Compilers - Second Assignment

Authors

Menozzi Matteo
Turci Gabriele
Turci Sologni Enrico

April 4, 2025

Contents

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	$\{\varnothing\}$	$\{\varnothing\}$	$\{\varnothing\}$	$\{\varnothing\}$

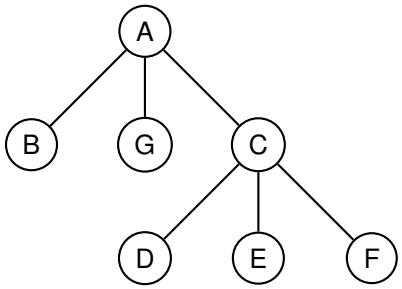
The algorithm stops after the second iteration because the input set from each basic block doesn't change between the first and second iterations.

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. We decided to omit the second iteration to avoid redundancy.

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.