WEEK 3 STUDIO

ABOUT ME

- Chen Yuan Bo
- Year 2, Computer Science
- Love dancing
- Telegram: @yuan_bobo

ABOUT YOU

- Name, School, Hobbies
- Why did you choose Computer Science?

HOW TO DO WELL IN CS1101S

- Do your tutorials. All of them.
- Understand. Don't memorize.
- Practice, practice, practice. (Missions, quests etc)
- Ask questions

AGENDA

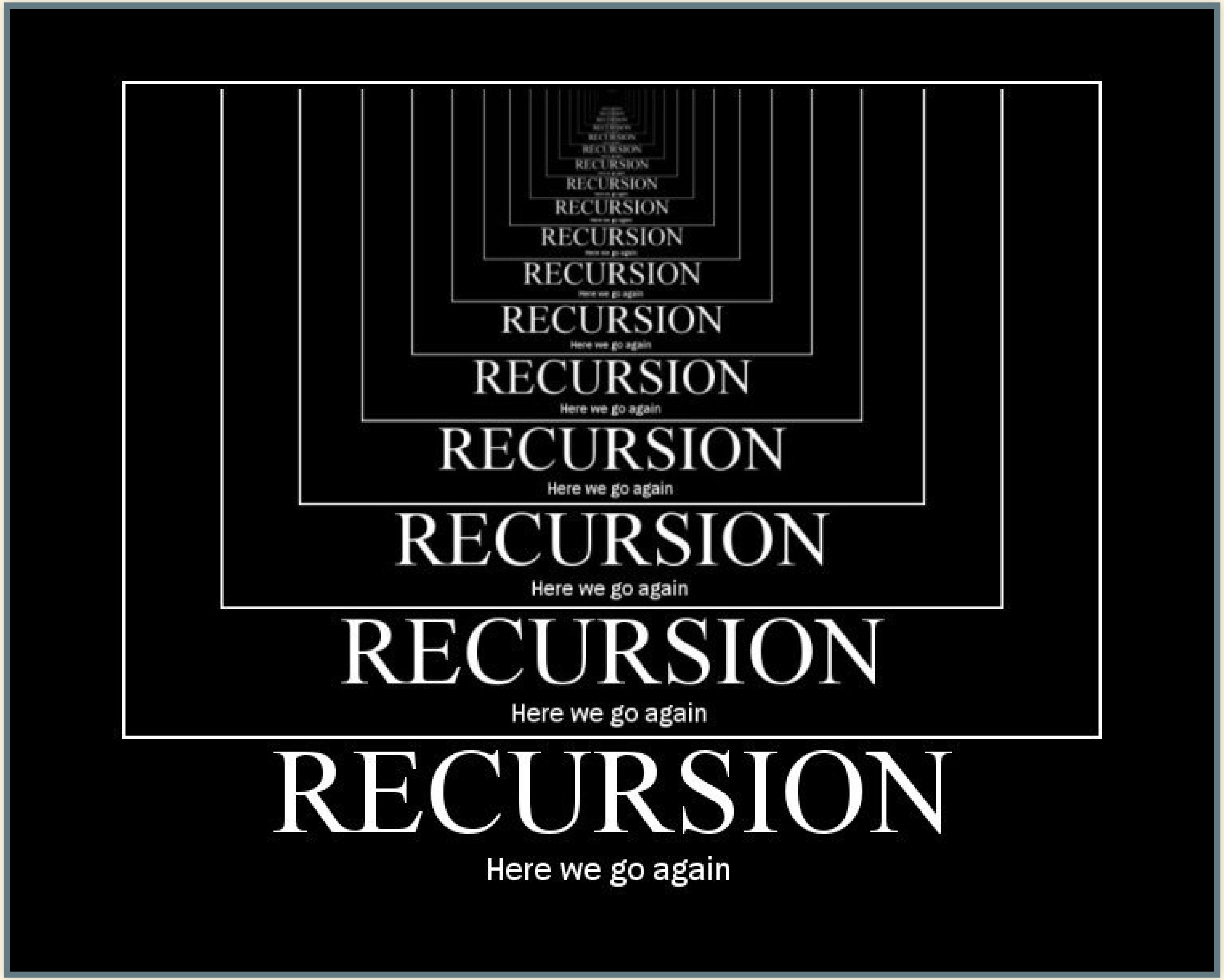
- Recursion
- Order of Growth
- Studio

RECURSION

WHAT IS RECURSION?

- Method of solving problems where solutions depends on solutions to smaller instances of the same problem

WHAT IS RECURSION?


RECURSION
Here we go again
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WHAT IS RECURSION?

WHAT IS RECURSION?

USING RECURSION TO SOLVE PROBLEMS

- Break the problem into smaller sub-problems
    - Use wishful thinking!
- Base case
    - Smallest sub-problem possible, where the function call just evaluates to a result directly

RECURSIVE FUNCTION

Any function that calls itself is a recursive function.

EXAMPLE RECURSIVE FUNCTION

```
function factorial(n) {
    return n === 1
        ? 1
        : n * factorial(n - 1);
}
```

TOWER OF HANOI

Tower of Hanoi consists of three pegs or towers with n disks placed one over the other.
The objective of the puzzle is to move the stack to another peg following these simple rules.

1. *Only one disk can be moved at a time.*
2. *No disk can be placed on top of the smaller disk.*

TOWER OF HANOI

```
function hanoi(num, current, target, other) {
    if (num === 1) {
        display("move " + current + " to " + target);
    } else {
        hanoi(num - 1, current, other, target);
        display("move " + current + " to " + target);
        hanoi(num - 1, other, target, current);
    }
}

hanoi(3, "1", "2", "3");
```

RECURSIVE PROCESS VS ITERATIVE PROCESS

- Deferred operations
- Why?

RECURSIVE PROCESS VS ITERATIVE PROCESS

```
function factorial(n) {
    return n === 1
        ? 1
        : n * factorial(n - 1);
}

function fact_iter(n) {
    return iter(1, 1, n);
}

function iter(counter, product, max_count) {
    return counter > max_count
        ? product
        : iter(counter + 1, counter * product, max_count);
}
```

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WHAT IS ORDER OF GROWTH?

- **Purpose**: Find a rough measure of the resources (time and/or space) used by a computational process (a program).
- **Approach**: Use a mathematical function to describe how the amount of resources consumed grows along with the scale of the problem.

TYPES OF COMPLEXITY (FOR CS1101S)

- Time: how long does the program run
  - Number of steps/function calls
- Space: how much memory do we need to run the program
  - Number of deferred operations

TYPES OF ORDER OF GROWTH

Order (Time)	Description	Example
$\mathcal{O}(1)$	Constant	Add, subtract, multiply, square...
$\mathcal{O}(\log n)$	Logarithmic	Binary search
$\mathcal{O}(n)$	Linear	Factorial
$\mathcal{O}(n \log n)$	Nifty	Merge Sort
$\mathcal{O}(n^2)$	Quadratic	Bubble Sort, Selection Sort
$\mathcal{O}(2^n)$	Exponential	Fibonacci

EXAMPLE 1

```
function foo(n) {
    return n < 0
        ? 0
        : foo(n - 1);
}
```

- Time complexity: $\mathcal{O}(n)$
- Space complexity: $\mathcal{O}(1)$

EXAMPLE 2

```
function foo(n) {
    return n < 0
        ? 0
        : foo(n - 1) + 2;
}
```

- Time complexity: $\mathcal{O}(n)$
- Space complexity: $\mathcal{O}(n)$

EXAMPLE 3

```
function foo(n) {
    return n < 1
        ? 0
        : foo(n / 2);
}
```

- Time complexity: $\mathcal{O}(\log n)$
- Space complexity: $\mathcal{O}(1)$

EXAMPLE 4

```
function foo(n) {
    return n < 1
        ? 0
        : foo(n / 3) + 3;
}
```

- Time complexity: $\mathcal{O}(\log n)$
- Space complexity: $\mathcal{O}(\log n)$

EXAMPLE 5

```
function foo(n) {
    const k = n / 3;

    function iter(n) {
        return n < 0
            ? 0
            : iter(n - k);
    }

    return iter(n);
}
```

- Time complexity: $\mathcal{O}(1)$
- Space complexity: $\mathcal{O}(1)$

EXAMPLE 6

```
function foo(n) {
    return n < 0
        ? 0
        : foo(n - 1) + foo(n - 1);
}
```

- Time complexity: $\mathcal{O}(2^n)$
- Space complexity: $\mathcal{O}(n)$

EXAMPLE 7

```
function foo(n) {
    return n < 1
        ? 0
        : foo(n / 2) + foo(n / 2);
}
```

- Time complexity: $\mathcal{O}(n)$
- Space complexity: $\mathcal{O}(\log n)$

EXAMPLE 8

```
function foo(n) {
    const k = math_sqrt(n);
    function iter(n) {
        return n < 0
            ? 0
            : iter(n - k);
    }
    return iter(n);
}
```

- Time complexity: $\mathcal{O}(\sqrt{n})$
- Space complexity: $\mathcal{O}(1)$

ATTENDANCE TAKING

1. Open telegram, search for @CS1101SBot
2. Start the bot, and type in

    ```
    /setup <Your matric number>
    ```

3. Once you have successfully registered, type

    ```
    /attend <token>
    ```

4. Receive reply that you have successfully marked your attendance.

STUDIO SHEET