Global Data flow Analysis

Basics

1) A program has several basic blocks
2) Basic blocks are connected with each other by some means which directs the execution of the program problem.
3) Flow Graph has node & edges
   - Nodes show Basic Blocks
   - Edges show the control flow
4) Data flow Analysis is
   - Intra-procedural Analysis
   - It determine the useful information for optimization

Examples of optimization

- Constant Propagation
- Dead Code Elimination

x = 4
Y = 2*w
Q = x + Y

—C.P→

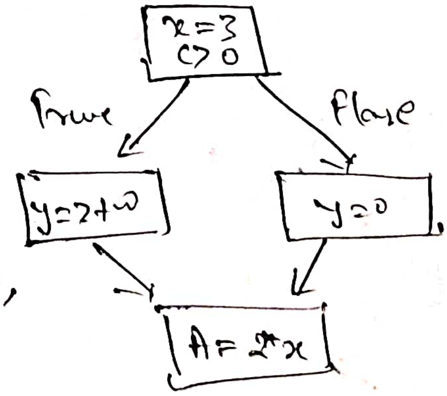
x = 4
Y = 2*w
Q = 4+Y

—D.C.E→

Y = 2*w
Q = 4+y

Data Flow Analysis

- Data flow Analysis tell us how to optimize the Basic blocks
- Since the value of x is not getting changed through the flow of the program, then x can be set as 3 in A = 2*x through Constant Propagation



- Global Constant Propagation need Global Data flow analysis

- Global Data flow Analysis collects the information about the entire program & distributes it to each block in the Flow Graph
- Data Flow can be collected in various blocks by setting up & solving up and solving a system of equation.
- A typical Data Flow Equation is given as

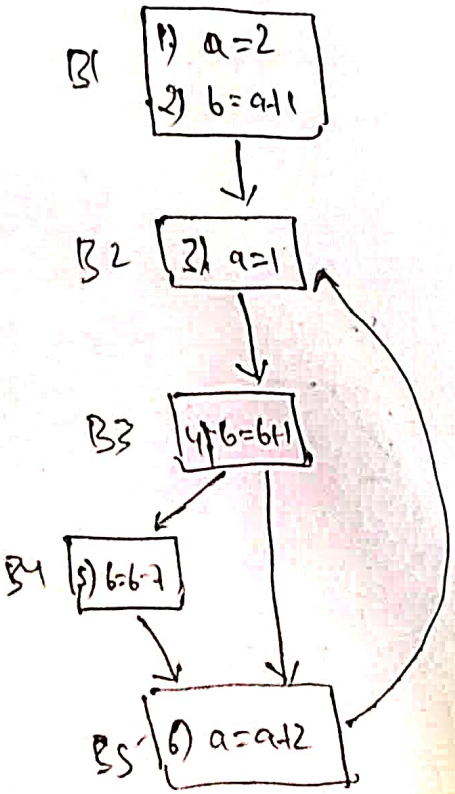
$$Out[s] = \{ In[s] - Kill[s] \} \cup Gen[s]$$

Out [s] : Definitions that reach Block B's Exit

Gen [s] : Definitions within Block B that reach the end of B

In [s] : Definitions that reaches B's Entry

Kill [s] : Definitions that never reaches the end of B



Generates

Block	Gen	Kill	In	Out
B1	{1,2}	{3,4,5,6}	ϕ	{1,2}
B2	{3}	{1,6}	ϕ	{3}
B3	{4}	{2,5}	ϕ	{4}
B4	{5}	{2,4}	ϕ	{5}
B5	{6}	{1,3}	ϕ	{6}

Iteration 1 (I1)

↳ Input to B1 is from no where hence i/p of B1 is ϕ

↳ Out [B1] = {In [B1] - Kill [B1]} ∪ Gen [B1]

= {ϕ - {3,4,5,6}} ∪ {1,2}

= {1,2}

↳ Input to B2 is from B1 & B5 hence

In [B2] = Out [B1] ∪ Out [B5] = {1,2,6}

Out [B2] = {In [B2] - Kill [B2]} ∪ Gen [B2]

= {{1,2,6} - {1,6}} ∪ {3} = {2,3}

↳ Input to B2 is from B2 hence In [B3] = Out [B2] = {3}

Out [B3] = {In [B3] - Kill [B3]} ∪ Gen [B3]

= {{3} - {2,5}} ∪ {4} = {3,4}

↳ Input to B4 is from B3 hence In [B4] = Out [B3] = {4}

Out [B4] = {In [B4] - Kill [B4]} ∪ Gen [B4]

= {{4} - {2,4}} ∪ {5} = {5}

↳ Input to B5 is from B3 & B4 hence In [B5] = Out [B3] ∪ Out [B4]

= {4,5}

Out [B5] = {In [B5] - Kill [B5]} ∪ Gen [B5]

= {{4,5} - {1,3}} ∪ {6}

= {4,5,6}

Iteration 2 (I2)

Block	Gen	Kill	In	Out
B1	{1,2}	{3,4,5,6}	ϕ	{1,2}
B2	{3}	{1,6}	{1,2,6}	{2,3}
B3	{4}	{2,5}	{3}	{3,4}
B4	{5}	{2,4}	{4}	{5}
B5	{6}	{1,3}	{4,5}	{4,5,6}

I3

Block	Gen	Kill	In	Out
B1	{1,2}	{3,4,5,6}	ϕ	{1,2}
B2	{3}	{1,6}	{1,2,4,5,6}	{2,3,4,5}
B3	{4}	{2,5}	{2,3}	{3,4}
B4	{5}	{2,4}	{3,4}	{3,5}
B5	{6}	{1,3}	{3,4,5}	{4,5,6}

≠ I4

You have to continue the Iteration till n^{th} & $(n-1)^{th}$ Iteration should not be same i.e then In & Out column be same,