Morgan Ciliv assignment 2 Part C

13. Note: $\circ$ means the pointed material goes at the circle

$$\frac{x \in dom\, \rho}{\langle VAR(x), \xi, \phi, \rho \rangle \Downarrow \langle \rho(x), \xi, \phi, \rho \rangle} \text{(FormalVar)}$$

$$\frac{\displaystyle x \in dom\, \rho \quad \circ \quad \frac{}{\langle LIT(3), \xi, \phi, \rho \rangle \Downarrow \langle 3, \xi, \phi, \rho \rangle}\text{(LIT)}}{\langle SET(VAR(x), LIT(3)), \xi, \phi, \rho \rangle \Downarrow \langle 3, \xi, \phi, \rho\{x \mapsto 3\} \rangle}\text{(Global Assign)} \quad \frac{x \in dom\, \rho}{\langle VAR(x), \xi, \phi, \rho \rangle \Downarrow \langle \rho(x), \xi, \phi, \rho \rangle}\text{(Formal Var)}$$

$$\overline{\langle BEGIN(SET(VAR(x), LIT(3)), VAR(x)), \xi, \phi, \rho \rangle \Downarrow \langle 3, \xi, \phi, \rho\{x \mapsto 3\} \rangle} \text{(BEGIN)}$$

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13.

14.

$$\frac{\langle VAR(x), \xi, \phi, \rho\rangle \Downarrow \langle x, \xi, \phi, \rho\rangle \quad x \neq 0 \quad \langle VAR(x), \xi, \phi, \rho\rangle \Downarrow \langle x, \xi, \phi, \rho\rangle}{\langle IF(VAR(x), VAR(x), LIT(0)), \xi, \phi, \rho\rangle \Downarrow \langle x, \xi, \phi, \rho\rangle} \ (\text{cIf True}) \qquad v_1 = x$$

$$\frac{\langle VAR(x), \xi, \phi, \rho\rangle \Downarrow \langle x, \xi, \phi, \rho\rangle \quad x = 0 \quad \langle LIT(0), \xi, \phi, \rho\rangle \Downarrow \langle 0, \xi, \phi, \rho\rangle}{\langle IF(VAR(x), VAR(x), LIT(0)), \xi, \phi, \rho\rangle \Downarrow \langle 0, \xi, \phi, \rho\rangle} \ (\text{cIf False}) \qquad v_1 = x = 0$$

We know v_2 is always x $\therefore$ $v_1 = v_2$

21. (a)

$$\frac{x \notin \operatorname{dom} \rho \quad x \notin \operatorname{dom} \xi}{\langle \mathrm{VAR}(x), \xi, \phi, \rho \rangle \Downarrow \langle \cancel{\xi(x)}, \xi\{x \mapsto 0\}, \phi, \rho \rangle} \text{ (UnboundVar Awk)}$$

$$\frac{x \notin \operatorname{dom} \rho \quad x \notin \operatorname{dom} \xi \quad \langle e, \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho \rangle}{\langle \mathrm{SET}(x, e), \xi, \phi, \rho \rangle \Downarrow \langle v, \xi\{x \mapsto v\}, \phi, \rho \}} \text{ (UnboundVar Assign Awk)}$$

21. (b)

$$\frac{x \notin \operatorname{dom} \rho \quad x \notin \operatorname{dom} \xi}{\langle \mathrm{VAR}(x), \xi, \phi, \rho \rangle \Downarrow \langle \rho(x), \xi, \phi, \rho\{x \mapsto 0\} \rangle} \text{ (UnboundVar Icon)}$$

(c) I prefer Awk because assignment is also included and it covers the chance that I want to use the variable outside of the local scope.

20. assume we have 2 derivations w/ the same e and same environments on the left, but different vs on the right, v_1 and v_2

Conjecture: if $\mathcal{D}$ is a valid derivation of $\langle e, \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi, \phi, \rho \rangle$ and $\langle e, \xi, \phi, \rho \rangle \Downarrow \langle v_2, \xi, \phi, \rho \rangle$ then $v_1 = v_2$. (Also induction hypothesis)

1. when the last rule used in $\mathcal{D}$ is literal, the deriv must have form

$$\mathcal{D} = \frac{}{\langle \text{LITERAL}(v), \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi, \phi, \rho \rangle} \text{LITERAL}$$

or another form w/ v_2 in place of v_1; however, $v_1 = v_2$ $\because$ the form of e is literal and each literal is unique by def. in Impcore

2. When the last rule used in $\mathcal{D}$ is FORMALVAR the deriv. must have the following form

$$\mathcal{D} = \frac{x \in dom\, e}{\langle \text{VAR}(x), \xi, \phi, \rho \rangle \Downarrow \langle e(x), \xi, \phi, \rho \rangle} \text{FormalVar}$$

or another form w/ v_2 in place of v_1; however, $v_1 = v_2$ $\because$ the form of e is variable and each variable in Impcore is unique by def.

Like 1 and 2 above we repeat the process for the following $\mathcal{D}$s

Reasoning is similar so don't have to repeat all parts.

3. $$\mathcal{D} = \frac{x \in dom\, \rho \quad x \in dom\, \xi}{\langle \text{VAR}(x), \xi, \phi, \rho \rangle \Downarrow \langle \xi(x), \xi, \phi, \rho \rangle} \text{GlobalVar}$$

4. $$\mathcal{D} = \frac{x \in dom\, \rho \quad \overset{\mathcal{D}_1}{\langle e, \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho' \rangle}}{\langle \text{SET}(x, e), \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho'\{x \mapsto v\} \rangle} \text{Formal assign}$$

further reasoning: assignment to a particular value is unique

5. Global Assign (similar to (4)) but global

6. $$\mathcal{D} = \frac{\overset{\mathcal{D}_1}{\langle e_1, \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi', \phi, \rho' \rangle} \quad v_1 \neq 0 \quad \overset{\mathcal{D}_2}{\langle e_2, \xi', \phi, \rho' \rangle \Downarrow \langle v_2, \xi'', \phi, \rho'' \rangle}}{\langle \text{IF}(e_1, e_2, e_3), \xi, \phi, \rho \rangle \Downarrow \langle v_2, \xi'', \phi, \rho'' \rangle} \text{IfTrue}$$

$\because$ both the antecedent and the consequence must be unique.

7. IfFalse is similar to IfTrue but false case

Given the different forms we've proved the proved Theoretical Impcore to be deterministic QED