

# **1.00**

## **Tutorial 5**

(Recursion and Inheritance)

### Topics

- Any Quiz 1 clarification/question
- Inheritance
- Recursion
- ProblemSet 4 discussion

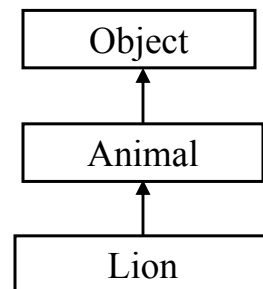
## Inheritance Basic Questions

- Why Inheritance ?
- From which java class do all other classes inherit implicitly?
- What is the keyword that Java uses to inherit from another classes?

## Inheritance Example

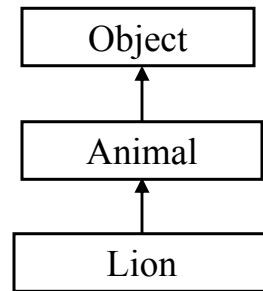
```
public class Animal {
    private double heartRate;
    public Animal(double d){
        heartRate = d;}
    public void breath(){
        //
    }
}

public class Lion extends Animal{
    private String type;
    public Lion(double rate){
        //constructor
    }
}
```



## Inheritance Question

- What are the types of
  - class `Animal`
  - class `Lion`
- What fields can each of the above classes access ?



## Inheritance Question (contd)

- Which of the following declarations is NOT allowed and why?
  - `Animal a1 = new Animal(79.6);`
  - `Animal a2 = new Lion(100.0);`
  - `Lion a3 = new Lion(100.0);`
  - `Lion a4 = new Animal(100.0);`
- Complete the constructor for the `Lion` class
  - you can assign type as “carnivorous”
  - What about rate variable ?

## Now, does this make sense ?

- Java models the hierarchical nature of categories with *inheritance*.
  - it helps you reuse components and manage complexity
- The keyword `extends` is used to express the hierarchical relationship.
- The subclass (e.g. `Lion`) inherits all methods and data members from its *superclasses* (e.g. `Animal`).
  - If the `Animal` class defines a `breathe()` method, the `Lion` class has one too.
  - The `Lion` class can override the method of `Animal` provided the method is not declared as `final`.

## Method Overloading & Inheritance

```
public class Lion extends Animal {
    private String type;
    //constructor

    public void breath() {
        System.out.println("breath() method of Lion");
    }
}
```

```
public class Cow extends Animal {
    private String type;
    //constructor

    public void breath() {
        super.breath();
        System.out.println("breath() method of Cow");
    }
}
```

## Method Overloading contd.

```
public class Animal {
    private double heartRate;
    //constructor

    public void breath() {
        System.out.print("breath() method of Animal" +"\t");
    }

    public static void main(String [] args){
        Animal [] a = {new Lion(150.0), new Cow(120.0)};
        a[0].breath();
        a[1].breath();
    }
}
```

What is the output from the main( ) method ?

## Recursion

- A divide and conquer approach
- Needs a **Base Case** and a way to solve a bigger problem using solutions to smaller problems

```
// The sum of the first n natural numbers

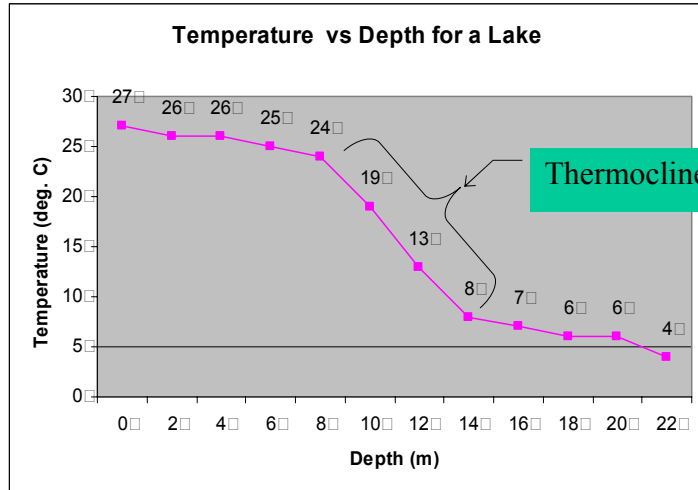
public static int sum (int n){
    if (n == 0) // Base Case
        return 0;
    else // General Case
        return (n + sum(n-1));
}
```

Write a recursive method for fact(n)  
where  
 $\text{fact}(n) = n * (n-1) * (n-2) \dots 2 * 1$

## Solution

```
public static int fact (int n){  
    if (n == 0) // Base Case  
        return 1;  
    else  
        return (n * fact(n-1));  
}
```

## Problem Set 4



## Problem Set 4 Concepts

- Where is the thermocline (depth values) ? (Temp. values shown at data points)
  - Largest change (6 deg. C) between 10m & 12m
  - Two other changes are almost as large (each 5 deg. C) between 8m & 10m and between 12m & 14m
  - All other temp. changes are much smaller (1 to 2 deg. C)
- How could you calculate the thermocline? (Note that adjacent depth values differ by 2.)

# Problem Set 4 Sample Output

```
Problems Javadoc Declaration Console x
<terminated> LakeTest [Java Application] C:\jdk1.4.2_06\bin\je

Lake: Nepessing
Area: 2.3
Depth: 35.0
Thermocline top: 10.0
Thermocline bottom: 12.0
Thermocline temperature diff: 7.0
Avg oxygen top: 14.333333333333334
Avg oxygen bottom: 6.666666666666667
Is oxygen below OK?: true
```

```
Lake Hadley temperatures
Min temperature: 12.0
Max temperature: 24.0

Lake Ortonville temperatures
Min temperature: 17.0
Max temperature: 26.0

Fish Lake temperatures
Min temperature: 14.0
Max temperature: 24.0

Number of lakes: 4
```