Unit-5

Principal source of optimization

Refer to Unit-4
→ optimization of Basic Block
→ Peephole optimization

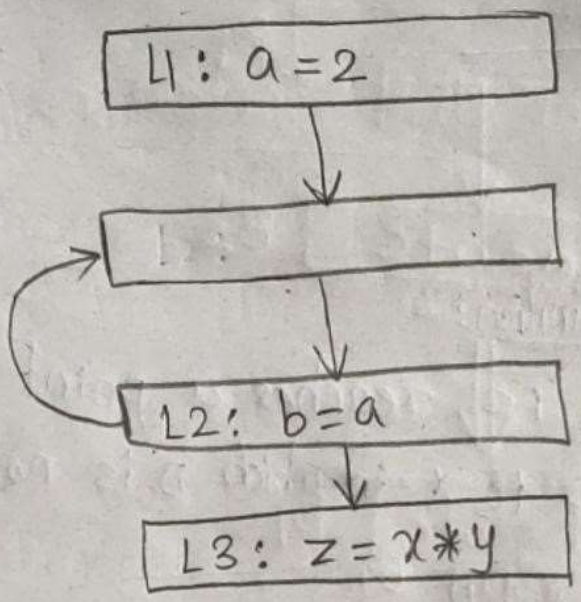
} only contents i.e inside topics

Data flow Analysis :-

* It is the analysis of flow of data in the control flow graph.
* The analysis that determines the information regarding the definition and use of data in the program.
* with the help of this analysis optimization can be done.

Basic technologies :-

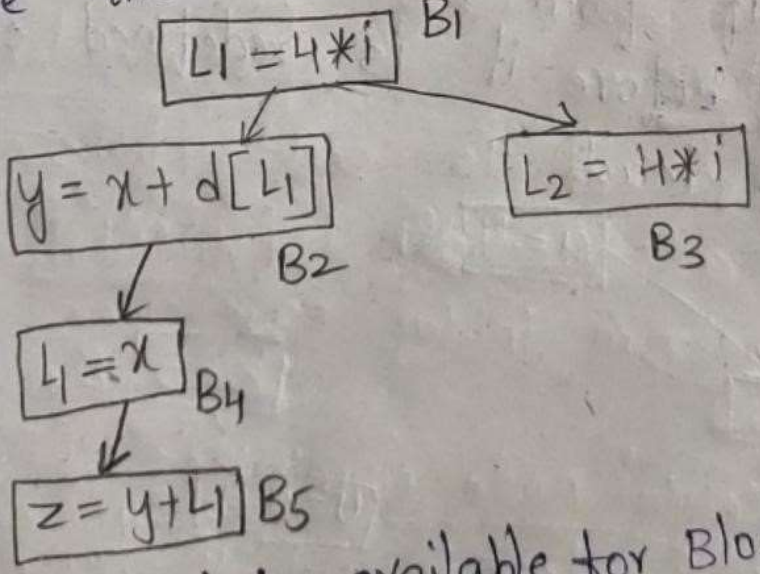
→ Definition point :- A point in a program containing some definition
→ Reference point :- A point in a program containing a reference to a data item
→ Evaluation point :- A point in a program containing evaluation of expression.



Data flow properties:-

~~* An expr~~ Available expression

* An expression is said to available at a program point x if along path it is reaching to x.
* An expression a+b is said to be available if none of the operands gets modified before their use.

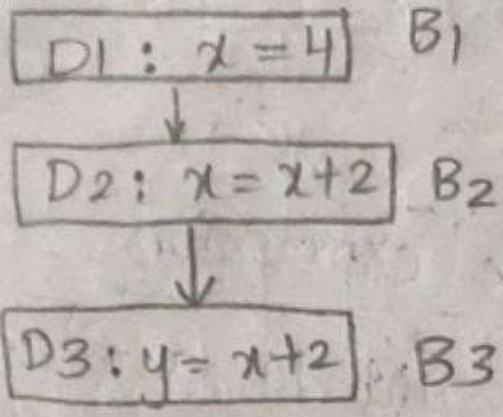


* Expression 4*i is available for Block B2, B3
* But at Block B4 its gets modified
* At Block B5 it is unavailable.

Reaching Definition:-

A definition D is reaches a point x if there is path D to x in which D is not killed

ex:-

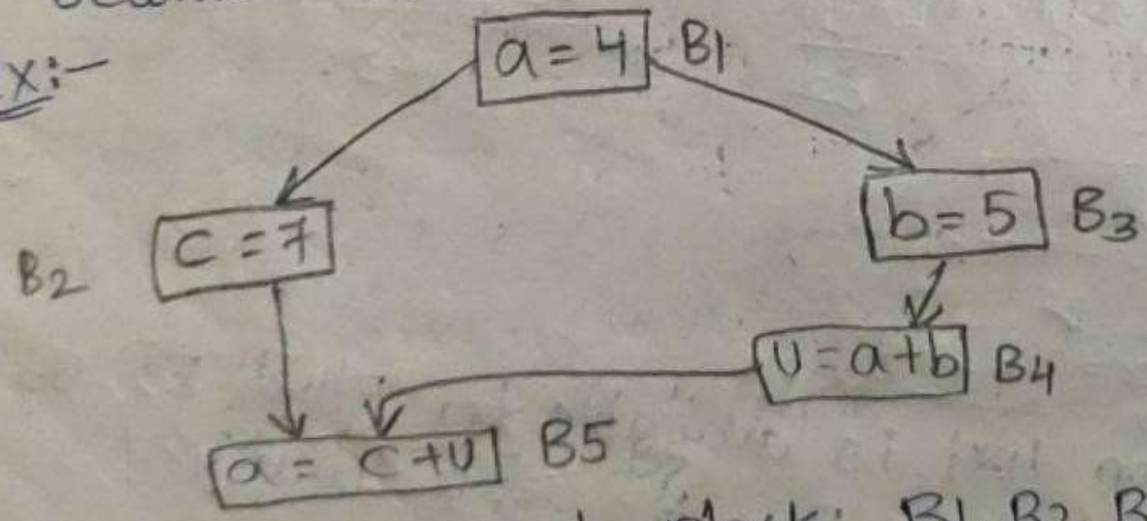


D1 is reaching definition for B2 but not for B3 (As x is modified / killed at D2)

Live Variable:-

*A variable is said to be live at some point p if from P to end of the variable is used before it is redefined else it becomes dead.

ex:-

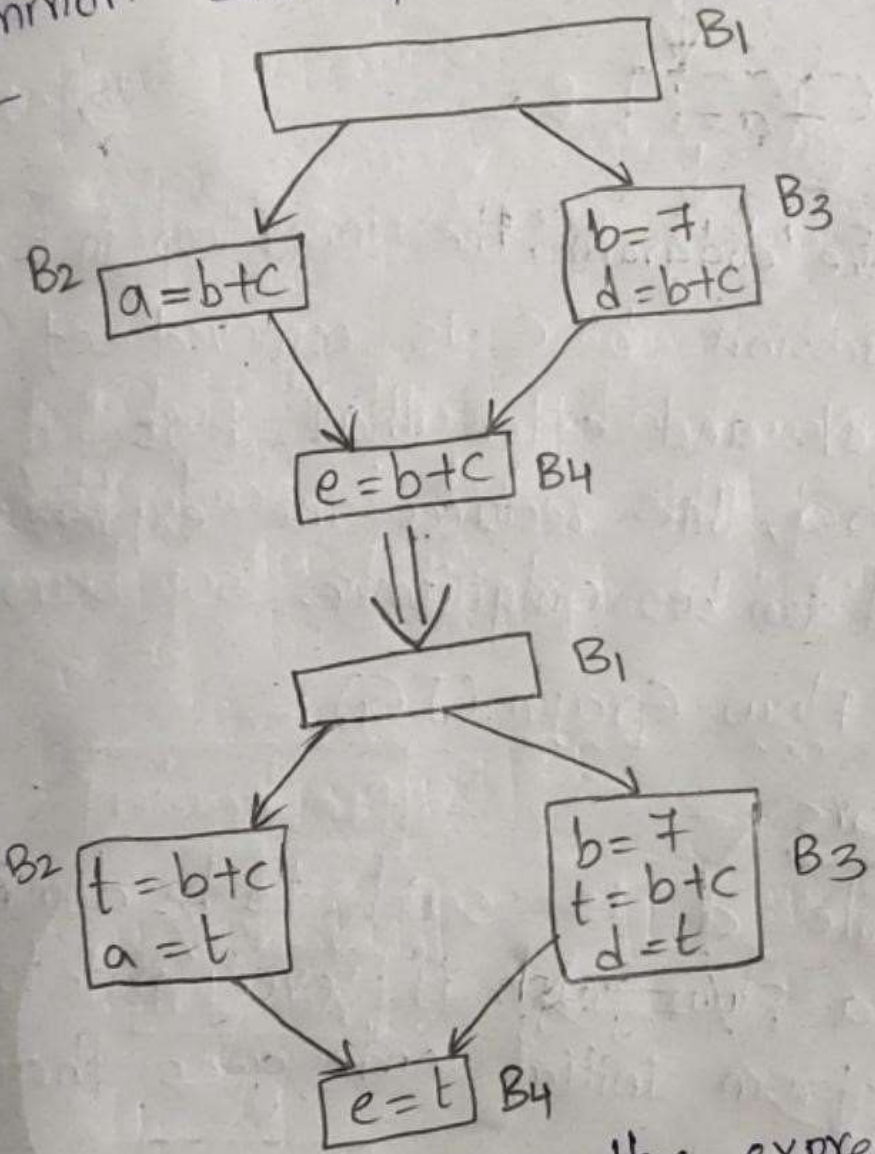


Here a is live at Block: B1, B2, B3, B4 but killed at B5

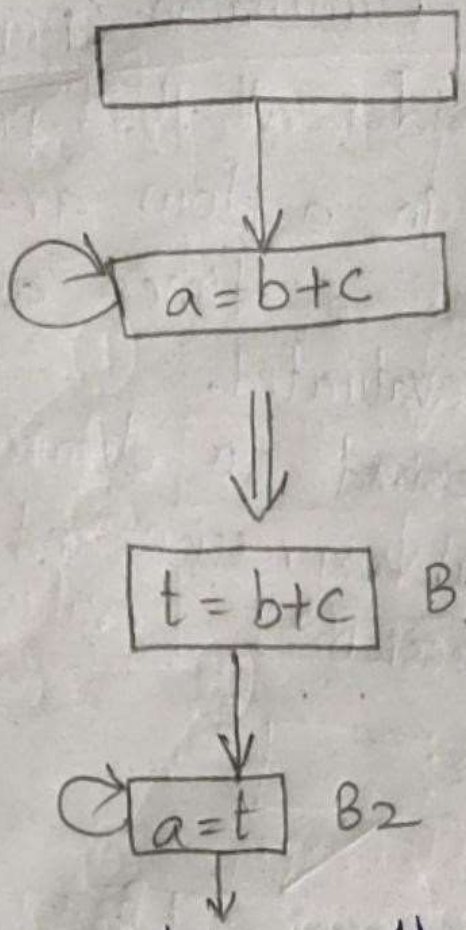
Partial Redundancy Elimination (PRE):-

* In PRE, we consider all the possible execution sequences in a flow graph, and look at the number of times an expression such as x, y is evaluated.
* PRE can be desired to eliminate both global common sub expression and local common sub expression.

ex:-



In the above diagram, the expression b+c computed in block B_4 is redundant, So in block B_2 and B_3, $t = b+c$ is added and in block B_4, t is assigned to $e=t$.



In the above diagram, the inner loop in B2, the expression b+c is removed and placed in B1 and after that t is assigned to a, this reduces the expression evaluated to be only once.

Loops in Flow Graph (FG) :-

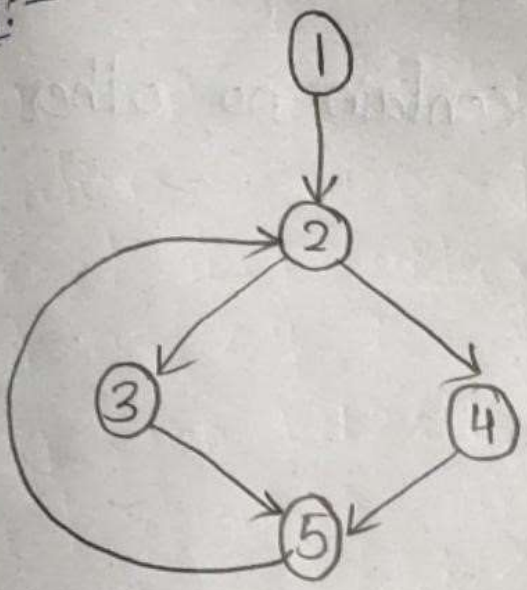
1) Dominators :-

A node d is said to be dominant node in a Flow graph if every path to none n from initial node goes through d only.

* Every initial node dominates all the remaining nodes in a Flow Graph.

* Every node dominates itself.

ex:-

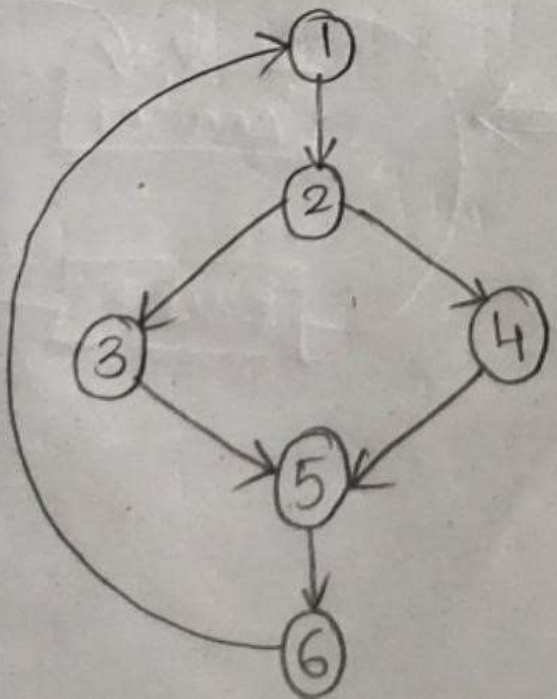


Node 1 dominates 2, 3, 4 and 5
Node 2 dominates 3, 4, 5
Node 3 dominates only itself
Node 4 dominates only itself
Node 5 dominates only itself.

2) Natural Loop :-

A Natural loop can be defined by a back edge $n \rightarrow d$ such that there exists a collection of all the nodes that can reach to n without going through d

ex:-



Natural loop:-

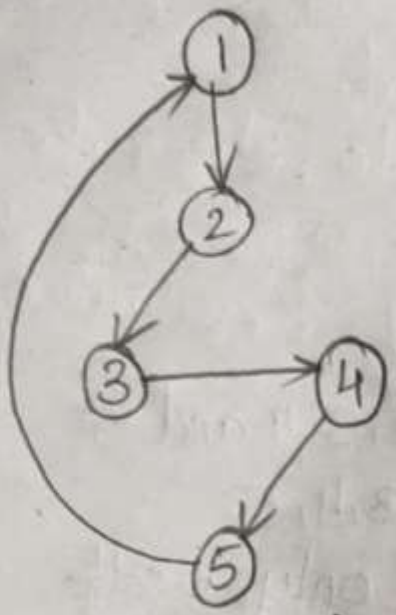
$6 \rightarrow 1$
$n \rightarrow d$

$\{2, 3, 4, 5, 6, 1\}$

Inner loop:-

It is a loop that contain no other loop.

ex:-



Here 2 to 4 is inner loop {2,3,4}

Pre header:-

It is a new header related such that successor of this block is header block.

* It is added to facilitate loop transformations.