

CS558 Programming Languages – Fall 2023 – Suggested Study Question Solutions for Lecture 4a

1. (a) L_1
- (b) Undefined
- (c) $\{a, b\}$
- (d) $\{a \mapsto L_1, b \mapsto L_2, \text{verb}'d' \mapsto L_2\}$
- (e) $\{a \mapsto L_1, b \mapsto L_3\}$
- (f) 20
- (g) 10
- (h) $\{L_1, L_2, L_3\}$
- (i) $\{L_1 \mapsto 10, L_3 \mapsto 30\}$

2. This is just the top example from slide 8 with the arguments to + swapped.

$$\frac{\frac{\langle 10, \emptyset, \emptyset \rangle \Downarrow \langle 10, \emptyset \rangle \text{ (Int)} \quad \frac{\langle x, E_1, S_1 \rangle \Downarrow \langle 10, S_1 \rangle \text{ (Var)} \quad \frac{\langle 21, E_1, S_2 \rangle \Downarrow \langle 21, S_2 \rangle \text{ (Int)} \quad \langle (:= x 21), E_1, S_2 \rangle \Downarrow \langle 21, S_2 \rangle \text{ (Add)}}{\langle (+ x (:= x 21)), E_1, S_1 \rangle \Downarrow \langle 31, S_2 \rangle \text{ (Let)}}}{\langle (\text{let } x 10 (+ x (:= x 21))), \emptyset, \emptyset \rangle \Downarrow \langle 31, \emptyset \rangle \text{ (Let)}}$$

where $E_1 = \{x \mapsto L_1\}$, $S_1 = \{L_1 \mapsto 10\}$, and $S_2 = \{L_1 \mapsto 21\}$.

3. (a)

$$\frac{\langle e_1, E, S \rangle \Downarrow \langle v_1, S' \rangle \quad \langle e_2, E, S' \rangle \Downarrow \langle v_2, S'' \rangle}{\langle (; e_1 e_2), E, S \rangle \Downarrow \langle v_2, S'' \rangle} \text{ (Sequence)}$$

(b) We can get the same effect using `let` expressions with an arbitrary (dummy) variable name. That is, `(; e1 e2)` is equivalent to `(let d e1 e2)` where `d` is any variable name that doesn't appear free in `e2`.