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IT2070 – Data Structures and Algorithms

Introduction

Subject Group

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Teaching Methods

- Lectures – 2 hours/week
- Tutorials – 1 hour/week
- Labs – 2 hours /week

Student Evaluation

- Assessments (Two exams) - 40 %
- Final Examination - 60 %

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Lectures will cover

Data Structures

- Stack data structure
- Queue data structure
- Linked list data structure
- Tree data structure

Algorithms

- Asymptotic Notations
- Algorithm designing techniques
- Searching and Sorting algorithms

Tutorials and Labs will cover

-Solve problems using the knowledge acquired in the lecture

-Get hands on experience in writing programs

- Java
- Python

Data Structures and Algorithms

- **Data Structures**

  - Data structure is an arrangement of data in a computer's memory or sometimes on a disk.

  Ex: stacks, queues, linked lists, trees

- **Algorithms**

  - Algorithms manipulate the data in these structures in various ways.

  Ex: searching and sorting algorithms

Data Structures and Algorithms

- **Usage of data structures**

  - Real world data storage
  - Real world modeling
    - queue, can model customers waiting in line
    - graphs, can represent airline routes between cities
  - Programmers Tools
    - stacks, queues are used to facilitate some other operations

Data Structures and Algorithms

Algorithms

Algorithm is a well defined computational procedure that takes some value or set of values as input and produce some value or set of values as output.

An algorithm should be

- correct.
- unambiguous.
- give the correct solution for all cases.
- simple.
- terminate.

Academic Integrity Policy

Are you aware that following are not accepted in SLIIT???

Plagiarism - using work and ideas of other individuals intentionally or unintentionally

Collusion - preparing individual assignments together and submitting similar work for assessment.

Cheating - obtaining or giving assistance during the course of an examination or assessment without approval

Falsification – providing fabricated information or making use of such materials

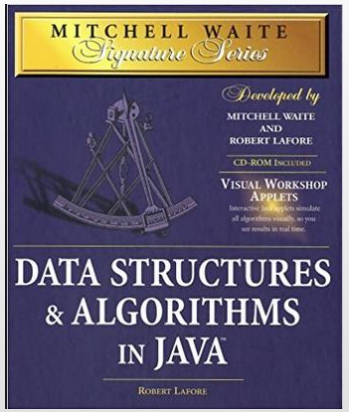
From year 2018 the committing above offenses come with serious consequences !

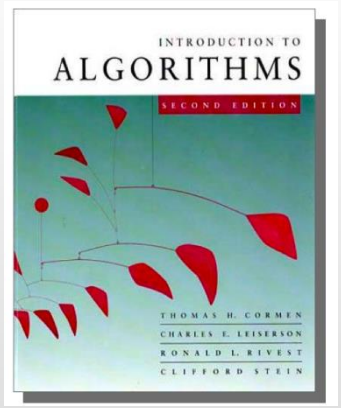
See General support section of Courseweb for full information.

References

1. Mitchell Waite,Robert Lafore, Data Structures and Algorithms in Java,2nd Edition, Waite Group Press,1998.

2. T.H. Cormen, C.E. Leiserson, R.L. Rivest, Introduction to Algorithms,3rd Edition, MIT Press, 2009.





IT2070 – Data Structures and Algorithms

Lecture 01

Introduction to Stack

Stack

- Allows access to only one data item; the last item inserted
- If you remove this item, then you can access the next-to-last item inserted

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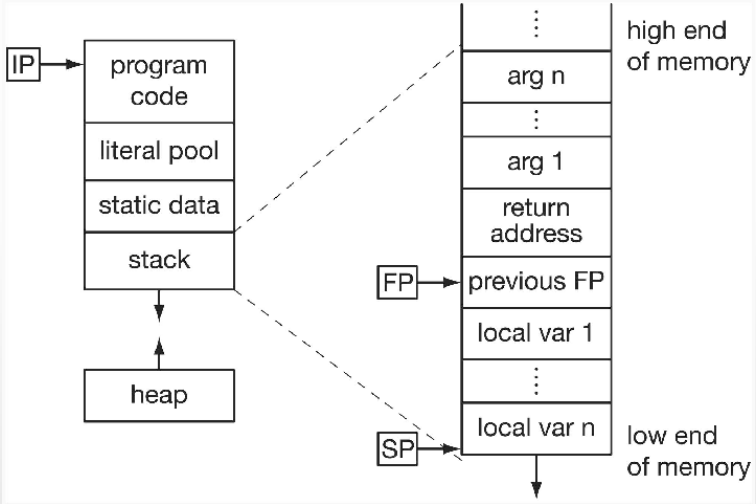
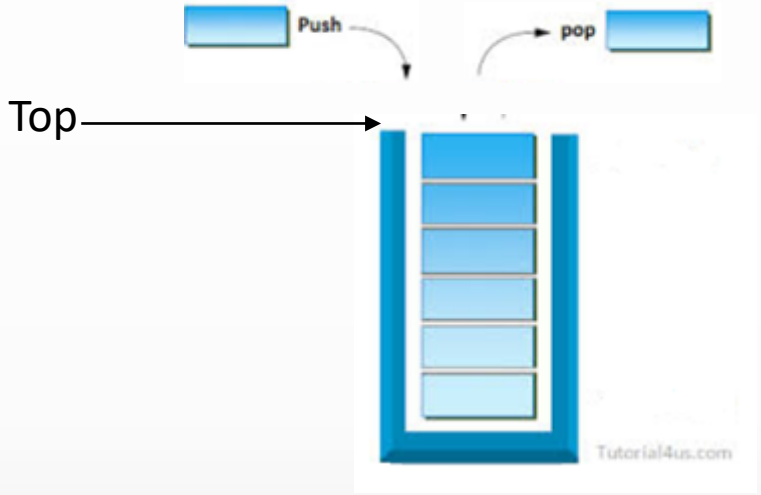
Application of Stacks

- String Reverse
- Page visited history in Web browser
- Undo sequence of text editor
- Recursive function calling
- Auxiliary data structure for Algorithms



Stack

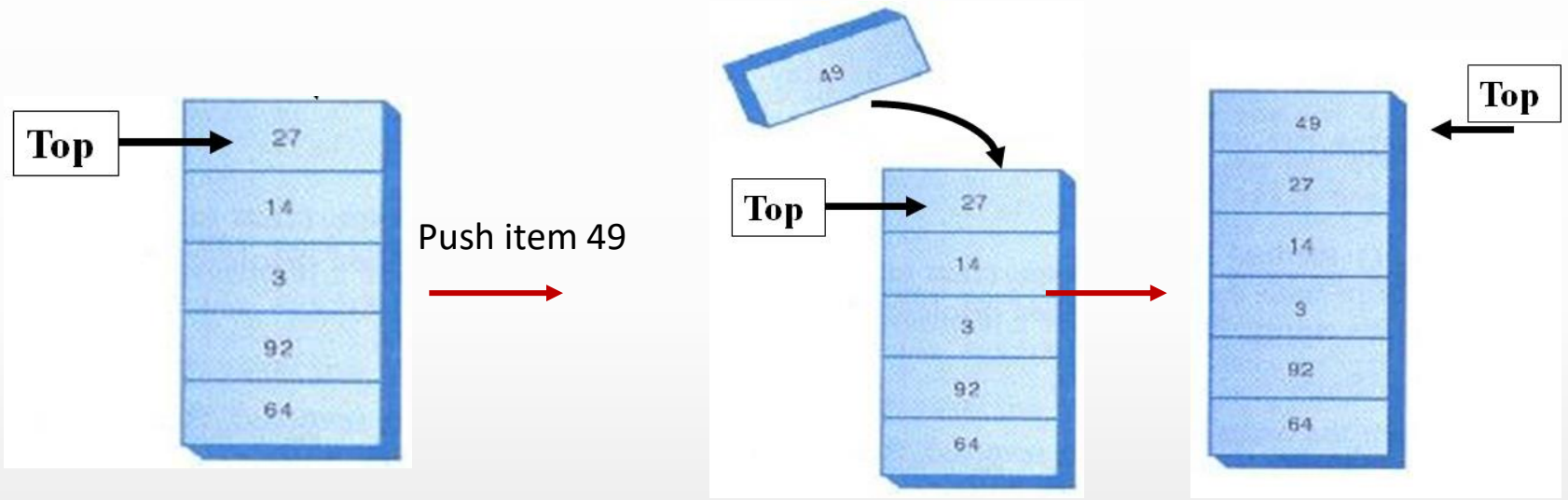


- In a stack all insertions and deletions are made at one end (Top). Insertions and deletions are restricted from the Middle and at the End of a Stack

- Adding an item is called Push
- Removing an item is called Pop

- Elements are removed from a Stack in the reverse order of that in which the elements were inserted into the Stack
- The elements are inserted and removed according to the Last-In-First-Out (LIFO) principle.

Stack - Push

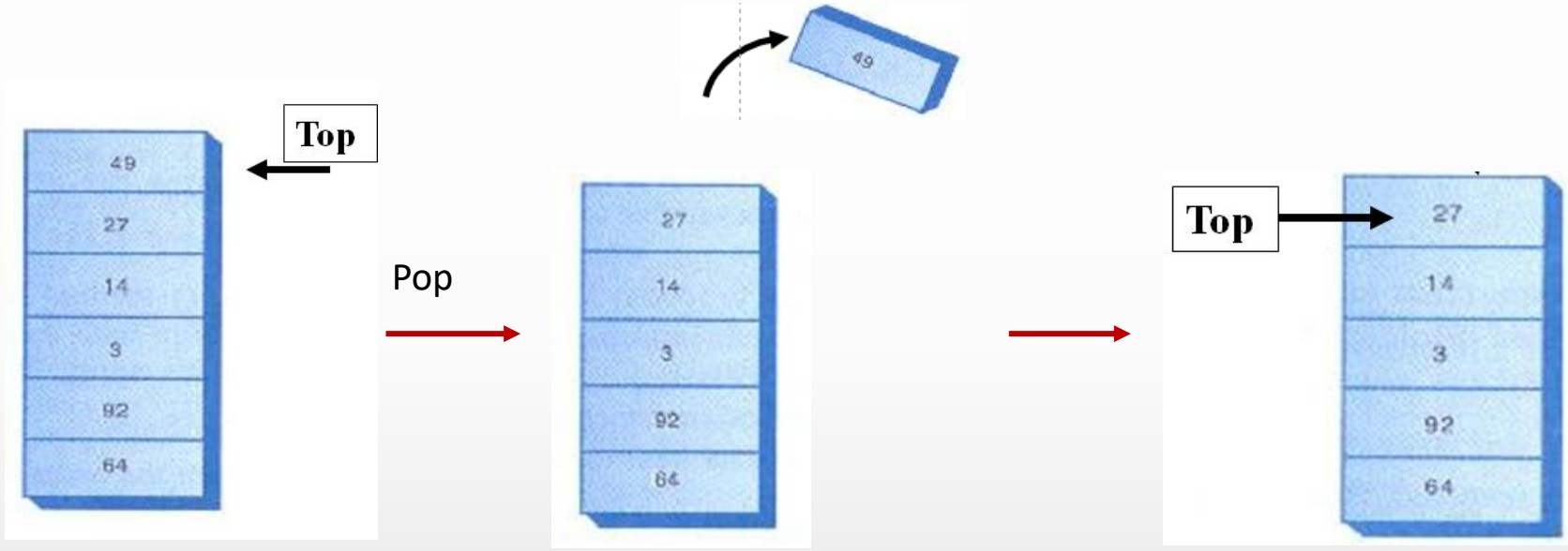


Before inserting

Item 49 is inserted on top

After inserting

Stack - Pop

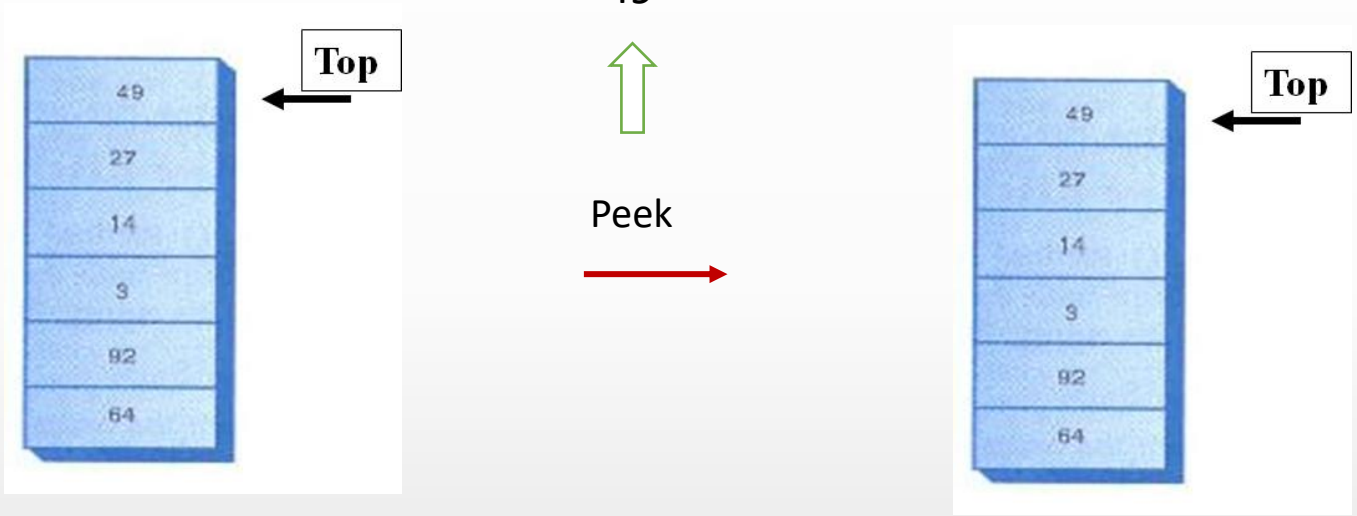


Before removing

Top item is removed

After removing

Stack - Peek

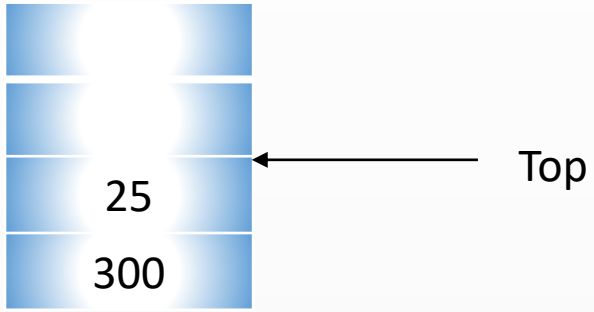


Stack remains the same

Peek is used to read the value from the top of the stack without removing it. You can peek only the Top item, all the other items are invisible to the stack user.

Question

Draw the stack frame after performing the below operations to the stack given below.



i) Push item 50
ii) Push item 500
iii) Peek
iv) Push item 100
v) Pop
vi) Pop
vii) Pop
viii) Pop

Uses of Stack

- The stack operations are built into the microprocessor.
- When a method is called, its return address and arguments are pushed onto a stack, and when it returns they're popped off.

Stack - Implementation

Stack implementation using an **array**

- Constructor creates a new stack of a size specified in its argument.

- Variable *top*, which stores the index of the item on the top of the stack.

```
class StackX {

    private int maxSize;    // size of stack array
    private double[] stackArray;
    private int top;          //top of the stack

    publc StackX(int s) {   // constructor

              maxSize = s;       // set array size
              stackArray = new double[maxSize];
              top = -1;            // no items
     }

     ……….
     ……….
}
```

Stack – Implementation - push

```
class StackX{

    private int maxSize;    // size of stack array
    private double[] stackArray;
    private int top;          //top of the stack

    publc StackX(int s) { // constructor

            maxSize = s;      // set array size
            stackArray = new double[maxSize];
            top = -1;           // no items
    }
   public void push(double j) {

            // increment top
            // insert item
   }
```

Stack – Implementation - push

```
class StackX {
      private int maxSize;    // size of stack array
      private double[] stackArray;
      private int top;          //top of the stack

      publc StackX(int s) {// constructor

                  maxSize = s;       // set array size
                  stackArray = new double[maxSize];
                  top = -1;           // no items
      }
     public void push(double j) {

                // increment top.  insert item
                stackArray[++top] = j;
     }
```

Stack – Implementation - push

```
class StackX
{
      private int maxSize;    // size of stack array
      private double[] stackArray;
      private int top;          //top of the stack

      public StackX(int s) {// constructor

                  maxSize = s;       // set array size
                  stackArray = new double[maxSize];
                  top = -1;           // no items
      }
     public void push(double j) {

                  // check whether stack is full
                  if (top == maxSize – 1)
                              System.out.println(“Stack is full”);
                  else
                              stackArray[++top] = j;
     }
```

Stack – Implementation – pop/peek

```
class StackX
{
      private int maxSize;    // size of stack array
      private double[] stackArray;
      private int top;          //top of the stack

      public StackX(int s) {// constructor

                  maxSize = s;      // set array size
                  stackArray = new double[maxSize];
                  top = -1;           // no items
      }
      public void push(double j) {

                  // check whether stack is full
                  if (top == maxSize – 1)
                      System.out.println("Stack is full");
                  else
                      stackArray[++top] = j;
      }
```

```
public double pop() {
            // check whether stack is empty
            // if not
            // access item and decrement top
    }

public double peek() {

            // check whether stack is empty
            // if not
            // access item
    }
```

Stack – Implementation – pop/peek

```
class StackX {
        private int maxSize;    // size of stack array
        private double[] stackArray;
        private int top;          //top of the stack

        public StackX(int s) { // constructor

                    maxSize = s;      // set array size
                    stackArray = new double[maxSize];
                    top = -1;          // no items
        }
        public void push(double j) {

                    // check whether stack is full
                    if (top == maxSize – 1)
                         System.out.println(“Stack is full”);
                    else
                         stackArray[++top] = j;
       }
```

```
public double pop() {
                if (top == -1)
                     return -99;
                else
                     return stackArray[top--];
     }

public double peek() {
                if (top == -1)
                     return -99;
                else
                     return stackArray[top];
     }
```

Question

isEmpty() method returns true if the stack is empty and isFull() method return true if the Stack is full.
Implement isEmpty() and isFull() methods of the stack class.

Creating a stack

Question

Using the implemented StackX class, Write a program to create a stack with maximum size 10 and insert the following items to the stack.

30 80 100 25

Delete all the items from the stack and display the deleted items.

Creating a stack

```
class StackApp {
        public static void main(String[] args) {
                StackX  theStack = new StackX(10);  // create a stack with max size 10

                theStack.push(30);  // insert given items
                theStack.push(80);
                theStack.push(100);
                theStack.push(25);

                while( !theStack.isEmpty() ) {    // until it is empty, delete item from stack

                        double val = theStack.pop();
                        System.out.print(val);
                        System.out.print(" ");
                }
        }
} // end of class
```

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References

1. Mitchell Waite,Robert Lafore, Data Structures and Algorithms in Java,2nd Edition, Waite Group Press,1998.