

Assignment 2 – Alessandro Franceschini

	Dataflow Problem 1
Domain	All expressions
Direction	Backward $IN[B] = f_B(OUT[B])$ $OUT[B] = \bigcap_{s \in Succ(B)} IN[s]$
Transfer function	$f_B(x) = (x - kill_B) \cup gen_B$
Meet Operation	Intersection (\cap)
Boundary Condition	$IN[EXIT] = \emptyset$
Initial interior points	$IN[B_i] = u$ (universal set)

[illegible]

	Dataflow Problem 2
Domain	All subsets of nodes
Direction	Forward $OUT[B] = f_B(IN[B]) \cup \{B\}$ $IN[B] = \bigcap_{p \in Pred(B)} OUT[p]$
Transfer function	$f_B(x) = IN[x]$
Meet Operation	Intersection (\cap)
Boundary Condition	$IN[START] = \emptyset$ $OUT[START] = \{START\}$
Initial interior points	$OUT[B_i] = U$ (universal set)

	ITERAZIONE 1		ITERAZIONE 2		ITERAZIONE 3		ITERAZIONE 4	
	IN[X]	OUT[X]	IN[X]	OUT[X]	IN[X]	OUT[X]	IN[X]	OUT[X]
A	\emptyset	{A}	\emptyset	{A}	\emptyset	{A}	\emptyset	{A}
B	{A}	{A,B,C,D,E,F,G}	{A}	{A,B}	{A}	{A,B}	{A}	{A,B}
C	{A}	{A,B,C,D,E,F,G}	{A}	{A,C}	{A}	{A,C}	{A}	{A,C}
D	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,C}	{A,C,D}	{A,C}	{A,C,D}
E	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,C}	{A,C,E}	{A,C}	{A,C,E}
F	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,C}	{A,C,F}
G	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B,C,D,E,F,G}	{A,B}	{A,B,G}	{A,B}	{A,B,G}

	ITERAZIONE 5	
	IN[X]	OUT[X]
A	\emptyset	{A}
B	{A}	{A,B}
C	{A}	{A,C}
D	{A,C}	{A,C,D}
E	{A,C}	{A,C,E}
F	{A,C}	{A,C,F}
G	{A}	{A,G}

	Dataflow Problem 3
Domain	All possible pairs (x,c)
Direction	Forward $OUT[B] = f_B(IN[B])$ $IN[B] = \bigcap_{p \in Pred(B)} OUT[p]$
Transfer function	$f_B(IN[B]) = (IN[B] - \{(x, _)\}) \cup gen_B$ Where: $gen_B = \begin{cases} \{(x, k)\}, & \text{if } B: x = k \text{ (k is a constant)} \\ \{(x, val(y))\}, & \text{if } B: x = y \text{ (y is a variable with constant value)} \\ \emptyset, & \text{if } B: x = y \text{ op } z \text{ and either } val(x) \text{ or } val(y) \text{ are not constants} \end{cases}$
Meet Operation	Intersection (\cap)
Boundary Condition	$OUT[START] = \emptyset$
Initial interior points	$OUT[B_i] = U$ (universal set)

$$U = \{(k,2), (a,4), (x,5), (x,8), (k,4), (b,2), (x,6), (y,8), (k,3), (k,5)\}$$

	ITERAZIONE 1		ITERAZIONE 2		ITERAZIONE 3	
	IN[B]	OUT[B]	IN[B]	OUT[B]	IN[B]	OUT[B]
entry	\emptyset	\emptyset	\emptyset	\emptyset	\emptyset	\emptyset
k = 2	\emptyset	U	\emptyset	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	\emptyset	$\{(k,2)\}$
if	U	U	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	U	$\{(k,2)\}$	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$
a = k + 2	U	U	U	U	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	U
x = 5	U	U	U	$\{(k,2), (a,4), (x,5), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	U	$\{(k,2), (a,4), (x,5), (k,4), (b,2), (y,8), (k,3), (k,5)\}$
a = k * 2	U	U	U	U	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	U
x = 8	U	U	U	$\{(k,2), (a,4), (x,8), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	U	$\{(k,2), (a,4), (x,8), (k,4), (b,2), (y,8), (k,3), (k,5)\}$
k = a	U	U	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(a,4), (x,5), (x,8), (k,4), (b,2), (x,6), (y,8)\}$	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(a,4), (k,4), (b,2), (y,8)\}$
while	U	U	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	U	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$
b = 2	U	U	U	U	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	U
x = a + k	U	U	U	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	U	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$
y = a * b	U	U	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	U	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	U
k++	U	U	U	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	U	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$
print(a + x)	U	U	U	U	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	U
exit	U	U	U	U	U	U

	ITERAZIONE 4		ITERAZIONE 5		ITERAZIONE 6	
	IN[B]	OUT[B]	IN[B]	OUT[B]	IN[B]	OUT[B]
entry	\emptyset	\emptyset	\emptyset	\emptyset	\emptyset	\emptyset
k = 2	\emptyset	$\{(k,2)\}$	\emptyset	$\{(k,2)\}$	\emptyset	$\{(k,2)\}$
if	$\{(k,2)\}$	$\{(k,2)\}$	$\{(k,2)\}$	$\{(k,2)\}$	$\{(k,2)\}$	$\{(k,2)\}$
a = k + 2	$\{(k,2)\}$	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(k,2)\}$	$\{(k,2), (a,4)\}$	$\{(k,2)\}$	$\{(k,2), (a,4)\}$
x = 5	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(k,2), (a,4), (x,5), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(k,2), (a,4)\}$	$\{(k,2), (a,4), (x,5), (b,2), (y,8)\}$	$\{(k,2), (a,4)\}$	$\{(k,2), (a,4), (x,5)\}$
a = k * 2	$\{(k,2)\}$	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(k,2)\}$	$\{(k,2), (a,4)\}$	$\{(k,2)\}$	$\{(k,2), (a,4)\}$
x = 8	$\{(k,2), (a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(k,2), (a,4), (x,8), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(k,2), (a,4)\}$	$\{(k,2), (a,4), (x,8), (b,2), (y,8)\}$	$\{(k,2), (a,4)\}$	$\{(k,2), (a,4), (x,8)\}$
k = a	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(a,4), (k,4), (b,2), (y,8)\}$	$\{(k,2), (a,4), (b,2), (y,8)\}$	$\{(k,4), (a,4), (b,2), (y,8)\}$	$\{(k,2), (a,4)\}$	$\{(k,4), (a,4), (b,2), (y,8)\}$
while	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$
b = 2	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$
x = a + k	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$
y = a * b	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$
k++	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(k,2), (a,4), (k,4), (b,2), (y,8), (k,3), (k,5)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$
print(a + x)	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$
exit	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	U	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (x,5), (x,8), (b,2), (x,6), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$	$\{(a,4), (b,2), (y,8)\}$

	ITERAZIONE 7		ITERAZIONE 8		ITERAZIONE 9	
	IN[B]	OUT[B]	IN[B]	OUT[B]	IN[B]	OUT[B]
entry	\emptyset	\emptyset	\emptyset	\emptyset	\emptyset	\emptyset
k = 2	\emptyset	{{(k,2)}}	\emptyset	{{(k,2)}}	\emptyset	{{(k,2)}}
if	{{(k,2)}}	{{(k,2)}}	{{(k,2)}}	{{(k,2)}}	{{(k,2)}}	{{(k,2)}}
a = k + 2	{{(k,2)}}	{{(k,2), (a,4)}}	{{(k,2)}}	{{(k,2), (a,4)}}	{{(k,2)}}	{{(k,2), (a,4)}}
x = 5	{{(k,2), (a,4)}}	{{(k,2), (a,4), (x,5)}}	{{(k,2), (a,4)}}	{{(k,2), (a,4), (x,5)}}	{{(k,2), (a,4)}}	{{(k,2), (a,4), (x,5)}}
a = k * 2	{{(k,2)}}	{{(k,2), (a,4)}}	{{(k,2)}}	{{(k,2), (a,4)}}	{{(k,2)}}	{{(k,2), (a,4)}}
x = 8	{{(k,2), (a,4)}}	{{(k,2), (a,4), (x,8)}}	{{(k,2), (a,4)}}	{{(k,2), (a,4), (x,8)}}	{{(k,2), (a,4)}}	{{(k,2), (a,4), (x,8)}}
k = a	{{(k,2), (a,4)}}	{{(k,4), (a,4)}}	{{(k,2), (a,4)}}	{{(k,4), (a,4)}}	{{(k,2), (a,4)}}	{{(k,4), (a,4)}}
while	{{(a,4)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4)}}	{{(a,4)}}	{{(a,4)}}	{{(a,4)}}
b = 2	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4)}}	{{(a,4), (b,2)}}
x = a + k	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2)}}	{{(a,4), (b,2), (y,8)}}
y = a * b	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}
k++	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}
print(a + x)	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4)}}	{{(a,4)}}
exit	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}	{{(a,4)}}	{{(a,4), (b,2), (y,8)}}

	ITERAZIONE 10	
	IN[B]	OUT[B]
entry	\emptyset	\emptyset
k = 2	\emptyset	{{(k,2)}}
if	{{(k,2)}}	{{(k,2)}}
a = k + 2	{{(k,2)}}	{{(k,2), (a,4)}}
x = 5	{{(k,2), (a,4)}}	{{(k,2), (a,4), (x,5)}}
a = k * 2	{{(k,2)}}	{{(k,2), (a,4)}}
x = 8	{{(k,2), (a,4)}}	{{(k,2), (a,4), (x,8)}}
k = a	{{(k,2), (a,4)}}	{{(k,4), (a,4)}}
while	{{(a,4)}}	{{(a,4)}}
b = 2	{{(a,4)}}	{{(a,4), (b,2)}}
x = a + k	{{(a,4), (b,2)}}	{{(a,4), (b,2)}}
y = a * b	{{(a,4), (b,2)}}	{{(a,4), (b,2), (y,8)}}
k++	{{(a,4), (b,2), (y,8)}}	{{(a,4), (b,2), (y,8)}}
print(a + x)	{{(a,4)}}	{{(a,4)}}
exit	{{(a,4)}}	{{(a,4)}}

