Annotated Type Rules

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1 Type system

Below you will find Figure 1, which describes the annotated type rules for our extended lambda calculus language for the second assignment of Automatic Program Analysis at Utrecht University.

$$\boxed{\widehat{\Gamma} \vdash e : \widehat{\tau}}$$

$$\frac{}{\widehat{\Gamma} \vdash c : \widehat{\tau}_c} \; [con]$$

$$\frac{\widehat{\Gamma}\,(x) = \widehat{\tau}}{\widehat{\Gamma} \vdash x : \widehat{\tau}} \; [var]$$

$$\frac{\widehat{\Gamma}\,[x \mapsto \widehat{\tau}_x] \vdash e_1 : \widehat{\tau}_0}{\widehat{\Gamma} \vdash \mathbf{fn}_\pi \; x \Rightarrow e_1 : \widehat{\tau}_x \xrightarrow{\{\pi\} \,\cup\, \varphi} \widehat{\tau}_0} \; [fn]$$

$$\frac{\widehat{\Gamma}\,[f \mapsto \widehat{\tau}_x \xrightarrow{\{\pi\} \,\cup\, \varphi} \widehat{\tau}_0]\,[x \mapsto \widehat{\tau}_x] \vdash e_1 : \widehat{\tau}_0}{\widehat{\Gamma} \vdash \mathbf{fun}_\pi \; f \; x \Rightarrow e_1 : \widehat{\tau}_x \xrightarrow{\{\pi\} \,\cup\, \varphi} \widehat{\tau}_0} \; [fun]$$

$$\frac{\widehat{\Gamma} \vdash e_1 : \widehat{\tau}_2 \xrightarrow{\varphi} \widehat{\tau}_0 \qquad \widehat{\Gamma} \vdash e_2 : \widehat{\tau}_2}{\widehat{\Gamma} \vdash e_1 \; e_2 : \widehat{\tau}_0} \; [app]$$

$$\frac{\widehat{\Gamma} \vdash e_1 : Bool \qquad \widehat{\Gamma} \vdash e_2 : \widehat{\tau} \qquad \widehat{\Gamma} \vdash e_3 : \widehat{\tau}}{\widehat{\Gamma} \vdash \mathbf{if} \; e_1 \; \mathbf{then} \; e_2 \; \mathbf{else} \; e_3 : \widehat{\tau}} \; [if]$$

$$\frac{\widehat{\Gamma} \vdash e_1 : \widehat{\tau}_1 \qquad \widehat{\Gamma}\,[x \mapsto \widehat{\tau}_1] \vdash e_2 : \widehat{\tau}_2}{\widehat{\Gamma} \vdash \mathbf{let} \; x = e_1 \; \mathbf{in} \; e_2 : \widehat{\tau}_2} \; [let]$$

$$\frac{\widehat{\Gamma} \vdash e_1 : \widehat{\tau}_{op}^1 \qquad \widehat{\Gamma} \vdash e_2 : \widehat{\tau}_{op}^2}{\widehat{\Gamma} \vdash e_1 \; op \; e_2 : \widehat{\tau}_{op}} \; [op]$$

$$\frac{\widehat{\Gamma} \vdash e_1 : \widehat{\tau}_1 \qquad \forall i :: \widehat{\Gamma} \vdash e_i : \widehat{\tau}_1 \qquad \forall j :: \widehat{\Gamma} \vdash e_j : \widehat{\tau}_0}{\widehat{\Gamma} \vdash \mathbf{case} \; e_1 \; \mathbf{of} \; [e_i \; \mathbf{then} \; e_j]^+ : \widehat{\tau}_0} \; [case]$$

$$\frac{\widehat{\Gamma} \vdash x : \widehat{\tau}_0 \qquad \widehat{\Gamma} \vdash xs : \widehat{\tau}_{list(\widehat{\tau}_0)}}{\widehat{\Gamma} \vdash (x : xs) : \widehat{\tau}_{list(\widehat{\tau}_0)}} \; [list\text{-}cons]$$

$$\frac{}{\widehat{\Gamma} \vdash [\,] : \widehat{\tau}_{list(\widehat{\tau}_0)}} \; [list\text{-}nil]$$

$$\frac{\widehat{\Gamma} \vdash e_1 : \widehat{\tau}_1 \qquad \widehat{\Gamma} \vdash e_2 : \widehat{\tau}_2}{\widehat{\Gamma} \vdash (e_1, e_2) : \widehat{\tau}_{pair(\widehat{\tau}_0)}} \; [pair]$$

Figure 1: Typing