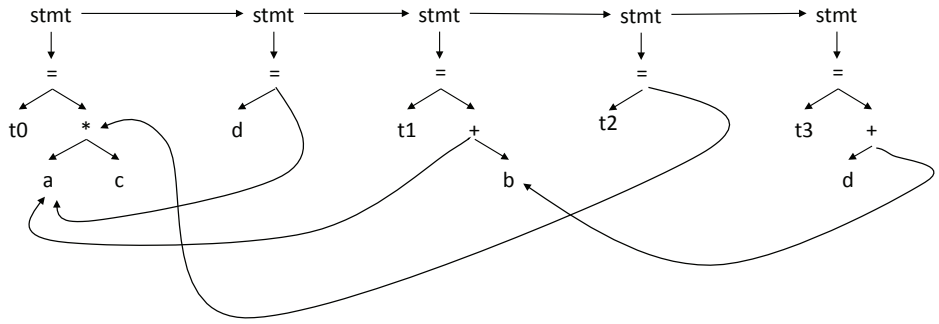
HW1 Solutions

1. DAG and LVN.

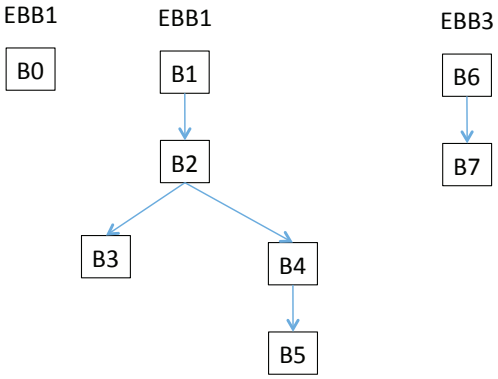
   (a) See the figure blow.



   (b) The superscripts are value numbers.

				After opt.	*Avail Expr.*
$t0^2$	$=$	$a^0 * c^1$			$(< 0 * 1 >, 2, t0)$
d^0	$=$	a^0			
$t1^4$	$=$	$a^0 + b^3$			$(< 0 + 3 >, 4, t1)$
$t2$	$=$	$a^0 * c^1$	$\Rightarrow$	$t2^2 = t0^2$	
$t3$	$=$	$d^0 + b^3$	$\Rightarrow$	$t3^4 = t1^4$	
$t4$	$=$	$t1^4 * 1$	$\Rightarrow$	$t4^4 = t1^4$	
e^1	$=$	c^1			
b	$=$	$a^0 * e^1$	$\Rightarrow$	$b^2 = t0^2$	
$t5^5$	$=$	$t1^4 + t2^2$			$(< 2 + 4 >, 5, t5)$
$t6^6$	$=$	$d^0 + b^2$			$(< 0 + 2 >, 6, t6)$
$t7$	$=$	$t4^4 + t2^2$	$\Rightarrow$	$t7^5 = t5^5$	
$t8$	$=$	$a^0 * e^1$	$\Rightarrow$	$t8^2 = t0^2$	
$t9$	$=$	$a^0 + t8^2$	$\Rightarrow$	$t9^6 = t6^6$	

2. (a) See the figure below.



   (b) I am skipping EBB1 which contains no oppoortunity for SVN.

For EBB2:

$Basicblock$					$After\ opt.$	$Avail\ Expr.$
$B1$						
	a^2	$=$	$d^0 - e^1$			$(< 0 - 1 >, 2)$
	c^4	$=$	$b^3 + a^2$			$(< 2 + 3 >, 4)$
$B2$						
	g^5	$=$	$b^3 * c^4$			$(< 3 * 4 >, 5)$
	f^6	$=$	1			
$B3$						
	d	$=$	$d^0 - e^1$	$\Rightarrow$	$d^2 = a^2$	
	e	$=$	$a^2 + b^3$	$\Rightarrow$	$e^4 = c^4$	
	b^7	$=$	$f^6 + g^5$			$(< 5 + 6 >, 7)$
$pop\ avail\ exprs\ for B3$						
$B4$						
	e	$=$	$b^3 + a^2$	$\Rightarrow$	$e^4 = c^4$	
	b^8	$=$	$f^6 + g^5$			$(< 5 + 6 >, 8)$
$B5$						
	d^9	$=$	$d^0 - e^4$			$(< 0 - 4 >, 9)$

For EBB3:

$Basicblock$					$After\ opt.$	$Avail\ Expr.$
$B6$						
	c^2	$=$	$b^0 * c^1$			$(< 0 * 1 >, 2)$
	b^5	$=$	$f^3 + g^4$			$(< 3 + 4 >, 5)$
	t^5	$=$	b^5			$(b\ redefined\ later)$
$B7$						
	b^6	$=$	$b^5 * c^2$			$(< 2 * 5 >, 6)$
	a^8	$=$	$b^6 - a^7$			$(< 6 - 7 >, 8)$
	g	$=$	$f^3 + g^4$	$\Rightarrow$	$g^5 = t^5$	

(c) No more expressions can be eliminated. f+g at B6 is in the avail_out of B3m B4, and B5 but not B1.

3. Control Flow Graph.

   (a) See the Figure 1.

   (b) See the Figure 1.

   (c) B0, B1, B2, B3, B4, B5

4. Global Redundancy Elimination.

   (a) U ={r4, r5, r6, r7, r8}
   GEN(B0) = {}
   RRSV(B0) = {}

   GEN(B1) = {r4, r5}
   PRSV(B1) = {r4}

   GEN(B2) = {}
   PRSV(B2) = {r4, r5, r7}

   GEN(B3) = {r4}
   PRSV(B3) = {r4, r5}

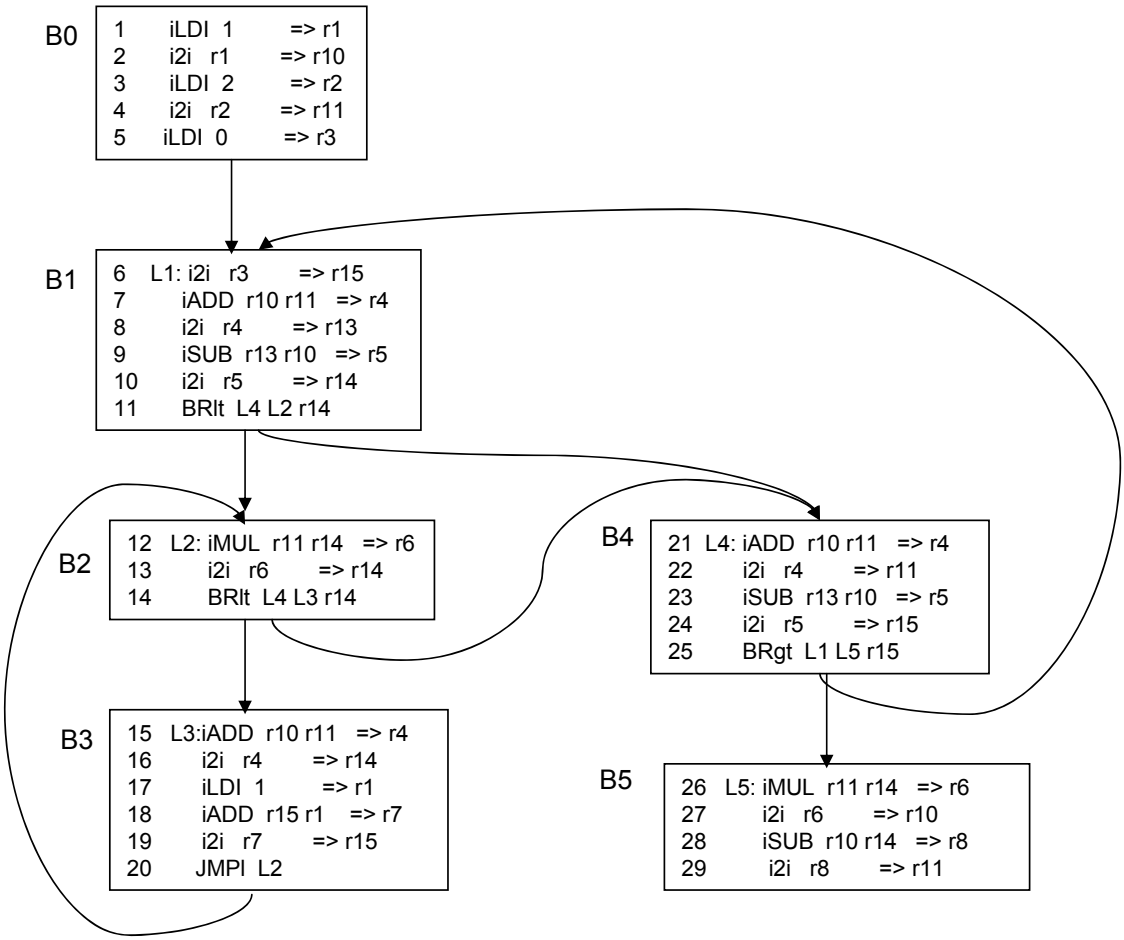


Figure 1: Control Flow Graph

GEN(B4) = {r5}
PRSV(B4) = {r5, r8}

GEN(B5) = {r8}
PRSV(B5) = {r7}

(b) **Init. (Iter. 0)**

IN(B0) = {}
OUT(B0) = {}

IN(B1) = U
OUT(B1) = {r4, r5}

IN(B2) = U
OUT(B2) = {r4, r5, r7}

IN(B3) = U
OUT(B3) = {r4, r5}

IN(B4) = U
OUT(B4) = {r5, r8}

IN(B5) = U
OUT(B5) = {r7, r8}

Iter. 1.

IN(B0) = {}
OUT(B0) = {}

IN(B1) = {}
OUT(B1) = {r4, r5}

IN(B2) = {r4, r5}
OUT(B2) = {r4, r5}

IN(B3) = {r4, r5}
OUT(B3) = {r4, r5}

IN(B4) = {r4, r5}
OUT(B4) = {r5}

IN(B5) = {r5}
OUT(B5) = {r8}

Iter. 2.

IN(B0) = {}
OUT(B0) = {}

IN(B1) = {}
OUT(B1) = {r4, r5}

IN(B2) = {r4, r5}
OUT(B2) = {r4, r5}

IN(B3) = {r4, r5}
OUT(B3) = {r4, r5}

IN(B4) = {r4, r5}
OUT(B4) = {r5}

IN(B5) = {r5}
OUT(B5) = {r8}

No change. Stop.

(c) Statements 15 in B3, 21 in B4, and 23 in B4 are removed.