Stack

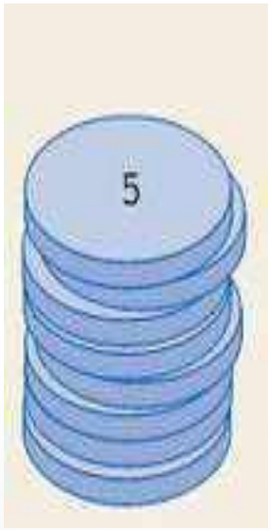
CONCEPT OFSTACKs

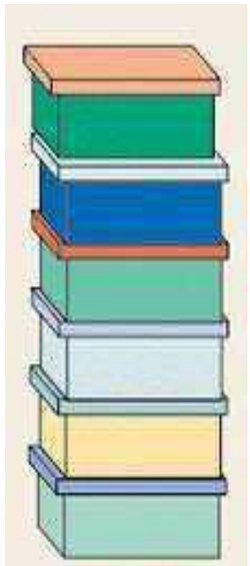
Definition :

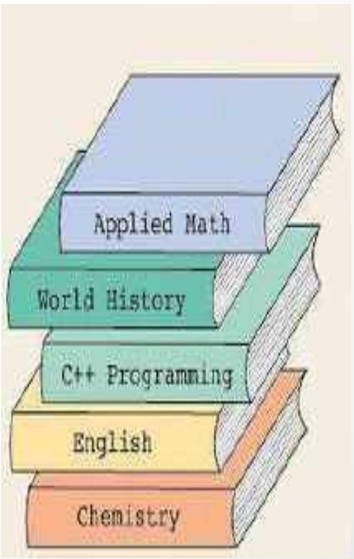
“ Stack is data structure in which addition and removal of an element is allowed at the same end is called as top of stack.”

- Stack isalso called as Last In First Out(LIFO) list.
- It means element which get added at last will be removed first.

e.g.

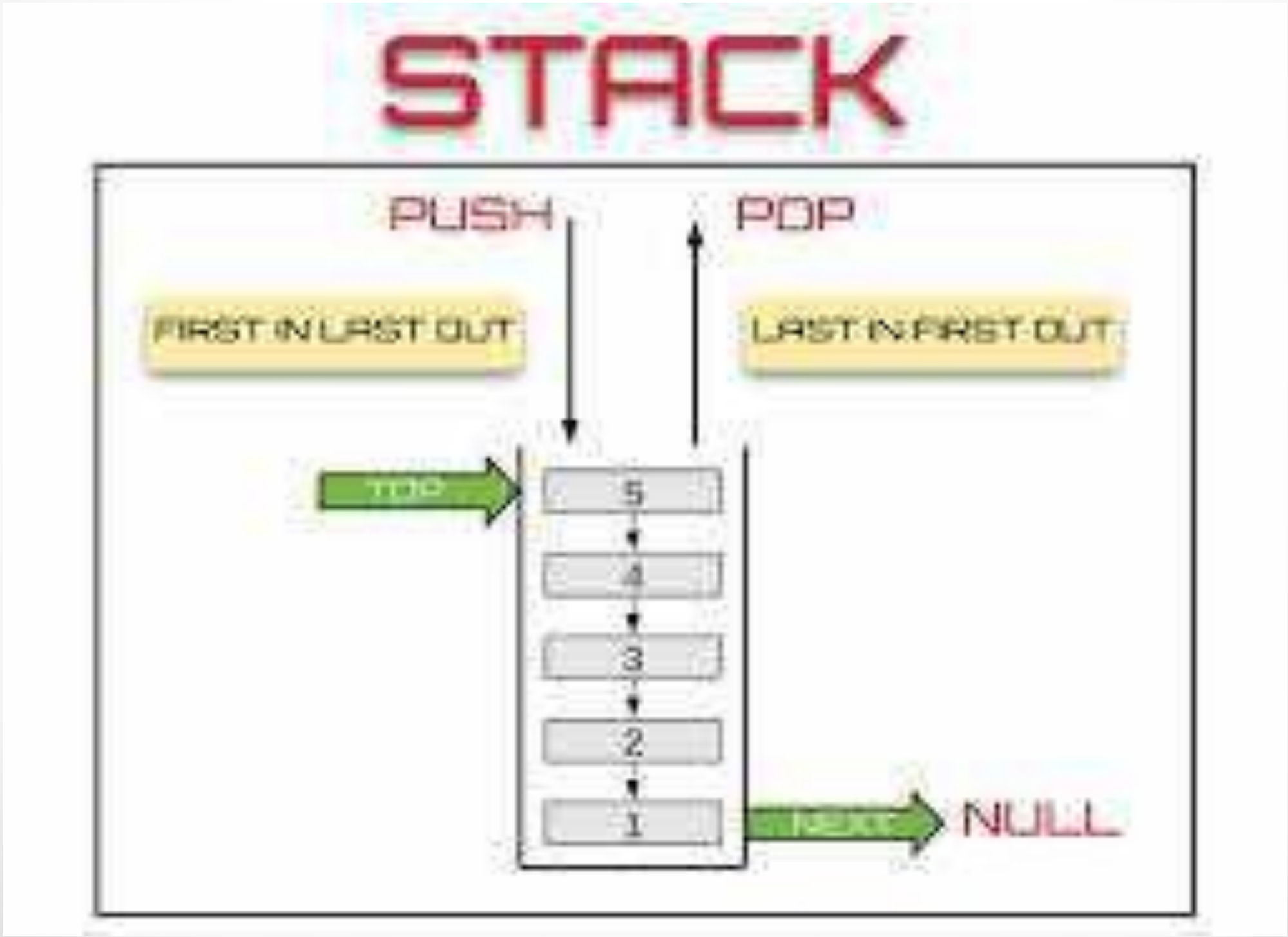






CONCEPT OFSTACKs

Example :



Components of Stack

Stack

- ***Top*** *is a variable which refers to last position in stack.*
- ***Element*** *is component which has data.*
- ***MaxStack*** *is variable that describes maximum number of elements in a stack.*

Main Operation

Operation

PUSH

Add data to element in stack.

POP

Take data from element in stack

Kinds of Operation

Operation

- *Stack Operation in array form*
- *Stack Operation in Linked list form*

STACK AS AN ADT

Stack is an abstract data type which is defined by the following structure and operation.

Stack operation :

1. createstack( )
2. Push( )
3. Pop( )
4. Peek( )
5. IsEmpty( )
6. IsFull( )
7. Size( )

STACK AS AN ADT

Createstack - it create new empty stack.

push( ) – Pushing (storing) an element on the stack. **pop( )** – Removing an element from the stack. **peek()** – get the top data element of the stack, without removing it.

isFull( ) – check if stack is full.

isEmpty( ) – check if stack is empty.

Size() – return the number of item in the stack.

STACK AS AN ADT

1. **Initializing stack**

:

```
void initstack ()
{
    stack[top] = -1 ;
}
```

STACK AS AN ADT

2. IsFull( ) stack :

check stack is full or not?

```
int is_full()
{
  if(top == SIZE-1)
        return(1);
     else
     return(0);
}
```

STACK AS AN ADT

3. IsEmpty( ) stack:

check stack is empty or not?

```
int is_empty()
{
  if(top == = -1)
        return(1);
  else
     return(0);
}
```

STACK AS AN ADT

4. Push( ) stack : add element in stac

```
void push()
{
    if(is_full() == 1)
    {
        printf("\n\tSTACK is over flow");
    }
    else
    {
        printf(" Enter an element to add in the stack :");
        scanf("%d",&ele);
        top++;
        stack[top] = ele;
    }
}
```

STACK AS AN ADT

5. pop( ) stack : remove element from

```
void pop()
{
    if(is_empty() == 1)
    {
        printf("\n\tSTACK is under flow");
    }
    else
    {
            printf("\n Element popped : %d",stack[top]);
        top--;
    }
}
```

STACK AS AN ADT

6. display( ) stack :displaying st

```
void display()
{
    int i;
  if(is_empty() == 1)
  {
    printf("\n\tSTACK is under flow");
  }
  else
  {
          printf("\n Stack elements : ");
        for(i = top;i>=0;i--)
          {
            printf(" %d ",stack[i]);
          }
  }
}
```

ALGORITHM TOIMPLEMENT STACK USING ARRAY

Step 1 : start

Step 2 : Display Menu : 1. push 2. pop 3. display

4. exit.

Step 3 : read choice

Step 4 : if choice 1 then call push (

) if choice 2 then call pop(

)

if choice 3 the call display ( )

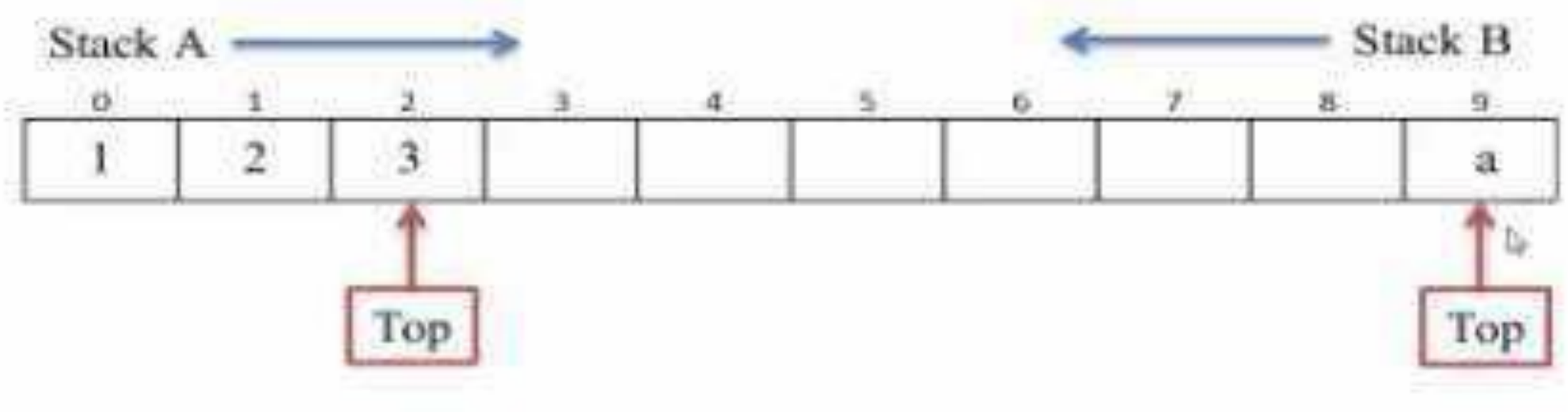
if choice 4 then call exit ( )

MULTIPLESTACKs

“When a stack is created using single array, we can not able to store large amount of data, thus this problem is rectified using more than one stack in the same array of sufficient array. This technique is called as **Multiple Stack**”

MULTIPLESTACKs

Example : When an array of STACK[n] is used to represent two stacks, say Stack A and Stack B. Then the value of n is such that the combined size of both the Stack[A] and Stack[B] will never exceed n. Stack[A] will grow from left to right, whereas Stack[B] will grow in opposite direction i.e. right to left.



APPLICATION OF STACKs

- Convert infix expression to postfix and prefix expressions
- Evaluate the postfix expression
- Reverse a string
- Check well-formed (nested) parenthesis
- Reverse a string
- Process subprogram function calls
- Parse (analyze the structure) of computer programs
- Simulate recursion
- In computations like decimal to binary conversion
- In Backtracking algorithms (often used in optimizations and in games)

REVERSINGOF STACKs

Algorithms :

Step 1 : start

Step 2 : accept string

Step 3 : insert string into character by character using push method

Step 4 : remove character from stack oneby one and print usingpop method

Step 5 : stop

REVERSINGOF STACKs

```
/*program For Reverse String */
#include<iostream.h>
#include<conio.h>
#include<stdlib.h>
# define MAX 10
class stack
{               char stk[MAX];
                int top;
  public:
                stack()
                 {       top=-1;         }

 void push()
{  int n,i;
    cout<<"Enter the size of string";
    cin>>n;
    if(n>MAX)
          {                   cout<<"out of size";
          }  else
          {    for(i=0;i<n;i++)
               cin>>stk[++top];
          }
          }
```

```
void reverse()
{               if(top<0)
       {   cout <<" stack empty";
                          return;
        }     for(int i=top;i>=0;i--)
                          cout <<stk[i] <<" ";
                          }};
main()
{    int ch;
    clrscr();
    stack st;
    while(1)
{  cout <<"\n1.push  2.reverse  3.exit\n Enter ur
choice";
                cin >> ch;
                switch(ch)
  {
                 case 1:  st.push();break;
                 case 2:  st.reverse();break;
                 case 3:  exit(0);
     }       }
return (0);             }
```

polish notation – Expression Evaluation and conversion

Notation is a way of writing arithmatic expression

Concepts : polish is a way of expressing arithmatic expression that avoids the use of brackets to define periorities for evaluation of operators.

There are three notation :

1. Infix notation
2. Prefix notation
3. Postfix notation

polish notation – Expression Evaluation and conversion

Infix	Prefix	Post fix
(operand) (operator) (operand)	(operator) (operand) (operand)	(operand) (operand) (operator).
(A+B)*C	*+ABC	AB+C*

The example ex pression in various forms- infix, prefix and postfix

- *The postfix expressions can be evaluated easily hence infix expression is converted into postfix expression usingstack.*

- *The following operators are written is in descending order of their precedence:*
  - *Exponentiation ^, Unary +, Unary –, and not~*
  - ***Multiplication * and division /***
  - *Addition + and subtraction –*
  - **<, £ , =, ¹, ³, >**
  - *AND*
  - ***OR***

The Operators and priorities

Operator Arithmetic, Boolean and relational	Priority
∧, Unary +, Unary − , ~	6
* /	5
+ −	4
<, ≤ , =, ≠, ≥, >	3
AND	2
OR	1

Algorithm Infix to postfix conversion

Step 1 : The input string (infix notation) is scanned from left to right.

Step 2 : If the scanned character (ch) is space or tab, it is skipped.

Step 3 : If the scanned character (ch) is digit or alphabet, it is appended to postfix string.

Step 4 : If the scanned character (ch) is opening parenthesis '(', it is pushed to stack.

Step 5 : If the scanned character (ch) is operator :

All operators from top of the stack are popped having more or same priority than ch and appended to postfix string.

When less priority operator is found, then it is pushed in the stack again with ch.

Step 6 : If the scanned character (ch) is closing parenthesis ')', then all the operators above the opening parenthesis are appended to postfix string.

Step 7 : After evaluations of all the characters, the remaining operators from stack are appended to postfix string.

Infix to postfix conversion

- Manual algorithm for converting infix to postfix

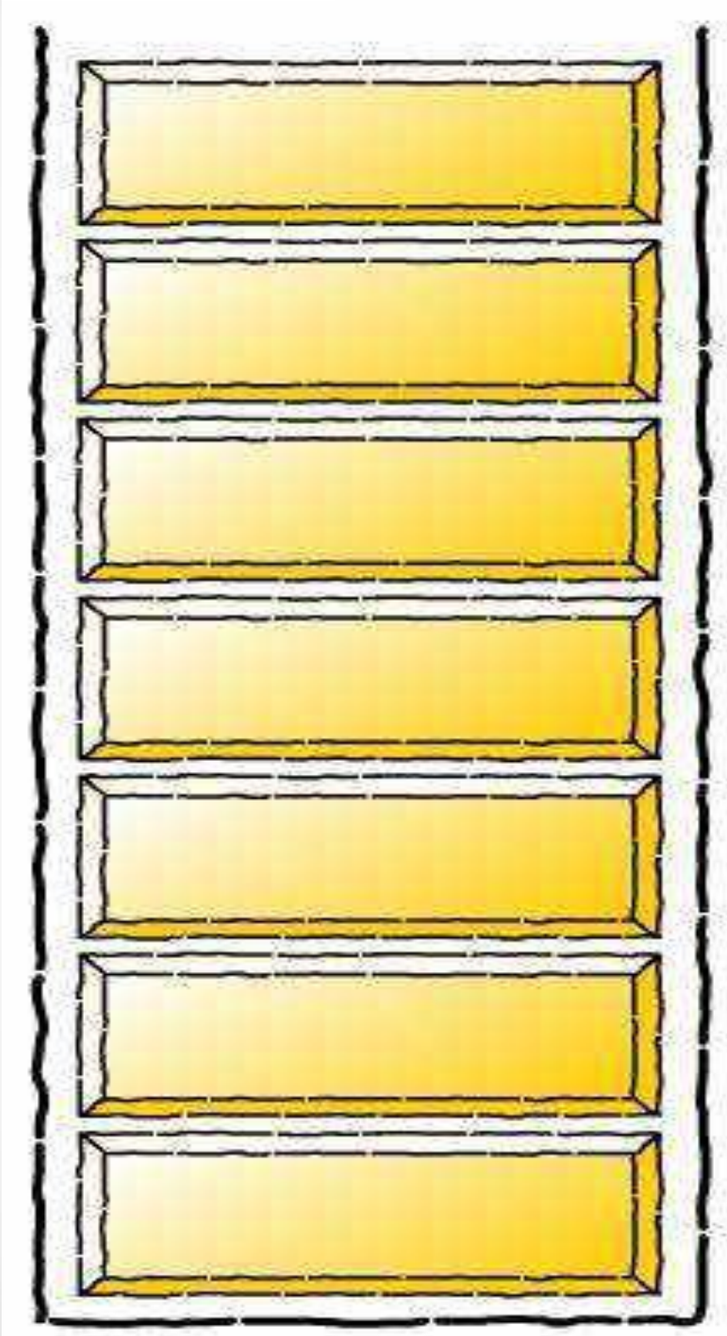
(a + b) * c

  - Write with parentheses to force correct operator precedence((a + b) * c)

  - Move operator to right inside parentheses
((a b +) c *)

  - Remove parentheses
a b + c *

Infix to postfix conversion

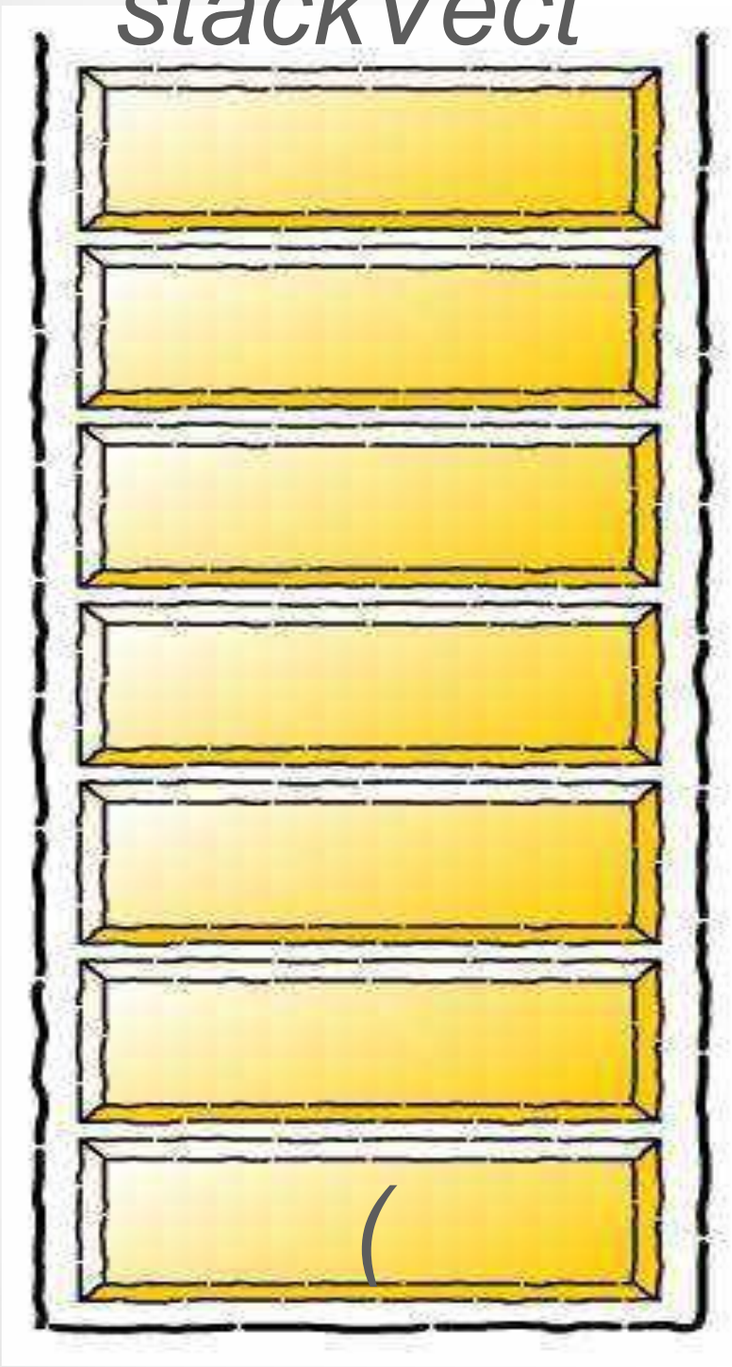


infixVect

(a + b - c) * d – (e + f)

postfixVect

Infix to postfix conversion



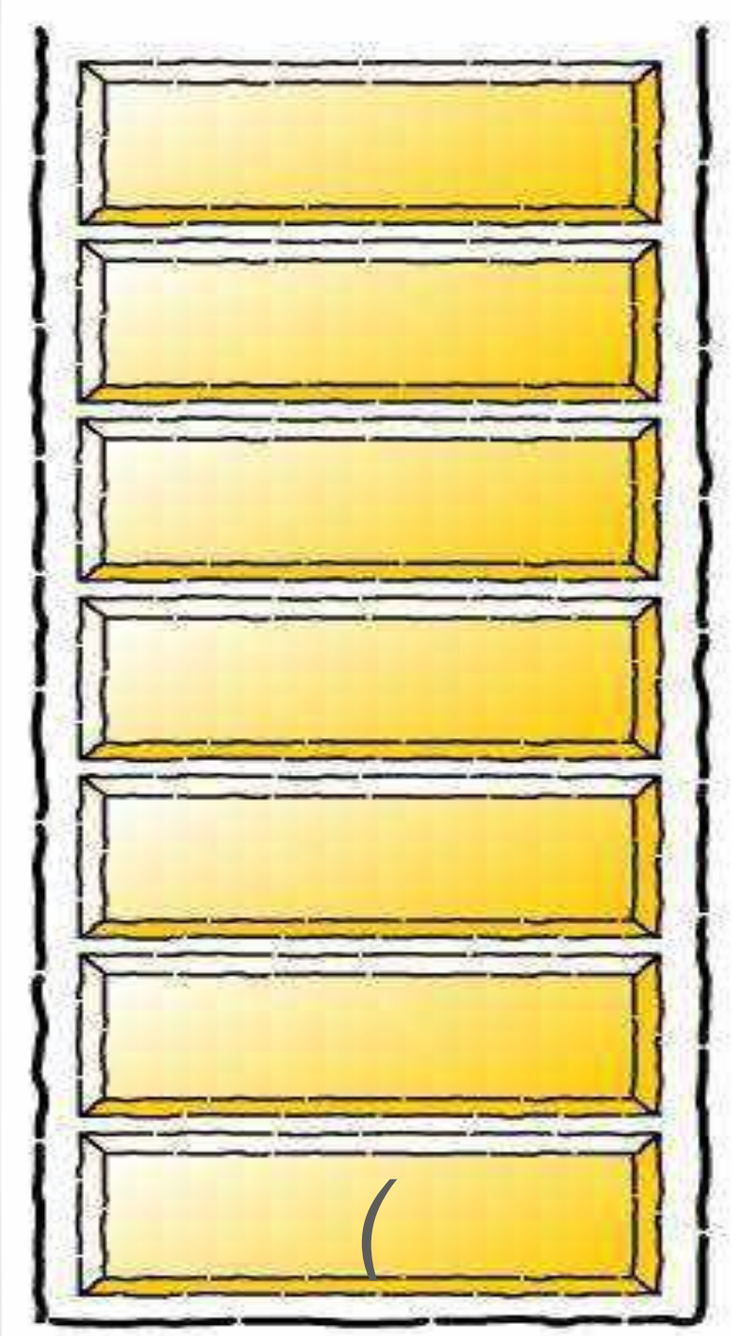
infixVect

a + b - c) * d – (e + f)

postfixVect

Infix to postfix conversion

stackVect



infixVect

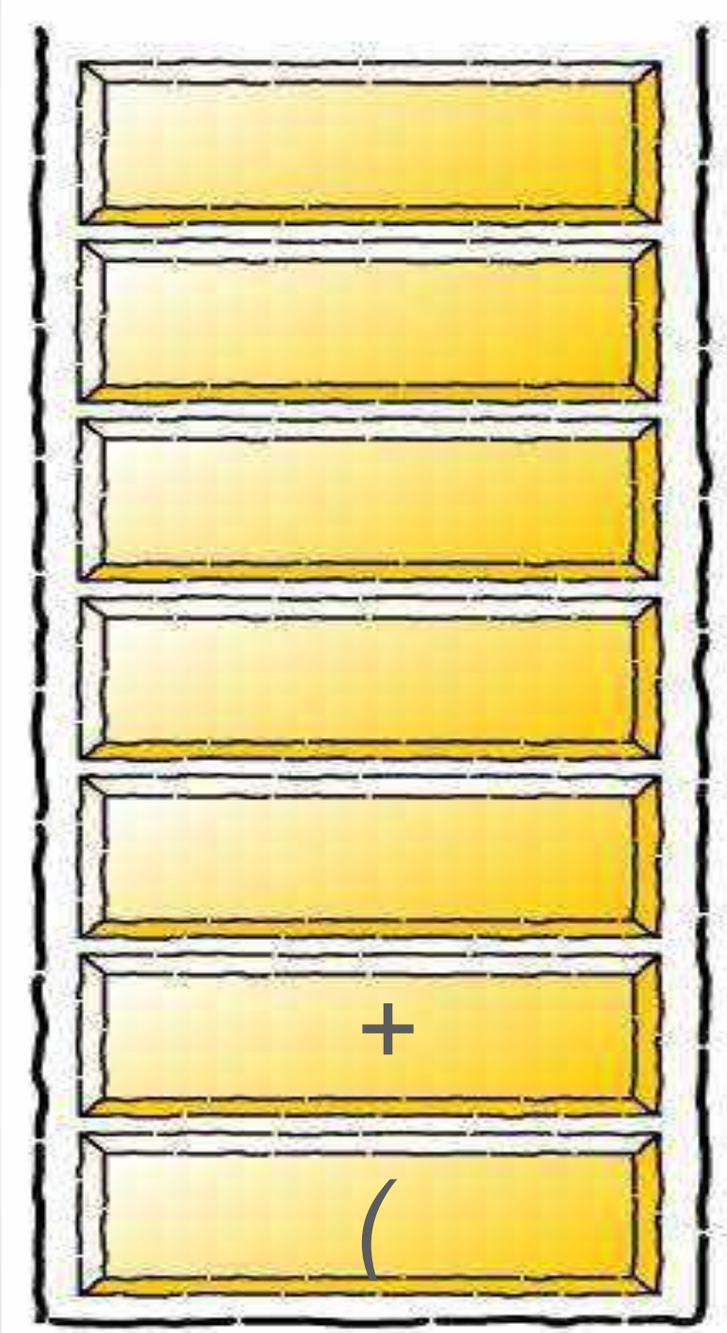
+ b - c) * d – (e + f)

postfixVect

a

Infix to postfix conversion

stackVect



infixVect

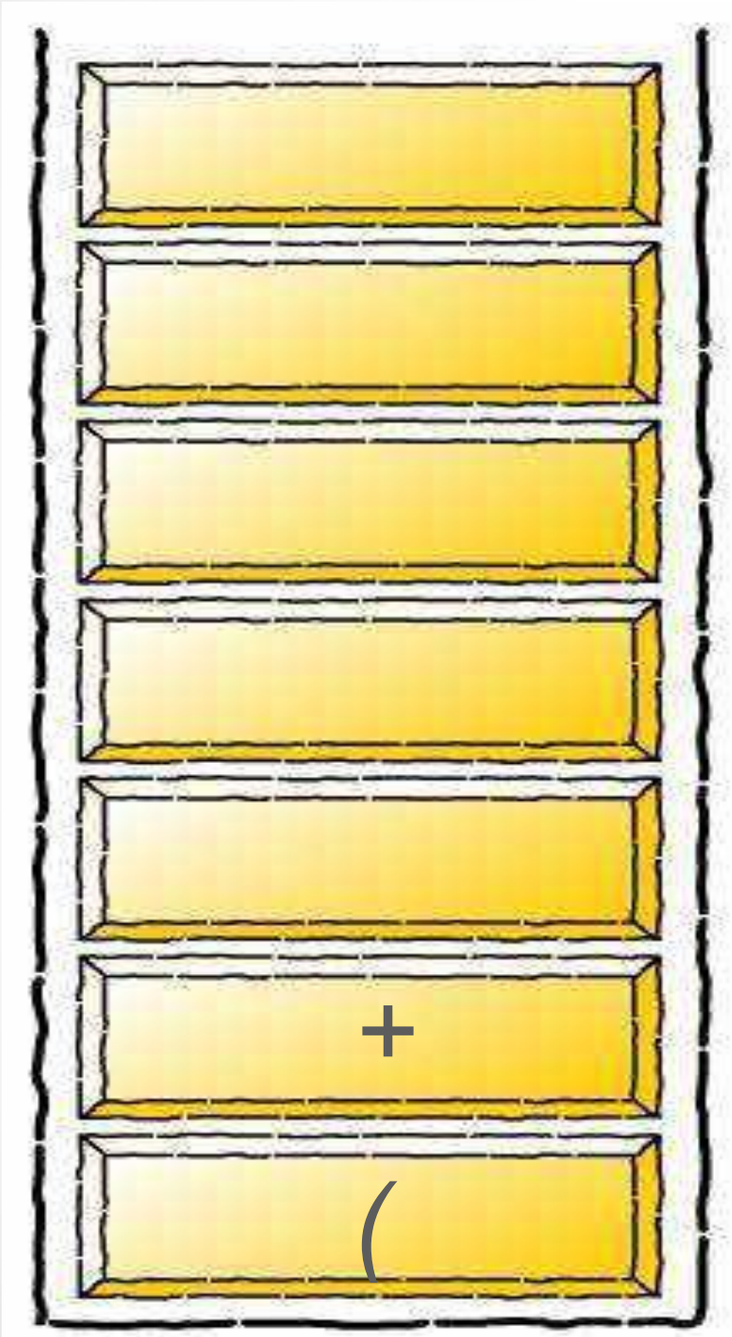
b - c) * d – (e + f)

postfixVect

a

Infix to postfix conversion

stackVect



infixVect

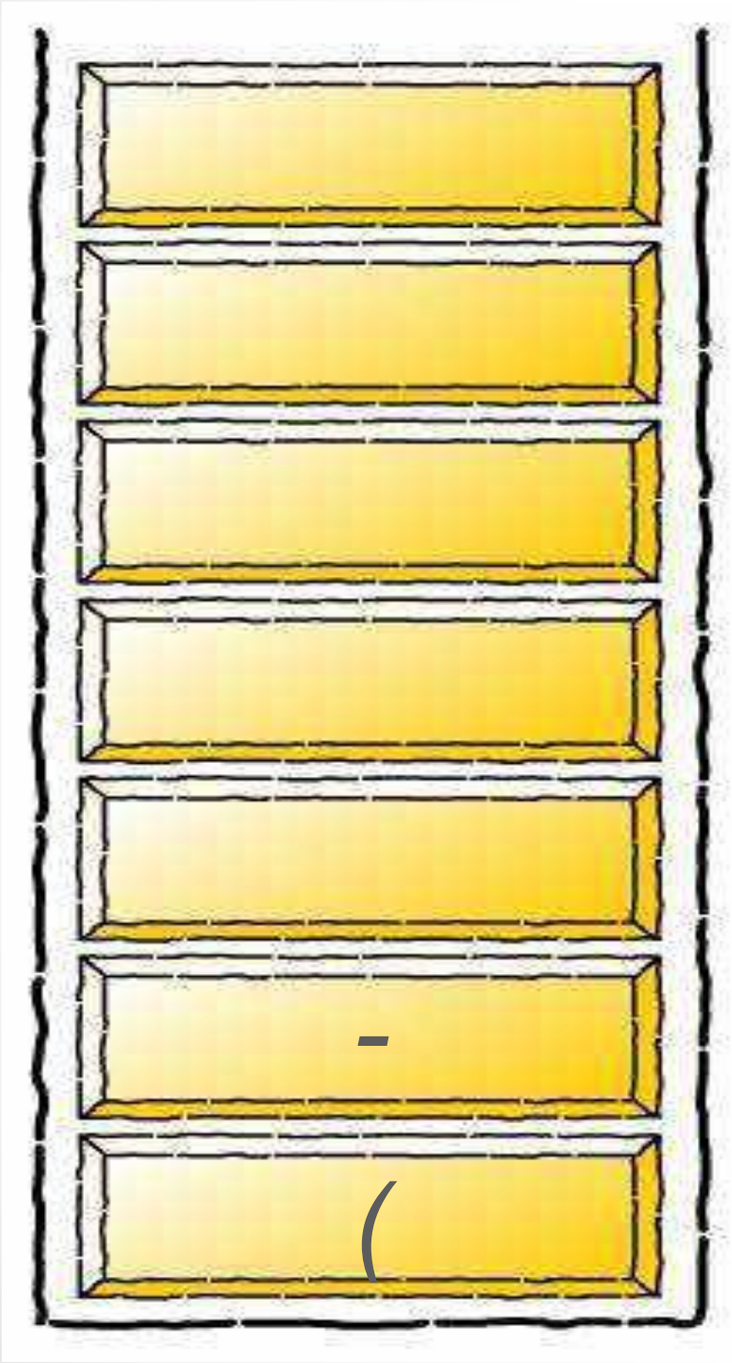
*- c) * d – (e + f)*

postfixVect

a b

Infix to postfix conversion

stackVect



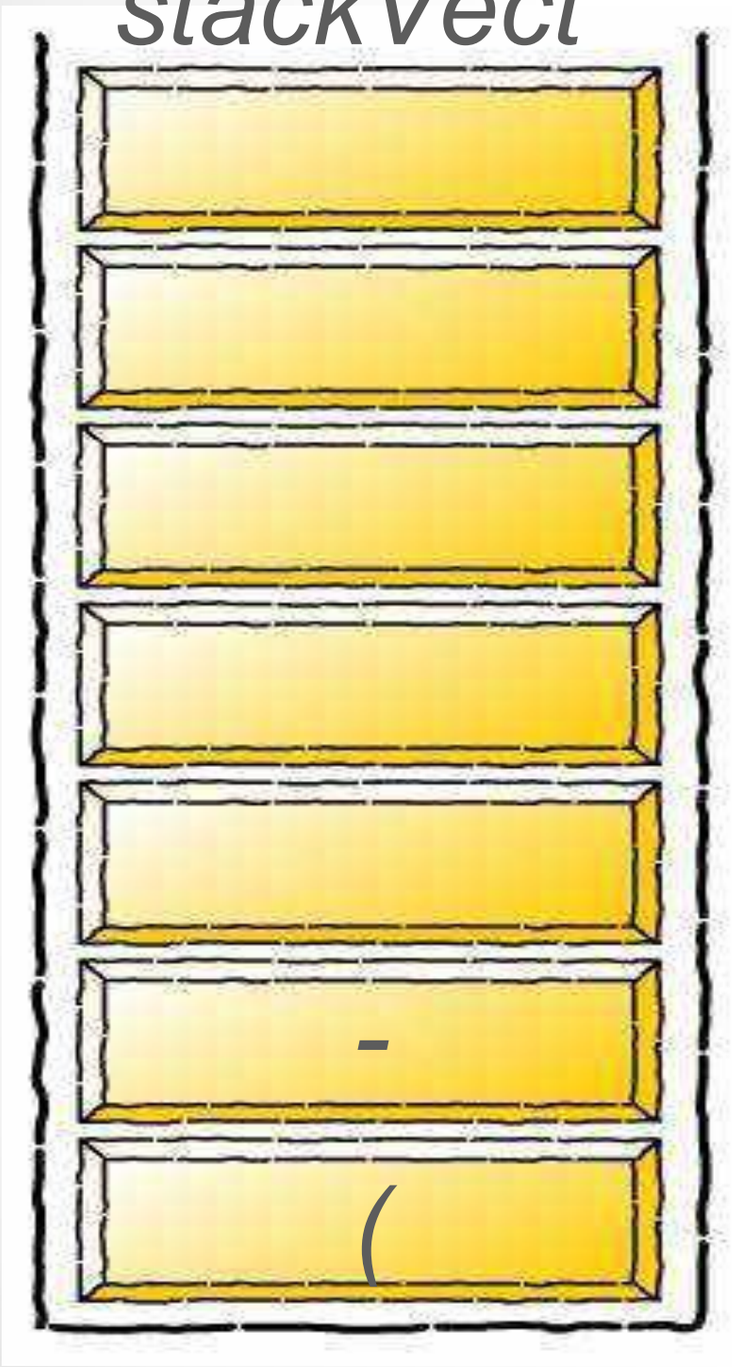
infixVect

c) * d – (e + f)

postfixVect

a b +

Infix to postfix conversion



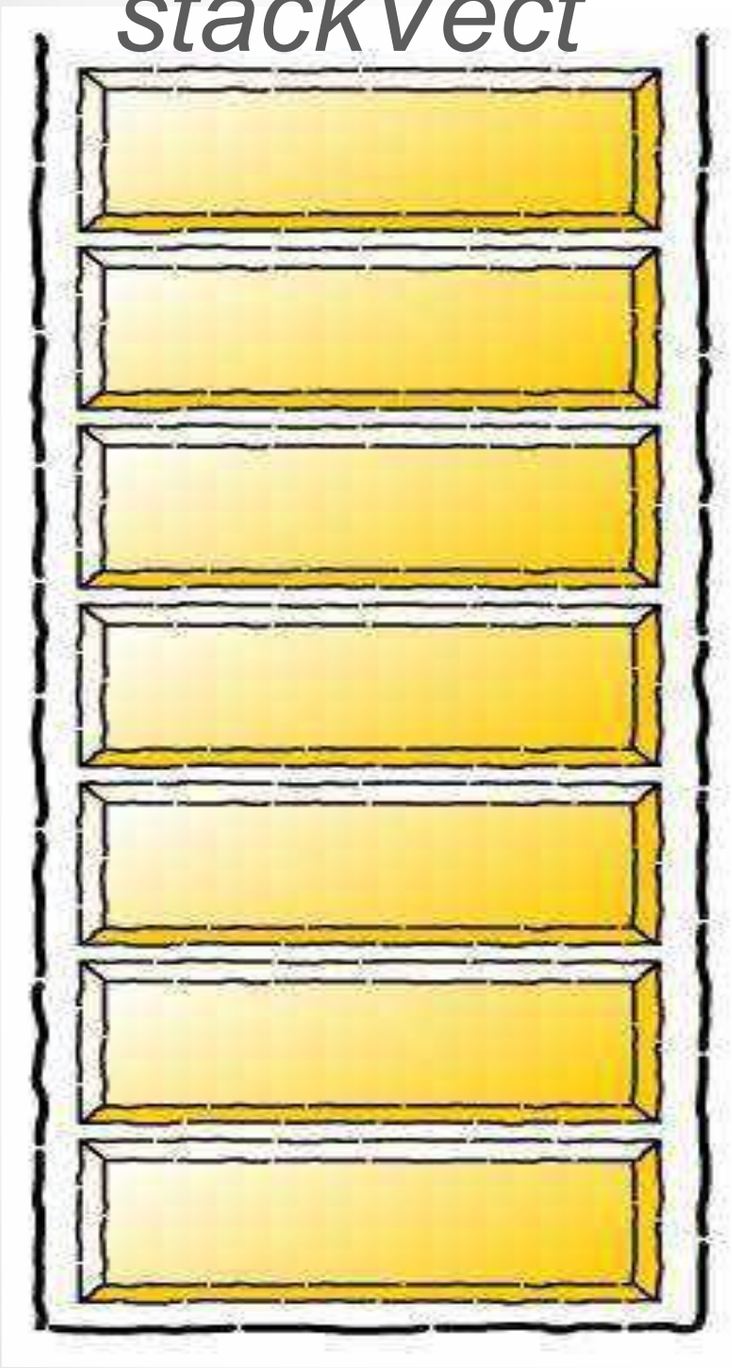
infixVect

) * d – (e + f)

postfixVect

a b + c

Infix to postfix conversion



infixVect

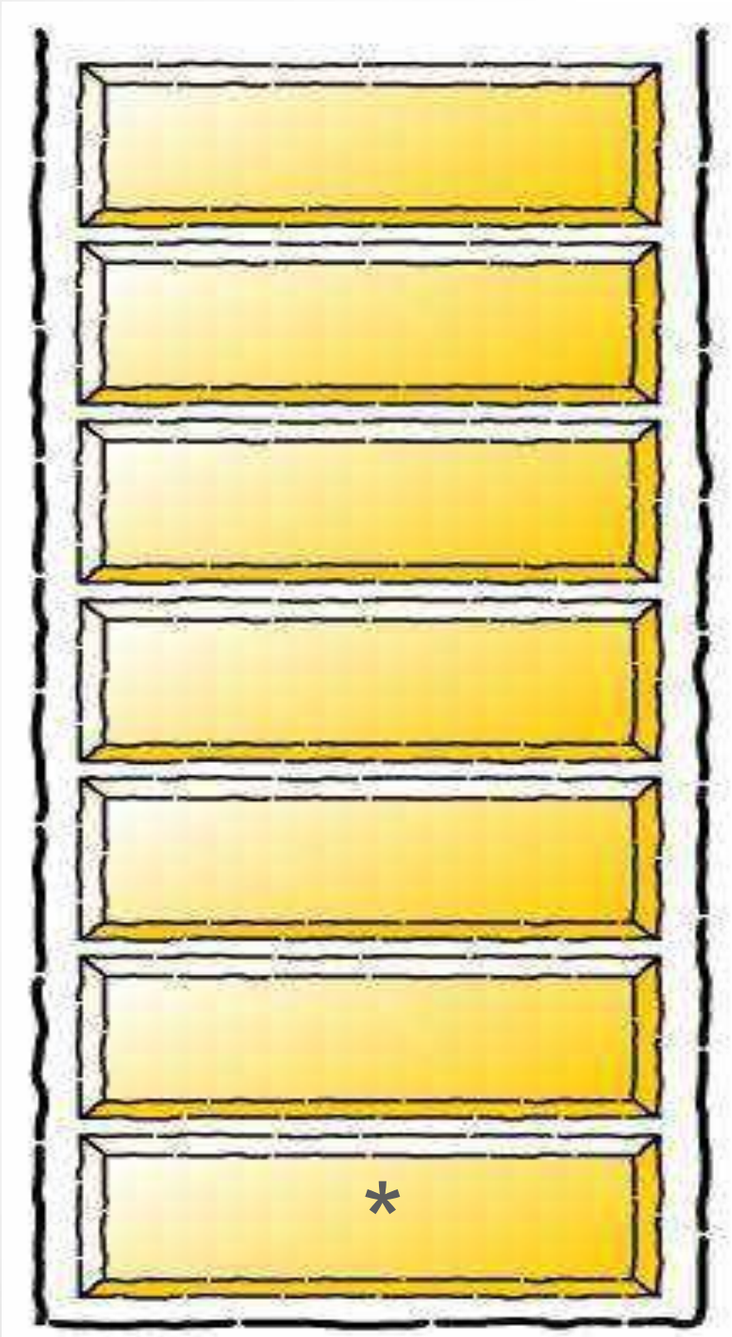
* d – (e + f)

postfixVect

a b + c -

Infix to postfix conversion

stackVect



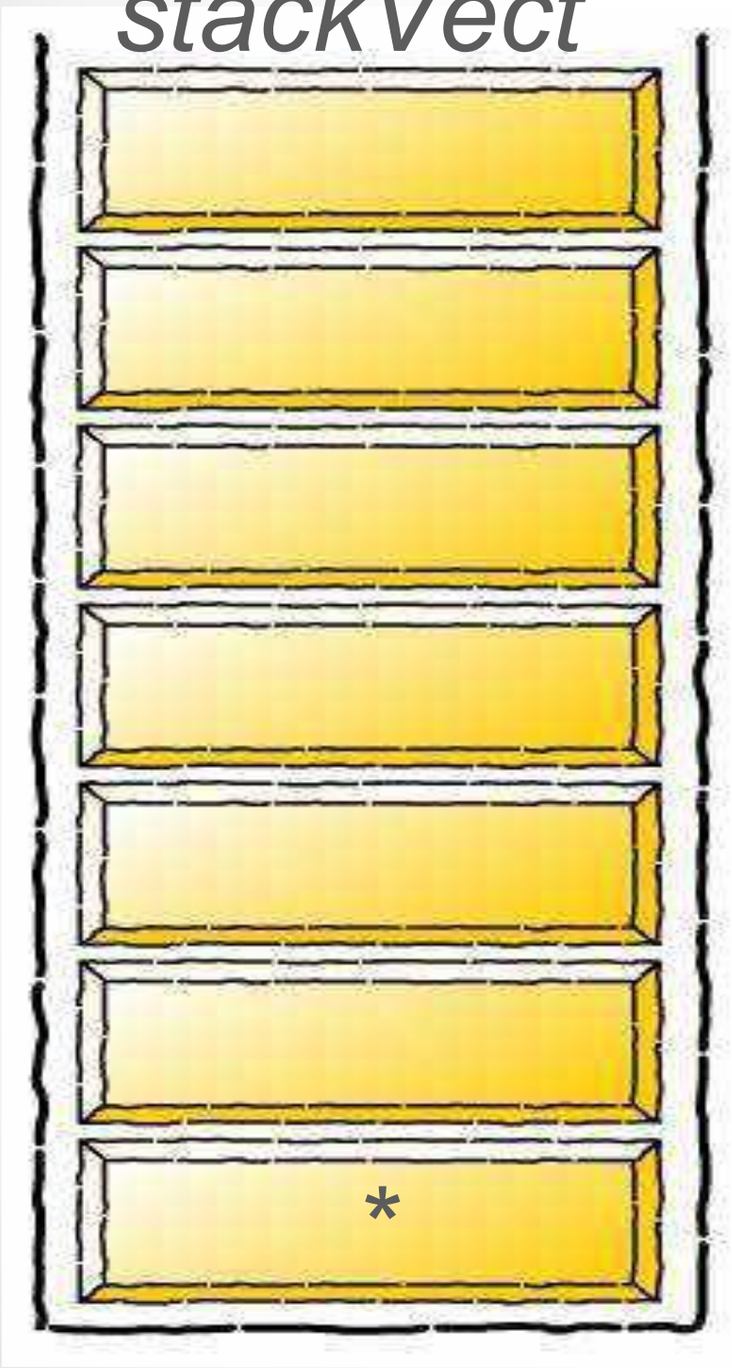
infixVect

d – (e + f)

postfixVect

a b + c -

Infix to postfix conversion



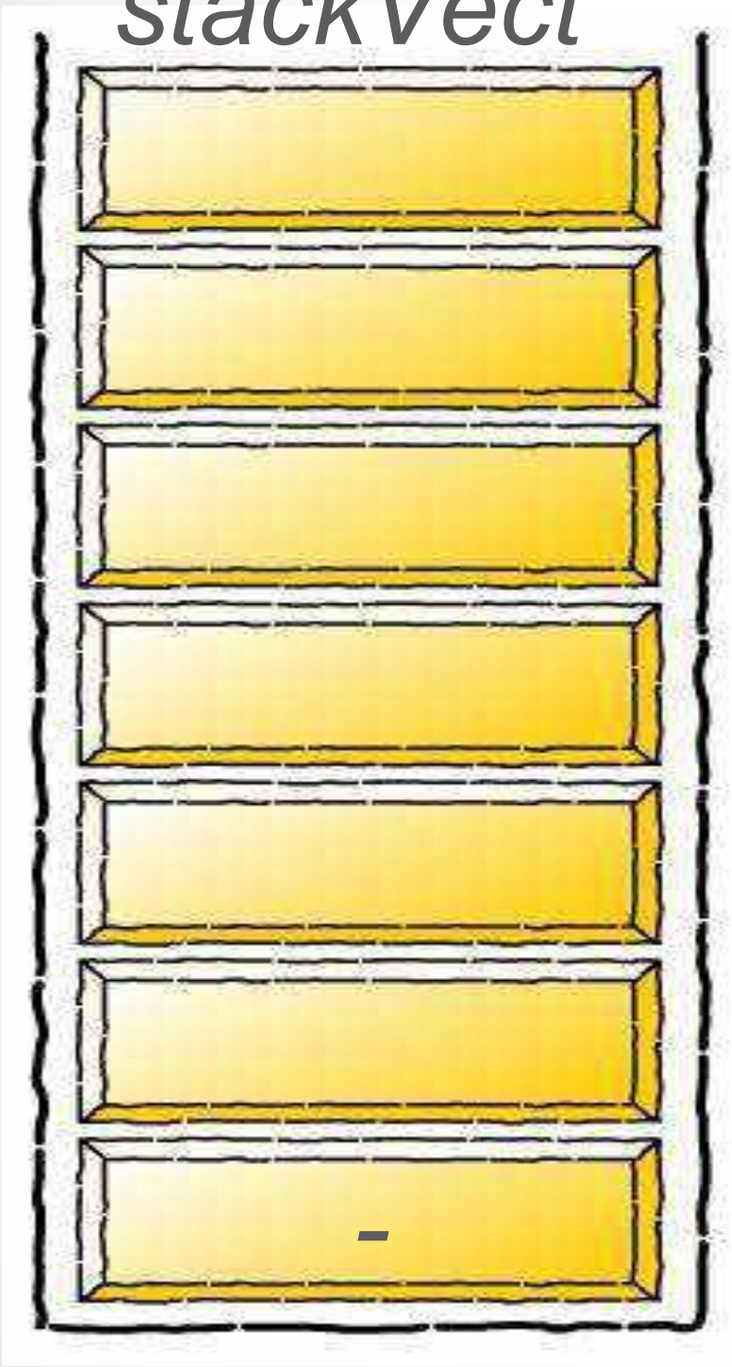
infixVect

– (e + f)

postfixVect

a b + c - d

Infix to postfix conversion



infixVect

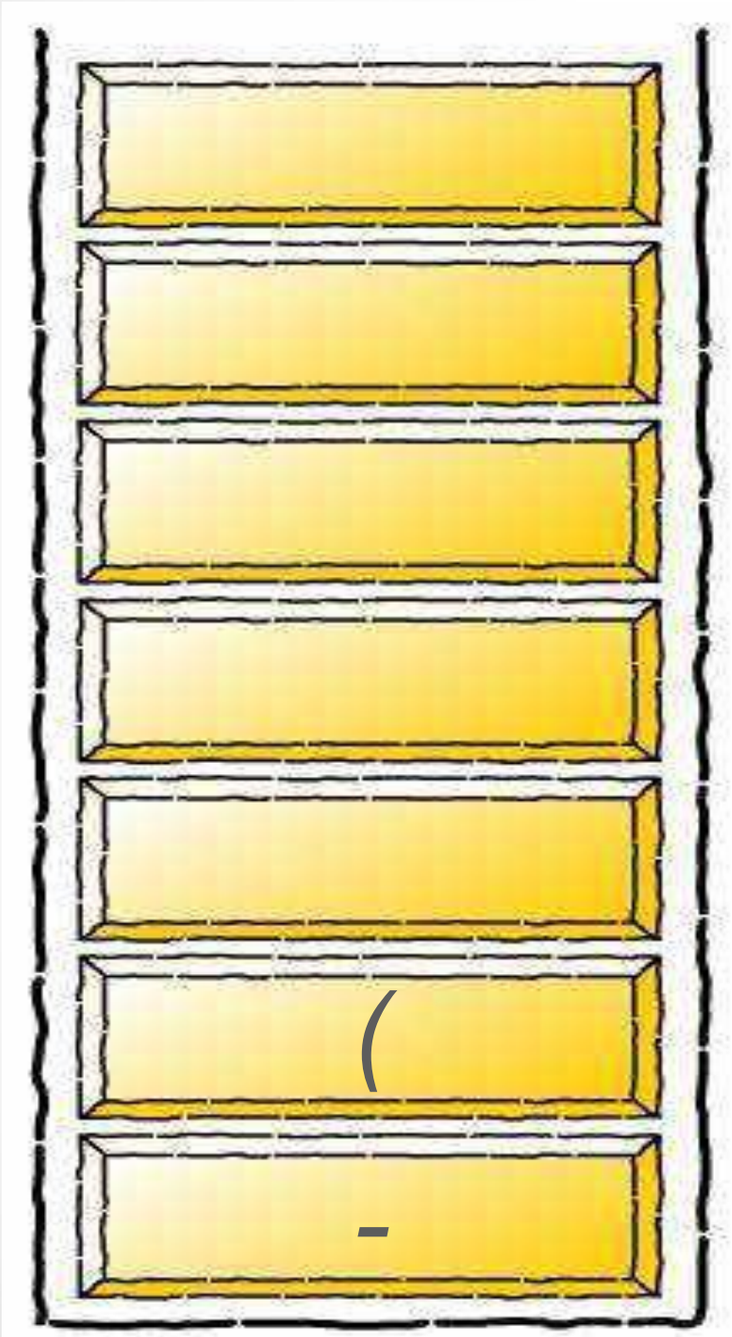
(e + f)

postfixVect

a b + c – d *

Infix to postfix conversion

stackVect



infixVect

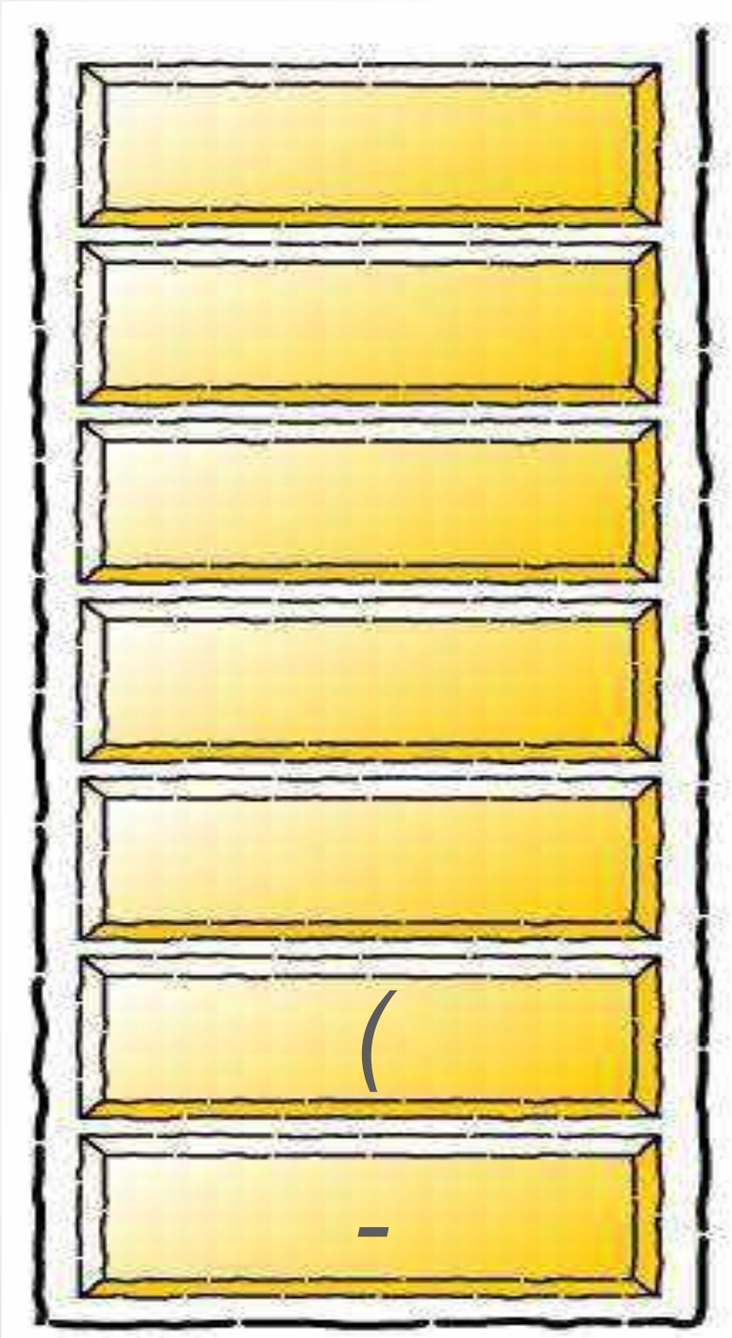
e + f)

postfixVect

*a b + c – d **

Infix to postfix conversion

stackVect



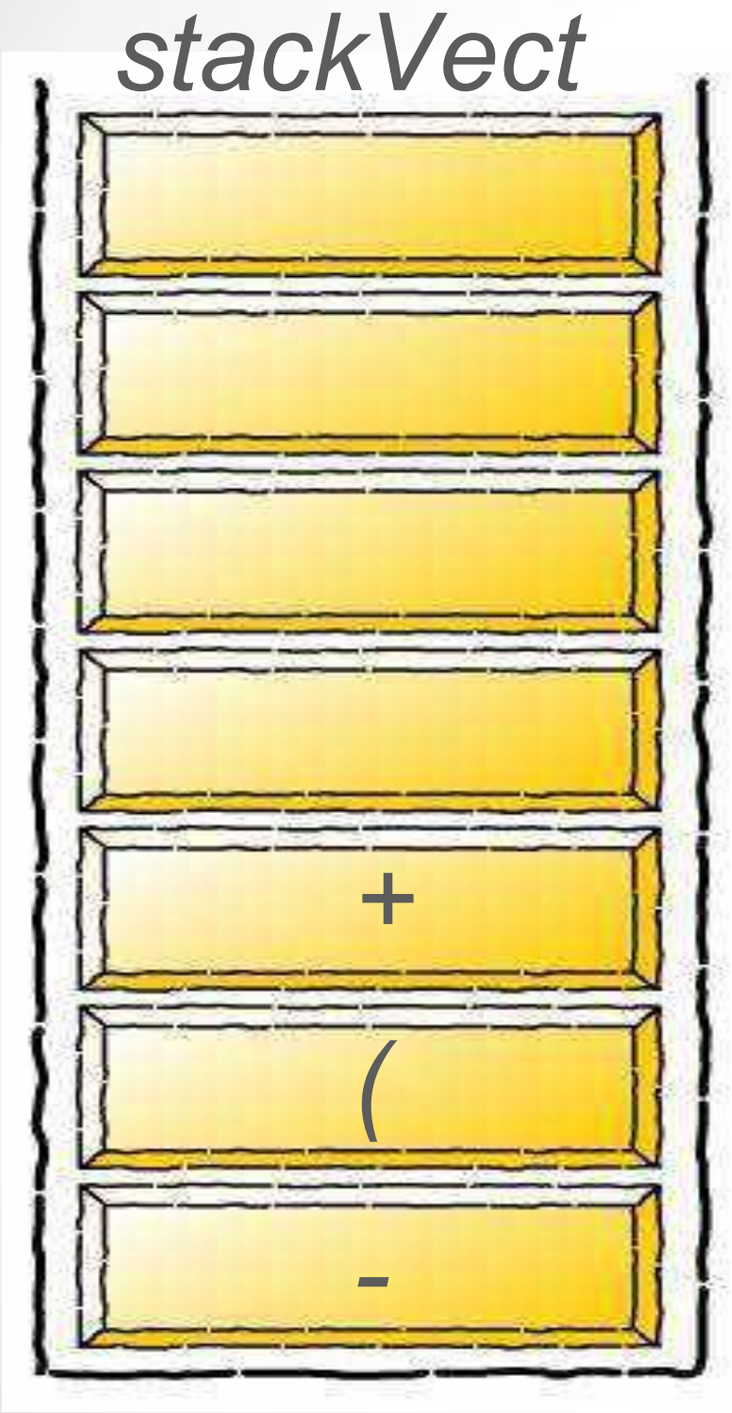
infixVect

+ f)

postfixVect

*a b + c – d * e*

Infix to postfix conversion



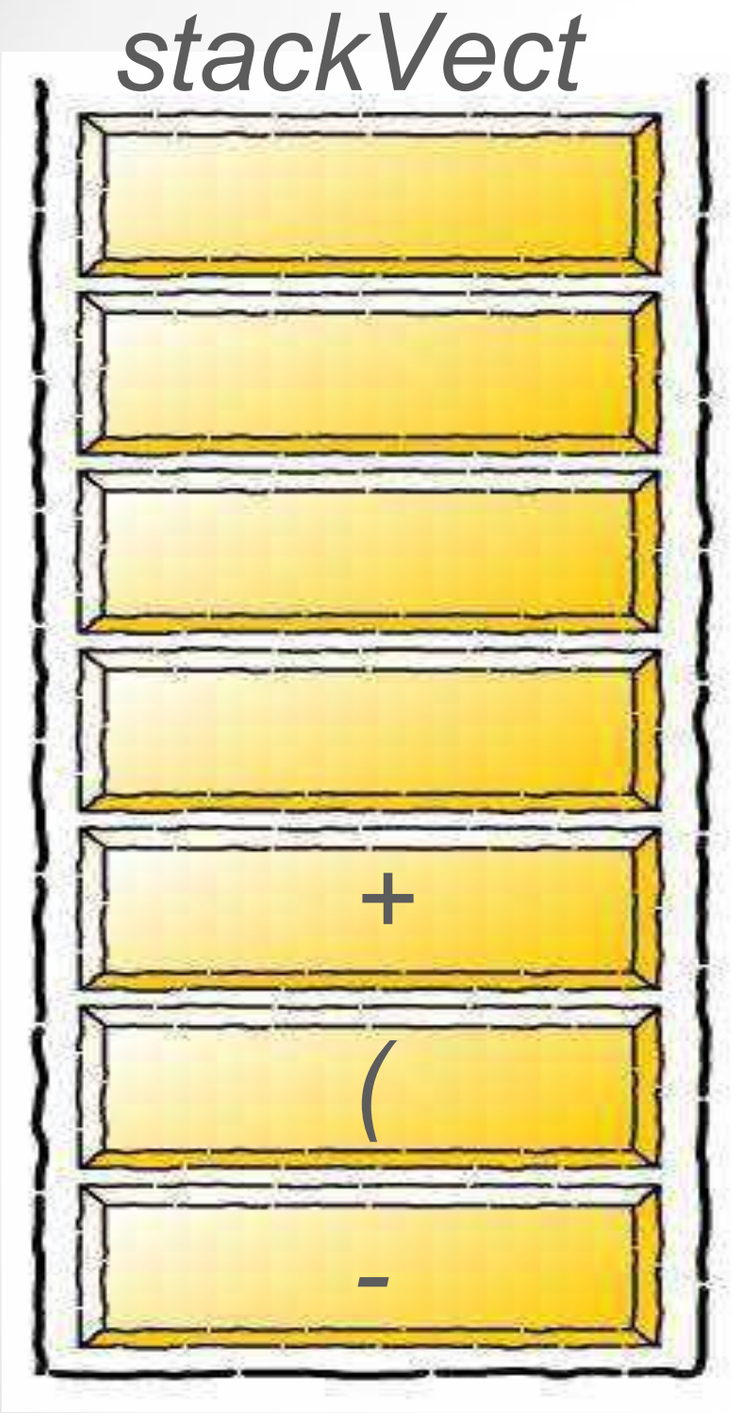
infixVect

f)

postfixVect

*a b + c – d * e*

Infix to postfix conversion



infixVect

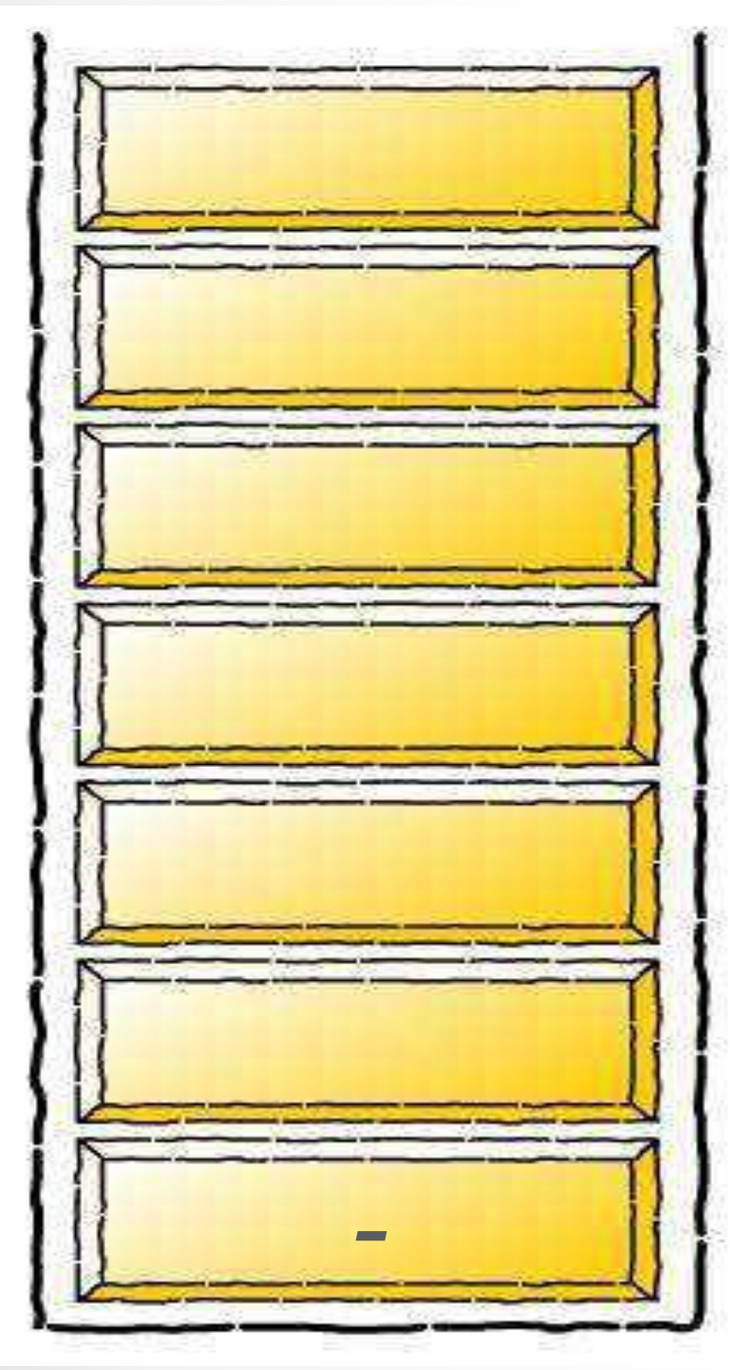
)

postfixVect

a b + c – d * e f

Infix to postfix conversion

stackVect



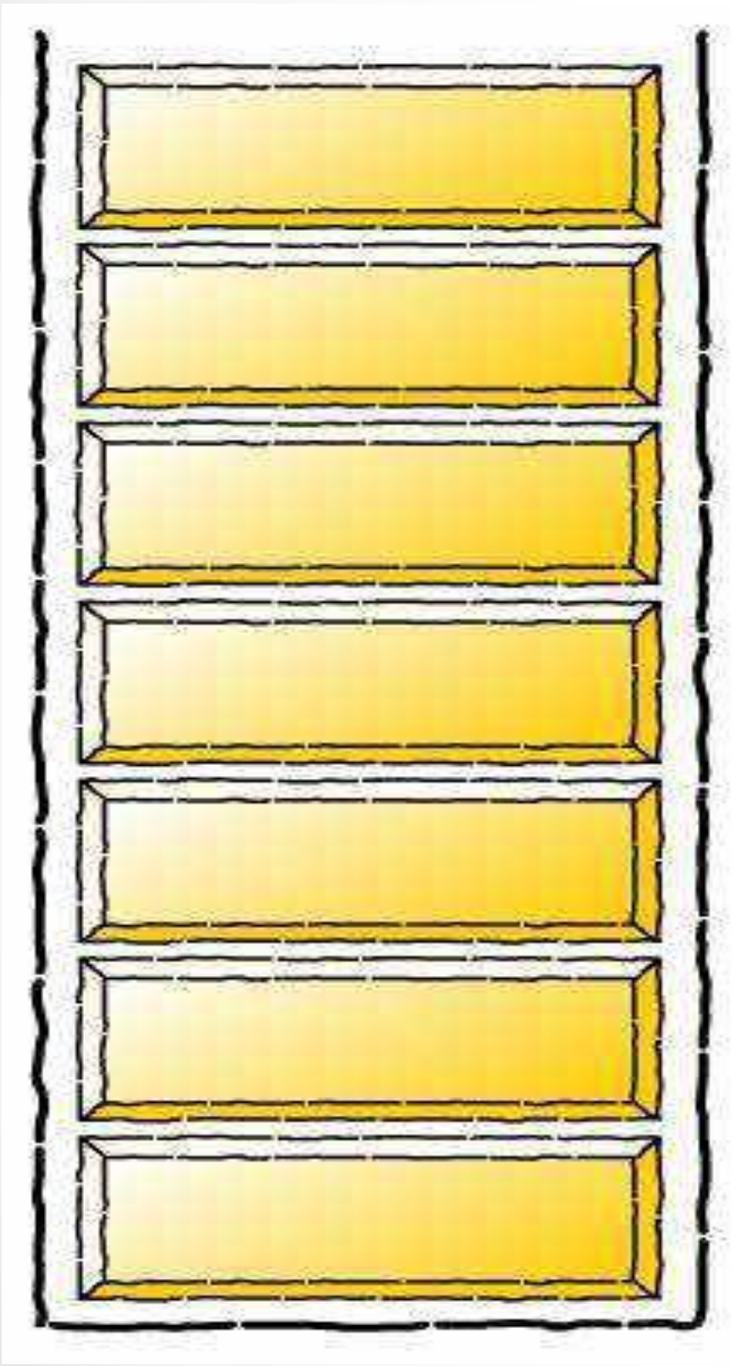
infixVect

postfixVect

*a b + c – d * e f +*

Infix to postfix conversion

stackVect



infixVect

postfixVect

*a b + c – d * e f + -*

Infix to postfix conversion

Contin.....

Conversion of Infix to Postfix

Example to Convert Infix to Postfix using stack

a + (b*c)

Read character	Stack	Output
a	Empty	a
+	+	a
(	+(	a
b	+(	ab
*	+(*	ab
c	+(*	abc
)	+	abc*
		abc*+

- *Resultant Postfix Expression: abc*+*

Infix to postfix conversion

Infix Exp

Character Scanned	Stack	Postfix)
A	–	A
*	*	A
B	*	AB
+	+	AB*
C	+	AB*C
*	+*	AB*C
D	+*	AB*CD
	Empty	AB*CD*+

Postfix expression is = AB*CD*+

- *Resultant Postfix Expression: abc*+*

Infix to postfix conversion

((A + B) * (C – D))/E

Table 4.8.1 : Infix to Postfix Conversion

Character from Infix	Stack	Postfix Expression
(	(	
(	((	
A	((	A
+	((+	A
B	((+	AB
)	(	AB+
*	(*	AB+
(	(*(	AB+
C	(*(	AB+C
-	(*(-	AB+C
D	(*(-	AB+CD
)	(*	AB+CD-
)		AB+CD-*
/	/	AB+CD-*
E	/	AB+CD-*E
		AB+CD-*E/

- *Resultant Postfix Expression: AB+CD-*E/*

Infix to postfix conversion

a ↑ b * c-d+e/f /(g + h)

Table 4.8.2 : Infix to Postfix Conversion

Character Scanned	Stack	Postfix)
A	–	a
↑	↑	a
B	↑	ab
*	↑	ab
C	*	ab ↑c
-	–	ab ↑ c*
D	–	ab ↑ c * d
+	+	ab ↑ c * d –
E	+	ab ↑ c * d – e
/	+ /	ab ↑ c * d – e
F	+ /	ab ↑ c * d – ef
/	+/	ab ↑ c * d – ef /
(	+ / (	ab ↑ c * d – ef /
G	+ / (	ab ↑ c * d – ef / g
+	+ / (	ab ↑ c * d – ef / g
H	+ / (+	ab ↑ c * d – ef / gh
	+ /	ab ↑ c * d – ef /gh +
	Empty	ab ↑ c * d – ef/ gh + / +

∴ Postfix expression is = ab ↑ c * d – ef / gh + /+

- *Resultant Postfix Expression:*

Infix to postfix conversion

Infix to postfix conversion

((A + B) * D)↑ (E – F)

Table 4.8.3 : Infix to Postfix Conversion

Character Scanned	Stack	Postfix
(	(	–
(	((	–
A	((	A
+	((+	A
B	((+	AB
)	(	AB+
*	(*	AB+
D	(*	AB+D
)	Empty	AB+D*
↑	↑	AB+D*
(	↑(	AB+D*E
E	↑(	AB+D*E
-	↑(–	AB+D*E
F	↑(–	AB+D*EF
	↑	AB+D*EF–
	Empty	AB+D*EF–↑

∴ Postfix expression = AB+D*EF–↑

Resultant Postfix Expression:

Infix to postfix conversion

Infix to postfix conversion

((a/(b-c+d))*(e - a)*c)

Character Scanned	Stack	Postfix)
(	(	-
(	((	-
A		a
/	((/	a
(	((/(	a
B		ab
–	((/(–	
C		abc
+	((/(+	abc-
D	((/(+	abc-d
)	((/	abc-d+
)		abc-d+/
*	(*	abc-d+/
(	(*(	abc-d+/
E	(*(	abc-d+/e
–	(*(–	abc-d+/e
A	(*(–	abc-d+/ea
)	(*	abc-d+/ea–
*	(*	abc-d+/ea–*
C	(*	abc-d+/ea–*c
)	empty	abc-d+/ea–*c*

- *Resultant Postfix Expression:* ***abc-d+/ea-*c****

Infix to postfix conversion

Infix Expression: ***A+ (B*C-(D/E^F)*G)*H***, where **^** is an exponential operator.

Symbol	Scanned	STACK	Postfix Expression	Description
1.		(		Start
2.	A	(	A	
3.	+	(+	A	
4.	(	(+(	A	
5.	B	(+(	AB	
6.	*	(+(*	AB	
7.	C	(+(*	ABC	
8.	-	(+(-	ABC*	'*' is at higher precedence than '-'
9.	(	(+(-(	ABC*	
10.	D	(+(-(	ABC*D	
11.	/	(+(-(/	ABC*D	
12.	E	(+(-(/	ABC*DE	
13.	^	(+(-(/^	ABC*DE	
14.	F	(+(-(/^	ABC*DEF	
15.	)	(+(-	ABC*DEF^/	Pop from top on Stack, that's why '^' Come first
16.	*	(+(-*	ABC*DEF^/	
17.	G	(+(-*	ABC*DEF^/G	
18.	)	(+	ABC*DEF^/G*-	Pop from top on Stack, that's why '^' Come first
19.	*	(+*	ABC*DEF^/G*-	
20.	H	(+*	ABC*DEF^/G*-H	
21.	)	Empty	ABC*DEF^/G*-H*+	END

- *Resultant Postfix Expression: ABC*DEF^/G*-H*+*

Infix to postfix conversion

Infix Expression: A+(B*(C-D)/E).

	RPN	Stack	Input Expression
1		(	A+(B*(C-D)/E)
2	A	+	+(B*(C-D)/E)
3	A	+ (	(B*(C-D)/E)
4	A	+ (	B*(C-D)/E)
5	AB	+ (	*(C-D)/E)
6	AB	* (+	(C-D)/E)
7	AB	* (+ (	C-D)/E)
8	ABC	* (+ (	-D)/E)
9	ABC	* (+ (	D)/E)
10	ABCD	* (+ (	)/E)
11	ABCD-	* (+	/E)
12	ABCD-*	/ (+	E)
13	ABCD-*E	/ (+	)
14	ABCD-*E/	+	
15	ABCD-*E/+		

- *Resultant Postfix Expression: ABCD-*E/+*

Infix to postfix conversion

Infix Expression: A * (B + C * D) + E.

Infix to Postfix using stack ...

- Example A * (B + C * D) + E becomes A B C D * + * E +

	current symbol	operator stack	postfix string
1	A		A
2	*	*	A
3	(	* (	A
4	B	* (	A B
5	+	* (+	A B
6	C	* (+	A B C
7	*	* (+ *	A B C
8	D	* (+ *	A B C D
9	)	*	A B C D * +
10	+	+	A B C D * + *
11	E	+	A B C D * + * E
12			A B C D * + * E +

- *Resultant Postfix Expression: ABCD*+*E+*

Infix to postfix conversion

Infix Expression : A+B*(C^D-E)				
Token	**Action**	**Result**	**Stack**	**Notes**
A	Add **A** to the result	A		
+	Push **+** to stack	A	+	
B	Add **B** to the result	AB	+	
*	Push ***** to stack	AB	* +	* has higher precedence than +
(	Push **(** to stack	AB	(* +	
C	Add **C** to the result	ABC	(* +	
^	Push **^** to stack	ABC	^ (* +	
D	Add **D** to the result	ABCD	^ (* +	
-	Pop **^** from stack and add to result	ABCD^	(* +	- has lower precedence than ^
	Push **-** to stack	ABCD^	- (* +	
E	Add **E** to the result	ABCD^E	- (* +	
)	Pop **-** from stack and add to result	ABCD^E-	(* +	Do process until (is popped from stack
	Pop **(** from stack	ABCD^E-	* +	
	Pop ***** from stack and add to result	ABCD^E-*	+	Given expression is iterated, do Process till stack is not Empty, It will give the final result
	Pop **+** from stack and add to result	**ABCD^E-*+**		
Postfix Expression : ABCD^E-*+				

Resultant Postfix Expression: ABCD^E-+*

Infix to postfix conversion

Suppose we want to convert 2*3/(2-1)+5*3 into Postfix form,

Expression	Stack	Output
2	Empty	2
*	*	2
3	*	23
/	/	23*
(	/(	23*
2	/(	23*2
-	/(-	23*2
1	/(-	23*21
)	/	23*21-
+	+	23*21-/
5	+	23*21-/5
*	+*	23*21-/53
3	+*	23*21-/53
	Empty	23*21-/53*+

Resultant Postfix Expression: ABCD+E*+*

So, the Postfix Expression is 23*21-/53*+

Infix to postfix conversion

Convert A * (B + C) * D
to postfix notation.

Scanned character	stack	postfix
A		A
*	*	A
(	*(	A
B	*(	AB
+	*(+	AB
C	*(+	ABC
)	*	ABC+
*	*	ABC+*
D	*	ABC+*D
	Empty	ABC+*D*

Resultant Postfix Expression: ABCD+*E+*

POSTFIX EXPRESSION EVALUATION

ALGORITHMS :

Step 1 : Read postfix expression from Left to Right

Step 2 : If operand is encountered, push it in Stack.

Step 3 : If operator is encountered, Pop two elements
A → Top element B → Next Top element
Evaluate B operator A

Step 4 : Push result into stack

Step 5 : Read next postfix element if not end of postfix string

Step 6 : Repeat from Step 2

Step 7 : Print the result popped from stack.

Resultant Postfix Expression: ABCD+*E+*

POSTFIX EXPRESSION EVALUATION

*POSTFIX EVALUATE EXPRESSION : 53+82-**

Reading symbol	Stack operations	Evaluated part of expression
Initially	Stack is Empty	Nothing
5	push(5)	Nothing
3	push(3)	Nothing

+	Value 1 = pop()
	Value 2 = pop()
	result = Value 2 + Value 1
	push(result)
		Value 1 = pop(); // 3
		Value 2 = pop(); // 5
		result = 5 + 3; // 8
		Push(8)
		(5 + 3)

8	push(8)	(5 + 3)
2	push(2)	(5 + 3)

–	Value 1 = pop()
	Value 2 = pop()
	result = Value 2 – Value 1
	push(result)
		Value 1 = pop(); // 2
		Value 2 = pop(); // 8
		result = 8 – 2; // 6
		Push(6)
		(8 – 2)
		(5 + 3),(8 – 2)

*	Value 1 = pop()
	Value 2 = pop()
	result = Value 2 + Value 1
	push(result)
		Value 1 = pop(); // 6
		Value 2 = pop(); // 8
		result = 8 * 6; // 48
		Push(48)
		(6 * 8)
		(5 + 3),(8 – 2)

End of expression	result = pop()	Display (result) 48 as final result

POSTFIX EXPRESSION EVALUATION

** Evaluate the following postfix expression and show stack after every step in tabular form. Given A=5, B=6, C=2, D=12, E=4*

*ABC + *DE\-*

ABC+*DE/-

This will become

5 6 2 + * 12 4 / -

Table 4.9.2 : Evaluate Postfix Expression

Reading	Stack	Evaluated
5	5	
6	5,6	
2	5,6,2	
+	5,8	6 + 2 = 8
*	40	5*8 = 40
12	40,12	
4	40,12,4	
/	40,3	12 / 4 = 3
-	37	40-3 = 37

Result is 37.

POSTFIX EXPRESSION EVALUATION

- *Evaluate the following postfix expression*

  *A : 6, 2, 3, +, - , 3, 8, 2, +, +, * , 2, ^, 3, +*

Reading	Stack	Evaluated
6	6	
2	6 2	
3	6 2 3	
+	6 5	2 + 3 = 5
-	1	6 – 5
3	1 3	
8	1 3 8	
2	1 3 8 2	
+	1 3 10	8 + 2 = 10
+	1 13	3 + 10 = 13
*	13	1 * 13
2	13 2	

Sem 3-Comp.)

Reading	Stack	Evaluated
^	169	$13^2 = 169$
3	169 3	
+	172	169 + 3 = 172

Result 172

POSTFIX EXPRESSION EVALUATION

- **Consider the following arithmetic expression written in postfix notation**

10, 2, * , 15, 3, / , + , 12, 3, 2, **↑ , + , + evaluate this expression to find its value**

Reading	Stack	Evaluated
10	10	
2	10 2	
*	20	10 * 2 = 20
15	20 15	
3	20 15 3	
/	20 5	15 / 3 = 5
+	25	20 + 5
12	25 12	
3	25 12 3	
2	25 12 3 2	
↑	25 12 9	$3^2 = 9$
+	25 21	12 + 9 = 21
+	46	25 + 21 = 46

Convert infix into prefix expression

convert the given infix to prefix expression and show detail of stack.

(A-B/C)*(D*E-F)

First we have to reverse the string

(F – E * D) * (C/B – A)

Table 4.10.1 : Evaluation of Prefix Expression

Character scanned	Stack	Postfix
(	(	–
F	(	F
–	(–	F
E	(–	FE
*	(– *	FE
D	(– *	FED
)	Empty	FED* –
*	*	FED* –
(	* (	FED * –
C	* (	FED * – C
/	* (/	FED * – C
B	* (/	FED * – CB
–	* (–	FED * – CB/
A)	* (–	FED * – CB/A
)	*	FED * – CB/A –
End	Empty	FED * – CB/A – *

Now reverse the expression :

Prefix expression : * – A/BC – * DEF

Convert infix into prefix expression

convert infix string ((A+B) * (C-D))/(E+F) into prefix string with stack.

---▯ first reverse the string (F+E)/((D-C) * (B+A))

Character Scanned	Stack	Postfix
(	(	_
F	(	F
+	(+	F
E	(+	FE
)	Empty	FE+
/	/	FE+
(	/(	FE+
(	/((	FE+
D	/((	FE+D
–	/((–	FE+D
C	/((–	FE+DC
)	/(	FE+DC–
*	/(*	FE+DC–
(	/(*(	FE+DC–
B	/(*(	FE+DC–B
+	/(*(+	FE+DC–B
A	/(*(+	FE+DC–BA
)	/(*	FE+DC-BA+
)	/	FE+DC-BA+*
	Empty	FE+DC-BA+*/

Reverse the string

Result will be : /* + AB – CD + EF

Convert prefix into postfix expr.

ALGORITHMS :

- Read the Prefix expression in reverse order (from right to left)
- If the symbol is an operand, then push it onto the Stack
- If the symbol is an operator, then pop two operands from the StackCreate a string by concatenating the two operands and the operator after them.string = operand1 operand2 operator And push the resultant string back to Stack.
- Repeat the above steps until end of Prefix expression.

Convert prefix into postfix expr.

Convert the following prefix expression into postfix expression

***+a-bc/-de+-fgh**

Expression scanned from right to left.

Prefix	Stack	Postfix
*+a-bc/-de+-fgh	-	–
*+a-bc/-de+-fg	h	–
*+a-bc/-de+-f	gh	–
*+a-bc/-de+-	fgh	–
*+a-bc/-de+	fg-h	fg-
*+a-bc/-de	fg-h+	fg-h+
*+a-bc/-d	e fg-h+	fg-h+
*+a-bc/-	d e fg-h+	fg-h+
*+a-bc/	de- fg-h+	fg-h+

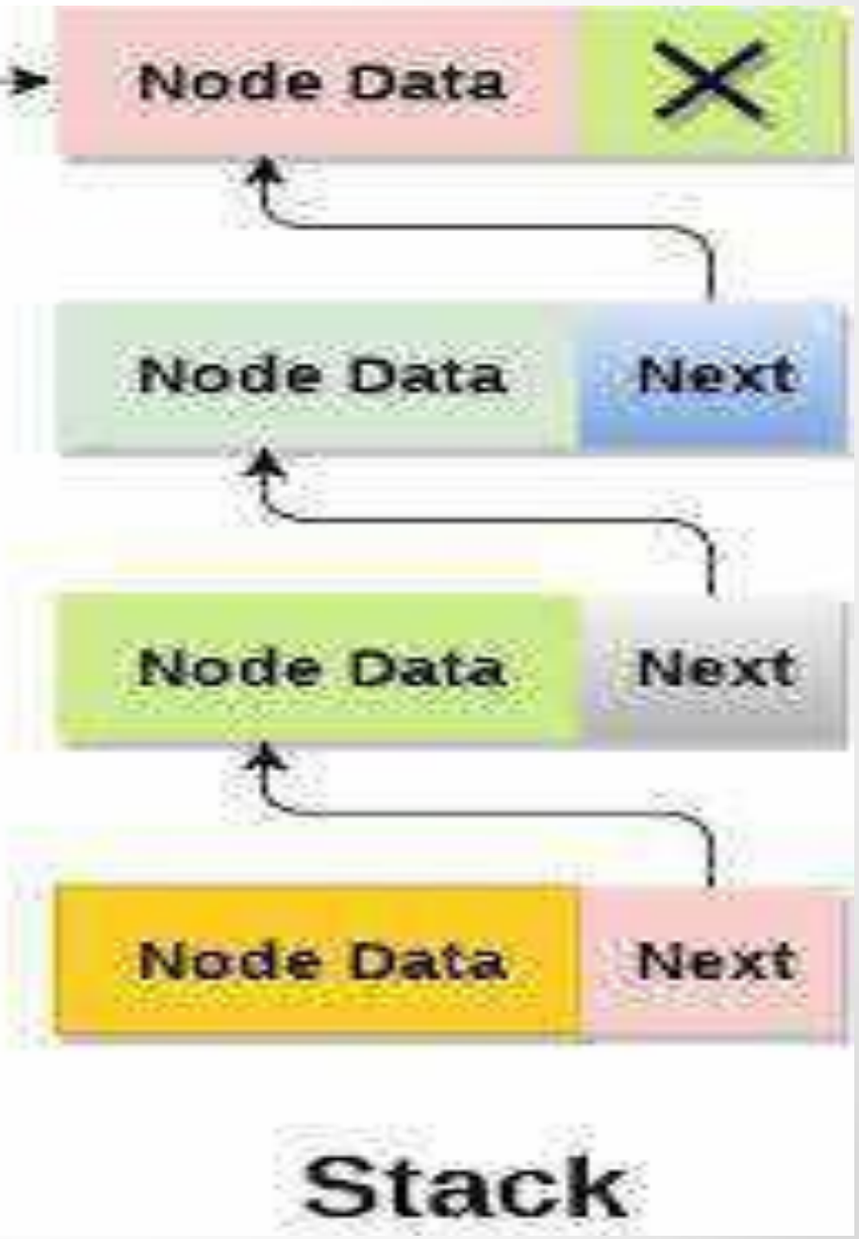
7

Prefix	Stack	Postfix
*+a-bc	de-fg-h+/	de-fg-h+/
*+a-b	c de-fg-h+/	de-fg-h+/
*+a-	b c de-fg-h+/	de-fg-h+/
*+a	bc- de-fg-h+/	de-fg-h+/
*+	a bc- de-fg-h+/	de-fg-h+/
*	abc-+ de-fg-h+/	de-fg-h+/
Empty	Empty	abc-+ de-fg-h+/*

∴ Postfix expression = AB+D*EF–↑

Linked stack operation

In stack elements are placed one above other. In the same manner in stack as linked list, we place node one above other.



Advantages of dynamic implementation of stack :

1. *No memory wastage*
2. *No memory shortage*
3. *No limitation on number of elements*

Stack operation using linked list

```
#include <iostream>
using namespace std;

struct Node {
    int data;
    struct Node *next;
};
struct Node* top = NULL;


void push(int val) {
    struct Node* newnode = (struct Node*) malloc(sizeof(struct Node));
    newnode->data = val;
    newnode->next = top;
    top = newnode;
}
```

Stack operation using linked list

```
void pop() {
   if(top==NULL)
      cout<<"Stack Underflow"<<endl;
   else {
      cout<<"The popped element is "<< top->data <<endl;
      top = top->next;
   }
}
```

Stack operation using linked list

```
void display() {
   struct Node* ptr;
   if(top==NULL)
      cout<<"stack is empty";
   else {
      ptr = top;
      cout<<"Stack elements are: ";
      while (ptr != NULL) {
         cout<< ptr->data <<" ";
         ptr = ptr->next;
      }
   }
   cout<<endl;
}
```

Stack operation using linked list

```
int main() {
   int ch, val;

   cout<<"1) Push in stack"<<endl;
   cout<<"2) Pop from stack"<<endl;
   cout<<"3) Display stack"<<endl;
   cout<<"4) Exit"<<endl;

do {
   cout<<"Enter choice: "<<endl;
   cin>>ch;
   switch(ch) {
      case 1: {
         cout<<"Enter value to be pushed:"<<endl;
         cin>>val;
         push(val);
```

Stack operation using linked list

```
case 2: {
        pop();
        break;
    }
    case 3: {
        display();
        break;
    }
    case 4: {
        cout<<"Exit"<<endl;
        break;
    }
    default: {
            cout<<"Invalid Choice"<<endl;
        }
    }
  }while(ch!=4);
    return 0;
}
```

RECURSION IN STACK

"Calling function inside itself is called as recursion. Such function is called as recursive function"

How recursion works?

How recursion works ?

```
void recurse()
{
  ...  ..  ...
  recurse();
  ...  ..  ...
}

int main()
{
  ...  ..  ...
  recurse();
  ...  ..  ...
}
```

recursive call

- The execution of recursion continues unless and until some specific condition is met to prevent its repetition.
- For the purpose of preventing infinite recursion, if...else statement (or similar approach) can be used in which one branch go for the recursive call while other doesn't.

RECURSION IN STACK

Advantages :

1. *It helps to reduce size of program*
2. *Easy to maintain function calling*
3. *Evaluation of stack can be through recursion*

Disadvantages :

1. *It takes more time bcz of stack overlapping*
2. *Stack overflow may ocuur*
3. *Memory requirement is more*
4. *Efficiency is less*

Backtracking algorithm strategy:

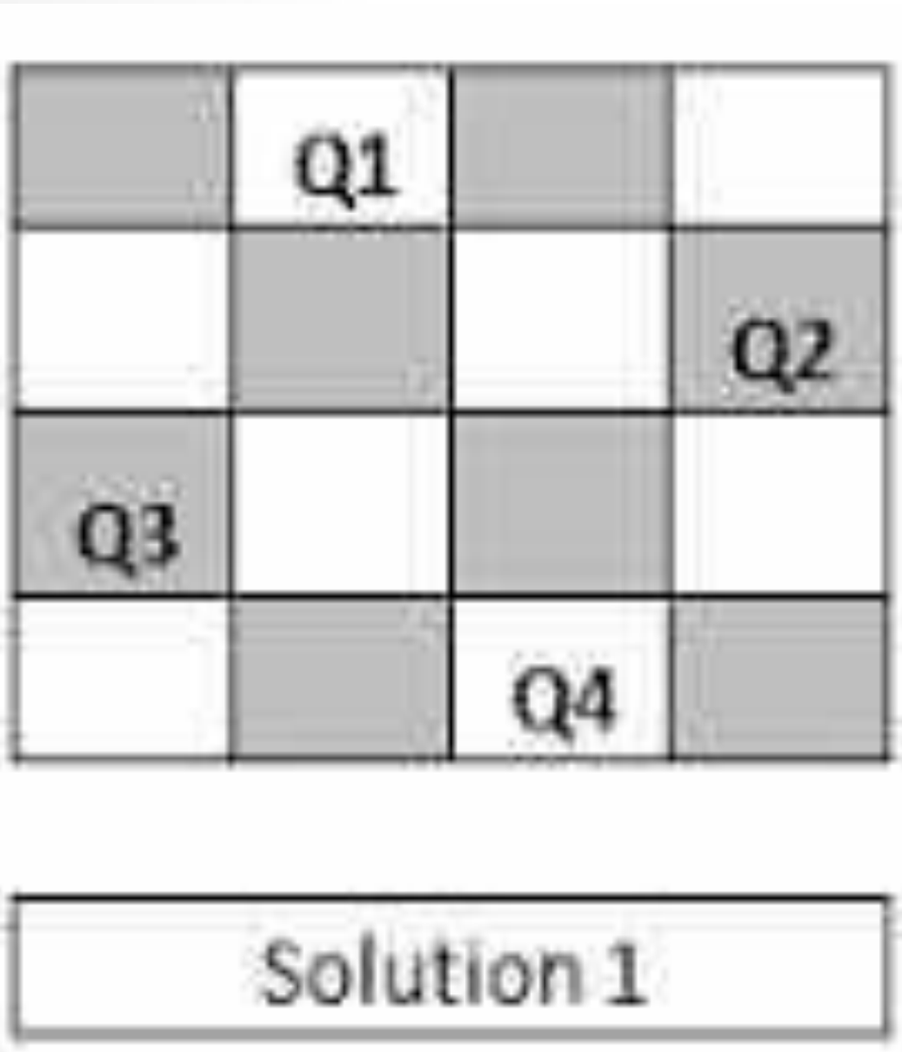
BACKTRACKING

- Backtracking is a simple, elegant, recursive technique which can be put to a variety of uses.
- You start at the root of a tree, the tree probably has some good and bad leaves. You want to get to a good leaf. At each node, you choose one of its children to move to, and you keep this up in a stack until you get to a leaf.
- Suppose you get to a bad leaf. You can *backtrack* to continue the search for a good leaf by revoking your *most recent* choice, and trying out the next option in that set of options.
- If you run out of options, revoke the choice that got you here, and try another choice at that node.
- If you end up at the root with no options left, there are no good leaves to be found.

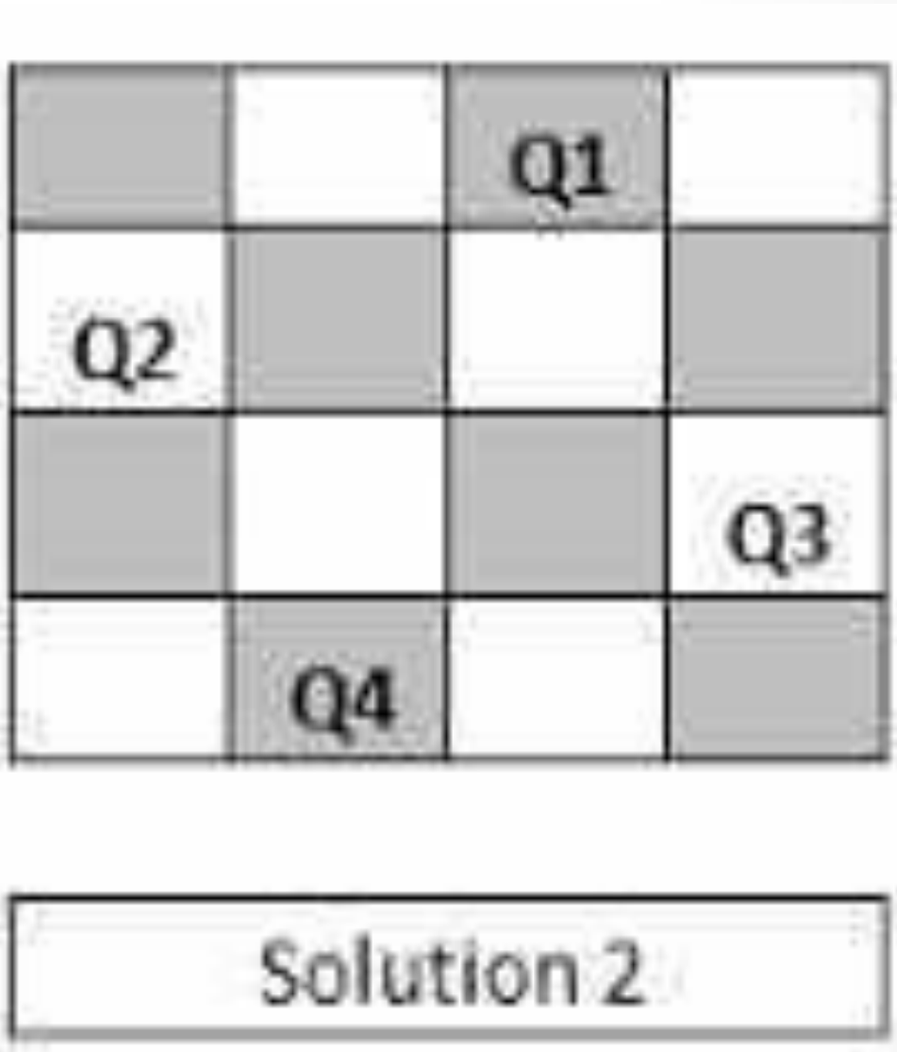
4-QUEEN PROBLEM

4-QUEEN PROBLEM

The N Queen is the problem of placing N chess queens on an N×N chessboard so that no two queens attack each other.



Solution 1



Solution 2

THANK YOU