

# Static Single Assignment Form

CMPT 379: Compilers

Instructor: Anoop Sarkar

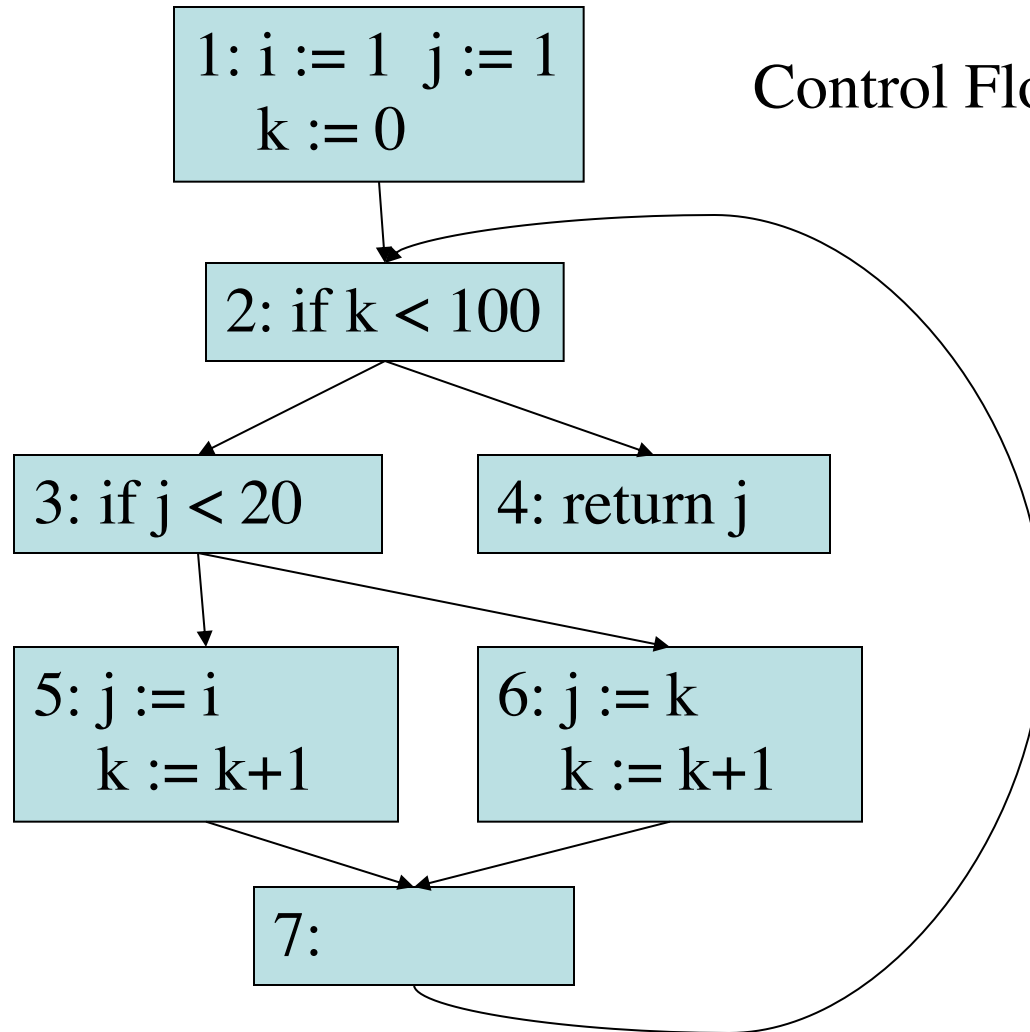
[anoopsarkar.github.io/compilers-class](https://anoopsarkar.github.io/compilers-class)

# Converting to SSA Form

## Program

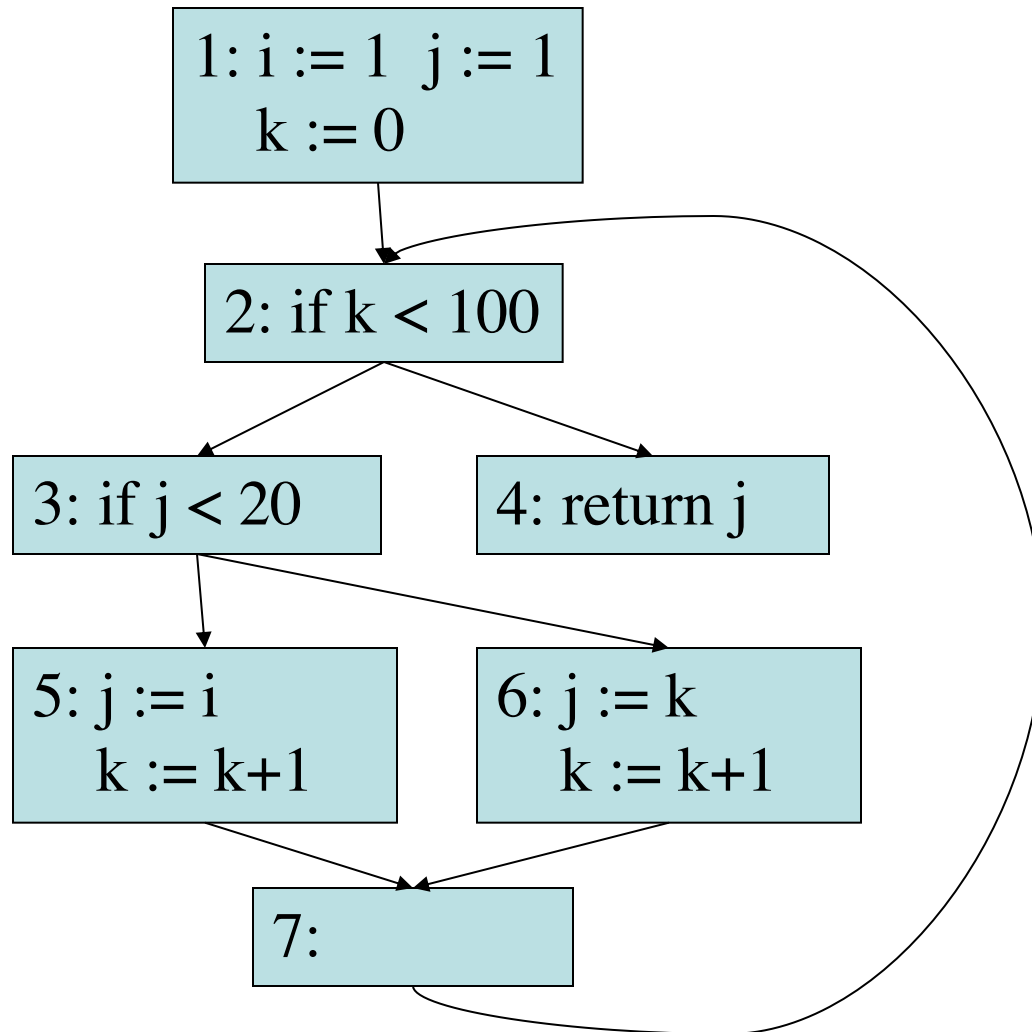
```
i:=1
j:=1
k:=0
while k<100:
  if j < 20:
    j:=i
    k:=k+1
  else:
    j:=k
    k:=k+1
return j
```

## Control Flow Graph



# Converting to SSA Form

## Control Flow Graph



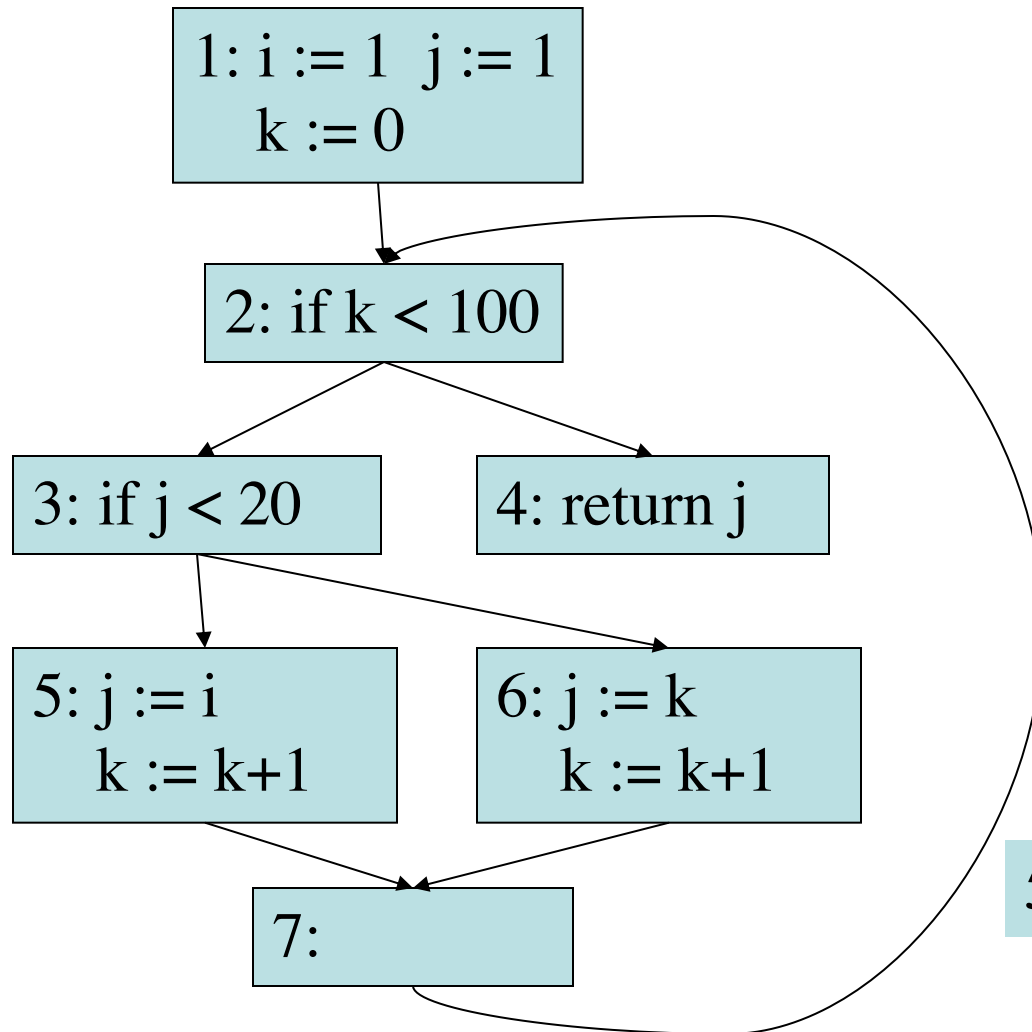
## Dominance Relations

- $D(1) = \{2,3,4,5,6,7\}$
- $D(2) = \{3,4,5,6,7\}$
- $D(3) = \{5,6,7\}$
- $D(4) = \{\}$
- $D(5) = \{\}$
- $D(6) = \{\}$
- $D(7) = \{\}$

## Dominance Relations

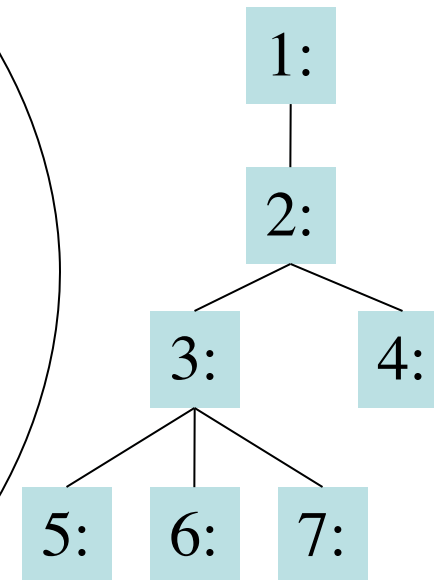
# Converting to SSA Form

## Control Flow Graph



- $D(1) = \{2,3,4,5,6,7\}$
- $D(2) = \{3,4,5,6,7\}$
- $D(3) = \{5,6,7\}$
- $D(4) = \{\}$
- $D(5) = \{\}$
- $D(6) = \{\}$
- $D(7) = \{\}$

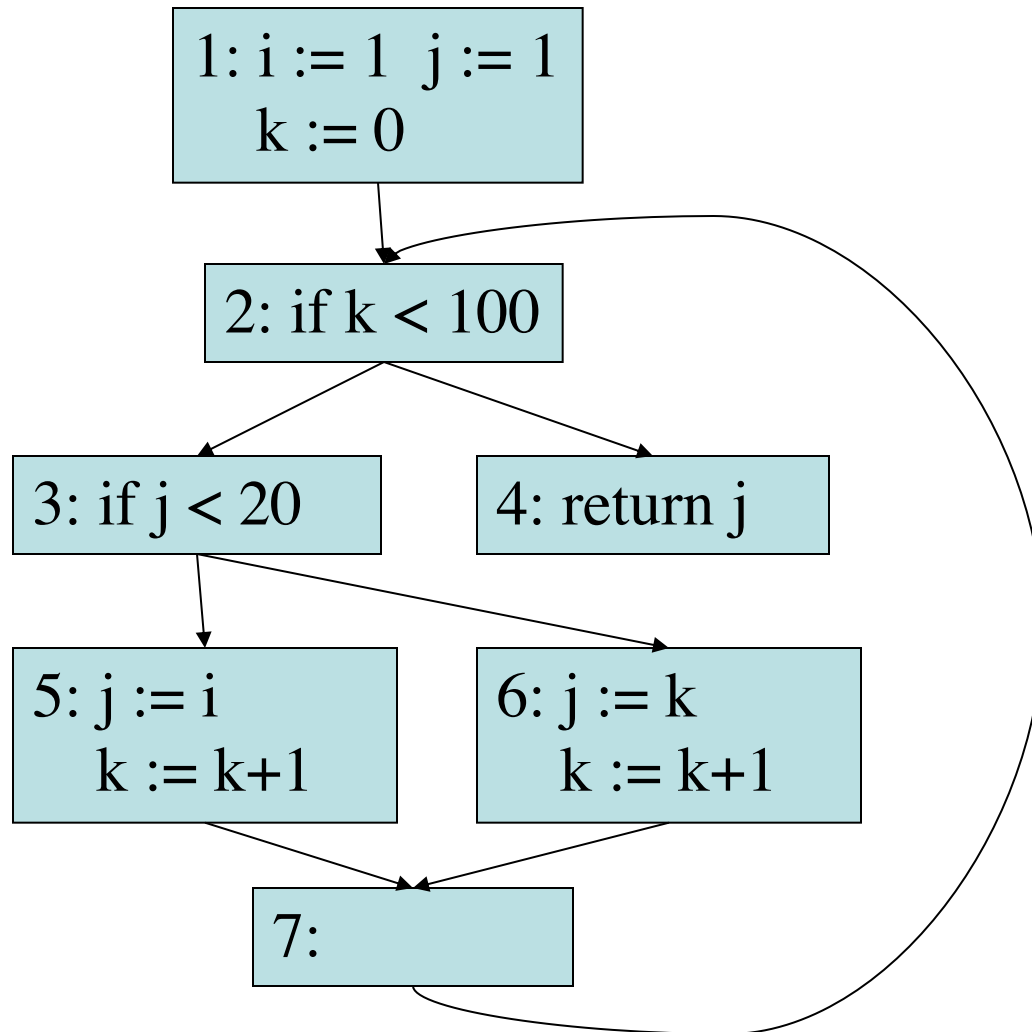
## Dominator Tree



## Dominance Relations

# Converting to SSA

## Control Flow Graph

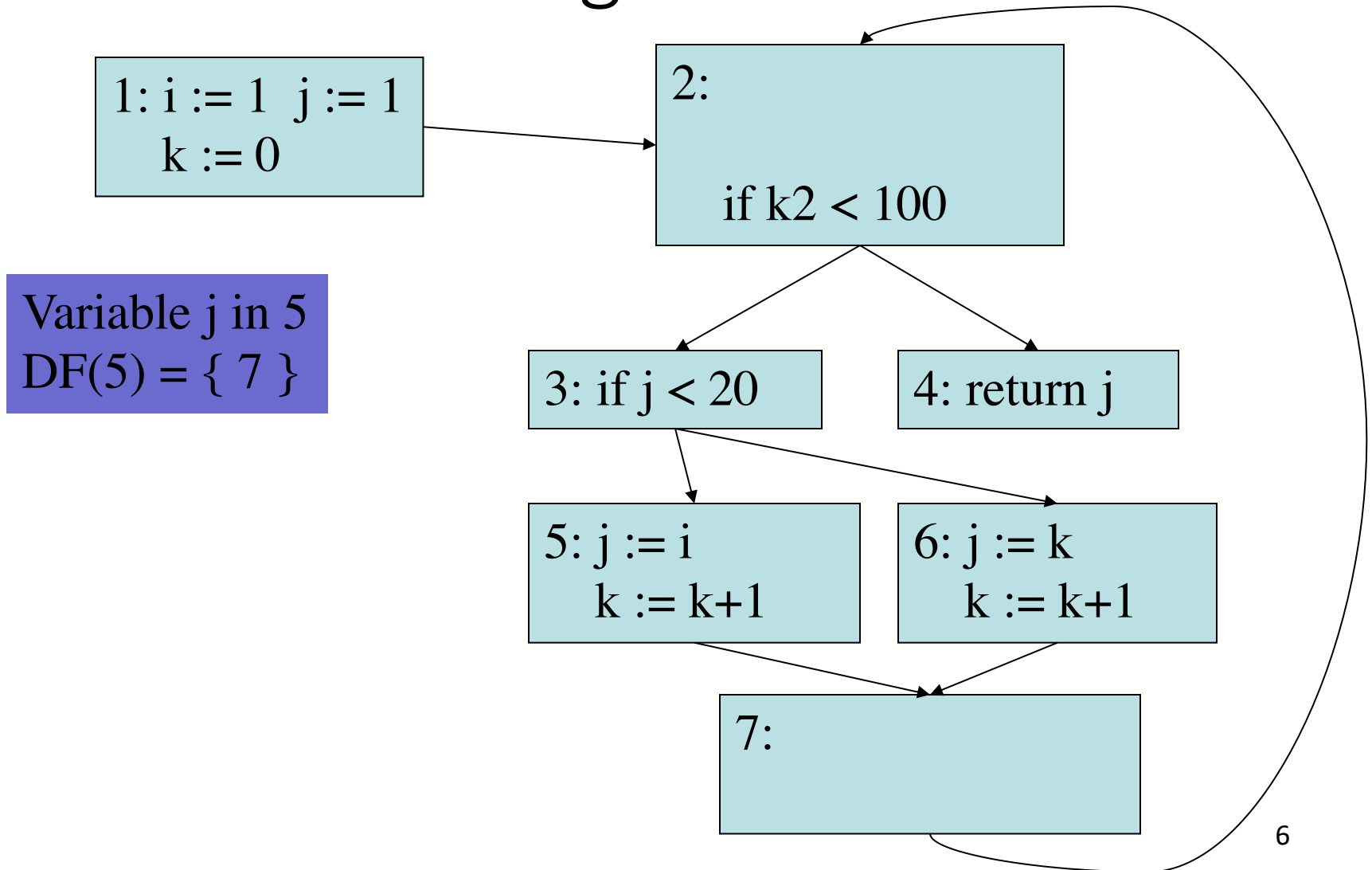


- $D(1) = \{2,3,4,5,6,7\}$
- $D(2) = \{3,4,5,6,7\}$
- $D(3) = \{5,6,7\}$
- $D(4) = \{\}$
- $D(5) = \{\}$
- $D(6) = \{\}$
- $D(7) = \{\}$

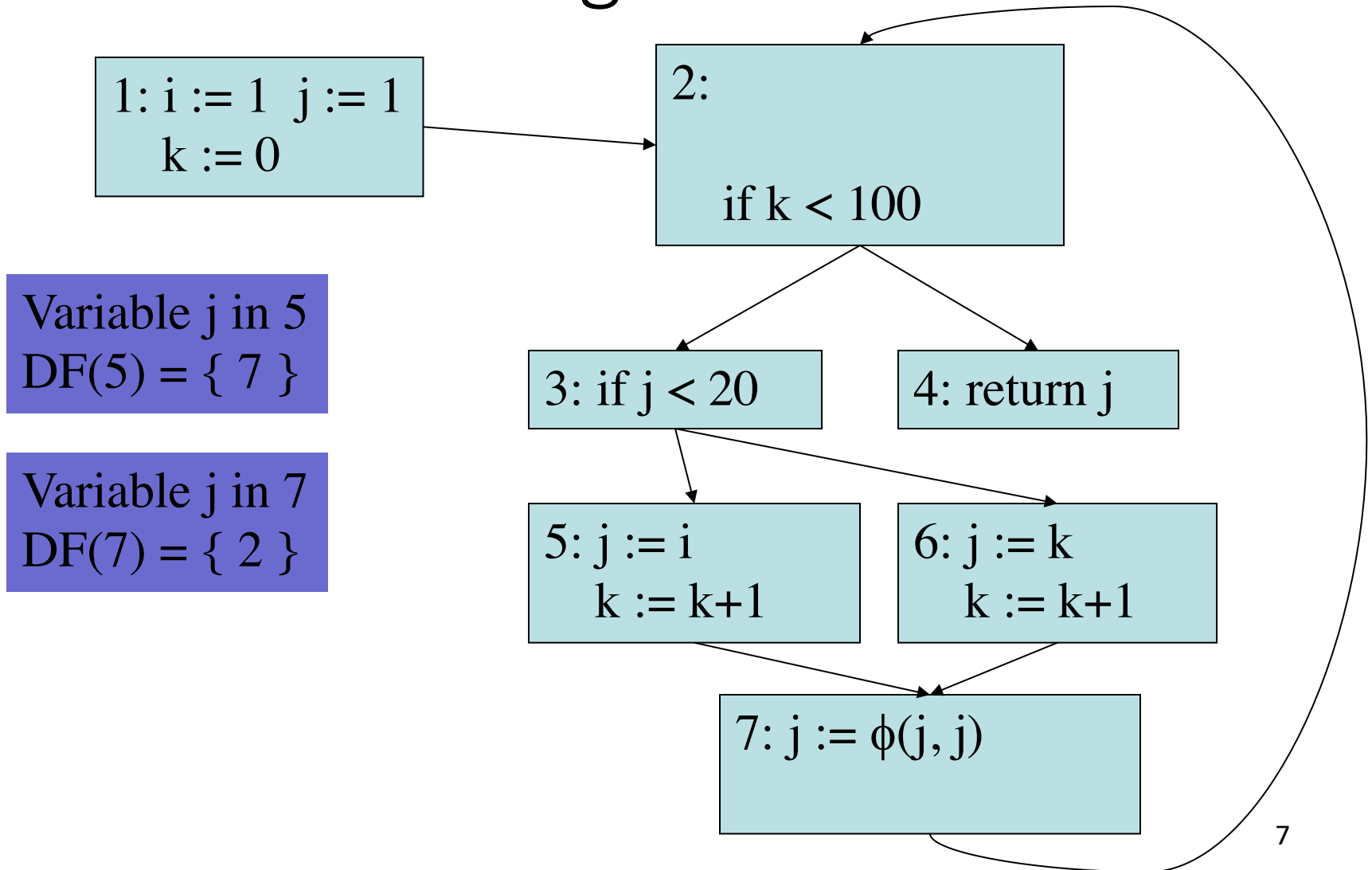
## Dominance Frontier

- $DF(1) = \{\}$
- $DF(2) = \{2\}$
- $DF(3) = \{2\}$
- $DF(4) = \{\}$
- $DF(5) = \{7\}$
- $DF(6) = \{7\}$
- $DF(7) = \{2\}$

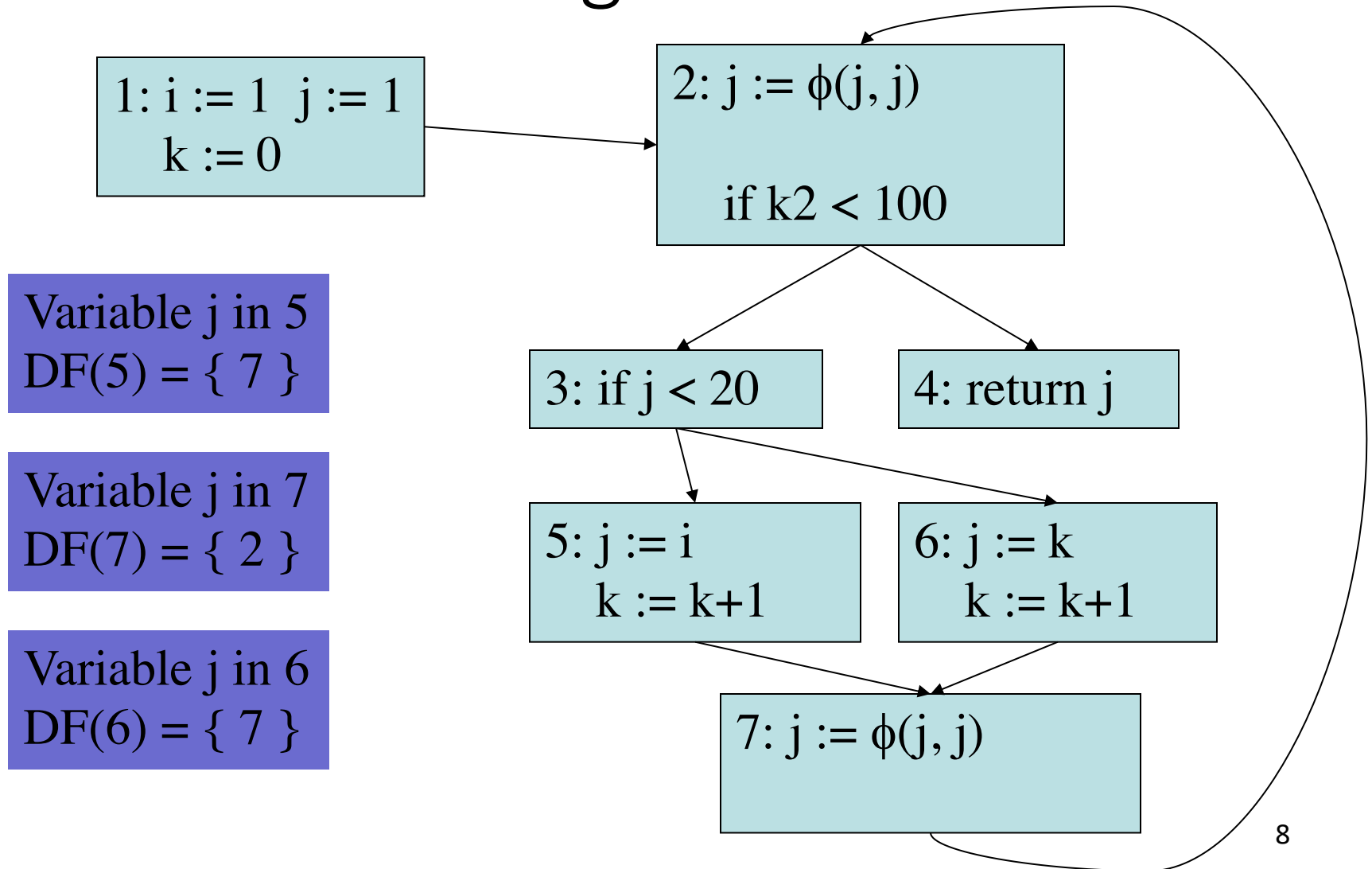
# Converting to SSA Form



# Converting to SSA Form



# Converting to SSA Form





# Converting to SSA Form

1:  $i := 1$   $j := 1$   
 $k := 0$

2:  $j := \phi(j, j)$   
 $k := \phi(k, k)$   
if  $k2 < 100$

3: if  $j < 20$

4: return  $j$

5:  $j := i$   
 $k := k + 1$

6:  $j := k$   
 $k := k + 1$

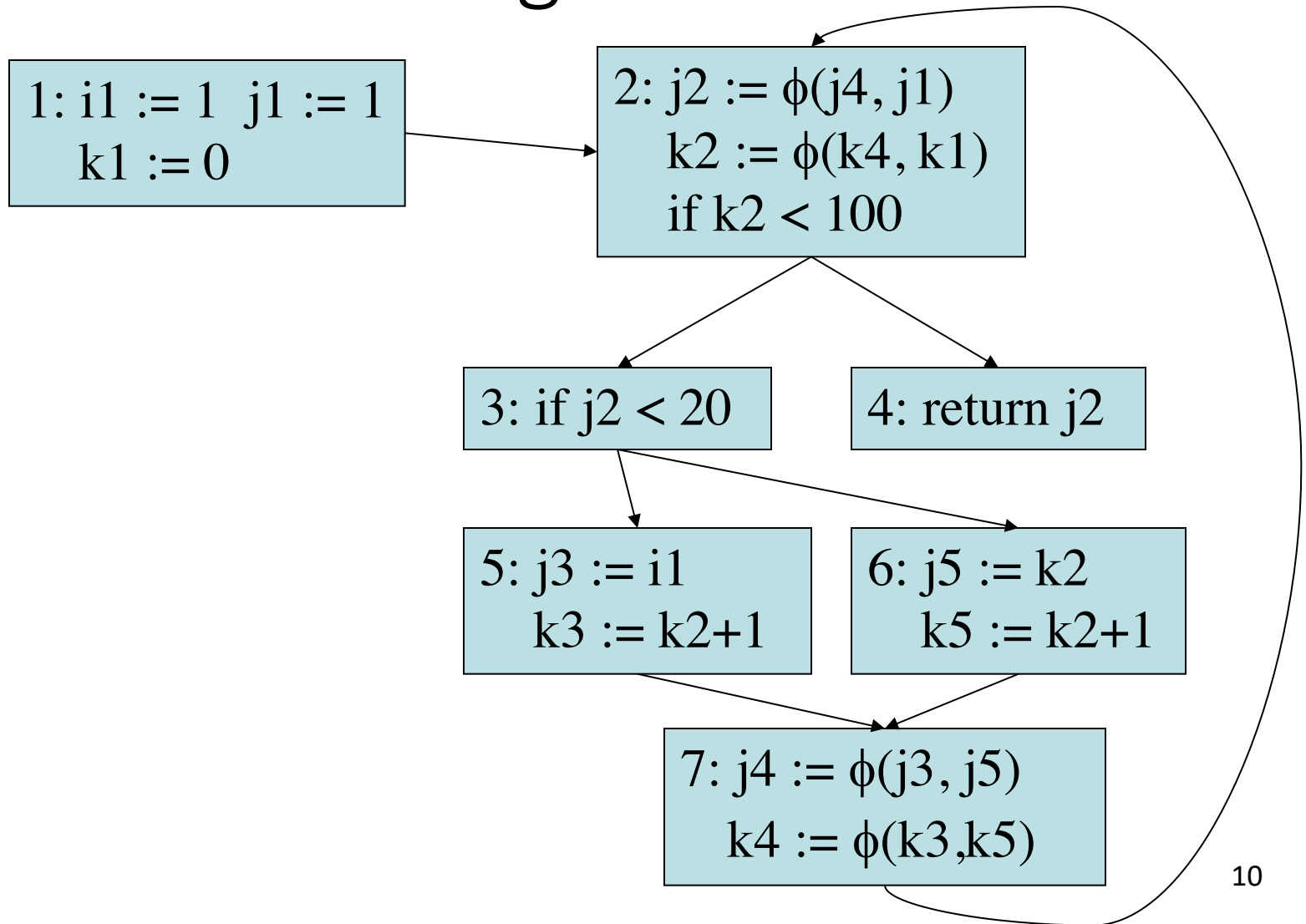
7:  $j := \phi(j, j)$   
 $k := \phi(k, k)$

Variable  $k$  in 5  
 $DF(5) = \{ 7 \}$

Variable  $k$  in 7  
 $DF(7) = \{ 2 \}$

Variable  $k$  in 6  
 $DF(6) = \{ 7 \}$

# Converting to SSA Form

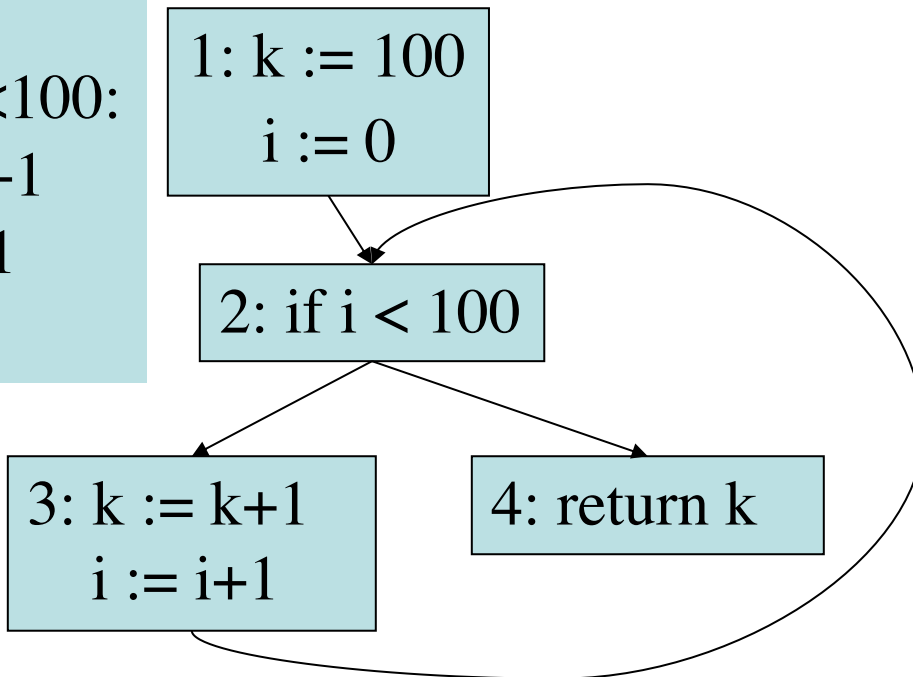


# Converting to SSA Form

## Program

```
k:=100  
i:=0  
while i<100:  
    k:=k+1  
    i:=i+1  
return k
```

## Control Flow Graph



## Dominance Relations

- $D(1) = \{2,3,4\}$
- $D(2) = \{3,4\}$
- $D(3) = \{\}$
- $D(4) = \{\}$

## Dominance Frontier

- $DF(1) = \{\}$
- $DF(2) = \{2\}$
- $DF(3) = \{2\}$
- $DF(4) = \{\}$

Variable i,k in 1  
DF(1) = {}

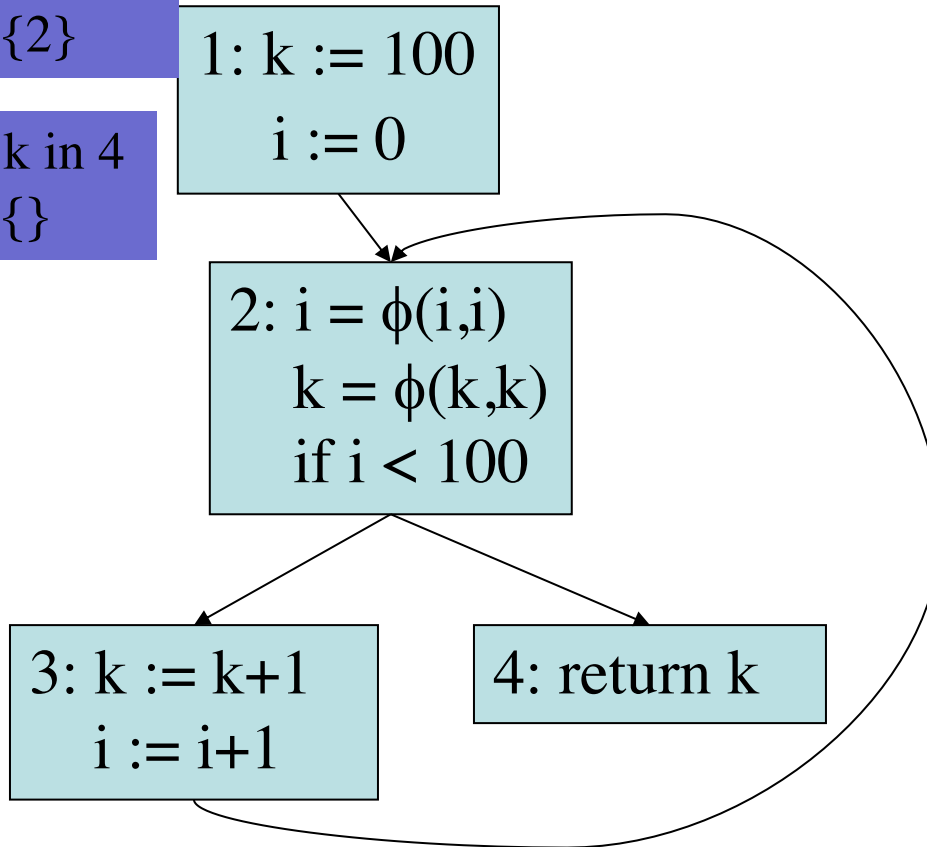
Variable i in 2  
DF(2) = {2}

Variable i,k in 3  
DF(3) = {2}

Variable k in 4  
DF(4) = {}

# Converting to SSA Form

## Control Flow Graph



## Dominance Relations

- $D(1) = \{2,3,4\}$
- $D(2) = \{3,4\}$
- $D(3) = \{\}$
- $D(4) = \{\}$

## Dominance Frontier

- $DF(1) = \{\}$
- $DF(2) = \{2\}$
- $DF(3) = \{2\}$
- $DF(4) = \{\}$

# Converting to SSA Form

