

Stacks

Joseph Chuang-Chieh Lin (林莊傑)

Department of Computer Science & Engineering,
National Taiwan Ocean University

Fall 2025



Outline

1 Definition

2 Implementation

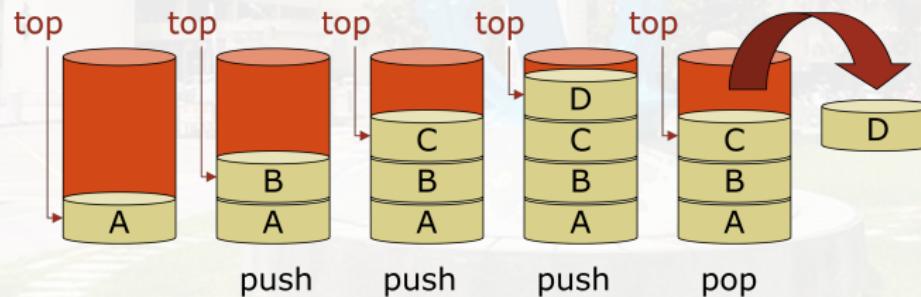
Outline

1 Definition

2 Implementation

Definition

- A stack is an ordered list in which **insertions** and deletions are made at the end “top”.
 - insertions: push/add
 - deletions: pop/remove
- Last-In-First-Out (LIFO).



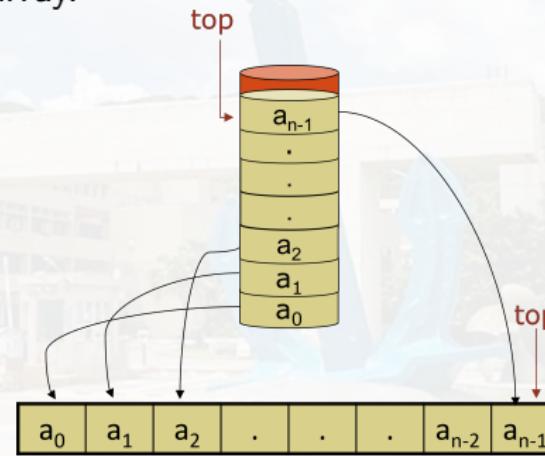
Outline

1 Definition

2 Implementation

Stack Implementation: Array

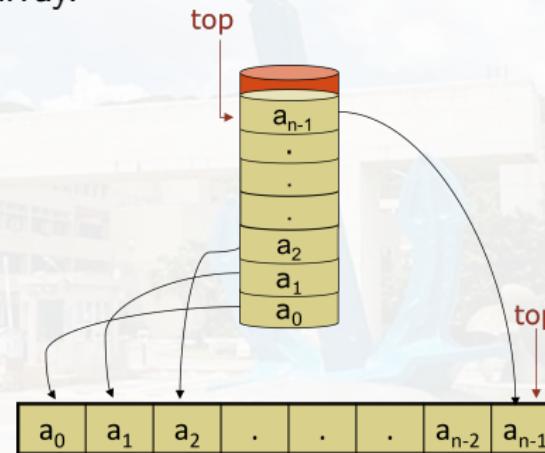
- The easiest way to implement the stack ADT is using one-dimensional array.



- An example in C++

Stack Implementation: Array

- The easiest way to implement the stack ADT is using one-dimensional array.



- An example in C++ (another way: using a linked list; will be introduced in the future).

Functions for Stacks

- Create a stack.
 - Create an empty stack with maximum size MAX_STACK_SIZE.

```
#define MAX_STACK_SIZE 101

typedef struct {
    int key; // can be of other types...
    /* other fields? */
} element;

element stack[MAX_STACK_SIZE];
int top = -1; // initially no element
```

Functions for Stacks (2/2)

- IsEmpty

- Return true if the stack is empty and false otherwise.



Functions for Stacks (2/2)

- IsEmpty
 - Return true if the stack is empty and false otherwise.
 $\text{top} < 0$
- IsFull
 - Return true if the stack is full and false otherwise.

Functions for Stacks (2/2)

- IsEmpty
 - Return true if the stack is empty and false otherwise.
`top < 0`
- IsFull
 - Return true if the stack is full and false otherwise.
`top >= MAX_STACK_SIZE-1;`
- Push (or Add)
 - Insert the element into the `top` of the stack.

Functions for Stacks (2/2)

- IsEmpty
 - Return true if the stack is empty and false otherwise.
`top < 0`
- IsFull
 - Return true if the stack is full and false otherwise.
`top >= MAX_STACK_SIZE-1;`
- Push (or Add)
 - Insert the element into the `top` of the stack.
`stack[++top] = element;`
- Pop (or Delete)
 - Remove and return the item on the top of the stack.

Functions for Stacks (2/2)

- IsEmpty
 - Return true if the stack is empty and false otherwise.
`top < 0`
- IsFull
 - Return true if the stack is full and false otherwise.
`top >= MAX_STACK_SIZE-1;`
- Push (or Add)
 - Insert the element into the `top` of the stack.
`stack[++top] = element;`
- Pop (or Delete)
 - Remove and return the item on the top of the stack.
`return stack[top--];`

isFull & isEmpty

```
bool isEmpty() {
    // note: bool type requires stdbool.h
    if (top == -1) return true;
    else return false;
}

bool isFull() {
    if (top >= MAX_STACK_SIZE-1) return true;
    else return false;
}
```

push & stackFull

```
void push(element item) {
    // add an item to the global stack
    if (top >= MAX_STACK_SIZE - 1) {
        stackFull();
    }
    stack[++top] = item;
}

void stackFull() {
    fprintf(stderr, "Stack is FULL!!!");
    exit(EXIT_FAILURE);
}
```

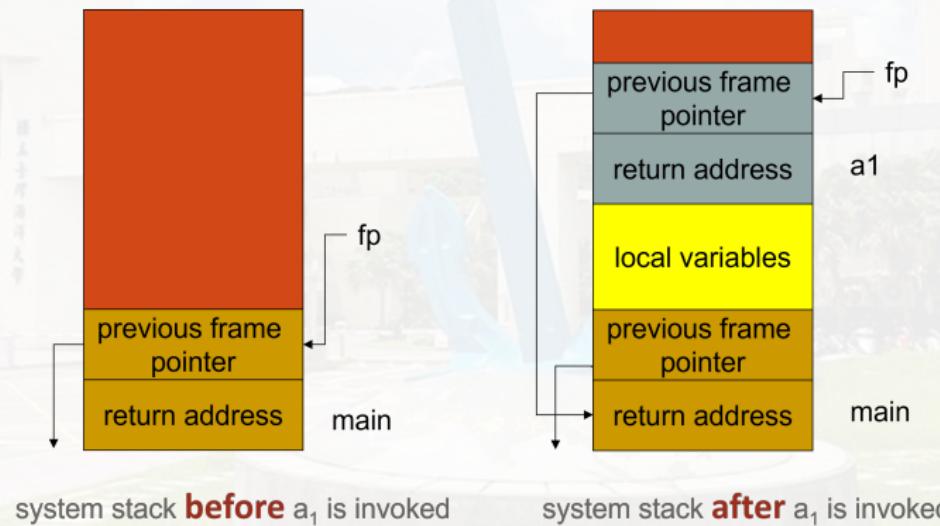
pop & stackEmpty

```
element pop() { // no argument is required!
    // return the top element from the stack
    if (top == - 1) {
        return stackEmpty(); // return an error key
    }
    return stack[top--];
}

element stackEmpty() {
    element errKey; // depending the struct of element
    errKey.key = -99;
    fprintf(stderr, "Stack is EMPTY!!");
    return errKey;
}
```

Supplementary: System Stack

- Stack frame of a function call



Easy Example: Summation from 1 to n

```
int sum(int n) {
    element result;
    result.key = 0;
    element tmp;
    tmp.key = n;
    push(tmp); // bootstrapping here!

    while (!isEmpty()) {
        tmp = pop(stack);
        result.key += tmp.key;
        tmp.key = tmp.key-1;
        if (tmp.key > 0) push(tmp);
    }
    return result.key;
}
```

Left Home Exercise: Fibonacci

- Try to use a stack to turn the following recursive function into a non-recursive one.

```
int Fibo(int n) {  
    if (n == 0) return 0;  
    else if (n == 1) return 1;  
    else return Fibo(n-1) + Fibo(n-2);  
}
```

Discussions

