Interprocedural Analysis

$$\hat{L} = \delta \rightarrow \mathcal{P}(\mathbf{Var}_\star \times \mathbf{Lab}_\star^?)$$

$$\mathsf{RD}_{entry}(\ell) = \lambda\delta. \begin{cases} \{(x,?) \mid x \in \mathbf{Var}_\star\}, & \text{if } \delta = [] \wedge \ell = init(S_\star) \\ \bigcup\{\mathsf{RD}_{exit}(\ell')(\delta) \mid (\ell',\ell) \in flow_\star \vee (\ell';\ell) \in flow_\star\}, & \text{otherwise} \end{cases}$$

$$\mathsf{RD}_{exit}(\ell) = \lambda\delta. \begin{cases} \hat{f}^1_\ell(\mathsf{RD}_{entry}(\ell))(\delta : \ell), & \text{if } call(\ell) \\ \hat{f}^2_{\ell_c,\ell}(\mathsf{RD}_{entry}(\ell_c), \mathsf{RD}_{entry}(\ell))(\delta), & \text{if } return(\ell) \text{ where } (\ell_c,\ell_n,\ell_x,\ell) \in inter\text{-}flow_\star \\ \hat{f}_\ell(\mathsf{RD}_{entry}(\ell))(\delta), & \text{otherwise} \end{cases}$$

$$\begin{aligned} call(\ell) &= (\exists \ell_n, \ell_x, \ell_r \in \mathbf{Lab}_\star :: (\ell,\ell_n,\ell_x,\ell_r) \in inter\text{-}flow_\star) \\ return(\ell) &= (\exists \ell_c, \ell_n, \ell_x \in \mathbf{Lab}_\star :: (\ell_c,\ell_n,\ell_x,\ell) \in inter\text{-}flow_\star) \end{aligned}$$

$$\hat{f}_\ell(Y) = \lambda\delta. \begin{cases} (Y(\delta) \setminus \{(x,\ell') \mid \ell' \in \mathbf{Lab}_\star^?\}) \cup \{(x,\ell)\}, & \text{if } B^\ell \text{ is of the form } [x := a]^\ell \\ \emptyset, & \text{otherwise} \end{cases}$$

$$\begin{aligned} \hat{f}^1_{\ell_c}(Y) = \lambda\delta'.\ & (Y(pop(\delta',\ l_c)) \setminus \{(x,\ell') \mid \ell' \in \mathbf{Lab}_\star^?, x \in val\text{-}formals(l_c) \vee x \in res\text{-}formals(l_c)\}) \\ & \cup\{(x,l_c) \mid x \in val\text{-}formals(l_c)\} \\ & \cup\{(y,?) \mid y \in res\text{-}formals(l_c)\} \end{aligned}$$

$$\begin{aligned} \hat{f}^2_{l_c,l_r}(X,Y) = \lambda\delta.\ & (\ \ (\ \ \{(x,\ell) \mid (x,\ell) \in X(\delta), x \in val\text{-}formals(l_r) \vee x \in res\text{-}formals(l_r)\} \\ & \qquad \cup (Y(\delta : l_c) \setminus \{(x,\ell') \mid \ell' \in \mathbf{Lab}_\star^?, x \in val\text{-}formals(l_r) \vee x \in res\text{-}formals(l_r)\})) \\ & \quad \setminus\{(z,\ell') \mid z \in res\text{-}actuals(l_r)\}) \\ & \cup\{(z,l_r) \mid z \in res\text{-}actuals(l_r)\} \end{aligned}$$

$$pop(\delta',\ l_c) = \begin{cases} \delta, & \text{if } \delta' = (\delta :\ l_c) \\ error, & \text{otherwise} \end{cases}$$

$$\begin{aligned} x \in val\text{-}formals(\ell) \Leftrightarrow\ & ([\text{call p(a, z)}]^\ell_{\ell_r} \in \mathbf{Blocks}_\star \vee [\text{call p(a, z)}]^{\ell_c}_\ell \in \mathbf{Blocks}_\star) \\ \wedge\ & (\text{proc p (val x, res y) is}^{\ell_n}\ S\ \text{end}^{\ell_x} \in D_\star) \end{aligned}$$

$$\begin{aligned} y \in res\text{-}formals(\ell) \Leftrightarrow\ & ([\text{call p(a, z)}]^\ell_{\ell_r} \in \mathbf{Blocks}_\star \vee [\text{call p(a, z)}]^{\ell_c}_\ell \in \mathbf{Blocks}_\star) \\ \wedge\ & (\text{proc p (val x, res y) is}^{\ell_n}\ S\ \text{end}^{\ell_x} \in D_\star) \end{aligned}$$

$$\begin{aligned} z \in res\text{-}actuals(\ell) \Leftrightarrow\ & ([\text{call p(a, z)}]^\ell_{\ell_r} \in \mathbf{Blocks}_\star \vee [\text{call p(a, z)}]^{\ell_c}_\ell \in \mathbf{Blocks}_\star) \\ \wedge\ & (\text{proc p (val x, res y) is}^{\ell_n}\ S\ \text{end}^{\ell_x} \in D_\star) \end{aligned}$$