Readings Part III (Intro), Sections 12.1, 12.2, 12.3
Self test Exercises 12.2-3, 12.3-1

Lecture 05

Dictionaries

keys: 5 7 2 0 20 4 9

Objects:= Sets s where each element x has field `x.key` - some totally ordered value. Keys are distinct.

Operations:

- `search(S,k)`: return $x \in S$ s.t. $x.key = k$, or NIL if no such x
- `delete(S,x)`: remove x from S (given element $x \in S$ not just $x.key$ or the values in the element)
  Q: Why not `delete(S,k)`?
  A: Achieved with `delete(S,search(S,k))`, separates "searching phase" from "deletion" phase, making it possible to analyse each one seperately
  Notice that `delete` assumes that we not only know the element x's values but that we have a pointer to the actual element x in the data structure.
- `insert(S,x)`: insert x in S; if some $y \in S$ has $y.key = x.key$, replace y by x

5	7	2	8	20	4	9	size[7]

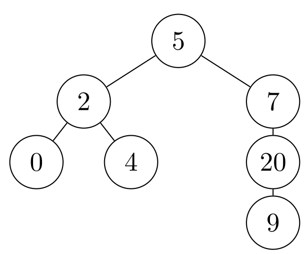
Complexity of `search`, `insert` for unsorted array $\in \Theta(n)$, `delete` $\in \Theta(1)$

0	2	4	5	7	9	30	size[7]

Complexity of `search` (binary) $\in \Theta(\log n)$, `insert`, `delete` $\in \Theta(n)$

head $\rightarrow 5 \leftrightarrow 7 \leftrightarrow 2 \leftrightarrow 0 \leftrightarrow 20 \leftrightarrow 4 \leftrightarrow 9$
Complexity of `search`, `insert` $\in \Theta(n)$, `delete` $\in \Theta(1)$

head $\rightarrow 0 \leftrightarrow 2 \leftrightarrow 4 \leftrightarrow 5 \leftrightarrow 7 \leftrightarrow 9 \leftrightarrow 20$
Complexity of `search`, `insert` $\in \Theta(n)$, `delete` $\in \Theta(1)$



Complexity of `search` $\in O(h)$

Summary

Data Structure	`search`	`insert`	`delete`
unsorted array	n	n	1
sorted array	$\log n$	n	n
unsorted singly-linked list	n	n	n
unsorted doubly-linked list	n	n	1
sorted doubly-linked list	n	n	1
binary search tree	n	n	n
balanced search tree	$\log n$	$\log n$	$\log n$
direct-access table(+)	1	1	1
hash table	n	n	n

(+) $\rightarrow$ all have space complexity $O(n)$ except direct-access tables, which require space equal to size of universe, e.g., if keys are 32-bit integers, a direct-access table requires space $\Omega(2^{32}$.