# Data Structure

Trainer : Nisha Dingare

Email : nisha.dingare@sunbeaminfo.com

# Stack :

- It is a basic/ linear /utility data structure.
- It is a collection/list of logically related similar type elements into which data elements can be added as well as deleted from only one end referred as “**top**” end.
- In this collection, element which was inserted last only can be deleted first, so this list works in **“last in first out /first in last out”** manner, and hence it is also called as **LIFO list/FILO list**.
- We can perform basic three operations on stack in O(1) time: Push, Pop & Peek.
  - **Push** : to insert/add an element onto the stack at top position
    - step1: check stack is not full.
    - step2: increment the value of top by 1.
    - step3: insert an element onto the stack at top position.
  - **Pop** : to delete/remove an element from the stack which is at top position.
    - step1: check stack is not empty.
    - step2: decrement the value of top by 1.
  - **Peek** : to get the value of an element which is at top position without push & pop.
    - step1: check stack is not empty.
    - step2: return the value of an element which is at top position.
- Stack Empty : top == -1
- Stack Full : top == SIZE-1

# Stack :

- Applications of Stack :
  - Stack is used by an OS to control of flow of an execution of program.
  - In recursion internally an OS uses a stack.
  - undo & redo functionalities of an OS are implemented by using stack.
  - Stack is used to implement advanced data structure algorithm like DFS: Depth First Search traversal in tree & graph.
  - Stack is used in algorithms to covert given infix expression into its equivalent postfix and prefix, and for postfix expression evaluation.

- Time complexity :
  - All the operations push, pop and peek take O(1) time.

- .dynamic implementation of stack by using linked list (dcll):
  - push : add_last( )
  - pop : delete_last( )
  - OR
  - push : add_first( )
  - pop : delete_first( )

# Stack Applications :

- Stack Application Algorithms: -
  - To convert given infix expression into its equivalent postfix expression
  - To convert given infix expression into its equivalent prefix expression
  - To convert given prefix expression into its equivalent postfix expression
  - To evaluate postfix expression.

- What is an expression?
  - An expression is a combination of an operands and operators.

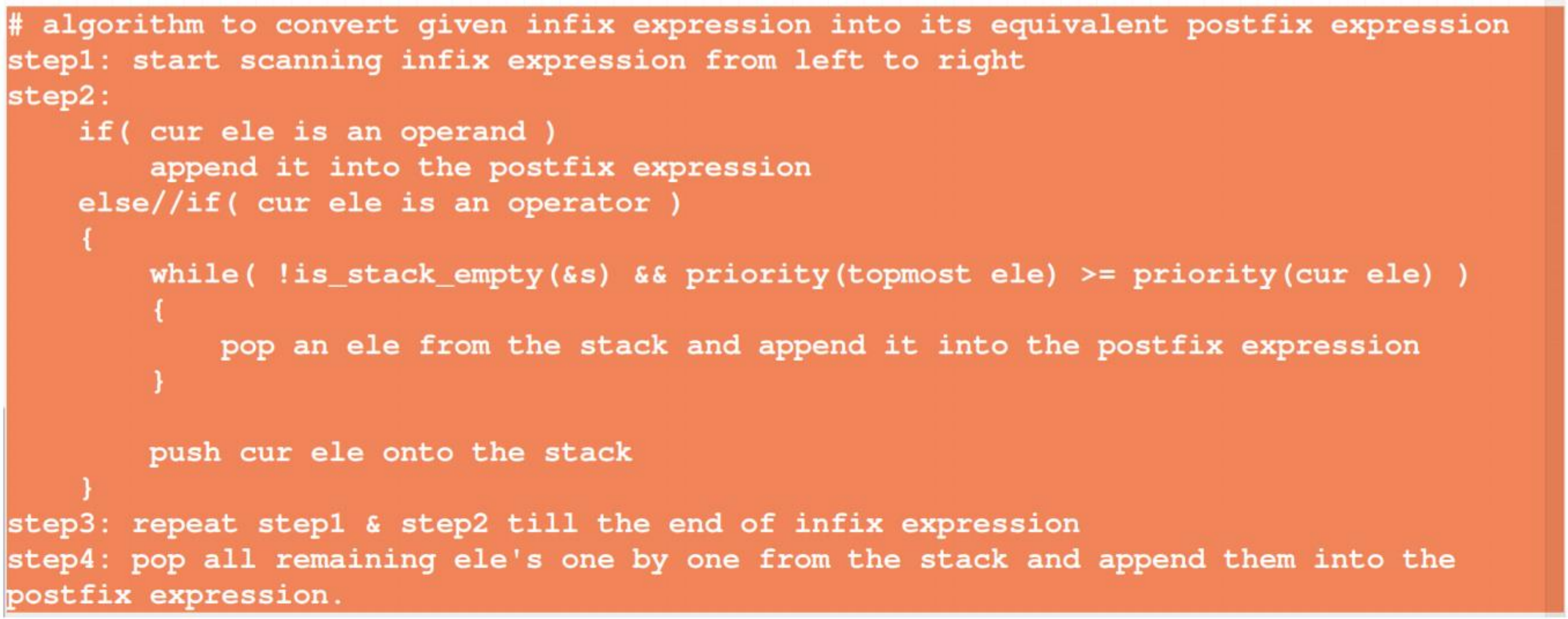
there are 3 types of expression:

1. infix expression : a+b
2. prefix expression : +ab
3. postfix expression : ab+

# Infix to Postfix :

**- Algorithm to convert given infix expression into its equivalent postfix  expression:**

Initially we have, an Infix expression, an empty Postfix expression & empty Stack.



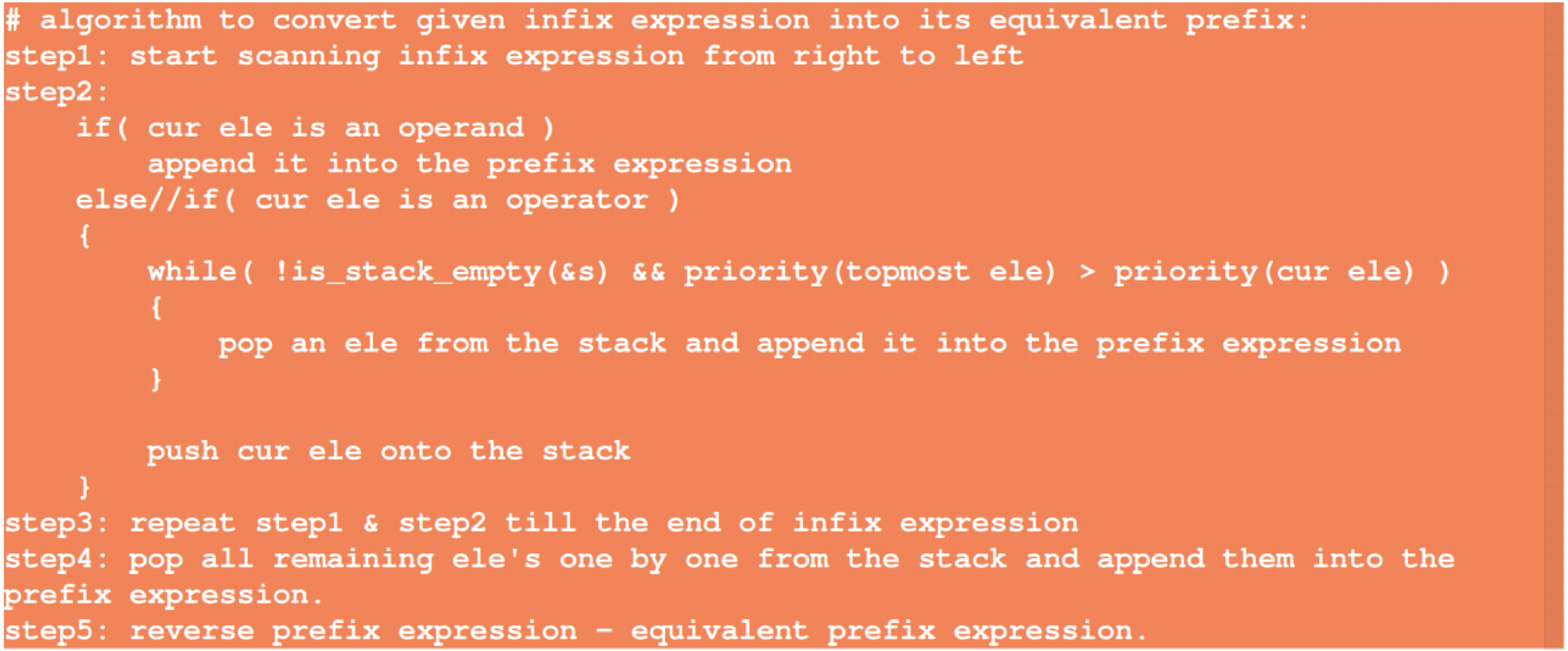
```
# algorithm to convert given infix expression into its equivalent postfix expression
step1: start scanning infix expression from left to right
step2:
    if( cur ele is an operand )
        append it into the postfix expression
    else//if( cur ele is an operator )
    {
        while( !is_stack_empty(&s) && priority(topmost ele) >= priority(cur ele) )
        {
            pop an ele from the stack and append it into the postfix expression
        }

        push cur ele onto the stack
    }
step3: repeat step1 & step2 till the end of infix expression
step4: pop all remaining ele's one by one from the stack and append them into the
postfix expression.
```

# Infix to Prefix :

**- Algorithm to convert given infix expression into its equivalent prefix  expression:**

Initially we have, an Infix expression, an empty Prefix expression & empty Stack.



```
# algorithm to convert given infix expression into its equivalent prefix:
step1: start scanning infix expression from right to left
step2:
    if( cur ele is an operand )
        append it into the prefix expression
    else//if( cur ele is an operator )
    {
        while( !is_stack_empty(&s) && priority(topmost ele) > priority(cur ele) )
        {
            pop an ele from the stack and append it into the prefix expression
        }

        push cur ele onto the stack
    }
step3: repeat step1 & step2 till the end of infix expression
step4: pop all remaining ele's one by one from the stack and append them into the
prefix expression.
step5: reverse prefix expression - equivalent prefix expression.
```

# Queue :

**Queue:** It is a collection/list of logically related similar type of elements into which elements can be added from one end referred as **rear** end, whereas elements can be deleted from another end referred as a **front** end.

-In this list, element which was inserted first can be deleted first, so this list works in **first in first out** manner, hence this list is also called as **FIFO list/LILO list.**

- Two basic operations can be performed on queue in O(1) time.

1. **Enqueue:** to insert/push/add an element into the queue from rear end.
2. **Dequeue:** to delete/remove/pop an element from the queue which is at front end.

- There are different types of queue:

1. **Linear Queue** (works in a fifo manner)
2. **Circular Queue** (works in a fifo manner)

**3.Priority Queue:** it is a type of queue in which elements can be inserted from rear end randomly (i.e. without checking priority), whereas an element which is having highest priority can only be deleted first.

- Priority queue can be implemented by using linked list, whereas it can be implemented efficiently by using **binary heap.**

**4. Double Ended Queue (deque) :** it is a type of queue in which elements can added as well as deleted from both the ends.

# Applications of Queue :

**Applications of Queue:**

-Queue is used to implement OS data structures like **job queue, ready queue, message queue, waiting queue** etc...

-Queue is used to implement OS algorithms like **FCFS CPU Scheduling, Priority CPU Scheduling, FIFO Page Replacement** etc...

-Queue is used to implenent an advanced data structure algorithms like **BFS: Breadth First Search** Traversal in tree and graph.

# Thank You !