

UNIT-3:-

Data Structures

Data Structure:-

Representation of data in particular manner.

particular way of organizing data in a computer. To reduce the space and time complexities of different tasks. Some popular data structures are

- | | |
|------------------|-------------------------|
| (i) Arrays | (vi) Binary Search Tree |
| (ii) Linked list | (vii) Graph |
| (iii) Stack | (viii) Heap |
| (iv) Queue | (ix) Hashing |
| (v) Binary Tree | (x) Misc |

Stack:-

- (i) Stack is ADT (Abstract Data Type).
- (ii) Stack follows LIFO (Last In First Out). The element which is placed last, it is accessed first.

ex:- Dec of cards, piles of plates etc.

- (iii) There are two ways to implement a stack.

→ Using arrays (Static, Dynamic)

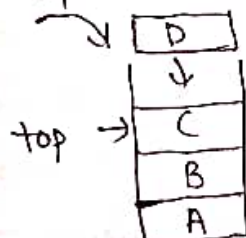
→ Using Linked List.

- (iv) Stack operations are

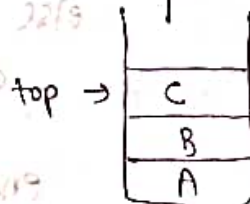
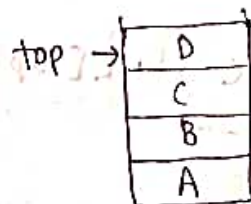
→ push() → pop() → peek() → isFull() → isEmpty()

- (v) top ^{pointer} is used.

- (vi) Representation.



push



pop

Algorithms:-

push():- pushing an element on the stack.

push operation steps \Rightarrow

step-1:- Checks if the stack is full.

step-2:- If the stack is full produces an error and exit.

step-3:- If the stack is not full, increment top

step-4:- Add data element to the stack location.

step-5:- Returns success.

Algorithm \Rightarrow begin

if top is equal to max-size

display "stack is full".

else

top++

stack[top] \leftarrow data

end

pop():- Removing an element from the stack

accessing an element from the stack.

pop operation steps \Rightarrow

step-1:- Check if the stack is empty.

step-2:- If stack is empty, produce an error and exit.

step-3:- If stack is not empty, decrement top.

step-4:- Decreases the value of top by 1.

step-5:- Returns success.

Algorithm \Rightarrow begin

if top is equal to -1

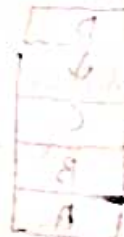
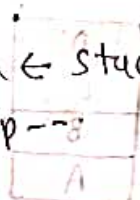
display "stack is empty".

else

data \leftarrow stack[top]

top--

end.



Applications Queue:-

- (i) CPU scheduling
- (ii) Handling website traffic

- (iii) Maintaining the playlist in media player.

peek():- get the top data element of the stack, without removing it.

Algorithm \Rightarrow begin
 return stack[top]
end.

isFull():- Checks if stack is Full, or not

Algorithm \Rightarrow begin
 if top == maxsize
 return true
 else
 return false.
end

isEmpty():- Checks if stack is empty, or not

Algorithm \Rightarrow begin
 if top == -1
 return true
 else
 return false.
end

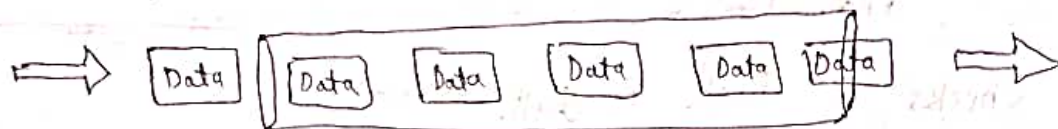
Applications of Stack:-

- (i) Evaluation of expressions.
- (ii) Backtracking
- (iii) Undo operations
- (iv) mouse gaming

Queues:-

- (i) Queue is ADT (Abstract Data Type)
- (ii) Queue follows FIFO (First In First Out). The data item stored first will be accessed first.
 ex- single lane one way road, bus stops, ticket windows
- (iii) There are two ways to implement queues.
 \rightarrow Using arrays (static, dynamic)
 \rightarrow Using Linked list

- (iv) Queue operations are
 \rightarrow enqueue() \rightarrow dequeue() \rightarrow peek() \rightarrow is Empty() \rightarrow is Full()
 (v) front, rear are ~~keywords~~ pointers in queue.
 (vi) Representation.



Algorithms:-

enqueue():- add an item to the queue.

enqueue operation steps:-

step-1:- Check if the queue is full.

step-2:- If the queue is full, produce ~~stack~~ ^{error} and exit.

step-3:- If the queue is not full, increment rear.

step-4:- Add data element to the queue location at

step-5:- return success. which rear is pointing

Algorithm \Rightarrow begin

if rear == maxsize

display "Queue is full".

else

rear++;

queue[rear] \leftarrow data

end

dequeue():- remove an item from the queue.

dequeue operation steps:-

step-1:- Check if the queue is empty.

step-2:- If the queue is empty, produce ~~stack~~ ^{error} and exit.

step-3:- If the queue is not empty, access the data where front is pointing.

step-4:- Increment front to the next available data element.

step-5:- return success.

Algorithm \Rightarrow begin
 if $\text{front} == \text{rear} == -1$
 display "Queue is empty".
 else
 data \leftarrow Queue[front]
 front++
 end

peek():- To see the data at the front of the queue.

Algorithm \Rightarrow begin
 return Queue[front]
 end.

isFull():- checks if queue is full or not

Algorithm \Rightarrow begin
 if $\text{rear} == \text{maxsize}$
 return true
 else
 return false.

isEmpty:- Checks if queue is empty or not

Algorithm \Rightarrow begin
 if $\text{front} == \text{rear} == -1$
 return true
 else
 return false
 end.

Arithmetic Expression Evaluation:-

Evaluation of Expressions:-

All expressions are usually represented in infix notation.

There are three types of expressions

(i) Infix notation ex:- $A + B$

(ii) pre-fix notation (polish notation) ex:- $+ AB$

(iii) post fix notation (Reverse polish notation) ex:- $AB +$

There are 3 levels of precedence for 5 binary operators.

- Highest :- Exponentiation (\wedge)
- Next highest :- Multiplication (\times) and division ($/$)
- Lowest :- Addition ($+$) and subtraction ($-$).

ex:- Infix notation = $(A-B) \wedge [C/(D+E) + F]$

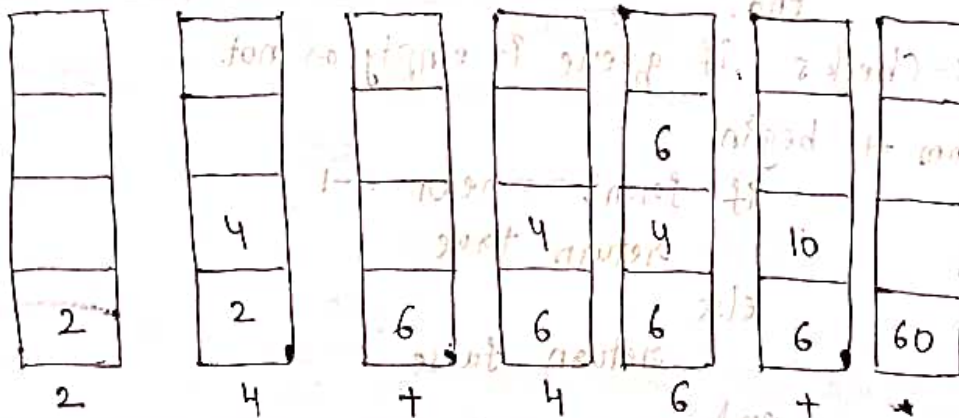
Postfix notation = $AB - CDE + / F + \wedge$

The procedure for getting the result is

- (i) Convert the expression to reverse polish notation
- (ii) Push the operands into the stack
- (iii) When any operator encountered then pop two topmost operands (or) elements.
- (iv) After push the result into the stack.
- (v) After the complete execution the final ~~expression~~ result remains on the top of the stack.

ex:- $(2+4) \wedge (4+6) = 60$

$2\ 4\ +\ 4\ 6\ +\ \wedge = 60$



ex:- $4\ 5\ 6\ +\ \wedge$

Step	IFP Symbol	Operation	Stack	Calculation
1	4	push	4	
2	5	push	4, 5	
3	6	push	4, 5, 6	
4	*	pop 2 elements & Evaluate	4	$5 * 6 = 30$
5		pop result	4, 30	
6	+	pop 2 elements & Evaluate		$4 + 30 = 34$
7		push result	34	
8		pop		34 (result)

Stack Operations:-

```
#include <stdio.h>
```

```
#include <conio.h>
```

```
int stack[100], choice, n, top = 0, value, i;
```

```
void main()
```

```
{
```

```
clrscr();
```

```
printf("Enter the size of stack\n");
```

```
scanf("%d", &n);
```

```
printf("Stack operations are\n 1. push\n 2. pop\n 3. display\n 4. exit\n");
```

```
while (choice != 4)
```

```
{ printf("Enter the choice\n");
```

```
scanf("%d", &choice);
```

```
switch (choice)
```

```
{
```

```
case 1: if (top >= n)
```

```
printf("Stack is full\n");
```

```
else
```

```
{ printf("Enter the value\n");
```

```
scanf("%d", &value);
```

```
top++;
```

```
stack[top] = value;
```

```
}
```

```
break;
```

```
case 2: if (top <= 0)
```

```
printf("Stack is empty\n");
```

```
else
```

```
{ printf("Value removed\n");
```

```
top--;
```

```
}
```

```
break;
```


case 3 : if (top >= 0)

{ printf("The stack elements are\n");

for (i=top; i>=0; i--)

{ printf("%d\n", stack[i]);

}

else

{ printf("stack is empty\n");

}

break;

case 4 : printf("Exiting\n"); break;

default : printf("Invalid choice\n");

}

}

getch();

}

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