Hazel Assistant Calculus WIP

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Abstract

The hazelnut assistant calculus provides an extensible framework for type- and value-directed completion and refactoring support in a structured editing context.

CCS Concepts: • **Software and its engineering → General programming languages**.

Keywords: live programming, code completion, refactoring, GUIs

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wazzzzzaaaaaaaaaaaaaaaaaaaaa

1 Assistant Calculus

blah blah blah types

TODOs:

- ~~get cursor icons from hazelnut paper~~
- ~~get right arrow for bidi~~
- ~~basic zipper cases~~
- remaining zipper cases? do i need to actually include mirror cases?
- ~~var + varapp~~
- ~~NOTE: we basically need a construct expression action for varapp~~
- ~~proj~~
- ~~base case for hole~~
- ~~base cases for non-empty holes, incld:~~
- ~~delete + act for general hexps~~
- ~~simple wrap for exprs incld. non-empty-holes~~
- complex (n-ary) wraps
- iterated wraps? with cutoffs? (:jean-shorts-emoji)
- ~~are there non-empty-hole suggests distinct from arbitrary expr suggests?~~ don't think so

$\boxed{\Gamma \vdash \hat{e} \Rightarrow \tau \curvearrowright \mathrm{A}}$ e synthesizes τ, suggesting actions A

$\boxed{\Gamma \vdash \hat{e} \Leftarrow \tau \curvearrowright \mathrm{A}}$ e analyzes against τ, suggesting actions A

$$\frac{\Gamma \vdash e_1 \Leftarrow \tau_2 \qquad \Gamma \vdash \hat{e}_2 \Leftarrow \tau_1 \curvearrowright \mathrm{A}}{\Gamma \vdash (\hat{e}_1, e_2) \Rightarrow \tau_1 \times \tau_2 \curvearrowright \mathrm{A}}$$

$$\frac{\Gamma \vdash \hat{e} \Rightarrow \tau_1 \curvearrowright \mathrm{A} \qquad \tau_1 \blacktriangleright_{\rightarrow} \tau_2 \rightarrow \tau \qquad \Gamma \vdash e_2 \Leftarrow \tau_2}{\Gamma \vdash \hat{e}_1(e_2) \Rightarrow \tau \curvearrowright \mathrm{A}}$$

$$\frac{\tau \blacktriangleright_{\rightarrow} \tau_1 \rightarrow \tau_2 \qquad \Gamma \vdash \hat{e} \Leftarrow \tau \curvearrowright \mathrm{A}}{\Gamma \vdash \lambda x.\hat{e} \Leftarrow \tau \curvearrowright \mathrm{A}}$$

Figure 1. Suggestion Zipper Cases

- ~~for all: change type to type consistency~~
- ~~for all: add numerical subscripts to types where missing~~
- ~~fig 4: make it consistency not equal~~
- ~~fig 5: change proj judgement to analysis~~
- ~~fig 4: change varapp proj to have x in gamma, not gamma comma x~~
- ~~consider matched product, matched arrow to suggest for unknown types~~
- above: not sure i want matched arrow type in fig 5? feels weirder to suggest an unknown typed var for fn than value...
- rankings:
- priviledge more specific types
- read contextual modal types
- ~~replace constructs with construct-expressions~~
- AppProj needs a better treatment for selection (should be first non-empty hole)... chain a separate action?
- implementation: implement ENTER vs TAB

References

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Suggest Hole Analytic
$$\frac{\text{Intros}(\tau) \curvearrowright A_{intros} \qquad \text{Elims}(\Gamma, \tau) \curvearrowright A_{elims}}{\Gamma \vdash \triangleright ⦇⦈ \triangleleft \Leftarrow \tau \curvearrowright A_{intros} \cup A_{elims}}$$

Suggest Expr Analytic
$$\frac{\text{Wraps}(e, \tau) \curvearrowright A_{wraps} \qquad \text{Replaces}(\Gamma, \tau) \curvearrowright A_{replaces}}{\Gamma \vdash \triangleright e \triangleleft \Leftarrow \tau \curvearrowright A_{wraps} \cup A_{replaces}}$$

Replacement
$$\frac{\Gamma \vdash \triangleright ⦇⦈ \triangleleft \Leftarrow \tau \curvearrowright A}{\text{Replaces}(\Gamma, \tau) \curvearrowright \{\texttt{del} \ ; \ \alpha \mid \alpha \in A\}}$$

Wrapping (simple)
$$\frac{\Gamma \vdash e \Rightarrow \tau_e \qquad \tau_e \sim \tau'}{\text{Wraps}(e, \tau) \curvearrowright \{\texttt{construct}\ f(\triangleright e \triangleleft) \mid f : \tau' \to \tau \in \Gamma\}}$$

Figure 2. Suggestion base cases

IntrosTriv
$$\frac{\tau \sim 1}{\text{Intros}(\tau) \curvearrowright \{\texttt{construct}\ \triangleright () \triangleleft\}}$$

IntrosProd
$$\frac{\tau \sim \tau_1 \times \tau_2}{\text{Intros}(\tau) \curvearrowright \{\texttt{construct}\ (\triangleright ⦇⦈ \triangleleft, ⦇⦈)\}}$$

IntrosArrow
$$\frac{\tau \sim \tau_1 \to \tau_2}{\text{Intros}(\tau) \curvearrowright \{\texttt{construct}\ \lambda x. \triangleright ⦇⦈ \triangleleft\}}$$

IntrosSum
$$\frac{\tau \sim \tau_1 + \tau_2}{\text{Intros}(\tau) \curvearrowright \{\texttt{construct inl}(\triangleright ⦇⦈ \triangleleft), \texttt{construct inr}(\triangleright ⦇⦈ \triangleleft)\}}$$

Figure 3. Introduction suggestions

Suggest Elims
$$\frac{\text{ElimCase} \curvearrowright A_{case} \qquad \text{Var}(\Gamma, \tau) \curvearrowright A_{var} \qquad \text{AppProj}(\Gamma, \tau) \curvearrowright A_{approj}}{\text{Elims}(\Gamma, \tau) \curvearrowright A_{case} \cup A_{var} \cup A_{approj}}$$

ElimCase
$$\frac{}{\text{ElimCase} \curvearrowright \{\texttt{construct case}(\triangleright ⦇⦈ \triangleleft, x.⦇⦈, y.⦇⦈)\}}$$

Var
$$\frac{\tau \sim \tau'}{\text{Var}(\Gamma, \tau) \curvearrowright \{\texttt{construct}\ \triangleright x \triangleleft \mid x : \tau' \in \Gamma\}}$$

AppProj
$$\frac{\tau \sim \tau'}{\text{AppProj}(\Gamma, \tau) \curvearrowright \{\texttt{construct}\ \triangleright e \triangleleft \mid x : \tau' \in \Gamma \ \wedge \ \Gamma \vdash x \rightsquigarrow e \Leftarrow \tau\}}$$

Figure 4. Elimination suggestions

$\boxed{\Gamma \vdash e \rightsquigarrow e' \Leftarrow \tau}$ e, applied to 0 or more holes, and projected 0 or more times, yields an expr analyzing to τ

AppProjBase
$$\frac{\Gamma \vdash e \Leftarrow \tau}{\Gamma \vdash e \rightsquigarrow e \Leftarrow \tau}$$

App
$$\frac{\Gamma \vdash e \Rightarrow \tau' \qquad \tau' \blacktriangleright_{\to} \_ \to \_ \qquad \Gamma \vdash e(⦇⦈) \rightsquigarrow e' \Leftarrow \tau}{\Gamma \vdash e \rightsquigarrow e' \Leftarrow \tau}$$

Proj1
$$\frac{\Gamma \vdash e \Rightarrow \tau' \qquad \tau' \blacktriangleright_{\times} \tau \times \_ \qquad \Gamma \vdash \pi_1 e \rightsquigarrow e' \Leftarrow \tau}{\Gamma \vdash e \rightsquigarrow e' \Leftarrow \tau}$$

Proj2
$$\frac{\Gamma \vdash e \Rightarrow \tau' \qquad \tau' \blacktriangleright_{\times} \_ \times \tau \qquad \Gamma \vdash \pi_2 e \rightsquigarrow e' \Leftarrow \tau}{\Gamma \vdash e \rightsquigarrow e' \Leftarrow \tau}$$

Figure 5. Supporting elimination judgments