Data Structures and its Applications

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DATA STRUCTURES AND ITS APPLICATIONS

Stacks

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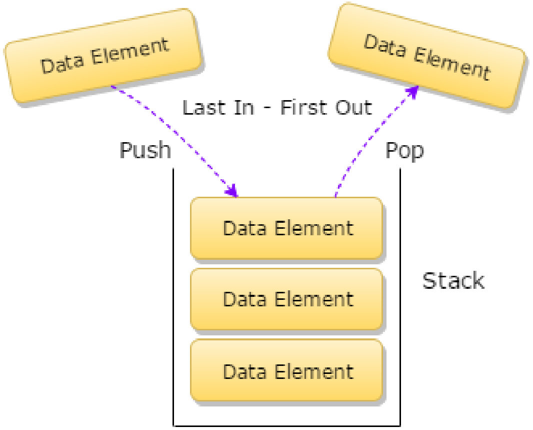
Stacks - Definition

- A Stack is a data Structure in which all the insertions and deletions of entries are at one end. This end is called the <u>TOP</u> of the stack.
- When an item is added to a stack it is called push into the stack
- When an item is removed it is called pop from the stack.
- The Last item pushed onto a stack is always the first that will be popped from the stack.
- This property is called the *last in, first out* or <u>LIFO</u> for short



Stacks – Representation in C

A stack in C is declared as a structure containing two objects :

- An array to hold the elements of the stack
- An Integer to indicate the position of the current stack top within the array
- Stack of integers can be done by the following declaration

```
#define STACKSIZE 100
struct stack
{
  int top;
  int items[STACKSIZE]
};
```

Once this is done, actual stack can be declared by

```
struct stack s;
```

Stacks – Representation in C

Items need not be restricted to integers, items can be of any type.

A stack can contain items of different types by using C unions.

```
#define STACKSIZE 100
#define INT 1
#define FLOAT 2
#define STRING 3
struct stackelement {
    int etype;
    union{
        int ival;
        float fval;
        char *pavl; //pointer to string
   } element;
};
```

Stacks – Representation in C

```
struct stack
{
  int top;
  struct stackelement items[STACKSIZE];
};
```

- The above declaration defines a stack whose items can either be integers, floating point numbers or string depending on the value of etype (previous slide).

Stacks – Implementation of operations of stack

Operations on stack

- Inserting an element on to the stack : push
- Deleting an element from the stack : pop
- Checking the top element : peep
- Checking if the stack is empty : empty
- Checking if the stack is full : overflow

Representation of stack will be as follows

```
#define STACKSIZE 100
struct stack
{
 int top;
 int items[STACKSIZE]
};
```

Stacks – Implementation of operations of stack

```
void push(struct stack *ps, int x)
/*ps is pointer to the structure representing stack, x is integer to be inserted
top is integer that indicates the position of the current stack top within the
        array, items is an integer array that represents stack, STACK_SIZE is the
        maximum size of the stack */
{
    if (ps->top == STACKSIZE -1) //check if the stack is full
            printf("STACK FULL Cannot insert..");
  else
   {
      ++(ps->top); //increment top
      ps->items[ps->top]=x; //insert the element at a location top
    }
}
```

Stacks – Implementation of operations of stack

```
int pop(struct stack *ps )
/*ps is pointer to the structure representing stack, top is integer that indicates
     the position of the current stack top within the array , items is an integer
     array that represents stack, STACK_SIZE is the maximum size of the stack */
 {
  if (ps->top == -1) // check if the stack is the empty
        printf("STACK EMPTY Cannot DELETE..");
 else
 {
    x=ps->items[ps->top]; //delete the element
    --(ps->top); //decrement top
   return x;
  }
}
```

Stacks – Implementation of operations of stack

```
int display(struct stack *ps )
/*ps is pointer to the structure representing stack, top is integer that indicates
    the position of the current stack top within the array , items is an integer
    array that represents stack, STACK_SIZE is the maximum size of the stack */
  {
   if (ps->top == -1) // check if the stack is the empty
          printf(“STACK EMPTY “);
 else
  {
     for (i=ps->top;i>=0;i--) // displays the elements from top
        printf(“%d”,ps->items[i]);
 }
}
```

Stacks – Implementation of operations of stack

```
int peep(struct stack *ps )
{
    if (ps->top == -1)
            printf(“STACK EMPTY ..”);
  else
   {
      x=ps->items[ps->top]; //get the element
      return x;
     }
}
```

Stacks – Implementation of operations of stack

```
int empty(struct stack *ps )
{
   if (ps->top == -1)
            return 1;
  return 0;
}
int overflow(struct stack *ps)
{
   if (ps->top==STACKSIZE-1)
     return 1;
 return 0;
}
```

implementation of stack operations where the items array and top are separate variables (Not part of structure)

```
void push(int *s, int *top, int x)
{
   if(*top==STACKSIZE-1)//check if the stack is full
  {
     printf("stack overflow..cannot insert");
    return 0;
 }
 else
   {
      ++*top; //increment the top
      s[*top]=x; //insert the element
   }
 return 1;
}
```

Stacks – Implementation of operations of stack

- Implementation of stack operations where the items and the top are separate variables (Not part of structure)

```
int pop(int *s, int *top)
{
   if(*top==-1)//check if the stack is empty
  {
     printf(“Stack empty .. Cannot delete”);
    return -1;
 }
 else
   {
     x=s[*top]; //insert the element
     --*top; //decrement top
    return x; // return the deleted element
   }
}
```

Stacks – Implementation of operations of stack

- **Implementation of stack operations where the items and the top are separate variables (Not part of structure)**

```
display(int *s, int *top)
{
    if(*top==-1)
     printf(“Empty stack”);
 else
  {
    for(i=*top;i>=0;i--) // display the elements from the top
       printf(“%d”,s[i]);
  }
}
```

Stacks – Application of Stack

- Write an algorithm to determine if an input character string is of the form x C y where x is a string consisting of the letters ‘A’ and ‘B’ and where y is the reverse of x. At each point you may read only the character of the string

```
 int check(t)
//the function returns 1 if string t is of the form x C y, else returns 0
//uses stack s and its operations push and pop
 {
    i=0;
    while(t[i]!=‘C’) //push all the characters of the string into the stack
 until C  is encountered
    {
      push(&s, t[i]);
      i=i+1;
    }
```

1. **If a stack is implemented using a fixed-size array of size N, which of the following statements is true regarding overflow conditions?**

a) Overflow occurs when top = N-1.

b) Overflow occurs when top = N.

c) Overflow depends on the element type, not the array size.

d) Overflow never occurs in an array-based stack.

1. **If a stack is implemented using a fixed-size array of size N, which of the following statements is true regarding overflow conditions?**

a) Overflow occurs when top = N-1.

b) Overflow occurs when top = N.

c) Overflow depends on the element type, not the array size.

d) Overflow never occurs in an array-based stack.

2. When two stacks are implemented in a single array (sharing memory from opposite ends), under what condition is the array completely full?

a) top1 + top2 = N

b) top2-top1=1

c) top1 == top2

d) top1 == top2 + 1

2. When two stacks are implemented in a single array (sharing memory from opposite ends), under what condition is the array completely full?

a) top1 + top2 = N

b) top2-top1=1

c) top1 == top2

d) top1 == top2 + 1

3. Which of the following is stored in a stack frame during a function call in C?

a) Return address only.

b) Local variables, return address, and saved registers.

c) Global variables and return address.

d) Only function parameters.

Multiple-Choice-Questions(MCQ)

3. Which of the following is stored in a stack frame during a function call in C?

a) Return address only.

b) Local variables, return address, and saved registers.

c) Global variables and return address.

d) Only function parameters.

4. Which of the following applications cannot be implemented using a stack?

a) Undo/Redo feature in text editors.

b) Parenthesis matching in expressions.

c) Level-order traversal of a binary tree.

d) Evaluating postfix expressions.

Multiple-Choice-Questions(MCQ)

4. Which of the following applications cannot be implemented using a stack?

a) Undo/Redo feature in text editors.

b) Parenthesis matching in expressions.

c) Level-order traversal of a binary tree.

d) Evaluating postfix expressions.

THANK YOU

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