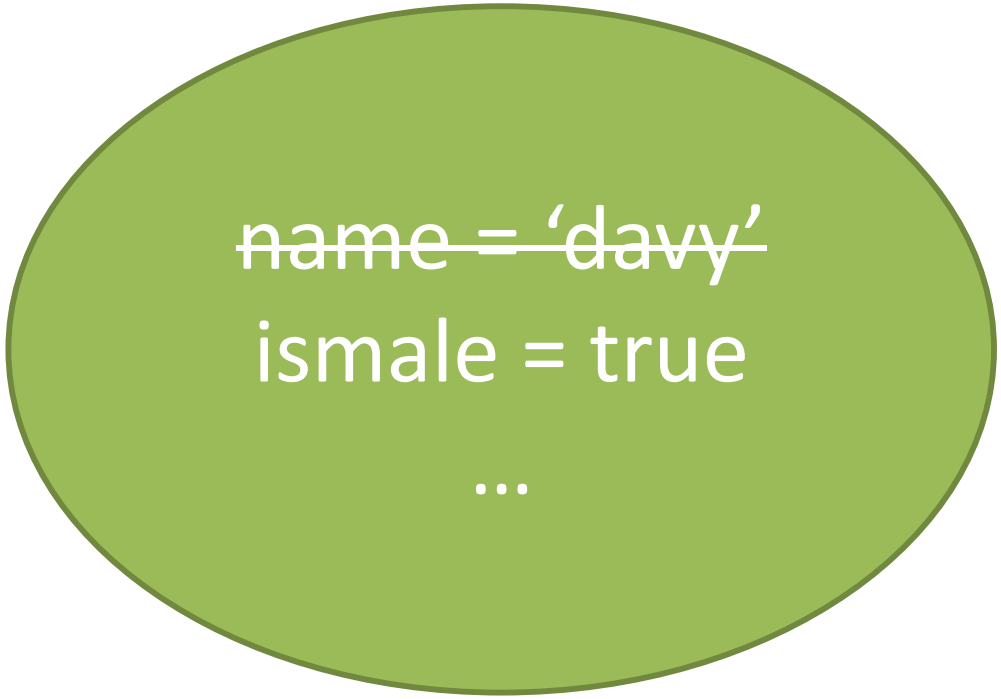
```
Baby shiloh1 = new Baby("shiloh");
Baby shiloh2 = new Baby("shiloh");
```



References

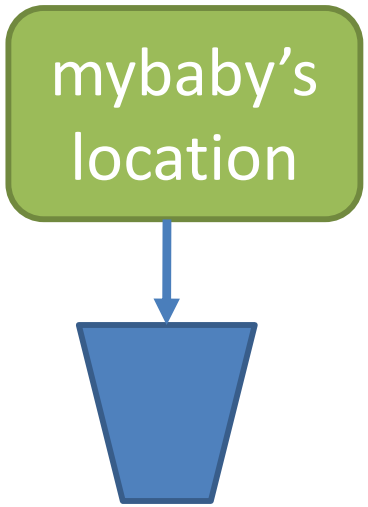
```
Baby mybaby = new Baby("davy", true)
mybaby.name = "david"
```

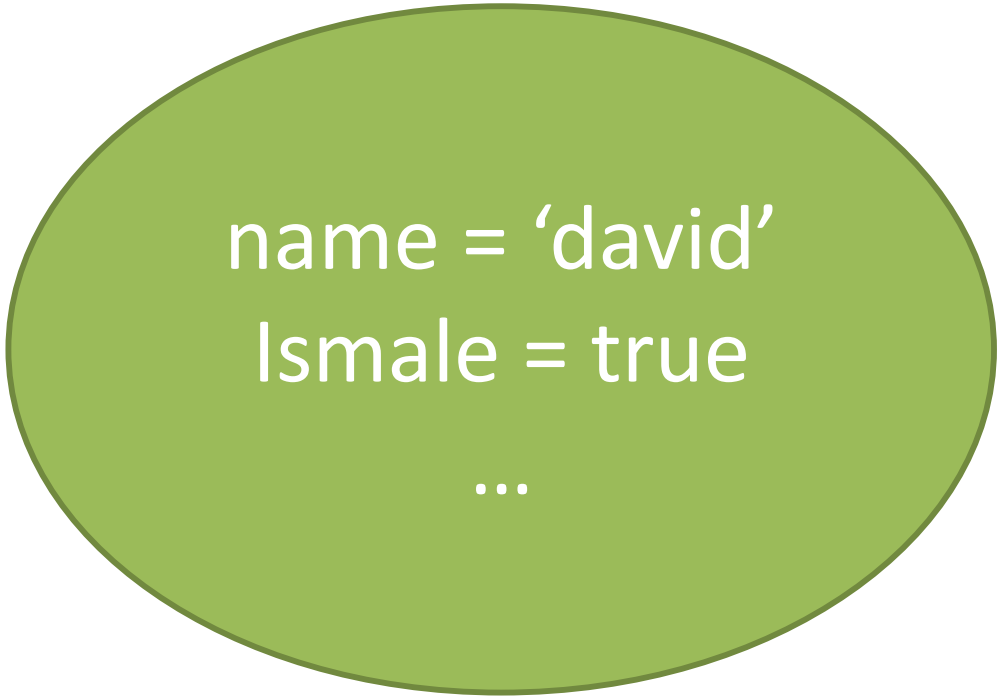




References

```
Baby mybaby = new Baby('davy', true)
mybaby.name = 'david'
```

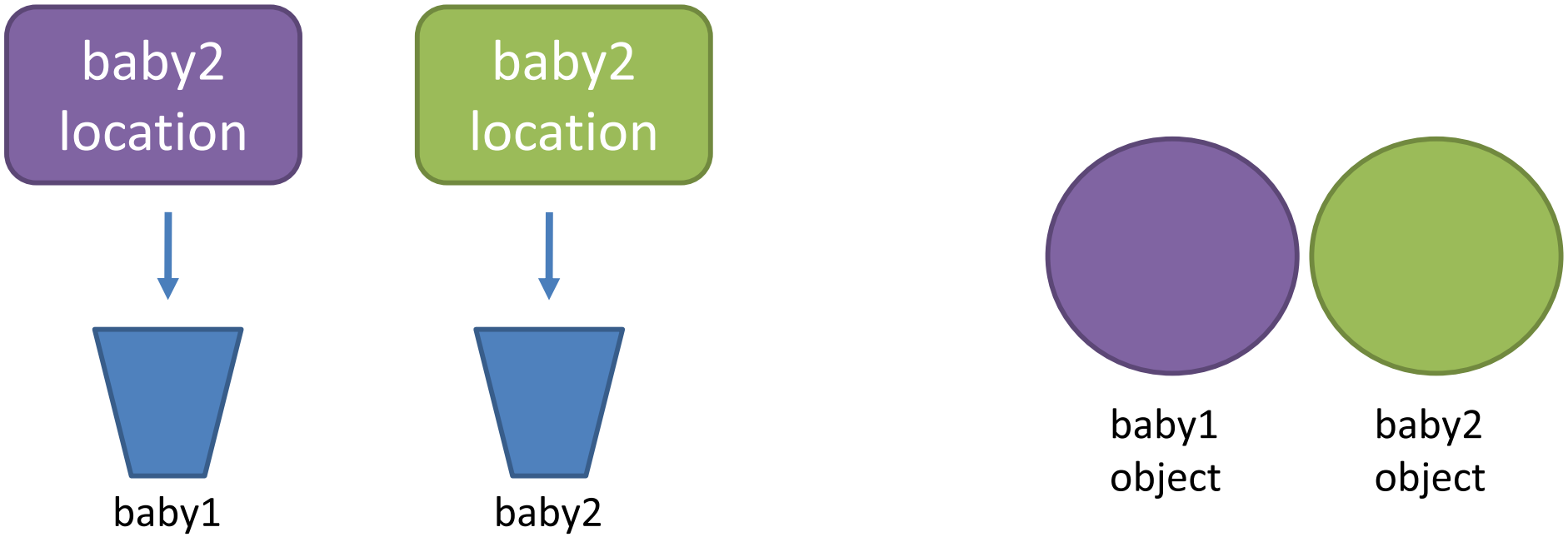




References

- Using = updates the reference.

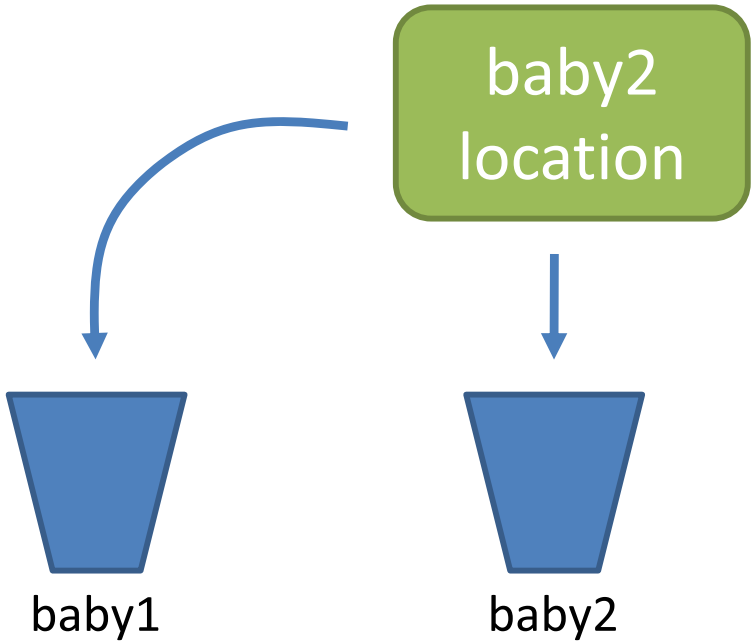
```
baby1 = baby2
```

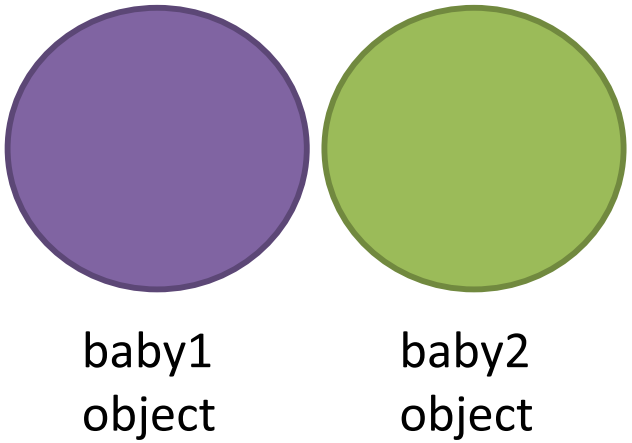


References

- Using = updates the reference.

```
baby1 = baby2
```





References

- using [ ] or •
  - Follows the reference to the object
  - May modify the object, but never the reference
- Imagine
  - Following directions to a house
  - Moving the furniture around
- Analogous to
  - Following the reference to an object
  - Changing fields in the object

Methods and references

```
void doSomething(int x, int[] ys, Baby b) {
    x = 99;
    ys[0] = 99;
    b.name = "99";
}
...

int i = 0;
int[] j = {0};
Baby k = new Baby("50", true);
doSomething(i, j, k);
```

i=? j=? k=?

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Very *Very* Basic Inheritance

- Making a Game

```
public class Dude {
    public String name;
    public int hp = 100
    public int mp = 0;

    public void sayName() {
          System.out.println(name);
    }
    public void punchFace(Dude target) {
          target.hp -= 10;
    }
}
```

Inheritance..

- Now create a Wizard…

```
public class Wizard {
    // ugh, gotta copy and paste
    // Dude's stuff
}
```

Inheritance?

- Now create a Wizard…

But Wait!

A Wizard does and has everything a Dude does and has!

Inheritance?

- Now create a Wizard…

Don’t Act Now!

You don’t have to Copy & Paste!

Buy Inheritance!

- Wizard is a **subclass** of Dude

```
public class Wizard extends Dude {
}
```

Buy Inheritance!

- Wizard can use everything* the Dude has!

```
wizard1.hp += 1;
```

- Wizard can do everything* Dude can do!

```
wizard1.punchFace(dude1);
```

- You can use a Wizard like a Dude too!

```
dude1.punchface(wizard1);
```

*except for private fields and methods

Buy Inheritance!

- Now augment a Wizard

```
public class Wizard extends Dude {
    ArrayList<Spell> spells;
    public class cast(String spell) {
        // cool stuff here
        ...
        mp -= 10;
    }
}
```

Inheriting from inherited classes

- What about a Grand Wizard?

```
public class GrandWizard extends Wizard {
    public void sayName() {
      System.out.println("Grand wizard" + name)
    }
}

grandWizard1.name = "Flash"
grandWizard1.sayName();
((Dude)grandWizard1).sayName();
```

How does Java do that?

- What Java does when it sees

```
grandWizard1.punchFace(dude1)
```

1. Look for `punchFace()` in the GrandWizard class
2. It's not there! Does GrandWizard have a parent?
3. Look for `punchFace()` in Wizard class
4. It's not there! Does Wizard have a parent?
5. Look for `punchFace()` in Dude class
6. Found it! Call `punchFace()`
7. Deduct hp from dude1

How does Java do that? pt2

- What Java does when it sees

```
((Dude)grandWizard1).sayName()
```

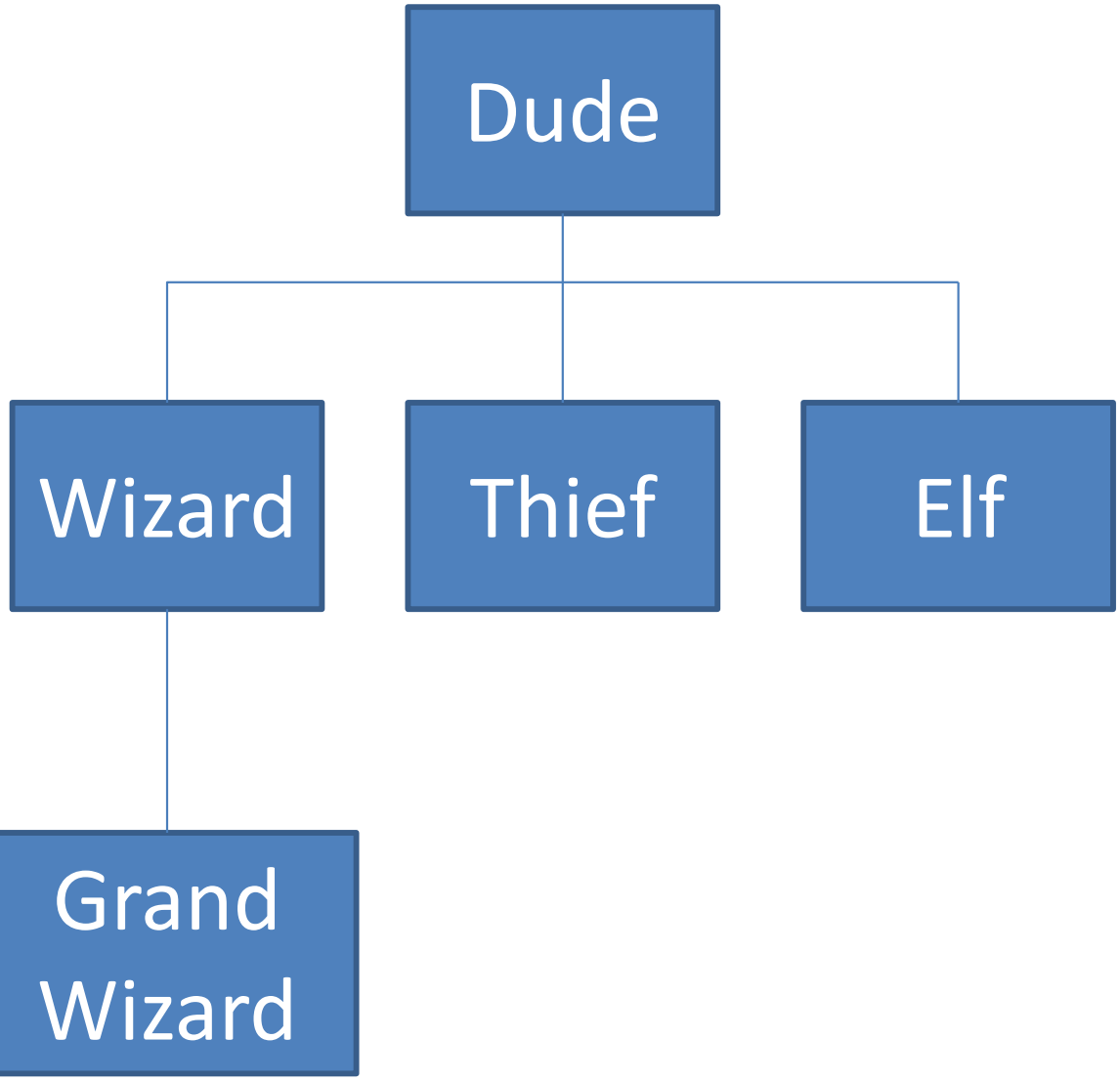
1. Cast to `Dude` tells Java to start looking in `Dude`
2. Look for `sayName()` in Dude class
3. Found it! Call `sayName()`

What's going on?

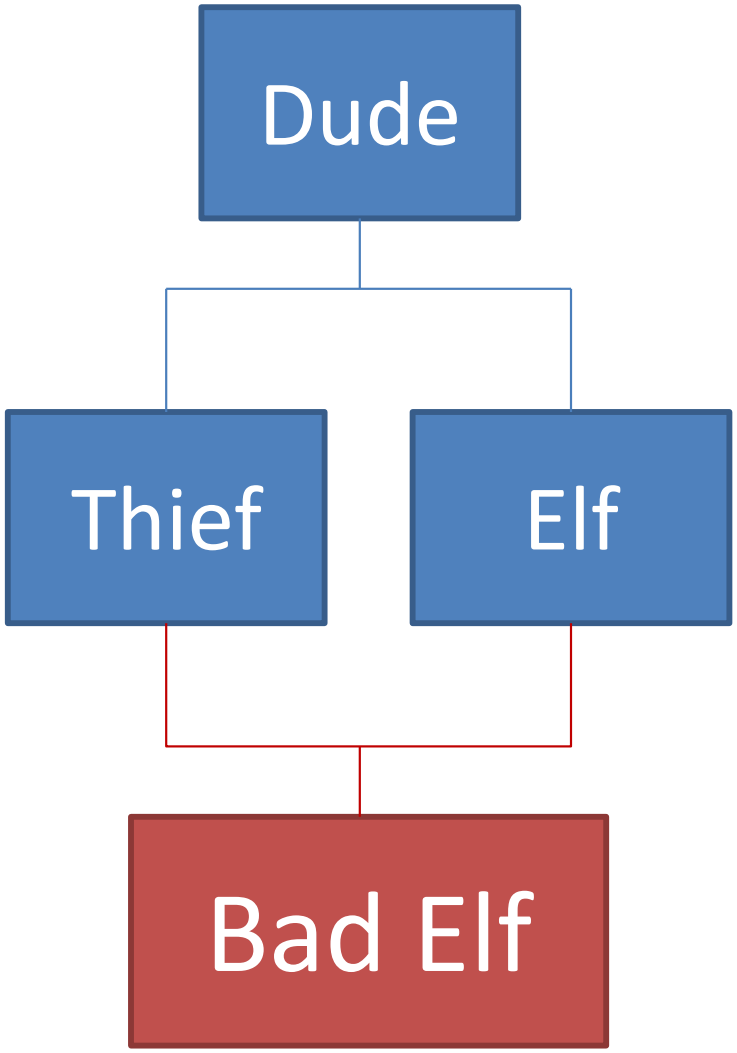
Parent of Wizard, Elf..

Subclass of Dude

Subclass of Wizard



You can only inherit from one class



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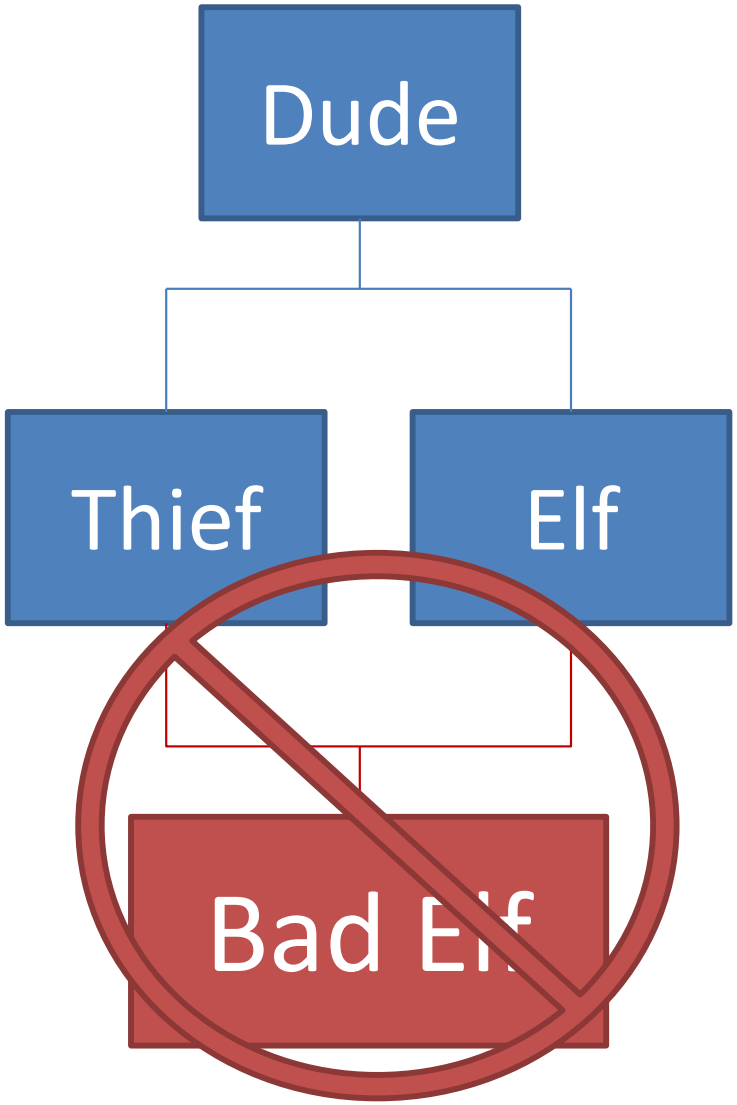


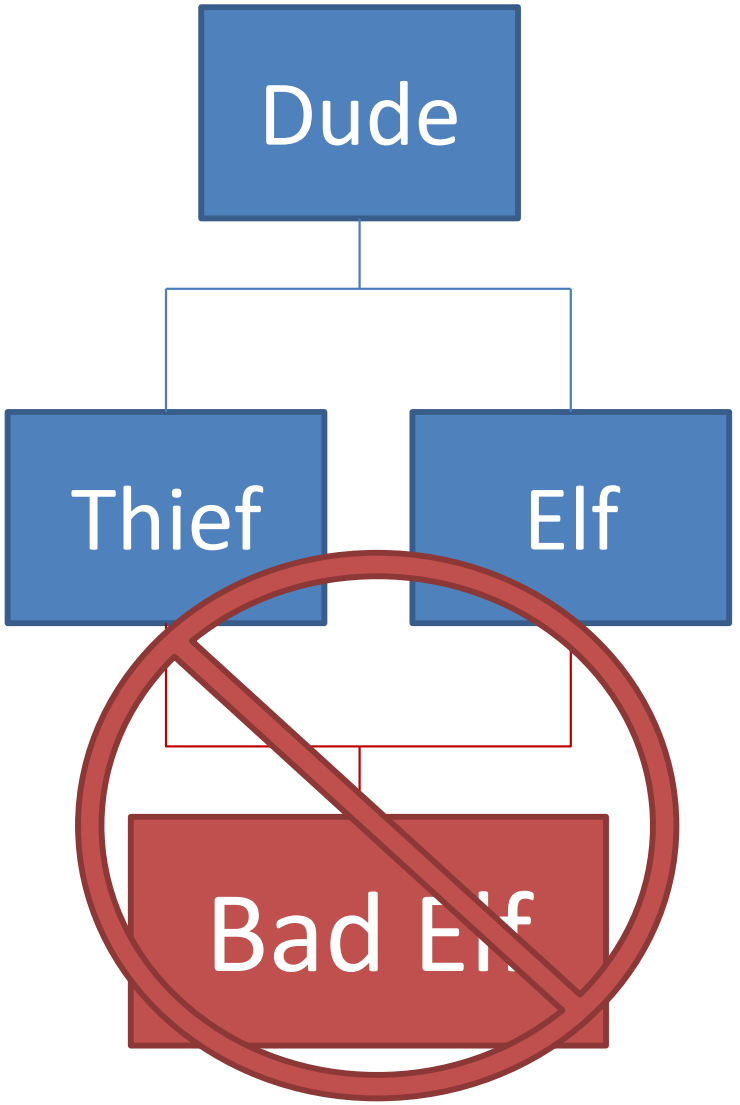
You can only inherit from one class

What if Thief and Elf both implement

```
public void sneakUp()
```

If they implemented differently, which `sneakUp()` does BadElf call?

Java Doesn't Know!!



Inheritance Summary

- class A extends B {} == A is a subclass of B
- A has all the fields and methods that B has
- A can add it's own fields and methods
- A can only have 1 parent
- A can replace a parent's method by re-implementing it
- If A doesn't implement something Java searches ancestors