What is Recursion?

How to write recursive code?

Function call Tracing

4 problems

TC and SC

Recursion → Function calling itself

```
void add (      ) {
    ___
    ___
    ___
    add(      )
}
```

Bigger Doll → smaller Doll
similar Doll
End Doll

Recursion → solving larger problems using smaller similar subproblem

$$sum(N) = 1 + 2 + 3 + \ldots + (N-1) + N$$

$$sum(N) = sum(N-1) + N$$

$$sum(5) = sum(4) + 5$$

↓

$1 + 2 + 3 + 4$

How to write a recursive code?

3 Logical steps:

1. Assumption : Decide what your fn does

2. Main Logic :
   Recursive relation to code /
   breaking big problem into smaller subproblem

3. Base condition
   End condition where recursion stops /
   smallest prob for which you already know answer

Q. Recursive code to calculate sum of N natural nos.

N = 4 ans = 10

```
// Given N, it will return sum of first N natural nos.
int sum (int N) {
    If (N==0) return 0
    If (N==1) return 1
    return sum(N-1) + N
}
```

Fn call Tracing

seq of fn calls that are made when a program is executed

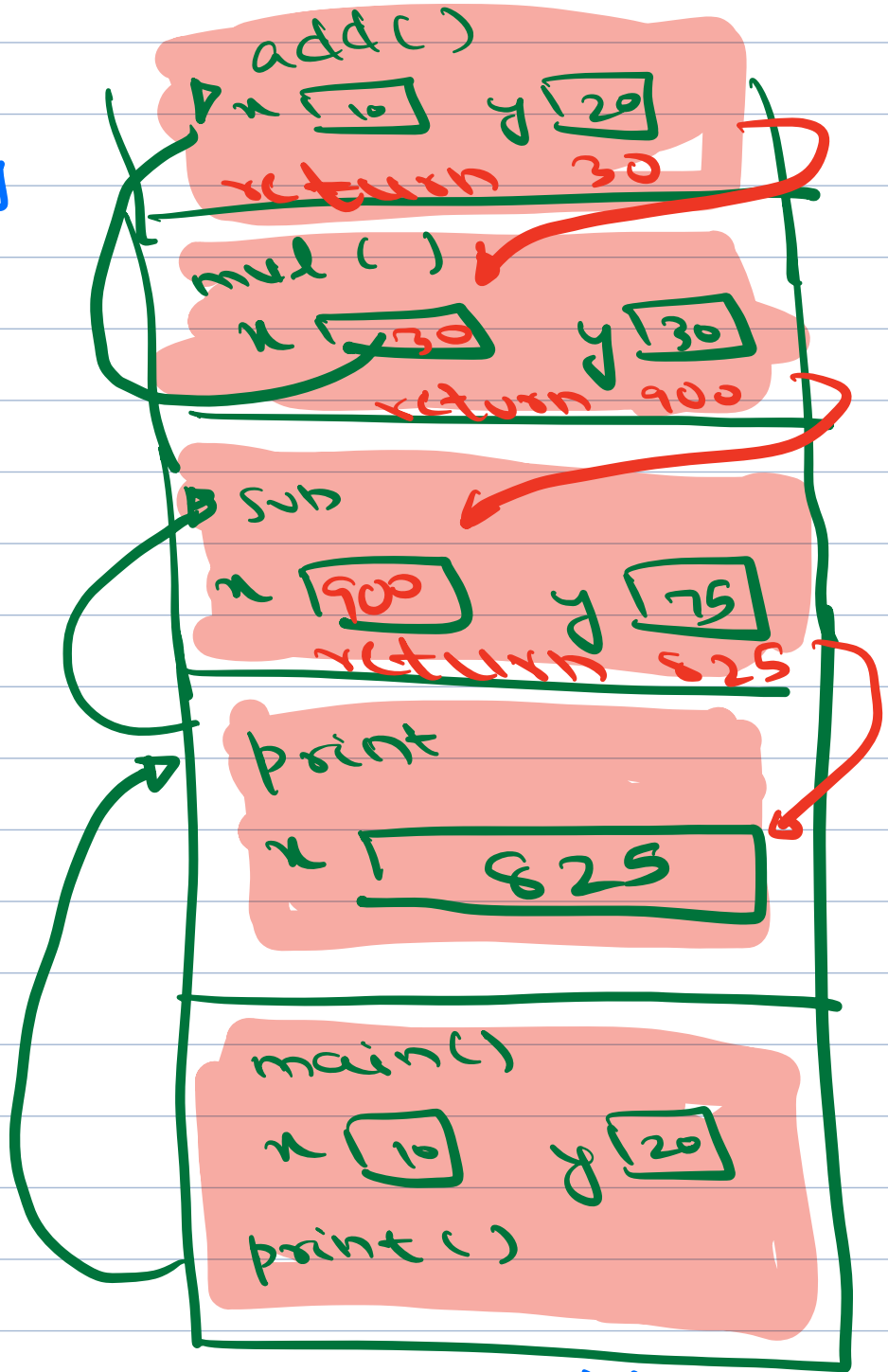
```
fn add(x,y) {
    return x+y
}

fn sub(x,y) {
    return x-y
}

fn mul(x,y) {
    return x*y
}

fn print(x) {
    cout << x
}

fn main() {
    x=10, y=20
    print(sub(mul(add(x,y),30),75))
}
```



NOTE: $1! = 1$

$0! = 1$

1. Given a +ve integer N, find factorial of N

N = 3 ans = 6 $3! = 3.2.1$

N = 4 ans = 24 $4! = 4.3.2.1$

N = 5 ans = 120

$fact(N) = 1 * 2 * 3 * 4 * \ldots (N-1) * N$

$fact(N) = fact(N-1) \times N$

$4! = 1 \times 2 \times 3 \times 4$

$4! = 3! \times 4$

```
① // Given N, it will return N!
  int fact (int N) {
③   if (N == 1) return 1
②   return fact(N-1) * N
  }
```

$N! = (N-1)! \times N$

This code fails for N = 0

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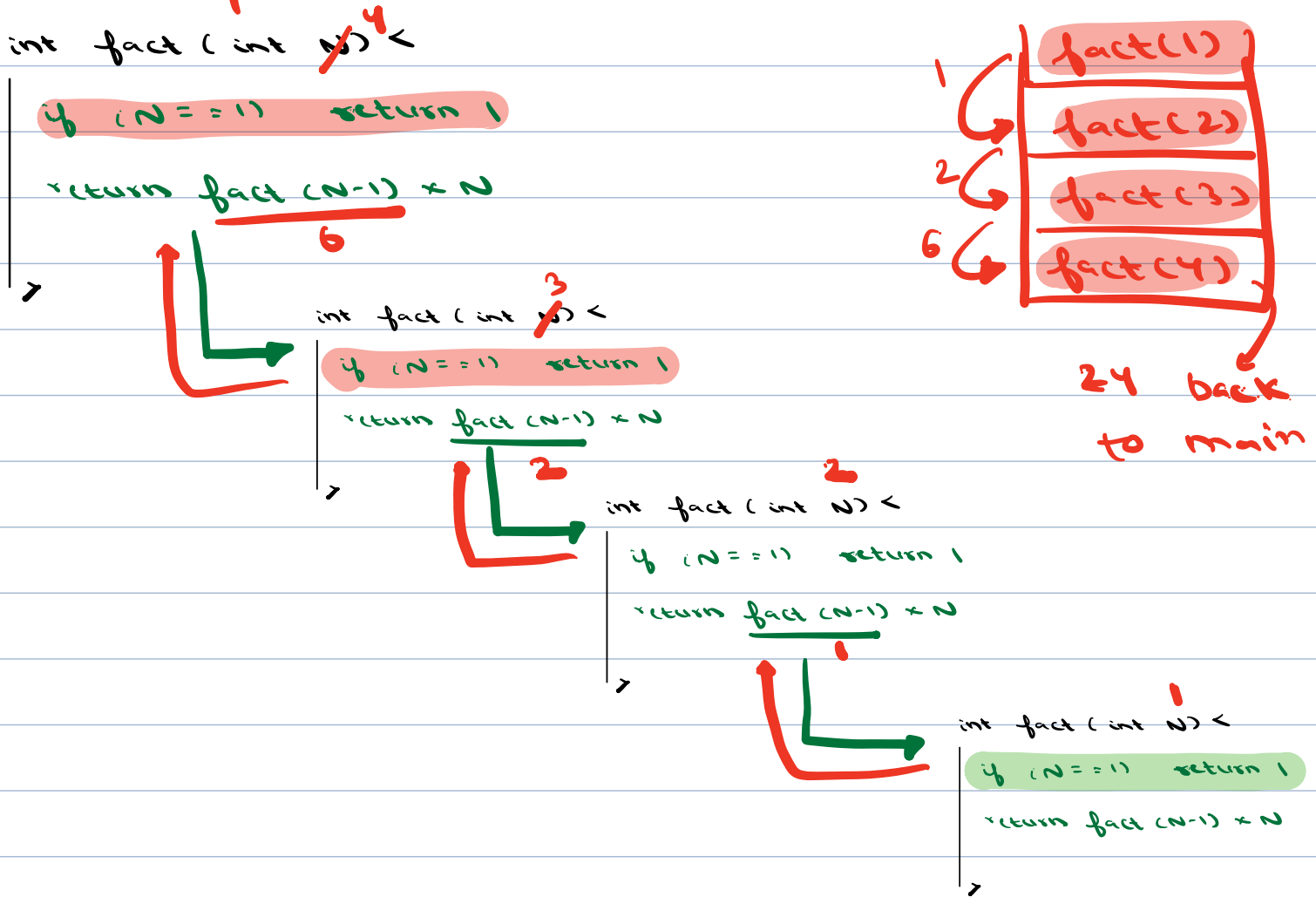


fact(0)

↓

fact(-1)

↓

fact(-2)

↓

fact(-3)

↓

⋮

Infinite recursion

↓

MLE (Memory Limit Exceeded)

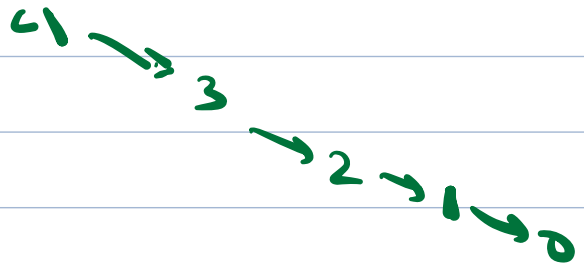
Fn call stack becomes full

Memory is exhausted before time

① // Given N, it will return N!

```
int fact ( int N) {
    if (N == 0)   return 1
    return fact (N-1) * N
}
```

③ ②




```
int main() {
    // I/P → n
    if (N ≥ 0)
    print ( fact (n))
    else
    print ("Invalid")
}
```

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