Stack

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Outline

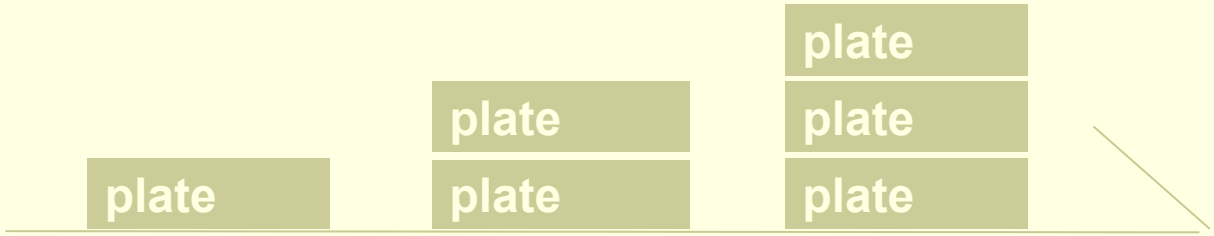
- Limitation of Linked list
- Intro to Stack
- Creation of Stack
- Stack representation using array
- Stack representation using Linked list

Stack

- Limitation with Linked list
  - insertion & deletion can be done at any node
  - not applicable for restricted insertion and deletion operation

Stack

- ✓ Items may added or removed only at one end
- ✓ Items may added or removed only from top of the stack
- ✓ Last In First Out (LIFO)



Stack

- It is a list in which elements are added or removed from Top of Stack (TOS)
- Every stack is associated with a pointer TOS
- Two basic operations of stack are -

  push - insert an element into stack

  pop - remove an element from stack

Basic operations of Stack

PUSH

size - size of the stack

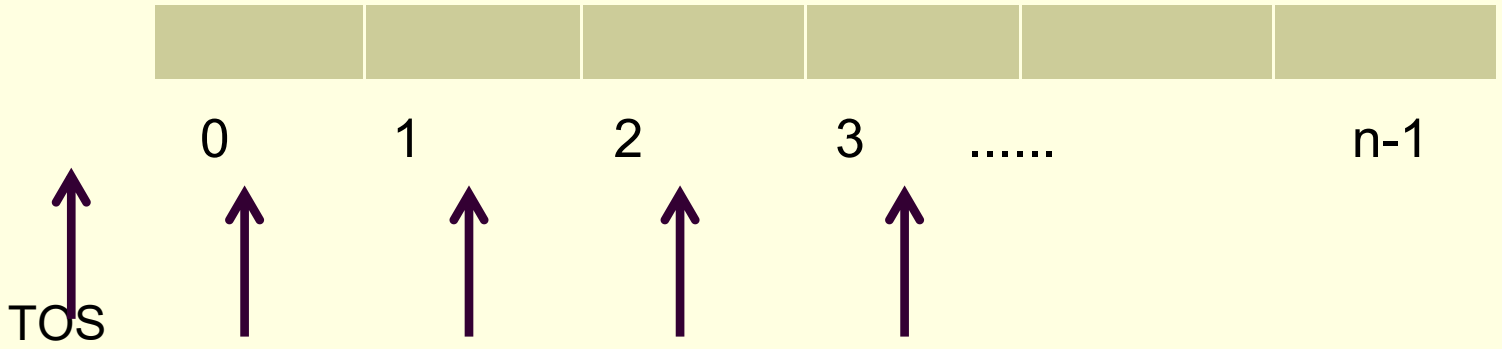
TOS - top of stack

1. if TOS >= size
   print “Stack overflow” and Exit
2. TOS = TOS+1
3. S[TOS] = value //inserting value
4. Exit

POP

1. if TOS =0 //stack is empty
   print “Stack underflow” and Exit
2. value = S[TOS]
3. TOS = TOS -1
4. Return value & Exit

Array implementation of Stack



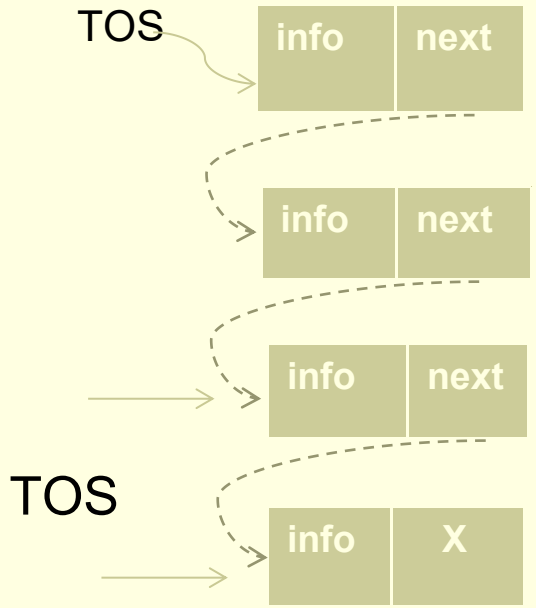
```
#define size 50
int tos = -1;
int stack[size];

void push(int s[], int d)
{
  if (tos== size-1)
            printf ("\n Stack overflow ");
  else
       {  ++tos ;
          s[tos]=d;
        }
}
```

```
int pop(int s[])
{
   int d;
   if (tos== -1)
        { d = 0;
          printf ("\n Stack underflow "); }
   else
        { d = s[tos] ;
          -- tos ; }
    return (d);
}
 void display(int s[])
{    int i;
      if (tos== -1)
          printf ("stack is empty");
      else
           for (i= tos; i>=0; i--)
               printf (" \t %d", s[i]);
}
```

Linked List implementation of Stack

```
struct node
{
  int info;
  struct node * next;
}
struct node *top;
```

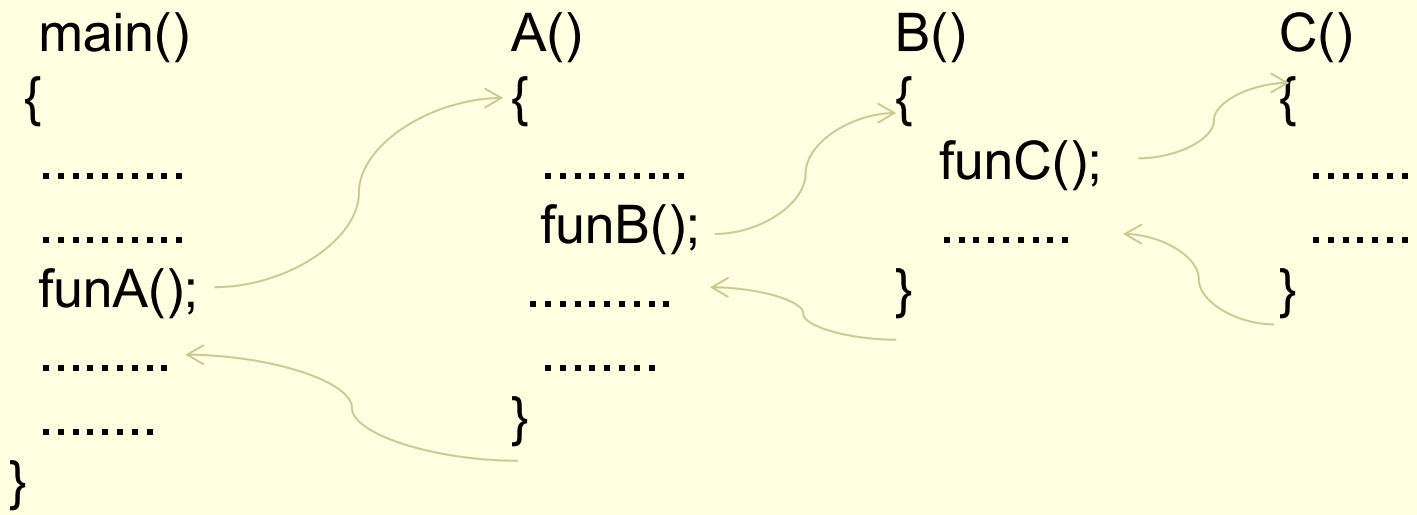


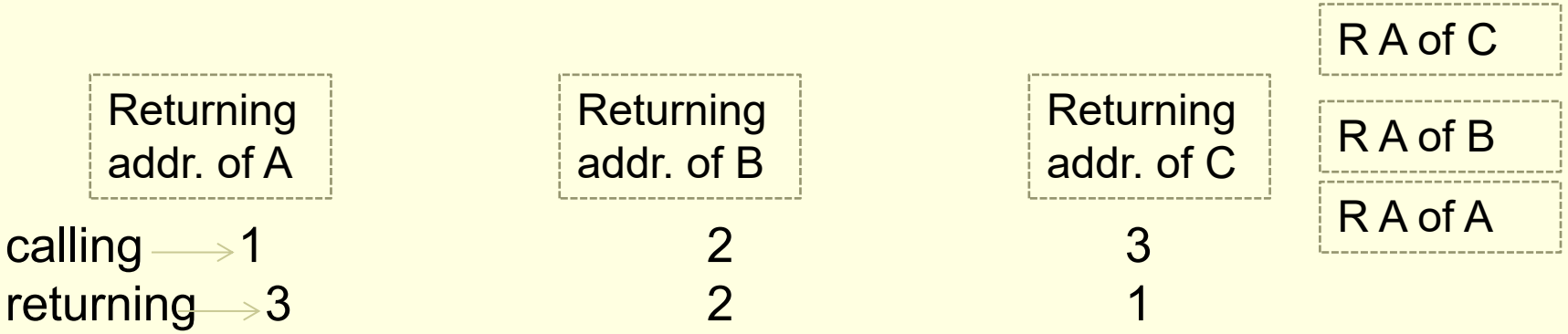
```
void push(struct node *top)
{
  struct node *nnode;
  nnode= (struct node *)
            malloc(sizeof(struct node));
 if (nnode== NULL)
    {printf ("\n Out of memory ");
     exit(0);
    }
printf ("\nEnter the node value ");
scanf ("%d",nnode->info);
nnode->next=top;
 top =nnode;
 }
```

```
int pop(struct node *top)
{
   struct node *temp;    int d;
   if (top==NULL)
         { printf ("\n Stack underflow ");
           exit(0); }
   temp =top;
   d = temp->info;
   top= top->next ;
   free(temp) ;
    return (d);
}
void display(struct node *top)
{   struct node *curr;
      curr= top;
 if (curr== NULL)
        { printf ("stack is empty"); exit(0); }
while (curr !=NULL)
              { printf ("\t %d", curr->info);
                curr= curr->next;     }
}
```

Application of Stack

- **Function call**





Application of Stack

- **Arithmatic Expression evaluation**

Three notations for writing expression

Infix - operator is between two operands

postfix (Reverse Polish)- operator follows the operands

prefix (Polish) - operator preceeds the two operands

Infix -	a+b
postfix-	ab+
prefix-	+ab

To evaluate an expression, the infix expression need to be converted to postfix expression

Application of Stack

- Conversion of infix to postfix

  a+(b*c) infix

  =a+ (bc*)

  =a(bc*)+

  =abc*+ postfix

- Expression is evaluated by scanning from left to right using Stack

Postfix expression evaluation

```
1. clear the stack
2. sym= input next character
3. while sym ≠ null do     {
4.          if sym is an operand
                        Push sym
            else {
5.                      Pop 2nd operand OP2
6.                      Pop 1st operand OP1
7.                      result= op1 sym op2
8.                      Push result
                    }
9.          sym= input next character
      }
10. return (Pop stack)
```

Postfix expression evaluation

(5+6) - {3 * (8/2)} 56+382/*-

Symbol	OP1	OP2	result	Stack
5				5
6				5, 6
+	5	6	11	11
3				11, 3
8				11,3,8
2				11,3,8,2
/	8	2	4	11,3,4
*	3	4	12	11,12
-	11	12	-1	-1

Application of Stack

❖Infix to Postfix conversion

Let Q be an arithmatic expression in infix notation. This algorithm find the equivalent postfix expression P.

1. Push '(' onto stack and add ')' to the end of Q
2. Scan Q from left to right and repeat steps 3 to 6 for each element of Q until the stack is empty
3. If an operand is found, add it to P
4. if a '(' is found, push it onto stack.
5. If an operator X is found then
    a) Repeatedly pop operators from stack and add to P each operator which has same or higher precedence than X
    b) Add X to stack
6. If a ')' is found then
    a) Repeatedly pop operators from stack and add to P each operator until a '(' is found
    b) Remove the '(' from stack
7. Exit

Infix to Postfix conversion

(-6*12)+(24/4))

Symbol	Stack	Postfix expression
	(	
(	((	
-6		-6
*	((*	
12		-6,12
)	(	-6,12, *
+	(+	
(	(+ (	
24		-6,12, *, 24
/	(+ (/	
4		-6,12, *, 24, 4
)	(+	-6,12, *, 24, 4, /
)		-6,12, *, 24, 4, /, +

Postfix expression evaluation

-6,12, *, 24, 4, /, +

Symbol	OP1	OP2	result	Stack
-6				-6
12				-6, 12
*	-6	12	-72	-72
24				-72, 24
4				-72, 24, 4
/	24	4	6	-72, 6
+	-72	6	-66	-66

Prefix expression evaluation

```
1. clear the stack
2. sym= input next character (from right to left)
3. while sym ≠ null do     {
4.          if sym is an operand
                        Push sym
            else {
5.                      Pop 1st operand OP1
6.                      Pop 2nd operand OP2
7.                      result= op1 sym op2
8.                      Push result
                    }
9.          sym= input next character
      }
10. return (Pop stack)
```

Prefix expression evaluation

-,*,3,+,16,2,/,12,6

Symbol	OP1	OP2	result	Stack
6				6
12				6, 12
/	12	6	2	2
2				2,2
16				2,2,16
+	16	2	18	2,18
3				2,18,3
*	3	18	54	2,54
-	54	2	52	52

Application of Stack

❖Infix to Prefix conversion

Let Q be an arithmatic expression in infix notation. This algorithm find the equivalent postfix expression P.

1. Push ')' onto stack and add '(' to the end of Q
2. Scan Q from left to right and repeat steps 3 to 6 for each element of Q until the stack is empty
3. If an operand is found, add it to P
4. if a ')' is found, push it onto stack.
5. If an operator X is found then
    a) Repeatedly pop operators from stack and add to P each operator which has same or higher precedence than X
    b) Add X to stack
6. If a '(' is found then
    a) Repeatedly pop operators from stack and add to P each operator until a ')' is found
    b) Remove the ')' from stack
7. Exit

Thank you