CM1602 : Data Structures and Algorithms for AI

4. Stack

Lecture 4 | R. Sivaraman

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MODULE CONTENT

Lecture	Topic
Lecture 01	Introduction to Fundamentals of Algorithms
Lecture 02	Analysis of Algorithms
Lecture 03	Array and Linked Lists
Lecture 04	Stack
Lecture 05	Queue
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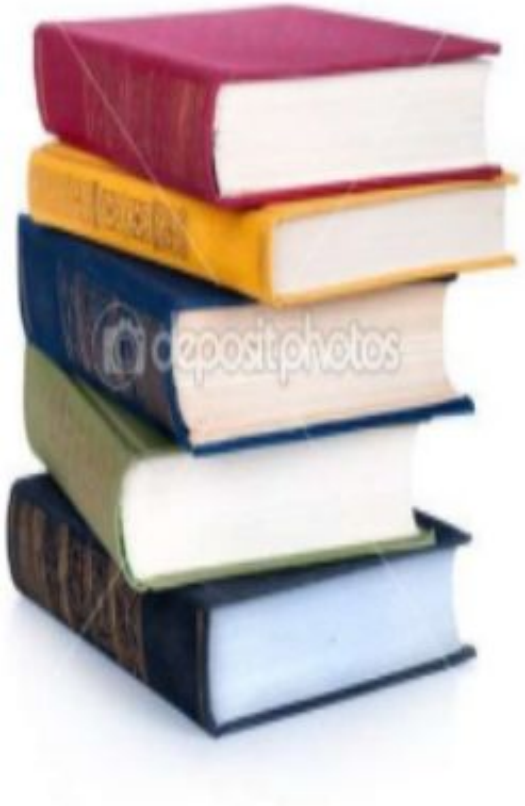
Lecture 07	Trees
Lecture 08	Maps, Sets, and Lists
Lecture 09	Graph algorithms

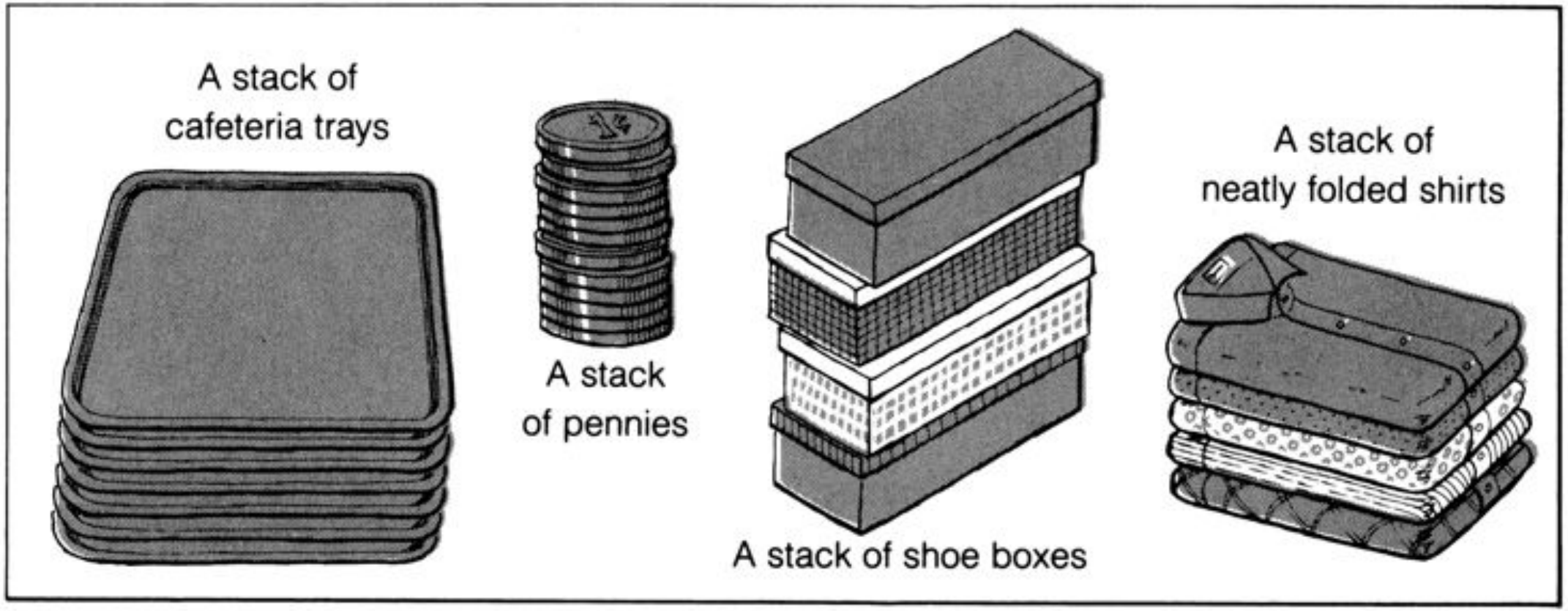
Learning Outcomes

- LO1 : Describe the fundamental concepts of algorithms and data structures.
- LO3 : Apply appropriate data structures given a real-world problem to meet requirements of programming language APIs.
- On completion of this lecture, students are expected to be able to:
  - Describe Stack and when stack is used
  - Implement Stack using an Array or Linked List

Introduction



Introduction

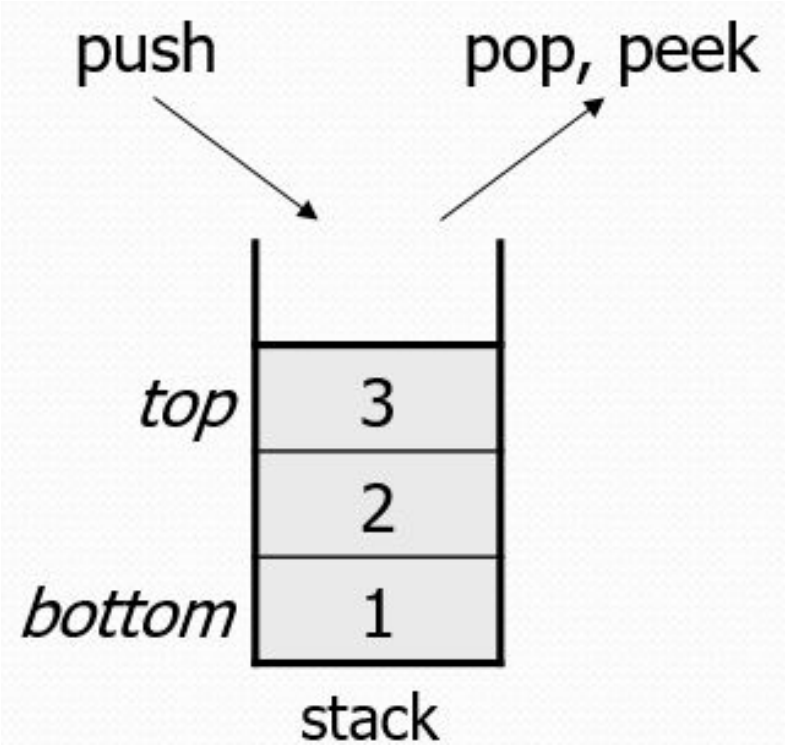


Introduction

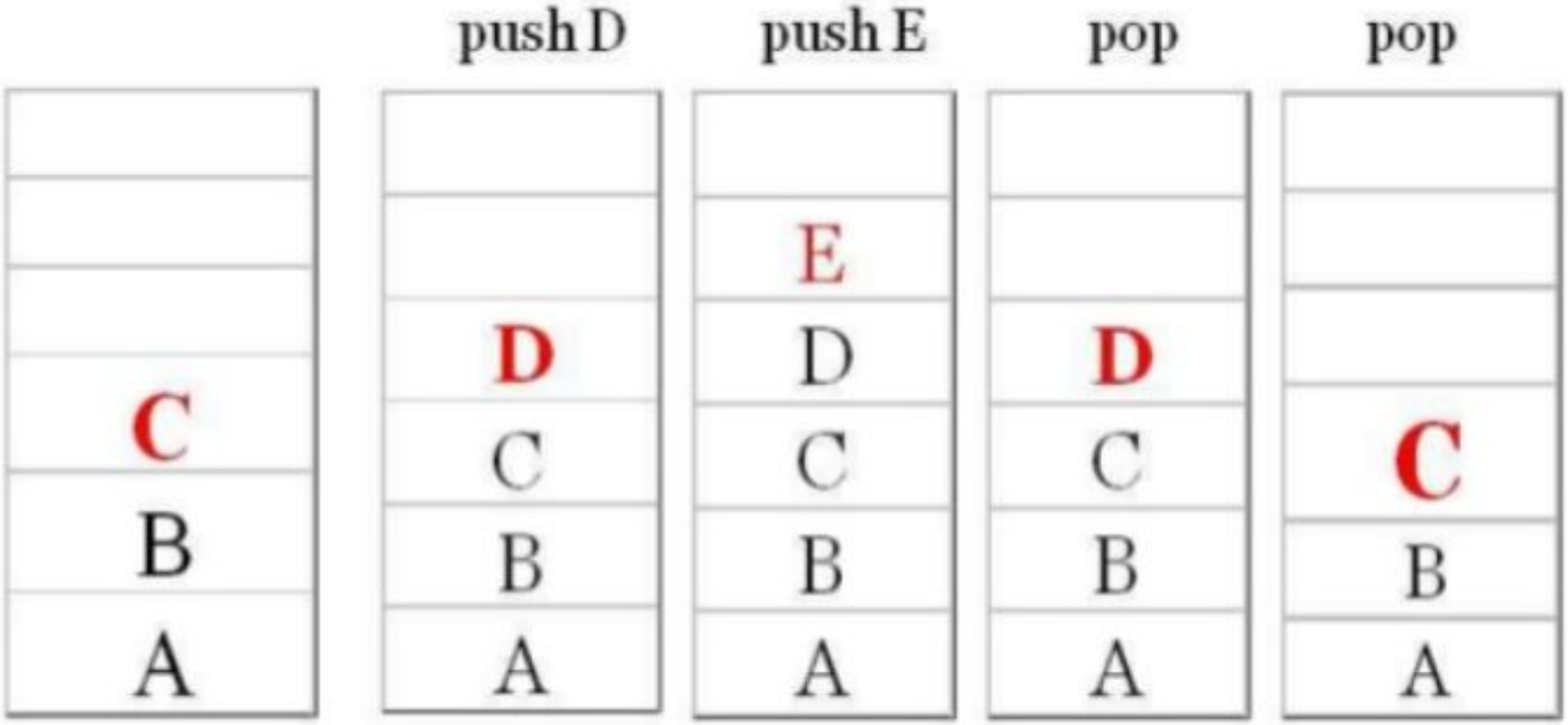
- Stack is a Linear Data Structure.
- It is an ordered group of homogeneous items of elements.
- Stack follows Last-In-First-Out (**LIFO**) principle.
- Elements are added to and removed from the top of the stack (the most recently added items are at the top of the stack).

Introduction

- basic stack operations:
  - push: Add an element to the top.
  - pop: Remove the top element.
  - peek: Examine the top element.
  - is Empty: Check if stack is empty
  - Is Full: Check if stack is full



Introduction



Stacks in computer science

- Programming languages and compilers:
  - method calls are placed onto a stack *(call=push, return=pop)*
  - compilers use stacks to evaluate expressions

- Matching up related pairs of things:
  - find out whether a string is a palindrome
  - examine a file to see if its braces { } match
  - convert "infix" expressions to pre/postfix

- Sophisticated algorithms:
  - searching through a maze with "backtracking"
  - many programs use an "undo stack" of previous operations

Stack Class

- Definitions: (provided by the user)
  - *MAX_ITEMS*: Max number of items that might be on the stack
  - Stack Array.
  - *Top – Top of the array – what is the initial value?*
- Operations
  - Peek()
  - Push ()
  - Pop ()
  - IsEmpty ()
  - IsFull ()

Stack Class

```
1  class Stack {
2      int maxSize;
3      int top;
4      int stackArray[];
5
6      Stack(int max)
7      {
8          top = -1;
9          maxSize = max;
10         stackArray = new int[maxSize];
11     }
```

Push Method

- *Function*: Adds new Item to the top of the stack.
- *Preconditions*: Stack has been initialized and is not full.
- *Post conditions*: new Item is at the top of the stack.
- Steps:
  - Check if stack is not full.
  - Increment top.
  - Add the value on top.

Push Method

```
24      void push(int x)
25      {
26          if (isFull()) {
27              System.out.println("Stack Overflow");
28          }
29          else {
30              stackArray[++top] = x;
31          }
32      }
33
```

Pop Method

- *Function*: Removes top Item from stack and returns it in item.
- *Preconditions*: Stack has been initialized and is not empty.
- *Post conditions*: Top element has been removed from stack and item is a copy of the removed element.
- Steps:
  - Check if stack is not empty.
  - Return the value on top.
  - Decrease top.

Pop Method

```
34      int pop()
35      {
36          if (isEmpty()) {
37              System.out.println("Stack Underflow");
38              return -1;
39          }
40          else {
41              //int x = stackArray[top];
42              //top--;
43              //return x;
44              return stackArray[top--];
45          }
46      }
```

Peek Method

```
48      int peek()
49      {
50          if (isEmpty()) {
51              System.out.println("Stack Underflow");
52              return -1;
53          }
54          else {
55              return stackArray[top];
56          }
57      }
```

IsEmpty() and IsFull() methods

```
13      boolean isEmpty()
14      {
15          return (top == -1);
16      }
17
18      boolean isFull()
19      {
20          return (top == (maxSize - 1);
21      }
22
```

Stack Implementation in Linked List

- Stack can be implemented by restricting Insertion and Deletion only at the end of the Linked List.
- Push() – Insert Last method of Linked List
- Pop() – Delete Last method of Linked List

Stack Node

```
class StackNode {
    int data;
    StackNode next;

    StackNode(int data)
    {
        this.data = data;
    }
}
```

StackLinkedList Class

```
public class StackAsLinkedList {

    StackNode head;
```

IsEmpty Method

```
public boolean isEmpty()
{
    if (head == null) {
        return true;
    }
    else
        return false;
}
```

IsFull Method

- This stack will never be full because it is implemented using Linked List

Push Method

```
public void push(int data)
{
    StackNode newNode = new StackNode(data);

    if (root == null) {
        root = newNode;
    }
    else {
        StackNode temp = root;
        root = newNode;
        newNode.next = temp;
    }
    System.out.println(data + " pushed to stack");
}
```

Pop Method

```
public int pop()
{
    int popped = Integer.MIN_VALUE;
    if (root == null) {
        System.out.println("Stack is Empty");
    }
    else {
        popped = root.data;
        root = root.next;
    }
    return popped;
}
```

Peek Method

```
public int peek()
{
    if (root == null) {
        System.out.println("Stack is empty");
        return Integer.MIN_VALUE;
    }
    else {
        return root.data;
    }
}
```