Laboratory-8

Question

Implement DAG Based Code Generation.

Dag.c:

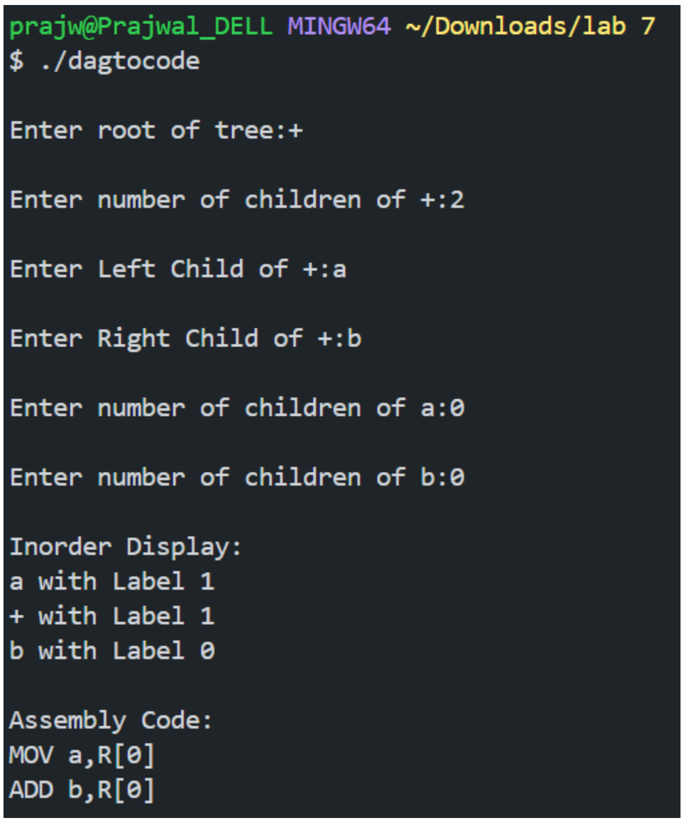
```
#include<stdlib.h>
#include<stdio.h>

/* We will implement DAG as Strictly Binary Tree where each node has zero
or two children */

struct bin_tree
{
char data;
int label;
struct bin_tree *right, *left;
};
typedef struct bin_tree node;

/* R is stack for storing registers */
int R[10];
int top;

/* op will be used for opcode name w.r.t. arithmetic operator e.g. ADD for
+ */
char *op;

/* insertnode() and insert() functions are for adding nodes to tree(DAG) */

void insertnode(node **tree,char val)
{
node *temp = NULL;

if(!(*tree))
    {
        temp = (node *)malloc(sizeof(node));
        temp->left = temp->right = NULL;
        temp->data = val;
        temp->label=-1;
        *tree = temp;
    }
}

void insert(node **tree,char val)
{
    char l,r;
    int numofchildren;

    insertnode(tree, val);

    printf("\nEnter number of children of %c:",val);
    scanf("%d",&numofchildren);
```

```c
  if(numofchildren==2)
   {
    printf("\nEnter Left Child of %c:",val);
    scanf("%s",&l);
    insertnode(&(*tree)->left,l);

    printf("\nEnter Right Child of %c:",val);
    scanf("%s",&r);
    insertnode(&(*tree)->right,r);

    insert(&(*tree)->left,l);
    insert(&(*tree)->right,r);
   }
}

/* findleafnodelabel() will find out the label of leaf nodes of tree(DAG)
*/

void findleafnodelabel(node *tree,int val)
{

if(tree->left != NULL && tree->right !=NULL)
{
findleafnodelabel(tree->left,1);
findleafnodelabel(tree->right,0);
}

else
{
tree->label=val;
}

}

/* findinteriornodelabel() will find out the label of interior nodes of
tree(DAG) */

void findinteriornodelabel(node *tree)
{
if(tree->left->label==-1)
{
findinteriornodelabel(tree->left);
}

else if(tree->right->label==-1)
{
findinteriornodelabel(tree->right);
}

else
{

if(tree->left != NULL && tree->right !=NULL)
{

if(tree->left->label == tree->right->label)
{

tree->label=(tree->left->label)+1;
}
else
{

if(tree->left->label > tree->right->label)
{
tree->label=tree->left->label;
}
else
{
tree->label=tree->right->label;
}

}
}
}
}

/* function print_inorder() will print inorder of nodes. Here we are also
printing label of each node of tree(DAG) */

void print_inorder(node * tree)
{
    if (tree)
    {
        print_inorder(tree->left);
        printf("%c with Label %d\n",tree->data,tree->label);
        print_inorder(tree->right);
    }
}

/* function swap() will swap the top and second top elements of Register
stack R */

void swap()
{
int temp;
temp=R[0];
R[0]=R[1];
R[1]=temp;
}

/* function pop() will remove and return topmost element of stack */

int pop()
{
int temp=R[top];
top--;
return temp;
}

/* function push() will increment top by one and will insert element at top
position of Register stack */

void push(int temp)
{
top++;
R[top]=temp;
}
```

```c
/* nameofoperation() will return opcode w.r.t. arithmetic operator */

char* nameofoperation(char temp)
{
switch(temp)
{
case '+': return "ADD"; break;
case '-': return "SUB"; break;
case '*': return "MUL"; break;
case '/': return "DIV"; break;
}
}

/* gencode() will generate Assembly code w.r.t. labels of tree(DAG) */

void gencode(node * tree)
{
if(tree->left != NULL && tree->right != NULL)
{
if(tree->left->label == 1 && tree->right->label == 0 && tree->left-
>left==NULL && tree->left->right==NULL && tree->right->left==NULL && tree-
>right->right==NULL)
{
printf("MOV %c,R[%d]\n",tree->left->data,R[top]);
op=nameofoperation(tree->data);
printf("%s %c,R[%d]\n",op,tree->right->data,R[top]);
}

else if(tree->left->label >= 1 && tree->right->label == 0)
{
gencode(tree->left);
op=nameofoperation(tree->data);
printf("%s %c,R[%d]\n",op,tree->right->data,R[top]);
}

else if(tree->left->label < tree->right->label)
{
int temp;
swap();
gencode(tree->right);
temp=pop();
gencode(tree->left);
push(temp);
swap();
op=nameofoperation(tree->data);
printf("%s R[%d],R[%d]\n",op,R[top-1],R[top]);
}

else if(tree->left->label >= tree->right->label)
{
int temp;
gencode(tree->left);
temp=pop();
gencode(tree->right);
push(temp);
op=nameofoperation(tree->data);
printf("%s R[%d],R[%d]\n",op,R[top-1],R[top]);
}

}
```

```
else if(tree->left == NULL && tree->right == NULL && tree->label == 1)
{
printf("MOV %c,R[%d]\n",tree->data,R[top]);
}

}

/* deltree() will free the memory allocated for tree(DAG) */

void deltree(node * tree)
{
    if (tree)
    {
        deltree(tree->left);
        deltree(tree->right);
        free(tree);
    }
}

/* Program execution will start from main() function */

void main()
{
    node *root;
    root = NULL;
    node *tmp;
    char val;
    int i,temp;

    /* Inserting nodes into tree(DAG) */

    printf("\nEnter root of tree:");
    scanf("%c",&val);

    insert(&root,val);

    /* Finding Labels of Leaf nodes */
    findleafnodelabel(root,1);

    /* Finding Labels of Interior nodes */
    while(root->label == -1)
       findinteriornodelabel(root);

    /* value of top = index of topmost element of stack R = label of Root
of tree(DAG) minus one */
    top=root->label - 1;

    /* Allocating Stack Registers */
    temp=top;
    for(i=0;i<=top;i++)
       {
          R[i]=temp;
          temp--;
       }

    /* Printing inorder of nodes of tree(DAG) */
    printf("\nInorder Display:\n");
    print_inorder(root);
    /* Printing assembly code w.r.t. labels of tree(DAG) */
    printf("\nAssembly Code:\n");
    gencode(root);

    /* Deleting all nodes of tree */
    deltree(root);
}
```

Output:



```
prajw@Prajwal_DELL MINGW64 ~/Downloads/lab 7
$ ./dagtocode

Enter root of tree:+

Enter number of children of +:2

Enter Left Child of +:a

Enter Right Child of +:b

Enter number of children of a:0

Enter number of children of b:0

Inorder Display:
a with Label 1
+ with Label 1
b with Label 0

Assembly Code:
MOV a,R[0]
ADD b,R[0]
```

Result:

DAG Based Code Generation was implemented successfully.