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CSPC62 : COMPILER DESIGN
LAB-7

Roll no. : **106119100**

Name : **Rajneesh Pandey**

Section : **CSE-B**

DAG construction and Simple code generation.

Code:

Construct_dag.cpp

```
#include <bits/stdc++.h>
using namespace std;

struct label_list
{
    char value;
    struct label_list *next;
};

struct dag_node
{
    char value;
    int index;
    int label;
    int parent_count;
    struct label_list *labels;
    struct dag_node *left, *right;
};

struct root_list
{
    struct dag_node *root;
    struct root_list *next;
};

struct three_address
{
    char op;
    char op1;
    char op2;
    char lhs;
};

int index_global = 0, n;
```

```cpp
three_address tac[100];
bool visited_left_most_child = 0;
stack<int> rstack, tstack;

label_list *insert_label(label_list *curr, char c)
{
    label_list *temp = new label_list;
    temp->value = c;
    temp->next = NULL;
    if (curr == NULL)
    {
        return temp;
    }
    label_list *start = curr;
    while (start->next)
    {
        start = start->next;
    }
    start->next = temp;
    return start;
}

dag_node *create_dag_node(char op, char result)
{

    dag_node *temp = new dag_node;
    temp->index = index_global++;
    temp->value = op;
    temp->left = temp->right = NULL;
    temp->labels = NULL;
    temp->labels = insert_label(temp->labels, result);

    return temp;
}

bool search_labels(dag_node *x, char value)
{
    if (x->value == value)
    {
        return 1;
    }
    label_list *start = x->labels;
    while (start)
    {
        if (start->value == value)
        {
            return 1;
        }
        start = start->next;
    }
    return 0;
}

bool check(dag_node *n1, dag_node *n2, char c1, char c2)
{
    if (search_labels(n1, c1) && search_labels(n2, c2))
    {
        return 1;
    }
    return 0;
}

dag_node *search_for_value(root_list *root, char value)
{
    int recent = -1;
    queue<dag_node *> q;
    dag_node *x, *result = NULL;
    vector<bool> visited(index_global, 0);

    root_list *start = root;
    while (start)
    {
        q.push(start->root);
        start = start->next;
    }

    while (!q.empty())
    {
        x = q.front();
        q.pop();
        visited[x->index] = 1;
        if (search_labels(x, value))
        {
            if (x->index > recent)
            {
                recent = x->index;
                result = x;
            }
        }

        dag_node *left = x->left;
        dag_node *right = x->right;
        if (left && !visited[left->index])
            q.push(left);

        if (right && !visited[right->index])
            q.push(right);
    }

    return result;
}

dag_node *search_for_similar(root_list *root, char op, char op1,
char op2)
{
    int recent = -1;
    queue<dag_node *> q;
    dag_node *x, *result = NULL;
    vector<bool> visited(index_global, 0);

    root_list *start = root;
    while (start)
    {
        q.push(start->root);
        start = start->next;
    }

    while (!q.empty())
    {
        x = q.front();

        q.pop();
        visited[x->index] = 1;
        if (search_labels(x, op))
        {
            if (check(x->left, x->right, op1, op2))
            {
                if (x->index > recent)
                {
                    result = x;
                    recent = x->index;
                }
            }
        }

        dag_node *left = x->left;
        dag_node *right = x->right;
        if (left && !visited[left->index])
            q.push(left);

        if (right && !visited[right->index])
            q.push(right);
    }

    return result;
}

root_list *add_to_end(root_list *curr, dag_node *root)
```

```
{
    root_list *temp = new root_list;
    temp->root = root;
    temp->next = NULL;
    if (curr == NULL)
    {
        return temp;
    }

    root_list *start = curr;
    while (start->next)
    {
        start = start->next;
    }
    start->next = temp;
    return curr;
}
root_list *create_dag(root_list *root, int curr)
{
    if (curr == n)
    {
        return root;
    }

    if (root == NULL)
    {
        dag_node *parent, *left, *right;
        parent = create_dag_node(tac[curr].op, tac[curr].lhs);
        left = create_dag_node(tac[curr].op1, tac[curr].op1);
        right = create_dag_node(tac[curr].op2, tac[curr].op2);
        parent->left = left;
        parent->right = right;
        root = new root_list;
        root->root = parent;
        root->next = NULL;
        return create_dag(root, curr + 1);
    }
    if (tac[curr].op == '=')
    {
        dag_node *temp = search_for_value(root, tac[curr].op1);
        temp->labels = insert_label(temp->labels, tac[curr].lhs);
        return create_dag(root, curr + 1);
    }
    else
    {
        dag_node *parent = search_for_similar(root, tac[curr].op,
tac[curr].op1, tac[curr].op2);
        dag_node *left = search_for_value(root, tac[curr].op1);
        dag_node *right = search_for_value(root, tac[curr].op2);


{

    if (left && right && parent)
    {
        if (parent->left->index == left->index && parent->right-
>index == right->index)

            parent->labels = insert_label(parent->labels,
tac[curr].lhs);
        return create_dag(root, curr + 1);
    }
}

parent = create_dag_node(tac[curr].op, tac[curr].lhs);

if (left == NULL)
{
    left = create_dag_node(tac[curr].op1, tac[curr].op1);
}
if (right == NULL)
{
    right = create_dag_node(tac[curr].op2, tac[curr].op2);
}

parent->left = left;
parent->right = right;

root_list *start = root;
root_list *temp = NULL;
while (start)
{
    if (start->root != left && start->root != right)
    {
        temp = add_to_end(temp, start->root);
    }
    start = start->next;
}
temp = add_to_end(temp, parent);
root = temp;
return create_dag(root, curr + 1);
    }
}

void inorder(dag_node *curr, vector<bool> &visited)
{
    curr->parent_count++;
    if (visited[curr->index])
    {
        if (curr->left != NULL)
        {
            inorder(curr->left, visited);
        }

        if (curr->right != NULL)
        {
            inorder(curr->right, visited);
        }

        return;
    }

    visited[curr->index] = 1;

    if (curr->left == NULL && curr->right == NULL)
    {
        cout << "Leaf with Index: " << curr->index << " ,Value: "
<< curr->value << " ,Label: " << curr->label << "\n\n";
    }
    else
    {
        cout << "Index: " << curr->index << " ,Value: " << curr-
>value << " ,Label: " << curr -> label << '\n';
        label_list *temp = curr->labels;
        cout << "Labels are: ";
        while (temp)
        {
            cout << temp->value << ' ';
            temp = temp->next;
        }
        cout << '\n';
        cout << "Left child has index " << curr->left->index <<
'\n';
        cout << "Right child has index " << curr->right->index <<
'\n';
        cout << '\n';
        inorder(curr->left, visited);
        inorder(curr->right, visited);
    }
}

dag_node *assign_labels(dag_node *curr, bool left_child,
vector<bool> &visited)
{
    if (visited[curr->index])
    {
        return curr;
    }

    visited[curr->index] = 1;

    if (curr->left == NULL && curr->right == NULL)
    {
        if (!left_child)
        {
            curr->label = 0;
        }
        else
        {
            curr->label = 1;
        }
        return curr;
    }

    curr->left = assign_labels(curr->left, 1, visited);
    curr->right = assign_labels(curr->right, 0, visited);

    if (curr->left->label == curr->right->label)
    {
        curr->label = curr->left->label + 1;
    }
    else
    {
        curr->label = max(curr->left->label, curr->right->label);
    }

    return curr;
}

void swap_registers()
{

    int temp1, temp2;
    temp1 = rstack.top();
    rstack.pop();
    temp2 = rstack.top();
    rstack.pop();

    rstack.push(temp1);
    rstack.push(temp2);
}

void gen_code(dag_node *curr, bool left_child)
{

    if (curr->left == NULL && curr->right == NULL)
    {
        if (left_child)
        {
            printf("MOV %c R%d\n", curr->value, rstack.top());
        }
    }
    else
    {
        int left_label = curr->left->label;
        int right_label = curr->right->label;

        if (right_label == 0)
        {
            gen_code(curr->left, 1);
            printf("%c %c R%d\n", curr->value, curr->right->value,
rstack.top());
        }
        else if (right_label > left_label && left_label <
rstack.size())
        {
            swap_registers();
            gen_code(curr->right, 0);
            int R = rstack.top();
            rstack.pop();
            gen_code(curr->left, 1);
            printf("%c R%d R%d\n", curr->value, R, rstack.top());
            rstack.push(R);
            swap_registers();
        }
        else if (left_label >= right_label && right_label <
rstack.size())
        {
            gen_code(curr->left, 1);
            int R = rstack.top();
            rstack.pop();
            gen_code(curr->right, 0);
            printf("%c R%d R%d\n", curr->value, rstack.top(), R);
            rstack.push(R);
        }
        else if (left_label >= right_label && left_label >
rstack.size() && right_label > rstack.size())
        {
            gen_code(curr->right, 0);
            int T = tstack.top();
            printf("MOV R%d T%d", rstack.top(), T);
            gen_code(curr->left, 1);
            tstack.push(T);
            printf("%c T%d R%d", curr->value, T, rstack.top());
        }
    }
}

int main()
{
    char lhs, op, op1, op2;
    string s;

    int i = 0;

    while (getline(cin, s))
    {
        if (s.size() <= 4)
        {
            tac[i].lhs = s[0];
            tac[i].op1 = s[2];
            tac[i].op = s[1];
            tac[i].op2 = ' ';
        }
        else
        {
            tac[i].lhs = s[0];
            tac[i].op1 = s[2];
            tac[i].op = s[3];
            tac[i].op2 = s[4];
        }
        i++;
    }
    n = i;

    root_list *root = NULL;
    root = create_dag(root, 0);

    root_list *start = root;
    vector<bool> visited(index_global, 0);
    while (start)
    {
        start->root = assign_labels(start->root, 1, visited);
        start = start->next;
    }

    fill(visited.begin(), visited.end(), 0);
    start = root;
    while (start)
    {
        inorder(start->root, visited);
        start = start->next;
    }
    rstack.push(0);
    rstack.push(1);
    for (int i = 0; i < 10; i++)
    {
        tstack.push(i);
    }

    gen_code(root->root, 1);
}
```

Lexer.l

```
%{
    #include"parser.tab.h"
%}
%%
[\t ] ;
[0-9]+ {yylval.symbol = (char)(yytext[0]);return NUMBER;}
[a-z] {yylval.symbol = (char)(yytext[0]);return LETTER;}
. {return yytext[0];}
\n\n {return 0;}
%%
int yywrap(){
    return 1;
}
```

Parser.y

```
%{
#include<string.h>
#include<stdio.h> int yylex(void);
int yyerror(const char *s);

struct node{
char value;
struct node *left, *right;
};

struct start_node{ char value;
struct node *left, *right; struct start_node *next;
};

struct label_list{ char value;
struct label_list* next;
};

struct dag_node{

char value; int index;
struct label_list *labels; struct dag_node *left, *right;
};

struct root_list{
struct dag_node* root; struct root_list* next;
};

struct three_address{ char operator; char operand1; char operand2;
char lhs;
struct three_address* next;
};

struct node* make_node(char);
struct start_node* create_start_node();

struct start_node *start_ptr = NULL;
struct three_address *start_three_address_ptr = NULL; struct
root_list *roots = NULL;

char label = 'A' - 1; int index = 0;

%}

%union{
char symbol;
struct node *sub_expr;
struct start_node *start_expr;
```

```
}


%left '+' '-'
%left '/' '*'


%token <symbol> LETTER NUMBER
%type <sub_expr> exp
%type <sub_expr> L
%type <start_expr> stmts
%type <start_expr> statement


%start S

%%

S: stmts {
start_ptr = $1;
};

stmts: statement stmts {
struct start_node* curr = $1;
}

| statement {
    $$ =$1;
    $$ = curr;
};


statement: L '=' exp ';' {


struct start_node *curr = create_start_node(); curr->left = $1;
curr->right = $3;
$$ = curr;
```

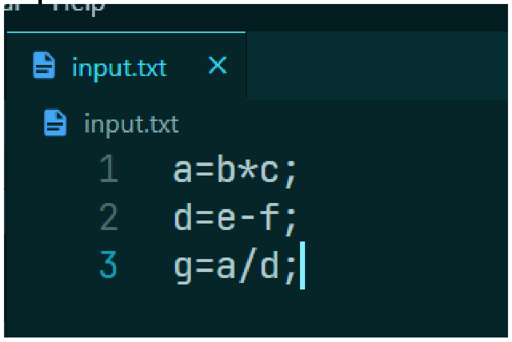
```
};



exp: exp '+' exp { struct node* curr = make_node('+'); curr->left
= $1;
curr->right = $3;
$$ = curr;
}

|exp '-' exp { struct node* curr = make_node('-');
curr->left = $1; curr->right = $3;
$$ = curr;
}
|exp '/' exp { struct node* curr = make_node('/');
curr->left = $1; curr->right = $3;
$$ = curr;
}


|exp '*' exp {
struct node *curr = make_node('*');
curr->left = $1;
curr->right = $3;
$$ = curr;
}
| '(' exp ')' {$$ = $2;}

|NUMBER {
    struct node* curr = make_node((char)$1);
    $$ = curr;
}

|LETTER {
struct node* curr = make_node((char)$1);
$$ = curr;
}
```

```
;

L: LETTER {
struct node* curr = make_node((char)$1);
$$ = curr;
};

%%


int yyerror(const char *s){

printf("%s",s);
}

struct start_node *create_start_node(){
struct start_node *temp_node = (struct start_node*)malloc(
sizeof(struct start_node) );
temp_node->value = '=';
temp_node->left = temp_node->right = NULL; temp_node->next = NULL;
return temp_node;

}

struct node* make_node(char s){
struct node* temp_node = (struct node*)malloc(sizeof(struct
node)); temp_node->left = NULL;
temp_node->right = NULL; temp_node->value = s; return temp_node;
}

struct three_address* add_to_end(struct three_address* start,
struct three_address* curr){
if(start == NULL){ return curr;
}
struct three_address* temp = start; while(temp-> next != NULL){
temp = temp->next;
}
```

```
temp->next = curr; return start;
}

struct three_address* make_three_address_node(char lhs, char op,
char op1, char op2){

struct three_address* temp_node = (struct
three_address*)malloc(sizeof(struct three_address));
temp_node->lhs = lhs; temp_node->operator = op; temp_node-
>operand1 = op1; if(op != '='){
temp_node->operand2 = op2;
}
temp_node->next = NULL; return temp_node;
}

char postfix(struct node* curr){


if(curr->left == NULL && curr->right == NULL){ return curr->value;
}

char lhs = postfix(curr->left); char rhs = postfix(curr->right);
char curr_char = ++label;

struct three_address *temp_node =
make_three_address_node(curr_char, curr-
>value, lhs, rhs);
start_three_address_ptr = add_to_end(start_three_address_ptr,
temp_node);

return curr_char;
}

void traverse(struct start_node *curr){ if(curr==NULL){
return;
}
```

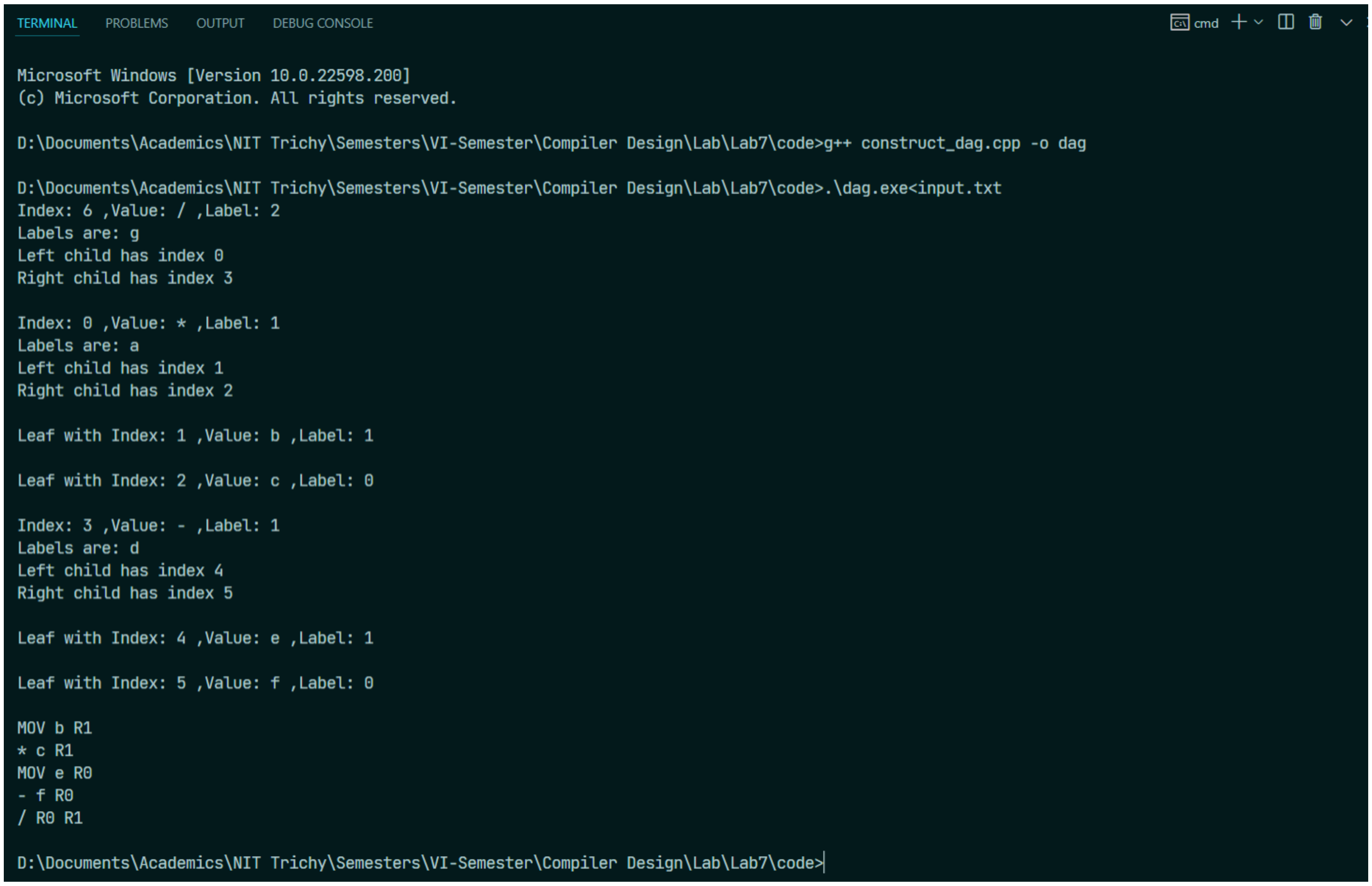
```
char lhs = postfix(curr->left); char rhs = postfix(curr->right);

struct three_address *temp_node = make_three_address_node(lhs,
'=', rhs, ' '); start_three_address_ptr =
add_to_end(start_three_address_ptr, temp_node);

traverse(curr->next);
}

void print_three_addr(){
struct three_address* temp = start_three_address_ptr; while(temp){
if(temp->operator == '='){
printf("%c %c %c\n", temp->lhs, temp->operator, temp->operand1);
}
else{
printf("%c = %c %c %c\n", temp->lhs, temp->operand1, temp-
>operator, temp->operand2);
}
temp = temp->next;
}
}

struct label_list* insert_label(struct label_list* curr, char c){
struct label_list* temp = (struct label_list*)malloc(sizeof(struct
label_list));
temp->value = c; if(curr == NULL){
return temp;
}

struct label_list* t = curr; while(t->next != NULL){
t = t->next;
}
t->next = temp; return t;
}

struct dag_node* search_value(char value){ struct start = roots;
while(start){
}
}

struct dag_node* create_dag_node(char op, char res){
struct dag_node* temp = (struct dag_node*)malloc(sizeof(struct
dag_node)); temp->labels = NULL;
temp->left = temp->right = NULL;
temp->labels = insert_label(temp->labels, res); temp->index =
index++;
temp->value = op; return temp;
}

void create_dag(struct three_address* curr){ if(roots == NULL){
struct dag_node* curr = create_dag_node(curr->operator, curr-
>lhs); struct dag_node* left = create_dag_node(curr->operand1, '
'); struct dag_node* right = create_dag_node(curr->operand2, ' ');
roots = curr;
}
else{
if(curr->operator == '='){
struct dag_node *temp = search_value(curr->operand1); temp->labels
= insert_label(temp->labels, curr->lhs);
}
else{
struct dag_node *temp
}
}

create_dag(curr->next);
}
int main(){
printf("Enter the expression: "); yyparse();
traverse(start_ptr); print_three_addr(); printf("\n"); return 0;
}
```

Input:



```
a=b*c;
d=e-f;
g=a/d;
```

Output:



```
Microsoft Windows [Version 10.0.22598.200]
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D:\Documents\Academics\NIT Trichy\Semesters\VI-Semester\Compiler Design\Lab\Lab7\code>g++ construct_dag.cpp -o dag

D:\Documents\Academics\NIT Trichy\Semesters\VI-Semester\Compiler Design\Lab\Lab7\code>.\dag.exe<input.txt
Index: 6 ,Value: / ,Label: 2
Labels are: g
Left child has index 0
Right child has index 3

Index: 0 ,Value: * ,Label: 1
Labels are: a
Left child has index 1
Right child has index 2

Leaf with Index: 1 ,Value: b ,Label: 1

Leaf with Index: 2 ,Value: c ,Label: 0

Index: 3 ,Value: - ,Label: 1
Labels are: d
Left child has index 4
Right child has index 5

Leaf with Index: 4 ,Value: e ,Label: 1

Leaf with Index: 5 ,Value: f ,Label: 0

MOV b R1
* c R1
MOV e R0
- f R0
/ R0 R1

D:\Documents\Academics\NIT Trichy\Semesters\VI-Semester\Compiler Design\Lab\Lab7\code>
```