# Written Assignment 4

CS 538, Spring 2020

Vinay Patil

## 1 While-language: basics (15)

(a) $(x \leftarrow x + 1, s_0)$

$\rightarrow (x \leftarrow x + 1, [0, 0])$

$\rightarrow (\textbf{skip}, [1, 0])$

(b) $(x \leftarrow 3; y \leftarrow y + x, s_0)$

$\rightarrow (x \leftarrow 3; y \leftarrow y + x, [0, 0])$

$\rightarrow (\textbf{skip}; y \leftarrow y + x, [3, 0])$

$\rightarrow (y \leftarrow y + x, [3, 0])$

$\rightarrow (\textbf{skip}, [3, 3])$

(c) $(\textbf{if } x < y \textbf{ then } x \leftarrow 2 \textbf{ else } x \leftarrow -2, s_0)$

$\rightarrow (\textbf{if } x < y \textbf{ then } x \leftarrow 2 \textbf{ else } x \leftarrow -2, [0, 0])$

$\rightarrow (x \leftarrow -2, [0, 0])$

$\rightarrow (\textbf{skip}, [-2, 0])$

(d) $(x \leftarrow -1; \textbf{if } x < y \textbf{ then } x \leftarrow 2 \textbf{ else } x \leftarrow -2, s_0)$

$\rightarrow (x \leftarrow -1; \textbf{if } x < y \textbf{ then } x \leftarrow 2 \textbf{ else } x \leftarrow -2, [0, 0])$

$\rightarrow (\textbf{skip}; \textbf{if } x < y \textbf{ then } x \leftarrow 2 \textbf{ else } x \leftarrow -2, [-1, 0])$

$\rightarrow (\textbf{if } x < y \textbf{ then } x \leftarrow 2 \textbf{ else } x \leftarrow -2, [-1, 0])$

$\rightarrow (x \leftarrow 2, [-1, 0])$

$\rightarrow (\textbf{skip}, [2, 0])$

(e) $(x \leftarrow 2; \textbf{while } y < x \textbf{ do } y \leftarrow y + 1, s_0)$

$\rightarrow (x \leftarrow 2; \textbf{while } y < x \textbf{ do } y \leftarrow y + 1, [0, 0])$

$\rightarrow$ (**skip**; **while** $y < x$ **do** $y \leftarrow y + 1, [2, 0]$)

$\rightarrow$ (**while** $y < x$ **do** $y \leftarrow y + 1, [2, 0]$)

$\rightarrow$ ($y \leftarrow y + 1$; **while** $y < x$ **do** $y \leftarrow y + 1, [2, 0]$)

$\rightarrow$ (**skip**; **while** $y < x$ **do** $y \leftarrow y + 1, [2, 1]$)

$\rightarrow$ (**while** $y < x$ **do** $y \leftarrow y + 1, [2, 1]$)

$\rightarrow$ ($y \leftarrow y + 1$; **while** $y < x$ **do** $y \leftarrow y + 1, [2, 1]$)

$\rightarrow$ (**skip**; **while** $y < x$ **do** $y \leftarrow y + 1, [2, 2]$)

$\rightarrow$ (**while** $y < x$ **do** $y \leftarrow y + 1, [2, 2]$)

$\rightarrow$ (**skip**, $[2, 2]$)

# 2 While-language: conditionals (10)

$$\frac{s(b) = true}{(\textbf{cond } \{b \Rightarrow c, \_ \Rightarrow c'\}, s) \rightarrow (c, s)} \qquad \frac{s(b) = false}{(\textbf{cond } \{b \Rightarrow c, \_ \Rightarrow c'\}, s) \rightarrow (c', s)}$$

$$\frac{s(b_1) = true}{(\textbf{cond } \{b_1 \Rightarrow c_1, b_2 \Rightarrow c_2, \_ \Rightarrow c_3\}, s) \rightarrow (c_1, s)} \qquad \frac{s(b_1) = false \ and \ s(b_2) = true}{(\textbf{cond } \{b_1 \Rightarrow c_1, b_2 \Rightarrow c_2, \_ \Rightarrow c_3\}, s) \rightarrow (c_2, s)}$$

$$\frac{s(b_1) = false \ and \ s(b_2) = false}{(\textbf{cond } \{b_1 \Rightarrow c_1, b_2 \Rightarrow c_2, \_ \Rightarrow c_3\}, s) \rightarrow (c_3, s)}$$

# 3 While-language: do-until (5)

$$\frac{}{(\textbf{do } c \textbf{ until } b, s) \rightarrow (c; \textbf{if } b \textbf{ then skip else } (\textbf{do } c \textbf{ until } b), s)}$$