# Hazel Assistant Calculus WIP

Andrew Blinn
University of Michigan, USA
blinnand@umich.edu

Cyrus Omar
University of Michigan, USA
comar@umich.edu

## 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

**ACM Reference Format:**
Andrew Blinn and Cyrus Omar. 2021. Hazel Assistant Calculus WIP. In *Proceedings of ACM Conference (Conference'17).* ACM, New York, NY, USA, **??** pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

YOOO

## 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
- var + varapp
- NOTE: we basically need a construct expression action for varapp
- proj NOT SURE THIS IS QUITE RIGHT...
- 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
- for all: change type to type consistency

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

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

`Suggest Hole Analytic`

$$\frac{\mathsf{Intros}(\tau) \curvearrowright \mathrm{A}_{intros} \qquad \mathsf{Elims}(\Gamma, \tau) \curvearrowright \mathrm{A}_{elims}}{\Gamma \vdash \triangleright ⦇⦈ \triangleleft \Leftarrow \tau \curvearrowright \mathrm{A}_{intros} \cup \mathrm{A}_{elims}}$$

`Suggest Expr Analytic`

$$\frac{\mathsf{Wraps}(e, \tau) \curvearrowright \mathrm{A}_{wraps} \qquad \mathsf{Replaces}(\Gamma, \tau) \curvearrowright \mathrm{A}_{replaces}}{\Gamma \vdash \triangleright e \triangleleft \Leftarrow \tau \curvearrowright \mathrm{A}_{wraps} \cup \mathrm{A}_{replaces}}$$

`Replacement`

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

`Wrapping (simple)`

$$\frac{\Gamma \vdash e \Rightarrow \tau'}{\mathsf{Wraps}(e, \tau) \curvearrowright \{\mathtt{construct}\ f(e) \mid f : \tau' \rightarrow \tau \in \Gamma\}}$$

**Figure 2.** Suggestion base cases

- 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 hgave x in gamma, not gamma comma x
- consider matched product, matched arrow to suggest for unknown types
- rankings:
- priviledge more specific types
- read contextual modal types

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
*Conference'17, July 2017, Washington, DC, USA*
© 2021 Association for Computing Machinery.
ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

$$\frac{}{\mathsf{Intros}(1) \curvearrowright \{\texttt{construct triv}\}}\ \texttt{IntrosTriv}$$

$$\frac{}{\mathsf{Intros}(\tau_1 \times \tau_2) \curvearrowright \{\texttt{construct pair}\}}\ \texttt{IntrosProd}$$

$$\frac{}{\mathsf{Intros}(\tau_1 \to \tau_2) \curvearrowright \{\texttt{construct lam x}\}}\ \texttt{IntrosArrow}$$

$$\frac{}{\mathsf{Intros}(\tau_1 + \tau_2) \curvearrowright \texttt{construct inj L}, \texttt{construct inj R}}\ \texttt{IntrosSum}$$

**Figure 3.** Introduction suggestions

$$\frac{\mathsf{ElimCase} \curvearrowright A_{case} \qquad \mathsf{Var}(\Gamma,\tau) \curvearrowright A_{var} \qquad \mathsf{VarApp}(\Gamma,\tau) \curvearrowright A_{varapp} \qquad \mathsf{Proj}(\Gamma,\tau) \curvearrowright A_{proj}}{\mathsf{Elims}(\Gamma,\tau) \curvearrowright A_{case} \cup A_{var} \cup A_{varapp} \cup A_{proj}}\ \texttt{Suggest Elims}$$

$$\frac{}{\mathsf{ElimCase} \curvearrowright \{\texttt{construct case x y}\}}\ \texttt{ElimCase}$$

$$\frac{}{\mathsf{Var}(\Gamma,\tau) \curvearrowright \{\texttt{construct var x} \mid x : \tau \in \Gamma\}}\ \texttt{Var}$$

$$\frac{}{\mathsf{VarApp}(\Gamma,\tau) \curvearrowright \{\texttt{construct e} \mid x : \tau \in \Gamma \land \Gamma \vdash x \rightsquigarrow e \Leftarrow \tau\}}\ \texttt{VarApp}$$

$$\frac{}{\mathsf{Proj}(\Gamma,\tau) \curvearrowright \{\texttt{construct e} \mid x : \tau \in \Gamma \land \Gamma \vdash x \twoheadrightarrow e \Leftarrow \tau\}}\ \texttt{Proj}$$

**Figure 4.** Elimination suggestions

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

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

$$\frac{\Gamma \vdash e \Rightarrow \_ \to \_ \qquad \Gamma \vdash e(\langle\!|\,|\!\rangle) \rightsquigarrow e' \Leftarrow \tau}{\Gamma \vdash e \rightsquigarrow e' \Leftarrow \tau}\ \texttt{App}$$

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

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

**Figure 5.** Supporting elimination judgments