

Algorithm Practice for Coding Interviews



Lecture Goals

1. Learn and analyze runtime of common sorting algorithms
2. Learn coding interview strategy

Common Algorithms

1. Selection Sort
2. Merge Sort

Selection Sort: Picture

| | | | | | |
|----|----|----|----|----|----|
| 30 | 19 | 11 | 8 | 1 | 6 |
| 6 | 19 | 11 | 8 | 1 | 30 |
| 6 | 1 | 11 | 8 | 19 | 30 |
| 6 | 8 | 1 | 11 | 19 | 30 |
| 6 | 1 | 8 | 11 | 19 | 30 |
| 1 | 6 | 8 | 11 | 19 | 30 |

Selection Sort: Pseudocode

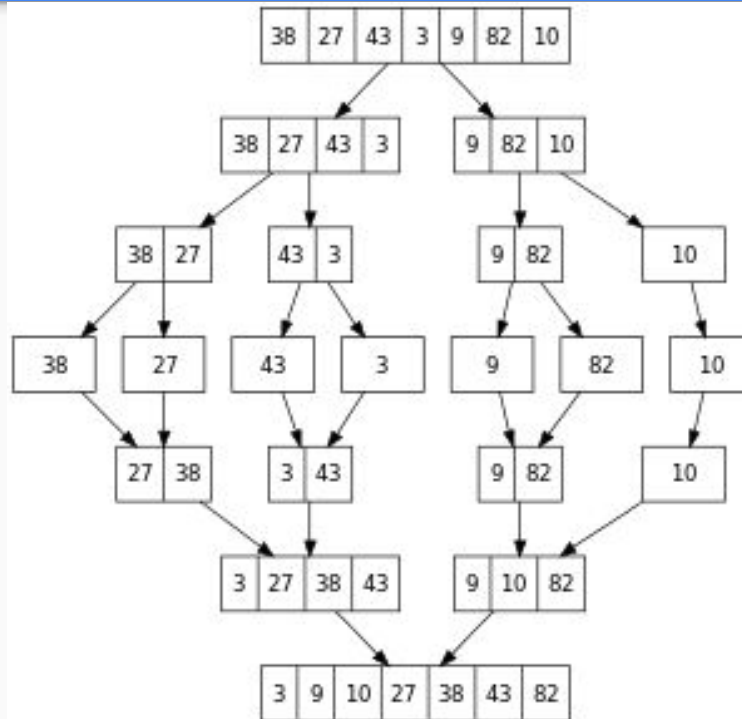
```
for index in range(len(list_), 0, -1):  
    max_index = find_max_index(list_[0:index])  
    list_[index], list[max_index] = list[max_index], list[index]
```

Selection Sort: Runtime Analysis

- 1st pass takes n steps to find max
- 2nd pass takes $n - 1$ steps to find max
- k th pass takes $n - (k - 1)$ steps to find max
- $n - 1$ passes are made

$$\rightarrow n + (n-1) + \dots + 3 + 2 = n(n-1)/2 - 1 = \mathbf{O(n^2)}$$

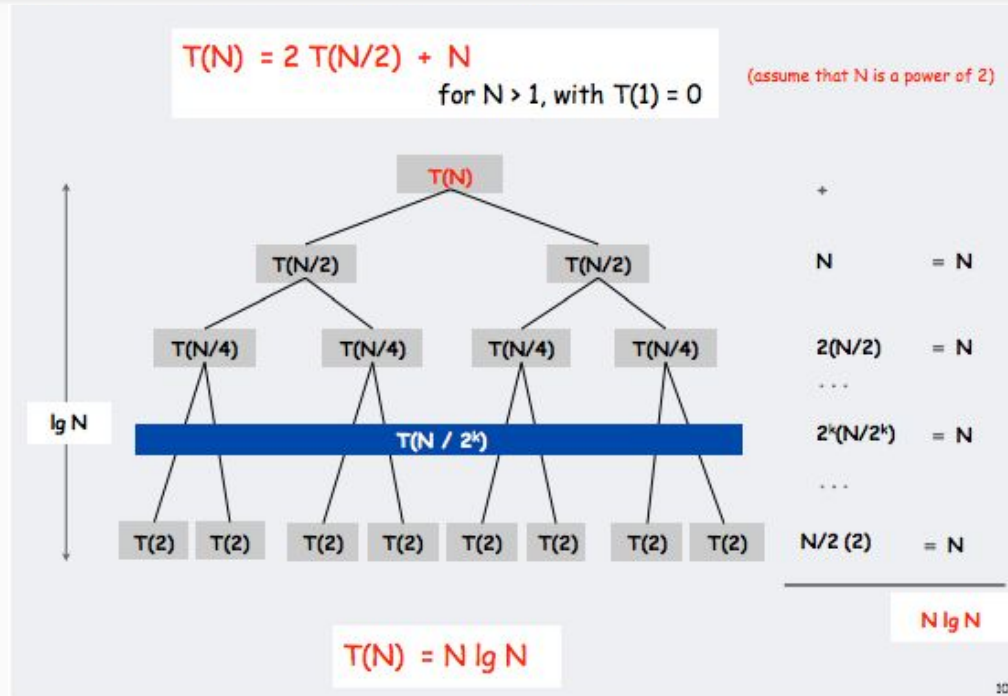
Merge Sort: Picture



Merge Sort: Code

```
def merge_sort(m):  
    if len(m) <= 1:  
        return m  
  
    middle = len(m) // 2  
    left = m[:middle]  
    right = m[middle:]  
  
    left = merge_sort(left)  
    right = merge_sort(right)  
    return list(merge(left, right))
```


Merge Sort: Runtime Analysis w/Recursion Tree



Merge Sort: Runtime Analysis w/Induction

Claim. If $T(N)$ satisfies this recurrence, then $T(N) = N \log_2 N$.

↙
assumes N is a power of 2

$$T(N) = \begin{cases} 0 & \text{if } N = 1 \\ \underbrace{2T(N/2)}_{\text{sorting both halves}} + \underbrace{N}_{\text{merging}} & \text{otherwise} \end{cases}$$

Pf. [by induction on n]

- Base case: $n = 1$.
- Inductive hypothesis: $T(n) = n \log_2 n$.
- Goal: show that $T(2n) = 2n \log_2 (2n)$.

$$\begin{aligned} T(2n) &= 2T(n) + 2n \\ &= 2n \log_2 n + 2n \\ &= 2n(\log_2(2n) - 1) + 2n \\ &= 2n \log_2(2n) \end{aligned}$$

Coding Interview Strategy

1. Ask Questions
2. Design an Algorithm
3. Pseudocode
4. Code
5. Test

Example Question: Pig Latin

Pig Latin has two rules:

1. If a word starts with a consonant and a vowel, put the first letter of the word at the end of the word and add "ay."
2. If a word starts with a vowel add the word "way" at the end of the word.

Your job for this interview:

Write a function that translates a given word into Pig Latin.

Other Interview Prep Resources

1. [Cracking the Coding Interview](#)
2. [Algorithm Design Manual](#)
3. [Interview Cake](#)