Compilers - Second Assignment

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1 Very Busy Expressions

The first point asks to create a general framework for identifying Very Busy Expressions (VBE) and apply this framework to a given problem, which is described using a Data Flow Graph (DFG). The graph can be found in the assignment slides.

Very Busy Expressions - DFA Framework	
Domain	Sets of Expressions
Direction	Backward: $in[b] = f_b(out[b])$ $out[b] = \wedge\ in[succ(b)]$
Transfer function	$f_b(x) = Gen_b \cup (x - Kill_b)$
Meet operation ($\wedge$)	$\cap$
Boundary Condition	$in[exit] = \varnothing$
Initial interior points	$in[b] = \mathbb{U}$

Very Busy Expressions - Iterations				
	1° Iteration		**2° Iteration**	
	IN[B]	OUT[B]	IN[B]	OUT[B]
BB1	$\{b-a\}$	$\{b-a\}$	$\{b-a\}$	$\{b-a\}$
BB2	$\{b-a\}$	$\{b-a\}$	$\{b-a\}$	$\{b-a\}$
BB3	$\{a-b,\ b-a\}$	$\{a-b\}$	$\{a-b,\ b-a\}$	$\{a-b\}$
BB4	$\{a-b\}$	$\{\varnothing\}$	$\{a-b\}$	$\{\varnothing\}$
BB5	$\{0,\ b-a\}$	$\{0\}$	$\{0,\ b-a\}$	$\{0\}$
BB6	$\{0\}$	$\{a-b\}$	$\{0\}$	$\{a-b\}$
BB7	$\{a-b\}$	$\{\varnothing\}$	$\{a-b\}$	$\{\varnothing\}$
BB8	$\{\varnothing\}$	$\{\varnothing\}$	$\{\varnothing\}$	$\{\varnothing\}$

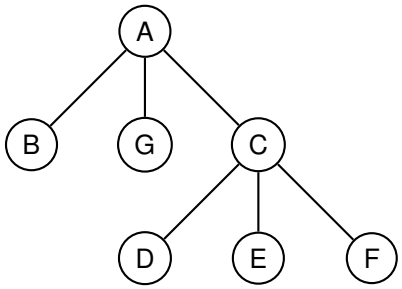
The algorithm stops after the second iteration because the input set from each basic block doesn't change between the first and second iterations.

2 Dominator Analysis

The second point asks to create a general framework to perform Dominator Analysis (DA) and apply this framework to a given problem, which is described using a Data Flow Graph (DFG). The graph can be found in the assignment slides.

Dominator Analysis - DFA Framework	
Domain	Sets of Basic Blocks
Direction	Forward: $out[b] = f_b(in[b])$ $in[b] = \wedge\ out[pred(b)]$
Transfer function	$f_b(x) = Def_b\ \cup\ x$
Meet operation ($\wedge$)	$\cap$
Boundary Condition	$out[entry]\ =\ \varnothing$
Initial interior points	$out[b]\ =\ \mathbb{U}$

Dominator Analysis - Iterations				
	1° Iteration		**2° Iteration**	
	IN[B]	OUT[B]	IN[B]	OUT[B]
A	$\{\varnothing\}$	$\{A\}$	$\{\varnothing\}$	$\{A\}$
B	$\{A\}$	$\{A, B\}$	$\{A\}$	$\{A, B\}$
C	$\{A\}$	$\{A, C\}$	$\{A\}$	$\{A, C\}$
D	$\{A, C\}$	$\{A, C, D\}$	$\{A, C\}$	$\{A, C, D\}$
E	$\{A, C\}$	$\{A, C, E\}$	$\{A, C\}$	$\{A, C, E\}$
F	$\{A, C\}$	$\{A, C, F\}$	$\{A, C\}$	$\{A, C, F\}$
G	$\{A\}$	$\{A, G\}$	$\{A\}$	$\{A, G\}$



Associated dominator tree.

The algorithm stops after the second iteration because the output set from each basic block doesn't change between the first and second iterations.

3 Constant Propagation

The third point asks to create a general framework for performing Constant Propagation (CP) analysis and apply this framework to a given problem, which is described using a Data Flow Graph (DFG). The graph can be found in the assignment slides.

Constant Propagation - DFA Framework	
Domain	Sets of Pairs $(var, const)$
Direction	Forward: $out[b] = f_b(in[b])$ $in[b] = \wedge\ out[pred(b)]$
Transfer function	$f_b(x) = Gen_b \cup (x - Kill_b)$
Meet operation ($\wedge$)	$\cap$
Boundary Condition	$out[entry] = \varnothing$
Initial interior points	$out[b] = \mathbb{U}$

Constant Propagation - Iterations				
	1° Iteration		**2° Iteration**	
	IN[B]	OUT[B]	IN[B]	OUT[B]
BB1	$\{\varnothing\}$	$\{\varnothing\}$	$\{\varnothing\}$	$\{\varnothing\}$
BB2	$\{\varnothing\}$	$\{(k,2)\}$	$\{\varnothing\}$	$\{(k,2)\}$
BB3	$\{(k,2)\}$	$\{(k,2)\}$	$\{(k,2)\}$	$\{(k,2)\}$
BB4	$\{(k,2)\}$	$\{(k,2),(a,4)\}$	$\{(k,2)\}$	$\{(k,2),(a,4)\}$
BB5	$\{(k,2),(a,4)\}$	$\{(k,2),(a,4),(x,5)\}$	$\{(k,2),(a,4)\}$	$\{(k,2),(a,4),(x,5)\}$
BB6	$\{(k,2)\}$	$\{(k,2),(a,4)\}$	$\{(k,2)\}$	$\{(k,2),(a,4)\}$
BB7	$\{(k,2),(a,4)\}$	$\{(k,2),(a,4),(x,8)\}$	$\{(k,2),(a,4)\}$	$\{(k,2),(a,4),(x,8)\}$
BB8	$\{(k,2),(a,4)\}$	$\{(k,4),(a,4)\}$	$\{(k,2),(a,4)\}$	$\{(k,4),(a,4)\}$
BB9	$\{(k,4),(a,4)\}$	$\{(k,4),(a,4)\}$	$\{(a,4)\}$	$\{(a,4)\}$
BB10	$\{(k,4),(a,4)\}$	$\{(k,4),(a,4),(b,2)\}$	$\{(a,4)\}$	$\{(a,4),(b,2)\}$
BB11	$\{(k,4),(a,4),(b,2)\}$	$\{(k,4),(a,4),(b,2),(x,8)\}$	$\{(a,4),(b,2)\}$	$\{(a,4),(b,2)\}$
BB12	$\{(k,4),(a,4),(b,2),(x,8)\}$	$\{(k,4),(a,4),(b,2),(x,8),(y,8)\}$	$\{(a,4),(b,2)\}$	$\{(a,4),(b,2),(y,8)\}$
BB13	$\{(k,4),(a,4),(b,2),(x,8),(y,8)\}$	$\{(k,5),(a,4),(b,2),(x,8),(y,8)\}$	$\{(a,4),(b,2),(y,8)\}$	$\{(a,4),(b,2),(y,8)\}$
BB14	$\{(k,4),(a,4)\}$	$\{(k,4),(a,4)\}$	$\{(a,4),(b,2),(y,8)\}$	$\{(a,4),(b,2),(y,8)\}$
BB15	$\{(k,4),(a,4)\}$	$\{(k,4),(a,4)\}$	$\{(a,4),(b,2),(y,8)\}$	$\{(a,4),(b,2),(y,8)\}$

Constant Propagation - Iterations		
	3° Iteration	
BB1	$\{\varnothing\}$	$\{\varnothing\}$
BB2	$\{\varnothing\}$	$\{(k,2)\}$
BB3	$\{(k,2)\}$	$\{(k,2)\}$
BB4	$\{(k,2)\}$	$\{(k,2),(a,4)\}$
BB5	$\{(k,2),(a,4)\}$	$\{(k,2),(a,4),(x,5)\}$
BB6	$\{(k,2)\}$	$\{(k,2),(a,4)\}$
BB7	$\{(k,2),(a,4)\}$	$\{(k,2),(a,4),(x,8)\}$
BB8	$\{(k,2),(a,4)\}$	$\{(k,4),(a,4)\}$
BB9	$\{(a,4)\}$	$\{(a,4)\}$
BB10	$\{(a,4)\}$	$\{(a,4),(b,2)\}$
BB11	$\{(a,4),(b,2)\}$	$\{(a,4),(b,2)\}$
BB12	$\{(a,4),(b,2)\}$	$\{(a,4),(b,2),(y,8)\}$
BB13	$\{(a,4),(b,2),(y,8)\}$	$\{(a,4),(b,2),(y,8)\}$
BB14	$\{(a,4),(b,2),(y,8)\}$	$\{(a,4),(b,2),(y,8)\}$
BB15	$\{(a,4),(b,2),(y,8)\}$	$\{(a,4),(b,2),(y,8)\}$

The algorithm stops after the third iteration because the output set from each basic block doesn't change between the second and third iterations.