SAGAR INSTITUTE OF RESEARCH AND TECHNOLOGY BHOPAL
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Semester

VI

Subject Code

CS603 (C)

Subject Name

Compiler Design

Unit-5

Topic: Loop Optimization

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LOOP OPTIMIZATION – (Before code generation)

It is a machine independent optimization. The code optimization can be significantly done in loops of the program. specially inner loop is a place, where program spends large amount of time. Hence if number of instructions are less in inner loop then the running time of the program will get decreased to a large extent. Hence loop optimization is a technique where optimization is performed on inner loops.

The loop optimization is carried out by following methods –

1. Eliminating Induction variables.
2. Eliminating loop invariant computations
   a) Code Motion,
   b) Loop Unrolling,
   c) Loop fusion.

1. ELIMINATING INDUCTION VARIABLES –

A variable 'X' is called an induction variable of loop, if the value of variable gets changed every time. It is either incremented or decremented by some constant.

• Example – consider a block B1.

B1

```
i = i+1
t1 = 4*i
t2 = a[t1]
if t2 < 10 go to B1
```

$\Longrightarrow$ Removal of $i=i+1$ & $t_1 = 4*i$
Replaced by $t_1 = t_1 + 4$

In the above code the value of i and t_1 are locked state. when value of i gets incremented by 1 then t_1 gets incremented by 4. Hence i and t_4 are induction variable.

2. LOOP INVARIANT COMPUTATIONS –

It's occur where same computation is performed, every time, when loop is executed.

To eliminate, we firstly identify invariant computations then move them outside the loop without changing the meaning of actual ~~prog~~ program.

- Example-

```
for i=0 to 10 do begin
    K = i + a/b;
    -----
    -----
    end;
```

Can be written as –

```
t = a/b;
for i=0 to 10 do begin
    K = i + t;
    -------
    -------
    end;
```

a] CODE MOTION –

It is a technique which move the code outside the loop. If there lies some expression in the loop, whose result remains unchanged even after executing the loop for several times, then such an expression should be placed just before the loop (i.e. outside the loop). Here before the loop means at the entry of the loop.

- Example-

```
while (i<= Max-1)            ⟹     n = max-1;
{                                   while (i<=n)
    sum = sum + a[i];               {
}                                       sum = sum + a[i];
                                    }
```

b] LOOP UNROLLING-

In this method the number of jumps and tests can be reduced by writing the code two times.

- Example-

```
int i=1;                      int i=1;
while (i<=100)                while (i<=100)
{                             {
   a[i]= b[i];        ==>        a[i]=b[i];
   i++;                          i++;
}                                a[i]=b[i];
                                 i++;
                              }
```

c] LOOP FUSION-

In loop fusion method several loops are merged to one loop.

- Example-

```
for i=1 to n do               for i=1 to n*m do
    j=1 to m do      ==>          a[i]=10;
    a[i, j]=10
```