

CS & IT ENGINEERING

Compiler Design

Intermediate code and code optimization

Lecture No. 5



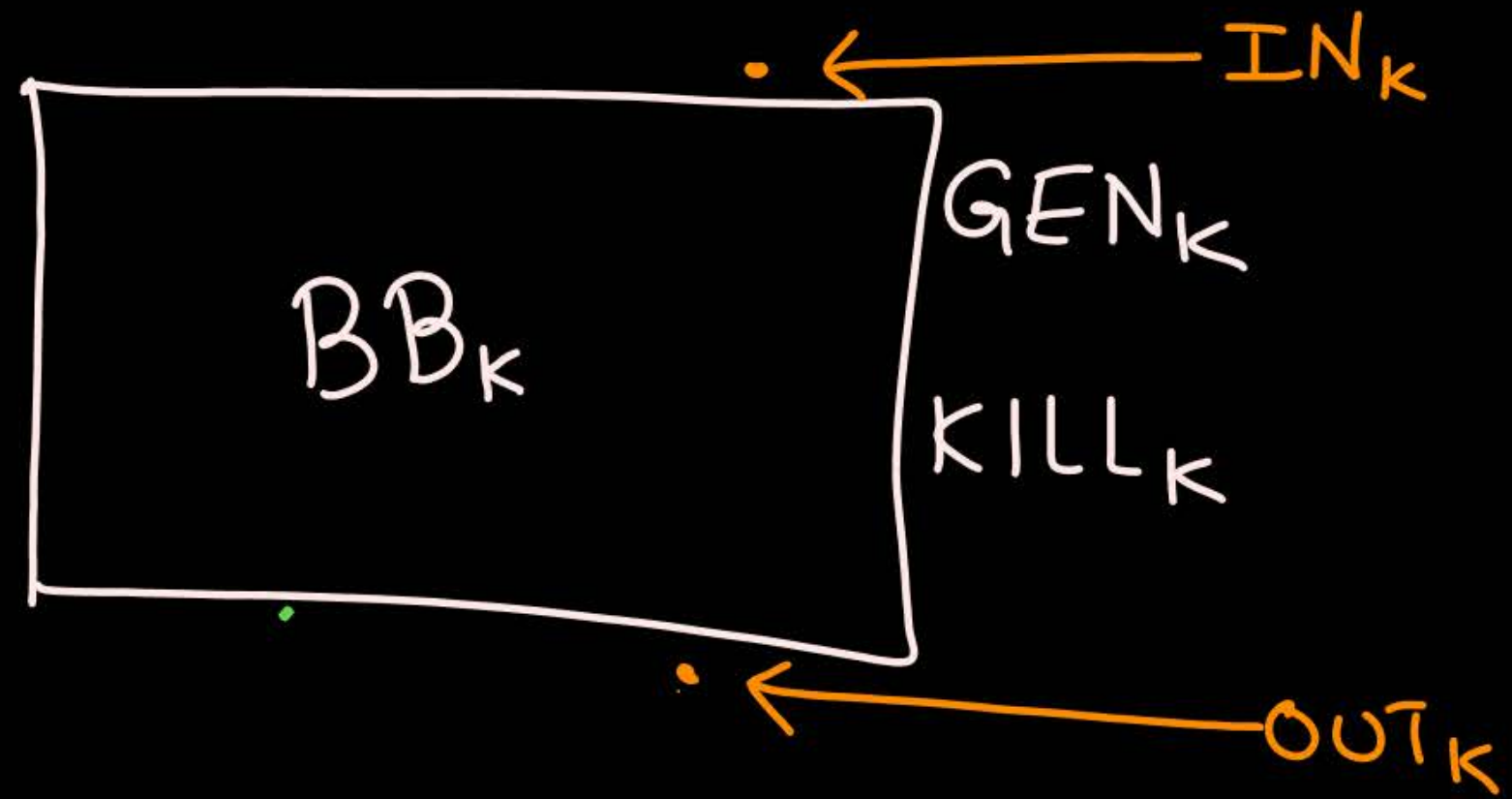
By- DEVA Sir



IN & OUT sets

Livevariable Analysis



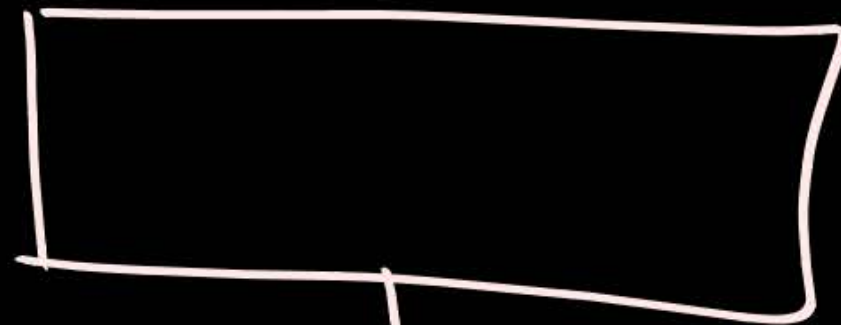


①

How to compute OUT_i for BB_i ?



Last BB_i

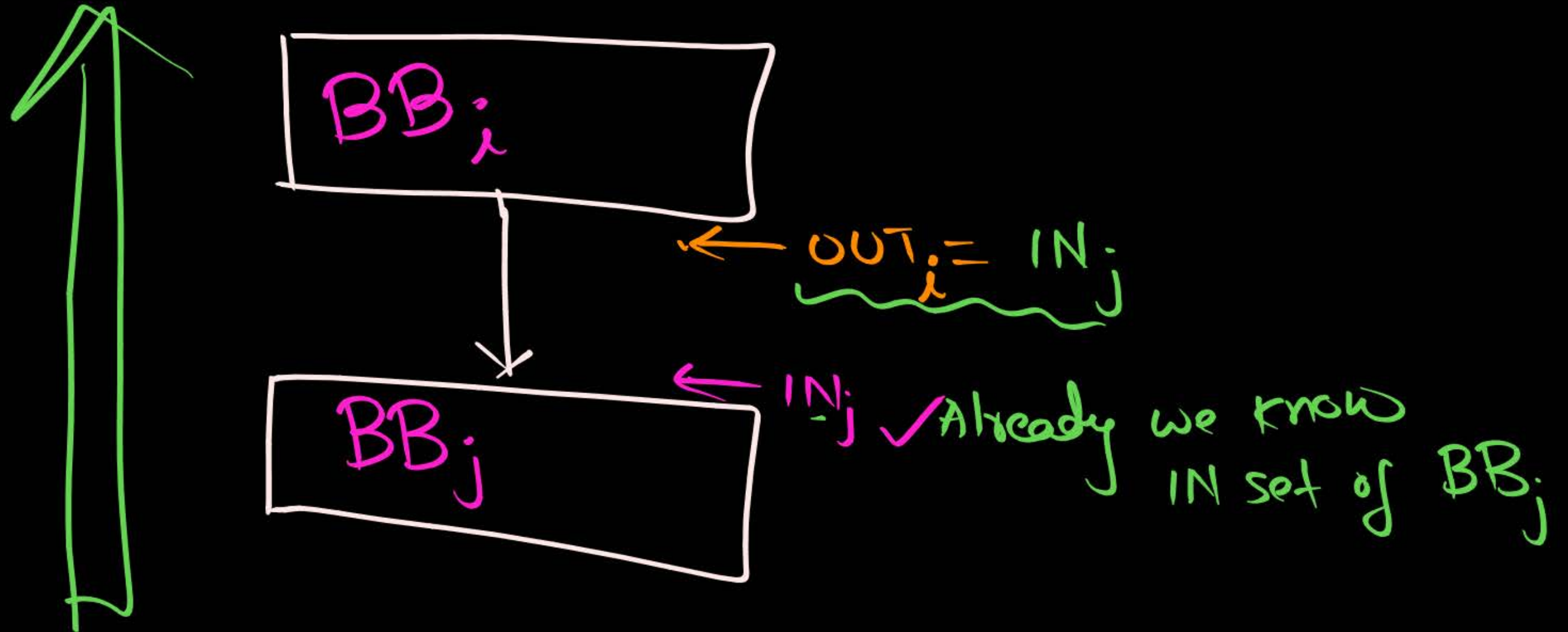


exit

$\leftarrow OUT_i = \emptyset$

II

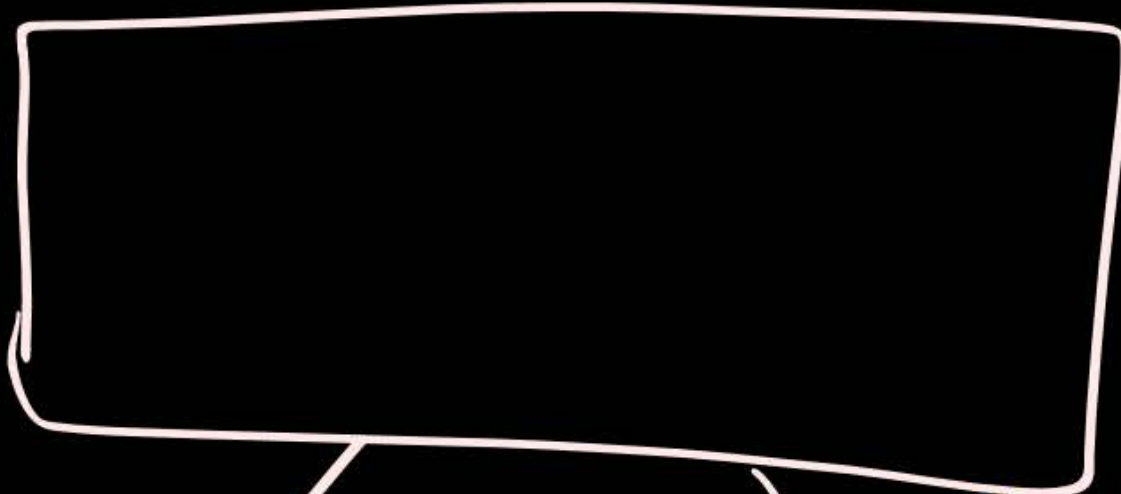
How to compute OUT_i ?



III

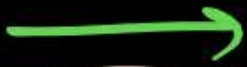


BB_i



$\leftarrow OUT_i = IN_j \cup IN_k$

IN_j

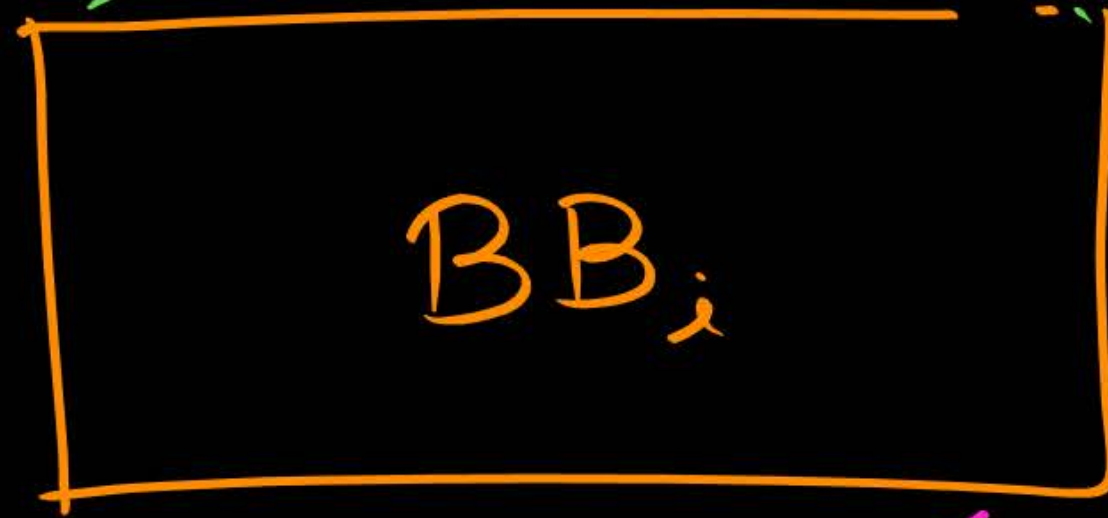


$\leftarrow IN_k$



How to compute IN_i for BB_i ?

$$IN_i = (OUT_i - KILL_i) \cup GEN_i$$



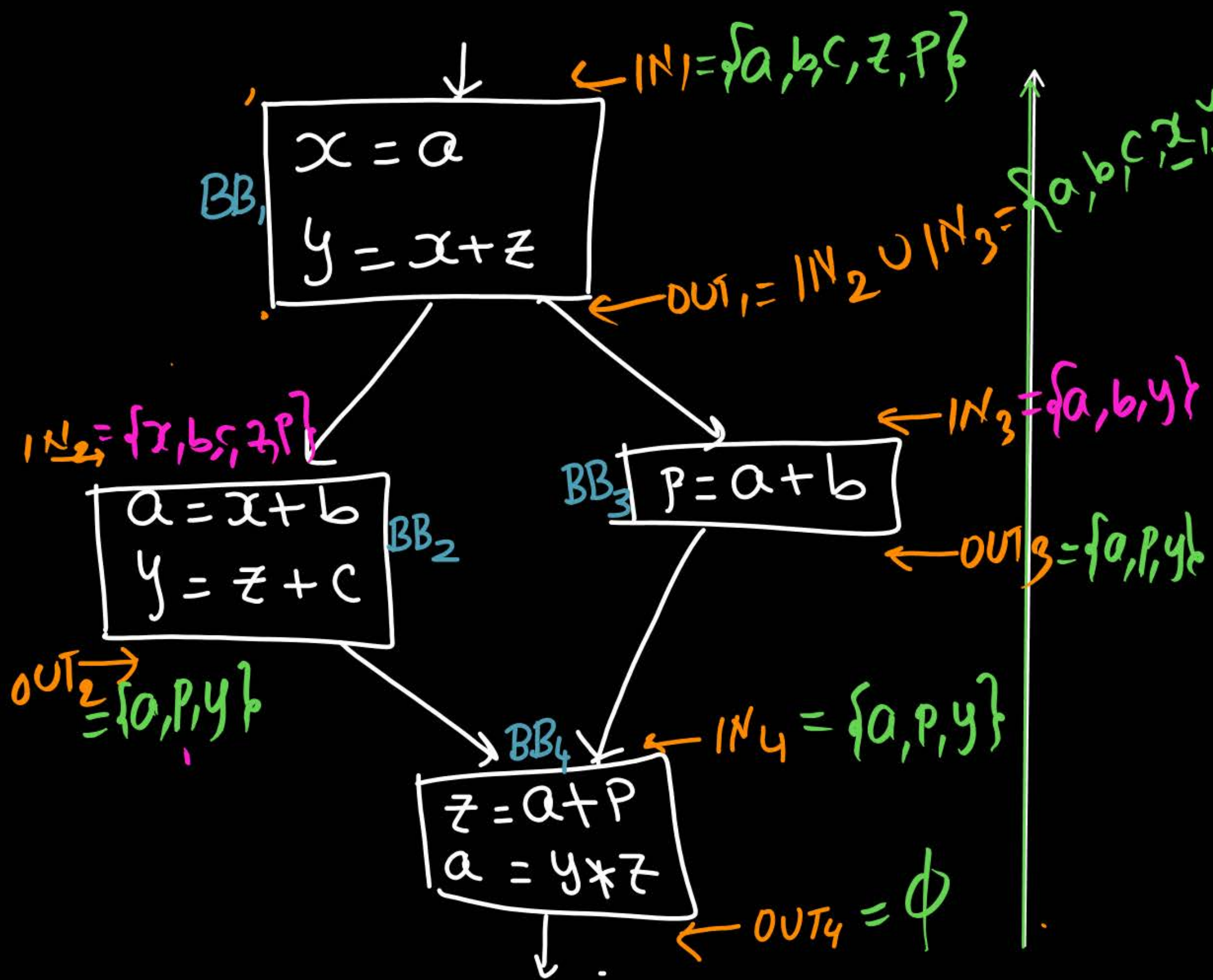
GEN_i
 $KILL_i$
 OUT_i } already computed



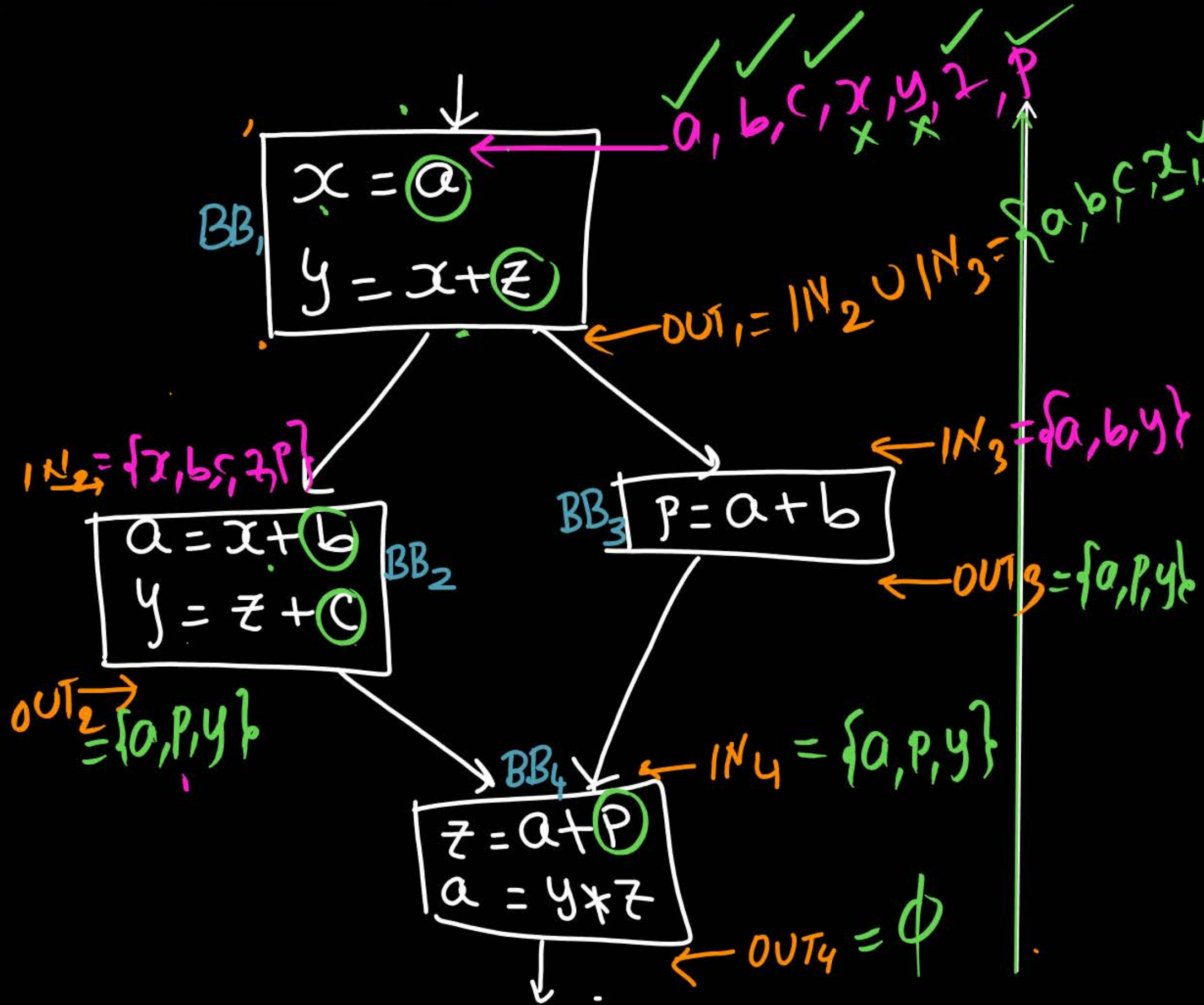
for BB

$$IN Set = (OUT set - KILL set) \cup GEN set$$

$$I = (O - K) \cup G$$

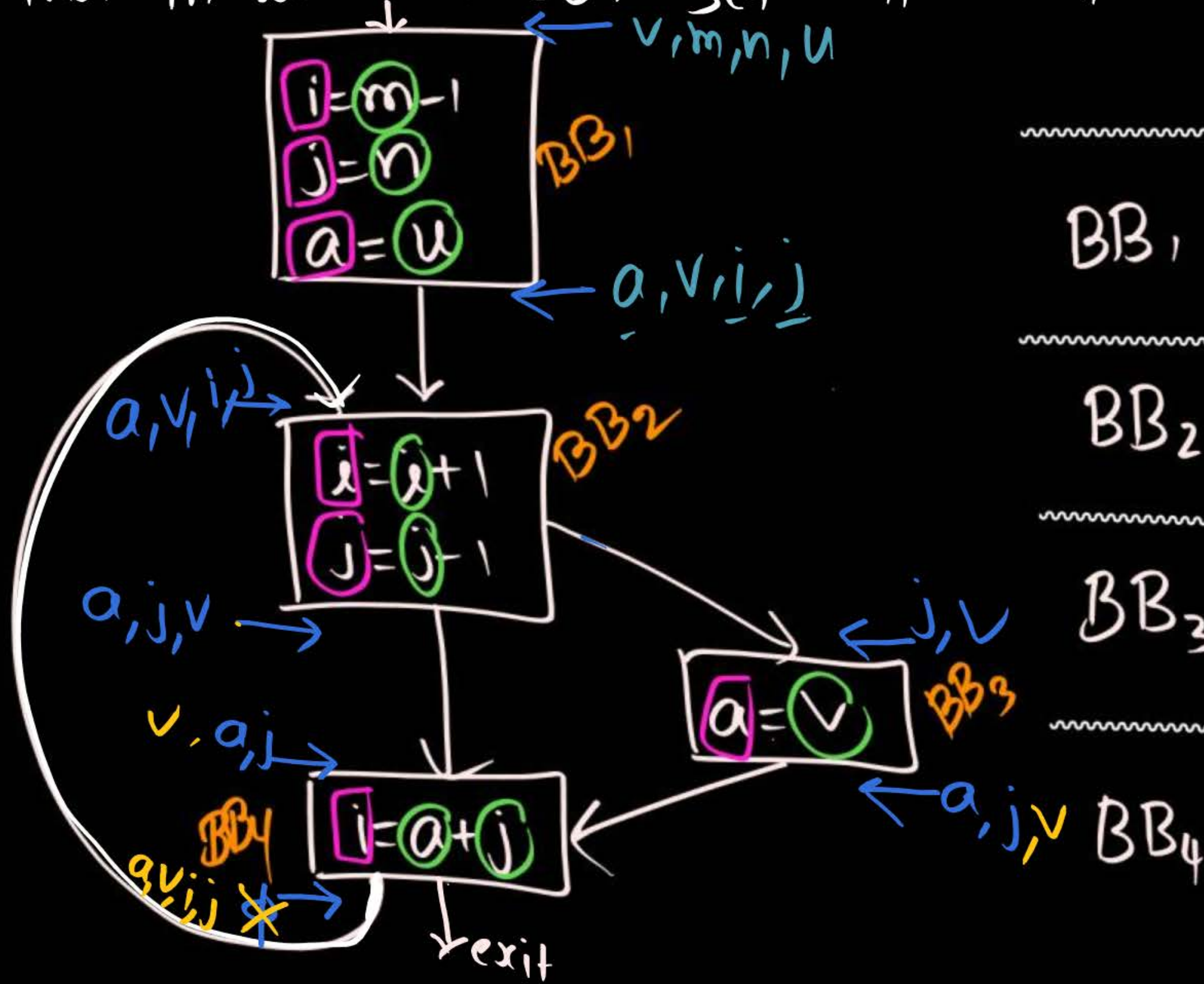


	(USE) GEN	(DEF) KILL
BB ₁	$\{a, z\}$	$\{x, y\}$
BB ₂	$\{x, b, c, z\}$	$\{a, y\}$
BB ₃	$\{a, b\}$	$\{p\}$
BB ₄	$\{a, p, y\}$	$\{a, z\}$



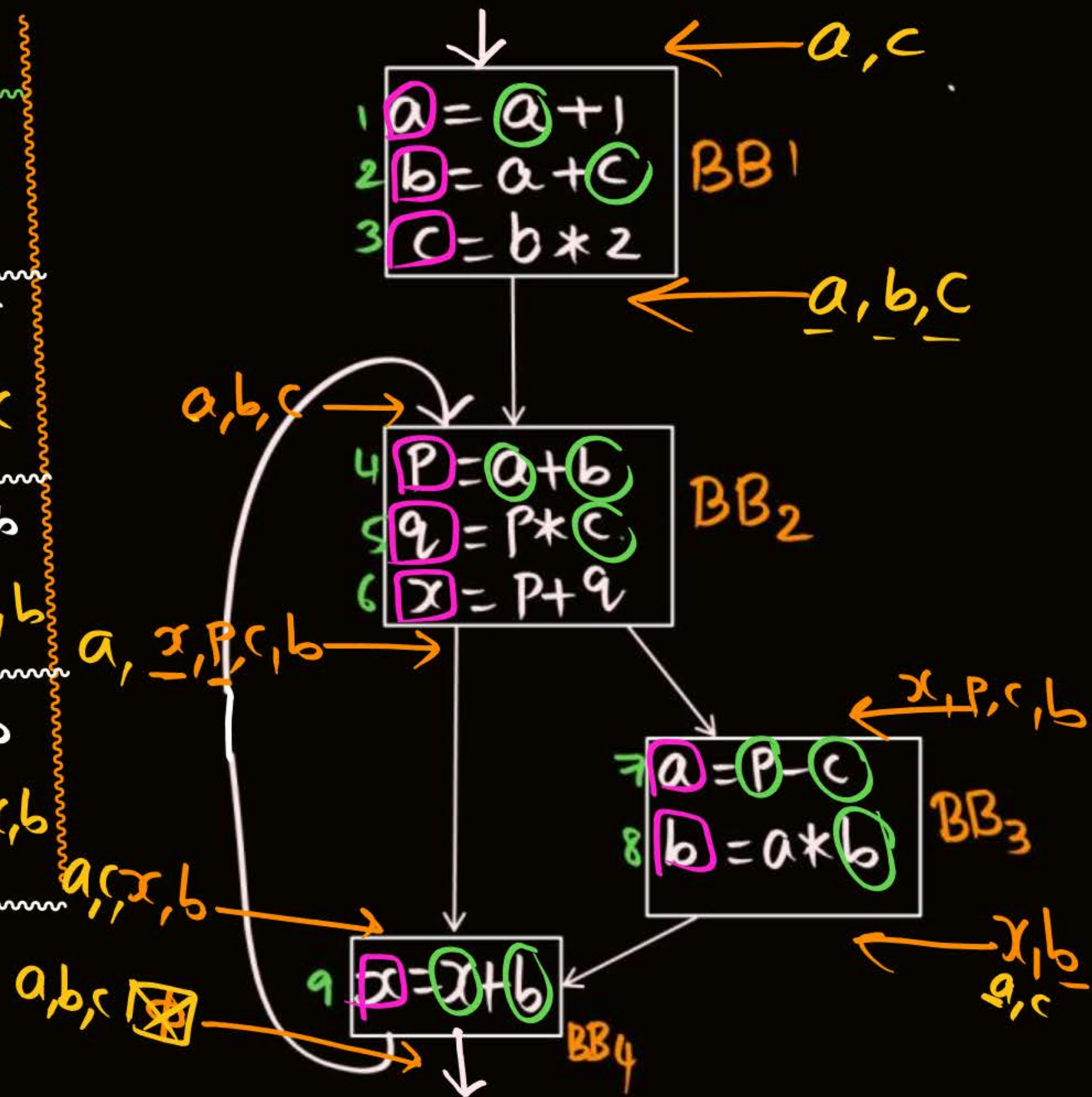
	(USE) GEN	(DEF) KILL
BB ₁	$\{a, z\}$	$\{x, y\}$
BB ₂	$\{x, b, c, z\}$	$\{a, y\}$
BB ₃	$\{a, b\}$	$\{p\}$
BB ₄	$\{a, p, y\}$	$\{a, z\}$

Find GEN^{set} and KILL Set for Every Basic Block
 Find IN set and OUT Set " " " "

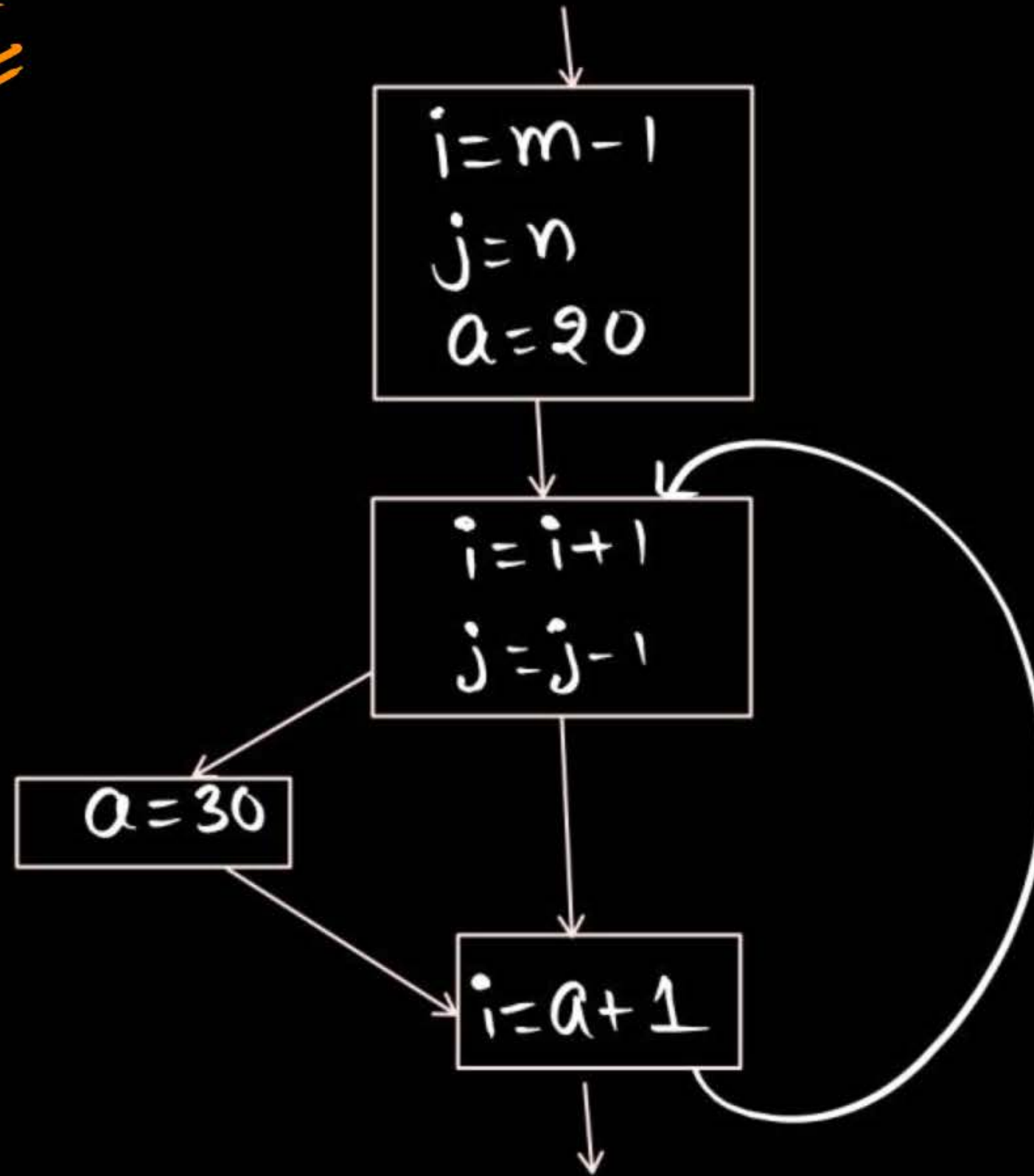


	GEN ^{set}	KILL ^{set}
BB ₁	m, n, u	i, j, a
BB ₂	i, j	i, j
BB ₃	v	a
BB ₄	a, j	i

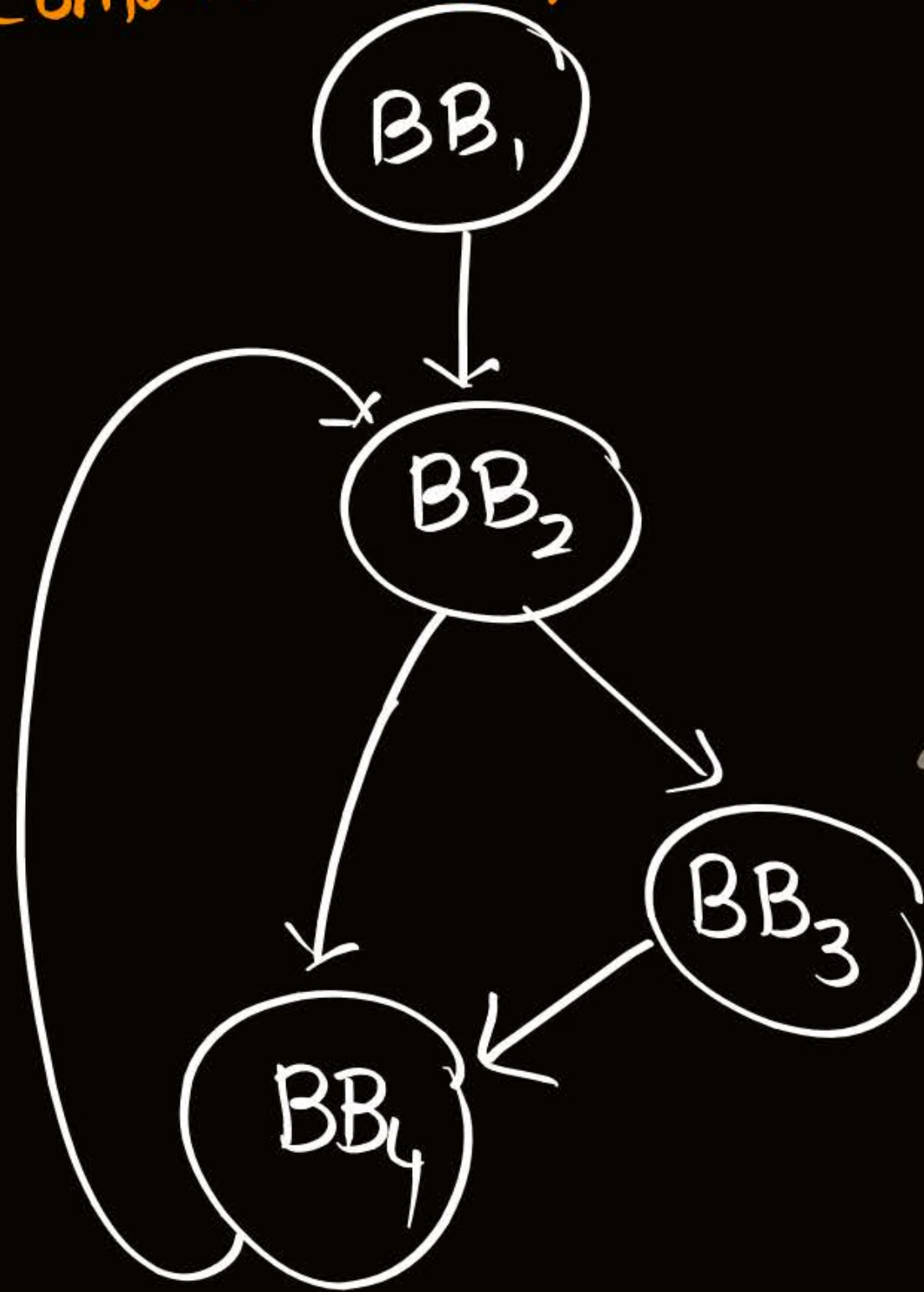
	GEN	KILL	OUT	IN
BB ₁	a, c	a, b, c	a, b, c	a, c
BB ₂	a, b, c	p, q, x	i) x, p, c, b ii) a, x, p, c, b	i) a, b, c ii) a, b, c
BB ₃	p, c, b	a, b	i) x, b ii) a, c, x, b	i) x, p, c, b ii) x, p, c, b
BB ₄	x, b	x	i) ϕ ii) a, b, c	i) x, b ii) a, c, x, b



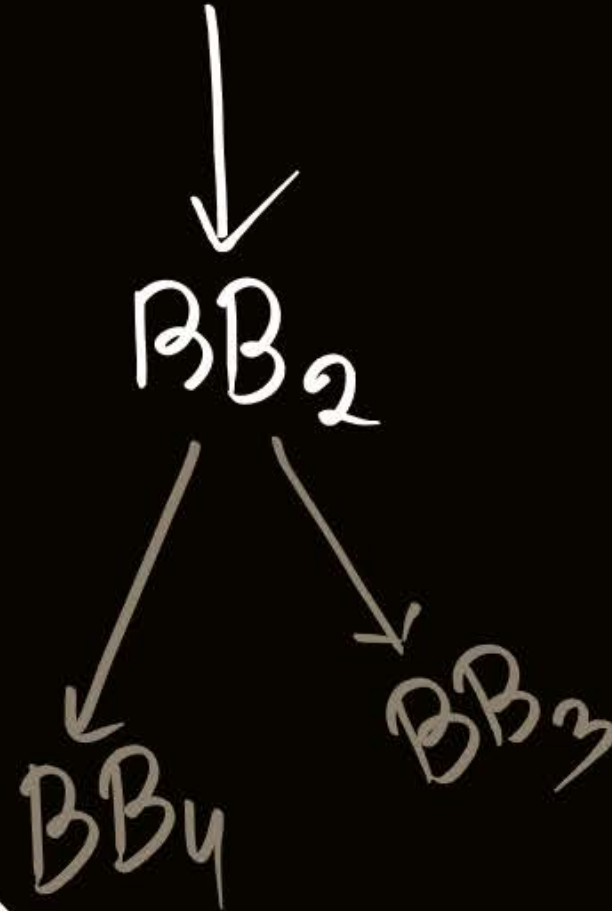
Home Work



Control Flow graph:



Dominator Tree
BB₁

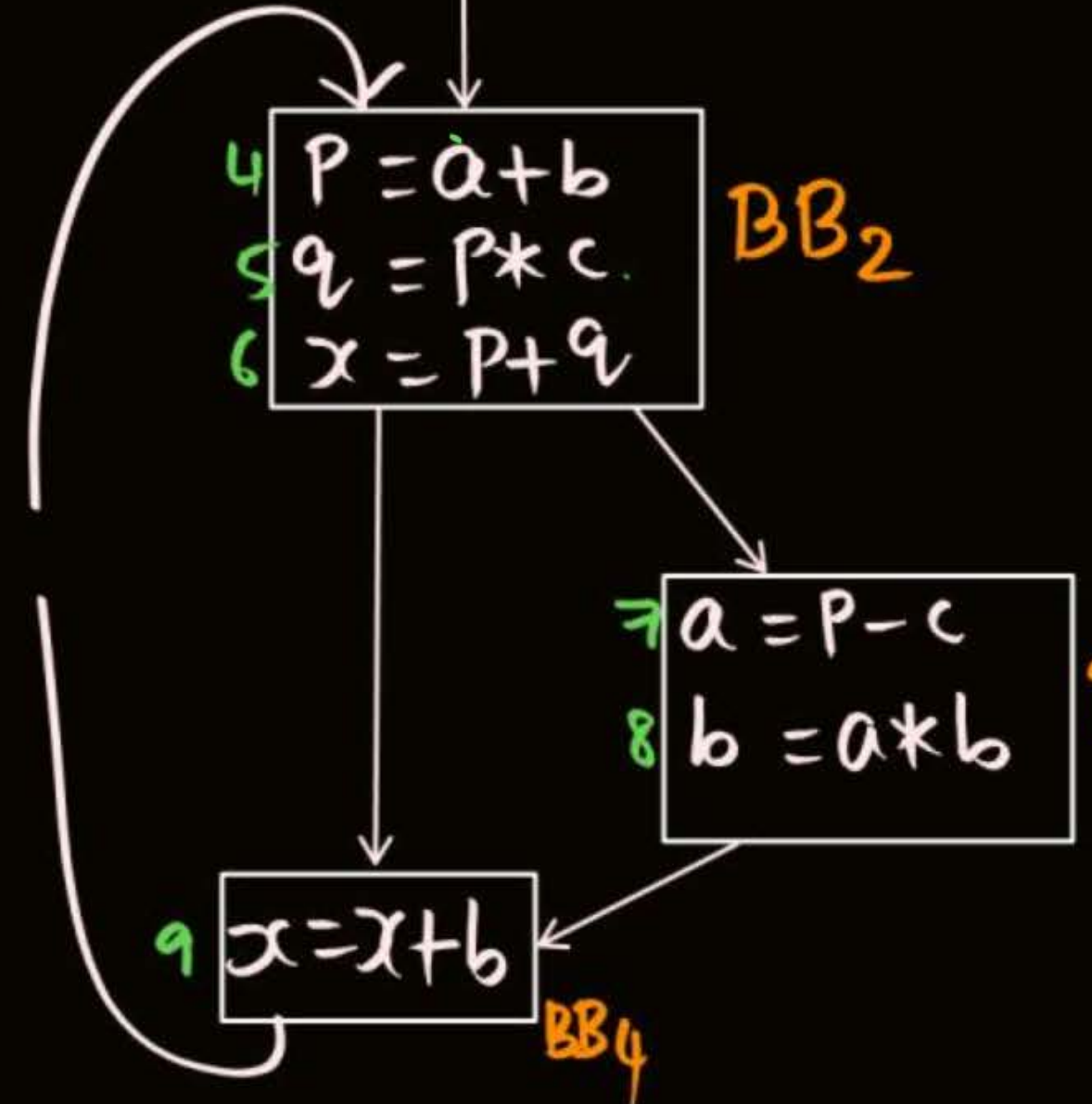


1 $a = a + 1$
2 $b = a + c$
3 $c = b * 2$ BB₁

4 $P = a + b$
5 $q = P * c$
6 $x = P + q$ BB₂

7 $a = P - c$
8 $b = a * b$ BB₃

9 $x = x + b$ BB₄



Dominator Tree

BB_i

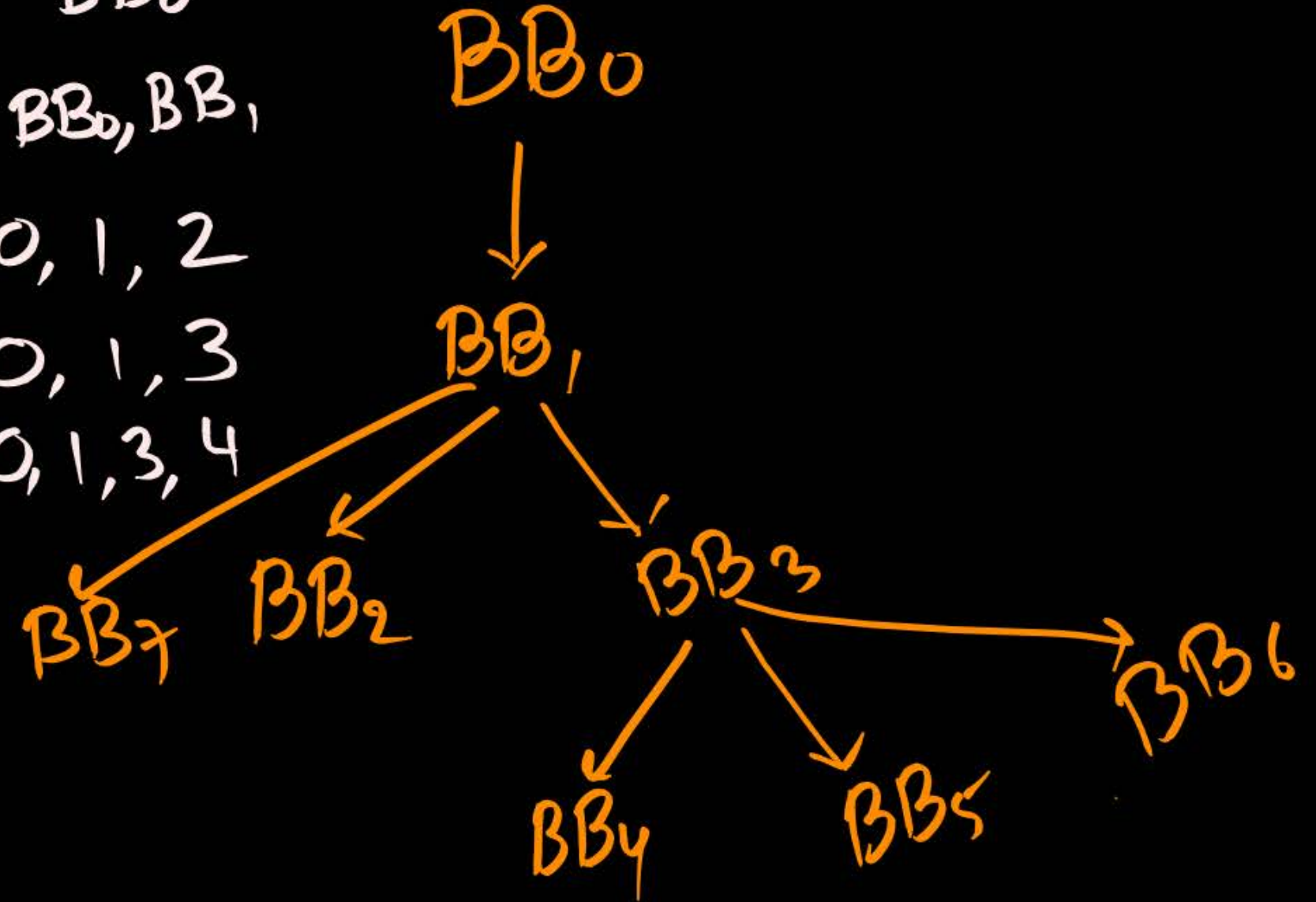
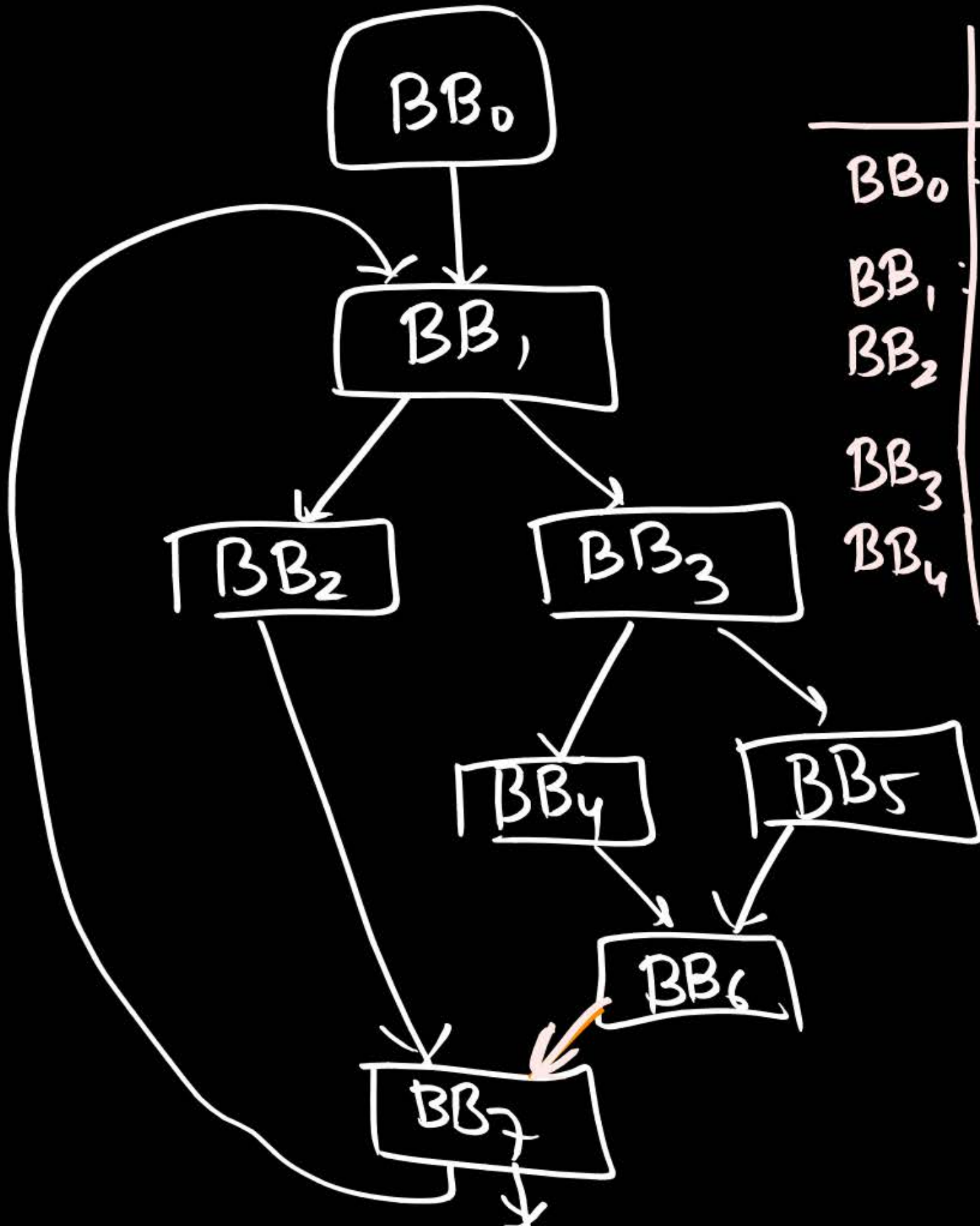


BB_j

include only Basic Blocks
they always present in path

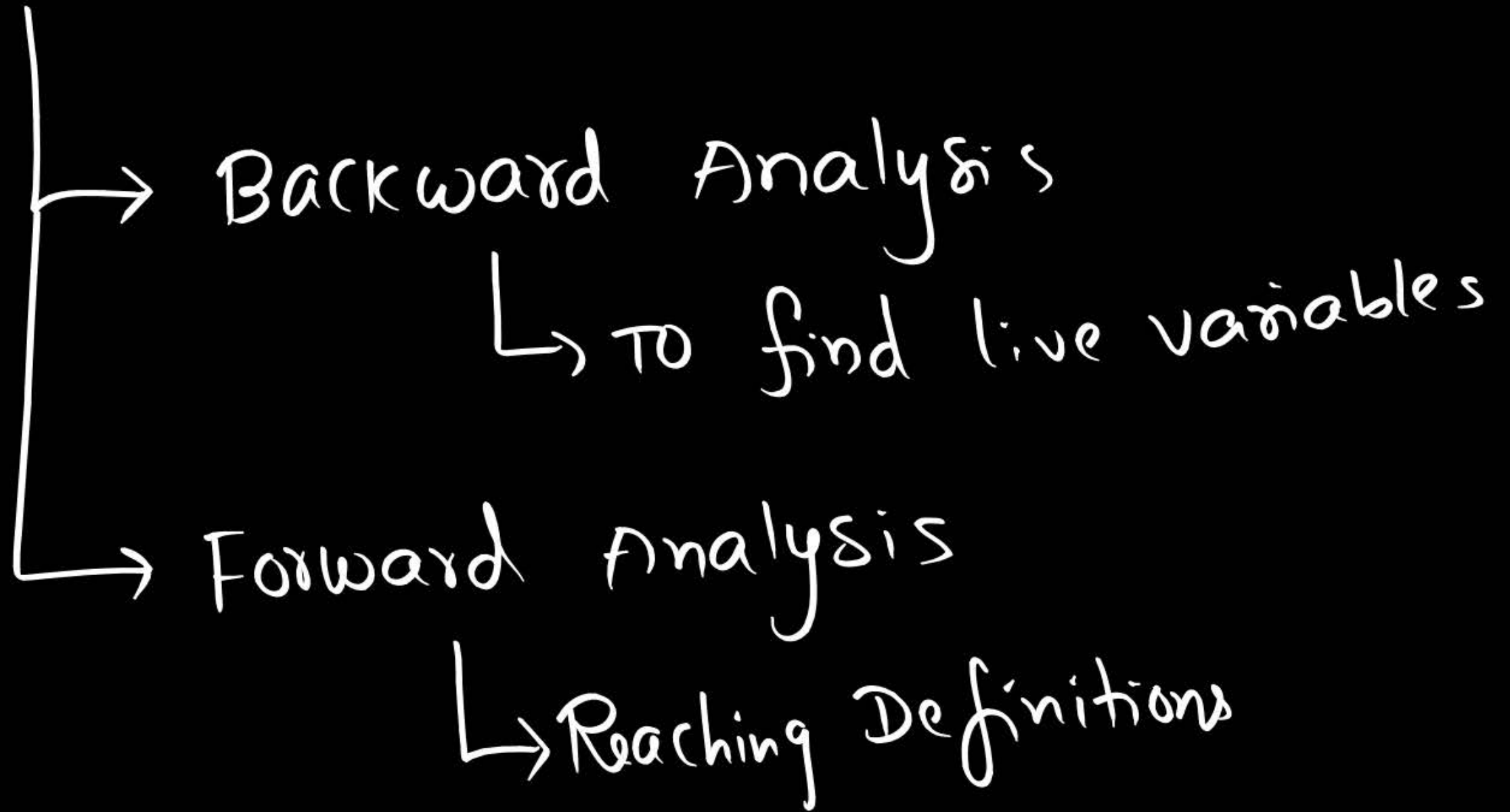
Dominator Tree

Dominator sequence	
BB ₀	BB ₀
BB ₁	BB ₀ , BB ₁
BB ₂	0, 1, 2
BB ₃	0, 1, 3
BB ₄	0, 1, 3, 4





Data Flow Analysis :

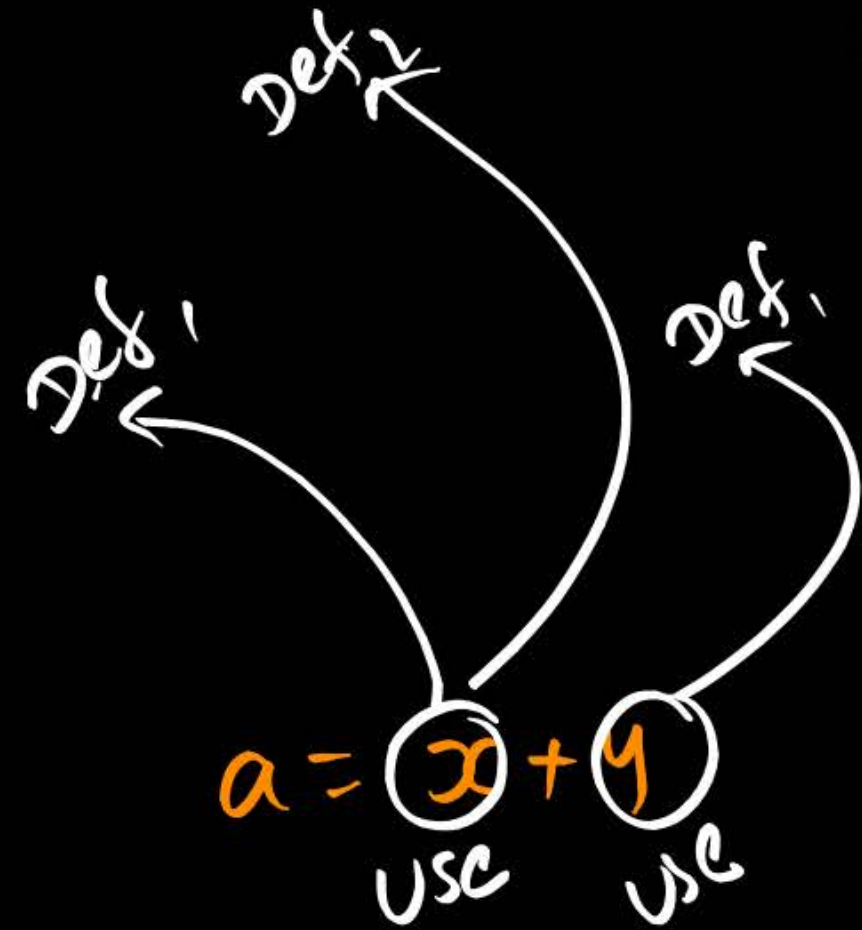
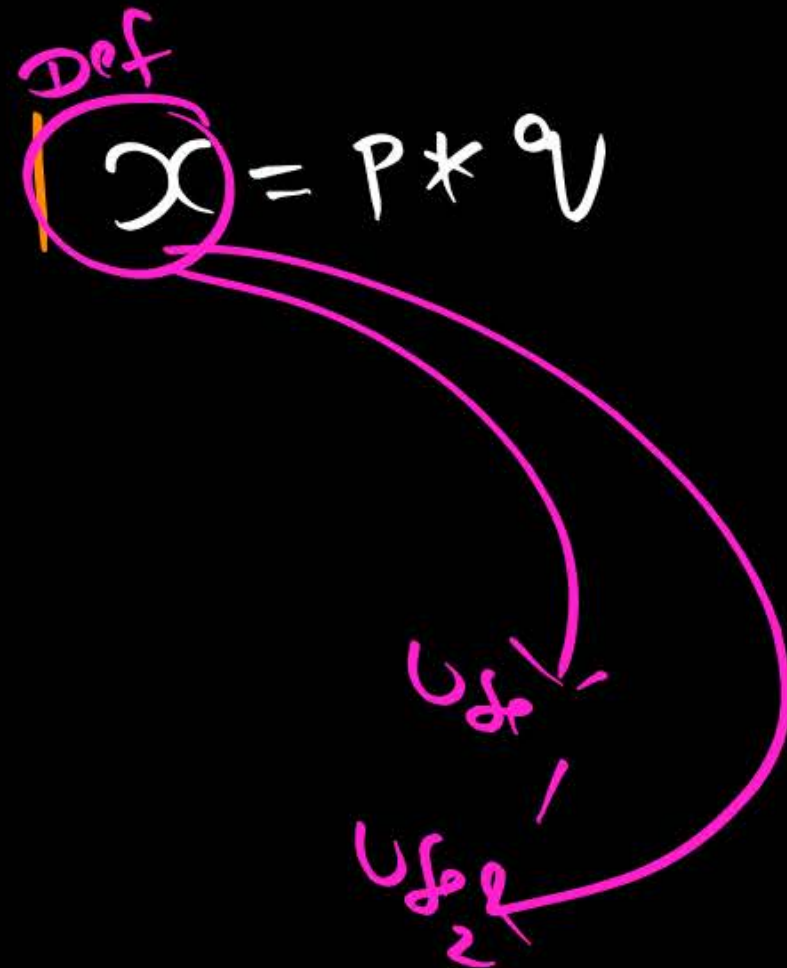


Reaching Definitions Analysis

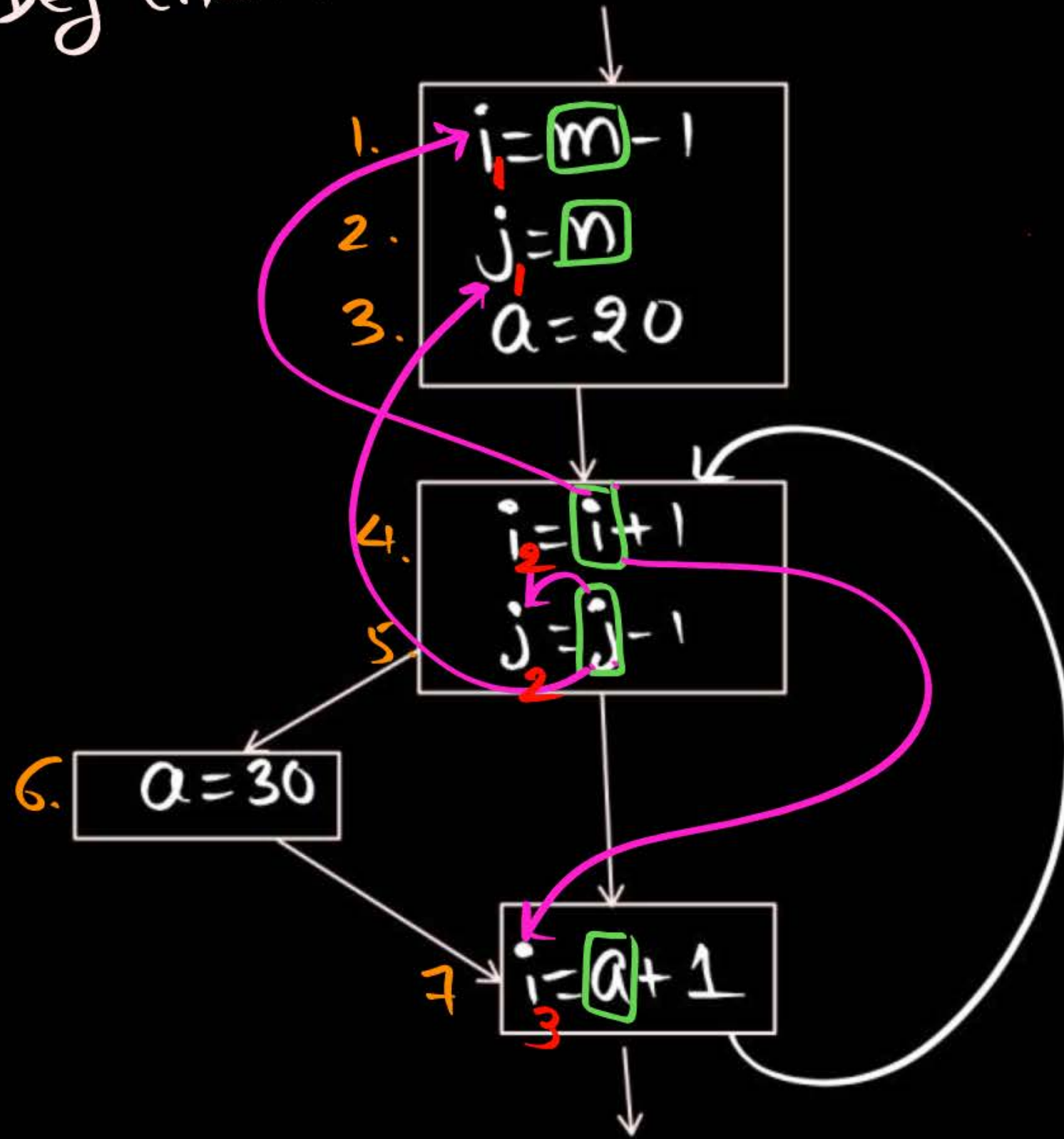


I) **Use**-Def chains

II) **Def**-Use chains



I) Use-Def chains



Statement	Use	Def
4	i	i_1, i_3
5	j	j_1, j_2
		$\phi(i) = \{i_1, i_3\}$
		$\phi(j) = \{j_1, j_2\}$

Use-Def chains

$$\boxed{\begin{array}{l} \boxed{x_1} = a + b \\ a = x - y \end{array}}$$

$$\boxed{\begin{array}{l} \boxed{x_2} = a * d \\ y = x - y \end{array}}$$

$$\boxed{b = \underbrace{x}_{\text{use}} - 7}$$

$$\phi(x) = \{x_1, x_2\}$$

Def - Uses chains

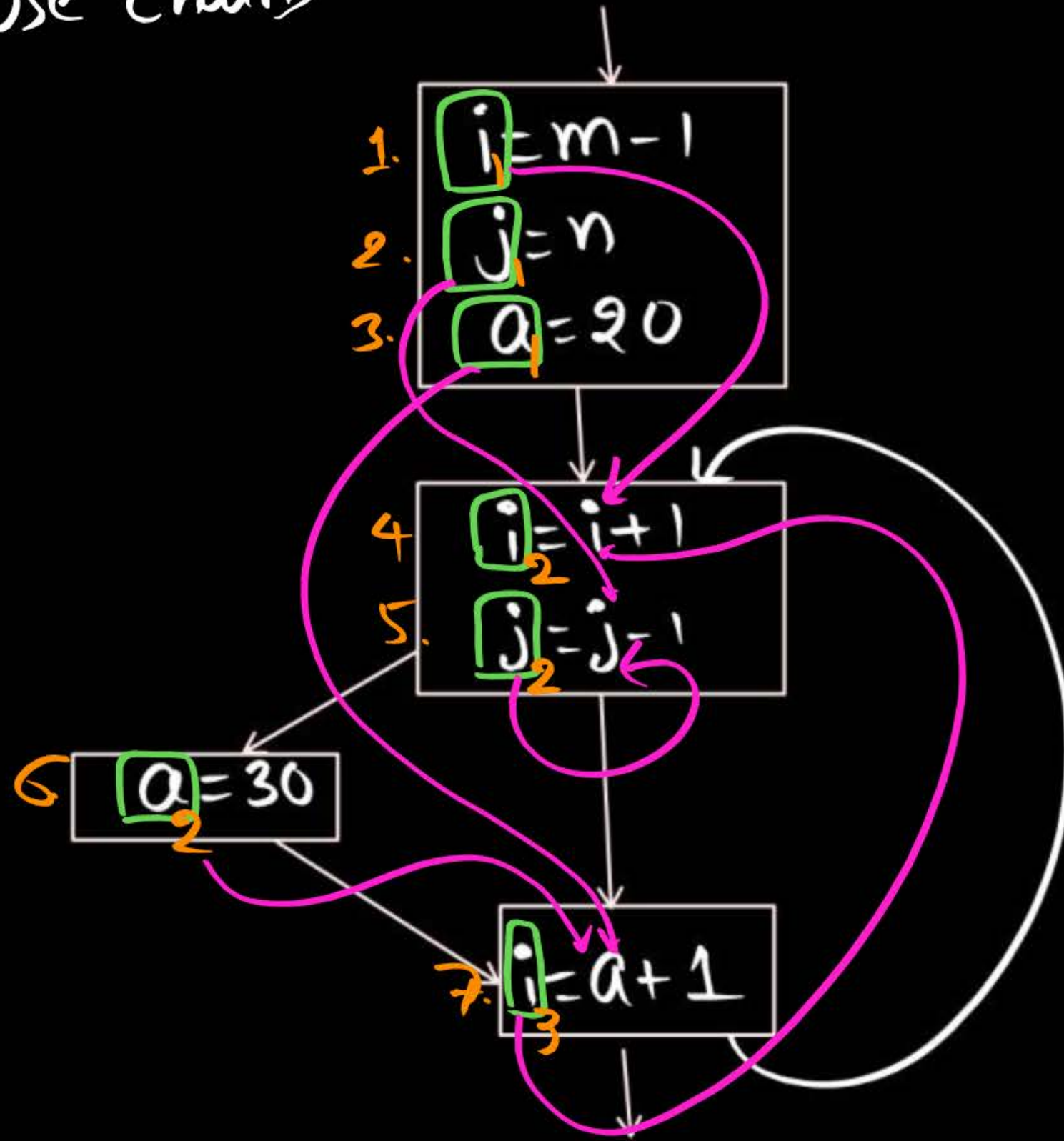
	Def	Uses
1	x	2, 4

definition

1. $x = a + b$
2. $b = x - y$
3. $c = a * b$
4. $z = x - b$

The diagram illustrates the definition of variable x in line 1 and its subsequent uses in lines 2, 3, and 4. A pink box highlights the variable x in the first line, with the word "definition" written above it. Three pink arrows originate from the box: one points to the x in line 2, one points to the x in line 3, and one points to the x in line 4, showing the flow of the definition through the code.

Q2) Def-use chains



	def	uses
1	i	4
2	j	5
3	a	7
4	i	X
5	j	5
6	a	7
7	i	4

Run Time Environments:

