SNS COLLEGE OF TECHNOLOGY

(Autonomous)

COIMBATORE-35

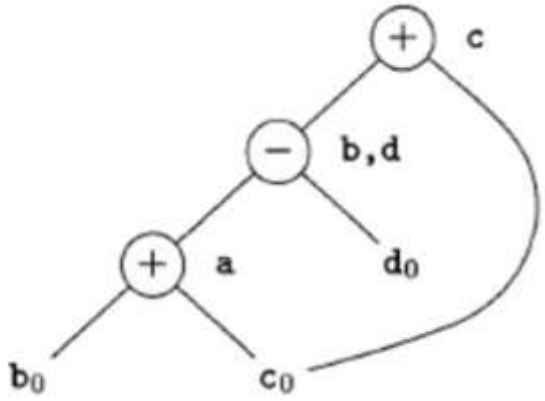
The DAG representation of basic blocks &Generating Code from DAG

The DAG representation of basic blocks

A DAG for a basic block is a directed acyclic graph with the following labels on nodes:

1. Leaves are labeled by unique identifiers, either variable names or constants.
2. Interior nodes are labeled by an operator symbol.
3. Nodes are also optionally given a sequence of identifiers for labels to store the computed values.

```
a = b + c
b = a - d
c = b + c
d = a - d
```



The DAG representation of basic blocks

Algorithm for construction of DAG

Input: A basic block

Output: A DAG for the basic block containing the following information:

1. A label for each node. For leaves, the label is an identifier. For interior nodes, an operator symbol.
2. For each node a list of attached identifiers to hold the computed values.

Case (i) x : = y OP z

Case (ii) x : = OP y

Case (iii) x : = y

The DAG representation of basic blocks

Method:

Step 1:

If y is undefined then create node(y).

If z is undefined, create node(z) for case(i).

Step 2:

For the case(i), create a node(OP) whose left child is node(y) and right child is node(z). (Checking for common sub expression). Let n be this node.

For case(ii), determine whether there is node(OP) with one child node(y). If not create such a node.

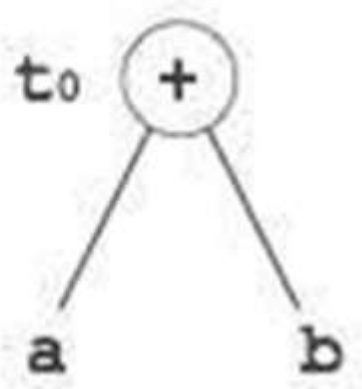
For case(iii), node n will be node(y).

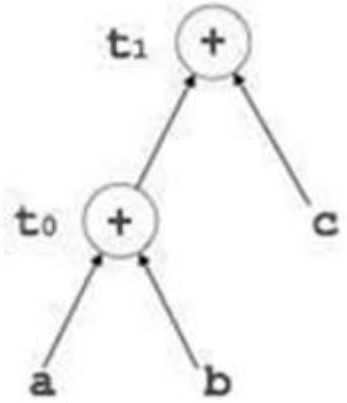
Step 3:

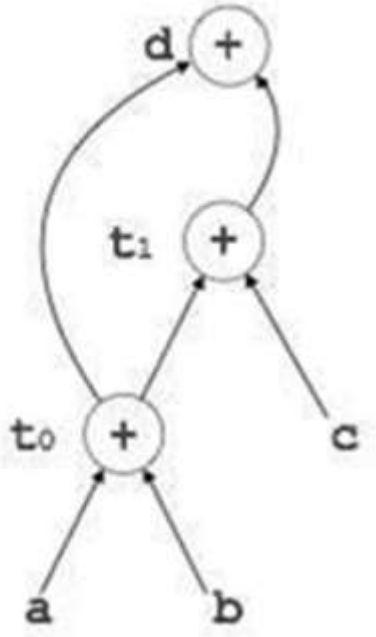
Delete x from the list of identifiers for node(x). Append x to the list of attached identifiers for the node n found in step 2 and set node(x) to n.

The DAG representation of basic blocks

$t_0 = a + b\ t_1 = t_0 + c\ d = t_0 + t_1$



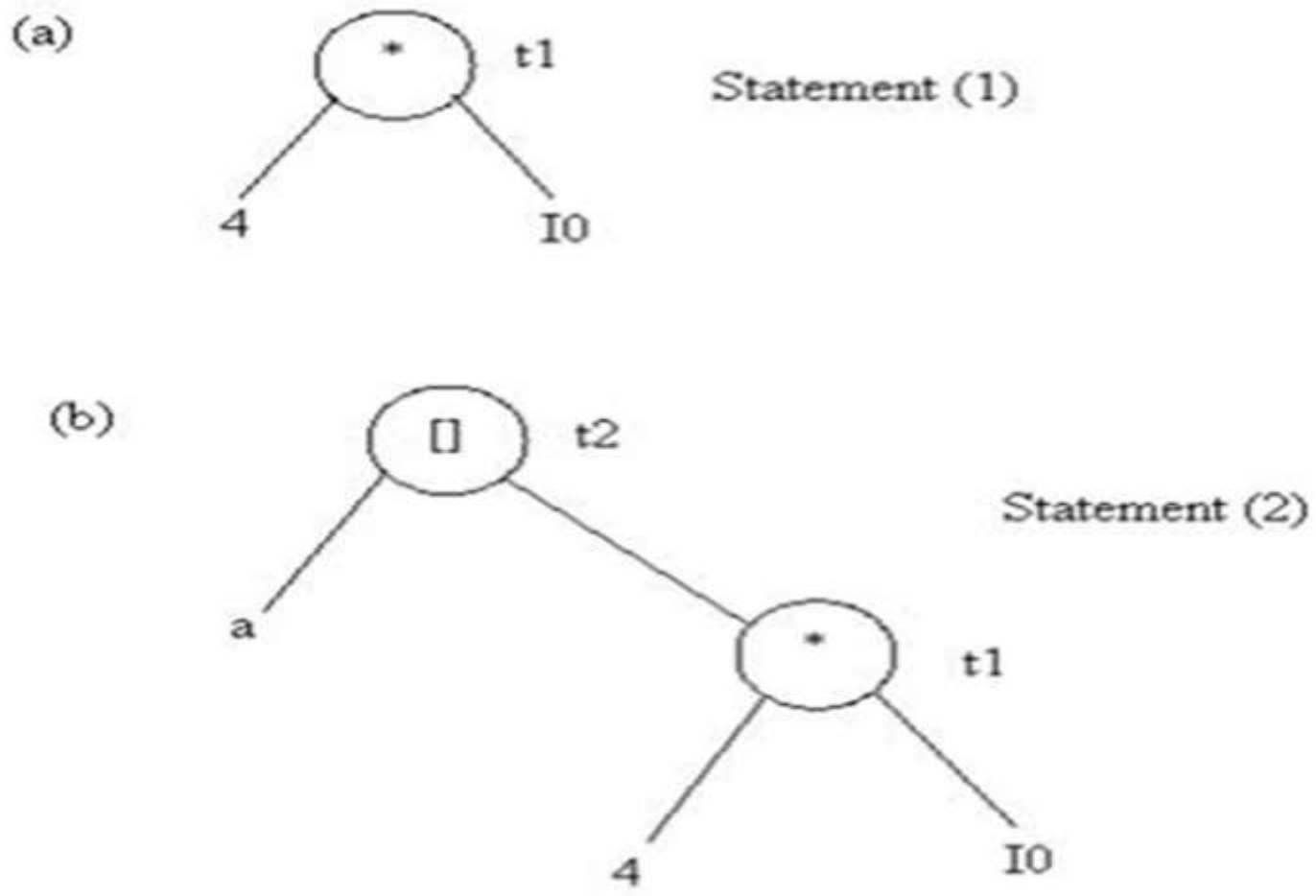




The DAG representation of basic blocks

```
1. t1 := 4* i
2. t2 := a[t1]
3. t3 := 4* i
4. t4 := b[t3]
5. t5 := t2*t4
6. t6 := prod+t5
7. prod := t6
8. t7 := i+1
9. i := t7
10. if i<=20 goto (1)
```

The DAG representation of basic blocks



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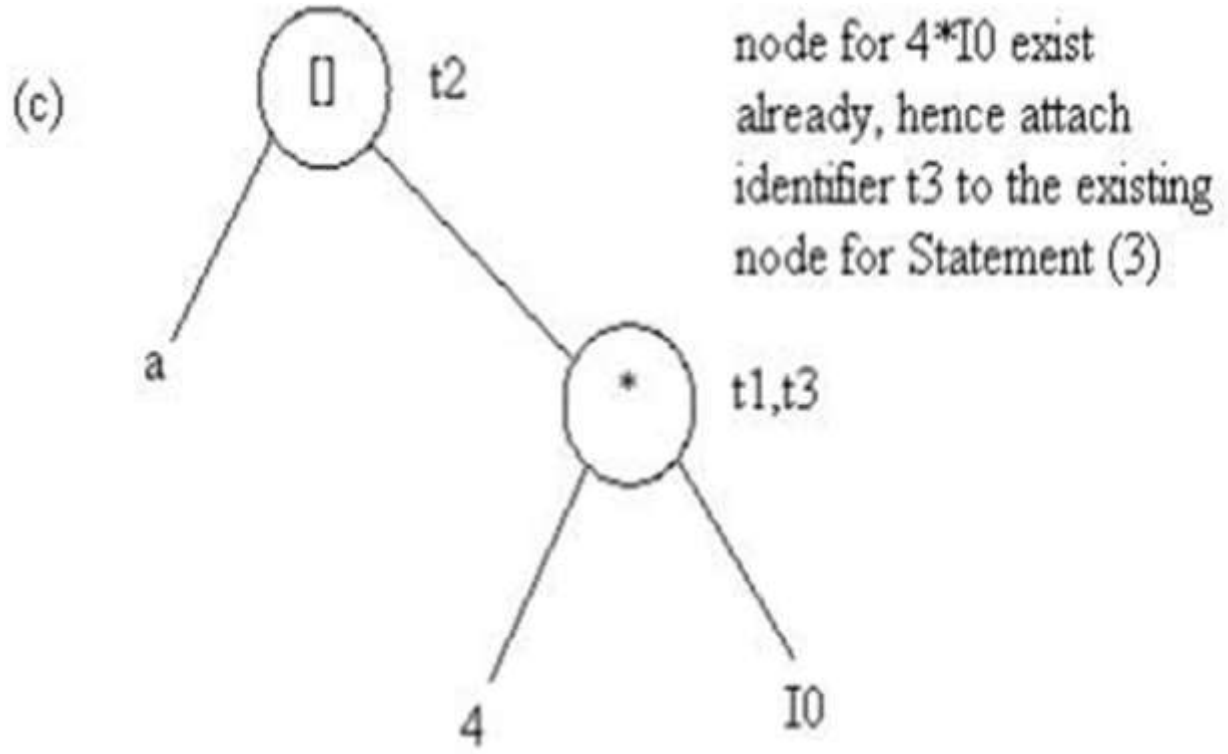
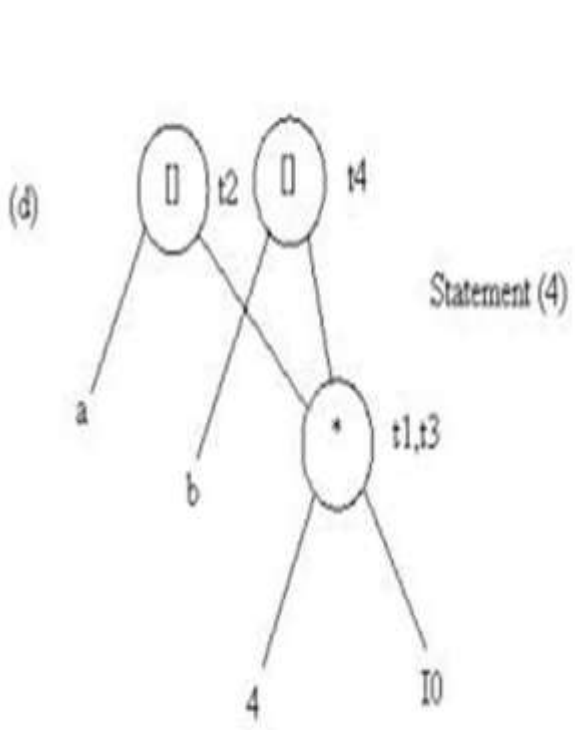
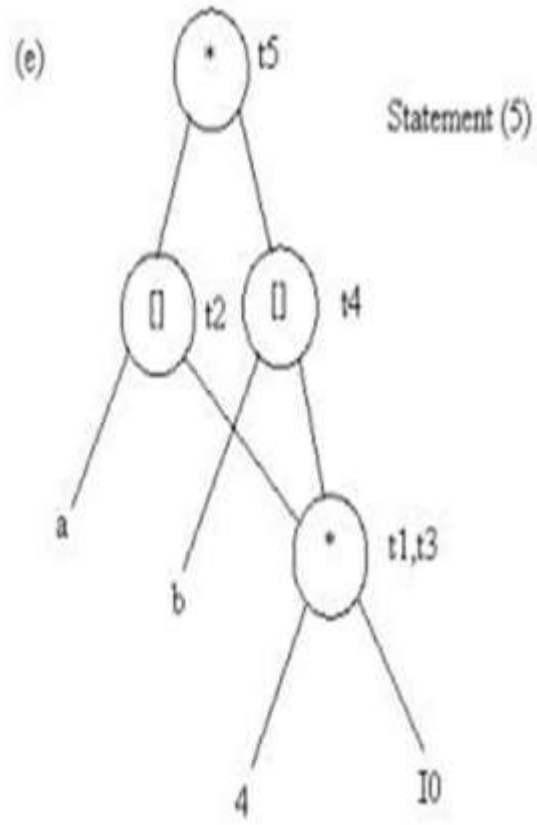


The DAG representation of basic blocks





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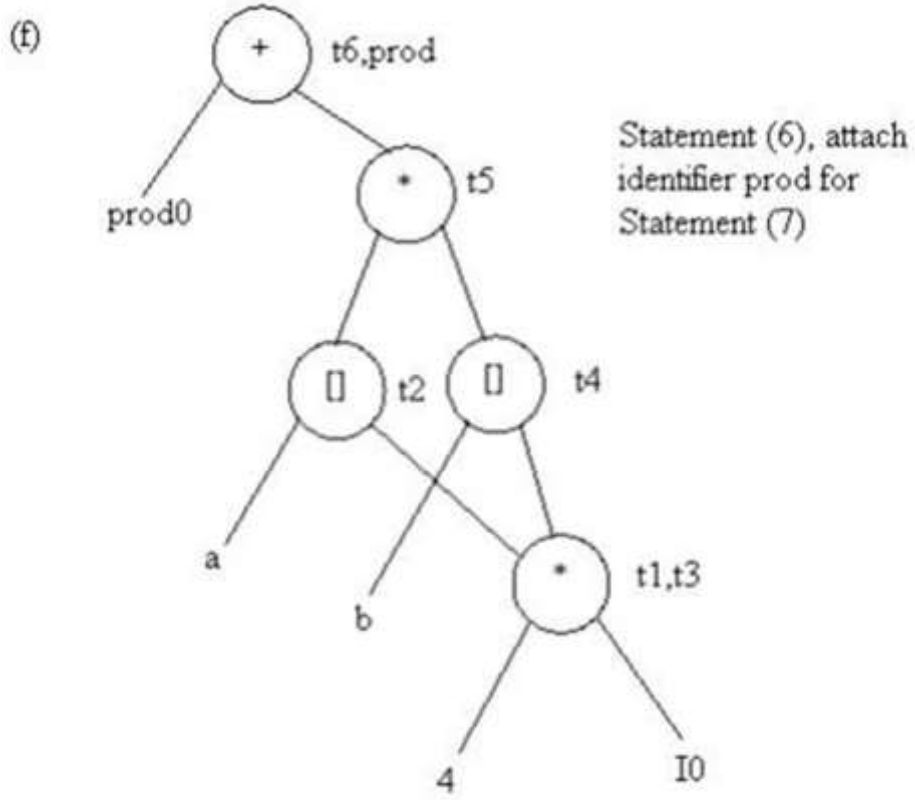

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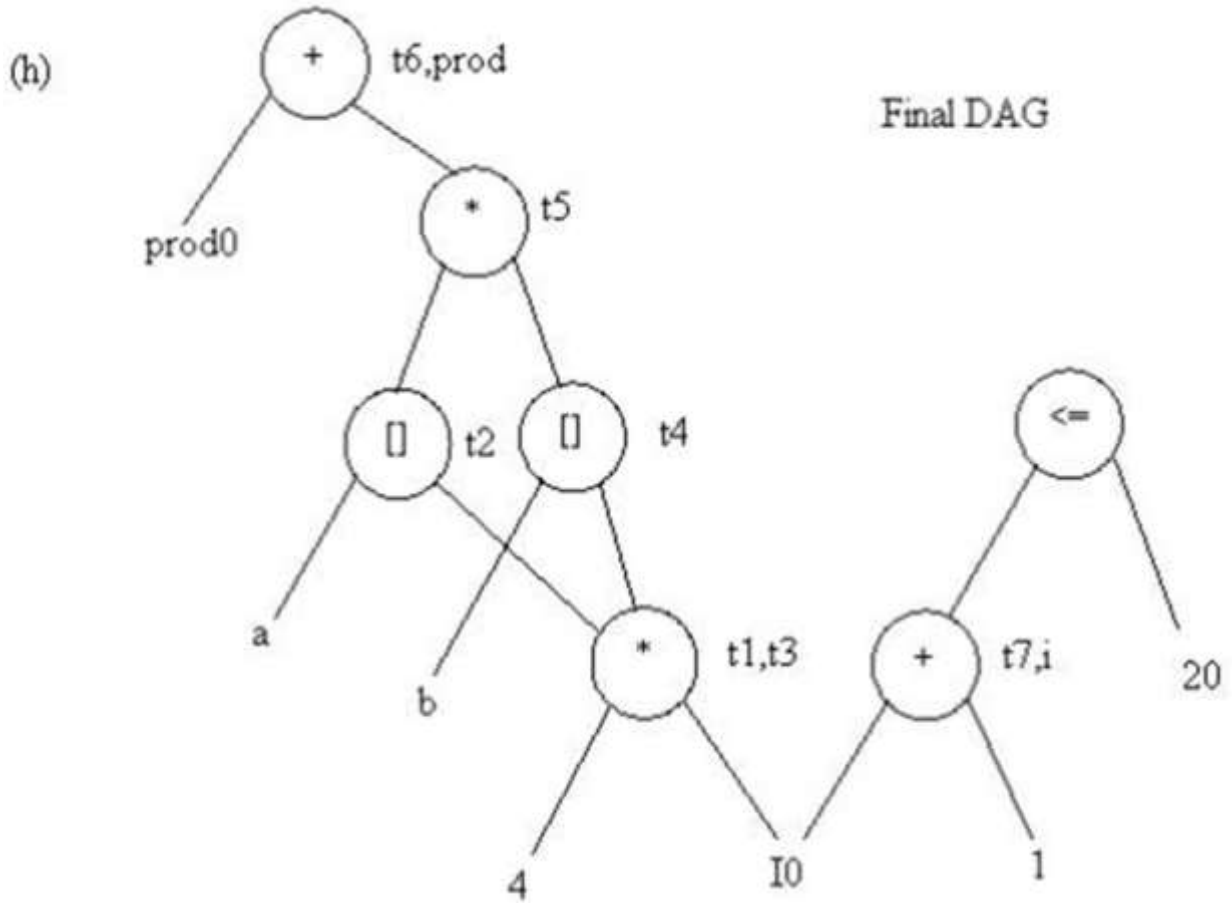


Generating code from DAG

Generating code from DAG

The advantage of generating code for a basic block from its dag representation is that from a dag we can easily see how to rearrange the order of the final computation sequence than we can start from a linear sequence of three-address statements or quadruples.

Rearranging the order

The order in which computations are done can affect the cost of resulting object code. For example, consider the following basic block:

t1 : = a + b

t2 : = c + d

t3 : = e - t2

t4 : = t1 - t3

Generating code from DAG

Generated code sequence for basic block:

MOV a , R0

ADD b , R0

MOV c , R1

ADD d , R1

MOV R0 , t1

MOV e , R0

SUB R1 , R0

MOV t1 , R1

SUB R0 , R1

MOV R1 , t4

Generating code from DAG

- **Rearranged basic block:**
- Now t1 occurs immediately before t4.
- t2 : = c + d
- t3 : = e - t2
- t1 : = a + b
- t4 : = t1 - t3

- **Revised code sequence:**
- MOV c , R0
- ADD d , R0
- MOV a , R0
- SUB R0 , R1
- MOV a , R0
- ADD b , R0
- SUB R1 , R0
- MOV R0 , t4

In this order, two instructions **MOV R0 , t1 and MOV t1 , R1** have been saved.

Generating code from DAG

A Heuristic ordering for Dags

The heuristic ordering algorithm attempts to make the evaluation of a nod the evaluation of its leftmost argument. The algorithm shown below produces the ordering in reverse.

Algorithm:

1) while unlisted interior nodes remain do begin
2) select an unlisted node n, all of whose parents have been listed;
3) list n;
4) while the leftmost child m of n has no unlisted parents and is not a

leaf do
begin
5) list m;
6) n = m
end
end

Generating code from DAG

- **Example: Consider the DAG shown below**
- Initially, the only node with no unlisted parents is 1 so set n=1 at line (2) and list 1 at line (3).
- Now, the left argument of 1, which is 2, has its parents listed, so we list 2 and set n=2 at line (6).
- Now, at line (4) we find the leftmost child of 2, which is 6, has an unlisted parent 5. Thus we select a new n at line (2), and node 3 is the only candidate.
- list 3 and proceed down its left chain, listing 4, 5 and 6. This leaves only 8 among the interior nodes so list that. The resulting list is 1234568 and the order of evaluation is 8654321.

Generating code from DAG

Code sequence:

t8 : = d + e

t6 : = a + b

t5 : = t6 - c

t4 : = t5 * t8

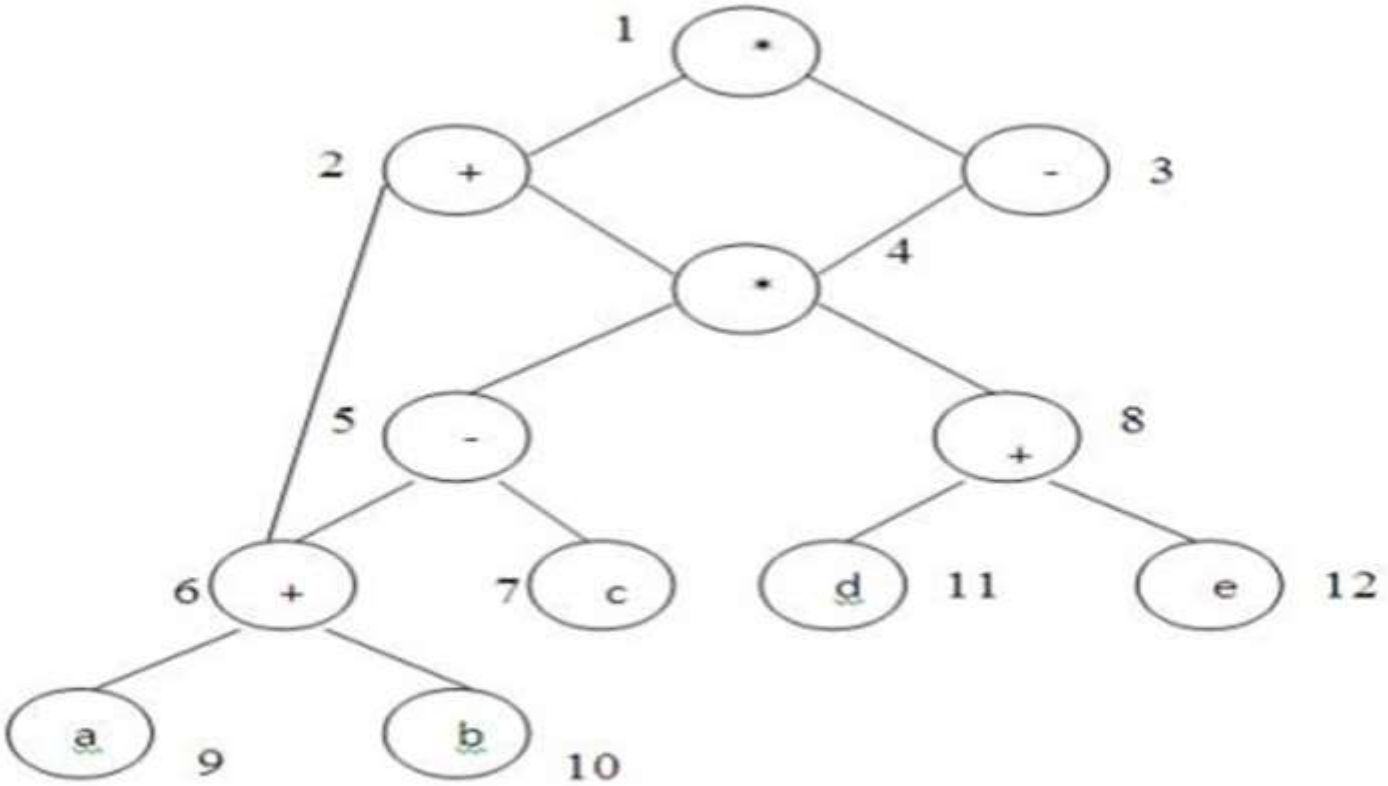
t3 : = t4 - e

t2 : = t6 + t4

t1 : = t2 * t3

This will yield an optimal code for the DAG on machine whatever be the number of registers.

Generating code from DAG



A DAG

Summarization