Lists Stacks & Queues

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Overview I

Comparisons

- Is a linear data structure.
- A List is a collection where the elements are ordered and therefore each element has an index which is the position in the list. Allows duplicates.
- A Set is an unordered collection in which no two elements are identical.
- A Bag is an unordered collection in which can have duplicates.

	Linked List	Array based
Access	$\Theta(n)$	$\Theta(1)$
Insertion	$O(n)$	$O(1)$
Deletion	$O(n)$	$O(n)$

Amortized Analysis

- In Amortized analysis, the time taken to execute a sequence is averaged over all the operations executed.
- Even though one of the operations in the sequence might take a long time, the average time taken over all operations is small.
- This is not the same as the average case.
- This guarantees the average performance of each operation in the worst-case.

Stacks

- It's a list structure where all operations occur on one end of the list, known as the top of the stack.
- To add an element is called a push operation.
- To remove an element is called a pop operation.
- To get the element at the top of the stack is called a top operation.

Array implementation

- Requires a means of handling array overflow, i.e. double size of array when full.
- `push()` has an amortized complexity of $O(1)$ in the worst case.
- `top()` does not alter the stack at all and simply gives the top element, this is $O(1)$ in the worst case.
- `pop()` only alters the last element, nothing is shifted and therefore has complexity $O(1)$ in the worst case.

Linked-list implementation

- `push()` has a complexity of $O(1)$ in the worst case, this is NOT amortized due to the lack of array overflow requirement.
- `top()` has $O(1)$ complexity in the worst case.
- `pop()` has $O(1)$ complexity in the worst case.

Parenthesis checking

- Stacks can be used to determine is parenthasis match correctly or not. e.g. $[a(b+c)da/c+e]/b$
- Use a stack to push the left side of the parenthesis and when the right side has been found, pop the parenthasis.
- When an item is popped, it is compared to the found parenthesis and if they are of the same type, then it's matching.

Intro

- A FIFO (First In First Out) queue is where the item at the front of the queue is used first.
- A new arrival joins the end.
- All insertions are made at one end of the list, known as the rear of the queue.
- The insertion method is known as an enqueue operation.
- All remoovals happen at the other end of the wueue known as the the front of the queue.
- The removal method is known as a dequeue operation.

Circular Array implementation

- Representing a queue in a traditional array such that the queue elements march through the array in one direction is not very convenient.
- This keeps track of the front rear points of the queue pointing to their respective positions.
- enqueue adds the element to `rearPos + 1%arrSize`.
- If the queue length is equal to `arrSize`, then the array is doubled in size, when copying elements over, they are copied in queue order and the front and rear keep pointing to their resepctive elements.
- dequeue simply removes the element pointed at by the `frontPos` and increments the front pointer to `frontPos = (frontPos + 1)% arrSize`.

Linked List implementation

- Keep track of front and rear nodes.
- enqueue Will create a new node and the current rear node points to the new node. The rear is then changed to point at the new node.
- dequeue simply removes the node pointed at by front and front points at the next node.

The End