Lab 04
Static Methods & Recursion

Objective(s):

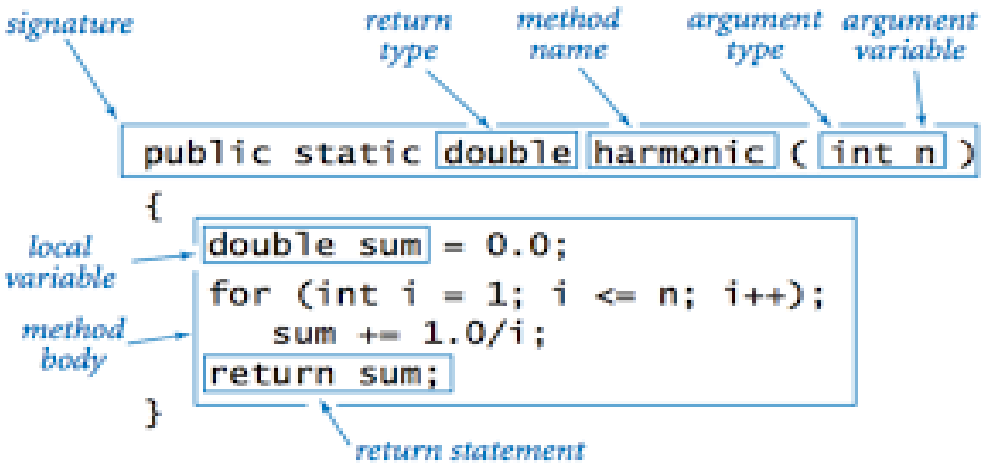
1. Static Methods
2. Types of Static Methods
3. Method Overloading
4. Recursion
5. Lab tasks
6. Post Lab questions

1: Static Methods

A method (function) is a group of statements that is executed when it is called from some point of the program.

Static methods are the methods in Java that can be called without creating an object of class. They are referenced by the class name itself or reference to the Object of that class. Static method belongs to the class rather than the object of a class

The following is its format:



Where:

- ***return_type*** is the data type specifier of the data returned by the function.
- ***method_name*** is the identifier by which it will be possible to call the function.

- ***parameters*** (as many as needed): Each parameter consists of a data type specifier followed by an identifier, like any regular variable declaration (for example: int x) and which acts within the function as a regular local variable. They allow to pass arguments to the function when it is called. The different parameters are separated by commas.
- ***statements*** is the function's body. It is a block of statements surrounded by {}

```
//Java Program to demonstrate the use of a static method.
class Student{
int rollno;
String name;
static String college = "ITS";
//static method to change the value of static variable
static void change(){
college = "BBDIT";
}
//constructor to initialize the variable
Student(int r, String n){
rollno = r;
name = n;
}
//method to display values
void display(){System.out.println(rollno+" "+name+" "+college);}
}
//Test class to create and display the values of object
public class TestStaticMethod{
public static void main(String args[]){
Student.change();//calling change method
//creating objects
Student s1 = new Student(111,"Karan");
Student s2 = new Student(222,"Aryan");
Student s3 = new Student(333,"Sonoo");
//calling display method
s1.display();
s2.display();
s3.display();
}
}
```

Restrictions

a. The static method cannot use non static data member or call non-static method directly.
b. this and super cannot be used in static context.

Why is the Java main method static?

It is because the object is not required to call a static method. If it were a non-static method, JVM creates an object first then call main() method that will lead the problem of extra memory allocation

2: Type of static Methods

Methods without Return Type and No Parameter

```
public static void method_name ( )
```

What we will do in this case for similar functionality code, create a function named drawLine() and call that function at repeated code locations.

```
public class Lab04 {
    public static void main(String [] args){
    drawLine();
    System.out.println("Object Oriented Programming");
    drawLine();
    System.out.println("Lab 02");
    drawLine();
    System.out.println("Department of Computer Sciences");
    drawLine();
    }
   public static void drawLine(){
      for(int i=1;i<30;i++)
        System.out.print("*");
        System.out.println();
    }
}
```

Methods without Return Type and with Parameters

```
public static void method_name ( par1, par2, par3 )
```

drawLine method with parameter to draw line according to the size provided in an argument.

```
public class Lab04 {
public static void main(String [] args){
        drawLine(30);
        System.out.println("Object Oriented Programming");
        drawLine(10);
        System.out.println("Lab 04");
        drawLine(10);
        System.out.println("Department of Computer Sciences");
        drawLine(30);
    }
public static void drawLine(int n){
   for(int i=1;i<n;i++) l
        System.out.print("*");
        System.out.println();
    }
}
```

Methods With Return Type but no Parameter

```
public static return_type method_name ( )
```

```
public class GetNameExample {
  public static void main(String [] args) {
    System.out.println("The  University Name is "+getUniversityName());
  }//main ends
  public static String getUniversityName(){
    return "Sukkur IBA University";
  }
}//class ends
```

Methods With Return Type and Parameters

```
public static return_type method_name (par1, par2, par3)
```

```
public class ArraySum {
   public static void main(String [] args) {
      int [] a = {2,3,5,8,4,9,7,6,7,8};
      int sum = findSum(a);//invoking method with array argument
      System.out.println("The result is "+sum);
   }//main ends
   public static int findSum(int[] b){
      int total=0;
      for(int i=0; i<b.length;i++){
          total+=b[i]; return total;
      }
   }
}//class ends
```

There are two types of parameter passing:

1. **Pass by Value**

```
public static void sum(int a, int b)
```

   - Call By value (copy of value) is when primitive data types are passed in the method call.

2. **Pass by Reference (value of memory address location)**

```
public static void displayCars(Car car)
public static void sort(int [] arrayB)
```

   - Objects and object variables are passed by reference or address.

3: Method Overloading

Method Overloading is a feature that allows a class to have more than one method having the same name, if their argument lists are different. It is similar to constructor overloading in Java, that allows a class to have more than one constructor having different parameters.

OR

Overloading allows different methods to have the same name, but different signatures where the signature can differ by the number of input parameters or type of input parameters or both.

Example:

```
// overloading in Java.
public class Sum {

    // Overloaded sum(). This sum takes two int parameters
    public int sum(int x, int y)
    {
        return (x + y);
    }

    // Overloaded sum(). This sum takes three int parameters
    public int sum(int x, int y, int z)
    {
        return (x + y + z);
    }

    // Overloaded sum(). This sum takes two double parameters
    public double sum(double x, double y)
    {
        return (x + y);
    }

    // Driver code
    public static void main(String args[])
    {
        Sum s = new Sum();
        System.out.println(s.sum(10, 20));
        System.out.println(s.sum(10, 20, 30));
        System.out.println(s.sum(10.5, 20.5));
    }
}
```

Three ways to overload a method

In order to overload a method, the parameters of the methods must differ in either of these:

1. **Number of parameters.**

   For example: This is a valid case of overloading

   ```
   add(int, int)
   add(int, int, int)
   ```

2. **Data type of parameters.**

   For example:

   ```
   add(int, int)
   add(int, float)
   ```

3. **Sequence of Data type of parameters.**

   For example:

```
add(int, float)
add(float, int)
```

Invalid case of method overloading:

If two methods have same name, same parameters and have different return type, then this is not a valid method overloading example. This will throw compilation error.

```
int add(int, int)
float add(int, int)
```

4: Recursion

The process in which a function calls itself directly or indirectly is called recursion and the corresponding function is called as recursive function. Using recursive algorithm, certain problems can be solved quite easily. It does this by making problem smaller (simpler) at each call.

A physical world example would be to place two parallel mirrors facing each other. Any object in between them would be reflected recursively.

Recursive functions have two important components:

1. **Base case** (i.e., when to stop), where the function directly computes an answer without calling itself. Usually the base case deals with the simplest possible form of the problem you're trying to solve. The base case returns a value without making any subsequent recursive calls. It does this for one or more special input values for which the function can be evaluated without recursion.
2. **Recursive case** (i.e., call ourselves), where the function calls itself as part of the computation.

Perhaps the simplest example is calculating factorial: $n! = n \cdot (n-1) \cdot \cdots \cdot 2 \cdot 1$. However, we can also see that $n! = n \cdot (n-1)!$. Thus, factorial is defined in terms of itself. For example,

factorial(5) = 5 * factorial(4)

= 5 * (4 * factorial(3))

= 5 * (4 * (3 * factorial(2)))

= 5 * (4 * (3 * (2 * factorial(1))))

= 5 * (4 * (3 * (2 * (1 * factorial(0)))))

= 5 * (4 * (3 * (2 * (1 * 1))))

= 5 * 4 * 3 * 2 * 1 * 1 = 120

We can trace this computation in precisely the same way that we trace any sequence of function calls.

```
factorial(5)
   factorial(4)
      factorial(3)
         factorial(2)
            factorial(1)
               return 1
            return 2*1 = 2
         return 3*2 = 6
      return 4*6 = 24
   return 5*24 = 120
```

When a recursive call is made, new storage locations for variables are allocated on the stack

Lab Tasks

Marks : 10, All Questions carry equal marks

Exercise 1 — CalculateBMI.java

Write a Java application with the following prototypes that returns the user's body mass index (BMI)

public static double calcluateBMI(double weight, double height)

To calculate BMI based on weight in pounds (lb) and height in inches (in), use this formula:

$$\text{BMI} = \frac{\text{mass(lb)}}{(\text{height(in)})^2} \times 703$$

and

public static String findStatus(double bmi)

Categorizes it as underweight, normal, overweight, or obese, based on the table from the United States Centers for Disease Control:

BMI	Weight Status
Below 18.5	Underweight
18.5 – 24.9	Normal

25.0-29.9	Overweight
30.0 and above	Obese

Prompt the user to enter weight in pounds and height in inches.

Exercise 2 (Method Overloading) — PrintTest.java

Create a class to print an integer and a character with two methods having the same name but different sequence of the integer and the character parameters. For example, if the parameters of the first method are of the form (int n, char c), then that of the second method will be of the form (char c, int n).

Exercise 3 (Static Method) — FindLastDigit.java

Write a static method named lastDigit that returns the last digit of an integer. For example, lastDigit(3852) should return 2

Exercise 4 (Recursion) — GCDCalculation.java

Find Greatest Common Divisor (GCD) of 2 numbers using recursion.

Exercise 5 (Recursion) — StrReverse.java

Write a recursive function that, given a string s= “OOP is Fun”, print the characters of s in reverse order

Post lab questions to ponder

1. Can constructors be static in java? Try it out and justify.
2. Why use iterations when we have recursion and vice versa?

3. Can we overload by return type?
4. Can you overload constructors? If yes, then how?

END