

Recursion

Recursion means function calling itself for different inputs or parameters.

Let's understand it step by step:

Example: Printing numbers from 1 to N recursively

```
var N=5;
var i=1;

function print1toN(i,N){
  if(i>N){
    return;
  }
  console.log(i);
  print1toN(i+1,N);
}
```

Output:

```
1
2
3
4
5
```

Visual Representation:

```
print1toN(1, 5) -> prints 1 -> calls print1toN(2, 5)
  print1toN(2, 5) -> prints 2 -> calls print1toN(3, 5)
    print1toN(3, 5) -> prints 3 -> calls print1toN(4, 5)
      print1toN(4, 5) -> prints 4 -> calls print1toN(5, 5)
        print1toN(5, 5) -> prints 5 -> calls print1toN(6, 5)
          print1toN(6, 5) -> i > N, so return
```

Steps involved:

1. Initial Call:

- `print1toN(1, 5)` is called.
- `i` (1) is not greater than `N` (5), so it proceeds, base case is not reached yet.
- `console.log(1)` prints 1.
- The function calls itself recursively: `print1toN(2, 5)`.

2. First Recursive Call:

- `print1toN(2, 5)` is called.
- `i` (2) is not greater than `N` (5), so it proceeds, base case is not reached yet.
- `console.log(2)` prints 2.
- The function calls itself recursively: `print1toN(3, 5)`.

3. Second Recursive Call:

- `print1toN(3, 5)` is called.
- `i` (3) is not greater than `N` (5), so it proceeds, base case is not reached yet.
- `console.log(3)` prints 3.
- The function calls itself recursively: `print1toN(4, 5)`.

4. Third Recursive Call:

- `print1toN(4, 5)` is called.
- `i` (4) is not greater than `N` (5), so it proceeds, base case is not reached yet.
- `console.log(4)` prints 4.
- The function calls itself recursively: `print1toN(5, 5)`.

5. Fourth Recursive Call:

- `print1toN(5, 5)` is called.
- `i` (5) is not greater than `N` (5), so it proceeds, base case is not reached yet.
- `console.log(5)` prints 5.
- The function calls itself recursively: `print1toN(6, 5)`.

6. Base Case (Termination):

- `print1toN(6, 5)` is called.
- `i` (6) is greater than `N` (5), so the function hits the base case, base case is not reached yet.
- The function returns without making further recursive calls, ending the recursion.

Another Example: Printing Numbers from N to 1

```
var N=5;
```

```
var i=N;
```

```
function print1toN(i,N){  
  if(i<=0){  
    return;  
  }  
  console.log(i);  
  print1toN(i-1,N);  
}  
print1toN(i,N);
```

Output:

5
4
3
2
1

Types of Recursion:

- 1.Head Recursion
- 2.Tail recursion

Head recursion:

When recursion is made above all statements and logics.

Example:

Suppose you are asked to print numbers from N to 1 but input i will start from 0
Simply, start from i=1 and print N to 1.

```
var N=5;
var i=1;

function print1toN(i,N){
  if(i>5){
    return;
  }

  print1toN(i+1,N);
  console.log(i);
}
print1toN(i,N);
```

Output:

5
4
3
2
1

In the above case as you can see the recursive call is made above the console.log statement.

Case-2:

Suppose you are asked to print numbers from 1 to N but input i will start from N
Simply, start from i=N and print 1 to N.

```
var N=5;
```

```
var i=N;

function print1toN(i,N){
  if(i<=0){
    return;
  }

  print1toN(i-1,N);
  console.log(i);
}
print1toN(i,N);
```

Output:

```
1
2
3
4
5
```

Tail recursion:

When recursion is made below all statements and logics.

Example:

Suppose you are asked to print numbers from 1 to N .

```
var N=5;
var i=1;

function print1toN(i,N){
  if(i>N){
    return;
  }
  console.log(i);
  print1toN(i+1,N);
}
print1toN(i,N);
```

Output:

```
1
2
3
4
5
```

In the above code, the recursive call is made below the console.log statement.

Practice Problems:

Factorial of a number:

```
var N=5;
```

```
function factorial(N){  
  if(N==0){  
    return 1;  
  }  
  
  return N*factorial(N-1);  
}  
console.log(factorial(N));
```

Output:

120

Nth Fibonacci Number:

Problem Link: <https://leetcode.com/problems/fibonacci-number/>

```
function fibonacci(n) {  
  if (n==1) {return 1;}  
  if (n==0) {  
    return 0;  
  }  
  return fibonacci(n-1)+fibonacci(n-2);  
}  
var fib = function(n) {  
  return fibonacci(n);  
};
```

Nth Tribonacci Number:

Problem Link: <https://leetcode.com/problems/n-th-tribonacci-number/>

```
function tribonacciNumber(n) {  
  if (n==0) {  
    return 0;  
  }  
}
```

```

    if(n==1 || n==2) {
        return 1;
    }
    return tribonacciNumber(n-1)+tribonacciNumber(n-2)+tribonacciNumber(n-3);
}
var tribonacci = function(n) {
    return tribonacciNumber(n);
};

```

Calculate Power Linearly:

Problem: Given two variables x,n you have to calculate x^n .

```

var x=3;
var n=7;

function calculatePower(x,n){
    if(n==1){
        return x;
    }
    return x*calculatePower(x,n-1);
}
console.log(calculatePower(x,n));

```

Output:
2187

Calculate Power Logarithmically:

Problem: Given two variables x,n you have to calculate x^n .

```

var x=3;
var n=7;

function calculatePower(x,n){
    if(n==1){
        return x;
    }
    if(n==0){
        return 1;
    }
    var power=calculatePower(x,Math.floor(n/2));
    power*=power;

```

```
    if(n%2!=0){
        power*=x;
    }
    return power;
}
console.log(calculatePower(x,n));
```

Output:
2187

Generate all subsequences of a string:

```
var ansArray=[];
function getSubsequences(S,i,res){
    if(i==S.length){
        ansArray.push(res);
        return;
    }

    getSubsequences(S,i+1,res+S[i]);

    getSubsequences(S,i+1,res);
}
getSubsequences("abc",0,"");
console.log(ansArray);
```