

# Dataflow Analysis

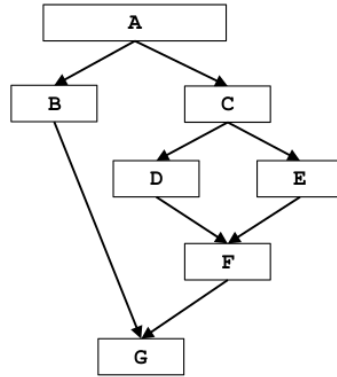
Matteo Lugli, Carlo Uguzzoni

## Dominator Analysis

### Example 1

Table 1:  $\text{Gen}_b = \{b\}$ ,  $\text{Kill}_b = \emptyset$

Dominator Analysis	
<b>Domain</b>	Basic Blocks
<b>Direction</b>	Forward
<b>Framework</b>	$\text{out}[b] = f_b(\text{in}[b])$ $\text{in}[b] = \cap \text{out}[\text{pred}(b)]$
<b>Transfer function</b>	$f_b(x) = \text{Gen}_b \cup (x - \text{kill}_b)$
<b>Meet operation</b>	$\cap$
<b>Boundary Condition</b>	$\text{in}[\text{entry}] = \text{entry}$
<b>Initial interior points</b>	$\text{out}[b] = U$

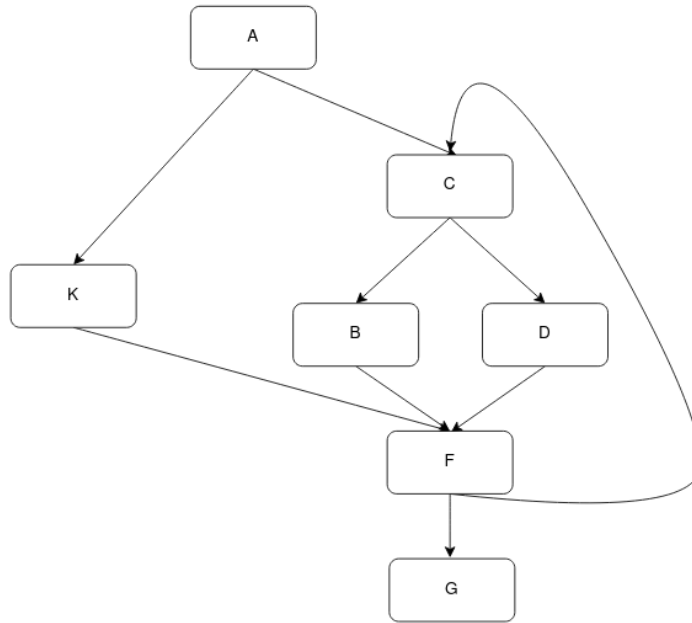


Iter 1<sup>1</sup>

	In	Out
<b>A</b>	<0000000>	<1000000>
<b>B</b>	<1000000>	<1100000>
<b>C</b>	<1000000>	<1010000>
<b>D</b>	<1010000>	<1011000>
<b>E</b>	<1010000>	<1010100>
<b>F</b>	<1010000>	<1010010>
<b>G</b>	<1000000>	<1000001>

<sup>1</sup>initialization is not considered as an iteration.

## Example 2



Iteration 1 <sup>2</sup>

	In	Out
<b>A</b>	$\{\emptyset\}$	$\{A\}$
<b>C</b>	$\{A\}$	$\{C,A\}$
<b>B</b>	$\{C,A\}$	$\{C,A,B\}$
<b>D</b>	$\{C,A\}$	$\{C,A,D\}$
<b>F</b>	$\{A\}$	$\{F,A\}$
<b>G</b>	$\{F,A\}$	$\{F,A,G\}$
<b>K</b>	$\{A\}$	$\{A,K\}$

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<sup>2</sup>initialization is not considered as an iteration.

# Very busy expression analysis

## Example 1

In this example, we assume that each BB contains just 1 expression, as showed in the graph.

	Very busy expression
<b>Domain</b>	Expressions
<b>Direction</b>	Backwards
<b>Framework</b>	$\text{in}[b] = f_b(\text{out}[b])$ $\text{out}[b] = \cap \text{in}[\text{succ}[(b)]$
<b>Direction</b>	Backwards
<b>Transfer function</b>	$f_b(x) = \text{Gen}_b \cup (x - \text{Kill}_b)$
<b>Meet Operation</b>	$\cap$
<b>Boundary condition</b>	$\text{in}[\text{exit}] = \emptyset$
<b>Initial interior points</b>	$\text{in}[b] = U$

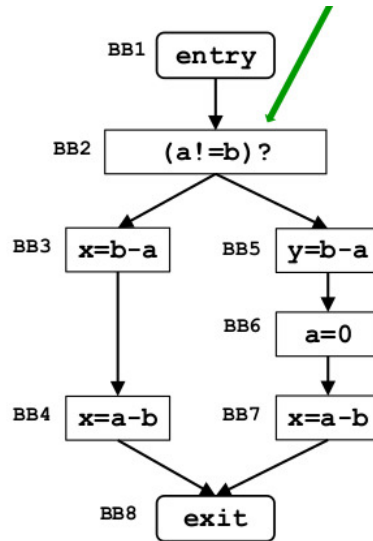


Figure 1:  $\text{Gen}_b$  = expressions evaluated in  $b$ ,  $\text{Kill}_b$  = every expression that contains a operand that is defined in  $b$

## Iteration 1 <sup>3</sup>

Expressions:

1.  $a \neq b$
2.  $b - a$
3.  $a - b$

BB	OUT	IN
8	000	000
7	000	001
4	000	001
6	001	000 <sup>4</sup>
5	000	010
3	001	011
2	010	110
1	110	110

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<sup>3</sup>initialization is not considered as an iteration.

<sup>4</sup> $a - b$  gets killed

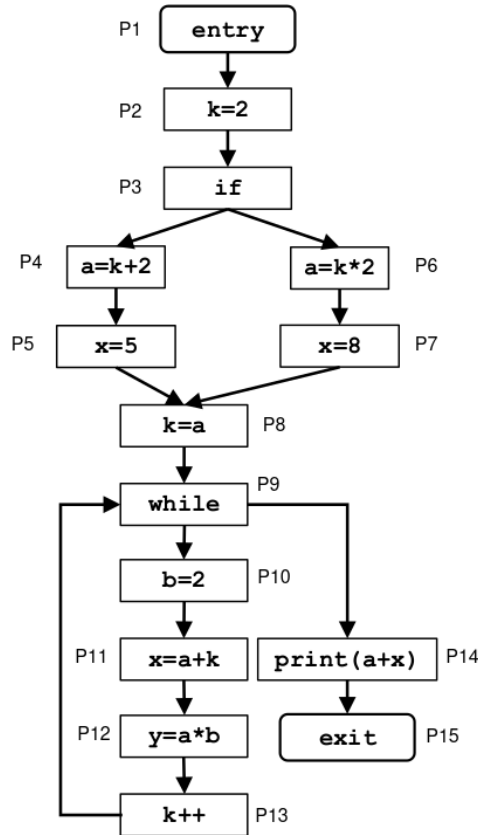
# Costant propagation analysis

## Example 1

In this example, we assume that each BB contains only 1 expression, as showed in the graph.

Table 2:  $\text{Gen}_b = (\text{lhs}, c)$  if operand is costant for each operand in rhs,  $\text{Kill}_b = (\text{lhs}, *)$

	Constant Propagation
<b>Domain</b>	couples (val, costant)
<b>Direction</b>	Forward
<b>Framework</b>	$\text{out}[b] = f_b(\text{in}[b])$ $\text{in}[b] = \cap \text{out}[\text{pred}(b)]$
<b>Transfer function</b>	$f_b(x) = \text{Gen}_b \cup (x - \text{kill}_b)$
<b>Meet operation</b>	$\cap$
<b>Boundary Condition</b>	$\text{in}[\text{entry}] = \emptyset$
<b>Initial interior points</b>	$\text{out}[b] = U$



## Iteration 1 <sup>5</sup>

Point	IN	OUT
P1	$\emptyset$	$\emptyset$
P2	$\emptyset$	(k:2)
P3	(k:2)	(k:2)
P4	(k:2)	(k:2),(a:4)
P5	(k:2),(a:4)	(k:2),(a:4),(x:5)
P6	(k:2)	(k:2),(a:4)
P7	(k:2),(a:4)	(k:2),(a:4),(x:8)
P8	(k:2),(a:4)	(k:4),(a:4)
P9	(k:4),(a:4)	(k:4),(a:4)
P10	(k:4),(a:4)	(k:4),(a:4),(b:2)
P11	(k:4),(a:4),(b:2)	(k:4),(a:4),(b:2),(x:8)
P12	(k:4),(a:4),(b:2),(x:8)	(k:4),(a:4),(b:2),(x:8),(y:8)
P13	(k:4),(a:4),(b:2),(x:8), (y:8)	<del>(k:4)</del> <b>(k:5),(a:4),(b:2),(x:8),(y:8)</b>
P14	(k:4),(a:4)	(k:4),(a:4)
P15	(k:4),(a:4)	(k:4),(a:4)

## Iteration 2

Point	IN	OUT
P1	$\emptyset$	$\emptyset$
P2	$\emptyset$	(k:2)
P3	(k:2)	(k:2)
P4	(k:2)	(k:2),(a:4)
P5	(k:2),(a:4)	(k:2),(a:4),(x:5)
P6	(k:2)	(k:2),(a:4)
P7	(k:2),(a:4)	(k:2),(a:4),(x:8)
P8	(k:2),(a:4)	(k:4),(a:4)
P9	<b>(a:4)</b>	(a:4)
P10	(a:4)	(a:4),(b:2)
P11	(a:4),(b:2)	(a:4),(b:2)
P12	(a:4),(b:2)	(a:4),(b:2),(y:8)
P13	(a:4),(b:2),(y:8)	(a:4),(b:2),(y:8)
P14	(a:4)	(a:4)
P15	(a:4)	(a:4)

<sup>5</sup>a  $\rightarrow$  10000, b  $\rightarrow$  01000, k  $\rightarrow$  00100, x  $\rightarrow$  00010, y  $\rightarrow$  00001, initialization is not considered as a iteration.