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Practical No. 8

Theory

Code Optimization-

Code Optimization is an approach to enhance the performance of the code.

The process of code optimization involves-

- Eliminating the unwanted code lines
- Rearranging the statements of the code

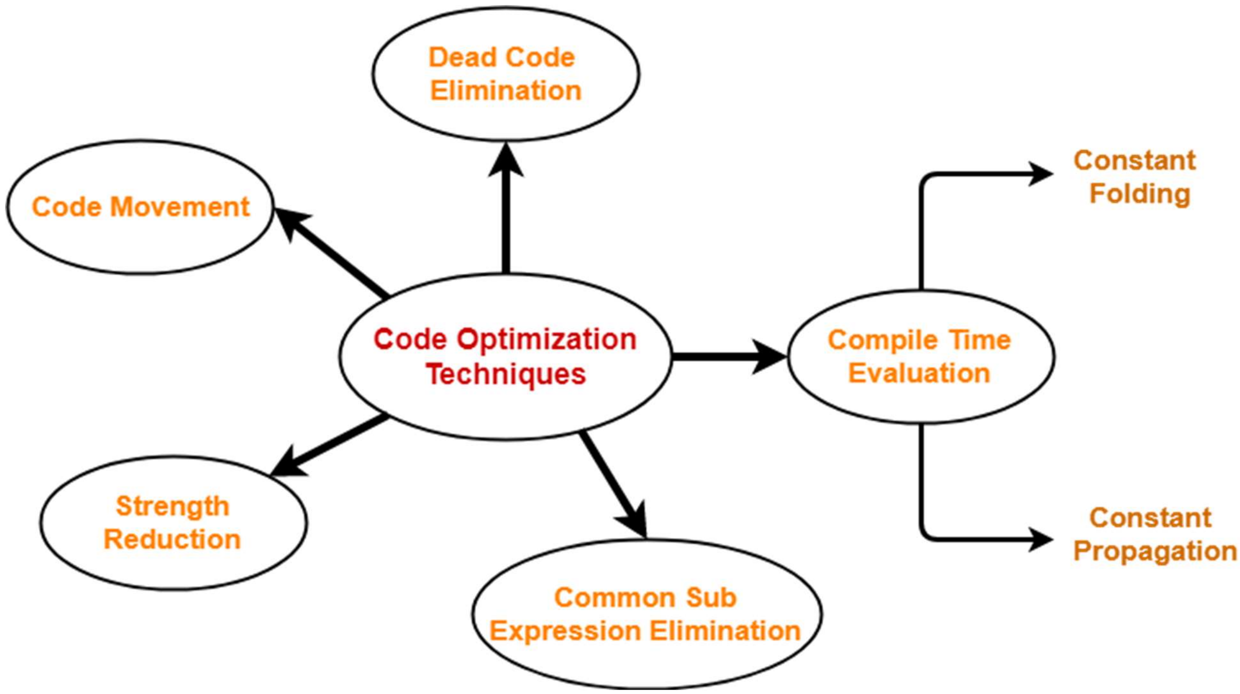
Advantages-

The optimized code has the following advantages-

- Optimized code has faster execution speed.
- Optimized code utilizes the memory efficiently.
- Optimized code gives better performance.

Code Optimization Techniques-

Important code optimization techniques are-



1. Compile Time Evaluation
2. Common sub-expression elimination
3. Dead Code Elimination
4. Code Movement
5. Strength Reduction

1. Compile Time Evaluation-

Two techniques that falls under compile time evaluation are-

A) Constant Folding-

In this technique,

- As the name suggests, it involves folding the constants.
- The expressions that contain the operands having constant values at compile time are evaluated.
- Those expressions are then replaced with their respective results.

Example-

Circumference of Circle = (22/7) x Diameter

Here,

- This technique evaluates the expression 22/7 at compile time.
- The expression is then replaced with its result 3.14.
- This saves the time at run time.

B) Constant Propagation-

In this technique,

- If some variable has been assigned some constant value, then it replaces that variable with its constant value in the further program during compilation.
- The condition is that the value of variable must not get alter in between.

Example-

pi = 3.14

radius = 10

Area of circle = pi x radius x radius

Here,

- This technique substitutes the value of variables ‘pi’ and ‘radius’ at compile time.
- It then evaluates the expression 3.14 x 10 x 10.
- The expression is then replaced with its result 314.
- This saves the time at run time.

2. Common Sub-Expression Elimination-

The expression that has been already computed before and appears again in the code for computation is called as **Common Sub-Expression**.

In this technique,

- As the name suggests, it involves eliminating the common sub expressions.
- The redundant expressions are eliminated to avoid their re-computation.
- The already computed result is used in the further program when required.

Example-

Code Before Optimization	Code After Optimization
S1 = 4 x i S2 = a[S1] S3 = 4 x j S4 = 4 x i // **Redundant Expression** S5 = n S6 = b[S4] + S5	S1 = 4 x I S2 = a[S1] S3 = 4 x j S5 = n S6 = b[S1] + S5

3. Code Movement-

In this technique,

- As the name suggests, it involves movement of the code.
- The code present inside the loop is moved out if it does not matter whether it is present inside or outside.
- Such a code unnecessarily gets execute again and again with each iteration of the loop.
- This leads to the wastage of time at run time.

Example-

Code Before Optimization	Code After Optimization

for (int j = 0 ; j < n ; j ++)
{
x = y + z ;
a[j] = 6 x j;
}
	x = y + z ;
	for (int j = 0 ; j < n ; j ++)
	{
	a[j] = 6 x j;
	}

4. Dead Code Elimination-

In this technique,

- As the name suggests, it involves eliminating the dead code.

- The statements of the code which either never executes or are unreachable or their output is never used are eliminated.

Example-

Code Before Optimization	Code After Optimization

i = 0 ;
if (i == 1)
{
a = x + 5 ;
}
	i = 0 ;

5. Strength Reduction-

In this technique,

- As the name suggests, it involves reducing the strength of expressions.
- This technique replaces the expensive and costly operators with the simple and cheaper ones.

Example-

Code Before Optimization	Code After Optimization
B = A x 2	B = A + A

Here,

- The expression "A x 2" is replaced with the expression "A + A".
- This is because the cost of multiplication operator is higher than that of addition operator.

Practicals

Aim:

Write a code to implement Local optimization techniques until no further optimization is possible for the given three address code.

Program:

```
l=["a=2","b=x^2","c=x","d=a+5","e=b+c","f=c*c","g=d+e","h=e*f"]

lhs=[]
rhs=[]

for i in l:
    i,j=i.split("=")
    lhs.append(i)
    rhs.append(list(j))

index=[]
ind=[]
def Elimination(lhs,rhs):
    for i in range(len(lhs)):
        if len(rhs[i])==1:
            for j in range(i+1,len(rhs)):
                for k in range(len(rhs[j])):
                    if rhs[j][k]==lhs[i]:
                        rhs[j][k]=rhs[i][0]
                nums=[]
                count=0
                for k in range(len(rhs[j])):
                    if rhs[j][k].isdigit():
                        count+=1
                        if count==2:
                            nums.append(j)

                for x in nums:
                    if '+' in rhs[x]:
                        rhs[x]=[str(int(rhs[x][0])+int(rhs[x][2]))]
                    elif '*' in rhs[x]:
                        rhs[x]=[str(int(rhs[x][0])*int(rhs[x][2]))]
                    elif '-' in rhs[x]:
                        rhs[x]=[str(int(rhs[x][0])-int(rhs[x][2]))]
                    elif '/' in rhs[x]:
                        rhs[x]=[str(int(rhs[x][0])/int(rhs[x][2]))]
                    elif '^' in rhs[nums[x]]:
                        rhs[x]=[str(int(rhs[x][0])*int(rhs[x][0]))]

                if len(rhs[j])==3:
                    if '^' in rhs[j]:
                        rhs[j][-2]='*'
```

```
                rhs[j][-1]=rhs[j][0]

            index.append(i)

    return lhs,rhs,index


lhs,rhs,index = Elimination(lhs,rhs)

for j in range(len(rhs)):
    for k in range(j+1,len(rhs)):
        if rhs[j] == rhs[k]:
            rhs[k] = [lhs[j]]
            lhs,rhs,index = Elimination(lhs,rhs)

t1=lhs.copy()
t2=rhs.copy()

for i in range(len(t2)):
    if len(t2[i])==1:
        if t2[i] in rhs and t1[i] :
            lhs.remove(t1[i])
            rhs.remove(t2[i])


for i in range(len(lhs)):
    print(lhs[i]," = ",end=" ")
    for j in range(len(rhs[i])):
        print(rhs[i][j],end=" ")
    print()
```

Output:

```
    print()

b  =  x * x
e  =  b + x
g  =  7 + e
h  =  e * b

In [ ]:
```