App Academy

Recursion

Recursion

- Recursion is a vital concept that must be understood as a prerequisite for many algorithms that we will see moving forward.
- Linked List problems are a good place to practice recursion due to their simplicity compared to trees or graphs.
- Recursion inherently creates a stack, specifically the call stack, which works very similarly to a stack created by an array.
- All recursion solutions can also be written iteratively, but this can actually overly complicate some problems.

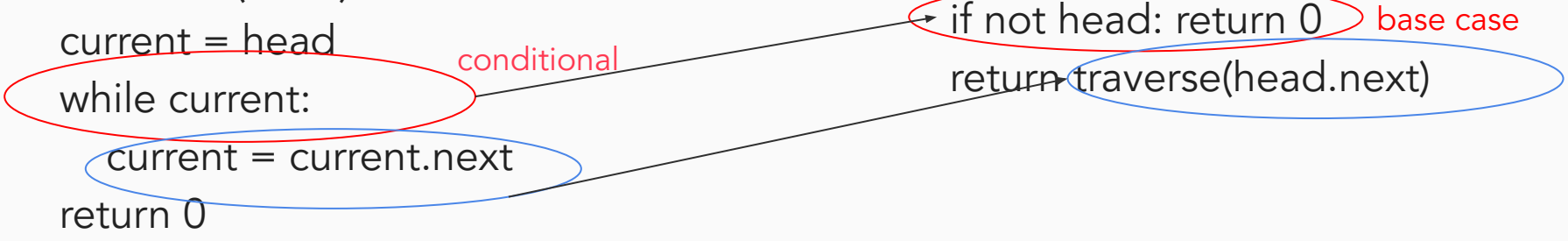
Comparing Recursive and Iterative Code

Iterative:

```
def traverse(head):
    current = head
    while current:
        current = current.next
    return 0
```

Recursive:

```
def traverse(head):
    if not head: return 0
    return traverse(head.next)
```



The most important part of a recursive function is the BASE CASE. This is the termination point of the function. It is similar to conditionals put in while loops.

Single Path Demo

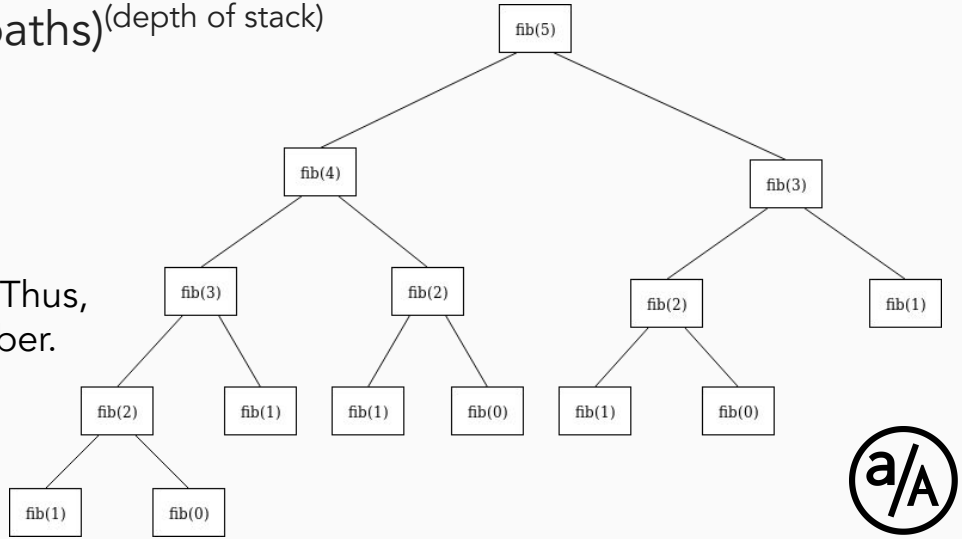
- Reverse Linked List

Runtime Complexity

- Single-path recursive functions usually run in O(n) where n is the depth of the stack
- Multi-path recursive functions can be analyzed with the following formula:

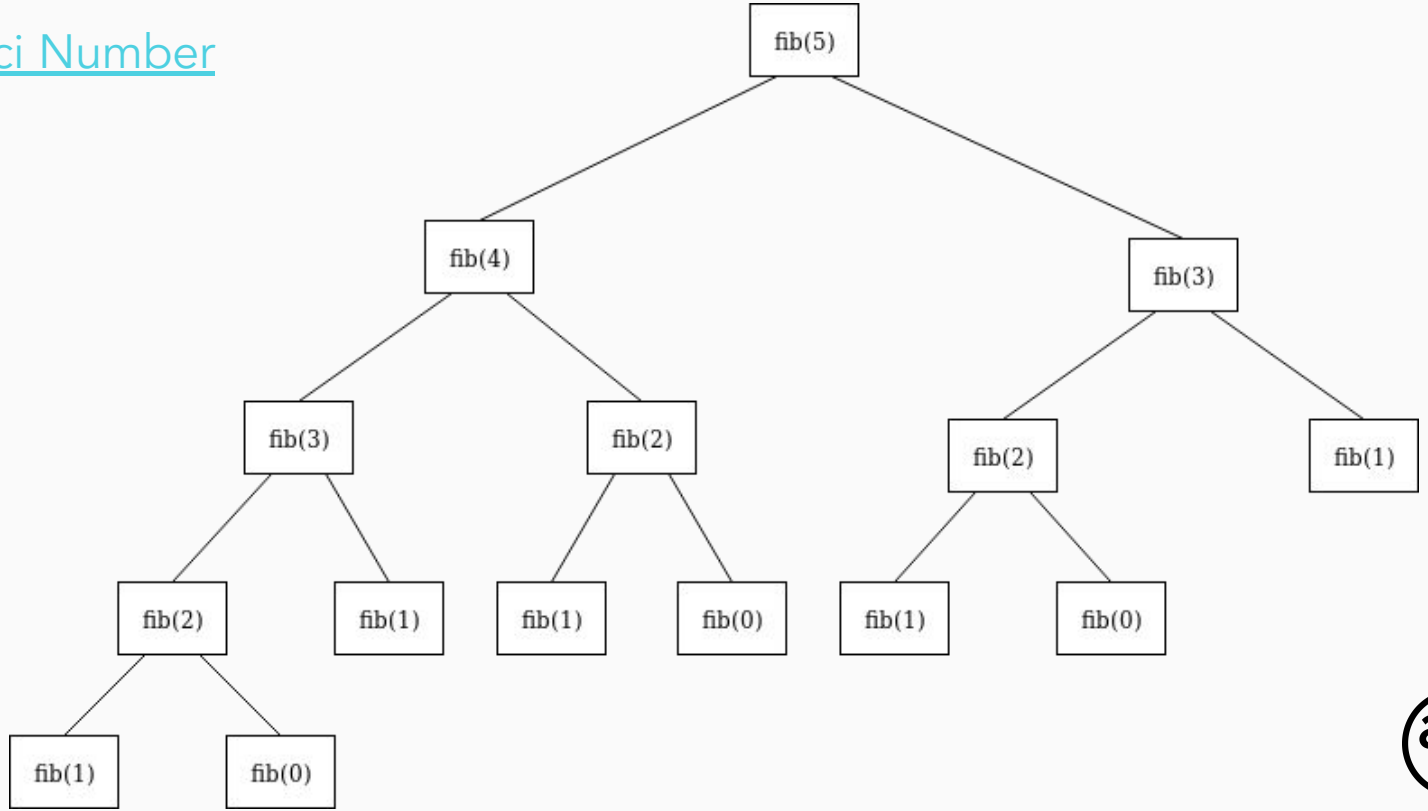
$$(\#\ \text{of paths})^{(\text{depth of stack})}$$

- The tree on the right represents a recursive Fibonacci function.
- Each node has at most 2 branching paths.
- The depth of the stack is 5, which is the input. Thus, we can call this $O(2^n)$ where n is our input number.



Demo

- Fibonacci Number



Drawbacks of Exponential Runtimes

- Exponential runtimes are extremely inefficient.
- If you run into exponential runtimes, there is likely a way to reduce the time complexity somehow (we will discuss this much later when we get to Dynamic Programming)
- Unique Paths (brute force)

Questions?