The Definition of Snail

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1 Snail の構文定義

EBNF 記法を用いて Snail の具象構文を以下に示す.

$$
\begin{aligned}
\mathit{toplevel} ::= {} & \mathit{let}\ [\mathit{rec}]\ \mathit{var}\ \{\mathit{var}\ [\ :\ \langle \mathit{type} \rangle]\} [: \langle \mathit{type} \rangle] = \langle \mathit{term} \rangle\ \{\langle \mathit{mutual\text{-}recursion\text{-}top\text{-}let} \rangle\} \\
| {} & \mathit{typedef}\ \mathit{cons}\ \{\mathit{var}\} = [\ |\ ]\ \{\langle \mathit{type\text{-}dec} \rangle\ |\ \}\ \langle \mathit{type\text{-}dec} \rangle\ \{\langle \mathit{mutual\text{-}recursion\text{-}type} \rangle\} \\
\mathit{mutual\text{-}recursion\text{-}type} ::= {} & \mathit{and}\ \mathit{cons}\ \{\mathit{var}\} = [\ |\ ]\ \{\langle \mathit{type\text{-}dec} \rangle\ |\ \}\ \langle \mathit{type\text{-}dec} \rangle \\
\mathit{mutual\text{-}recursion\text{-}top\text{-}let} ::= {} & \mathit{and}\ \mathit{var}\ \{\mathit{var}\ [\ :\ \langle \mathit{type} \rangle]\}\ :\ \langle \mathit{type} \rangle = \langle \mathit{term} \rangle \\
\mathit{type\text{-}dec} ::= {} & \mathit{cons}\ [\mathit{of}\ \langle \mathit{type} \rangle] \\
\mathit{type} ::= {} & \langle \mathit{type} \rangle \to \langle \mathit{type} \rangle \\
| {} & !\ '['\ \langle \mathit{expmod} \rangle\ ']'\ '\{'\ \langle \mathit{type} \rangle\ '\}' \\
| {} & \langle \mathit{simple\text{-}type} \rangle \\
| {} & \langle \mathit{type} \rangle\ \langle \mathit{simple\text{-}type} \rangle \\
\mathit{expmod} ::= {} & \mathit{int} \\
| {} & \infty \\
\mathit{simple\text{-}type} ::= {} & '('\ \langle \mathit{type} \rangle\ ')' \\
| {} & \mathit{var} \\
| {} & \mathit{cons} \\
| {} & () \\
\mathit{pattern} ::= {} & \langle \mathit{simple\text{-}pattern} \rangle \\
| {} & \langle \mathit{pattern} \rangle\ \langle \mathit{simple\text{-}pattern} \rangle \\
| {} & \langle \mathit{simple\text{-}pattern} \rangle\ \mathit{binop}\ \langle \mathit{simple\text{-}pattern} \rangle
\end{aligned}
$$

$$
\begin{aligned}
\textit{simple-pattern} ::= {} & '(' \ \langle \textit{pattern} \rangle \ ')' \\
| \ & \textit{var} \\
| \ & \textit{cons} \ '[' \ \langle \textit{simple-pattern} \rangle \ ']' \\
| \ & [\,] \\
| \ & \_
\end{aligned}
$$

$$
\textit{mutual-recursion-let} ::= \textit{and} \ \textit{var} \ \{\textit{var} \ [\ : \ \langle \textit{type} \rangle]\} \ : \ \langle \textit{type} \rangle = \langle \textit{term} \rangle
$$

$$
\begin{aligned}
\textit{term} ::= {} & \langle \textit{simple-term} \rangle \\
| \ & \langle \textit{term} \rangle \ \langle \textit{simple-term} \rangle \\
| \ & \textit{let} \ [\textit{rec}] \ \textit{var} \ \{\textit{var} \ [\ : \ \langle \textit{type} \rangle]\} : \langle \textit{type} \rangle = \langle \textit{term} \rangle \ \{\langle \textit{mutual-recursion-let} \rangle\} \ \textit{in} \ \langle \textit{term} \rangle \\
| \ & \textit{fun} \ \{\textit{var} \ [\ : \ \langle \textit{type} \rangle]\} \ \rightarrow \langle \textit{term} \rangle \\
| \ & \textit{match} \ \langle \textit{term} \rangle \ \textit{with} \ [\,|\,] \ \{\langle \textit{pattern} \rangle \rightarrow \langle \textit{term} \rangle \ | \ \} \ \langle \textit{pattern} \rangle \rightarrow \langle \textit{term} \rangle \\
| \ & \textit{if} \ \langle \textit{term} \rangle \ \textit{then} \ \langle \textit{term} \rangle \ \textit{else} \ \langle \textit{term} \rangle
\end{aligned}
$$

$$
\begin{aligned}
\textit{simple-term} ::= {} & '(' \ \langle \textit{term} \rangle \ [\ : \langle \textit{type} \rangle] \ ')' \\
| \ & ! \ \langle \textit{term} \rangle \\
| \ & \textit{int} \\
| \ & \textit{float} \\
| \ & \textit{string} \\
| \ & \textit{bool} \\
| \ & \textit{var} \\
| \ & \textit{cons} \ [\langle \textit{simple-term} \rangle] \\
| \ & () \\
| \ & [\,] \\
| \ & \textit{list}
\end{aligned}
$$

終端記号の意味を以下のように定義する.

- var 先頭が小文字で始まる文字列.
- cons 先頭が大文字で始まる文字列.
- list 組み込みリストの構文糖衣,[1,2,3] など.
- string 文字列リテラル.
- int 整数リテラル.
- float 小数リテラル.
- bool 真偽値リテラル.
- その他 予約語.

2 Snail の型システム

Snail は次のような型付け規則を持つ.

2.1 型付け規則

$$\frac{}{\vdash int : Int}\ (\textsc{Int}) \qquad \frac{\Gamma, x : [A]_r \vdash e : B}{\Gamma \vdash fun\ (!x : !_r A) \to e :\ !_r A \multimap B}\ (\textsc{fun-exp})$$

$$\frac{}{\vdash float : Float}\ (\textsc{Float}) \qquad \frac{\Gamma \vdash e : A \multimap B \quad \Delta \vdash e' : A}{\Gamma + \Delta \vdash e\ e' : B}\ (\textsc{app})$$

$$\frac{}{\vdash string : String}\ (\textsc{String}) \qquad \frac{\Gamma \vdash e : Bool \quad \Delta \vdash e_1 : A \quad \Delta \vdash e_2 : A}{\Gamma + \Delta \vdash if\ e\ then\ e_1\ else\ e_2 : A}\ (\textsc{if})$$

$$\frac{}{\vdash bool : Bool}\ (\textsc{Bool}) \qquad \frac{\Gamma \vdash e : A \quad \Delta, x : A \vdash e' : B}{\Gamma + \Delta \vdash let\ x = e\ in\ e' : B}\ (\textsc{let})$$

$$\frac{}{x : A \vdash x : A}\ (\textsc{id}) \qquad \frac{\Gamma \vdash e : !_r A \quad \Delta, x : [A]_r \vdash e' : B}{\Gamma + \Delta \vdash let\ !x = e\ in\ e' : B}\ (\textsc{let-exp})$$

$$\frac{\Gamma, x : A \vdash e : B}{\Gamma, x : [A]_1 \vdash e : B}\ (\textsc{der}) \qquad \frac{[\Gamma], x : [A]_p \vdash e :\ A \quad \Delta, x :\ [A]_\infty \vdash e' :\ B}{\infty * [\Gamma] + \Delta \vdash let\ rec\ x = e\ in\ e' : B}\ (\textsc{let-rec})$$

$$\frac{[\Gamma] \vdash e : B}{r * [\Gamma] \vdash !e : !_r B}\ (\textsc{pr})$$

$$\frac{\Gamma, x : A \vdash e : B}{\Gamma \vdash fun\ x \to e : A \multimap B}\ (\textsc{fun}) \qquad \frac{\Delta \vdash e :\ B \quad \Gamma <: \Delta}{\Gamma, \Theta \vdash e : B}\ (\textsc{sub})$$

2.2 部分型付け規則

$$\frac{}{A <: A}\ (\textsc{o-i}) \qquad \frac{A <: B \quad q \preceq p}{[A]_p <: [B]_q}\ (\textsc{o-d})$$

$$\frac{A <: B \quad q \preceq p}{!_p A <: !_q B}\ (\textsc{o-b}) \qquad \frac{}{\Gamma <: \Gamma}\ (\textsc{o-ic})$$

$$\frac{A' <: A \quad B <: B'}{A \multimap B <: A' \multimap B'}\ (\textsc{o-l}) \qquad \frac{\Gamma <: \Delta \quad A <: B}{\Gamma, x : B <: \Delta, x : A}\ (\textsc{o-c})$$

3　参考文献