Stack

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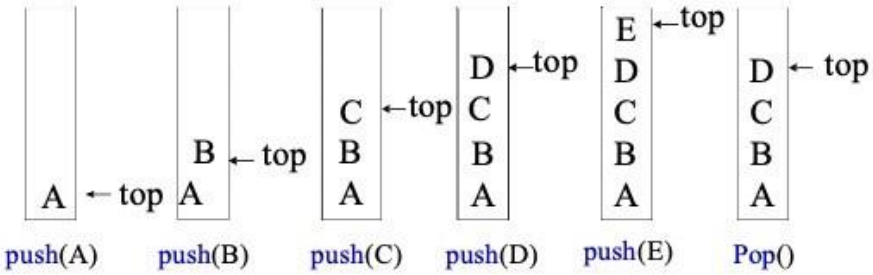
Stack

- A stack is a last in, first out (LIFO) data structure
  - Items are removed from a stack in the reverse order from the way they were inserted.

Stack: Last In First Out

- A *stack* is a list with the restriction that insertions and deletions can be performed in only one position, namely, the *top* of the stack.
- The operations: push (insert) and pop (delete)



Application of Stack

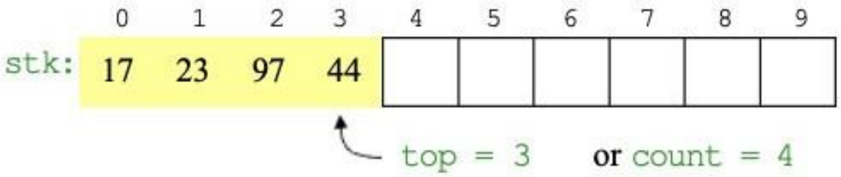
- Direct applications
  - Page-visited history in a Web browser
  - Undo sequence in a text editor
  - Saving local variables when one function calls another, and this one calls another, and so on.

- Indirect applications
  - Auxiliary data structure for algorithms
  - Component of other data structures

Array Implementation of Stack

- To implement a stack, items are inserted and removed at the same end (called the top)
- To use an array to implement a stack, you need both the array itself and an integer
  - The integer tells you either:
    - Which location is currently the top of the stack, or
    - How many elements are in the stack

Stacks by Array: Push and Pop



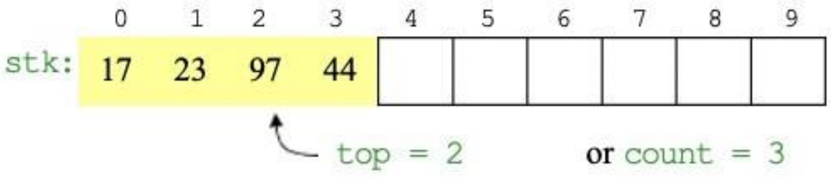
	0	1	2	3	4	5	6	7	8	9
stk:	17	23	97	44						

top = 3 or count = 4

- If the bottom of the stack is at location 0, then an empty stack is represented by

  top = -1 or count =0
- To add (push) an element, either:
  - Increment top and store the element in stk[top], or
  - Store the element in stk[count] and increment count
- To remove (pop) an element, either:
  - Get the element from stk[top] and decrement top, or
  - Decrement count and get the element in stk[count]

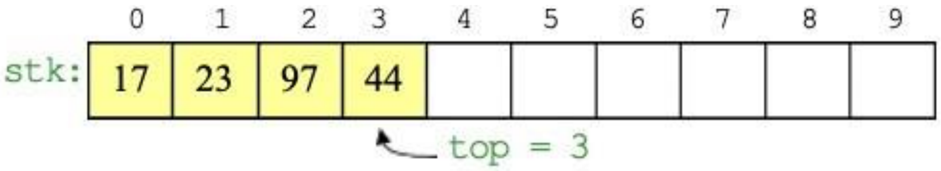
Stacks by Array: After Popping



- When you pop an element, do you just leave the “deleted” element sitting in the array?
- The surprising answer is, *“it depends”*
  - If this is an array of primitives, *or* if you are programming in C or C++,
  - *then* doing anything more is just a waste of time
  - If you are programming in Java, and the array contains objects, you should
    set the “deleted” array element to null
  - Why? To allow it to be garbage collected!

Stacks by Array: Error Checking

- There are two stack errors that can occur:
  - Underflow: trying to pop (or peek at) an empty stack
  - Overflow: tryingto push onto an already full stack
- For underflow, you should throw an exception
  - You could create your own, more informative exception
- For overflow, you could do the same things
  - Or, you could check for the problem, and copy everything into a new, larger array



```
void push(int x){
    if(top >= n-1)
    printf("\n STACK over flow");
    else {
        top++;
        stk[top] = x;
    }
}
```

```
int pop() {
    int y;
    if(top <= -1)
      printf("\n Stack under flow");
    else {
        y = stk[top];
        top--;
        return y;
    }
}
```

Stack

- **Sample Question:** Show the status of a STACK implemented by an array of size, m=5 for the operations: push(10), push(20), pop(), push(30), push(40), pop(), pop(), pop().

Initial stack, top = -1

Push(10) , top = 0

10				

Push(20) , top = 1

10	20			

Pop() , top = 0

10				

Push(30) , top = 1

10	30			

Push(40) , top = 2

10	30	40		

Pop() , top = 1

10	30			

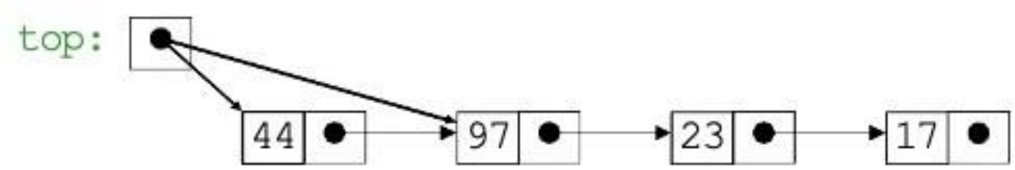
Pop() , top = 0

10				

Pop() , top = -1

Linked List Implementation of Stack

- Since all the actions happen at the top of a stack, a singly-linked list (SLL) is a fine way to implement it
- The header of the list points to the top of the stack
- Pushing is inserting an element at the front of the list
- Popping is removing an element from the front of the list

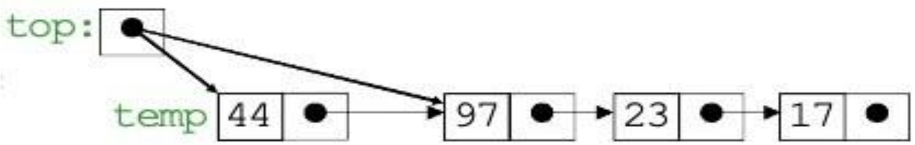


Linked List Implementation of Stack

- With a linked-list representation, overflow will not happen (unless you exhaust memory, which is another kind of problem)
- Underflow can happen, and should be handled the same way as for an array implementation
- When a node is popped from a list, and the node references an object, the reference (the pointer in the node) need to be set to null.

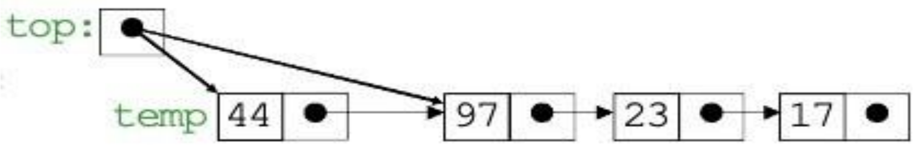
Push() Implementation – Linked List

```
struct Node {

int value;

struct Node* next;

};

struct Node* top;

void push(int data) {

struct Node* temp = (struct Node
*)malloc(sizeof(struct Node));

if (!temp){

cout << "\n Heap Overflow";

exit(1);

}

temp->value = data;

temp->next = top;

top = temp;

}
```



Pop() Implementation – Linked List

```
int pop(){
   struct Node*
   temp;
   int data;
   if (top == NULL) {
        cout << "\n Stack Underflow"
        << endl;
        exit(1);
   }
  else {
     data = top->value;
     temp = top;
     top = top->next;
     free(temp);
     return data;
  }
}
```



THANK YOU