Data Structures and Algorithms

Java Review: Recursion

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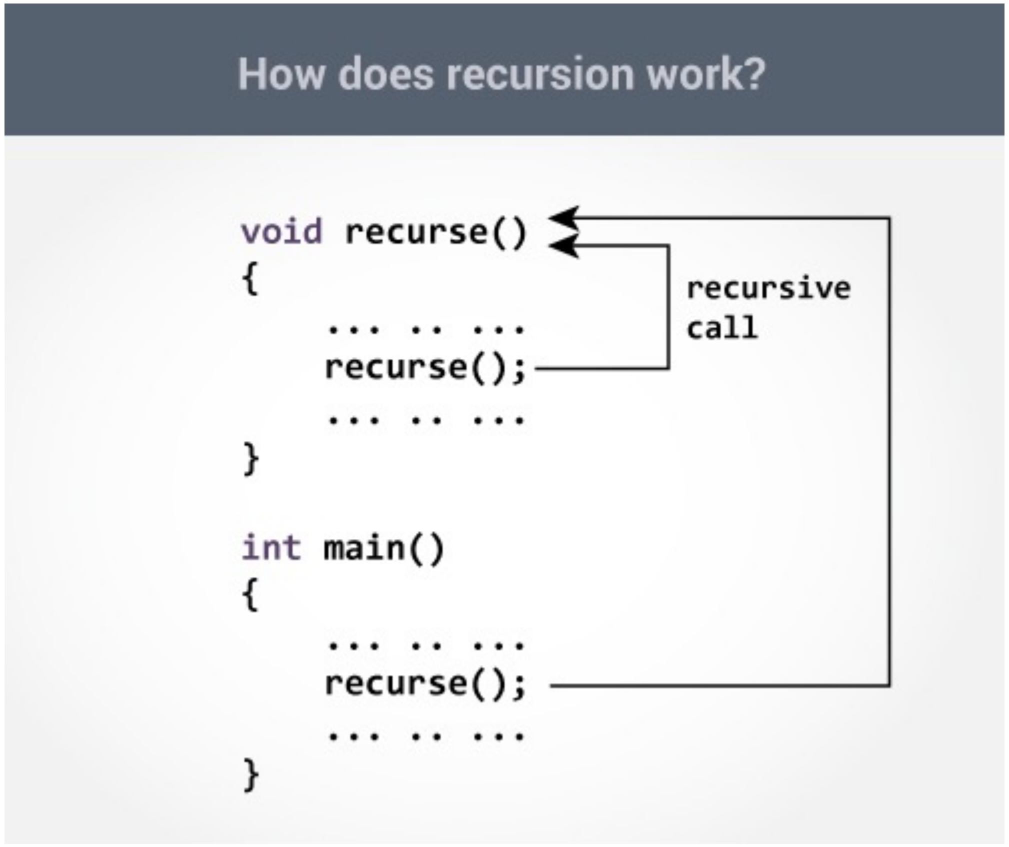
How Does Recursion Work?

- A function that calls itself is known as a recursive function.

```
void recurse()
{
    ... .. ...
    recurse();
    ... .. ...
}

int main()
{
    ... .. ...
    recurse();
    ... .. ...
}
```


How does recursion work?

```
void recurse()
{
    ... .. ...
    recurse();
    ... .. ...
}

int main()
{
    ... .. ...
    recurse();
    ... .. ...
}
```

Recursion

- The recursion continues until some condition (termination condition) is met.
- Always write the termination condition and make sure that the condition is reachable.
- Otherwise the recursion WILL NOT STOP!

Will this recursion stop?

```
import java.util.Scanner;

public class Start {

    public static int recurse(int i) {
      return recurse(i-1);
    }

    public static void main(String[] args) {
        Scanner scan = new Scanner(System.in);
        System.out.print("Enter an integer: ");
        int i = scan.nextInt();
        System.out.println(recurse(i));
    }

}
```

Will this recursion stop?

```java
import java.util.Scanner;

public class Start {

    public static int recurse(int i) {
        if(i==0)
            return 0;
        return recurse(i-1);
    }

    public static void main(String[] args) {
        Scanner scan = new Scanner(System.in);
        System.out.print("Enter an integer: ");
        int i = scan.nextInt();
        System.out.println(recurse(i));
    }

}
```

Will this recursion stop?

```java
import java.util.Scanner;

public class Start {

    public static int recurse(int i) {
        if(i<=0)
            return 0;
        return recurse(i-1);
    }

    public static void main(String[] args) {
        Scanner scan = new Scanner(System.in);
        System.out.print("Enter an integer: ");
        int i = scan.nextInt();
        System.out.println(recurse(i));
    }

}
```

What does it print?

```java
public class Start {

    public static void recurse(int i) {
        if(i<0)
            return;
        System.out.println(i);
        recurse(i-1);
    }

    public static void main(String[] args) {
        recurse(3);
    }

}
```

What does it print?

```
public class Start {

    public static void recurse(int i) {
        if(i<0)
            return;
        recurse(i-1);
        System.out.println(i); }

    public static void main(String[] args) {
        recurse(3);
    }

}
```

What problems does recursion solve?

A recursive function solves a problem where the solution depends on solutions to smaller instances of the same problem.

Recursion Example: Sum of Natural Numbers

- Sum(n) = 0 + 1 + 2 + … + (n-1) + n, for all n>=0
- Recursion build-up:
  - Step, if n>0, Sum(n) = n + Sum(n-1)
  - Base, if n=0: Sum(0)=0
- Any case will collapse to the base case step by step.

Recursion Example

```java
import java.util.Scanner;
public class Start {

  public static int sum(int n) {
    if(n==0)
      return 0;
    return n + sum(n-1);
  }

  public static void main(String[] args) {
    Scanner scan = new Scanner(System.in);
    System.out.print("Enter a positive integer: ");
    int n = scan.nextInt();

    System.out.println(sum(n));
  }

}
```

Output

```
Enter a positive integer:
3
6
```

What is the problem of the example?

Task 1

- Read in a positive number and compute its factorial using recursion.
- Note that your class should be named "T1", and should contain
  - a main function, which does IO
  - and a recursive function, int factR(int n), which computes the factorial

Task 1

- You may build you recursion as follows.
  - Step, if n>1: factR(n) = n * factR(n-1)
  - Base, if n=1: factR(1) = 1

Task 2

- Read in and compute the greatest common divisor (GCD) of two natural numbers using recursion.
- GCD(x, y) is the greatest natural number which divides both x and y
  - GCD(6, 5) = 1
  - GCD(6, 9) = 3
  - GCD(6, 0) = 6
- Note that your class should be named “T2” and should contain
  - a main function, which does IO
  - and a recursive function, int GCD(int x, int y), which computes the GCD of x and y.

Task 2

- You can build your recursion as follows. If x>=y (swap x and y otherwise),
  - Step, if y>0: GCD(x, y) = GCD(y, x % y)
  - Base, if y=0: GCD(x, 0) = x
- For example,
  - GCD(9, 6) = GCD(6, 3) = GCD(3, 0) = 3

Submission

- Save your java files as T1.java and T2.java, compress them into #####.zip and submit the zip file to iSpace.
- Note: ##### is your student ID.