



### My Notes

Important Concepts worth keeping

## Binomial Heap : Delete

head [H] → ② → ① → ⑦

結果:

head [H] → ⑩ → ⑦

So in everything, do to others what you would have them do to you... (New Testament)

### My Questions

Problems & Difficulties needing exploration

	Insertion	Deletion	Retrieval	Traversal
Unsorted array based	$O(1)$	$O(n)$	$O(n)$	$O(n)$
Unsorted pointer based	$O(1)$	$O(n)$	$O(n)$	$O(n)$
Sorted array based	$O(n)$	$O(n)$	$O(\log n)$	$O(n)$
Sorted pointer based	$O(n)$	$O(n)$	$O(n)$	$O(n)$
Binary search tree	$O(\log n)$	$O(\log n)$	$O(\log n)$	$O(n)$
Hashing	$O(1)$	$O(1)$	$O(1)$	$O(n)$

### My Opinions

Thoughts, inspirations, and suggestions

Balanced Binary Tree:

1. 2-3 tree
2. 2-3-4 tree
3. AVL tree
4. Red-Black tree

所以無論何事，你們也要人怎樣待你們，你們也要怎樣待人。 (馬太福音)

### My Notes

Important Concepts worth keeping

## 2-3 tree

Insertion:

1. Locate the leaf at which the search for I would terminate.
2. Insert the new item I into the leaf.
3. If the leaf now contains only two items, then done.
4. If the leaf now contains three items, split the leaf into two nodes.

Deletion: 如果 delete 內部節點，先 swap 中序後繼者，再 delete leaf.

(a) Redistribute values

(b) Merge into a leaf

(c) Redistribute values and children

8 Begin from the end in mind. —Steven Covey

### My Questions

Problems & Difficulties needing exploration

## 2-3-4 tree

Insertion:

\* 只要遇到滿的就分裂，故不需要遞迴。

Deletion: 如果不是在 leaf 刪除，就和中序後繼者交換再刪除。

\* 只要只有 1 個 key 就合併，之後再刪除。  
if 兄弟節點有 2 個 key 就 rotate

Summary:

優點：樹高較 2-3 樹矮

缺點：用空間換時間 (同 2-3 tree)

### My Opinions

Thoughts, inspirations, and suggestions

2-3 tree & 2-3-4 tree Summary:

1. 一個節點內可以放不只 1 個 key。
2. 很容易達到平衡。(優)
3. 空間上會有浪費 (空間換時間) 但效率是好的。(缺)

總結功：以經為始  
—史提芬·柯維



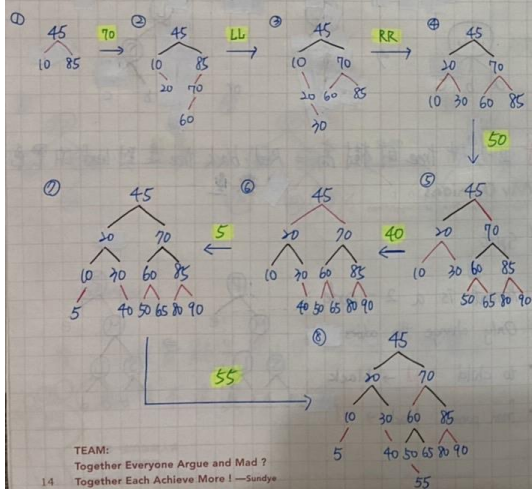


Important Concepts worth keeping

Color change +

- ① LL Rotation
- ② RR Rotation
- ③ LR Rotation
- ④ RL Rotation

\* 45, 85, 10, 70, 20, 60, 30, 50, 65, 80, 90, 40, 5, 55

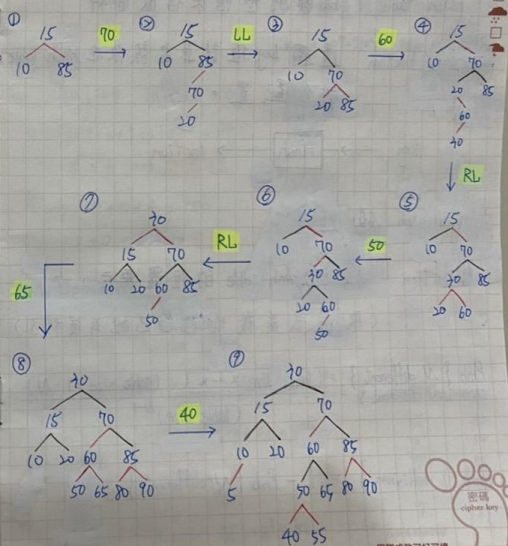


TEAM:  
Together Everyone Argue and Mad ?  
Together Each Achieve More ! —Sundya

### Problems & Difficulties needing exploration

\* 2條連續紅線就 Rotate.

\* 15, 85, 10, 70, 20, 60, 30, 50, 65, 80, 90, 40, 5, 55



團隊成效可好可壞，  
運作之妙在於一心。