

Basic Programming Practicum

Function 2 Recursion



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Study Program

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1 Laboratory

1.1 Experiment 1

In this experiment, a program will be created to calculate the factorial value of a number using a recursive function. In addition, a function for calculating factorial values will be made using an iterative algorithm as a comparison.

1. Create a new project
2. Create a new class, name it **Experiment**
3. Create a static function with the name `factorialRecursive()`, with return data type that is `int` and has 1 parameter with `int` data type in the form of a number calculated for its factorial value.

```
static int factorialRecursive(int n) {  
    if (n == 0) {  
        return 1;  
    } else {  
        return n * factorialRecursive(n - 1);  
    }  
}
```

4. Create another static function with the name `factorialIterative()`, with return data type that is `int` and has 1 parameter with `int` data type in the form of a number calculated for its factorial value.

```
static int factorialIterative(int n) {  
    int factor = 1;  
    for (int i = n; i >= 1; i++) {  
        factor = factor * i;  
    }  
    return factor;  
}
```

5. Create a `main` function and make a call to the two previously created functions, and display the results obtained.

6. Compile and run the program

```
programming-practicum > 2022-12-29 > function-2-recursion > codes > Experiment.java > Experiment
1 public class Experiment {
2     static int factorialRecursive(int n) {
3         if (n == 0) {
4             return 1;
5         } else {
6             return n * factorialRecursive(n - 1);
7         }
8     }
9
10    static int factorialIterative(int n) {
11        int factor = 1;
12        for (int i = n; i >= 1; i--) {
13            factor = factor * i;
14        }
15        return factor;
16    }
17
18    public static void main(String[] args) {
19        System.out.println("Recursive: " + factorialRecursive(10));
20        System.out.println("Iterative: " + factorialIterative(10));
21    }
22 }
23
```

```
> javac Experiment.java && java Experiment
Recursive: 3628800
Iterative: 3628800
> |
```

Figure 1: Experiment 1 code and output

7. If traced, when calling the `factorialRecursive(5)` function, the process that occurs can be illustrated as follows:

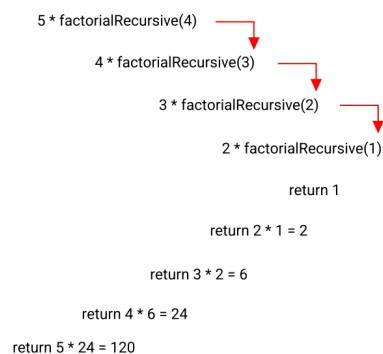


Figure 2: Traced recursive function

1.2 Experiment 2

In this experiment, a program will be created to calculate the power of a number using a recursive function.

1. Create a new class, name it **Experiment2**
2. Create a static function with the name `calculatePower()`, with return data type that is `int` and has 2 parameter with `int` data type in the form of numbers to be calculated and the exponents.

```
static int calculatePower(int x, int y) {  
    if (y == 0) {  
        return 1;  
    } else {  
        return x * calculatePower(x, y - 1);  
    }  
}
```

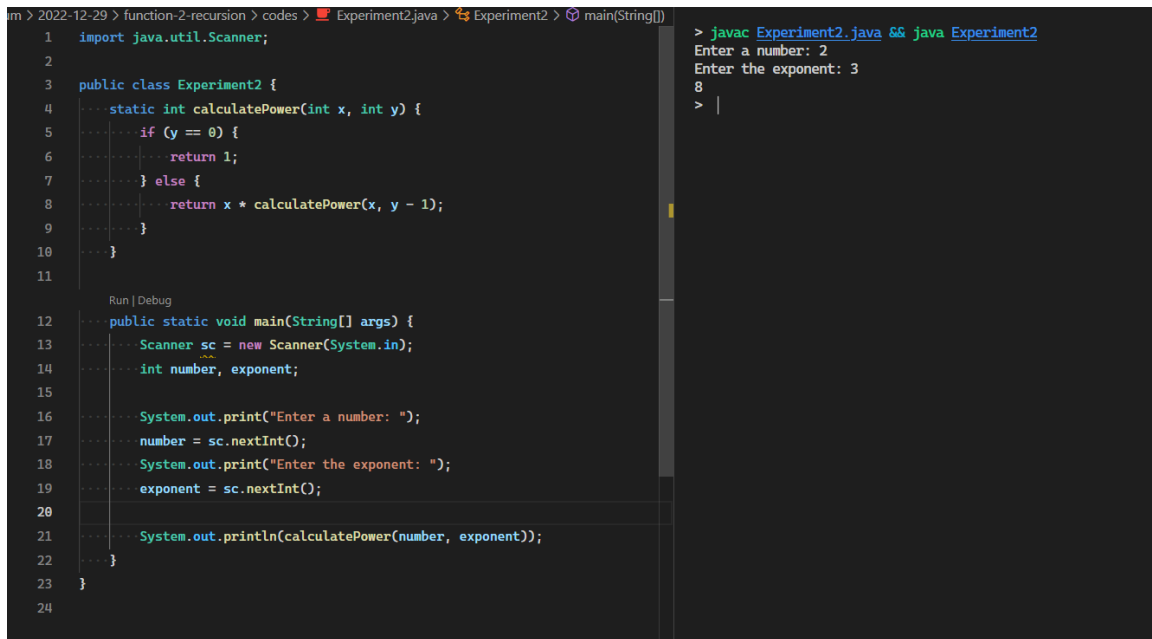
3. Create a `main` function and declare a `Scanner` with the name `sc`
4. Create two variables of type `int` with name `number` and `exponent`
5. Add the following code to accept input from the keyboard

```
System.out.print("Enter a number: ");  
number = sc.nextInt();  
System.out.print("Enter the exponent: ");  
exponent = sc.nextInt();
```

6. Call the `calculatePower` function that was created previously by sending two parameter values.

```
System.out.println(calculatePower(number, exponent));
```

7. Compile and run the program



```
1 import java.util.Scanner;
2
3 public class Experiment2 {
4     static int calculatePower(int x, int y) {
5         if (y == 0) {
6             return 1;
7         } else {
8             return x * calculatePower(x, y - 1);
9         }
10    }
11
12    public static void main(String[] args) {
13        Scanner sc = new Scanner(System.in);
14        int number, exponent;
15
16        System.out.print("Enter a number: ");
17        number = sc.nextInt();
18        System.out.print("Enter the exponent: ");
19        exponent = sc.nextInt();
20
21        System.out.println(calculatePower(number, exponent));
22    }
23 }
24
```

```
> javac Experiment2.java && java Experiment2
Enter a number: 2
Enter the exponent: 3
8
> |
```

Figure 3: Experiment 2 code and output

1.3 Experiment 3

In this experiment, a program will be created to calculate the amount of customer money deposited in the bank after earning interest for several years using the recursive function

1. Create a new class, name it **Experiment3**
2. Create a static function with the name `calculateInterest()`, with return data type that is double and has 2 parameter with int data type int in the form of customer balance and time spent saving. In this case, it is assumed that the interest set by the bank is 11% annually. Because the interest calculation is $interest * balance$, so to calculate the amount of money after adding interest is $balance + interest * balance$. In this case, the interest rate is $0.11 * balance$, and the balance is considered $1 * balance$, so $1 * balance + 0.11 * balance$ can be summarized into $1.11 * balance$ for calculating the balance after adding interest (in a year).

```
static double calculateInterest(double balance, int year) {
    if (year == 0) {
        return balance;
    }
}
```

```

    } else {
        return 1.11 * calculateInterest(balance, year - 1);
    }
}

```

3. Create a main function and declare a `Scanner` with the name `sc`
4. Create a variable of type `double` named `openingBalance` and a variable of type `int` named `year`
5. Add the following code to accept input from the keyboard

```

System.out.print("Enter the opening balance: ");
openingBalance = sc.nextDouble();
System.out.print("Enter the duration of saving (years): ");
year = sc.nextInt();

```

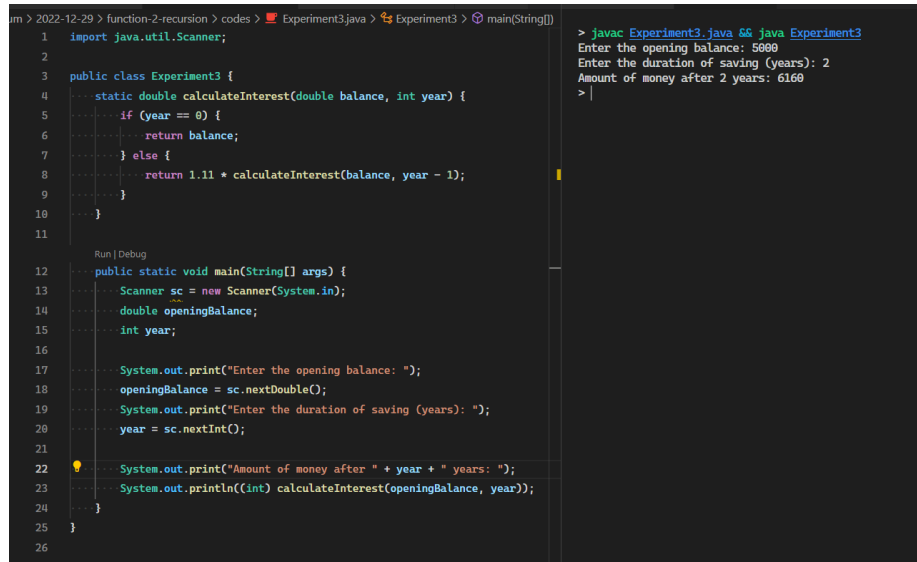
6. Call the `calculateInterest` function that was created previously by sending two parameter values

```

System.out.print("Amount of money after " + year + " years: ");
System.out.println((int) calculateInterest(openingBalance, year));

```

7. Compile and run the program



```

1  import java.util.Scanner;
2
3  public class Experiment3 {
4      static double calculateInterest(double balance, int year) {
5          if (year == 0) {
6              return balance;
7          } else {
8              return 1.11 * calculateInterest(balance, year - 1);
9          }
10     }
11
12     public static void main(String[] args) {
13         Scanner sc = new Scanner(System.in);
14         double openingBalance;
15         int year;
16
17         System.out.print("Enter the opening balance: ");
18         openingBalance = sc.nextDouble();
19         System.out.print("Enter the duration of saving (years): ");
20         year = sc.nextInt();
21
22         System.out.print("Amount of money after " + year + " years: ");
23         System.out.println((int) calculateInterest(openingBalance, year));
24     }
25 }
26
> javac Experiment3.java && java Experiment3
Enter the opening balance: 5000
Enter the duration of saving (years): 2
Amount of money after 2 years: 6160
> |

```

Figure 4: Experiment 3 code and output

Questions!

1. What is a recursive function?

It's a type of function that calls itself. Though, it usually has base case that makes it stop, similar to an iterative loop.

2. What are the examples of recursive functions?

A function to calculate a factorial.

3. In **Experiment 1**, do the `factorialRecursive()` function and `factorialIterative()` function give the same result? Explain the difference in the flow of the program in the use of recursive functions and iterative functions!

The results are the same because they both are trying to do the same thing. The difference is how they achieve it. The former uses a recursive method while the latter uses the iterative method. The recursive method calls itself but changing the argument on each recursion.

4. In **Experiment 2**, there is a recursive function call `calculatePower(number, exponent)` in the main function, then the `calculatePower()` function calls are repeated. Explain how long the function calling process will be executed!

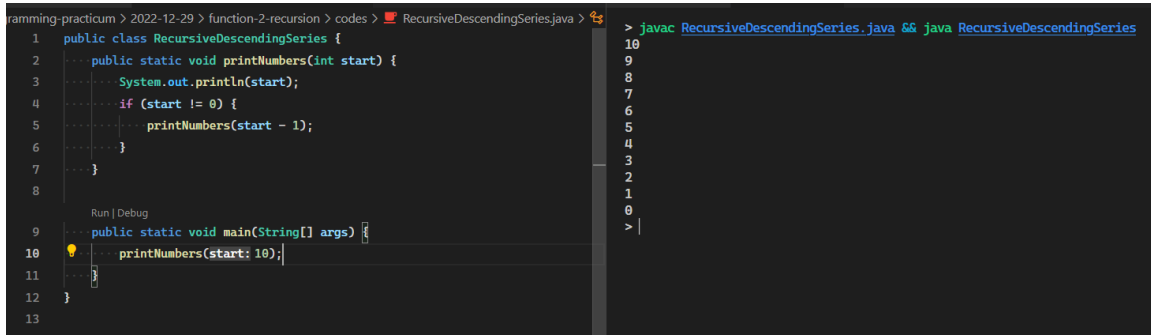
The function will be executed as long as the exponent doesn't reach 0. If it reaches zero then it will stop. For example, if the exponent is 5 then it will stop after the 5th recursion.

5. In **Experiment 3**, state which program code block is the "base case" and "recursion call"!

The condition that states `if (year == 0)` is the base case because it returns a plain value while the else block is the recursion value because it returns the result of the invocation of itself.

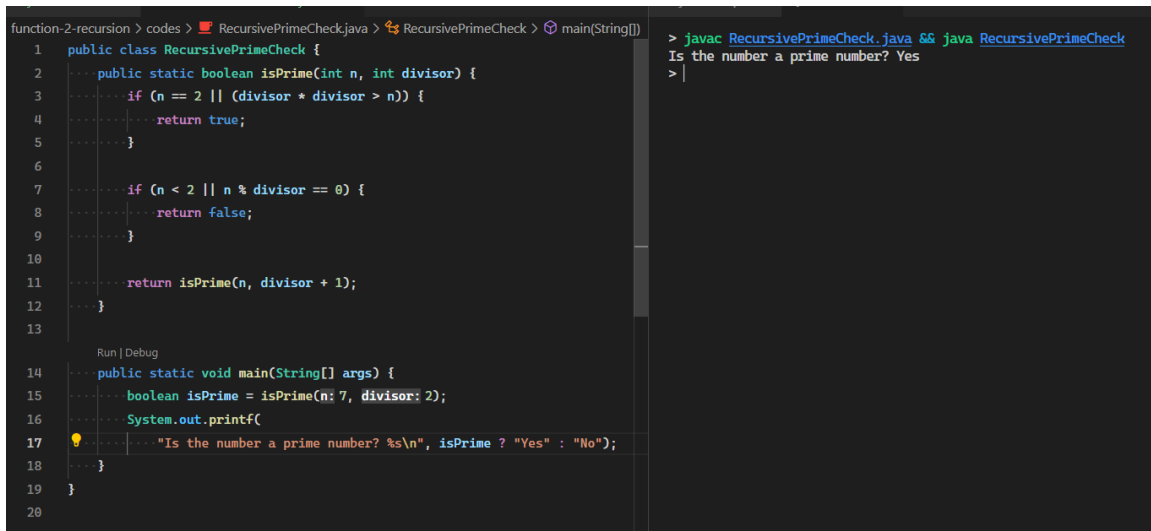
2 Assignment

1. Create a program to display the numbers n through 0 using recursive and iterative functions. (**RecursiveDescendingSeries**)



```
ramming-practicum > 2022-12-29 > function-2-recursion > codes > RecursiveDescendingSeries.java >   
1 public class RecursiveDescendingSeries {  
2     public static void printNumbers(int start) {  
3         System.out.println(start);  
4         if (start != 0) {  
5             printNumbers(start - 1);  
6         }  
7     }  
8  
9     Run | Debug  
10    public static void main(String[] args) {  
11        printNumbers(start: 10);  
12    }  
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3. Create a program that includes a recursive function to check whether a number n is a prime number or not. n is said to be not a prime number if it is evenly divided by a number less than n (**RecursivePrimeCheck**)



```
function-2-recursion > codes > RecursivePrimeCheck.java > RecursivePrimeCheck > main(String[])
1 public class RecursivePrimeCheck {
2     public static boolean isPrime(int n, int divisor) {
3         if (n == 2 || (divisor * divisor > n)) {
4             return true;
5         }
6
7         if (n < 2 || n % divisor == 0) {
8             return false;
9         }
10
11        return isPrime(n, divisor + 1);
12    }
13
14    Run | Debug
15    public static void main(String[] args) {
16        boolean isPrime = isPrime(n: 7, divisor: 2);
17        System.out.printf(
18            "Is the number a prime number? %s\n", isPrime ? "Yes" : "No");
19    }
20 }
```

```
> javac RecursivePrimeCheck.java && java RecursivePrimeCheck
Is the number a prime number? Yes
> |
```

Figure 7: Assignment 3 code and output