COL106 - Data Structures and Algorithms

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Basic Data Structures

LIST ADT

- Arrays
  - Dynamic Arrays
- Linked List
  - Singly Linked List
  - Doubly Linked List

Specialized ADTs

- Stacks (~~FIFO~~) LIFO
- Queues (~~LIFO~~) FIFO

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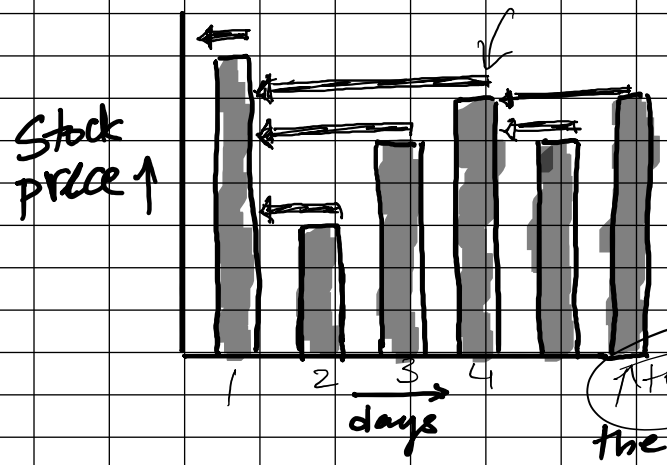
Consider Stock Trading



We are interested in knowing for each day, what are the no. of consecutive sequence of previous days when the stock price is less than that days.

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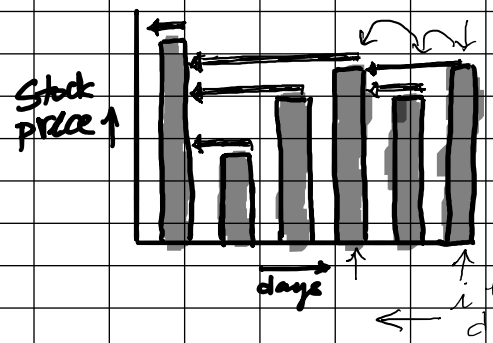
$O(n^3)$

Consider Stock Trading



Let's say we are on i-th day.

⊛ Starting from the previous day keep increasing the window of time past as long as the stock price is lower.

loop runs for (i-1) times

```
i-th day.
let S ← 1
for ((S ≤ i) && StockPrice[i-S] ≤ StockPrice[i])
    S ← S+1
Span[i] ← S
```

ith day span is stored in array Span.

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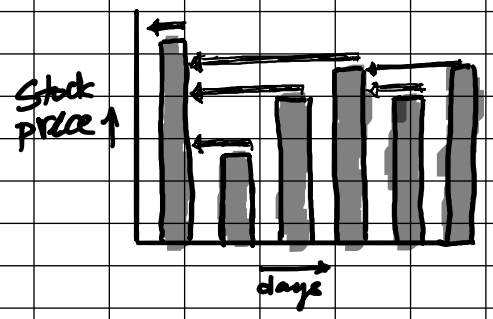
Consider Stock Trading



Let's say we are on i-th day.

* Starting from the previous day keep increasing the window of time past as long as the stock price is lower.

Over all values of i ⇒ $O(n^2)$

```
i-th day.
let S ← 1
for (S ≤ i && StockPrice[i-S] ≤ StockPrice[i])
    S ← S+1
Span[i] ← S
```

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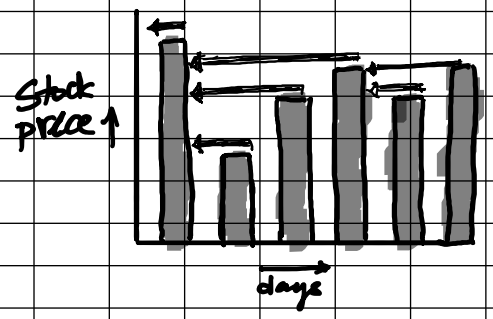
Consider Stock Trading



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```
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for (S ≤ i && StockPrice[i-S] ≤ StockPrice[i])
    S ← S+1
Span[i] ← S
```

Can we do better?

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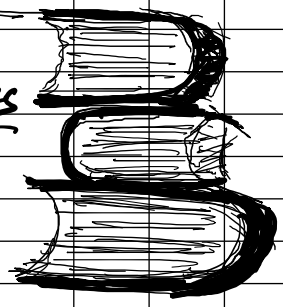
Stack ADT

- Stores Objects
- Insertions & deletions are strictly "Last in - First out"

A stack of books



That book you bought first but too afraid to read :-)

or a stack of plates

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Stack ADT

- Stores Objects
- Insertions & deletions are strictly "Last in - First out"

Two operations on stacks

push (x) : inserts object x

pop () : removes the last inserted object from the stack and returns it.

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Stack ADT

- Stores Objects
- Insertions & deletions are strictly "Last in - First out"

Two operations on stacks

push(x) : inserts object x

pop() : removes the last inserted object from the stack and returns it. ← return will in the end

Additionally,

top() : returns the last inserted object

size() :

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Stack Class in Java

```
public class Stack<E> .... {
    boolean ~~empty()~~;  isEmpty();
    E       peek ();      // same as top()
    E       pop ();
    E       push (E o);
    :
}
```

If the stack is empty, pop() and top() return null.

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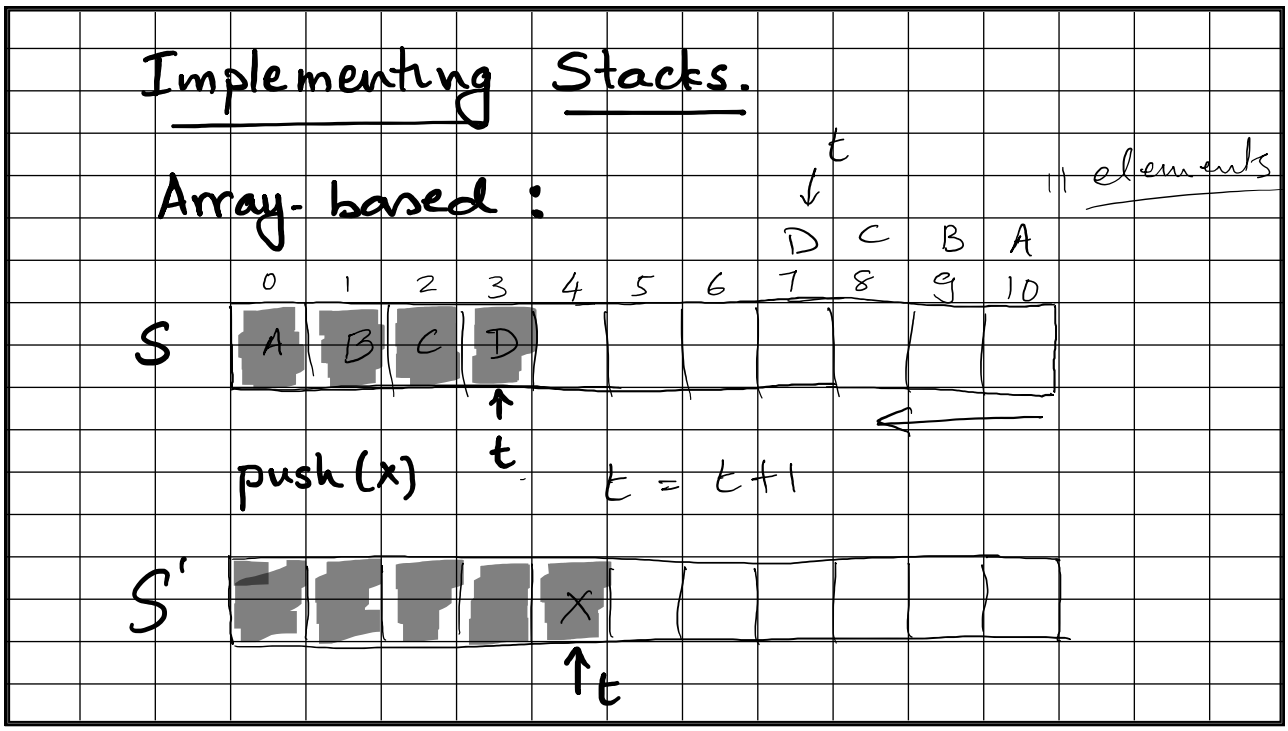
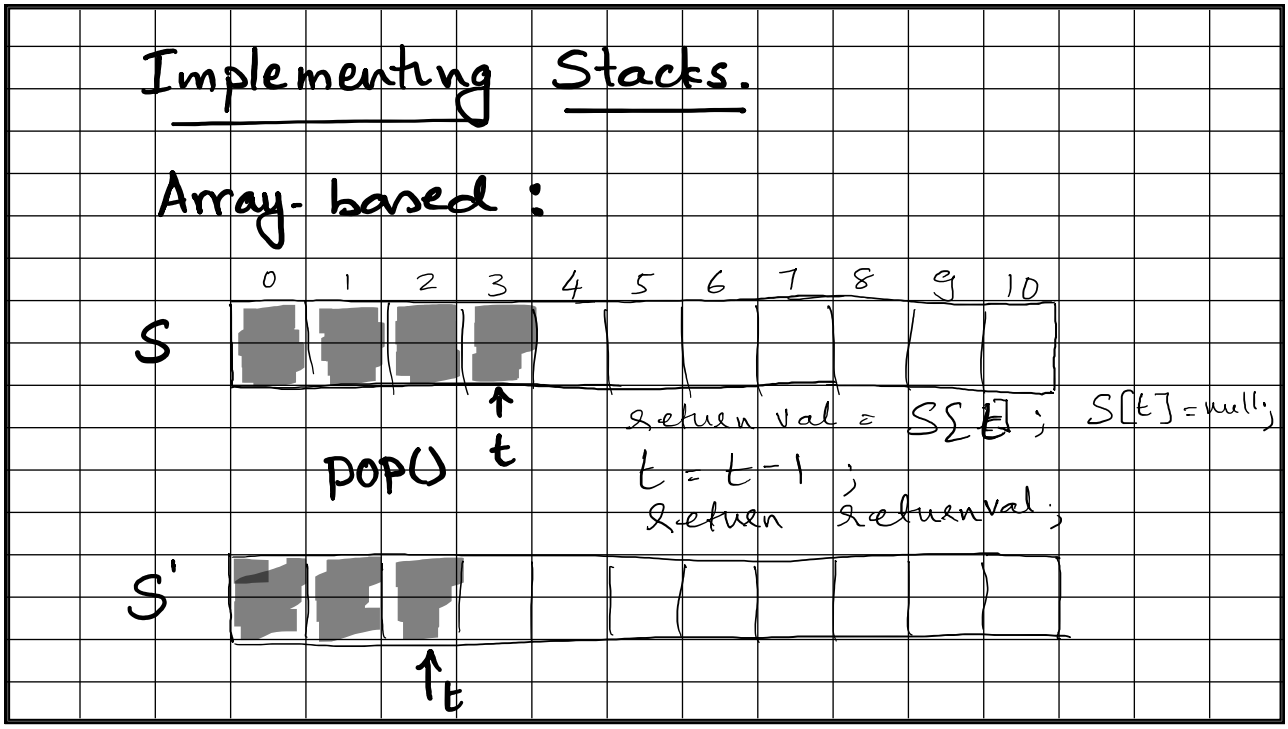

Implementing Stacks.
Array-based:
t
D C B A
11 elements
0 1 2 3 4 5 6 7 8 9 10
S
A B C D
t
push(x)
t = t+1
S'
X
t

11


Implementing Stacks.
Array-based:
0 1 2 3 4 5 6 7 8 9 10
S
t
pop()
return val = S[t]; S[t] = null;
t = t-1;
return returnval;
S'
t

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Array-based Stack

```
pop() {
    if (isEmpty()) then
        return null;
    t ← t-1;
    return S[t+1];
}
```

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Array-based Stack

```
pop() {                          // isEmpty(): (t == -1)
    if (isEmpty()) then
        return null;
    t ← t-1;
    return S[t+1];
}
```

O(1)

```
push(X) {
    if (t == S.length-1)
    then
        throw Exception;
    t ← t+1;
    S[t] ← X;
}
```

O(1)

* Maximum size of the Stack is defined apriori cannot be (easily) changed.

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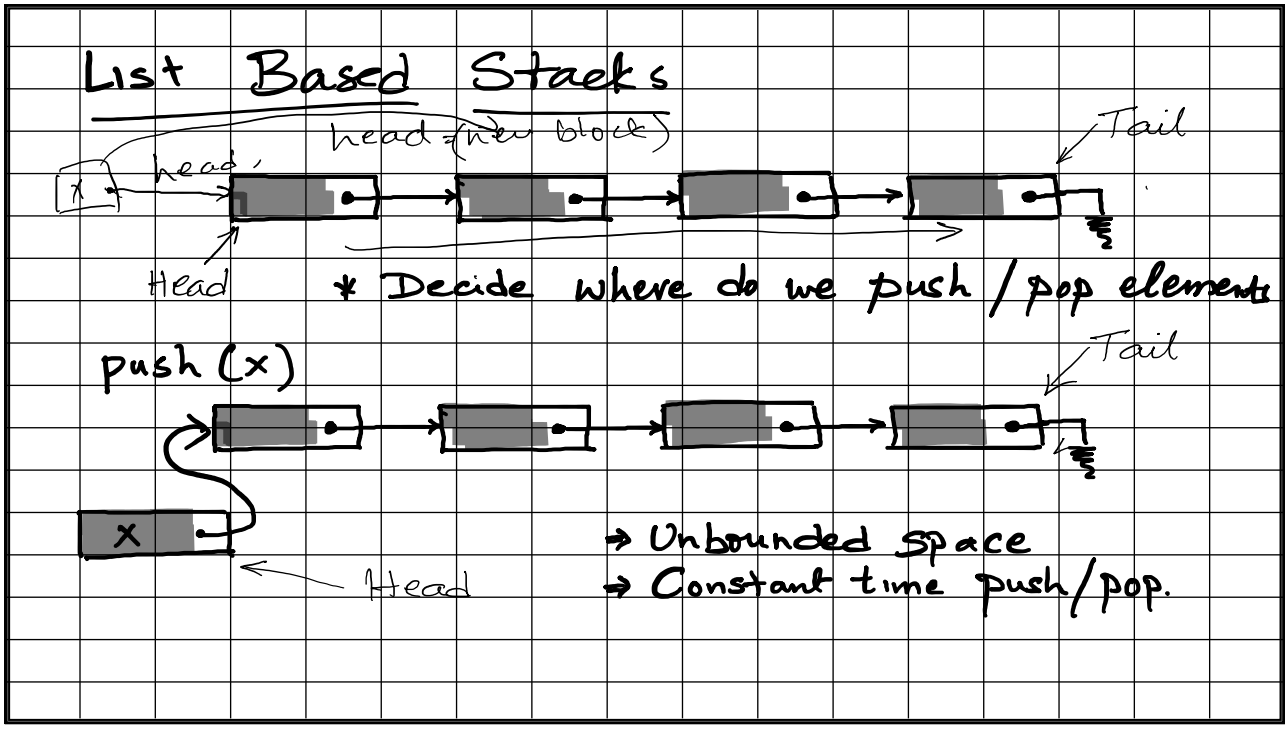
List Based Stacks
head (new block)
head
Tail
Head
* Decide where do we push / pop elements
push (x)
Tail
x
Head
→ Unbounded space
→ Constant time push/pop.

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