

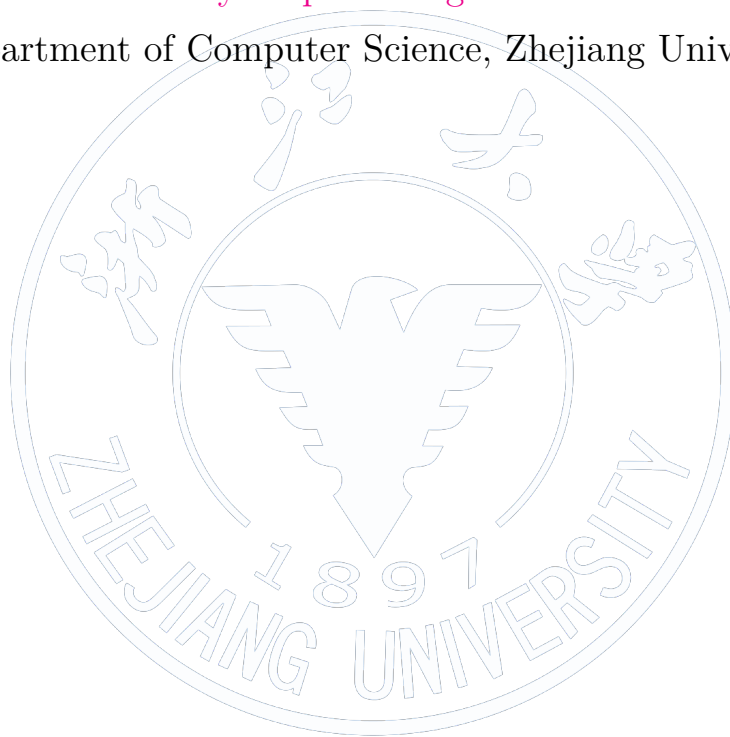
資料結構

Data Structure

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1 Overview

1. 本文頁碼標記依照 TKB 筆記 [2] 的頁碼。

2. TKB 筆記 [2] 章節頁碼：

Chapter	Page No.	Importance
1	3	***
2	259	*
3	52	***
4	259	*
5	82	*****
6	228	*****
7	180	*****
8	221	***
9	129	*****

3.

$$\log 2 = 0.3010$$

$$\log 3 = 0.4771$$

$$\log 5 = 0.6990$$

$$\log 7 = 0.8451$$

(1)

4. OBST 在「演算法」中，不再贅述。

Trees				
Tree	Insert x	Delete x	Search x	Remark
BST	$O(\log n) \sim O(n)$			Create: $O(n \log n) \sim O(n^2)$
AVL tree	$O(\log_m n)$			$F_{h+2} - 1 \leq n \leq 2^h - 1$
B tree				$1 + 2^{\frac{\lceil \frac{m}{2} \rceil^{h-1} - 1}{\lceil \frac{m}{2} \rceil - 1}} \leq n \leq \frac{m^h - 1}{m - 1}$
RBT				$h \leq 2 \log(n + 1)$
Splay tree				Worst: $O(n)$, Amortized: $O(\log n)$

Priority queues					
Operations	Max (Min)	Min-max & Deap & SMMH	Leftist	Binomial	Fibonacci
Insert x	$O(\log n)$	$O(\log n)$	$O(\log n)$	$O(\log n), O(1)^*$	$O(1)^*$
Delete max	$O(\log n)$	$O(\log n)$			
Delete min	$O(n)$	$O(\log n)$	$O(\log n)$	$O(\log n)$	$O(\log n)^*$
Delete x				$O(\log n)$	$O(\log n)^*$
Merge	$O(n)$		$O(\log n)$	$O(\log n)$	$O(1)^*$
Decrease key				$O(\log n)$	$O(1)^*$
Search x	$O(n)$				
Find max	$O(1)$	$O(1)$			
Find min		$O(1)$		$O(\log n)$	$O(1)$
Remark			$\text{shortest}(\text{root}) \leq \log(n+1) - 1$		

Sorting algorithms					
Method	Time complexity			Space complexity	Stable
	Best	Worst	Average		
Insertion	$O(n)$	$O(n^2)$		$O(1)$	✓
Selection	$O(n^2)$			$O(1)$	×
Bubble	$O(n)$	$O(n^2)$		$O(1)$	✓
Shell	$O(n^{1.5})$	$O(n^2)$		$O(1)$	×
Quick	$O(n \log n)$	$O(n^2)$	$O(n \log n)$	$O(\log n) \sim O(n)$	×
Merge	$O(n \log n)$			$O(n)$	✓
Heap	$O(n \log n)$			$O(1)$	×
LSD Radix	$O(n \times k)$			$O(n + k)$	✓
Bucket/MSD Radix	$O(n)$	$O(n^2)$	$O(n + k)$	$O(n \times k)$	✓
Counting	$O(n + k)$				✓

2 Summary

1. Theorem (17) Permutation:

```
1: function PERM(list, i, n)
2:   if i == n then
3:     PRINT(list)
4:   else
5:     for j := i to n do
6:       SWAP(list, i, j)
7:       PERM(list, i + 1, n)
8:       SWAP(list, i, j)
9:     end for
10:  end if
11: end function
```

2. Theorem (87) 節點數:

$$n = \left(\sum_{i=1}^{\deg} i \times n_i \right) + 1$$

$$n_0 = n_2 + 1 \text{ (二叉樹)}$$

(2)

3. Theorem (116)

```

1: function CREATEMINHEAP(Tree s, size n)
2:   for i := n/2 to 1 do                                ▷ Start from parent of the last node.
3:     tmp := s[i]
4:     j := 2 × i                                          ▷ Left child of i.
5:     while j ≤ n do                                    ▷ There is a child.
6:       if j < n then                                    ▷ Right child exists.
7:         if s[j] > s[j + 1] then                        ▷ Choose the smaller child.
8:           j := j + 1
9:         end if
10:      end if
11:      if tmp ≤ s[j] then
12:        Break.
13:      else                                              ▷ Percolate one level.
14:        s[j/2] := s[j]
15:        j := j × 2
16:      end if
17:    end while
18:    s[j/2] := tmp
19:  end for
20: end function

```

4. **Theorem (257)** 尋找 articulation point: 若 root 有 ≥ 2 子節點, 則 root 為 articulation point; \exists 非 root 節點 u , 若 $\exists v$ 為 u 子節點, 且 $low(v) \geq dfn(u)$, 則 u 為 articulation point.

5. **Theorem ()**

- AVL trees are ideal for sorting items of an **ordered dictionary**.
- Different number binary trees of height h :

$$H_n = \begin{cases} 2H_{n-1} \times \sum_{i=0}^{h-2} H_i + H_{i-1}^2 & , h \geq 2 \\ H_0 = 1, H_1 = 3 \end{cases} \quad (3)$$

- *vector* in C++ STL is similar to regular array that it supports direct access.
 - Elements in *vector* is stored in consecutive memory.
 - If we make a sequence of n insertions, there is a way that we can achieve $\Theta(n)$ amortized cost.
- (105NYCU-16) We can use **array** to implement **any** data structure, even user-defined structure.

- (110NTU-1) (**FALSE**) Quicksort where the leftmost or rightmost element is always chosen as pivot CAN the worst-case occur.



References

- [1] Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. *Introduction to Algorithms, Third Edition*. The MIT Press, 3 edition, 2009.
- [2] wjungle@ptt. 資料結構 @tkb 筆記. <https://drive.google.com/file/d/0B8-2o6L73Q2VeFpGejlYRk1WeFk/view?usp=sharing>, 2017.

