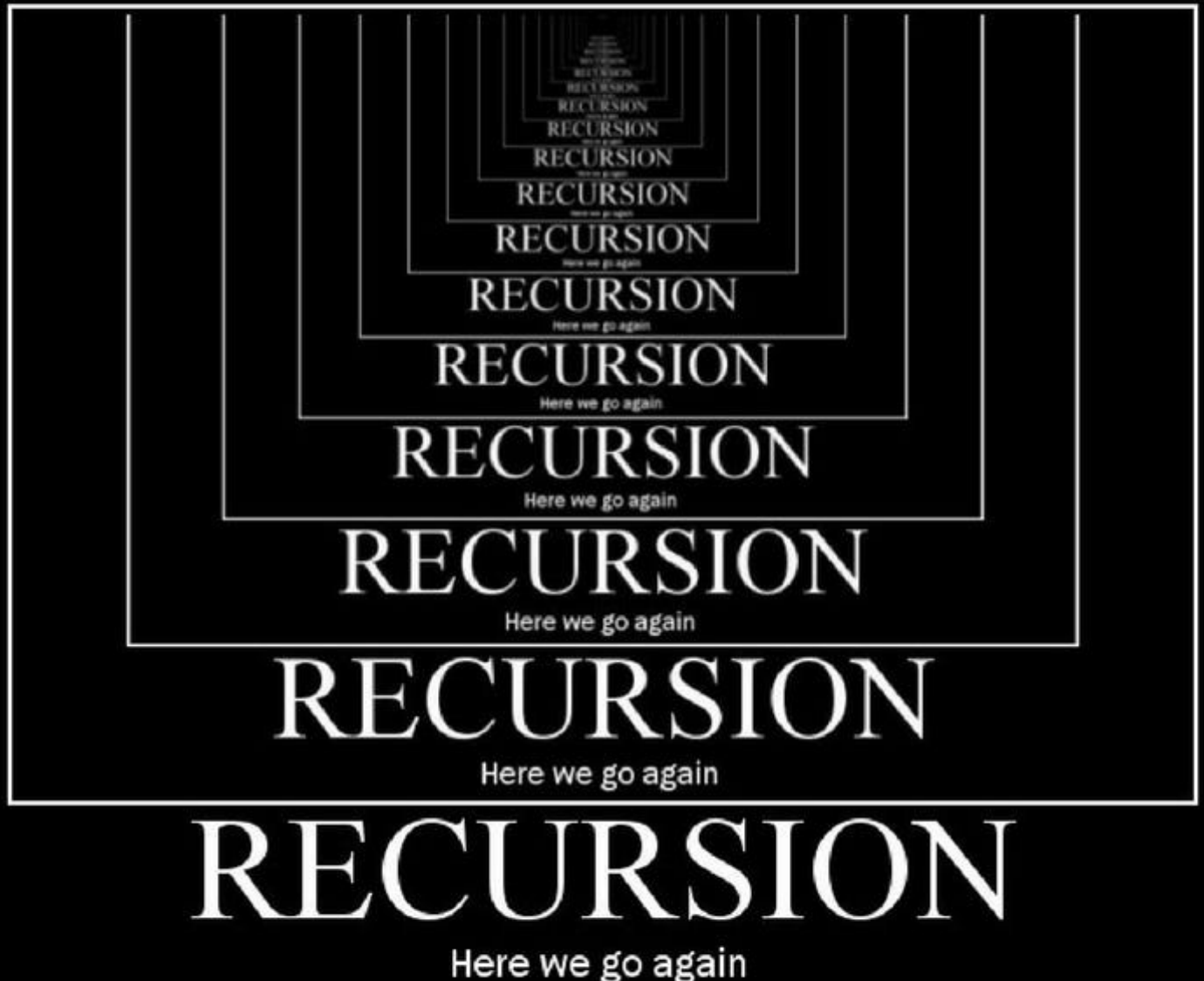
Recursion

Basics


RECURSION
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Lecture Contents

- Definition of ***Recursion***
- What we know
  - *Recursion* in Mathematics
  - *Recursion* in Linguistics
  - *Recursion* in Java
    - `Fibonacci()`
    - `printStars()`

Recursion

- Recursion is the process of defining a problem in terms of itself.

Recursion

- the process of defining a problem in terms of itself.
- a technique or process where a function or algorithm solves a problem by calling itself with a smaller or simpler input repeatedly, until a base case or termination condition is reached.

Recursion in Mathematics

- Fibonacci numbers

$$\{0, 1, 1, 2, 3, 5, 8, 13, 21, ...\}$$

Recursion in Mathematics

- Fibonacci numbers

$$F_n = F_{n-1} + F_{n-2}$$

$$\{0, 1, 1, 2, 3, 5, 8, 13, 21, \ldots\}$$

Recursion in Mathematics

- Fibonacci numbers

$$F_n = F_{n-1} + F_{n-2}$$

$$F_0 = 0;\ \ F_1 = 1$$ // base case (stopping criterion)

$$\{0, 1, 1, 2, 3, 5, 8, 13, 21, \ldots\}$$

Recursion in Mathematics

- Factorial $n!$

Recursion in Mathematics

- Factorial $n! = n \times (n-1) \times (n-2) \times \ \ldots \ \times 3 \times 2 \times 1$

Recursion in Mathematics

- Factorial $n! = n \times (n-1) \times (n-2) \times \ \ldots \ \times 3 \times 2 \times 1$

$$\{1, 1, 2, 6, 24, 120, 720, 5040, 40320, \ldots\}$$

Recursion in Mathematics

- Factorial $n! = n \times (n-1) \times (n-2) \times \ \ldots \ \times 3 \times 2 \times 1$

$$F_n = n \times F_{n-1}$$

$$\{1, 1, 2, 6, 24, 120, 720, 5040, 40320, \ldots\}$$

Recursion in Mathematics

- Factorial $n!$

$$F_n = n \times F_{n-1}$$

$$F_0 = 1$$ // base case (stopping criterion)

$$\{1, 1, 2, 6, 24, 120, 720, 5040, 40320, \ldots\}$$

Recursion in Mathematics

- Recursion in mathematics
  - Recursive definition

$$NEXT = NOW + 3$$
$$Starting\ at\ 5$$

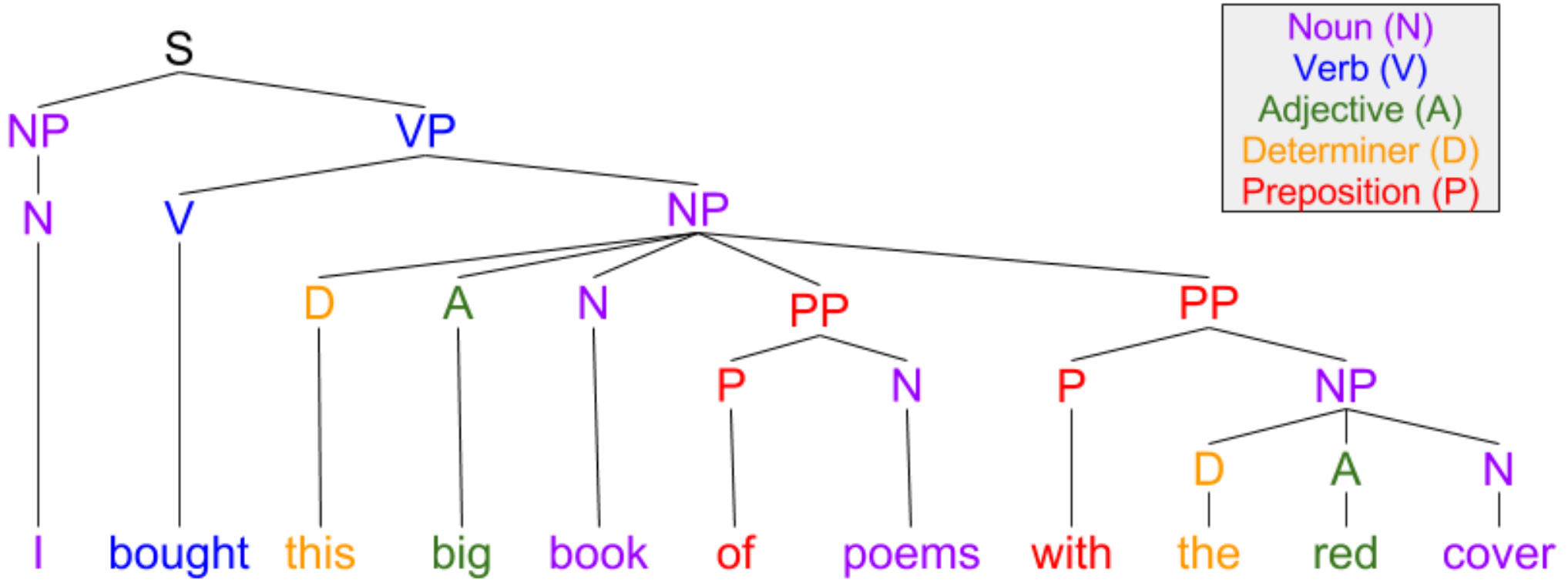
$$NEXT = 3 * NOW$$
$$Starting\ at\ 3$$

  - Non-Recursive Equivalent

$$y = 3x + 2$$

$$y = 3^x$$

Recursion in Linguistics



Fibonacci in Java

$$F_n = F_{n-1} + F_{n-2}$$

$$F_0 = 0;\ \ F_1 = 1$$

Implement using → a loop in Java

```
public static int
    loopFibonacci(int n)
{




}
```

Fibonacci in Java

$$F_n = F_{n-1} + F_{n-2}$$

$$F_0 = 0;\ F_1 = 1$$

```
public static int
loopFibonacci(int n)
{
    if (n == 0) {
       return 0;
     }

    int fMinus1 = 0;
    int f = 1;

    for(int i = 2; i <= n; i++) {
       int tmp = f;
       f = f + fMinus1;
       fMinus1 = tmp;
    }

    return f;
}
```

Fibonacci in Java

$$F_n = F_{n-1} + F_{n-2}$$

$$F_0 = 0;\ F_1 = 1$$

```
public static int fibonacci(int n)
{
   if(n <= 1) {
      return n;
   } else {
      return fibonacci(n-1) +
             fibonacci(n-2);
   }
}
```

```
public static int
loopFibonacci(int n)
{
   if (n == 0) {
      return 0;
    }

   int fMinus1 = 0;
   int f = 1;

   for(int i = 2; i <= n; i++) {
      int tmp = f;
      f = f + fMinus1;
      fMinus1 = tmp;
   }

   return f;
}
```

Exercise: `printStars`

- Method `printStarts` takes an integer parameter, `n`, and prints out to the console that number of asterisks.
  - Write the method using a loop.
  - Write the method using recursion.

Recursion

Basics