Lecture 2
Local Optimizations

I  Basic blocks
II Flow graphs
I. Basic Blocks & Flow Graphs

- We will work (optimize) within basic blocks

- Definitions:
  
  A Basic Block (BB) = sequence of consecutive statements in which flow control enters at the beginning and leaves at the end w/o halt or branching except at the end

Example:

\[
\begin{align*}
t1 & := a*a \\
t2 & := a*b \\
t3 & := 2*t2 \\
t4 & := t1+t3 \\
t5 & := b*b \\
t6 & := t4+t5
\end{align*}
\]
BB Definitions

\[ x := y + z \]

- Definition of variables \( x \)
- Use of variables \( y, z \)
- Live variables -- if variable will be used later

Definition: LEADER instructions are instructions that:

1. First statement in the program
2. Any statement that is a target of a branch
3. Any statement that follows a branch
Algorithm for Partitioning in BB

Input: Program a sequence of 3 address statements
Output: List of BB (sequence of instructions that belong to 1! BB

1. The set of LEADERS (initial instructions in BB)
2. For all x in LEADERS, the set BLOCK(x) of all instructions in the BB beginning at x
Method

Begin

LEADERS := {1}
for j := 1 to |PROG| do
    if INST(j) is a branch then
        add index of branch target to LEADERS
    endif
endfor

TODO := LEADERS
While TODO != O
    x := smallest indexed element from TODO
    TODO := TODO - {x}
    BLOCK(x) := {x}
    for i := x+1 to |PROG| and While i != LEADER do
        BLOCK(x) := BLOCK(x) + {i}
    endfor
endwhile

End
Example

(1) prod:= 0 --> L1
(2) i:=1

(3) t1:= 4*i --> L2
(4) t2:= a[t1]
(5) t3:= 4*i
(6) t4:= b[t3]
(7) t5:= t2*t4
(8) t6:= prod+t5
(9) prod=t6
(10) t7:= i+1
(11) i:=y7
(12) if i<=20 goto (3)
BB Representation, Organization

- Records in linked list
  
  \[\text{count of quadruples, ptr to LEADER, ptr to next BB}\]

- **Flow graph: Directed Graph**
  
  - Nodes are BB’s
  - Edges represent control flow
Loops

Definition:

Collection of nodes that is

1. Strongly connected (From any node in the loop there exists a path of length \( \geq 1 \) that is wholly within the loop)
2. Has a unique entry node

Example:

![Diagram showing a loop with a head BB]

head BB of loop