# 算法分析和複雜性理論

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## 1　作業目標與章節摘要

1. LeetCode 56. Merge Intervals 合併區間
2. LeetCode 148. Sort List 排序鍊錶
3. LeetCode 274. H-Index, H 指數

## 2　作業內容概述

作業可以從 GitHub 下的 kancheng/kan-cs-report-in-2022 專案找到，作業程式碼與文件目錄為 kan-cs-report-in-2022/AATCC/lab-report/w3。實際執行的環境與實驗設備為 Google 的 Colab 、MacBook Pro (Retina, 15-inch, Mid 2014) 、Acer Aspire R7 與 HP Victus (Nvidia GeForce RTX 3060)。

本作業 GitHub 專案為 kancheng/kan-cs-report-in-2022 下的 AATCC‘ 的目錄。程式碼可以從 code 目錄下可以找到 *.pynb，內容包含上次課堂練習、LeetCode 範例思路整理與作業。

https://github.com/kancheng/kan-cs-report-in-2022/tree/main/AATCC

Fig. 1. 作業專案位置

1. LeetCode : https://leetcode.com/
2. LeetCode CN : https://leetcode-cn.com/
3. OnlineGDB : https://www.onlinegdb.com/

LeetCode 的平台部分，CN 的平台有針對簡體中文使用者進行處理，包含中英文切換等功能。OnlineGDB 則可線上進行簡易的環境測試，其程式碼涵蓋 C, C++, C#, Java, Python, JS, Rust, Go。

# 3 LeetCode 56. Merge Intervals 合併區間

## 3.1 LeetCode 56. 題目

Given an array of intervals where intervals[i] = [$start_i, end_i$], merge all overlapping intervals, and return an array of the non-overlapping intervals that cover all the intervals in the input.

**以數組** intervals **表示若干個區間的集合，其中單個區間為** intervals[i] = [$start_i, end_i$] **。請你合併所有重疊的區間，並返回一個不重疊的區間數組，該數組需恰好覆蓋輸入中的所有區間。**

Example 1:

```
Input: intervals = [[1,3],[2,6],[8,10],[15,18]]
Output: [[1,6],[8,10],[15,18]]
Explanation: Since intervals [1,3] and [2,6] overlaps, merge them into [1,6].
```

Example 2:

```
Input: intervals = [[1,4],[4,5]]
Output: [[1,5]]
Explanation: Intervals [1,4] and [4,5] are considered overlapping.
```

Constraints:

1. 1 <= intervals.length <= $10^4$
2. intervals[i].length == 2
3. 0 <= $start_i$ <= $end_i$ <= $10^4$

## 3.2 LeetCode 56. 思路總結

**先按照區間起點進行排序。然後從區間起點小的開始掃描，依次合併每個有重疊的區間。**

## 3.3 LeetCode 56. Code 範例

LeetCode 56. Python

```python
from typing import List
class Solution:
    def merge(self, intervals: List[List[int]]) -> List[List[int]]:
        intervals.sort()
        ans = [intervals[0]]
        L, R = 1, 0
        while L < len(intervals):
            if ans[R][1] < intervals[L][0]:
                ans.append(intervals[L])
                L += 1
                R += 1
            else:
                ans[R] = [ans[R][0], max(ans[R][1], intervals[L][1])]
                L += 1
        return ans
```

## 3.4 LeetCode 56. 結果

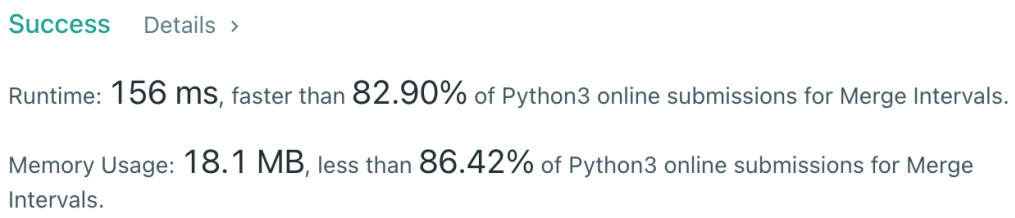


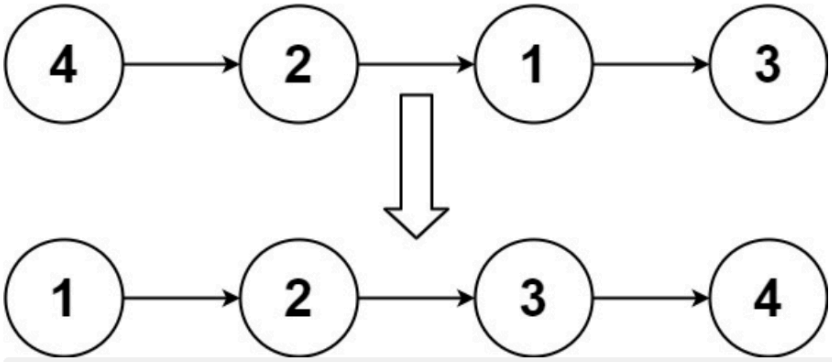

Fig. 2. LeetCode 56 結果

# 4 LeetCode 148. Sort List 排序鍊錶

## 4.1 LeetCode 148. 題目

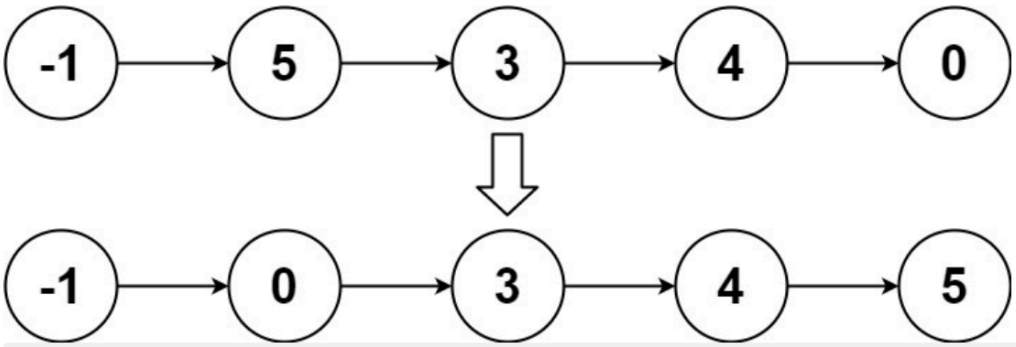
Given the head of a linked list, return the list after sorting it in ascending order.
給你鍊錶的頭結點 head ，請將其按升序排列並返回排序後的鍊錶。

**Example 1:**




```
Input: head = [4,2,1,3]
Output: [1,2,3,4]
```

**Example 2:**




```
Input: head = [-1,5,3,4,0]
Output: [-1,0,3,4,5]
```

Fig. 3. Example

Example 1:

```
Input: head = [4,2,1,3]
Output: [1,2,3,4]
```

Example 2:

```
Input: head = [-1,5,3,4,0]
Output: [-1,0,3,4,5]
```

Example 3:

```
Input: head = []
Output: []
```

Constraints:

1. The number of nodes in the list is in the range [0, 5 * $10^4$].(**鍊錶中節點的數目在範圍** [0, 5 * $10^4$])
2. $-10^5$ <= Node.val <= $10^5$

Follow up: Can you sort the linked list in O(n logn) time and O(1) memory (i.e. constant space)?
**你可以在** O(n log n) **時間複雜度和常數級空間複雜度下，對鍊錶進行排序嗎？**

## 4.2 LeetCode 148. 思路總結

**歸併排序..**

## 4.3 LeetCode 148. Code 範例

```python
# Definition for singly-linked list.
class ListNode:
    def __init__(self, val=0, next=None):
        self.val = val
        self.next = next

class Solution:
    def sortList(self, head: ListNode) -> ListNode:
        h_head = ListNode(-1, head)
        mem = []
        while(head is not None):
            next_h = head.next
            head.next = None
            mem.append(head)
            head = next_h
        mem = sorted(mem, key=lambda x: x.val)
        n = len(mem)
        if n == 0:
            return None
        h_head.next = mem[0]
        for i in range(n-1):
            mem[i].next = mem[i+1]
        return h_head.next
```

## 4.4 LeetCode 148. 結果

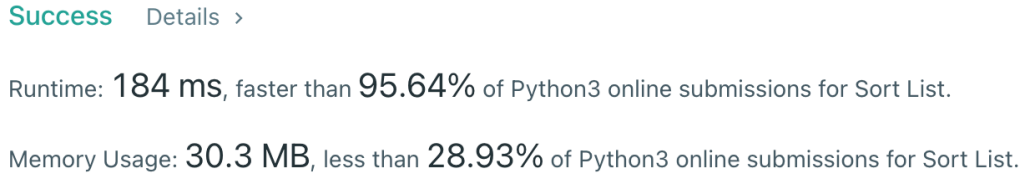



Fig. 4. LeetCode 148 結果

# 5 LeetCode 274. H-Index, H 指數點

## 5.1 LeetCode 274. 題目

Given an array of integers citations where citations[i] is the number of citations a researcher received for their ith paper, return compute the researcher's h-index.

According to the definition of h-index on Wikipedia: A scientist has an index h if h of their n papers have at least h citations each, and the other n − h papers have no more than h citations each.

If there are several possible values for h, the maximum one is taken as the h-index.

給你一個整數數組 citations ，其中 citations[i] 表示研究者的第 i 篇論文被引用的次數。計算並返回該研究者的 h 指數。

根據維基百科上 h 指數的定義：h 代表“高引用次數”，一名科研人員的 h 指數是指他（她）的（n 篇論文中）總共有 h 篇論文分別被引用了至少 h 次。且其餘的 n - h 篇論文每篇被引用次數不超過 h 次。

如果 h 有多種可能的值，h 指數是其中最大的那個。

Example 1:

```
Input: citations = [3,0,6,1,5]
Output: 3
Explanation: [3,0,6,1,5] means the researcher has 5 papers in total and each of
    them had received 3, 0, 6, 1, 5 citations respectively.
Since the researcher has 3 papers with at least 3 citations each and the
    remaining two with no more than 3 citations each, their h-index is 3.

給定數組表示研究者總共有 5 篇論文，每篇論文相應的被引用了 3, 0, 6, 1, 5 次。
由於研究者有 3 篇論文每篇 至少 被引用了 3 次，其餘兩篇論文每篇被引用 不多於 3
    次，所以她的 h 指數是 3。
```

Example 2:

```
Input: citations = [1,3,1]
Output: 1
```

Constraints:

1. n == citations.length
2. 1 <= n <= 5000
3. 0 <= citations[i] <= 1000

Follow up: Could you do this in one pass?(你能嘗試使用一趟掃描實現嗎？)

## 5.2 LeetCode 274. 思路總結

可以先將數組裡面的數從小到大排序。因為要找最大的 h-index，所以從數組末尾開始往前找，找到第一個數組的值，小於，總長度減去下標的值，這個值就是 h-index。

## 5.3 LeetCode 274. Code 範例

```
class Solution(object):
    def hIndex(self, citations):
        index = 0
        citations.sort(reverse=True)
        for i in citations:
```

```
6             if i > index:
7                 index +=1
8         return index
```

## 5.4 LeetCode 274. 結果

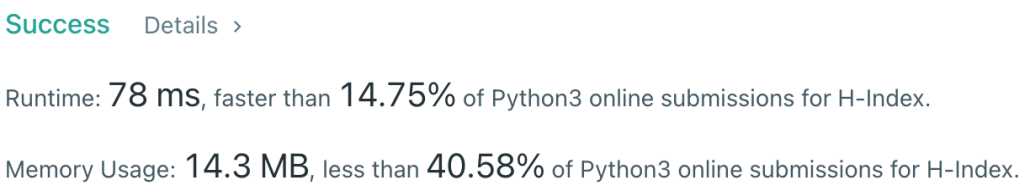



Fig. 5. LeetCode 274 結果