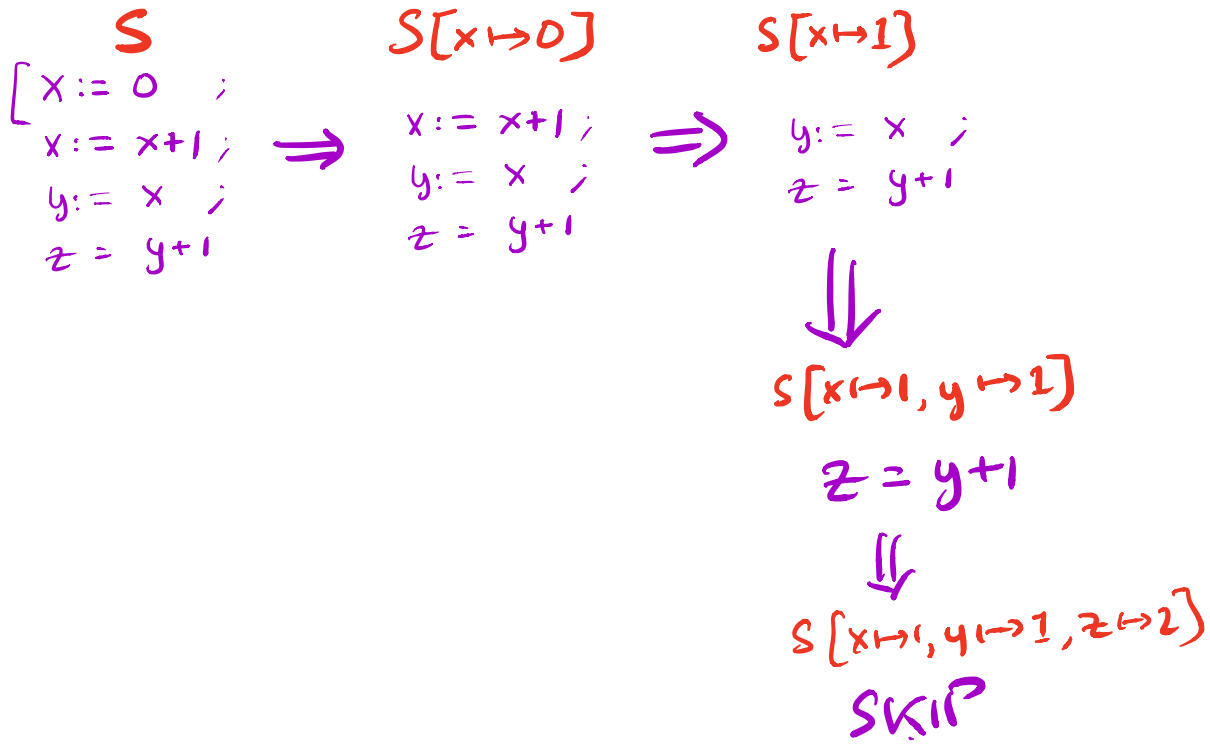
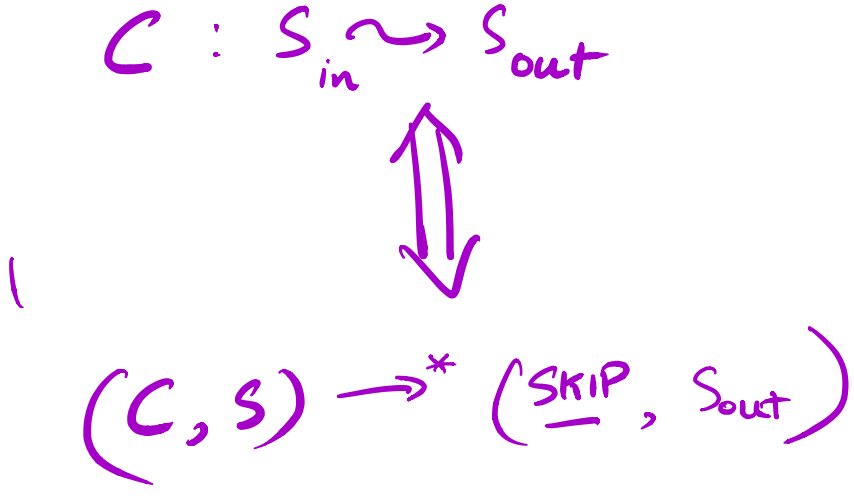
SMALL-STEP

$C : S_{in} \to S_{out}$

$Com ::=$ SKIP + STATE
| $x := a$ ✓
| $c_1 ; c_2$ ✓
| IF b THEN c_1 ELSE c_2
| WHILE b DO c

$(c, s) \rightsquigarrow (c', s')$


s
x := 0 ;
x := x+1 ;
y := x ;
z = y+1
⇒
s[x↦0]
x := x+1 ;
y := x ;
z = y+1
⇒
s[x↦1]
y := x ;
z = y+1
s[x↦1, y↦1]
z = y+1
s[x↦1, y↦1, z↦2]
SKIP


C : s_in ⇝ s_out
(C, s) →* (SKIP, s_out)

$$\frac{}{(\text{SKIP};c, s) \rightsquigarrow (c, s)}\ [\text{Seq1}]$$

$$\frac{(c_A, s) \rightsquigarrow (c_A', s')}{(c_A; c_B, s) \rightsquigarrow (c_A'; c_B, s')}\ [\text{Seq2}]$$

$$\frac{}{(x := a, s) \rightsquigarrow (\text{SKIP}, s[x \mapsto aval\ a\ s])}\ [\text{S-ASGN}]$$

$$\frac{bval\ b\ s = \text{TRUE}}{(\text{IF } b\ c_1\ c_2, s) \rightsquigarrow (c_1, s)}$$

$$\frac{bval\ b\ s = \text{FALSE}}{(\text{IF } b\ c_1\ c_2, s) \rightsquigarrow (c_2, s)}$$

$$\frac{bval\ b\ s = \text{False}}{(\text{while } b, c)\ s \rightsquigarrow (\text{SKIP}, s)}$$

$$\frac{bval\ b\ s = \text{TRUE}}{(\text{while } b\ c, s) \rightsquigarrow (c; \text{while } b\ c, s)}$$

$$\frac{}{(\text{while } b\ c, s) \rightsquigarrow (\text{unwhile } b\ c, s)}$$

unwhile bc = if b (c; while bc) skip

S $\quad\quad$ $S[x \mapsto 0]$

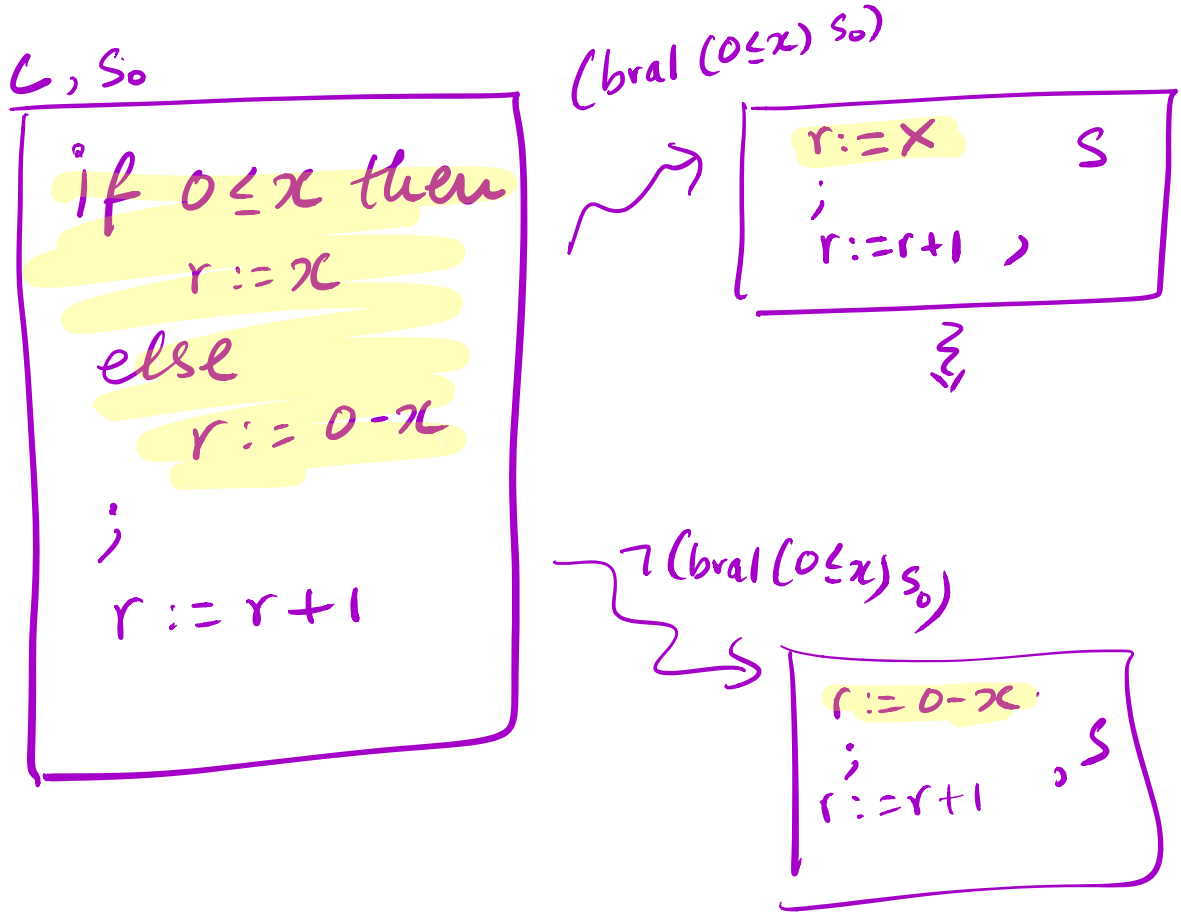
c_1 { $x := 0$;

c_2 { $x := x+1$; $\Rightarrow$ $x := x+1$;
$y := x$; $\quad\quad$ $y := x$;
$z = y+1$ $\quad\quad$ $z = y+1$

$$\frac{\dfrac{}{(c_1, S) \overset{x:=0}{\rightsquigarrow} (\text{SKIP}, S[x \mapsto 0])}\,[\text{S-ASGN}]}{(c_1; c_2, S) \rightarrow (\text{SKIP}; c_2, S[x \mapsto 0])}\,[\text{S-SEQ2}]$$

$x := 0$; $x-$ $y-$ $z-$

$$\frac{}{(\text{SKIP}; c_2, S[x \mapsto 0]) \rightsquigarrow (c_2, S[x \mapsto 0])}\,[\text{seq-1}]$$



$(C, s) \rightsquigarrow (C_1, s_1)$

$(C, s) \rightsquigarrow (C_2, s_2)$

(1) AT MOST ONE SUCCESSOR CONFIG

(2) $(SKIP, s) \not\rightsquigarrow$ ___

$(SKIP, s) \rightsquigarrow (?, s)$

IF $(c, s) \rightsquigarrow (c', s')$

THEN $c \neq SKIP$

$P \Rightarrow Q$

$\neg Q \Rightarrow \neg P$

IF it rains THEN RJ-gets-wet

P "transition" Q "cmd-not-SKIP"

IF $\neg$ RJ-is-wet THEN $\neg$ rain

cmd-is-SKIP "no-transition"

Config = $(C, S) \rightsquigarrow (C_1, S_1)$

① Deterministic ✓ $\rightsquigarrow (C_2'', S_2'')$

② Smallstep $\overset{?}{=}$ Bigstep

↳ final?

↳ "executing entire program"

Smallstep $\Rightarrow$ Exec "whole" PGM

(C, S)

$\vdots$

(C_{n-1}, S_{n-1})

(C_n, S_n)

$\vdots$

$(SKIP, S')$

BIGSTEP

$C_n : S_n \Rightarrow S'$

$C_{n-1} : S_{n-1} \Rightarrow S'$

$\vdots$

$C, S \Rightarrow S'$

IF $(C, S) \rightsquigarrow (SKIP, S')$

THEN $C : S \Rightarrow S'$

IF

$(C, S) \rightsquigarrow^* (\text{SKIP}, S')$

THEN

BSTEP C S S'

"node" ~ (C, S)

"edge" ~ $(C, S) \rightsquigarrow (C', S')$

Path Prop

① $(C, S) \rightsquigarrow (C', S')$ ② $(C', S') \rightsquigarrow^* (C'', S'')$

$(C, S) \rightsquigarrow^* (C'', S'')$