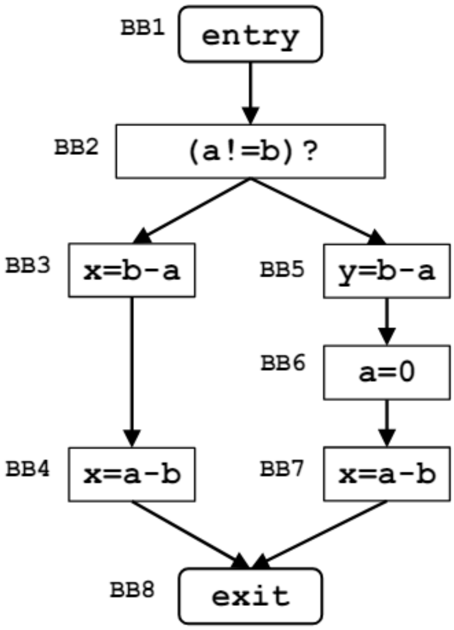
Very Busy Expression



Domain	*Sets of expression*
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 Operator (∧)	∩
Boundary Condition	$In[exit] = \emptyset$
Initial Interior Points	$In[B] = u$

- $Gen[B] \rightarrow$ le espressioni usate nel blocco B che non hanno operandi definiti nel blocco stesso.
- $Kill[B] \rightarrow$ tutte le espressioni che contengono variabili definite nel blocco B

Tabella Gen-Kill

	Gen	**Kill**
BB2	-	-
BB3	$(b - a)$	-
BB4	$(a - b)$	-
BB5	$(b - a)$	-
BB6	-	$(a - b)$, $(b - a)$
BB7	$(a - b)$	-

Tabella iterazioni

	Iterazione 1		*Iterazione 2*	
	$In[B]$	$Out[B]$	$In[B]$	$Out[B]$
BB1	$\emptyset$	$(b - a)$	$\emptyset$	$(b - a)$
BB2	$(b - a)$	$\{(b - a), (a - b)\} \cap \{(b - a)\} = (b - a)$	$(b - a)$	$\{(b - a), (a - b)\} \cap \{(b - a)\} = (b - a)$
BB3	$(b - a)$,$(a - b)$	$(a - b)$	$(b - a)$,$(a - b)$	$(a - b)$
BB4	$(a - b)$	$\emptyset$	$(a - b)$	$\emptyset$
BB5	$(b - a)$	$\emptyset$	$(b - a)$	$\emptyset$
BB6	$\emptyset$	$(a - b)$	$\emptyset$	$(a - b)$
BB7	$(a - b)$	$\emptyset$	$(a - b)$	$\emptyset$

Passi dell'algoritmo

1° Iterazione

$$OldIn[B4] = \emptyset$$
$$In[B4] = (a-b) \cup (\emptyset - \emptyset) = \{(a-b)\}$$

$$OldIn[B3] = \emptyset$$
$$In[B3] = (b-a) \cup ((a-b) - \emptyset) = \{(b-a),(a-b)\}$$

$$OldIn[B7] = \emptyset$$
$$In[B7] = (a-b) \cup (\emptyset - \emptyset) = \{(a-b)\}$$

$$OldIn[B6] = \emptyset$$
$$In[B6] = \emptyset \cup ((a-b) - (a-b)) = \emptyset$$

$$OldIn[B5] = \emptyset$$
$$In[B4] = (b-a) \cup (\emptyset - \emptyset) = \{(b-a)\}$$

$$OldIn[B2] = \emptyset$$
$$In[B2] = \emptyset \cup (\{(b-a),(a-b)\} \cap \{(b-a)\} - \emptyset) = \{(b-a)\}$$

$$OldIn[Entry] = \emptyset$$
$$In[Entry] = \emptyset \cup (\{(b-a)\} - \emptyset) = \{(b-a)\}$$

2° Iterazione

$$OldIn[B4] = \{(a-b)\}$$
$$In[B4] = (a-b) \cup (\emptyset - \emptyset) = \{(a-b)\}$$

$$OldIn[B3] = \{(b-a),(a-b)\}$$
$$In[B3] = (b-a) \cup ((a-b) - \emptyset) = \{(b-a),(a-b)\}$$

$$OldIn[B7] = \{(a-b)\}$$
$$In[B7] = (a-b) \cup (\emptyset - \emptyset) = \{(a-b)\}$$

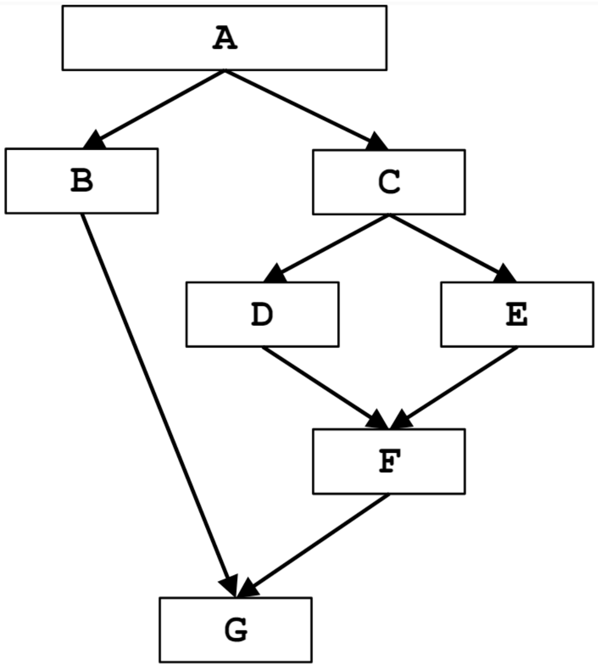
$$OldIn[B6] = \emptyset$$
$$In[B6] = \emptyset \cup ((a-b) - (a-b)) = \emptyset$$

$$OldIn[B5] = \{(b-a)\}$$
$$In[B4] = (b-a) \cup (\emptyset - \emptyset) = \{(b-a)\}$$

$$OldIn[B2] = \{(b-a)\}$$
$$In[B2] = \emptyset \cup (\{(b-a),(a-b)\} \cap \{(b-a)\} - \emptyset) = \{(b-a)\}$$

$$OldIn[Entry] = \{(b-a)\}$$
$$In[Entry] = \emptyset \cup (\{(b-a)\} - \emptyset) = \{(b-a)\}$$

Dominator Analysis



Domain	Sets of Basic Block
Direction	Forward: $Out[B] = f_b(In[B])$ $In[B] = \wedge Out[pred(B)]$
Transfer Function	$f_b(x) = Gen[B] \cup x$
Meet Operator (∧)	$\cap$
Boundary Condition	$Out[entry] = entry$
Initial Interior Points	$Out[B] = Universal\, Set$

- $Gen[B] \rightarrow$ il blocco stesso

Tabella Gen-Kill

Ogni blocco genera solo sé stesso e non uccide niente.

Passi dell'algoritmo

$In[A] = \emptyset$
$Out[A] = A$

$In[B] = A$
$Out[B] = B \cup A = A, B$

$In[C] = A$
$Out[C] = C \cup A = A, C$

$In[D] = A, C$
$Out[D] = D \cup \{A, C\} = A, C, D$

$In[E] = A, C$
$Out[E] = E \cup \{A, C\} = A, C, E$

$In[F] = Out[D] \cap Out[E] = \{A, C, D\} \cap \{A, C, E\} = \{A, C\}$
$Out[F] = F \cup (\{A, C, D\} \cap \{A, C, E\}) = \{A, C, F\}$

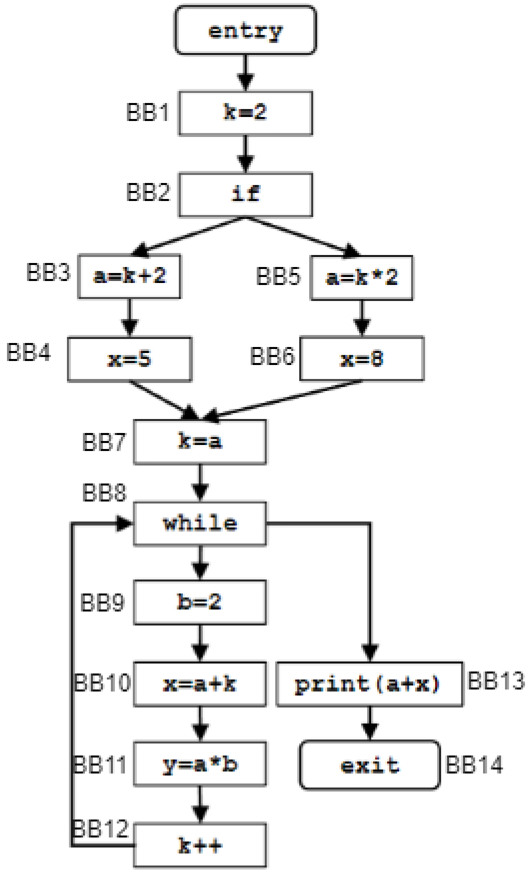
$In[G] = Out[B] \cap Out[F] = \{A, C, F\} \cap \{A, B\} = \{A\}$
$Out[G] = G \cup (\{A, C, F\} \cap \{A, B\}) = \{A, G\}$

Tabella iterazioni

	$In[B]$	$Out[B]$
A	/	A
B	A	A, B
C	A	A, C
D	A, C	A, C, D
E	A, C	A, C, E
F	$\{A, C, D\} \cap \{A, C, E\} = A, C$	A, C, F
G	$\{A, C, F\} \cap \{A, B\} = A$	A, G

(Iterazione 2 analoga)

Constant Propagation



Domain	Sets of $[x, c]$
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 Operator (∧)	$\cap$
Boundary Condition	$Out[entry] = \emptyset$
Initial Interior Points	$Out[B] = Universal\ Set$

- $Gen[B] \rightarrow$ le definizioni che hanno uno o entrambi gli operandi costanti in B
- $Kill[B] \rightarrow$ tutte le coppie che contengono le variabili definite nuovamente nel blocco B

Tabella Gen-Kill

	Gen	**Kill**
BB1	$[k, 2]$	-
BB2	-	-
BB3	-	-
BB4	$[x, 5]$	$[x, 8]$
BB5	-	-
BB6	$[x, 8]$	$[x, 5]$
BB7	-	$[k, 2]$
BB8	-	-
BB9	$[b, 2]$	
BB10	-	$[x, 5]$, $[x, 8]$
BB11	-	-
BB12	-	$[k, 2]$

Tabella iterazioni

	Iterazione 1		*Iterazione 2*	
	$In[B]$	$Out[B]$	$In[B]$	$Out[B]$
BB1	$\emptyset$	$[k, 2]$	$\emptyset$	$[k, 2]$
BB2	$[k, 2]$	$[k, 2]$	$[k, 2]$	$[k, 2]$
BB3	$[k, 2]$	$[k, 2]$	$[k, 2]$	$[k, 2]$
BB4	$[k, 2]$	$[k, 2]$, $[x, 5]$	$[k, 2]$	$[k, 2]$, $[x, 5]$
BB5	$[k, 2]$	$[k, 2]$	$[k, 2]$	$[k, 2]$
BB6	$[k, 2]$	$[k, 2]$, $[x, 8]$	$[k, 2]$	$[k, 2]$, $[x, 8]$
BB7	$[k, 2]$	$\emptyset$	$[k, 2]$	$\emptyset$
BB8	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$
BB9	$\emptyset$	$[b, 2]$	$\emptyset$	$[b, 2]$
BB10	$[b, 2]$	$[b, 2]$	$[b, 2]$	$[b, 2]$
BB11	$[b, 2]$	$[b, 2]$	$[b, 2]$	$[b, 2]$
BB12	$[b, 2]$	$[b, 2]$	$[b, 2]$	$[b, 2]$
BB13	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$

Passi dell'algoritmo

1° Iterazione

$OldOut[BB1] = u$
$In[BB1] = \emptyset$
$Out[BB1] = [k,2] \cup (\emptyset - \emptyset) = [k,2]$

$OldOut[BB2] = u$
$In[BB2] = [k,2]$
$Out[BB2] = \emptyset \cup ([k,2] - \emptyset) = [k,2]$

$OldOut[BB3] = u$
$In[BB3] = [k,2]$
$Out[BB3] = \emptyset \cup ([k,2] - \emptyset) = [k,2]$

$OldOut[BB4] = u$
$In[BB4] = [k,2]$
$Out[BB4] = [x,5] \cup ([k,2] - [x,8]) = \{[x,5],[k,2]\}$

$OldOut[BB5] = u$
$In[BB5] = [k,2]$
$Out[BB5] = \emptyset \cup ([k,2] - \emptyset) = [k,2]$

$OldOut[BB6] = u$
$In[BB6] = [k,2]$
$Out[BB6] = [x,8] \cup ([k,2] - [x,5]) = \{[x,8],[k,2]\}$

$OldOut[BB7] = u$
$In[BB7] = Out[BB4] \cap Out[BB6] =$
$= \{[x,8],[k,2]\} \cap \{[x,5],[k,2]\} = [k,2]$
$Out[BB7] = \emptyset \cup ([k,2] - [k,2]) = \emptyset$

$OldOut[BB8] = u$
$In[BB8] = Out[BB12] \cap Out[BB7] = \emptyset$
$Out[BB8] = \emptyset \cup (\emptyset - \emptyset) = \emptyset$

$OldOut[BB9] = u$
$In[BB9] = \emptyset$
$Out[BB9] = [b,2] \cup (\emptyset - \emptyset) = [b,2]$

$OldOut[BB10] = u$
$In[BB10] = [b,2]$
$Out[BB10] = \emptyset \cup ([b,2] - [x,5], [x,8]) = [b,2]$

$OldOut[BB11] = u$

2° Iterazione

$OldOut[BB1] = [k,2]$
$In[BB1] = \emptyset$
$Out[BB1] = [k,2] \cup (\emptyset - \emptyset) = [k,2]$

$OldOut[BB2] = [k,2]$
$In[BB2] = [k,2]$
$Out[BB2] = \emptyset \cup ([k,2] - \emptyset) = [k,2]$

$OldOut[BB3] = [k,2]$
$In[BB3] = [k,2]$
$Out[BB3] = \emptyset \cup ([k,2] - \emptyset) = [k,2]$

$OldOut[BB4] = \{[x,5],[k,2]\}$
$In[BB4] = [k,2]$
$Out[BB4] = [x,5] \cup ([k,2] - [x,8]) = \{[x,5],[k,2]\}$

$OldOut[BB5] = [k,2]$
$In[BB5] = [k,2]$
$Out[BB5] = \emptyset \cup ([k,2] - \emptyset) = [k,2]$

$OldOut[BB6] = \{[x,8],[k,2]\}$
$In[BB6] = [k,2]$
$Out[BB6] = [x,8] \cup ([k,2] - [x,5]) = \{[x,8],[k,2]\}$

$OldOut[BB7] = \emptyset$
$In[BB7] = Out[BB4] \cap Out[BB6] =$
$= \{[x,8],[k,2]\} \cap \{[x,5],[k,2]\} = [k,2]$
$Out[BB7] = \emptyset \cup ([k,2] - [k,2]) = \emptyset$

$OldOut[BB8] = \emptyset$
$In[BB8] = Out[BB12] \cap Out[BB7] = \emptyset$
$Out[BB8] = \emptyset \cup (\emptyset - \emptyset) = \emptyset$

$OldOut[BB9] = [b,2]$
$In[BB9] = \emptyset$
$Out[BB9] = [b,2] \cup (\emptyset - \emptyset) = [b,2]$

$OldOut[BB10] = [b,2]$
$In[BB10] = [b,2]$
$Out[BB10] = \emptyset \cup ([b,2] - [x,5], [x,8]) = [b,2]$

$OldOut[BB11] = [b,2]$

$In[BB11] \; = \; [b,2]$
$Out[BB11] \; = \; \emptyset \; \cup \; ([b,2] \; - \emptyset) \; = \; [b,2]$

$OldOut[BB12] \; = u$
$In[BB12] \; = \; [b,2]$
$Out[BB12] \; = \; \emptyset \; \cup \; ([b,2] \; - \; [k,2]) \; = \; [b,2]$

$OldOut[BB13] \; = u$
$In[BB13] \; = \; \emptyset$
$Out[BB13] \; = \; \emptyset \; \cup \; (\emptyset - \emptyset) \; = \emptyset$

$In[BB11] \; = \; [b,2]$
$Out[BB11] \; = \; \emptyset \; \cup \; ([b,2] \; - \emptyset) \; = \; [b,2]$

$OldOut[BB12] \; = [b,2]u$
$In[BB12] \; = \; [b,2]$
$Out[BB12] \; = \; \emptyset \; \cup \; ([b,2] \; - \; [k,2]) \; = \; [b,2]$

$OldOut[BB13] \; = \emptyset$
$In[BB13] \; = \; \emptyset$
$Out[BB13] \; = \; \emptyset \; \cup \; (\emptyset - \emptyset) \; = \emptyset$