Logiweb codex of base

base, $[* \bowtie *]$, " $*$ ", , $*$, $*$, $*[*]*$, **Preassociative** $*;*$, **Postassociative** $*;*$, $[*]$, $*$, priority $*$ end,

$*$, $*$, $(*)^{\mathbf{t}}$, string$(*) + *$, string$(*) ++ *$, pyk, $[* \overset{*}{\to} *]$, $*$ linebreak$[4]$ $*$, bracket $*$ end bracket, big bracket $*$ end bracket, $\$ * \$$, **flush left** $[*]$, x, y, z, tex, name, prio, T, if$(*,*,*)$, $[* \overset{*}{\Rightarrow} *]$, val, $*$, !$*$, "$*$, #$*$, \$$*$, %$*$, &$*$, '$*$, $(*,)*$, $**$, $+*$, ,$*$, -$*$, .$*$, /$*$, 0$*$, 1$*$, 2$*$, 3$*$, 4$*$, 5$*$, 6$*$, 7$*$, 8$*$, 9$*$, :$*$, ;$*$, <$*$, =$*$, >$*$, ?$*$, @$*$, A$*$, B$*$, C$*$, D$*$, E$*$, F$*$, G$*$, H$*$, I$*$, J$*$, K$*$, L$*$, M$*$, N$*$, O$*$, P$*$, Q$*$, R$*$, S$*$, T$*$, U$*$, V$*$, W$*$, X$*$, Y$*$, Z$*$, $[*$, \$*$, $]*$, $\hat{\ }*$, $\_*$, '$*$, a$*$, b$*$, c$*$, d$*$, e$*$, f$*$, g$*$, h$*$, i$*$, j$*$, k$*$, l$*$, m$*$, n$*$, o$*$, p$*$, q$*$, r$*$, s$*$, t$*$, u$*$, v$*$, w$*$, x$*$, y$*$, z$*$, $\{*$, $|*$, $\}*$, $\tilde{\ }*$, claim, $\bot$, f$(*)$, $(*)^{\mathrm{I}}$, F, $\underline{0}$, $\underline{1}$, $\underline{2}$, $\underline{3}$, $\underline{4}$, $\underline{5}$, $\underline{6}$, $\underline{7}$, $\underline{8}$, $\underline{9}$, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, $(*)^{\mathrm{M}}$, If$(*,*,*)$, array$\{*\}$ $*$ end array, l, c, r, empty, $\langle * | * := * \rangle$, $\mathcal{M}(*)$, $\tilde{\mathcal{U}}(*)$, $\mathcal{U}(*)$, $\mathcal{U}^{\mathrm{M}}(*)$, **apply**$(*,*)$, **apply**$_1(*,*)$, identifier$(*)$, identifier$_1(*)$, array-plus$(*,*)$, array-remove$(*,*,*)$, array-put$(*,*,*,*)$, array-add$(*,*,*,*,*)$, bit$(*,*)$, bit$_1(*,*)$, rack, "vector", "bibliography", "dictionary", "body", "codex", "expansion", "code", "cache", "diagnose", "pyk", "tex", "texname", "value", "message", "macro", "definition", "unpack", "claim", "priority", "lambda", "apply", "true", "if", "quote", "proclaim", "define", "introduce", "hide", "pre", "post", $\mathcal{E}(*,*,*)$, $\mathcal{E}_2(*,*,*,*,*)$, $\mathcal{E}_3(*,*,*,*)$, $\mathcal{E}_4(*,*,*,*)$, **lookup**$(*,*,*)$, **abstract**$(*,*,*,*)$, $\lceil * \rceil$, $\mathcal{M}(*,*,*)$, $\mathcal{M}_2(*,*,*,*)$, $\mathcal{M}^*(*,*,*)$, macro, s_0, **zip**$(*,*)$, **assoc**$_1(*,*,*)$, $(*)^{\mathbf{P}}$, self, $[* \overset{\cdot\cdot}{=} *]$, $[* \overset{\cdot}{=} *]$, $[* \overset{\cdot}{=} *]$, $[* \overset{\mathrm{pyk}}{=} *]$, $[* \overset{\mathrm{tex}}{=} *]$, $[* \overset{\mathrm{name}}{=} *]$, **Priority table**$[*]$, $\tilde{\mathcal{M}}_1$, $\tilde{\mathcal{M}}_2(*)$, $\tilde{\mathcal{M}}_3(*)$, $\tilde{\mathcal{M}}_4(*,*,*)$, $\tilde{\mathcal{M}}(*,*)$, $\tilde{\mathcal{Q}}(*,*,*)$, $\tilde{\mathcal{Q}}_2(*,*,*)$, $\tilde{\mathcal{Q}}_3(*,*,*,*)$, $\tilde{\mathcal{Q}}^*(*,*,*)$, $(*)$, $(*)$, display$(*)$, statement$(*)$, $[*]^{\cdot}$, $[*]^{-}$, **aspect**$(*,*)$, **aspect**$(*,*,*)$, $\langle * \rangle$, **tuple**$_1(*)$, **tuple**$_2(*)$, let$_2(*,*)$, let$_1(*,*)$, $[* \overset{\mathrm{claim}}{=} *]$, checker, **check**$(*,*)$, **check**$_2(*,*,*)$, **check**$_3(*,*,*)$, **check**$^*(*,*)$, **check**$_2^*(*,*,*)$, $[*]^{\cdot}$, $[*]^{-}$, $[*]^{\circ}$, msg, $[* \overset{\mathrm{msg}}{=} *]$, <stmt>, stmt, $[* \overset{\mathrm{stmt}}{=} *]$, HeadNil$'$, HeadPair$'$, Transitivity$'$, $\underline{\bot}$, Contra$'$, T'_{E}, L_1, $\underline{*}$, $\mathcal{A}$, $\mathcal{B}$, $\mathcal{C}$, $\mathcal{D}$, $\mathcal{E}$, $\mathcal{F}$, $\mathcal{G}$, $\mathcal{H}$, $\mathcal{I}$, $\mathcal{J}$, $\mathcal{K}$, $\mathcal{L}$, $\mathcal{M}$, $\mathcal{N}$, $\mathcal{O}$, $\mathcal{P}$, $\mathcal{Q}$, $\mathcal{R}$, $\mathcal{S}$, $\mathcal{T}$, $\mathcal{U}$, $\mathcal{V}$, $\mathcal{W}$, $\mathcal{X}$, $\mathcal{Y}$, $\mathcal{Z}$, $\langle * | * := * \rangle$, $\langle '* | * := * \rangle$, $\emptyset$, Remainder, $(*)^{\mathbf{v}}$, intro$(*,*,*,*)$, intro$(*,*,*)$, error$(*,*)$, error$_2(*,*,*)$, proof$(*,*,*)$, proof$_2(*,*,*)$, $\mathcal{S}(*,*)$, $\mathcal{S}^{\mathrm{I}}(*,*)$, $\mathcal{S}^{\triangleright}(*,*)$, $\mathcal{S}_1^{\triangleright}(*,*,*)$, $\mathcal{S}^{\mathrm{E}}(*,*)$, $\mathcal{S}_1^{\mathrm{E}}(*,*,*)$, $\mathcal{S}^{+}(*,*)$, $\mathcal{S}_1^{+}(*,*,*)$, $\mathcal{S}^{-}(*,*)$, $\mathcal{S}_1^{-}(*,*,*)$, $\mathcal{S}^{*}(*,*)$, $\mathcal{S}_1^{*}(*,*,*)$, $\mathcal{S}_2^{*}(*,*,*,*)$, $\mathcal{S}^{@}(*,*)$, $\mathcal{S}_1^{@}(*,*,*)$, $\mathcal{S}^{\vdash}(*,*)$, $\mathcal{S}_1^{\vdash}(*,*,*,*)$, $\mathcal{S}^{\Vdash}(*,*)$, $\mathcal{S}_1^{\Vdash}(*,*,*,*)$, $\mathcal{S}^{\mathrm{i.e.}}(*,*)$, $\mathcal{S}_1^{\mathrm{i.e.}}(*,*,*,*)$, $\mathcal{S}_2^{\mathrm{i.e.}}(*,*,*,*,*)$, $\mathcal{S}^{\forall}(*,*)$, $\mathcal{S}_1^{\forall}(*,*,*)$, $\mathcal{S}^{\mathrm{i}}(*,*)$, $\mathcal{S}_1^{\mathrm{i}}(*,*,*)$, $\mathcal{S}_2^{\mathrm{i}}(*,*,*,*)$, $\mathcal{T}(*)$, claims$(*,*,*)$, claims$_2(*,*,*)$, <proof>, proof, [**Lemma** $*:*$], [**Proof of** $*:*$], [$*$ **lemma** $*:*$], [$*$ **antilemma** $*:*$], [$*$ **rule** $*:*$], [$*$ **antirule** $*:*$], verifier, $\mathcal{V}_1(*)$, $\mathcal{V}_2(*,*)$, $\mathcal{V}_3(*,*,*,*)$, $\mathcal{V}_4(*,*)$, $\mathcal{V}_5(*,*,*,*)$, $\mathcal{V}_6(*,*,*,*)$, $\mathcal{V}_7(*,*,*,*)$, Cut$(*,*)$, Head$_{\oplus}(*)$, Tail$_{\oplus}(*)$, rule$_1(*,*)$, rule$(*,*)$, Rule tactic, Plus$(*,*)$,

[**Theory** ∗], theory$_2$(∗, ∗), theory$_3$(∗, ∗), theory$_4$(∗, ∗, ∗), HeadNil″, HeadPair″, Transitivity″, Contra″, HeadNil, HeadPair, Transitivity, Contra, T$_E$, ragged right, ragged right expansion , parm(∗, ∗, ∗), parm*(∗, ∗, ∗), inst(∗, ∗), inst*(∗, ∗), occur(∗, ∗, ∗), occur*(∗, ∗, ∗), unify(∗ = ∗, ∗), unify*(∗ = ∗, ∗), unify$_2$(∗ = ∗, ∗), L$_a$, L$_b$, L$_c$, L$_d$, L$_e$, L$_f$, L$_g$, L$_h$, L$_i$, L$_j$, L$_k$, L$_l$, L$_m$, L$_n$, L$_o$, L$_p$, L$_q$, L$_r$, L$_s$, L$_t$, L$_u$, L$_v$, L$_w$, L$_x$, L$_y$, L$_z$, L$_A$, L$_B$, L$_C$, L$_D$, L$_E$, L$_F$, L$_G$, L$_H$, L$_I$, L$_J$, L$_K$, L$_L$, L$_M$, L$_N$, L$_O$, L$_P$, L$_Q$, L$_R$, L$_S$, L$_T$, L$_U$, L$_V$, L$_W$, L$_X$, L$_Y$, L$_Z$, L$_?$, Reflexivity, Reflexivity$_1$, Commutativity, Commutativity$_1$, <tactic>, tactic, [∗ $\overset{\text{tactic}}{=}$ ∗], $\mathcal{P}$(∗, ∗, ∗), $\mathcal{P}$*(∗, ∗, ∗), p$_0$, conclude$_1$(∗, ∗), conclude$_2$(∗, ∗, ∗), conclude$_3$(∗, ∗, ∗, ∗), conclude$_4$(∗, ∗), ∗_{∗}, ∗/indexintro(∗, ∗, ∗, ∗), ∗/intro(∗, ∗, ∗), ∗/bothintro(∗, ∗, ∗, ∗, ∗), ∗/nameintro(∗, ∗, ∗, ∗), ∗′, ∗[∗], ∗[∗→∗], ∗[∗⇒∗], ∗0, ∗1, 0b, ∗-color(∗), ∗-color*(∗), ∗^{H}, ∗^{T}, ∗^{U}, ∗^{h}, ∗^{t}, ∗^{s}, ∗^{c}, ∗^{d}, ∗^{a}, ∗^{C}, ∗^{M}, ∗^{B}, ∗^{r}, ∗^{i}, ∗^{d}, ∗^{R}, ∗^{0}, ∗^{1}, ∗^{2}, ∗^{3}, ∗^{4}, ∗^{5}, ∗^{6}, ∗^{7}, ∗^{8}, ∗^{9}, ∗^{E}, ∗$^{\mathcal{V}}$, ∗$^{\mathcal{C}}$, ∗$^{\mathcal{C}^*}$, newline ∗, macro newline ∗, ∗ ' ∗, ∗ ` ∗, ∗ · ∗, ∗ ·$_0$ ∗, ∗ + ∗, ∗ +$_0$ ∗, ∗ +$_1$ ∗, ∗ − ∗, ∗ −$_0$ ∗, ∗ −$_1$ ∗, ∗ ∪ {∗}, ∗ ∪ ∗, ∗\{∗}, ∗ ∴ ∗, ∗ $\underline{∴}$ ∗, ∗ :: ∗, ∗ $\underline{+2∗}$ ∗, ∗ :: ∗, ∗ +2∗ ∗, ∗, ∗, ∗ $\overset{B}{\approx}$ ∗, ∗ $\overset{D}{\approx}$ ∗, ∗ $\overset{C}{\approx}$ ∗, ∗ $\overset{P}{\approx}$ ∗, ∗ ≈ ∗, ∗ = ∗, ∗ $\overset{+}{\to}$ ∗, ∗ $\overset{t}{=}$ ∗, ∗ $\overset{t^*}{=}$ ∗, ∗ $\overset{r}{=}$ ∗, ∗ ∈$_t$ ∗, ∗ ⊆$_T$ ∗, ∗ $\overset{T}{=}$ ∗, ∗ $\overset{s}{=}$ ∗, ∗ free in ∗, ∗ free in* ∗, ∗ free for ∗ in ∗, ∗ free for* ∗ in ∗, ∗ ∈$_c$ ∗, ∗ < ∗, ∗ <′ ∗, ∗ ≤′ ∗, ¬∗, ∗ ∧ ∗, ∗ $\ddot{\wedge}$ ∗, ∗ $\tilde{\wedge}$ ∗, ∗ ∧$_c$ ∗, ∗ ∨ ∗, ∗ ∥ ∗, ∗ $\ddot{\vee}$ ∗, ∗ $\ddot{\Rightarrow}$ ∗, ∗ : ∗, ∗ spy ∗, ∗!∗, ∗ $\left\{ \begin{array}{c} ∗ \\ ∗ \end{array} \right.$, λ ∗ .∗, Λ ∗ .∗, Λ∗,

if ∗ **then** ∗ **else** ∗, **let** ∗ = ∗ **in** ∗, **let** ∗ $\doteq$ ∗ in ∗, ∗^{I}, ∗$^▷$, ∗^{V}, ∗$^+$, ∗$^−$, ∗*, ∗@∗, ∗ ▷ ∗, ∗ ▷ ∗, ∗ ≫ ∗, ∗ ⊢ ∗, ∗ ⊩ ∗, ∗ i.e. ∗, ∀∗:∗, ∗ ⊕ ∗, ∗;∗, ∗ proves ∗, ∗ **proof of** ∗ : ∗, Line ∗ : ∗ ≫ ∗;∗, Last line ∗ ≫ ∗□, Line ∗ : Premise ≫ ∗;∗, Line ∗ : Side-condition ≫ ∗;∗, Arbitrary ≫ ∗;∗, Local ≫ ∗ = ∗;∗, ∗&∗, ∗\\∗,

base

[base $\overset{\text{prio}}{\to}$
Preassociative
[base], [bracket ∗ end bracket], [big bracket ∗ end bracket], [\$ ∗ \$],
[**flush left** [∗]], [x], [y], [z], [[∗ ⋈ ∗]], [[∗ $\overset{*}{\to}$ ∗]], [pyk], [tex], [name], [prio], [∗], [T], [if(∗, ∗, ∗)], [[∗ $\overset{*}{\Rightarrow}$ ∗]], [val], [claim], [⊥], [f(∗)], [(∗)^I], [F], [0], [1], [2], [3], [4], [5], [6], [7], [8], [9], [0], [1], [2], [3], [4], [5], [6], [7], [8], [9], [a], [b], [c], [d], [e], [f], [g], [h], [i], [j], [k], [l], [m], [n], [o], [p], [q], [r], [s], [t], [u], [v], [w], [(∗)^M], [If(∗, ∗, ∗)], [array{∗} ∗ end array], [l], [c], [r], [empty], [⟨∗ | ∗ := ∗⟩], [$\mathcal{M}$(∗)], [$\tilde{\mathcal{U}}$(∗)], [$\mathcal{U}$(∗)], [$\mathcal{U}^M$(∗)], [**apply**(∗, ∗)], [**apply**$_1$(∗, ∗)], [identifier(∗)], [identifier$_1$(∗, ∗)], [array-plus(∗, ∗)], [array-remove(∗, ∗, ∗)], [array-put(∗, ∗, ∗, ∗)], [array-add(∗, ∗, ∗, ∗, ∗)], [bit(∗, ∗)], [bit$_1$(∗, ∗)], [rack], ["vector"], ["bibliography"], ["dictionary"], ["body"], ["codex"], ["expansion"], ["code"], ["cache"], ["diagnose"], ["pyk"], ["tex"], ["texname"], ["value"], ["message"], ["macro"], ["definition"], ["unpack"], ["claim"], ["priority"], ["lambda"], ["apply"], ["true"], ["if"], ["quote"], ["proclaim"], ["define"], ["introduce"], ["hide"], ["pre"], ["post"], [$\mathcal{E}$(∗, ∗, ∗)], [$\mathcal{E}_2$(∗, ∗, ∗, ∗)], [$\mathcal{E}_3$(∗, ∗, ∗)], [$\mathcal{E}_4$(∗, ∗, ∗)], [**lookup**(∗, ∗, ∗)],

[**abstract**(∗, ∗, ∗, ∗)], [[⌜∗⌝]], [$\mathcal{M}$(∗, ∗, ∗)], [$\mathcal{M}_2$(∗, ∗, ∗, ∗)], [$\mathcal{M}^*$(∗, ∗, ∗)], [macro],
[s_0], [**zip**(∗, ∗)], [**assoc**$_1$(∗, ∗, ∗)], [(∗)$^\mathbf{P}$], [self], [[∗ $\overset{.}{=}$ ∗]], [[∗ $\overset{..}{=}$ ∗]], [[∗ $\overset{.}{=}$ ∗]],
[[∗ $\overset{\mathrm{pyk}}{=}$ ∗]], [[∗ $\overset{\mathrm{tex}}{=}$ ∗]], [[∗ $\overset{\mathrm{name}}{=}$ ∗]], [**Priority table**[∗]], [$\tilde{\mathcal{M}}_1$], [$\tilde{\mathcal{M}}_2$(∗)], [$\tilde{\mathcal{M}}_3$(∗)],
[$\tilde{\mathcal{M}}_4$(∗, ∗, ∗, ∗)], [$\tilde{\mathcal{M}}$(∗, ∗, ∗)], [$\tilde{\mathcal{Q}}$(∗, ∗, ∗)], [$\tilde{\mathcal{Q}}_2$(∗, ∗, ∗)], [$\tilde{\mathcal{Q}}_3$(∗, ∗, ∗, ∗)], [$\tilde{\mathcal{Q}}^*$(∗, ∗, ∗)],
[(∗)], [(∗)], [display(∗)], [statement(∗)], [[∗]⌐], [[∗]⁻], [**aspect**(∗, ∗)],
[**aspect**(∗, ∗, ∗)], [⟨∗⟩], [**tuple**$_1$(∗)], [**tuple**$_2$(∗)], [let$_2$(∗, ∗)], [let$_1$(∗, ∗)],
[[∗ $\overset{\mathrm{claim}}{=}$ ∗]], [checker], [**check**(∗, ∗)], [**check**$_2$(∗, ∗, ∗)], [**check**$_3$(∗, ∗, ∗)],
[**check**∗(∗, ∗)], [**check**$_2^*$(∗, ∗, ∗)], [[∗]⌐], [[∗]⁻], [[∗]°], [msg], [[∗ $\overset{\mathrm{msg}}{=}$ ∗]], [<stmt>],
[stmt], [[∗ $\overset{\mathrm{stmt}}{=}$ ∗]], [HeadNil′], [HeadPair′], [Transitivity′], [⫫], [Contra′], [T′$_\mathrm{E}$],
[L_1], [⁎], [$\mathcal{A}$], [$\mathcal{B}$], [$\mathcal{C}$], [$\mathcal{D}$], [$\mathcal{E}$], [$\mathcal{F}$], [$\mathcal{G}$], [$\mathcal{H}$], [$\mathcal{I}$], [$\mathcal{J}$], [$\mathcal{K}$], [$\mathcal{L}$], [$\mathcal{M}$], [$\mathcal{N}$], [$\mathcal{O}$], [$\mathcal{P}$], [$\mathcal{Q}$],
[$\mathcal{R}$], [$\mathcal{S}$], [$\mathcal{T}$], [$\mathcal{U}$], [$\mathcal{V}$], [$\mathcal{W}$], [$\mathcal{X}$], [$\mathcal{Y}$], [$\mathcal{Z}$], [⟨∗ | ∗ := ∗⟩], [⟨′∗ | ∗ := ∗⟩], [∅], [Remainder],
[(∗)$^\mathbf{v}$], [intro(∗, ∗, ∗, ∗)], [intro(∗, ∗, ∗)], [error(∗, ∗)], [error$_2$(∗, ∗)], [proof(∗, ∗, ∗)],
[proof$_2$(∗, ∗)], [$\mathcal{S}$(∗, ∗)], [$\mathcal{S}^\mathrm{I}$(∗, ∗)], [$\mathcal{S}^\triangleright$(∗, ∗)], [$\mathcal{S}_1^\triangleright$(∗, ∗, ∗)], [$\mathcal{S}^\mathrm{E}$(∗, ∗)], [$\mathcal{S}_1^\mathrm{E}$(∗, ∗, ∗)],
[$\mathcal{S}^+$(∗, ∗)], [$\mathcal{S}_1^+$(∗, ∗, ∗)], [$\mathcal{S}^-$(∗, ∗)], [$\mathcal{S}_1^-$(∗, ∗, ∗)], [$\mathcal{S}^*$(∗, ∗)], [$\mathcal{S}_1^*$(∗, ∗, ∗)],
[$\mathcal{S}_2^*$(∗, ∗, ∗, ∗)], [$\mathcal{S}^@$(∗, ∗)], [$\mathcal{S}_1^@$(∗, ∗, ∗)], [$\mathcal{S}^\vdash$(∗, ∗)], [$\mathcal{S}_1^\vdash$(∗, ∗, ∗)], [$\mathcal{S}^\Vdash$(∗, ∗)],
[$\mathcal{S}_1^\Vdash$(∗, ∗, ∗, ∗)], [$\mathcal{S}^\mathrm{i.e.}$(∗, ∗)], [$\mathcal{S}_1^\mathrm{i.e.}$(∗, ∗, ∗, ∗)], [$\mathcal{S}_2^\mathrm{i.e.}$(∗, ∗, ∗, ∗)], [$\mathcal{S}^\forall$(∗, ∗)],
[$\mathcal{S}_1^\forall$(∗, ∗, ∗, ∗)], [$\mathcal{S}^{;}$(∗, ∗)], [$\mathcal{S}_1^{;}$(∗, ∗, ∗)], [$\mathcal{S}_2^{;}$(∗, ∗, ∗, ∗)], [$\mathcal{T}$(∗)], [claims(∗, ∗, ∗)],
[claims$_2$(∗, ∗, ∗)], [<proof>], [proof], [[**Lemma** ∗ : ∗]], [[**Proof of** ∗ : ∗]],
[[∗ **lemma** ∗ : ∗]], [[∗ **antilemma** ∗ : ∗]], [[∗ **rule** ∗ : ∗]], [[∗ **antirule** ∗ : ∗]],
[verifier], [$\mathcal{V}_1$(∗)], [$\mathcal{V}_2$(∗, ∗)], [$\mathcal{V}_3$(∗, ∗, ∗, ∗)], [$\mathcal{V}_4$(∗, ∗)], [$\mathcal{V}_5$(∗, ∗, ∗, ∗)], [$\mathcal{V}_6$(∗, ∗, ∗, ∗)],
[$\mathcal{V}_7$(∗, ∗, ∗, ∗)], [Cut(∗, ∗)], [Head$_\oplus$(∗)], [Tail$_\oplus$(∗)], [rule$_1$(∗, ∗)], [rule(∗, ∗)],
[Rule tactic], [Plus(∗, ∗)], [[**Theory** ∗]], [theory$_2$(∗, ∗)], [theory$_3$(∗, ∗)],
[theory$_4$(∗, ∗, ∗)], [HeadNil″], [HeadPair″], [Transitivity″], [Contra″], [HeadNil],
[HeadPair], [Transitivity], [Contra], [T$_\mathrm{E}$], [ragged right],
[ragged right expansion], [parm(∗, ∗, ∗)], [parm∗(∗, ∗, ∗)], [inst(∗, ∗)],
[inst∗(∗, ∗)], [occur(∗, ∗, ∗)], [occur∗(∗, ∗, ∗)], [unify(∗ = ∗, ∗)], [unify∗(∗ = ∗, ∗)],
[unify$_2$(∗ = ∗, ∗)], [L_a], [L_b], [L_c], [L_d], [L_e], [L_f], [L_g], [L_h], [L_i], [L_j], [L_k], [L_l], [L_m],
[L_n], [L_o], [L_p], [L_q], [L_r], [L_s], [L_t], [L_u], [L_v], [L_w], [L_x], [L_y], [L_z], [L_A], [L_B], [L_C],
[L_D], [L_E], [L_F], [L_G], [L_H], [L_I], [L_J], [L_K], [L_L], [L_M], [L_N], [L_O], [L_P], [L_Q], [L_R],
[L_S], [L_T], [L_U], [L_V], [L_W], [L_X], [L_Y], [L_Z], [$L_?$], [Reflexivity], [Reflexivity$_1$],
[Commutativity], [Commutativity$_1$], [<tactic>], [tactic], [[∗ $\overset{\mathrm{tactic}}{=}$ ∗]], [$\mathcal{P}$(∗, ∗, ∗)],
[$\mathcal{P}^*$(∗, ∗, ∗)], [p_0], [conclude$_1$(∗, ∗)], [conclude$_2$(∗, ∗, ∗)], [conclude$_3$(∗, ∗, ∗, ∗)],
[conclude$_4$(∗, ∗)];

Preassociative
[∗_{∗}], [∗/indexintro(∗, ∗, ∗, ∗)], [∗/intro(∗, ∗, ∗)], [∗/bothintro(∗, ∗, ∗, ∗, ∗)],
[∗/nameintro(∗, ∗, ∗, ∗)], [∗′], [∗[∗]], [∗[∗→∗]], [∗[∗⇒∗]], [∗0], [∗1], [0b], [∗-color(∗)],
[∗-color∗(∗)], [∗$^\mathrm{H}$], [∗$^\mathrm{T}$], [∗$^\mathrm{U}$], [∗$^\mathrm{h}$], [∗$^\mathrm{t}$], [∗$^\mathrm{s}$], [∗$^\mathrm{c}$], [∗$^\mathrm{d}$], [∗$^\mathrm{a}$], [∗$^\mathrm{C}$], [∗$^\mathrm{M}$], [∗$^\mathrm{B}$], [∗$^\mathrm{r}$], [∗$^\mathrm{i}$],
[∗$^\mathrm{d}$], [∗$^\mathrm{R}$], [∗^{0}], [∗^{1}], [∗^{2}], [∗^{3}], [∗^{4}], [∗^{5}], [∗^{6}], [∗^{7}], [∗^{8}], [∗^{9}], [∗$^\mathrm{E}$], [∗$^\mathcal{V}$], [∗$^\mathcal{C}$], [∗$^{\mathcal{C}^*}$];

Preassociative
[" ∗ "], [], [(∗)$^\mathbf{t}$], [string(∗) + ∗], [string(∗) ++ ∗], [
∗], [∗], [!∗], ["∗], [#∗], [$∗], [%∗], [&∗], ['∗], [(∗), [)∗], [∗∗], [+∗], [,∗], [-∗], [.∗], [/∗],
[0∗], [1∗], [2∗], [3∗], [4∗], [5∗], [6∗], [7∗], [8∗], [9∗], [:∗], [;∗], [<∗], [=∗], [>∗], [?∗],
[@∗], [A∗], [B∗], [C∗], [D∗], [E∗], [F∗], [G∗], [H∗], [I∗], [J∗], [K∗], [L∗], [M∗], [N∗],
[O∗], [P∗], [Q∗], [R∗], [S∗], [T∗], [U∗], [V∗], [W∗], [X∗], [Y∗], [Z∗], [[∗], [\∗], []∗], [^∗],

3

[_*], ['*], [a*], [b*], [c*], [d*], [e*], [f*], [g*], [h*], [i*], [j*], [k*], [l*], [m*], [n*], [o*],
[p*], [q*], [r*], [s*], [t*], [u*], [v*], [w*], [x*], [y*], [z*], [{*], [|*], [}*], [~*],
[**Preassociative** *; *], [**Postassociative** *; *], [[*], *], [priority * end],
[newline *], [macro newline *];

Preassociative
[* ' *], [* ` *];

Preassociative
[* · *], [* ·₀ *];

Preassociative
[* + *], [* +₀ *], [* +₁ *], [* − *], [* −₀ *], [* −₁ *];

Preassociative
[* ∪ {*}], [* ∪ *], [*\{*}];

Postassociative
[* ∴ *], [* ∴̲ *], [* ∷̲ *], [* +2* *], [* ∷ *], [* +2* *];

Postassociative
[*, *];

Preassociative
[* ≈̇ᴮ *], [* ≈̇ᴰ *], [* ≈̇ᶜ *], [* ≈̇ᴾ *], [* ≈ *], [* = *], [* →̇ *], [* =̇ᵗ *], [* =̇ᵗ* *], [* =̇ʳ *],
[* ∈ₜ *], [* ⊆ᴛ *], [* =ᵀ *], [* =ˢ *], [* free in *], [* free in* *], [* free for * in *],
[* free for* * in *], [* ∈ᶜ *], [* < *], [* <′ *], [* ≤′ *];

Preassociative
[¬*];

Preassociative
[* ∧ *], [* ∧̈ *], [* ∧̃ *], [* ∧ᶜ *];

Preassociative
[* ∨ *], [* ∥ *], [* ∨̈ *];

Postassociative
[* ⇒̈ *];

Postassociative
[* : *], [* spy *], [*!*];

Preassociative
[* { * * }];

Preassociative
[λ * .*], [Λ * .*], [Λ*], [**if** * **then** * **else** *], [**let** * = * **in** *], [**let** * =̇ * in *];

Preassociative
[*ᴵ], [*▷], [*ⱽ], [*⁺], [*⁻], [**];

Preassociative
[* @ *], [* ▷ *], [* ▶ *], [* ≫ *];

Postassociative
[* ⊢ *], [* ⊪ *], [* i.e. *];

Preassociative
[∀*: *];

Postassociative
[* ⊕ *];

Postassociative
$[*; *];$
Preassociative
$[* \text{ proves } *];$
Preassociative
$[* \textbf{ proof of } * : *], [\text{Line} * : * \gg *; *], [\text{Last line} * \gg * \square],$
$[\text{Line} * : \text{Premise} \gg *; *], [\text{Line} * : \text{Side-condition} \gg *; *], [\text{Arbitrary} \gg *; *],$
$[\text{Local} \gg * = *; *];$
Postassociative
$[* , *], [*[*]*];$
Preassociative
$[*\&*];$
Preassociative
$[*\backslash\backslash *], [* \text{ linebreak}[4] *];]$

$[\text{base} \overset{\text{macro}}{\rightarrow} \lambda \mathsf{t}.\lambda \mathsf{c}.\mathcal{M}(\mathsf{t}, \mathsf{s_0}, \mathsf{c})]$

$[\text{base} \overset{\text{claim}}{\rightarrow} \text{checker} \wedge_{\mathsf{c}} \text{verifier}]$

$[\text{base} \overset{\text{pyk}}{\rightarrow} \text{``base''}]$

$\left[* \bowtie * \right]$

Predef: proclaim

$[[\mathsf{x} \bowtie \mathsf{y}] \overset{\text{tex}}{\rightarrow} ``$
$[\#1/\text{tex name/tex}.$
$\backslash\text{bowtie}\#2.$
$]"]$

$[[* \bowtie *] \overset{\text{pyk}}{\rightarrow} \text{``proclaim " as " end proclaim''}]$


``` * ''


Predef: hide

$[``\mathsf{x}" \overset{\text{name}}{\rightarrow} ``$
$\backslash\text{mbox}\{``\}\#1.$
$\backslash\text{mbox}\{"\}"]$

$[``\mathsf{x}" \overset{\text{macro}}{\rightarrow} \lambda \mathsf{t}.\lambda \mathsf{s}.\lambda \mathsf{c}.\mathsf{t}]$

$[``\mathsf{x}" \overset{\text{tex}}{\rightarrow} ``\#1."]$

$[`` * " \overset{\text{pyk}}{\rightarrow} \text{``unicode start of text " end unicode text''}]$

$[\overset{\text{tex}}{\rightarrow}$ ""]

$[\overset{\text{pyk}}{\rightarrow}$ "unicode end of text"]

$*$ , $*$

$[x , y \overset{\text{name}}{\rightarrow}$ "#1.
\mathrel{\mathrm{,}}#2."]

$[x , y \overset{\text{val}}{\rightarrow} \lceil **\rceil^R :: x :: y :: T]$

$[x , y \overset{\text{tex}}{\rightarrow}$ "#1.#2."]

$[* , * \overset{\text{pyk}}{\rightarrow}$ "" , ""]

$*[\ *\ ]*$

$[x[y]z \overset{\text{name}}{\rightarrow}$ "#1.
{[}#2.
{]}#3."]

$[x[y]z \overset{\text{tex}}{\rightarrow}$ "#1.#2.#3."]

$[*[\ *\ ]* \overset{\text{pyk}}{\rightarrow}$ "" [ "" ] ""]

## Preassociative $*$; $*$

Predef: pre

$[\textbf{Preassociative}\, x; y \overset{\text{name}}{\rightarrow}$ "
\mathbf{Preassociative}\, #1.
; #2."]

$[\textbf{Preassociative}\, x; y \overset{\text{tex}}{\rightarrow}$ "
\newline \mathbf {Preassociative} \newline #1.
; #2."]

$[\textbf{Preassociative}\, *; * \overset{\text{pyk}}{\rightarrow}$ "preassociative " greater than ""]

## Postassociative $*$; $*$

Predef: post

[**Postassociative** x; y $\overset{\text{name}}{\rightarrow}$ "
\mathbf{Postassociative}\, #1.
; #2."]

[**Postassociative** x; y $\overset{\text{tex}}{\rightarrow}$ "
\newline\mathbf{Postassociative} \newline #1.
; #2."]

[**Postassociative** *; * $\overset{\text{pyk}}{\rightarrow}$ "postassociative " greater than ""]


$\left[*\right], *$

[[x], y $\overset{\text{name}}{\rightarrow}$ "
[#1.
] , \linebreak [0] #2."]

[[x], y $\overset{\text{tex}}{\rightarrow}$ "
[#1/tex name/tex.
] , \linebreak [0] #2."]

[[*], * $\overset{\text{pyk}}{\rightarrow}$ "priority " equal ""]


priority $*$ end

[priority x end $\overset{\text{name}}{\rightarrow}$ "
\mathrm{priority} \, #1.
\, \mathrm{end}"]

[priority x end $\overset{\text{tex}}{\rightarrow}$ "
[#1/tex name/tex.
"]

[priority * end $\overset{\text{pyk}}{\rightarrow}$ "priority " end priority"]



$*$

[
x $\overset{\text{name}}{\rightarrow}$ "
\newline #1."]

[
x $\overset{\text{tex}}{\rightarrow}$ "
#1."]

[
$* \overset{\text{pyk}}{\to}$ "unicode newline ""]


$*$

$[* \overset{\text{tex}}{\to}$ "
\ast "]
$[* \overset{\text{pyk}}{\to}$ "x"]


$\left(*\right)^{\mathbf{t}}$

$[(\mathsf{x})^{\mathbf{t}} \overset{\text{name}}{\to}$ "
(#1.
)ˆ{\bf t}"]
$[(\mathsf{x})^{\mathbf{t}} \overset{\text{val}}{\to} \lceil * \rceil^{\text{R}} :: \mathsf{x} :: \mathsf{T}]$
$[(\mathsf{x})^{\mathbf{t}} \overset{\text{tex}}{\to}$ "#1/tex name."]
$[(*)^{\mathbf{t}} \overset{\text{pyk}}{\to}$ "text " end text"]


## $\mathbf{string}(*) + *$

$[\text{string}(\mathsf{x}) + \mathsf{y} \overset{\text{name}}{\to}$ "
\mbox{string}(#1.
)+#2."]
$[\text{string}(\mathsf{x}) + \mathsf{y} \overset{\text{tex}}{\to}$ "
\mathrm{#1/tex name.
}+\newline#2."]
$[\text{string}(*) + * \overset{\text{pyk}}{\to}$ "text " plus ""]


## $\mathbf{string}(*) ++ *$

$[\text{string}(\mathsf{x}) ++ \mathsf{y} \overset{\text{name}}{\to}$ "\mbox{string}(#1.
)\mathrel{++}#2."]
$[\text{string}(\mathsf{x}) ++ \mathsf{y} \overset{\text{tex}}{\to}$ "
\mathrm{#1/tex name.
}\;{++}\newline{}\qquad#2."]

[string(∗) ++ ∗ $\overset{\text{pyk}}{\rightarrow}$ "text " plus indent ""]

# pyk

Predef: pyk

[pyk $\overset{\text{tex}}{\rightarrow}$ "
\mathrm{pyk}"]

[pyk $\overset{\text{pyk}}{\rightarrow}$ "pyk"]

$$\left[\ast \xrightarrow{\ast} \ast\right]$$

Predef: define

[[y $\overset{x}{\rightarrow}$ z] $\overset{\text{tex}}{\rightarrow}$ "
[#2/tex name/tex.
\stackrel{#1.
}{\rightarrow}#3.
]"]

[[∗ $\overset{\ast}{\rightarrow}$ ∗] $\overset{\text{pyk}}{\rightarrow}$ "define " of " as " end define"]

# ∗ linebreak[4] ∗

[x linebreak[4] y $\overset{\text{name}}{\rightarrow}$ "#1.
\mathrel{linebreak[4]} #2."]

[x linebreak[4] y $\overset{\text{tex}}{\rightarrow}$ "#1.
\linebreak[4] #2."]

[∗ linebreak[4] ∗ $\overset{\text{pyk}}{\rightarrow}$ "" linebreak ""]

# bracket ∗ end bracket

[bracket x end bracket $\overset{\text{name}}{\rightarrow}$ "
\mbox{bracket \$#1.\$ end bracket}"]

[bracket x end bracket $\overset{\text{tex}}{\rightarrow}$ "\$[#1.]\$"]

[bracket ∗ end bracket $\overset{\text{pyk}}{\rightarrow}$ "bracket " end bracket"]

## big bracket $*$ end bracket

[big bracket x end bracket $\overset{\text{name}}{\rightarrow}$ "
\mbox{big bracket \$#1.\$ end bracket}"]

[big bracket x end bracket $\overset{\text{tex}}{\rightarrow}$ "\$\left[#1.\right]\$"]

[big bracket $*$ end bracket $\overset{\text{pyk}}{\rightarrow}$ "big bracket " end bracket"]


## $\$ * \$$

[ \$x\$ $\overset{\text{name}}{\rightarrow}$ "
\ \\$#1.\\$\linebreak[0]\ "]

[ \$x\$ $\overset{\text{tex}}{\rightarrow}$ "\$#1.\$"]

[ $\$ * \$$ $\overset{\text{pyk}}{\rightarrow}$ "math " end math"]


## flush left $[*]$

[**flush left** [x] $\overset{\text{name}}{\rightarrow}$ "
\mathbf{flush\ left\ }[ #1.
]"]

[**flush left** [x] $\overset{\text{tex}}{\rightarrow}$ "
\begin {flushleft}#1.
\end {flushleft}"]

[**flush left** $[*]$ $\overset{\text{pyk}}{\rightarrow}$ "flush left " end left"]


## x

[x $\overset{\text{tex}}{\rightarrow}$ "
\mathsf{x}"]

[x $\overset{\text{pyk}}{\rightarrow}$ "var x"]


## y

[y $\overset{\text{tex}}{\rightarrow}$ "
\mathsf{y}"]

[y $\overset{\text{pyk}}{\rightarrow}$ "var y"]

### z

$[\mathsf{z} \xrightarrow{\text{tex}} ``$
$\mathsf{z}\}"]$

$[\mathsf{z} \xrightarrow{\text{pyk}} ``\text{var z}"]$

## tex

Predef: tex

$[\text{tex} \xrightarrow{\text{tex}} ``$
$\mathrm{tex}"]$

$[\text{tex} \xrightarrow{\text{pyk}} ``\text{tex}"]$

## name

Predef: texname

$[\text{name} \xrightarrow{\text{tex}} ``$
$\mathrm{name}"]$

$[\text{name} \xrightarrow{\text{pyk}} ``\text{tex name}"]$

## prio

Predef: priority

$[\text{prio} \xrightarrow{\text{tex}} ``$
$\mathrm{prio}"]$

$[\text{prio} \xrightarrow{\text{pyk}} ``\text{priority}"]$

## T

Predef: true

$[\mathsf{T} \xrightarrow{\text{tex}} ``$
$\mathsf{T}"]$

$[\mathsf{T} \xrightarrow{\text{pyk}} ``\text{true}"]$

## if$(*, *, *)$

Predef: if

$[\mathrm{if}(*, *, *) \overset{\text{tex}}{\to}$ "
\mathrm {if}(#1.
, \linebreak [0]#2.
, \linebreak [0]#3.
)"]

$[\mathrm{if}(*, *, *) \overset{\text{pyk}}{\to}$ "if " then " else " end if"]

## $\left[* \overset{*}{\Rightarrow} *\right]$

Predef: introduce

$[[* \overset{*}{\Rightarrow} *] \overset{\text{tex}}{\to}$ "
[#2/tex name/tex.
\stackrel {#1.
}{\Rightarrow }#3.
"]

$[[* \overset{*}{\Rightarrow} *] \overset{\text{pyk}}{\to}$ "introduce " of " as " end introduce"]

## val

Predef: value

$[\mathrm{val} \overset{\text{tex}}{\to}$ "
\mathrm {val}"]

$[\mathrm{val} \overset{\text{pyk}}{\to}$ "value"]

## $*$

$[\, \mathsf{x} \overset{\text{name}}{\to}$ "
\linebreak [0]\ \hskip0em plus2.0em{}#1."]

$[\, \mathsf{x} \overset{\text{tex}}{\to}$ " #1."]

$[\, * \overset{\text{pyk}}{\to}$ "unicode space ""]

## !∗

[!x $\overset{\text{tex}}{\to}$ "!#1."]

[!∗ $\overset{\text{pyk}}{\to}$ "unicode exclamation mark ""]


## "∗

["x $\overset{\text{name}}{\to}$ "
\mbox {\tt \char34}#1."]

["x $\overset{\text{tex}}{\to}$ ""#1."]

["∗ $\overset{\text{pyk}}{\to}$ "unicode quotation mark ""]


## #∗

[#x $\overset{\text{name}}{\to}$ "
\#·#1."]

[#x $\overset{\text{tex}}{\to}$ "#·#1."]

[#∗ $\overset{\text{pyk}}{\to}$ "unicode number sign ""]


## $∗

[$x $\overset{\text{name}}{\to}$ "
\$#1."]

[$x $\overset{\text{tex}}{\to}$ "$#1."]

[$∗ $\overset{\text{pyk}}{\to}$ "unicode dollar sign ""]


## %∗

[%x $\overset{\text{name}}{\to}$ "
\%#1."]

[%x $\overset{\text{tex}}{\to}$ "%#1."]

[%∗ $\overset{\text{pyk}}{\to}$ "unicode percent ""]

&∗

[&x $\overset{\text{name}}{\rightarrow}$ "
\&#1."]
[&x $\overset{\text{tex}}{\rightarrow}$ "&#1."]
[&∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode ampersand ""]


'∗

['x $\overset{\text{name}}{\rightarrow}$ "
\mbox {'}#1."]
['x $\overset{\text{tex}}{\rightarrow}$ "'#1."]
['∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode apostrophe ""]


(∗

[(x $\overset{\text{tex}}{\rightarrow}$ "(#1."]
[(∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode left parenthesis ""]


)∗

[)x $\overset{\text{tex}}{\rightarrow}$ ")#1."]
[)∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode right parenthesis ""]


∗∗

[∗x $\overset{\text{name}}{\rightarrow}$ "
{∗}#1."]
[∗x $\overset{\text{tex}}{\rightarrow}$ "∗#1."]
[∗∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode asterisk ""]

# $+*$

$[+\mathsf{x} \overset{\text{name}}{\rightarrow} ``$
$\{+\}\#1."]$
$[+\mathsf{x} \overset{\text{tex}}{\rightarrow} ``+\#1."]$
$[+* \overset{\text{pyk}}{\rightarrow} ``\text{unicode plus sign ""}]$

# $,*$

$[,\mathsf{x} \overset{\text{tex}}{\rightarrow} ``,\#1."]$
$[,* \overset{\text{pyk}}{\rightarrow} ``\text{unicode comma ""}]$

# $\text{-}*$

$[\text{-}\mathsf{x} \overset{\text{name}}{\rightarrow} ``$
$\backslash\text{mbox\{-\}}\#1."]$
$[\text{-}\mathsf{x} \overset{\text{tex}}{\rightarrow} ``\text{-}\#1."]$
$[\text{-}* \overset{\text{pyk}}{\rightarrow} ``\text{unicode hyphen ""}]$

# $.*$

$[.\mathsf{x} \overset{\text{tex}}{\rightarrow} ``.\#1."]$
$[.* \overset{\text{pyk}}{\rightarrow} ``\text{unicode period ""}]$

# $/*$

$[/\mathsf{x} \overset{\text{tex}}{\rightarrow} ``/\#1."]$
$[/* \overset{\text{pyk}}{\rightarrow} ``\text{unicode slash ""}]$

# $0*$

$[0\mathsf{x} \overset{\text{tex}}{\rightarrow} ``0\#1."]$
$[0* \overset{\text{pyk}}{\rightarrow} ``\text{unicode zero ""}]$

## 1∗

[1x $\overset{\text{tex}}{\to}$ "1#1."]

[1∗ $\overset{\text{pyk}}{\to}$ "unicode one ""]

## 2∗

[2x $\overset{\text{tex}}{\to}$ "2#1."]

[2∗ $\overset{\text{pyk}}{\to}$ "unicode two ""]

## 3∗

[3x $\overset{\text{tex}}{\to}$ "3#1."]

[3∗ $\overset{\text{pyk}}{\to}$ "unicode three ""]

## 4∗

[4x $\overset{\text{tex}}{\to}$ "4#1."]

[4∗ $\overset{\text{pyk}}{\to}$ "unicode four ""]

## 5∗

[5x $\overset{\text{tex}}{\to}$ "5#1."]

[5∗ $\overset{\text{pyk}}{\to}$ "unicode five ""]

## 6∗

[6x $\overset{\text{tex}}{\to}$ "6#1."]

[6∗ $\overset{\text{pyk}}{\to}$ "unicode six ""]

## 7∗

[7x $\overset{\text{tex}}{\to}$ "7#1."]

$[7* \overset{\text{pyk}}{\rightarrow}$ "unicode seven ""]

## 8*

$[8\text{x} \overset{\text{tex}}{\rightarrow}$ "8#1."]
$[8* \overset{\text{pyk}}{\rightarrow}$ "unicode eight ""]

## 9*

$[9\text{x} \overset{\text{tex}}{\rightarrow}$ "9#1."]
$[9* \overset{\text{pyk}}{\rightarrow}$ "unicode nine ""]

## :*

$[:\text{x} \overset{\text{name}}{\rightarrow}$ "
$\{:\}$#1."]
$[:\text{x} \overset{\text{tex}}{\rightarrow}$ ":#1."]
$[:* \overset{\text{pyk}}{\rightarrow}$ "unicode colon ""]

## ; *

$[;\text{x} \overset{\text{tex}}{\rightarrow}$ "; #1."]
$[; * \overset{\text{pyk}}{\rightarrow}$ "unicode semicolon ""]

## <*

$[<\text{x} \overset{\text{name}}{\rightarrow}$ "
$\{<\}$#1."]
$[<\text{x} \overset{\text{tex}}{\rightarrow}$ "<#1."]
$[<* \overset{\text{pyk}}{\rightarrow}$ "unicode less than ""]

## =∗

[=x $\overset{\text{name}}{\rightarrow}$ "
{=}#1."]

[=x $\overset{\text{tex}}{\rightarrow}$ "=#1."]

[=∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode equal sign ""]


## >∗

[>x $\overset{\text{name}}{\rightarrow}$ "
{>}#1."]

[>x $\overset{\text{tex}}{\rightarrow}$ ">#1."]

[>∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode greater than ""]


## ?∗

[?x $\overset{\text{tex}}{\rightarrow}$ "?#1."]

[?∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode question mark ""]


## @∗

[@x $\overset{\text{tex}}{\rightarrow}$ "@#1."]

[@∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode commercial at ""]


## A∗

[Ax $\overset{\text{tex}}{\rightarrow}$ "A#1."]

[A∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode capital a ""]


## B∗

[Bx $\overset{\text{tex}}{\rightarrow}$ "B#1."]

[B∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode capital b ""]

## C∗

[Cx $\overset{\text{tex}}{\rightarrow}$ "C#1."]

[C∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode capital c ""]

## D∗

[Dx $\overset{\text{tex}}{\rightarrow}$ "D#1."]

[D∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode capital d ""]

## E∗

[Ex $\overset{\text{tex}}{\rightarrow}$ "E#1."]

[E∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode capital e ""]

## F∗

[Fx $\overset{\text{tex}}{\rightarrow}$ "F#1."]

[F∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode capital f ""]

## G∗

[Gx $\overset{\text{tex}}{\rightarrow}$ "G#1."]

[G∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode capital g ""]

## H∗

[Hx $\overset{\text{tex}}{\rightarrow}$ "H#1."]

[H∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode capital h ""]

## I∗

[Ix $\overset{\text{tex}}{\rightarrow}$ "I#1."]

[I∗ $\xrightarrow{\text{pyk}}$ "unicode capital i "”]

## J∗

[Jx $\xrightarrow{\text{tex}}$ "J#1."]
[J∗ $\xrightarrow{\text{pyk}}$ "unicode capital j "”]

## K∗

[Kx $\xrightarrow{\text{tex}}$ "K#1."]
[K∗ $\xrightarrow{\text{pyk}}$ "unicode capital k "”]

## L∗

[Lx $\xrightarrow{\text{tex}}$ "L#1."]
[L∗ $\xrightarrow{\text{pyk}}$ "unicode capital l "”]

## M∗

[Mx $\xrightarrow{\text{tex}}$ "M#1."]
[M∗ $\xrightarrow{\text{pyk}}$ "unicode capital m "”]

## N∗

[Nx $\xrightarrow{\text{tex}}$ "N#1."]
[N∗ $\xrightarrow{\text{pyk}}$ "unicode capital n "”]

## O∗

[Ox $\xrightarrow{\text{tex}}$ "O#1."]
[O∗ $\xrightarrow{\text{pyk}}$ "unicode capital o "”]

## P∗

[Px $\overset{\text{tex}}{\to}$ "P#1."]

[P∗ $\overset{\text{pyk}}{\to}$ "unicode capital p "]

## Q∗

[Qx $\overset{\text{tex}}{\to}$ "Q#1."]

[Q∗ $\overset{\text{pyk}}{\to}$ "unicode capital q "]

## R∗

[Rx $\overset{\text{tex}}{\to}$ "R#1."]

[R∗ $\overset{\text{pyk}}{\to}$ "unicode capital r "]

## S∗

[Sx $\overset{\text{tex}}{\to}$ "S#1."]

[S∗ $\overset{\text{pyk}}{\to}$ "unicode capital s "]

## T∗

[Tx $\overset{\text{tex}}{\to}$ "T#1."]

[T∗ $\overset{\text{pyk}}{\to}$ "unicode capital t "]

## U∗

[Ux $\overset{\text{tex}}{\to}$ "U#1."]

[U∗ $\overset{\text{pyk}}{\to}$ "unicode capital u "]

## V∗

[Vx $\overset{\text{tex}}{\to}$ "V#1."]

[V∗ $\overset{\text{pyk}}{\to}$ "unicode capital v ""]

## W∗

[Wx $\overset{\text{tex}}{\to}$ "W#1."]
[W∗ $\overset{\text{pyk}}{\to}$ "unicode capital w ""]

## X∗

[Xx $\overset{\text{tex}}{\to}$ "X#1."]
[X∗ $\overset{\text{pyk}}{\to}$ "unicode capital x ""]

## Y∗

[Yx $\overset{\text{tex}}{\to}$ "Y#1."]
[Y∗ $\overset{\text{pyk}}{\to}$ "unicode capital y ""]

## Z∗

[Zx $\overset{\text{tex}}{\to}$ "Z#1."]
[Z∗ $\overset{\text{pyk}}{\to}$ "unicode capital z ""]

## [∗

[[x $\overset{\text{tex}}{\to}$ "[#1."]
[[∗ $\overset{\text{pyk}}{\to}$ "unicode left bracket ""]

## \∗

[\x $\overset{\text{name}}{\to}$ "
\mbox {$\backslash $}#1."]
[\x $\overset{\text{tex}}{\to}$ "\#1."]
[\∗ $\overset{\text{pyk}}{\to}$ "unicode backslash ""]

]∗

[]x $\overset{\text{tex}}{\rightarrow}$ "]#1."]
[]∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode right bracket ""]


^∗

[^x $\overset{\text{name}}{\rightarrow}$ "
{\char94}#1."]
[^x $\overset{\text{tex}}{\rightarrow}$ "^#1."]
[^∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode circumflex ""]


_∗

[_x $\overset{\text{name}}{\rightarrow}$ "
\_#1."]
[_x $\overset{\text{tex}}{\rightarrow}$ "_#1."]
[_∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode underscore ""]


'∗

['x $\overset{\text{name}}{\rightarrow}$ "
\mbox {'}#1."]
['x $\overset{\text{tex}}{\rightarrow}$ "'#1."]
['∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode grave accent ""]


a∗

[ax $\overset{\text{tex}}{\rightarrow}$ "a#1."]
[a∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small a ""]


b∗

[bx $\overset{\text{tex}}{\rightarrow}$ "b#1."]

[b∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small b ""]

## c∗

[cx $\overset{\text{tex}}{\rightarrow}$ "c#1."]
[c∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small c ""]

## d∗

[dx $\overset{\text{tex}}{\rightarrow}$ "d#1."]
[d∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small d ""]

## e∗

[ex $\overset{\text{tex}}{\rightarrow}$ "e#1."]
[e∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small e ""]

## f∗

[fx $\overset{\text{tex}}{\rightarrow}$ "f#1."]
[f∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small f ""]

## g∗

[gx $\overset{\text{tex}}{\rightarrow}$ "g#1."]
[g∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small g ""]

## h∗

[hx $\overset{\text{tex}}{\rightarrow}$ "h#1."]
[h∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small h ""]

## i∗

[ix $\overset{\text{tex}}{\rightarrow}$ "i#1."]

[i∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small i ""]

## j∗

[jx $\overset{\text{tex}}{\rightarrow}$ "j#1."]

[j∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small j ""]

## k∗

[kx $\overset{\text{tex}}{\rightarrow}$ "k#1."]

[k∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small k ""]

## l∗

[lx $\overset{\text{tex}}{\rightarrow}$ "l#1."]

[l∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small l ""]

## m∗

[mx $\overset{\text{tex}}{\rightarrow}$ "m#1."]

[m∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small m ""]

## n∗

[nx $\overset{\text{tex}}{\rightarrow}$ "n#1."]

[n∗ $\overset{\text{pyk}}{\rightarrow}$ "unicode small n ""]

## o∗

[ox $\overset{\text{tex}}{\rightarrow}$ "o#1."]

[o∗ $\overset{\text{pyk}}{\to}$ "unicode small o ""]

## p∗

[px $\overset{\text{tex}}{\to}$ "p#1."]
[p∗ $\overset{\text{pyk}}{\to}$ "unicode small p ""]

## q∗

[qx $\overset{\text{tex}}{\to}$ "q#1."]
[q∗ $\overset{\text{pyk}}{\to}$ "unicode small q ""]

## r∗

[rx $\overset{\text{tex}}{\to}$ "r#1."]
[r∗ $\overset{\text{pyk}}{\to}$ "unicode small r ""]

## s∗

[sx $\overset{\text{tex}}{\to}$ "s#1."]
[s∗ $\overset{\text{pyk}}{\to}$ "unicode small s ""]

## t∗

[tx $\overset{\text{tex}}{\to}$ "t#1."]
[t∗ $\overset{\text{pyk}}{\to}$ "unicode small t ""]

## u∗

[ux $\overset{\text{tex}}{\to}$ "u#1."]
[u∗ $\overset{\text{pyk}}{\to}$ "unicode small u ""]

## v∗

[vx $\overset{\text{tex}}{\to}$ "v#1."]

[v∗ $\overset{\text{pyk}}{\to}$ "unicode small v ""]

## w∗

[wx $\overset{\text{tex}}{\to}$ "w#1."]

[w∗ $\overset{\text{pyk}}{\to}$ "unicode small w ""]

## x∗

[xx $\overset{\text{tex}}{\to}$ "x#1."]

[x∗ $\overset{\text{pyk}}{\to}$ "unicode small x ""]

## y∗

[yx $\overset{\text{tex}}{\to}$ "y#1."]

[y∗ $\overset{\text{pyk}}{\to}$ "unicode small y ""]

## z∗

[zx $\overset{\text{tex}}{\to}$ "z#1."]

[z∗ $\overset{\text{pyk}}{\to}$ "unicode small z ""]

## $\{$∗

[{x $\overset{\text{name}}{\to}$ "
\{#1."]

[{x $\overset{\text{tex}}{\to}$ "{#1."]

[{∗ $\overset{\text{pyk}}{\to}$ "unicode left brace ""]

# |∗

[|x $\overset{\text{tex}}{\to}$ "|#1."]

[|∗ $\overset{\text{pyk}}{\to}$ "unicode vertical line ""]

# }∗

[}x $\overset{\text{name}}{\to}$ "
\}#1."]

[}x $\overset{\text{tex}}{\to}$ "}#1."]

[}∗ $\overset{\text{pyk}}{\to}$ "unicode right brace """]

# ~∗

[~x $\overset{\text{name}}{\to}$ "
\char126 #1."]

[~x $\overset{\text{tex}}{\to}$ "~#1."]

[~∗ $\overset{\text{pyk}}{\to}$ "unicode tilde """]

# claim

Predef: claim

[claim $\overset{\text{tex}}{\to}$ "
\mathrm {claim}"]

[claim $\overset{\text{pyk}}{\to}$ "claim"]

# ⊥

[⊥ $\overset{\text{val}}{\Rightarrow}$ $(\lambda x.x$ ' $x)^{\text{I}}$ ' $(\lambda x.x$ ' $x)^{\text{I}}$]

[⊥ $\overset{\text{tex}}{\to}$ "
\bot "]

[⊥ $\overset{\text{pyk}}{\to}$ "bottom"]

$f(*)$

$[f(x) \overset{\text{val}}{\to} \text{if}(x, \mathsf{T}, f(x' \mathsf{T}))]$

$[f(*) \overset{\text{tex}}{\to}$ "
f(#1.
)"]

$[f(*) \overset{\text{pyk}}{\to}$ "function f of " end function"]

$(*)^{\mathrm{I}}$

$[(x)^{\mathrm{I}} \overset{\text{val}}{\to} x]$

$[(*)^{\mathrm{I}} \overset{\text{tex}}{\to}$ "
(#1.
)\{\}\^{}\{I\} "]

$[(*)^{\mathrm{I}} \overset{\text{pyk}}{\to}$ "identity " end identity"]

## F

$[\mathsf{F} \overset{\text{val}}{\Rightarrow} \mathsf{T} \therefore \mathsf{T}]$

$[\mathsf{F} \overset{\text{tex}}{\to}$ "
\mathsf {F}"]

$[\mathsf{F} \overset{\text{pyk}}{\to}$ "false"]

## $\underline{0}$

$[\underline{0} \overset{\text{val}}{\to} \mathsf{T}]$

$[\underline{0} \overset{\text{tex}}{\to}$ "
\underline {0}"]

$[\underline{0} \overset{\text{pyk}}{\to}$ "untagged zero"]

## $\underline{1}$

$[\underline{1} \overset{\text{val}}{\to} \mathsf{F} \underline{+2*}\ \underline{0}]$

$[\underline{1} \overset{\text{tex}}{\to} ``$
\underline {1}"]

$[\underline{1} \overset{\text{pyk}}{\to} \text{"untagged one"}]$

## $\underline{2}$

$[\underline{2} \overset{\text{val}}{\to} \mathsf{T} \ \underline{+2*} \ \underline{1}]$

$[\underline{2} \overset{\text{tex}}{\to} ``$
\underline {2}"]

$[\underline{2} \overset{\text{pyk}}{\to} \text{"untagged two"}]$

## $\underline{3}$

$[\underline{3} \overset{\text{val}}{\to} \mathsf{F} \ \underline{+2*} \ \underline{1}]$

$[\underline{3} \overset{\text{tex}}{\to} ``$
\underline {3}"]

$[\underline{3} \overset{\text{pyk}}{\to} \text{"untagged three"}]$

## $\underline{4}$

$[\underline{4} \overset{\text{val}}{\to} \mathsf{T} \ \underline{+2*} \ \underline{2}]$

$[\underline{4} \overset{\text{tex}}{\to} ``$
\underline {4}"]

$[\underline{4} \overset{\text{pyk}}{\to} \text{"untagged four"}]$

## $\underline{5}$

$[\underline{5} \overset{\text{val}}{\to} \mathsf{F} \ \underline{+2*} \ \underline{2}]$

$[\underline{5} \overset{\text{tex}}{\to} ``$
\underline {5}"]

$[\underline{5} \overset{\text{pyk}}{\to} \text{"untagged five"}]$

## $\underline{6}$

$[\underline{6} \overset{\text{val}}{\to} \mathsf{T} \underline{+2*}\ \underline{3}]$

$[\underline{6} \overset{\text{tex}}{\to}$ "
\underline {6}"]

$[\underline{6} \overset{\text{pyk}}{\to}$ "untagged six"]

## $\underline{7}$

$[\underline{7} \overset{\text{val}}{\to} \mathsf{F} \underline{+2*}\ \underline{3}]$

$[\underline{7} \overset{\text{tex}}{\to}$ "
\underline {7}"]

$[\underline{7} \overset{\text{pyk}}{\to}$ "untagged seven"]

## $\underline{8}$

$[\underline{8} \overset{\text{val}}{\to} \mathsf{T} \underline{+2*}\ \underline{4}]$

$[\underline{8} \overset{\text{tex}}{\to}$ "
\underline {8}"]

$[\underline{8} \overset{\text{pyk}}{\to}$ "untagged eight"]

## $\underline{9}$

$[\underline{9} \overset{\text{val}}{\to} \mathsf{F} \underline{+2*}\ \underline{4}]$

$[\underline{9} \overset{\text{tex}}{\to}$ "
\underline {9}"]

$[\underline{9} \overset{\text{pyk}}{\to}$ "untagged nine"]

## 0

$[0 \overset{\text{val}}{\Rightarrow} \mathsf{T} \therefore \mathsf{T}]$

$[0 \overset{\text{tex}}{\to}$ "
0"]

$[0 \xrightarrow{\text{pyk}} \text{"zero"}]$

# 1

$[1 \xrightarrow{\text{val}} \mathsf{F} + 2* \, 0]$
$[1 \xrightarrow{\text{tex}} \text{"}$
$1\text{"}]$
$[1 \xrightarrow{\text{pyk}} \text{"one"}]$

# 2

$[2 \xrightarrow{\text{val}} \mathsf{T} + 2* \, 1]$
$[2 \xrightarrow{\text{tex}} \text{"}$
$2\text{"}]$
$[2 \xrightarrow{\text{pyk}} \text{"two"}]$

# 3

$[3 \xrightarrow{\text{val}} \mathsf{F} + 2* \, 1]$
$[3 \xrightarrow{\text{tex}} \text{"}$
$3\text{"}]$
$[3 \xrightarrow{\text{pyk}} \text{"three"}]$

# 4

$[4 \xrightarrow{\text{val}} \mathsf{T} + 2* \, 2]$
$[4 \xrightarrow{\text{tex}} \text{"}$
$4\text{"}]$
$[4 \xrightarrow{\text{pyk}} \text{"four"}]$

# 5

$[5 \xrightarrow{\text{val}} \mathsf{F} + 2* \, 2]$

$[5 \xrightarrow{\text{tex}} ``$
$5"]$

$[5 \xrightarrow{\text{pyk}} \text{``five''}]$

# 6

$[6 \xrightarrow{\text{val}} \mathsf{T} +2* 3]$

$[6 \xrightarrow{\text{tex}} ``$
$6"]$

$[6 \xrightarrow{\text{pyk}} \text{``six''}]$

# 7

$[7 \xrightarrow{\text{val}} \mathsf{F} +2* 3]$

$[7 \xrightarrow{\text{tex}} ``$
$7"]$

$[7 \xrightarrow{\text{pyk}} \text{``seven''}]$

# 8

$[8 \xrightarrow{\text{val}} \mathsf{T} +2* 4]$

$[8 \xrightarrow{\text{tex}} ``$
$8"]$

$[8 \xrightarrow{\text{pyk}} \text{``eight''}]$

# 9

$[9 \xrightarrow{\text{val}} \mathsf{F} +2* 4]$

$[9 \xrightarrow{\text{tex}} ``$
$9"]$

$[9 \xrightarrow{\text{pyk}} \text{``nine''}]$

## a

$[a \overset{\text{tex}}{\rightarrow} ``$
$\backslash \text{mathsf } \{a\}"]$

$[a \overset{\text{pyk}}{\rightarrow} ``\text{var a}"]$

## b

$[b \overset{\text{tex}}{\rightarrow} ``$
$\backslash \text{mathsf } \{b\}"]$

$[b \overset{\text{pyk}}{\rightarrow} ``\text{var b}"]$

## c

$[c \overset{\text{tex}}{\rightarrow} ``$
$\backslash \text{mathsf } \{c\}"]$

$[c \overset{\text{pyk}}{\rightarrow} ``\text{var c}"]$

## d

$[d \overset{\text{tex}}{\rightarrow} ``$
$\backslash \text{mathsf } \{d\}"]$

$[d \overset{\text{pyk}}{\rightarrow} ``\text{var d}"]$

## e

$[e \overset{\text{tex}}{\rightarrow} ``$
$\backslash \text{mathsf } \{e\}"]$

$[e \overset{\text{pyk}}{\rightarrow} ``\text{var e}"]$

## f

$[f \overset{\text{tex}}{\rightarrow} ``$
$\backslash \text{mathsf } \{f\}"]$

$[f \overset{\text{pyk}}{\rightarrow} ``\text{var f}"]$

## g

[g $\overset{\text{tex}}{\rightarrow}$ "
\mathsf {g}"]

[g $\overset{\text{pyk}}{\rightarrow}$ "var g"]

## h

[h $\overset{\text{tex}}{\rightarrow}$ "
\mathsf {h}"]

[h $\overset{\text{pyk}}{\rightarrow}$ "var h"]

## i

[i $\overset{\text{tex}}{\rightarrow}$ "
\mathsf {i}"]

[i $\overset{\text{pyk}}{\rightarrow}$ "var i"]

## j

[j $\overset{\text{tex}}{\rightarrow}$ "
\mathsf {j}"]

[j $\overset{\text{pyk}}{\rightarrow}$ "var j"]

## k

[k $\overset{\text{tex}}{\rightarrow}$ "
\mathsf {k}"]

[k $\overset{\text{pyk}}{\rightarrow}$ "var k"]

## l

[l $\overset{\text{tex}}{\rightarrow}$ "
\mathsf {l}"]

[l $\overset{\text{pyk}}{\rightarrow}$ "var l"]

## m

$[\mathsf{m} \overset{\text{tex}}{\to} "$
$\mathsf{\backslash mathsf\ \{m\}}"]$

$[\mathsf{m} \overset{\text{pyk}}{\to} \text{"var m"}]$

## n

$[\mathsf{n} \overset{\text{tex}}{\to} "$
$\mathsf{\backslash mathsf\ \{n\}}"]$

$[\mathsf{n} \overset{\text{pyk}}{\to} \text{"var n"}]$

## o

$[\mathsf{o} \overset{\text{tex}}{\to} "$
$\mathsf{\backslash mathsf\ \{o\}}"]$

$[\mathsf{o} \overset{\text{pyk}}{\to} \text{"var o"}]$

## p

$[\mathsf{p} \overset{\text{tex}}{\to} "$
$\mathsf{\backslash mathsf\ \{p\}}"]$

$[\mathsf{p} \overset{\text{pyk}}{\to} \text{"var p"}]$

## q

$[\mathsf{q} \overset{\text{tex}}{\to} "$
$\mathsf{\backslash mathsf\ \{q\}}"]$

$[\mathsf{q} \overset{\text{pyk}}{\to} \text{"var q"}]$

## r

$[\mathsf{r} \overset{\text{tex}}{\to} "$
$\mathsf{\backslash mathsf\ \{r\}}"]$

$[\mathsf{r} \overset{\text{pyk}}{\to} \text{"var r"}]$

## s

$[\mathsf{s} \overset{\text{tex}}{\rightarrow}$ "
\mathsf {s}"]

$[\mathsf{s} \overset{\text{pyk}}{\rightarrow}$ "var s"]

## t

$[\mathsf{t} \overset{\text{tex}}{\rightarrow}$ "
\mathsf {t}"]

$[\mathsf{t} \overset{\text{pyk}}{\rightarrow}$ "var t"]

## u

$[\mathsf{u} \overset{\text{tex}}{\rightarrow}$ "
\mathsf {u}"]

$[\mathsf{u} \overset{\text{pyk}}{\rightarrow}$ "var u"]

## v

$[\mathsf{v} \overset{\text{tex}}{\rightarrow}$ "
\mathsf {v}"]

$[\mathsf{v} \overset{\text{pyk}}{\rightarrow}$ "var v"]

## w

$[\mathsf{w} \overset{\text{tex}}{\rightarrow}$ "
\mathsf {w}"]

$[\mathsf{w} \overset{\text{pyk}}{\rightarrow}$ "var w"]

## $\left(*\right)^{\mathrm{M}}$

$[(\mathsf{x})^{\mathrm{M}} \overset{\text{val}}{\rightarrow} \mathsf{x}^{\mathrm{M}}]$

$[(*)^{\mathrm{M}} \overset{\text{tex}}{\rightarrow}$ "
(\#1.

)^M"]

$[(*)^{\mathrm{M}} \overset{\mathrm{pyk}}{\to}$ "tagged parenthesis " end tagged"]

## $\mathrm{If}(*, *, *)$

$[\mathrm{If}(\mathsf{x}, \mathsf{y}, \mathsf{z}) \overset{\mathrm{val}}{\Rightarrow} \mathrm{if}(\mathsf{x}^{\mathrm{M}}, \mathsf{y}^{\mathrm{M}}, \mathsf{z}^{\mathrm{M}})]$

$[\mathrm{If}(*, *, *) \overset{\mathrm{tex}}{\to}$ "
\mathrm {If}(#1.
, \linebreak [0]#2.
, \linebreak [0]#3.
)"]

$[\mathrm{If}(*, *, *) \overset{\mathrm{pyk}}{\to}$ "tagged if " then " else " end if"]

## $\mathrm{array}\{*\} * \mathrm{end\ array}$

$[\mathrm{array}\{*\} * \mathrm{end\ array} \overset{\mathrm{name}}{\to}$ "\mathrm {array}\{#1.
\}#2.
\mathrm {end\ array}"]

$[\mathrm{array}\{*\} * \mathrm{end\ array} \overset{\mathrm{tex}}{\to}$ "
\begin {array}{#1.
}#2.
\end {array}"]

$[\mathrm{array}\{*\} * \mathrm{end\ array} \overset{\mathrm{pyk}}{\to}$ "array " is " end array"]

## l

$[\mathrm{l} \overset{\mathrm{tex}}{\to}$ "
l"]

$[\mathrm{l} \overset{\mathrm{pyk}}{\to}$ "left"]

## c

$[\mathrm{c} \overset{\mathrm{tex}}{\to}$ "
c"]

$[\mathrm{c} \overset{\mathrm{pyk}}{\to}$ "center"]

# r

$[\mathrm{r} \xrightarrow{\text{tex}} \text{"}$
$\mathrm{r}\text{"}]$

$[\mathrm{r} \xrightarrow{\text{pyk}} \text{"right"}]$

# empty

$[\mathrm{empty} \xrightarrow{\text{name}} \text{"}$
$\backslash\mathrm{mathrm} \{empty\}\text{"}]$

$[\mathrm{empty} \xrightarrow{\text{tex}} \text{"}$
$\text{"}]$

$[\mathrm{empty} \xrightarrow{\text{pyk}} \text{"empty"}]$

# $\langle * \mid * := * \rangle$

$[\langle * \mid * := * \rangle \xrightarrow{\text{tex}} \text{"}$
$\backslash\mathrm{langle} \ \#1.$
$\backslash, \{|\}\#2.$
$\{:=\}\backslash, \#3.$
$\backslash\mathrm{rangle} \ \text{"}]$

$[\langle * \mid * := * \rangle \xrightarrow{\text{pyk}} \text{"substitute " set " to " end substitute"}]$

# $\mathcal{M}(*)$

$[\mathcal{M}(\mathsf{x}) \xrightarrow{\text{val}} (\underline{0} \mathbin{\underline{\therefore}} \underline{1} \mathbin{\underline{\therefore}} \mathsf{T})^{\mathrm{I}} \mathbin{\therefore} \mathsf{x}]$

$[\mathcal{M}(*) \xrightarrow{\text{tex}} \text{"}$
$\{\backslash\mathrm{cal\ M}\}(\#1.$
$)\text{"}]$

$[\mathcal{M}(*) \xrightarrow{\text{pyk}} \text{"map tag " end tag"}]$

# $\tilde{\mathcal{U}}(*)$

$[\tilde{\mathcal{U}}(\mathsf{x}) \xrightarrow{\text{val}} \mathrm{if}(\mathsf{x}^{\mathrm{d}}, \mathsf{x}, \mathsf{x}^{\mathrm{T}})]$

$[\tilde{\mathcal{U}}(*) \overset{\text{tex}}{\to}$ "
\tilde {{\cal U}}(#1.
)"]

$[\tilde{\mathcal{U}}(*) \overset{\text{pyk}}{\to}$ "raw map untag " end untag"]

# $\mathcal{U}(*)$

$[\mathcal{U}(\mathsf{x}) \overset{\text{val}}{\to} \tilde{\mathcal{U}}(\mathsf{x}^{\mathrm{M}})]$

$[\mathcal{U}(*) \overset{\text{tex}}{\to}$ "
{\cal U}(#1.
)"]

$[\mathcal{U}(*) \overset{\text{pyk}}{\to}$ "map untag " end untag"]

# $\mathcal{U}^{\mathrm{M}}(*)$

$[\mathcal{U}^{\mathrm{M}}(\mathsf{x}) \overset{\text{val}}{\Rightarrow} \mathcal{U}(\mathsf{x})^{\mathrm{M}}]$

$[\mathcal{U}^{\mathrm{M}}(*) \overset{\text{tex}}{\to}$ "
{\cal U}^M(#1.
)"]

$[\mathcal{U}^{\mathrm{M}}(*) \overset{\text{pyk}}{\to}$ "normalizing untag " end untag"]

# $\mathbf{apply}(*, *)$

$[\mathbf{apply}(\mathsf{f}, \mathsf{x}) \overset{\text{val}}{\Rightarrow} \mathbf{apply}_1(\mathsf{f}^{\mathrm{M}}, \mathsf{x}^{\mathrm{M}})]$

$[\mathbf{apply}(*, *) \overset{\text{tex}}{\to}$ "
\mathbf {apply}(#1.
,#2.
)"]

$[\mathbf{apply}(*, *) \overset{\text{pyk}}{\to}$ "apply " to " end apply"]

# $\mathbf{apply}_1(*, *)$

$[\mathbf{apply}_1(\mathsf{f}, \mathsf{x}) \overset{\text{val}}{\to} \mathsf{f}^{\mathrm{d}} \left\{ \begin{array}{l} \mathrm{If}(\mathsf{x}^{\mathrm{d}}, \mathsf{f}, \mathsf{f}) \\ \mathrm{If}(\mathsf{x}^{\mathrm{d}}, \mathcal{M}(\mathsf{f}^{\mathrm{T}} \text{ ' } \mathsf{x}), \mathcal{M}(\mathsf{f}^{\mathrm{T}} \text{ ' } (\mathsf{x}^{\mathrm{T}})^{\mathrm{I}})) \end{array} \right. ]$

$[\mathbf{apply}_1(*,*) \overset{\text{tex}}{\to}$ "
\mathbf {apply}_1(#1.
,#2.
)"]

$[\mathbf{apply}_1(*,*) \overset{\text{pyk}}{\to}$ "apply one " to " end apply"]


# identifier($*$)

$[\text{identifier}(\mathsf{x}) \overset{\text{val}}{\to} \text{If}(\mathsf{x}^t, 0, \text{identifier}_1(\mathsf{x}^i, \text{identifier}(\mathsf{x}^1)))]$

$[\text{identifier}(\mathsf{x}) \overset{\text{tex}}{\to}$ "
identifier( #1.
)"]

$[\text{identifier}(*) \overset{\text{pyk}}{\to}$ "identifier " end identifier"]


# identifier$_1(*, *)$

$[\text{identifier}_1(\mathsf{x}, \mathsf{y}) \overset{\text{val}}{\to} \text{If}(\mathsf{x}^6, \mathsf{y},$
$\mathsf{x}^0 +2* \mathsf{x}^1 +2* \mathsf{x}^2 +2* \mathsf{x}^3 +2* \mathsf{x}^4 +2* \mathsf{x}^5 +2* \mathsf{F} +2* \mathsf{T} +2* \mathsf{y})]$

$[\text{identifier}_1(\mathsf{x}, \mathsf{y}) \overset{\text{tex}}{\to}$ "
identifier_{1}( #1.
, #2.
)"]

$[\text{identifier}_1(*, *) \overset{\text{pyk}}{\to}$ "identifier one " plus id " end identifier"]


# array-plus($*, *$)

$$[\text{array-plus}(\mathsf{x}, \mathsf{y}) \overset{\text{val}}{\to} \mathsf{x}^a \left\{ \begin{array}{l} \mathsf{y}^a \left\{ \begin{array}{l} \mathsf{T} \\ \mathsf{y}^{hc} \left\{ \begin{array}{l} \mathsf{y} \\ \mathsf{x} :: \mathsf{y} \end{array} \right. \end{array} \right. \\ \mathsf{y}^a \left\{ \begin{array}{l} \mathsf{x}^{hc} \left\{ \begin{array}{l} \mathsf{x} \\ \mathsf{x} :: \mathsf{y} \end{array} \right. \\ \mathsf{x} :: \mathsf{y} \end{array} \right. \end{array} \right. \quad ]$$

$[\text{array-plus}(\mathsf{x}, \mathsf{y}) \overset{\text{tex}}{\to}$ "
array\mbox{-}\linebreak[0]plus( #1.
, #2.
)"]

$[\text{array-plus}(*, *) \overset{\text{pyk}}{\to}$ "array plus " and " end plus"]

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## array-remove$(*, *, *)$

[array-remove$(\mathsf{i}, \mathsf{a}, \mathsf{l}) \overset{\text{val}}{\to}$

$\mathsf{i}!\mathsf{l}!\mathsf{a}^{\mathsf{a}} \begin{cases} \mathsf{T} \\ \mathsf{a}^{\text{hc}} \begin{cases} \mathsf{a}^{\text{h}} \approx \mathsf{i} \begin{cases} \mathsf{T} \\ \mathsf{a} \end{cases} \\ \text{bit}(\mathsf{l}, \mathsf{i}) \begin{cases} \text{array-plus}(\text{array-remove}(\mathsf{i}, \mathsf{a}^{\text{h}}, \mathsf{l} + 1), \mathsf{a}^{\text{t}}) \\ \text{array-plus}(\mathsf{a}^{\text{h}}, \text{array-remove}(\mathsf{i}, \mathsf{a}^{\text{t}}, \mathsf{l} + 1)) \end{cases} \end{cases} \end{cases}$ ]

[array-remove$(\mathsf{i}, \mathsf{a}, \mathsf{l}) \overset{\text{tex}}{\to}$ "
array\mbox{-}\linebreak[0]remove( #1.
, #2.
, #3.
)"]

[array-remove$(*, *, *) \overset{\text{pyk}}{\to}$ "array remove " array " level " end remove"]

## array-put$(*, *, *, *)$

[array-put$(\mathsf{i}, \mathsf{v}, \mathsf{a}, \mathsf{l}) \overset{\text{val}}{\to}$

$\mathsf{l}!\mathsf{a}^{\mathsf{a}} \begin{cases} \mathsf{i} :: \mathsf{v} \\ \mathsf{a}^{\text{hc}} \begin{cases} \mathsf{a}^{\text{h}} \approx \mathsf{i} \begin{cases} \mathsf{i} :: \mathsf{v} \\ \text{array-add}(\mathsf{i}, \mathsf{v}, \mathsf{a}^{\text{h}}, \mathsf{a}^{\text{t}}, \mathsf{l}) \end{cases} \\ \text{bit}(\mathsf{l}, \mathsf{i}) \begin{cases} \text{array-put}(\mathsf{i}, \mathsf{v}, \mathsf{a}^{\text{h}}, \mathsf{l} + 1) :: \mathsf{a}^{\text{t}} \\ \mathsf{a}^{\text{h}} :: \text{array-put}(\mathsf{i}, \mathsf{v}, \mathsf{a}^{\text{t}}, \mathsf{l} + 1) \end{cases} \end{cases} \end{cases}$ ]

[array-put$(\mathsf{i}, \mathsf{v}, \mathsf{a}, \mathsf{l}) \overset{\text{tex}}{\to}$ "
array\mbox{-}\linebreak[0]put( #1.
, #2.
, #3.
, #4.
)"]

[array-put$(*, *, *, *) \overset{\text{pyk}}{\to}$ "array put " value " array " level " end put"]

## array-add$(*, *, *, *, *)$

[array-add$(\mathsf{i}, \mathsf{v}, \mathsf{i}', \mathsf{v}', \mathsf{l}) \overset{\text{val}}{\to}$

$\text{bit}(\mathsf{l}, \mathsf{i}) \begin{cases} \text{bit}(\mathsf{l}, \mathsf{i}') \begin{cases} \text{array-add}(\mathsf{i}, \mathsf{v}, \mathsf{i}', \mathsf{v}', \mathsf{l} + 1) :: \mathsf{T} \\ (\mathsf{i} :: \mathsf{v})^{\text{M}} :: (\mathsf{i}' :: \mathsf{v}')^{\text{M}} \end{cases} \\ \text{bit}(\mathsf{l}, \mathsf{i}') \begin{cases} (\mathsf{i}' :: \mathsf{v}')^{\text{M}} :: (\mathsf{i} :: \mathsf{v})^{\text{M}} \\ \mathsf{T} :: \text{array-add}(\mathsf{i}, \mathsf{v}, \mathsf{i}', \mathsf{v}', \mathsf{l} + 1) \end{cases} \end{cases}$ ]

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[array-add(i, v, i', v', l) $\overset{\text{tex}}{\rightarrow}$ "
array\mbox{-}\linebreak[0]add( #1.
, #2.
, #3.
, #4.
, #5.
)"]

[array-add($*, *, *, *, *$) $\overset{\text{pyk}}{\rightarrow}$ "array add " value " index " value " level " end add"]


# bit$(*, *)$

[bit(x, y) $\overset{\text{val}}{\rightarrow}$ If(x$^c \wedge$ y$^c$, bit$_1$(x, y), T)]

[bit(x, y) $\overset{\text{tex}}{\rightarrow}$ "
bit( #1.
, #2.
)"]

[bit$(*, *)$ $\overset{\text{pyk}}{\rightarrow}$ "bit " of " end bit"]


# bit$_1(*, *)$

[bit$_1$(x, y) $\overset{\text{val}}{\rightarrow}$ If(x$^s$, y$^h$, bit(x $-$ 1, y$^t$))]

[bit$_1$(x, y) $\overset{\text{tex}}{\rightarrow}$ "
bit_1( #1.
, #2.
)"]

[bit$_1(*, *)$ $\overset{\text{pyk}}{\rightarrow}$ "bit one " of " end bit"]


# rack

[rack $\overset{\text{val}}{\rightarrow}$ base[base[0]]]

[rack $\overset{\text{tex}}{\rightarrow}$ "
rack"]

[rack $\overset{\text{pyk}}{\rightarrow}$ "example rack"]

## "vector"

["vector" $\overset{\mathrm{val}}{\to}$ identifier($\lceil$"vector"$\rceil$)]

["vector" $\overset{\mathrm{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {vector}\mbox {\tt \char34}"]

["vector" $\overset{\mathrm{pyk}}{\to}$ "vector hook"]


## "bibliography"

["bibliography" $\overset{\mathrm{val}}{\to}$ identifier($\lceil$"bibliography"$\rceil$)]

["bibliography" $\overset{\mathrm{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {bibliography}\mbox {\tt \char34}"]

["bibliography" $\overset{\mathrm{pyk}}{\to}$ "bibliography hook"]


## "dictionary"

["dictionary" $\overset{\mathrm{val}}{\to}$ identifier($\lceil$"dictionary"$\rceil$)]

["dictionary" $\overset{\mathrm{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {dictionary}\mbox {\tt \char34}"]

["dictionary" $\overset{\mathrm{pyk}}{\to}$ "dictionary hook"]


## "body"

["body" $\overset{\mathrm{val}}{\to}$ identifier($\lceil$"body"$\rceil$)]

["body" $\overset{\mathrm{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {body}\mbox {\tt \char34}"]

["body" $\overset{\mathrm{pyk}}{\to}$ "body hook"]


## "codex"

["codex" $\overset{\mathrm{val}}{\to}$ identifier($\lceil$"codex"$\rceil$)]

["codex" $\overset{\mathrm{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {codex}\mbox {\tt \char34}"]

["codex" $\overset{\text{pyk}}{\rightarrow}$ "codex hook"]

## "expansion"

["expansion" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"expansion"$\rceil$)]

["expansion" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {expansion}\mbox {\tt \char34}"]

["expansion" $\overset{\text{pyk}}{\rightarrow}$ "expansion hook"]

## "code"

["code" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"code"$\rceil$)]

["code" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {code}\mbox {\tt \char34}"]

["code" $\overset{\text{pyk}}{\rightarrow}$ "code hook"]

## "cache"

["cache" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"cache"$\rceil$)]

["cache" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {cache}\mbox {\tt \char34}"]

["cache" $\overset{\text{pyk}}{\rightarrow}$ "cache hook"]

## "diagnose"

["diagnose" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"diagnose"$\rceil$)]

["diagnose" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {diagnose}\mbox {\tt \char34}"]

["diagnose" $\overset{\text{pyk}}{\rightarrow}$ "diagnose hook"]

## "pyk"

["pyk" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"pyk"$\rceil$)]

["pyk" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {pyk}\mbox {\tt \char34}"]

["pyk" $\overset{\text{pyk}}{\to}$ "pyk aspect"]

## "tex"

["tex" $\overset{\text{val}}{\to}$ identifier($\lceil$"tex"$\rceil$)]

["tex" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {tex}\mbox {\tt \char34}"]

["tex" $\overset{\text{pyk}}{\to}$ "tex aspect"]

## "texname"

["texname" $\overset{\text{val}}{\to}$ identifier($\lceil$"texname"$\rceil$)]

["texname" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {texname}\mbox {\tt \char34}"]

["texname" $\overset{\text{pyk}}{\to}$ "texname aspect"]

## "value"

["value" $\overset{\text{val}}{\to}$ identifier($\lceil$"value"$\rceil$)]

["value" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {value}\mbox {\tt \char34}"]

["value" $\overset{\text{pyk}}{\to}$ "value aspect"]

## "message"

["message" $\overset{\text{val}}{\to}$ identifier($\lceil$"message"$\rceil$)]

["message" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {message}\mbox {\tt \char34}"]

["message" $\overset{\text{pyk}}{\to}$ "message aspect"]

## "macro"

["macro" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"macro"$\rceil$)]

["macro" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {macro}\mbox {\tt \char34}"]

["macro" $\overset{\text{pyk}}{\rightarrow}$ "macro aspect"]

## "definition"

["definition" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"definition"$\rceil$)]

["definition" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {definition}\mbox {\tt \char34}"]

["definition" $\overset{\text{pyk}}{\rightarrow}$ "definition aspect"]

## "unpack"

["unpack" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"unpack"$\rceil$)]

["unpack" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {unpack}\mbox {\tt \char34}"]

["unpack" $\overset{\text{pyk}}{\rightarrow}$ "unpack aspect"]

## "claim"

["claim" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"claim"$\rceil$)]

["claim" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {claim}\mbox {\tt \char34}"]

["claim" $\overset{\text{pyk}}{\rightarrow}$ "claim aspect"]

## "priority"

["priority" $\overset{\text{val}}{\rightarrow}$ identifier($\lceil$"priority"$\rceil$)]

["priority" $\overset{\text{tex}}{\rightarrow}$ "
\mbox {\tt \char34}\mathrm {priority}\mbox {\tt \char34}"]

["priority" $\overset{\text{pyk}}{\rightarrow}$ "priority aspect"]

## "lambda"

["lambda" $\overset{\text{val}}{\to}$ identifier($\lceil$"lambda"$\rceil$)]

["lambda" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {lambda}\mbox {\tt \char34}"]

["lambda" $\overset{\text{pyk}}{\to}$ "lambda identifier"]

## "apply"

["apply" $\overset{\text{val}}{\to}$ identifier($\lceil$"apply"$\rceil$)]

["apply" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {apply}\mbox {\tt \char34}"]

["apply" $\overset{\text{pyk}}{\to}$ "apply identifier"]

## "true"

["true" $\overset{\text{val}}{\to}$ identifier($\lceil$"true"$\rceil$)]

["true" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {true}\mbox {\tt \char34}"]

["true" $\overset{\text{pyk}}{\to}$ "true identifier"]

## "if"

["if" $\overset{\text{val}}{\to}$ identifier($\lceil$"if"$\rceil$)]

["if" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {if}\mbox {\tt \char34}"]

["if" $\overset{\text{pyk}}{\to}$ "if identifier"]

## "quote"

["quote" $\overset{\text{val}}{\to}$ identifier($\lceil$"quote"$\rceil$)]

["quote" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {quote}\mbox {\tt \char34}"]

["quote" $\overset{\text{pyk}}{\to}$ "quote identifier"]

## "proclaim"

["proclaim" $\overset{\text{val}}{\to}$ identifier($\ulcorner$"proclaim"$\urcorner$)]

["proclaim" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {proclaim}\mbox {\tt \char34}"]

["proclaim" $\overset{\text{pyk}}{\to}$ "proclaim identifier"]


## "define"

["define" $\overset{\text{val}}{\to}$ identifier($\ulcorner$"define"$\urcorner$)]

["define" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {define}\mbox {\tt \char34}"]

["define" $\overset{\text{pyk}}{\to}$ "define identifier"]


## "introduce"

["introduce" $\overset{\text{val}}{\to}$ identifier($\ulcorner$"introduce"$\urcorner$)]

["introduce" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {introduce}\mbox {\tt \char34}"]

["introduce" $\overset{\text{pyk}}{\to}$ "introduce identifier"]


## "hide"

["hide" $\overset{\text{val}}{\to}$ identifier($\ulcorner$"hide"$\urcorner$)]

["hide" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {hide}\mbox {\tt \char34}"]

["hide" $\overset{\text{pyk}}{\to}$ "hide identifier"]


## "pre"

["pre" $\overset{\text{val}}{\to}$ identifier($\ulcorner$"pre"$\urcorner$)]

["pre" $\overset{\text{tex}}{\to}$ "
\mbox {\tt \char34}\mathrm {pre}\mbox {\tt \char34}"]

["pre" $\overset{\text{pyk}}{\to}$ "pre identifier"]

## "post"

$["post" \overset{\text{val}}{\to} \text{identifier}(\ulcorner "post" \urcorner)]$

$["post" \overset{\text{tex}}{\to} ``$
\mbox {\tt \char34}\mathrm {post}\mbox {\tt \char34}"]

$["post" \overset{\text{pyk}}{\to} ``\text{post identifier}"]$

## $\mathcal{E}(*, *, *)$

$[\mathcal{E}(\mathsf{t}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\to} \mathcal{E}_2(\mathsf{t}, \mathsf{t}^{\mathsf{r}}, \mathsf{t}^{\mathsf{i}}, \mathsf{s}, \mathsf{c})]$

$[\mathcal{E}(*, *, *) \overset{\text{tex}}{\to} ``$
{\cal E}(#1.
, #2.
, #3.
)"]

$[\mathcal{E}(*, *, *) \overset{\text{pyk}}{\to} ``\text{eval " stack " cache " end eval}"]$

## $\mathcal{E}_2(*, *, *, *, *)$

$[\mathcal{E}_2(\mathsf{t}, \mathsf{r}, \mathsf{i}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\to} \mathsf{i}^{\mathsf{s}} \left\{ \begin{array}{l} \mathsf{t}!\mathsf{s}!\text{If}(\mathsf{r} \approx \mathsf{c}[0], \mathsf{c}, \mathsf{c}[\mathsf{c}[0]]["\text{cache}"][\mathsf{r}]) \\ \mathcal{E}_3(\mathsf{t}, \mathsf{c}[\mathsf{r}]["\text{code}"][\mathsf{i}], \mathsf{s}, \mathsf{c}) \end{array} \right. ]$

$[\mathcal{E}_2(*, *, *, *, *) \overset{\text{tex}}{\to} ``$
{\cal E}_2(#1.
, #2.
, #3.
, #4.
, #5.
)"]

$[\mathcal{E}_2(*, *, *, *, *) \overset{\text{pyk}}{\to} ``\text{eval two " ref " id " stack " cache " end eval}"]$

## $\mathcal{E}_3(*, *, *, *)$

$[\mathcal{E}_3(\mathsf{t}, \mathsf{f}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\to} \mathsf{f}^{\mathsf{c}} \left\{ \begin{array}{l} \mathsf{f}^{\mathsf{s}} \left\{ \begin{array}{l} \mathbf{abstract}(\mathsf{t}^1, \mathsf{t}^2, \mathsf{s}, \mathsf{c}) \\ \mathsf{c}!\mathsf{s}!\mathsf{t}^1 \end{array} \right. \\ \mathsf{f} \left\{ \begin{array}{l} \mathsf{c}!\mathbf{lookup}(\mathsf{t}, \mathsf{s}, \mathsf{T}) \\ \mathcal{E}_4(\mathsf{f}, \mathsf{t}^{\mathsf{t}}, \mathsf{s}, \mathsf{c}) \end{array} \right. \end{array} \right. ]$

$[\mathcal{E}_3(*, *, *, *) \overset{\text{tex}}{\rightarrow} \text{``}$
$\{\backslash\text{cal E}\}\_3(\#1.$
$, \#2.$
$, \#3.$
$, \#4.$
$)\text{''}]$

$[\mathcal{E}_3(*, *, *, *) \overset{\text{pyk}}{\rightarrow} \text{``eval three '' function '' stack '' cache '' end eval''}]$

## $\mathcal{E}_4(*, *, *, *)$

$[\mathcal{E}_4(\mathsf{f}, \mathsf{a}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\rightarrow} \text{If}(\mathsf{a}, \mathsf{s}!\mathsf{c}!\mathsf{f}, \mathcal{E}_4(\mathbf{apply}(\mathsf{f}, \mathcal{E}(\mathsf{a}^{\mathsf{h}}, \mathsf{s}, \mathsf{c})), \mathsf{a}^{\mathsf{t}}, \mathsf{s}, \mathsf{c}))]$

$[\mathcal{E}_4(*, *, *, *) \overset{\text{tex}}{\rightarrow} \text{``}$
$\{\backslash\text{cal E}\}\_4(\#1.$
$, \#2.$
$, \#3.$
$, \#4.$
$)\text{''}]$

$[\mathcal{E}_4(*, *, *, *) \overset{\text{pyk}}{\rightarrow} \text{``eval four '' arguments '' stack '' cache '' end eval''}]$

## $\mathbf{lookup}(*, *, *)$

$[\mathbf{lookup}(\mathsf{v}, \mathsf{s}, \mathsf{d}) \overset{\text{val}}{\rightarrow} \mathsf{v}!\mathsf{d}!\text{If}(\mathsf{s}, \mathsf{d}, \text{If}(\mathsf{v} \overset{\text{t}}{=} \mathsf{s}^{\mathsf{hh}}, \mathsf{s}^{\mathsf{ht}}, \mathbf{lookup}(\mathsf{v}, \mathsf{s}^{\mathsf{t}}, \mathsf{d})))]$

$[\mathbf{lookup}(*, *, *) \overset{\text{tex}}{\rightarrow} \text{``}$
$\backslash\text{mathbf }\{\text{lookup}\}(\#1.$
$, \#2.$
$, \#3.$
$)\text{''}]$

$[\mathbf{lookup}(*, *, *) \overset{\text{pyk}}{\rightarrow} \text{``lookup '' stack '' default '' end lookup''}]$

## $\mathbf{abstract}(*, *, *, *)$

$[\mathbf{abstract}(\mathsf{v}, \mathsf{t}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\rightarrow} \mathsf{v}!\mathsf{t}!\mathsf{s}!\mathsf{c}!\Lambda\lambda\mathsf{x}.\mathcal{E}(\mathsf{t}, (\mathsf{v} :: \mathsf{x})^{\mathrm{M}} :: \mathsf{s}, \mathsf{c})]$

$[\mathbf{abstract}(*, *, *, *) \overset{\text{tex}}{\rightarrow} \text{``}$
$\backslash\text{mathbf }\{\text{abstract}\}(\#1.$
$, \#2.$
$, \#3.$

, #4.
)"]

[**abstract**$(*, *, *, *) \overset{\text{pyk}}{\rightarrow}$ "abstract " term " stack " cache " end abstract"]

$$\lceil * \rceil$$

Predef: quote

$[[\lceil * \rceil] \overset{\text{tex}}{\rightarrow}$ "
\lceil #1.
\rceil "]

$[[\lceil * \rceil] \overset{\text{pyk}}{\rightarrow}$ "quote " end quote"]

$$\mathcal{M}(*, *, *)$$

$[\mathcal{M}(\mathsf{t}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\rightarrow} \mathsf{s}!\mathsf{c}!\mathrm{If}(\mathsf{t}^{\mathrm{is}}, \mathsf{t}, \mathcal{M}_2(\mathsf{t}, \mathbf{aspect}("\mathrm{macro}", \mathsf{t}, \mathsf{c}), \mathsf{s}, \mathsf{c}))]$

$[\mathcal{M}(*, *, *) \overset{\text{tex}}{\rightarrow}$ "
{\cal M}(#1.
, #2.
, #3.
)"]

$[\mathcal{M}(*, *, *) \overset{\text{pyk}}{\rightarrow}$ "expand " state " cache " end expand"]

$$\mathcal{M}_2(*, *, *, *)$$

$[\mathcal{M}_2(\mathsf{t}, \mathsf{d}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\rightarrow} \mathsf{d} \begin{cases} \mathsf{t}^{\mathrm{h}} :: \mathcal{M}^*(\mathsf{t}^{\mathrm{t}}, \mathsf{s}, \mathsf{c}) \\ \mathcal{U}^{\mathrm{M}}(\mathcal{E}(\mathsf{d}^3, \mathsf{T}, \mathsf{c}) \cdot \mathsf{t} \cdot \mathsf{s} \cdot \mathsf{c}) \end{cases} ]$

$[\mathcal{M}_2(*, *, *, *) \overset{\text{tex}}{\rightarrow}$ "
{\cal M}\_2(#1.
, #2.
, #3.
, #4.
)"]

$[\mathcal{M}_2(*, *, *, *) \overset{\text{pyk}}{\rightarrow}$ "expand two " definition " state " cache " end expand"]

$\mathcal{M}^*(*, *, *)$

$[\mathcal{M}^*(\mathsf{a}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\rightarrow} \mathsf{s}!\mathsf{c}!\mathsf{If}(\mathsf{a}, \mathsf{T}, \mathcal{M}(\mathsf{a}^\mathsf{h}, \mathsf{s}, \mathsf{c}) :: \mathcal{M}^*(\mathsf{a}^\mathsf{t}, \mathsf{s}, \mathsf{c}))]$

$[\mathcal{M}^*(*, *, *) \overset{\text{tex}}{\rightarrow}$ "
{\cal M}^*(#1.
,#2.
,#3.
)"]

$[\mathcal{M}^*(*, *, *) \overset{\text{pyk}}{\rightarrow}$ "expand list " state " cache " end expand"]

## macro

Predef: macro
[macro $\overset{\text{tex}}{\rightarrow}$ "
\mathrm {macro}"]

[macro $\overset{\text{pyk}}{\rightarrow}$ "macro"]

$\mathsf{s}_0$

$[\mathsf{s}_0 \overset{\text{val}}{\rightarrow} \mathcal{M}(\lambda \mathsf{t}.\lambda \mathsf{s}.\lambda \mathsf{c}.\mathcal{M}(\mathsf{t}, \mathsf{s}, \mathsf{c})) :: \mathsf{T}]$

$[\mathsf{s}_0 \overset{\text{tex}}{\rightarrow}$ "
s_0"]

$[\mathsf{s}_0 \overset{\text{pyk}}{\rightarrow}$ "macro state"]

## $\mathbf{zip}(*, *)$

$[\mathbf{zip}(\mathsf{p}, \mathsf{a}) \overset{\text{val}}{\rightarrow} \mathsf{a}!\mathsf{If}(\mathsf{p}, \mathsf{T}, (\mathsf{p}^\mathsf{h} :: \mathsf{a}^\mathsf{h})^\mathsf{M} :: \mathbf{zip}(\mathsf{p}^\mathsf{t}, \mathsf{a}^\mathsf{t}))]$

$[\mathbf{zip}(*, *) \overset{\text{tex}}{\rightarrow}$ "
\mathbf {zip}(#1.
,#2.
)"]

$[\mathbf{zip}(*, *) \overset{\text{pyk}}{\rightarrow}$ "zip " with " end zip"]

## $\mathbf{assoc}_1(*, *, *)$

$$[\mathbf{assoc}_1(\mathsf{a},\mathsf{d},\mathsf{i}) \overset{\text{val}}{\to} \mathsf{a}^{\mathsf{a}} \left\{ \begin{array}{l} \mathsf{d!i!T} \\ \mathsf{a}^{\mathsf{hc}} \left\{ \begin{array}{l} \mathsf{i} \approx \mathsf{a}^{\mathsf{h}} \left\{ \begin{array}{l} \mathsf{d!a}^{\mathsf{t}} \\ \mathsf{d!T} \end{array} \right. \\ \mathsf{d}^{\mathsf{h}} \left\{ \begin{array}{l} \mathbf{assoc}_1(\mathsf{a}^{\mathsf{h}},\mathsf{d}^{\mathsf{t}},\mathsf{i}) \\ \mathbf{assoc}_1(\mathsf{a}^{\mathsf{t}},\mathsf{d}^{\mathsf{t}},\mathsf{i}) \end{array} \right. \end{array} \right. \end{array} \right. ]$$

$[\mathbf{assoc}_1(*, *, *) \overset{\text{tex}}{\to}$ "
\mathbf {assoc}_1(#1.
,#2.
,#3.
)"]

$[\mathbf{assoc}_1(*, *, *) \overset{\text{pyk}}{\to}$ "assoc one " address " index " end assoc"]


## $(*)^{\mathbf{P}}$

$[(\mathsf{x})^{\mathbf{P}} \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\mathsf{t}^1]$

$[(*)^{\mathbf{P}} \overset{\text{tex}}{\to}$ "(#1.
)^{\mathbf {p}}"]

$[(*)^{\mathbf{P}} \overset{\text{pyk}}{\to}$ "protect " end protect"]


## self

$[\text{self} \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.(\mathsf{c}[0] :: 0 :: \mathsf{t}^{\mathsf{d}})^{\mathsf{I}} :: \mathsf{T}]$

$[\text{self} \overset{\text{pyk}}{\to}$ "self"]


## $\left[ * \overset{..}{=} * \right]$

$[[\mathsf{x} \overset{.}{=} \mathsf{y}] \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_3(\mathsf{t})]$

$[[* \overset{..}{=} *] \overset{\text{tex}}{\to}$ "
[#1/tex name/tex.
\mathrel {\ddot {=}}#2.
]"]

$[[* \overset{..}{=} *] \overset{\text{pyk}}{\to}$ "macro define " as " end define"]

$$\left[ * \overset{\cdot}{=} * \right]$$

$$[[\mathsf{x} \overset{\cdot}{=} \mathsf{y}] \overset{\mathrm{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c}, \lceil[[\mathsf{x} \overset{\cdot}{=} \mathsf{y}] \overset{..}{=} [(\mathsf{x})^{\mathbf{p}} \overset{\mathrm{val}}{\rightarrow} \mathsf{y}]]\rceil)]$$

$[[* \overset{\cdot}{=} *] \overset{\mathrm{tex}}{\rightarrow}$ "
[#1/tex name/tex.
\mathrel {\dot {=}}#2.
"]

$[[* \overset{\cdot}{=} *] \overset{\mathrm{pyk}}{\rightarrow}$ "value define " as " end define"]


$$\left[ * \overset{\prime}{=} * \right]$$

$$[[\mathsf{x} \overset{\prime}{=} \mathsf{y}] \overset{\mathrm{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c}, \lceil[[\mathsf{x} \overset{\prime}{=} \mathsf{y}] \overset{..}{=} [(\mathsf{x})^{\mathbf{p}} \overset{\mathrm{val}}{\Rightarrow} \mathsf{y}]]\rceil)]$$

$[[* \overset{\prime}{=} *] \overset{\mathrm{tex}}{\rightarrow}$ "
[#1/tex name/tex.
\mathrel {\acute {=}}#2.
"]

$[[* \overset{\prime}{=} *] \overset{\mathrm{pyk}}{\rightarrow}$ "intro define " as " end define"]


$$\left[ * \overset{\mathrm{pyk}}{=} * \right]$$

$$[[\mathsf{x} \overset{\mathrm{pyk}}{=} \mathsf{y}] \overset{\mathrm{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c}, \lceil[[\mathsf{x} \overset{\mathrm{pyk}}{=} \mathsf{y}] \overset{..}{=} [(\mathsf{x})^{\mathbf{p}} \overset{\mathrm{pyk}}{\rightarrow} \mathsf{y}]]\rceil)]$$

$[[* \overset{\mathrm{pyk}}{=} *] \overset{\mathrm{tex}}{\rightarrow}$ "
[#1/tex name/tex.
\stackrel {\mathrm {pyk}}{=} #2/tex name.
"]

$[[* \overset{\mathrm{pyk}}{=} *] \overset{\mathrm{pyk}}{\rightarrow}$ "pyk define " as " end define"]


$$\left[ * \overset{\mathrm{tex}}{=} * \right]$$

$$[[\mathsf{x} \overset{\mathrm{tex}}{=} \mathsf{y}] \overset{\mathrm{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c}, \lceil[[\mathsf{x} \overset{\mathrm{tex}}{=} \mathsf{y}] \overset{..}{=} [(\mathsf{x})^{\mathbf{p}} \overset{\mathrm{tex}}{\rightarrow} \mathsf{y}]]\rceil)]$$

$[[* \overset{\mathrm{tex}}{=} *] \overset{\mathrm{tex}}{\rightarrow}$ "
[#1/tex name/tex.
\stackrel {\mathrm {tex}}{=} #2/tex name.
"]

$[[* \overset{\mathrm{tex}}{=} *] \overset{\mathrm{pyk}}{\rightarrow}$ "tex define " as " end define"]

$[* \stackrel{\mathrm{name}}{=} *]$

$[[\mathsf{x} \stackrel{\mathrm{name}}{=} \mathsf{y}] \stackrel{\mathrm{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[[\mathsf{x} \stackrel{\mathrm{name}}{=} \mathsf{y}] \doteq [(\mathsf{x})^{\mathbf{P}} \stackrel{\mathrm{name}}{\rightarrow} \mathsf{y}]]\rceil)]$

$[[* \stackrel{\mathrm{name}}{=} *] \stackrel{\mathrm{tex}}{\rightarrow}$ "
[#1/tex name/tex.
\stackrel {\mathrm {name}}{=} #2/tex name.
"]

$[[* \stackrel{\mathrm{name}}{=} *] \stackrel{\mathrm{pyk}}{\rightarrow}$ "tex name define " as " end define"]


# Priority table[*]

$[\mathbf{Priority\ table}[\mathsf{x}] \stackrel{\mathrm{name}}{\rightarrow}$ "
\mathbf{Priority\ table} [ #1.
"]

$[\mathbf{Priority\ table}[\mathsf{x}] \stackrel{\mathrm{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathbf{Priority\ table}[\mathsf{x}] \doteq [\mathrm{self} \stackrel{\mathrm{prio}}{\rightarrow} (\mathsf{x})^{\mathbf{P}}]]\rceil)]$

$[\mathbf{Priority\ table}[\mathsf{x}] \stackrel{\mathrm{tex}}{\rightarrow}$ "
\mathbf{Priority\ table} #1.
\mathbf{End\ table}"]

$[\mathbf{Priority\ table}[*] \stackrel{\mathrm{pyk}}{\rightarrow}$ "priority table " end table"]


# $\tilde{\mathcal{M}}_1$

$[\tilde{\mathcal{M}}_1 \stackrel{\mathrm{val}}{\rightarrow} \lceil[\mathsf{x} \stackrel{\mathrm{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil\mathsf{d}\rceil)]\rceil]]$

$[\tilde{\mathcal{M}}_1 \stackrel{\mathrm{tex}}{\rightarrow}$ "
\tilde {{\cal M}}_1"]

$[\tilde{\mathcal{M}}_1 \stackrel{\mathrm{pyk}}{\rightarrow}$ "macro define one"]


# $\tilde{\mathcal{M}}_2(*)$

$[\tilde{\mathcal{M}}_2(\mathsf{t}) \stackrel{\mathrm{val}}{\rightarrow} (\lceil\mathsf{x}\rceil :: \mathsf{t}^1)^{\mathrm{M}} :: (\lceil\mathsf{d}\rceil :: \mathsf{t})^{\mathrm{M}} :: \mathsf{T}]$

$[\tilde{\mathcal{M}}_2(*) \stackrel{\mathrm{tex}}{\rightarrow}$ "
\tilde {{\cal M}}_2(#1.
)"]

$[\tilde{\mathcal{M}}_2(*) \stackrel{\mathrm{pyk}}{\rightarrow}$ "macro define two " end define"]

$\tilde{\mathcal{M}}_3(*)$

$[\tilde{\mathcal{M}}_3(\mathsf{t}) \overset{\mathrm{val}}{\rightarrow} \tilde{\mathcal{Q}}(\mathsf{t}, \tilde{\mathcal{M}}_1, \tilde{\mathcal{M}}_2(\mathsf{t}))]$

$[\tilde{\mathcal{M}}_3(*) \overset{\mathrm{tex}}{\rightarrow}$ "
\tilde {{\cal M}}_3(#1.
)"]

$[\tilde{\mathcal{M}}_3(*) \overset{\mathrm{pyk}}{\rightarrow}$ "macro define three " end define"]


$\tilde{\mathcal{M}}_4(*, *, *, *)$

$[\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \mathsf{d}) \overset{\mathrm{val}}{\rightarrow} \tilde{\mathcal{M}}(\tilde{\mathcal{Q}}(\mathsf{t}, \mathsf{d}^2, \mathbf{zip}(\mathsf{d}^{1\mathsf{t}}, \mathsf{t}^{\mathsf{t}})), \mathsf{s}, \mathsf{c})]$

$[\tilde{\mathcal{M}}_4(*, *, *, *) \overset{\mathrm{tex}}{\rightarrow}$ "
\tilde {{\cal M}}_4(#1.
,#2.
,#3.
,#4.
)"]

$[\tilde{\mathcal{M}}_4(*, *, *, *) \overset{\mathrm{pyk}}{\rightarrow}$ "macro define four " state " cache " definition " end define"]


$\tilde{\mathcal{M}}(*, *, *)$

$[\tilde{\mathcal{M}}(\mathsf{t}, \mathsf{s}, \mathsf{c}) \overset{\mathrm{val}}{\rightarrow} \mathcal{U}(\mathsf{s}^{\mathsf{h}} \text{ ' } \mathsf{t} \text{ ' } \mathsf{s} \text{ ' } \mathsf{c})]$

$[\tilde{\mathcal{M}}(*, *, *) \overset{\mathrm{tex}}{\rightarrow}$ "
\tilde {{\cal M}}(#1.
,#2.
,#3.
)"]

$[\tilde{\mathcal{M}}(*, *, *) \overset{\mathrm{pyk}}{\rightarrow}$ "state expand " state " cache " end expand"]


$\tilde{\mathcal{Q}}(*, *, *)$

$[\tilde{\mathcal{Q}}(\mathsf{r}, \mathsf{t}, \mathsf{s}) \overset{\mathrm{val}}{\rightarrow} \tilde{\mathcal{Q}}_2(\mathsf{r}^{\mathsf{d}}, \mathsf{t}, \mathsf{s})]$

$[\tilde{\mathcal{Q}}(*, *, *) \overset{\mathrm{tex}}{\rightarrow}$ "
\tilde {{\cal Q}}(#1.
,#2.

, #3.
)"]

$[\tilde{\mathcal{Q}}(*, *, *) \overset{\text{pyk}}{\to}$ "quote expand " term " stack " end expand"]

# $\tilde{\mathcal{Q}}_2(*, *, *)$

$[\tilde{\mathcal{Q}}_2(\mathsf{r}, \mathsf{t}, \mathsf{s}) \overset{\text{val}}{\to} \tilde{\mathcal{Q}}_3(\mathsf{r}, \mathsf{t}, \mathsf{s}, \textbf{lookup}(\mathsf{t}, \mathsf{s}, \mathsf{T}))]$

$[\tilde{\mathcal{Q}}_2(*, *, *) \overset{\text{tex}}{\to}$ "
\tilde {{\cal Q}}_2(#1.
, #2.
, #3.
)"]

$[\tilde{\mathcal{Q}}_2(*, *, *) \overset{\text{pyk}}{\to}$ "quote expand two " term " stack " end expand"]

# $\tilde{\mathcal{Q}}_3(*, *, *, *)$

$[\tilde{\mathcal{Q}}_3(\mathsf{r}, \mathsf{t}, \mathsf{s}, \mathsf{v}) \overset{\text{val}}{\to} \mathsf{v} \left\{ \begin{array}{l} (\mathsf{t}^{\mathsf{r}} :: \mathsf{t}^{\mathsf{i}} :: \mathsf{r})^{\mathrm{M}} :: \tilde{\mathcal{Q}}^*(\mathsf{r}, \mathsf{t}^{\mathsf{t}}, \mathsf{s}) \\ \mathsf{r}!\mathsf{t}!\mathsf{s}!\mathsf{v} \end{array} \right.$ ]

$[\tilde{\mathcal{Q}}_3(*, *, *, *) \overset{\text{tex}}{\to}$ "
\tilde {{\cal Q}}_3(#1.
, #2.
, #3.
, #4.
)"]

$[\tilde{\mathcal{Q}}_3(*, *, *, *) \overset{\text{pyk}}{\to}$ "quote expand three " term " stack " value " end expand"]

# $\tilde{\mathcal{Q}}^*(*, *, *)$

$[\tilde{\mathcal{Q}}^*(\mathsf{r}, \mathsf{t}, \mathsf{s}) \overset{\text{val}}{\to} \mathsf{t} \left\{ \begin{array}{l} \mathsf{r}!\mathsf{t}!\mathsf{s}!\mathsf{T} \\ \tilde{\mathcal{Q}}_2(\mathsf{r}, \mathsf{t}^{\mathsf{h}}, \mathsf{s}) :: \tilde{\mathcal{Q}}^*(\mathsf{r}, \mathsf{t}^{\mathsf{t}}, \mathsf{s}) \end{array} \right.$ ]

$[\tilde{\mathcal{Q}}^*(*, *, *) \overset{\text{tex}}{\to}$ "
\tilde {{\cal Q}}^*(#1.
, #2.
, #3.
)"]

$[\tilde{\mathcal{Q}}^*(*, *, *) \overset{\text{pyk}}{\to}$ "quote expand star " term " stack " end expand"]

$(*)$

$[(\mathsf{x}) \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[(\mathsf{x}) \overset{.}{=} \mathsf{x}]\rceil)]$

$[(*) \overset{\text{tex}}{\rightarrow}$ "
(#1.
)"]

$[(*) \overset{\text{pyk}}{\rightarrow}$ "parenthesis " end parenthesis"]


$(*)$

$[(\mathsf{x}) \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[(\mathsf{x}) \overset{.}{=} \mathsf{x}]\rceil)]$

$[(\mathsf{x}) \overset{\text{tex}}{\rightarrow}$ "
\left( #1.
\right) "]

$[(*) \overset{\text{pyk}}{\rightarrow}$ "big parenthesis " end parenthesis"]


# display($*$)

$[\text{display}(\mathsf{x}) \overset{\text{name}}{\rightarrow}$ "
display(#1.
)"]

$[\text{display}(\mathsf{x}) \overset{\text{tex}}{\rightarrow}$ "

\addvspace{\abovedisplayskip}

\setlength{\leftskip}{\mathindent}\noindent #1.
\everypar{\setlength{\parindent}{\docparindent}}
\setlength{\parindent}{0mm}

\setlength{\leftskip}{0mm}
\addvspace{\belowdisplayskip}

"]

$[\text{display}(*) \overset{\text{pyk}}{\rightarrow}$ "display " end display"]

## statement(∗)

[statement(x) $\overset{\text{name}}{\to}$ "
statement(#1.
)"]

[statement(x) $\overset{\text{tex}}{\to}$ "

\addvspace{\abovedisplayskip}

\setlength{\leftskip}{0mm}\noindent #1.
\everypar{\setlength{\parindent}{\docparindent}}
\setlength{\parindent}{0mm}

\setlength{\leftskip}{0mm}
\addvspace{\belowdisplayskip}

"]

[statement(∗) $\overset{\text{pyk}}{\to}$ "statement " end statement"]

## $[∗]^{\cdot}$

$[[x]^{\cdot} \overset{\text{macro}}{\to} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil [[x]^{\cdot} \overset{\cdot}{=} [[x] \text{ spy } x]^{\cdot}] \rceil)]$

$[[x]^{\cdot} \overset{\text{tex}}{\to}$ "
[#1.
]^{\cdot} \text{"]}

$[[∗]^{\cdot} \overset{\text{pyk}}{\to}$ "spying test " end test"]

## $[∗]^{-}$

$[[x]^{-} \overset{\text{macro}}{\to} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil [[x]^{-} \overset{\cdot}{=} [[x] \text{ spy } x]^{-}] \rceil)]$

$[[x]^{-} \overset{\text{tex}}{\to}$ "
[#1.
]^{-} \text{"]}$

$[[∗]^{-} \overset{\text{pyk}}{\to}$ "false spying test " end test"]

## $\mathbf{aspect}(*, *)$

$[\mathbf{aspect}(\mathsf{a}, \mathsf{c}) \overset{\text{val}}{\rightarrow} \mathsf{a}^{\mathsf{c}} \left\{ \begin{array}{l} \mathsf{c}[0][\mathsf{a}] \\ \mathsf{c}[\mathsf{a}^{\mathsf{r}}][\mathsf{a}^{\mathsf{i}}] \end{array} \right.$ ]

$[\mathbf{aspect}(\mathsf{a}, \mathsf{c}) \overset{\text{tex}}{\rightarrow}$ "
\mathbf{aspect}( #1.
, #2.
)"]

$[\mathbf{aspect}(*, *) \overset{\text{pyk}}{\rightarrow}$ "aspect " subcodex " end aspect"]


## $\mathbf{aspect}(*, *, *)$

$[\mathbf{aspect}(\mathsf{a}, \mathsf{t}, \mathsf{c}) \overset{\text{val}}{\rightarrow} \mathbf{aspect}(\mathsf{a}, \mathsf{c}[\mathsf{t}^{\mathsf{r}}][\text{"codex"}][\mathsf{t}^{\mathsf{r}}][\mathsf{t}^{\mathsf{i}}])]$

$[\mathbf{aspect}(*, *, *) \overset{\text{tex}}{\rightarrow}$ "
\mathbf{aspect}( #1.
, #2.
, #3.
)"]

$[\mathbf{aspect}(*, *, *) \overset{\text{pyk}}{\rightarrow}$ "aspect " term " cache " end aspect"]


## $\langle * \rangle$

$[\langle \mathsf{x} \rangle \overset{\text{macro}}{\rightarrow} \lambda \mathsf{t}.\lambda \mathsf{s}.\lambda \mathsf{c}.\tilde{\mathcal{M}}(\mathbf{tuple}_1(\mathsf{t}), \mathsf{s}, \mathsf{c})]$

$[\langle * \rangle \overset{\text{tex}}{\rightarrow}$ "
\langle #1.
\rangle "]

$[\langle * \rangle \overset{\text{pyk}}{\rightarrow}$ "tuple " end tuple"]


## $\mathbf{tuple}_1(*)$

$[\mathbf{tuple}_1(\mathsf{t}) \overset{\text{val}}{\rightarrow} \mathsf{t}^1 \overset{\mathsf{r}}{=} \lceil \mathsf{x}, \mathsf{y} \rceil \left\{ \begin{array}{l} \tilde{\mathcal{Q}}(\mathsf{t}, \lceil \mathsf{x} :: \langle \mathsf{y} \rangle \rceil, \mathbf{tuple}_2(\mathsf{t}^1)) \\ \tilde{\mathcal{Q}}(\mathsf{t}, \lceil \mathsf{x} :: \mathsf{T} \rceil, \lceil \mathsf{x} \rceil :: \mathsf{t}^1 :: \mathsf{T}) \end{array} \right.$ ]

$[\mathbf{tuple}_1(*) \overset{\text{tex}}{\rightarrow}$ "
\mathbf {tuple}\_1( #1.
) "]

$[\mathbf{tuple}_1(*) \overset{\text{pyk}}{\rightarrow}$ "tuple one " end tuple"]

# $\mathbf{tuple}_2(*)$

$[\mathbf{tuple}_2(\mathsf{t}) \overset{\mathrm{val}}{\rightarrow} \lceil \mathsf{x} \rceil :: \mathsf{t}^1 :: \lceil \mathsf{y} \rceil :: \mathsf{t}^2 :: \mathsf{T}]$

$[\mathbf{tuple}_2(*) \overset{\mathrm{tex}}{\rightarrow}$ "
\mathbf {tuple}_2( #1.
) "]

$[\mathbf{tuple}_2(*) \overset{\mathrm{pyk}}{\rightarrow}$ "tuple two " end tuple"]


## $\mathrm{let}_2(*, *)$

$[\mathrm{let}_2(\mathsf{f}, \mathsf{y}) \overset{\mathrm{val}}{\rightarrow} (\mathsf{y}!\mathsf{f}\,{}'\,\mathsf{y})^{\mathrm{I}}]$

$[\mathrm{let}_2(\mathsf{f}, \mathsf{y}) \overset{\mathrm{tex}}{\rightarrow}$ "
let_2( #1.
, #2.
)"]

$[\mathrm{let}_2(*, *) \overset{\mathrm{pyk}}{\rightarrow}$ "let two " apply " end let"]


## $\mathrm{let}_1(*, *)$

$[\mathrm{let}_1(\mathsf{f}, \mathsf{y}) \overset{\mathrm{val}}{\Rightarrow} \mathrm{let}_2(\mathsf{f}, \mathsf{y}^{\mathrm{M}})^{\mathrm{M}}]$

$[\mathrm{let}_1(\mathsf{f}, \mathsf{y}) \overset{\mathrm{tex}}{\rightarrow}$ "
let_1( #1.
, #2.
)"]

$[\mathrm{let}_1(*, *) \overset{\mathrm{pyk}}{\rightarrow}$ "let one " apply " end let"]


## $\left[ * \overset{\mathrm{claim}}{=} * \right]$

$[[\mathsf{x} \overset{\mathrm{claim}}{=} \mathsf{y}] \overset{\mathrm{macro}}{\rightarrow} \lambda \mathsf{t}.\lambda \mathsf{s}.\lambda \mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil [[\mathsf{x} \overset{\mathrm{claim}}{=} \mathsf{y}] \overset{\cdot\cdot}{=} [\mathsf{x} \overset{\mathrm{claim}}{\rightarrow} \mathsf{y}]]\rceil])]$

$[[* \overset{\mathrm{claim}}{=} *] \overset{\mathrm{tex}}{\rightarrow}$ "
[#1/tex name/tex.
\stackrel {claim}{=}#2.
"]

$[[* \overset{\mathrm{claim}}{=} *] \overset{\mathrm{pyk}}{\rightarrow}$ "claim define " as " end define"]

## checker

[checker $\overset{\text{val}}{\to}$ λt.λc.**check**(t, c)]

[checker $\overset{\text{pyk}}{\to}$ "checker"]

## check(∗, ∗)

[**check**(t, c) $\overset{\text{val}}{\to}$ If(t$^{\text{is}}$, c!T, **check**$_2$(t, c, **aspect**("claim", t, c)))]

[**check**(∗, ∗) $\overset{\text{tex}}{\to}$ "
\mathbf{check}( #1.
, #2.
)"]

[**check**(∗, ∗) $\overset{\text{pyk}}{\to}$ "check " cache " end check"]

## check$_2$(∗, ∗, ∗)

[**check**$_2$(t, c, d) $\overset{\text{val}}{\to}$ d $\left\{ \begin{array}{l} \textbf{check}_3(\textsf{t}, \textsf{c}, \textbf{aspect}("definition", \textsf{t}, \textsf{c})) \\ \mathcal{U}^{\text{M}}(\mathcal{E}(\textsf{d}^3, \textsf{T}, \textsf{c}) \ ` \ \textsf{t} \ ` \ \textsf{c}) \end{array} \right.$ ]

[**check**$_2$(∗, ∗, ∗) $\overset{\text{tex}}{\to}$ "
\mathbf{check}_2( #1.
, #2.
, #3.
)"]

[**check**$_2$(∗, ∗, ∗) $\overset{\text{pyk}}{\to}$ "check two " cache " def " end check"]

## check$_3$(∗, ∗, ∗)

[**check**$_3$(t, c, d) $\overset{\text{val}}{\to}$ If(d, **check**$^*$(t$^{\text{t}}$, c), t!c!T)]

[**check**$_3$(∗, ∗, ∗) $\overset{\text{tex}}{\to}$ "
\mathbf{check}_3( #1.
, #2.
, #3.
)"]

[**check**$_3$(∗, ∗, ∗) $\overset{\text{pyk}}{\to}$ "check three " cache " def " end check"]

# $\mathbf{check}^*(*, *)$

$[\mathbf{check}^*(\mathsf{t}, \mathsf{c}) \overset{\mathrm{val}}{\to} \mathrm{If}(\mathsf{t}, \mathsf{c}!\mathsf{T}, \mathbf{check}_2^*(\mathsf{t}^\mathsf{t}, \mathsf{c}, \mathbf{check}(\mathsf{t}^\mathsf{h}, \mathsf{c})))]$

$[\mathbf{check}^*(*, *) \overset{\mathrm{tex}}{\to}$ "
\mathbf{check}^*( #1.
, #2.
)"]

$[\mathbf{check}^*(*, *) \overset{\mathrm{pyk}}{\to}$ "check list " cache " end check"]


# $\mathbf{check}_2^*(*, *, *)$

$[\mathbf{check}_2^*(\mathsf{t}, \mathsf{c}, \mathsf{v}) \overset{\mathrm{val}}{\to} \mathrm{If}(\neg\mathsf{v}, \mathsf{t}!\mathsf{c}!\mathsf{v}, \mathbf{check}^*(\mathsf{t}, \mathsf{c}))]$

$[\mathbf{check}_2^*(*, *, *) \overset{\mathrm{tex}}{\to}$ "
\mathbf{check}^*\_2( #1.
, #2.
, #3.
)"]

$[\mathbf{check}_2^*(*, *, *) \overset{\mathrm{pyk}}{\to}$ "check list two " cache " value " end check"]


# $\left[*\right]^{\cdot}$

$[[\mathsf{t}]^{\cdot} \overset{\mathrm{claim}}{\to} \lambda\mathsf{t}.\lambda\mathsf{c}.\mathrm{if}(\mathcal{U}(\mathcal{E}(\mathsf{t}^1, \mathsf{T}, \mathsf{c})), \mathsf{T}, \mathsf{t})]$

$[[*]^{\cdot} \overset{\mathrm{tex}}{\to}$ "
\relax [ #1.
\relax ]^{\cdot} "]

$[[*]^{\cdot} \overset{\mathrm{pyk}}{\to}$ "test " end test"]


# $\left[*\right]^{-}$

$[[\mathsf{x}]^{-} \overset{\mathrm{claim}}{\to} \lambda\mathsf{t}.\lambda\mathsf{c}.\mathrm{if}(\mathcal{U}(\mathcal{E}(\mathsf{t}^1, \mathsf{T}, \mathsf{c})), \mathsf{t}, \mathsf{T})]$

$[[\mathsf{x}]^{-} \overset{\mathrm{tex}}{\to}$ "
\relax [ #1.
\relax ]^{-} "]

$[[*]^{-} \overset{\mathrm{pyk}}{\to}$ "false test " end test"]

$[*]^\circ$

$[[\mathsf{t}]^\circ \stackrel{\text{claim}}{\to} \lambda\mathsf{t}.\lambda\mathsf{c}.\mathcal{U}(\mathcal{E}(\mathsf{t}^1, \mathsf{T}, \mathsf{c}))]$

$[[*]^\circ \stackrel{\text{tex}}{\to}$ "
\relax [ #1.
\relax ]^{\circ} "]

$[[*]^\circ \stackrel{\text{pyk}}{\to}$ "raw test " end test"]

## msg

Predef: message

$[\text{msg} \stackrel{\text{tex}}{\to}$ "
msg"]

$[\text{msg} \stackrel{\text{pyk}}{\to}$ "message"]

$\left[* \stackrel{\text{msg}}{=} *\right]$

$[[\mathsf{x} \stackrel{\text{msg}}{=} \mathsf{y}] \stackrel{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[[\mathsf{x} \stackrel{\text{msg}}{=} \mathsf{y}] \doteq [(\mathsf{x})^{\mathbf{P}} \stackrel{\text{msg}}{\to} \mathsf{y}]]\rceil])]$

$[[\mathsf{x} \stackrel{\text{msg}}{=} \mathsf{y}] \stackrel{\text{tex}}{\to}$ "
[#1/tex name/tex.
\stackrel {msg}{=} #2.
]"]

$[[* \stackrel{\text{msg}}{=} *] \stackrel{\text{pyk}}{\to}$ "message define " as " end define"]

## <stmt>

$[<\text{stmt}> \stackrel{\text{val}}{\to} \lceil<\text{stmt}>\rceil]$

$[<\text{stmt}> \stackrel{\text{tex}}{\to}$ "
{<}stmt{>}"]

$[<\text{stmt}> \stackrel{\text{pyk}}{\to}$ "the statement aspect"]

## stmt

$[\text{stmt} \stackrel{\text{msg}}{\to} <\text{stmt}>]$

$[\text{stmt} \overset{\text{tex}}{\to} \text{“}$
$\text{stmt”}]$

$[\text{stmt} \overset{\text{pyk}}{\to} \text{“statement”}]$

$\left[* \overset{\text{stmt}}{=} *\right]$

$[[\mathsf{x} \overset{\text{stmt}}{=} \mathsf{y}] \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[[\mathsf{x} \overset{\text{stmt}}{=} \mathsf{y}] \doteq [(\mathsf{x})^{\mathbf{p}} \overset{\text{stmt}}{\to} \mathsf{y}]]\rceil)]$

$[[\mathsf{x} \overset{\text{stmt}}{=} \mathsf{y}] \overset{\text{tex}}{\to} \text{“}$
$[\#1/\text{tex name}/\text{tex}.$
$\backslash\text{stackrel }\{\text{stmt}\}\{=\}\#2.$
$\text{]”}]$

$[[* \overset{\text{stmt}}{=} *] \overset{\text{pyk}}{\to} \text{“statement define " as " end define”}]$

# HeadNil$'$

$[\text{HeadNil}' \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\text{HeadNil}' \doteq \mathsf{T}^{\mathrm{h}} = \mathsf{T}]\rceil)]$

$[\text{HeadNil}' \overset{\text{tex}}{\to} \text{“}$
$\text{HeadNil'”}]$

$[\text{HeadNil}' \overset{\text{pyk}}{\to} \text{“example axiom”}]$

# HeadPair$'$

$[\text{HeadPair}' \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\text{HeadPair}' \doteq \forall\mathcal{A}: \forall\mathcal{B}: (\mathcal{A}::\mathcal{B})^{\mathrm{h}} = \mathcal{A}]\rceil)]$

$[\text{HeadPair}' \overset{\text{tex}}{\to} \text{“}$
$\text{HeadPair'”}]$

$[\text{HeadPair}' \overset{\text{pyk}}{\to} \text{“example scheme”}]$

# Transitivity$'$

$[\text{Transitivity}' \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\text{Transitivity}' \doteq \forall\mathcal{A}: \forall\mathcal{B}: \forall\mathcal{C}: \mathcal{A} = \mathcal{B} \vdash$
$\mathcal{A} = \mathcal{C} \vdash \mathcal{B} = \mathcal{C}]\rceil)]$

$[\text{Transitivity}' \overset{\text{tex}}{\to} \text{“}$
$\text{Transitivity'”}]$

$[\text{Transitivity}' \overset{\text{pyk}}{\to} \text{“example rule”}]$

## ⊥⊥

$[⊥⊥ \overset{\text{val}}{\rightarrow} \lceil ⊥⊥ \rceil^{\text{R}} :: \mathsf{T}]$

$[⊥⊥ \overset{\text{tex}}{\rightarrow}$ "
{\makebox [0mm][l]{\$\bot \$}\, {\bot }}"]

$[⊥⊥ \overset{\text{pyk}}{\rightarrow}$ "absurdity"]

## Contra′

$[\text{Contra}' \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\text{Contra}' \overset{.}{=} \mathsf{T} :: \mathsf{T} = \mathsf{T} \vdash ⊥⊥]\rceil])]$

$[\text{Contra}' \overset{\text{tex}}{\rightarrow}$ "
Contra′"]

$[\text{Contra}' \overset{\text{pyk}}{\rightarrow}$ "contraexample"]

## $\text{T}'_{\text{E}}$

$[\mathsf{T}'_{\text{E}} \overset{\text{stmt}}{\rightarrow} \mathsf{T}^{\text{h}} = \mathsf{T} \oplus \forall\underline{\mathsf{a}}\colon \forall\underline{\mathsf{b}}\colon \underline{\mathsf{a}} :: \underline{\mathsf{b}}^{\text{h}} = \underline{\mathsf{a}} \oplus \forall\underline{\mathsf{a}}\colon \forall\underline{\mathsf{b}}\colon \forall\underline{\mathsf{c}}\colon \underline{\mathsf{a}} = \underline{\mathsf{b}} \vdash \underline{\mathsf{a}} = \underline{\mathsf{c}} \vdash \underline{\mathsf{b}} = \underline{\mathsf{c}} \oplus \mathsf{T} ::$
$\mathsf{T} = \mathsf{T} \vdash ⊥⊥]$

$[\mathsf{T}'_{\text{E}} \overset{\text{tex}}{\rightarrow}$ "
T'_{E}"]

$[\mathsf{T}'_{\text{E}} \overset{\text{pyk}}{\rightarrow}$ "example theory primed"]

## $\text{L}_1$

$[\mathsf{L}_1 \overset{\text{stmt}}{\rightarrow} \mathsf{T}'_{\text{E}} \vdash \forall\underline{\mathsf{a}}\colon \forall\underline{\mathsf{b}}\colon \underline{\mathsf{a}} = \underline{\mathsf{b}} \vdash \underline{\mathsf{b}} = \underline{\mathsf{a}}]$

$[\mathsf{L}_1 \overset{\text{tex}}{\rightarrow}$ "
L_{1}"]

$[\mathsf{L}_1 \overset{\text{pyk}}{\rightarrow}$ "example lemma"]

## $\underline{*}$

$[\underline{\mathsf{x}} \overset{\text{tex}}{\rightarrow}$ "\underline{#1.}"]

$[\underline{*} \overset{\text{pyk}}{\rightarrow}$ "metavar " end metavar"]

## $\mathcal{A}$

$[\mathcal{A} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{A} \overset{.}{=} \underline{\mathsf{a}}]\rceil)]$

$[\mathcal{A} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal A}\}\text{''}]$

$[\mathcal{A} \overset{\text{pyk}}{\rightarrow} \text{``meta a''}]$

## $\mathcal{B}$

$[\mathcal{B} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{B} \overset{.}{=} \underline{\mathsf{b}}]\rceil)]$

$[\mathcal{B} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal B}\}\text{''}]$

$[\mathcal{B} \overset{\text{pyk}}{\rightarrow} \text{``meta b''}]$

## $\mathcal{C}$

$[\mathcal{C} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{C} \overset{.}{=} \underline{\mathsf{c}}]\rceil)]$

$[\mathcal{C} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal C}\}\text{''}]$

$[\mathcal{C} \overset{\text{pyk}}{\rightarrow} \text{``meta c''}]$

## $\mathcal{D}$

$[\mathcal{D} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{D} \overset{.}{=} \underline{\mathsf{d}}]\rceil)]$

$[\mathcal{D} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal D}\}\text{''}]$

$[\mathcal{D} \overset{\text{pyk}}{\rightarrow} \text{``meta d''}]$

## $\mathcal{E}$

$[\mathcal{E} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{E} \overset{.}{=} \underline{\mathsf{e}}]\rceil)]$

$[\mathcal{E} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal E}\}\text{''}]$

$[\mathcal{E} \overset{\text{pyk}}{\rightarrow} \text{``meta e''}]$

## $\mathcal{F}$

$[\mathcal{F} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{F} \overset{.}{=} \underline{\mathsf{f}}]\rceil)]$

$[\mathcal{F} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal F}\}\text{''}]$

$[\mathcal{F} \overset{\text{pyk}}{\rightarrow} \text{``meta f''}]$

## $\mathcal{G}$

$[\mathcal{G} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{G} \overset{..}{=} \underline{\mathsf{g}}]\rceil)]$

$[\mathcal{G} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal G}\}\text{''}]$

$[\mathcal{G} \overset{\text{pyk}}{\rightarrow} \text{``meta g''}]$

## $\mathcal{H}$

$[\mathcal{H} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{H} \overset{..}{=} \underline{\mathsf{h}}]\rceil)]$

$[\mathcal{H} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal H}\}\text{''}]$

$[\mathcal{H} \overset{\text{pyk}}{\rightarrow} \text{``meta h''}]$

## $\mathcal{I}$

$[\mathcal{I} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{I} \overset{..}{=} \underline{\mathsf{i}}]\rceil)]$

$[\mathcal{I} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal I}\}\text{''}]$

$[\mathcal{I} \overset{\text{pyk}}{\rightarrow} \text{``meta i''}]$

## $\mathcal{J}$

$[\mathcal{J} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{J} \overset{..}{=} \underline{\mathsf{j}}]\rceil)]$

$[\mathcal{J} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal J}\}\text{''}]$

$[\mathcal{J} \overset{\text{pyk}}{\rightarrow} \text{``meta j''}]$

## $\mathcal{K}$

$[\mathcal{K} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{K} \overset{..}{=} \underline{\mathsf{k}}]\rceil)]$

$[\mathcal{K} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal K}\}\text{''}]$

$[\mathcal{K} \overset{\text{pyk}}{\rightarrow} \text{``meta k''}]$

## $\mathcal{L}$

$[\mathcal{L} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{L} \overset{..}{=} \underline{\mathsf{l}}]\rceil)]$

$[\mathcal{L} \overset{\text{tex}}{\rightarrow} \text{``\{\textbackslash cal L\}''}]$

$[\mathcal{L} \overset{\text{pyk}}{\rightarrow} \text{``meta l''}]$


## $\mathcal{M}$

$[\mathcal{M} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{M} \overset{..}{=} \underline{\mathsf{m}}]\rceil)]$

$[\mathcal{M} \overset{\text{tex}}{\rightarrow} \text{``\{\textbackslash cal M\}''}]$

$[\mathcal{M} \overset{\text{pyk}}{\rightarrow} \text{``meta m''}]$


## $\mathcal{N}$

$[\mathcal{N} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{N} \overset{..}{=} \underline{\mathsf{n}}]\rceil)]$

$[\mathcal{N} \overset{\text{tex}}{\rightarrow} \text{``\{\textbackslash cal N\}''}]$

$[\mathcal{N} \overset{\text{pyk}}{\rightarrow} \text{``meta n''}]$


## $\mathcal{O}$

$[\mathcal{O} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{O} \overset{..}{=} \underline{\mathsf{o}}]\rceil)]$

$[\mathcal{O} \overset{\text{tex}}{\rightarrow} \text{``\{\textbackslash cal O\}''}]$

$[\mathcal{O} \overset{\text{pyk}}{\rightarrow} \text{``meta o''}]$


## $\mathcal{P}$

$[\mathcal{P} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{P} \overset{..}{=} \underline{\mathsf{p}}]\rceil)]$

$[\mathcal{P} \overset{\text{tex}}{\rightarrow} \text{``\{\textbackslash cal P\}''}]$

$[\mathcal{P} \overset{\text{pyk}}{\rightarrow} \text{``meta p''}]$


## $\mathcal{Q}$

$[\mathcal{Q} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{Q} \overset{..}{=} \underline{\mathsf{q}}]\rceil)]$

$[\mathcal{Q} \overset{\text{tex}}{\rightarrow} \text{``\{\char92 cal Q\}''}]$

$[\mathcal{Q} \overset{\text{pyk}}{\rightarrow} \text{``meta q''}]$

## $\mathcal{R}$

$[\mathcal{R} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{R} \overset{..}{=} \underline{\mathsf{r}}]\rceil)]$

$[\mathcal{R} \overset{\text{tex}}{\rightarrow} \text{``\{\char92 cal R\}''}]$

$[\mathcal{R} \overset{\text{pyk}}{\rightarrow} \text{``meta r''}]$

## $\mathcal{S}$

$[\mathcal{S} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{S} \overset{..}{=} \underline{\mathsf{s}}]\rceil)]$

$[\mathcal{S} \overset{\text{tex}}{\rightarrow} \text{``\{\char92 cal S\}''}]$

$[\mathcal{S} \overset{\text{pyk}}{\rightarrow} \text{``meta s''}]$

## $\mathcal{T}$

$[\mathcal{T} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{T} \overset{..}{=} \underline{\mathsf{t}}]\rceil)]$

$[\mathcal{T} \overset{\text{tex}}{\rightarrow} \text{``\{\char92 cal T\}''}]$

$[\mathcal{T} \overset{\text{pyk}}{\rightarrow} \text{``meta t''}]$

## $\mathcal{U}$

$[\mathcal{U} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{U} \overset{..}{=} \underline{\mathsf{u}}]\rceil)]$

$[\mathcal{U} \overset{\text{tex}}{\rightarrow} \text{``\{\char92 cal U\}''}]$

$[\mathcal{U} \overset{\text{pyk}}{\rightarrow} \text{``meta u''}]$

## $\mathcal{V}$

$[\mathcal{V} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{V} \overset{..}{=} \underline{\mathsf{v}}]\rceil)]$

$[\mathcal{V} \overset{\text{tex}}{\rightarrow} \text{``\{\char92 cal V\}''}]$

$[\mathcal{V} \overset{\text{pyk}}{\rightarrow} \text{``meta v''}]$

## $\mathcal{W}$

$[\mathcal{W} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{W} \overset{.}{=} \underline{\mathsf{w}}]\rceil)]$

$[\mathcal{W} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal W}\}\text{''}]$

$[\mathcal{W} \overset{\text{pyk}}{\rightarrow} \text{``meta w''}]$

## $\mathcal{X}$

$[\mathcal{X} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{X} \overset{.}{=} \underline{\mathsf{x}}]\rceil)]$

$[\mathcal{X} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal X}\}\text{''}]$

$[\mathcal{X} \overset{\text{pyk}}{\rightarrow} \text{``meta x''}]$

## $\mathcal{Y}$

$[\mathcal{Y} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{Y} \overset{.}{=} \underline{\mathsf{y}}]\rceil)]$

$[\mathcal{Y} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal Y}\}\text{''}]$

$[\mathcal{Y} \overset{\text{pyk}}{\rightarrow} \text{``meta y''}]$

## $\mathcal{Z}$

$[\mathcal{Z} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathcal{Z} \overset{.}{=} \underline{\mathsf{z}}]\rceil)]$

$[\mathcal{Z} \overset{\text{tex}}{\rightarrow} \text{``}\{\backslash\text{cal Z}\}\text{''}]$

$[\mathcal{Z} \overset{\text{pyk}}{\rightarrow} \text{``meta z''}]$

## $\langle * \mid * := * \rangle$

$[\langle \mathsf{a} \mid \mathsf{x}{:=}\, \mathsf{b}\rangle \overset{\text{val}}{\rightarrow} \mathsf{x}!\mathsf{b}!$
$\text{If}(\mathsf{a}^{\mathcal{V}}, \text{If}(\mathsf{a} \overset{\mathsf{t}}{=} \mathsf{x}, \mathsf{b}, \mathsf{a}),$
$\text{If}(\neg\mathsf{a} \overset{\mathsf{r}}{=} \lceil\forall*{:}*\rceil, \mathsf{a}^{\mathsf{h}} :: \langle^*\mathsf{a}^{\mathsf{t}} \mid \mathsf{x}{:=}\, \mathsf{b}\rangle,$
$\text{If}(\mathsf{a}^1 \overset{\mathsf{t}}{=} \mathsf{x}, \mathsf{a},$
$\mathsf{a}^0 :: \mathsf{a}^1 :: \langle\mathsf{a}^2 \mid \mathsf{x}{:=}\, \mathsf{b}\rangle :: \mathsf{T})))]$

$[\langle \mathsf{a} \mid \mathsf{x}{:=}\, \mathsf{b}\rangle \overset{\text{tex}}{\rightarrow} \text{``}$
$\backslash\text{langle } \#1.$
$\backslash, \{\backslash\text{protect}\backslash\text{vert}\}\#2.$

$\{:=\}\backslash, \#3.$
$\backslash \mathrm{rangle}\ "]$

$[\langle * \mid * := * \rangle \overset{\mathrm{pyk}}{\to} \text{``sub " set " to " end sub"}]$


$\left\langle {}^{*}* \mid * := * \right\rangle$


$[\langle {}^{*}\mathsf{a} \mid \mathsf{x}{:=}\,\mathsf{b}\rangle \overset{\mathrm{val}}{\to} \mathsf{x}!\mathsf{b}!\mathsf{If}(\mathsf{a}, \mathsf{T}, \langle \mathsf{a}^{\mathsf{h}} \mid \mathsf{x}{:=}\,\mathsf{b}\rangle :: \langle {}^{*}\mathsf{a}^{\mathsf{t}} \mid \mathsf{x}{:=}\,\mathsf{b}\rangle)]$

$[\langle {}^{*}\mathsf{a} \mid \mathsf{x}{:=}\,\mathsf{b}\rangle \overset{\mathrm{tex}}{\to} \text{``}$
$\backslash \mathrm{langle}\ \hat{}\ \{\ \backslash \mathrm{ast}\ \}\ \#1.$
$\backslash, \{\backslash \mathrm{protect}\backslash \mathrm{vert}\}\#2.$
$\{:=\}\backslash, \#3.$
$\backslash \mathrm{rangle}\ "]$

$[\langle {}^{*}* \mid * := * \rangle \overset{\mathrm{pyk}}{\to} \text{``sub star " set " to " end sub"}]$


$\emptyset$

$[\emptyset \overset{\mathrm{val}}{\to} \mathsf{T}]$

$[\emptyset \overset{\mathrm{tex}}{\to} \text{``}$
$\backslash \mathrm{emptyset}\ "]$

$[\emptyset \overset{\mathrm{pyk}}{\to} \text{``the empty set"}]$


## Remainder

$[\mathrm{Remainder} \overset{\mathrm{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathrm{Remainder} \overset{.}{=} \mathrm{HeadPair}' \oplus$
$\mathrm{Transitivity}' \oplus \mathrm{Contra}']\rceil)]$

$[\mathrm{Remainder} \overset{\mathrm{tex}}{\to} \text{``}$
$\mathrm{Remainder}"]$

$[\mathrm{Remainder} \overset{\mathrm{pyk}}{\to} \text{``example remainder"}]$


$\left( * \right)^{\mathbf{v}}$

$[(\mathsf{x})^{\mathbf{v}} \overset{\mathrm{name}}{\to} \text{``}$
$(\ \#1.$
$)\hat{}\{\backslash \mathrm{bf}\ \mathrm{v}\}"]$

$[(\mathsf{x})^{\mathbf{v}} \overset{\mathrm{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[(\mathsf{x})^{\mathbf{v}} \overset{.}{=} \mathsf{x}]\rceil)]$

$[(\mathsf{x})^{\mathbf{v}} \stackrel{\text{tex}}{\rightarrow} \text{``\#1/tex name.''}]$

$[(*)^{\mathbf{v}} \stackrel{\text{pyk}}{\rightarrow} \text{``make visible " end visible''}]$


# $\text{intro}(*, *, *, *)$

$[\text{intro}(\mathsf{x}, \mathsf{i}, \mathsf{p}, \mathsf{t}) \stackrel{\text{name}}{\rightarrow} \text{``}$
$\text{intro}(\#1.$
$, \#2.$
$, \#3.$
$, \#4.$
$)\text{''}]$

$[\text{intro}(\mathsf{x}, \mathsf{i}, \mathsf{p}, \mathsf{t}) \stackrel{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\text{intro}(\mathsf{x}, \mathsf{i}, \mathsf{p}, \mathsf{t}) \stackrel{..}{=} \ \$[\mathsf{x} \stackrel{\text{tex}}{=} \mathsf{t}]\$ \,]\rceil)]$

$[\text{intro}(\mathsf{x}, \mathsf{i}, \mathsf{p}, \mathsf{t}) \stackrel{\text{tex}}{\rightarrow}$ "\index{#2.: #3. @#2.: \$[#1/tex name/tex.]\$ #3.}%
\index{pyk: #3. \$[#1/tex name/tex.]\$}%
\tex{
\$[#1/tex name/tex.
\stackrel {\mathrm {tex}}{=} #4/tex name.
]\$}\$[ #1/tex name/tex.%
]\$\footnote{\$[#1/tex name/tex.
\stackrel {\mathrm {pyk}}{=} #3/tex name.
]\$}"]

$[\text{intro}(*, *, *, *) \stackrel{\text{pyk}}{\rightarrow} \text{``intro " index " pyk " tex " end intro''}]$


# $\text{intro}(*, *, *)$

$[\text{intro}(\mathsf{x}, \mathsf{p}, \mathsf{t}) \stackrel{\text{name}}{\rightarrow} \text{``}$
$\text{intro}(\#1.$
$, \#2.$
$, \#3.$
$)\text{''}]$

$[\text{intro}(\mathsf{x}, \mathsf{p}, \mathsf{t}) \stackrel{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\text{intro}(\mathsf{x}, \mathsf{p}, \mathsf{t}) \stackrel{..}{=} \ \$[\mathsf{x} \stackrel{\text{tex}}{=} \mathsf{t}]\$ \,]\rceil)]$

$[\text{intro}(\mathsf{x}, \mathsf{p}, \mathsf{t}) \stackrel{\text{tex}}{\rightarrow}$ "\index{\alpha #2. @\back \makebox[20mm][l]{\$[#1/tex name/tex.]\$}#2.}%
\index{pyk: #2. \$[#1/tex name/tex.]\$}%
\tex{
\$[#1/tex name/tex.
\stackrel {\mathrm {tex}}{=} #3/tex name.
]\$}\$[ #1/tex name/tex.%
]\$\footnote{\$[#1/tex name/tex.

\stackrel {\mathrm {pyk}}{=} #2/tex name.
]$}"]

$[\text{intro}(*, *, *) \overset{\text{pyk}}{\rightarrow} \text{"intro " pyk " tex " end intro"}]$


# $\text{error}(*, *)$

$[\text{error}(\mathsf{m}, \mathsf{t}) \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\text{error}(\mathsf{m}, \mathsf{t}) \doteq \text{error}_2(\lceil\mathsf{m}\rceil, \mathsf{t})]\rceil)]$

$[\text{error}(\mathsf{m}, \mathsf{t}) \overset{\text{tex}}{\rightarrow}$ "
error(#1/tex name.
, #2.
)"]

$[\text{error}(*, *) \overset{\text{pyk}}{\rightarrow} \text{"error " term " end error"}]$


# $\text{error}_2(*, *)$

$[\text{error}_2(\mathsf{m}, \mathsf{t}) \overset{\text{val}}{\rightarrow} \mathsf{t}\text{-color}(\mathsf{m}^1\lceil$ "
"$\rceil^1\mathsf{t})]$

$[\text{error}_2(\mathsf{m}, \mathsf{t}) \overset{\text{tex}}{\rightarrow}$ "
error_{2}(#1/tex name.
, #2.
)"]

$[\text{error}_2(*, *) \overset{\text{pyk}}{\rightarrow} \text{"error two " term " end error"}]$


# $\text{proof}(*, *, *)$

$[\text{proof}(\mathsf{p}, \mathsf{t}, \mathsf{c}) \overset{\text{val}}{\rightarrow} \text{proof}_2(\mathcal{S}(\mathsf{c}, \mathsf{p}), \mathsf{t})]$

$[\text{proof}(\mathsf{p}, \mathsf{t}, \mathsf{c}) \overset{\text{tex}}{\rightarrow}$ "
proof( #1.
, #2.
, #3.
)"]

$[\text{proof}(*, *, *) \overset{\text{pyk}}{\rightarrow} \text{"proof " term " cache " end proof"}]$

# $\mathrm{proof}_2(*, *)$

$[\mathrm{proof}_2(\mathsf{q}, \mathsf{t}) \overset{\mathrm{val}}{\to} \mathsf{t}!$
$\mathrm{If}(\mathsf{q}^{\mathrm{E}}, \mathsf{q},$
$\mathrm{If}(\neg\mathsf{q}^0, \mathrm{error}_2(\lceil\text{"Proof has at least one unresolved premise. Lemma; premise}$
$\text{reads:"}\rceil, \mathsf{t}; \mathsf{q}^{0\mathrm{h}}),$
$\mathrm{If}(\neg\mathsf{q}^1, \mathrm{error}_2(\lceil\text{"Proof has at least one unresolved side condition.}$
$\text{Lemma; condition reads:"}\rceil, \mathsf{t}; \mathsf{q}^{1\mathrm{h}}),$
$\mathrm{If}(\mathsf{q}^2 \overset{\mathsf{t}}{=} \mathsf{t}, \mathsf{T},$
$\mathrm{error}_2(\lceil\text{"Lemma does not match conclusion. Lemma; conclusion}$
$\text{reads:"}\rceil, \mathsf{t}; \mathsf{q}^2)))))]$

$[\mathrm{proof}_2(\mathsf{q}, \mathsf{t}) \overset{\mathrm{tex}}{\to} \text{"}$
$\text{proof}\_\{2\}( \ \#1.$
$, \ \#2.$
$)\text{"}]$

$[\mathrm{proof}_2(*, *) \overset{\mathrm{pyk}}{\to} \text{"proof two " term " end proof"}]$

# $\mathcal{S}(*, *)$

$[\mathcal{S}(\mathsf{c}, \mathsf{t}) \overset{\mathrm{val}}{\to} \mathsf{c}!$
$\mathrm{If}(\mathsf{t}^{\mathrm{E}}, \mathsf{t},$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil *^{\mathrm{I}}\rceil, \mathcal{S}^{\mathrm{I}}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil *^{\triangleright}\rceil, \mathcal{S}^{\triangleright}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil *^{\mathrm{V}}\rceil, \mathcal{S}^{\mathrm{E}}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil *^{+}\rceil, \mathcal{S}^{+}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil *^{-}\rceil, \mathcal{S}^{-}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil *^{*}\rceil, \mathcal{S}^{*}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil * @ *\rceil, \mathcal{S}^{@}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil * \vdash *\rceil, \mathcal{S}^{\vdash}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil * \Vdash *\rceil, \mathcal{S}^{\Vdash}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil * \text{ i.e. } *\rceil, \mathcal{S}^{\mathrm{i.e.}}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil \forall *: *\rceil, \mathcal{S}^{\forall}(\mathsf{c}, \mathsf{t}),$
$\mathrm{If}(\mathsf{t} \overset{\mathrm{r}}{=} \lceil *; *\rceil, \mathcal{S}^{;}(\mathsf{c}, \mathsf{t}),$
$\mathrm{error}_2(\lceil\text{"Unknown sequent operator:"}\rceil, \mathsf{t})))))))))))))))]$

$[\mathcal{S}(\mathsf{x}, \mathsf{y}) \overset{\mathrm{tex}}{\to} \text{"}$
$\{\backslash\text{cal S}\}(\#1.$
$, \ \#2.$
$)\text{"}]$

$[\mathcal{S}(*, *) \overset{\mathrm{pyk}}{\to} \text{"sequent eval " term " end eval"}]$

$$\mathcal{S}^{\mathrm{I}}(*, *)$$

$[\mathcal{S}^{\mathrm{I}}(\mathsf{c}, \mathsf{t}) \overset{\mathrm{val}}{\rightarrow} \mathsf{c}!\emptyset :: \emptyset :: \mathsf{t}\text{-color}(\mathsf{t}^1 \vdash \mathsf{t}^1) :: \mathsf{T}]$

$[\mathcal{S}^{\mathrm{I}}(\mathsf{x}, \mathsf{y}) \overset{\mathrm{tex}}{\rightarrow}$ "
{\cal S}^{I}(#1.
, #2.
)"]

$[\mathcal{S}^{\mathrm{I}}(*, *) \overset{\mathrm{pyk}}{\rightarrow}$ "seqeval init " term " end eval"]

$$\mathcal{S}^{\rhd}(*, *)$$

$[\mathcal{S}^{\rhd}(\mathsf{c}, \mathsf{t}) \overset{\mathrm{val}}{\rightarrow} \mathcal{S}_1^{\rhd}(\mathsf{c}, \mathsf{t}, \mathcal{S}(\mathsf{c}, \mathsf{t}^1))]$

$[\mathcal{S}^{\rhd}(\mathsf{x}, \mathsf{y}) \overset{\mathrm{tex}}{\rightarrow}$ "
{\cal S}^{\rhd}(#1.
, #2.
)"]

$[\mathcal{S}^{\rhd}(*, *) \overset{\mathrm{pyk}}{\rightarrow}$ "seqeval modus " term " end eval"]

$$\mathcal{S}_1^{\rhd}(*, *, *)$$

$[\mathcal{S}_1^{\rhd}(\mathsf{c}, \mathsf{t}, \mathsf{q}) \overset{\mathrm{val}}{\rightarrow} \mathsf{c}!\mathsf{t}!$
$\mathrm{If}(\mathsf{q}^{\mathrm{E}}, \mathsf{q},$
$\mathrm{If}(\mathsf{q}^2 \overset{\mathrm{r}}{=} \lceil * \vdash * \rceil, \mathsf{q}^0 \cup \{\mathsf{q}^{21}\} :: \mathsf{q}^1 :: \mathsf{q}^{22} :: \mathsf{T},$
$\mathrm{If}(\mathsf{q}^2 \overset{\mathrm{r}}{=} \lceil * \Vdash * \rceil, \mathsf{q}^0 :: \mathsf{q}^1 \cup \{\mathsf{q}^{21}\} :: \mathsf{q}^{22} :: \mathsf{T},$
$\mathrm{error}_2(\lceil$"The modus operation requires the conclusion of its argument to be an inference or an endorsement"$\rceil, \mathsf{t}))))]$

$[\mathcal{S}_1^{\rhd}(\mathsf{x}, \mathsf{y}, \mathsf{z}) \overset{\mathrm{tex}}{\rightarrow}$ "
{\cal S}_{1}^{\rhd}(#1.
, #2.
, #3.
)"]

$[\mathcal{S}_1^{\rhd}(*, *, *) \overset{\mathrm{pyk}}{\rightarrow}$ "seqeval modus one " term " sequent " end eval"]

$$\mathcal{S}^{\mathrm{E}}(*, *)$$

$[\mathcal{S}^{\mathrm{E}}(\mathsf{c}, \mathsf{t}) \overset{\mathrm{val}}{\rightarrow} \mathcal{S}_1^{\mathrm{E}}(\mathsf{c}, \mathsf{t}, \mathcal{S}(\mathsf{c}, \mathsf{t}^1))]$

$[\mathcal{S}^{\mathrm{E}}(\mathsf{x},\mathsf{y}) \stackrel{\mathrm{tex}}{\rightarrow}$ "
{\cal S}^{E}(#1.
, #2.
)"]

$[\mathcal{S}^{\mathrm{E}}(*,*) \stackrel{\mathrm{pyk}}{\rightarrow}$ "seqeval verify " term " end eval"]


$$\mathcal{S}^{\mathrm{E}}_1\big(*,*,*\big)$$


$[\mathcal{S}^{\mathrm{E}}_1(\mathsf{c},\mathsf{t},\mathsf{q}) \stackrel{\mathrm{val}}{\rightarrow} \mathsf{c}!\mathsf{t}!$
$\mathrm{If}(\mathsf{q}^{\mathrm{E}},\mathsf{q},$
$\mathrm{If}(\neg\mathsf{q}^2 \stackrel{\mathrm{r}}{=} \lceil * \Vdash * \rceil, \mathrm{error}_2(\lceil$ "The verify operation requires the conclusion of its
argument to be an endorsement:" $\rceil,\mathsf{t}),$
$\mathrm{If}(\mathcal{U}^{\mathrm{M}}(\mathcal{E}(\mathsf{q}^{21},\mathsf{T},\mathsf{c}) \, ` \, \mathsf{c}),\mathsf{q}^0 :: \mathsf{q}^1 :: \mathsf{q}^{22} :: \mathsf{T},$
$\mathrm{error}_2(\lceil$ "False side condition:" $\rceil,\mathsf{t}))))]$

$[\mathcal{S}^{\mathrm{E}}_1(\mathsf{x},\mathsf{y},\mathsf{z}) \stackrel{\mathrm{tex}}{\rightarrow}$ "
{\cal S}_{1}^{E}(#1.
, #2.
, #3.
)"]

$[\mathcal{S}^{\mathrm{E}}_1(*,*,*) \stackrel{\mathrm{pyk}}{\rightarrow}$ "seqeval verify one " term " sequent " end eval"]


$$\mathcal{S}^{+}\big(*,*\big)$$


$[\mathcal{S}^{+}(\mathsf{c},\mathsf{t}) \stackrel{\mathrm{val}}{\rightarrow} \mathcal{S}^{+}_1(\mathsf{c},\mathsf{t},\mathcal{S}(\mathsf{c},\mathsf{t}^1))]$

$[\mathcal{S}^{+}(\mathsf{x},\mathsf{y}) \stackrel{\mathrm{tex}}{\rightarrow}$ "
{\cal S}^{+}(#1.
, #2.
)"]

$[\mathcal{S}^{+}(*,*) \stackrel{\mathrm{pyk}}{\rightarrow}$ "sequent eval plus " term " end eval"]


$$\mathcal{S}^{+}_1\big(*,*,*\big)$$


$[\mathcal{S}^{+}_1(\mathsf{c},\mathsf{t},\mathsf{q}) \stackrel{\mathrm{val}}{\rightarrow} \mathsf{c}!\mathsf{t}!$
$\mathrm{If}(\mathsf{q}^{\mathrm{E}},\mathsf{q},$
$\mathrm{If}(\mathsf{q}^2 \stackrel{\mathrm{r}}{=} \lceil * \vdash * \rceil \wedge \mathsf{q}^{22} \stackrel{\mathrm{r}}{=} \lceil * \vdash * \rceil,$
$\mathsf{q}^0 :: \mathsf{q}^1 :: \mathsf{t}\text{-color}(\mathsf{q}^{21} \oplus \mathsf{q}^{221} \vdash \mathsf{q}^{222}) :: \mathsf{T},$
$\mathrm{error}_2(\lceil$ "Term; conclusion not fit for decurrying:" $\rceil,\mathsf{t};\mathsf{q}^2)))]$

$[\mathcal{S}_1^+(\mathsf{x},\mathsf{y},\mathsf{z}) \overset{\text{tex}}{\to}$ "
{\cal S}_{1}^{+}(#1.
, #2.
, #3.
)"]

$[\mathcal{S}_1^+(*,*,*) \overset{\text{pyk}}{\to}$ "seqeval plus one " term " sequent " end eval"]


$$\mathcal{S}^-\big(*,*\big)$$

$[\mathcal{S}^-(\mathsf{c},\mathsf{t}) \overset{\text{val}}{\to} \mathcal{S}_1^-(\mathsf{c},\mathsf{t},\mathcal{S}(\mathsf{c},\mathsf{t}^1))]$

$[\mathcal{S}^-(\mathsf{x},\mathsf{y}) \overset{\text{tex}}{\to}$ "
{\cal S}^{-}(#1.
, #2.
)"]

$[\mathcal{S}^-(*,*) \overset{\text{pyk}}{\to}$ "seqeval minus " term " end eval"]


$$\mathcal{S}_1^-\big(*,*,*\big)$$

$[\mathcal{S}_1^-(\mathsf{c},\mathsf{t},\mathsf{q}) \overset{\text{val}}{\to} \mathsf{c}!\mathsf{t}!$
If$(\mathsf{q}^{\mathrm{E}},\mathsf{q},$
If$(\mathsf{q}^2 \overset{\mathrm{r}}{=} \lceil * \vdash * \rceil \wedge \mathsf{q}^{21} \overset{\mathrm{r}}{=} \lceil * \oplus * \rceil,$
$\mathsf{q}^0 :: \mathsf{q}^1 :: \mathsf{t}\text{-color}(\mathsf{q}^{211} \vdash \mathsf{q}^{212} \vdash \mathsf{q}^{22}) :: \mathsf{T},$
$\text{error}_2(\lceil\text{"Term; conclusion not fit for decurrying:"}\rceil,\mathsf{t};\mathsf{q}^2)))]$

$[\mathcal{S}_1^-(\mathsf{x},\mathsf{y},\mathsf{z}) \overset{\text{tex}}{\to}$ "
{\cal S}_{1}^{-}(#1.
, #2.
, #3.
)"]

$[\mathcal{S}_1^-(*,*,*) \overset{\text{pyk}}{\to}$ "seqeval minus one " term " sequent " end eval"]


$$\mathcal{S}^*\big(*,*\big)$$

$[\mathcal{S}^*(\mathsf{c},\mathsf{t}) \overset{\text{val}}{\to} \mathcal{S}_1^*(\mathsf{c},\mathsf{t},\mathcal{S}(\mathsf{c},\mathsf{t}^1))]$

$[\mathcal{S}^*(\mathsf{x},\mathsf{y}) \overset{\text{tex}}{\to}$ "
{\cal S}^{\ast}(#1.
, #2.
)"]

$[\mathcal{S}^*(*,*) \overset{\text{pyk}}{\to}$ "seqeval deref " term " end eval"$]$

$$\mathcal{S}_1^*\big(*,*,*\big)$$

$[\mathcal{S}_1^*(\mathsf{c},\mathsf{t},\mathsf{q}) \overset{\text{val}}{\to} \mathsf{c}!\mathsf{t}!$
$\text{If}(\mathsf{q}^{\mathrm{E}},\mathsf{q},$
$\mathcal{S}_2^*(\mathsf{c},\mathsf{t},\mathsf{q},\mathbf{aspect}(<\text{stmt}>,\mathsf{q}^2,\mathsf{c})))]$

$[\mathcal{S}_1^*(\mathsf{x},\mathsf{y},\mathsf{z}) \overset{\text{tex}}{\to}$ "
{\cal S}_{1}^{\ast}(\#1.
, \#2.
, \#3.
)"$]$

$[\mathcal{S}_1^*(*,*,*) \overset{\text{pyk}}{\to}$ "seqeval deref one " term " sequent " end eval"$]$

$$\mathcal{S}_2^*\big(*,*,*,*\big)$$

$[\mathcal{S}_2^*(\mathsf{c},\mathsf{t},\mathsf{q},\mathsf{d}) \overset{\text{val}}{\to} \mathsf{c}!\mathsf{t}!\mathsf{q}!$
$\text{If}(\mathsf{d},\text{error}_2(\lceil$ "Dereferencing construct that has no statement def:"$\rceil),\mathsf{t}),$
$\mathsf{q}^0 :: \mathsf{q}^1 :: \mathsf{d}^3 :: \mathsf{T})]$

$[\mathcal{S}_2^*(\mathsf{c},\mathsf{t},\mathsf{q},\mathsf{d}) \overset{\text{tex}}{\to}$ "
{\cal S}_{2}^{\ast}(\#1.
, \#2.
, \#3.
, \#4.
)"$]$

$[\mathcal{S}_2^*(*,*,*,*) \overset{\text{pyk}}{\to}$ "seqeval deref two " term " sequent " def " end eval"$]$

$$\mathcal{S}^{@}\big(*,*\big)$$

$[\mathcal{S}^{@}(\mathsf{c},\mathsf{t}) \overset{\text{val}}{\to} \mathcal{S}_1^{@}(\mathsf{c},\mathsf{t},\mathcal{S}(\mathsf{c},\mathsf{t}^1))]$

$[\mathcal{S}^{@}(\mathsf{x},\mathsf{y}) \overset{\text{tex}}{\to}$ "
{\cal S}^{\char64}(\#1.
, \#2.
)"$]$

$[\mathcal{S}^{@}(*,*) \overset{\text{pyk}}{\to}$ "seqeval at " term " end eval"$]$

$$\mathcal{S}_1^@(*, *, *)$$

$[\mathcal{S}_1^@(\mathsf{c},\mathsf{t},\mathsf{q}) \overset{\mathrm{val}}{\to} \mathsf{c}!\mathsf{t}!$
$\mathrm{If}(\mathsf{q}^{\mathrm{E}},\mathsf{q},$
$\mathrm{If}(\neg\mathsf{q}^2 \overset{\mathrm{r}}{=} \lceil\forall*:*\rceil, \mathrm{error}_2(\lceil\text{``Quantifier elimination requires the conclusion of its}$
$\text{argument to be a quantifier:''}\rceil,\mathsf{t}),$
$\mathrm{If}(\neg\mathsf{t}^2 \text{ free for } \mathsf{q}^{21} \text{ in } \mathsf{q}^{22}, \mathrm{error}_2(\lceil\text{``Quantifier elimination leads to variable}$
$\text{clash:''}\rceil,\mathsf{t}),$
$\mathsf{q}^0 :: \mathsf{q}^1 :: \langle\mathsf{q}^{22} \,|\mathsf{q}^{21}{:=}\,\mathsf{t}^2\rangle :: \mathsf{T})))]$

$[\mathcal{S}_1^@(\mathsf{c},\mathsf{t},\mathsf{q}) \overset{\mathrm{tex}}{\to} \text{``}$
$\{\backslash\mathrm{cal\ S}\}\_\{1\}\hat{}\{\backslash\mathrm{char64}\}(\#1.$
$, \#2.$
$, \#3.$
$)\text{''}]$

$[\mathcal{S}_1^@(*, *, *) \overset{\mathrm{pyk}}{\to} \text{``seqeval at one " term " sequent " end eval''}]$


$$\mathcal{S}^{\vdash}(*, *)$$

$[\mathcal{S}^{\vdash}(\mathsf{c},\mathsf{t}) \overset{\mathrm{val}}{\to} \mathcal{S}_1^{\vdash}(\mathsf{c},\mathsf{t},\mathsf{t}^1, \mathcal{S}(\mathsf{c},\mathsf{t}^2))]$

$[\mathcal{S}^{\vdash}(\mathsf{x},\mathsf{y}) \overset{\mathrm{tex}}{\to} \text{``}$
$\{\backslash\mathrm{cal\ S}\}\hat{}\{\backslash\mathrm{vdash}\}(\#1.$
$, \#2.$
$)\text{''}]$

$[\mathcal{S}^{\vdash}(*, *) \overset{\mathrm{pyk}}{\to} \text{``seqeval infer " term " end eval''}]$


$$\mathcal{S}_1^{\vdash}(*, *, *, *)$$

$[\mathcal{S}_1^{\vdash}(\mathsf{c},\mathsf{t},\mathsf{p},\mathsf{q}) \overset{\mathrm{val}}{\to} \mathsf{c}!\mathsf{t}!\mathsf{p}!$
$\mathrm{If}(\mathsf{q}^{\mathrm{E}},\mathsf{q},$
$\mathsf{q}^0\backslash\{\mathsf{p}\} :: \mathsf{q}^1 :: \mathsf{t}\text{-}\mathrm{color}(\mathsf{p} \vdash \mathsf{q}^2) :: \mathsf{T})]$

$[\mathcal{S}_1^{\vdash}(\mathsf{x},\mathsf{y},\mathsf{z},\mathsf{u}) \overset{\mathrm{tex}}{\to} \text{``}$
$\{\backslash\mathrm{cal\ S}\}\_\{1\}\hat{}\{\backslash\mathrm{vdash}\}(\#1.$
$, \#2.$
$, \#3.$
$, \#4.$
$)\text{''}]$

$[\mathcal{S}_1^{\vdash}(*, *, *, *) \overset{\mathrm{pyk}}{\to} \text{``seqeval infer one " term " premise " sequent " end eval''}]$

$$\mathcal{S}^{\Vdash}(*, *)$$

$[\mathcal{S}^{\Vdash}(\mathsf{c}, \mathsf{t}) \overset{\text{val}}{\to} \mathcal{S}_1^{\Vdash}(\mathsf{c}, \mathsf{t}, \mathsf{t}^1, \mathcal{S}(\mathsf{c}, \mathsf{t}^2))]$

$[\mathcal{S}^{\Vdash}(\mathsf{x}, \mathsf{y}) \overset{\text{tex}}{\to}$ "
`{\cal S}^{\makebox [0mm][l]{\scriptsize $\vdash $}\, {\vdash }}(#1.`
`, #2.`
`)"]`

$[\mathcal{S}^{\Vdash}(*, *) \overset{\text{pyk}}{\to}$ "seqeval endorse " term " end eval"]


$$\mathcal{S}_1^{\Vdash}(*, *, *, *)$$

$[\mathcal{S}_1^{\Vdash}(\mathsf{c}, \mathsf{t}, \mathsf{p}, \mathsf{q}) \overset{\text{val}}{\to} \mathsf{c!t!p!}$
$\mathrm{If}(\mathsf{q}^{\mathrm{E}}, \mathsf{q},$
$\mathsf{q}^0 :: \mathsf{q}^1 \backslash \{\mathsf{p}\} :: \mathsf{t}\text{-color}(\mathsf{p} \Vdash \mathsf{q}^2) :: \mathsf{T})]$

$[\mathcal{S}_1^{\Vdash}(\mathsf{x}, \mathsf{y}, \mathsf{z}, \mathsf{u}) \overset{\text{tex}}{\to}$ "
`{\cal S}_{1}^{\makebox [0mm][l]{\scriptsize $\vdash $}\, {\vdash }}(#1.`
`, #2.`
`, #3.`
`, #4.`
`)"]`

$[\mathcal{S}_1^{\Vdash}(*, *, *, *) \overset{\text{pyk}}{\to}$ "seqeval endorse one " term " side " sequent " end eval"]


$$\mathcal{S}^{\text{i.e.}}(*, *)$$

$[\mathcal{S}^{\text{i.e.}}(\mathsf{c}, \mathsf{t}) \overset{\text{val}}{\to} \mathcal{S}_1^{\text{i.e.}}(\mathsf{c}, \mathsf{t}, \mathsf{t}^2, \mathcal{S}(\mathsf{c}, \mathsf{t}^1))]$

$[\mathcal{S}^{\text{i.e.}}(\mathsf{x}, \mathsf{y}) \overset{\text{tex}}{\to}$ "
`{\cal S}^{i.e.}(#1.`
`, #2.`
`)"]`

$[\mathcal{S}^{\text{i.e.}}(*, *) \overset{\text{pyk}}{\to}$ "seqeval est " term " end eval"]


$$\mathcal{S}_1^{\text{i.e.}}(*, *, *, *)$$

$[\mathcal{S}_1^{\text{i.e.}}(\mathsf{c}, \mathsf{t}, \mathsf{a}, \mathsf{q}) \overset{\text{val}}{\to} \mathsf{c!t!a!}$
$\mathrm{If}(\mathsf{q}^{\mathrm{E}}, \mathsf{q}, \mathcal{S}_2^{\text{i.e.}}(\mathsf{c}, \mathsf{t}, \mathsf{a}, \mathsf{q}, \mathbf{aspect}(<\text{stmt}>, \mathsf{a}, \mathsf{c})))]$

$[\mathcal{S}_1^{\text{i.e.}}(\mathsf{x}, \mathsf{y}, \mathsf{z}, \mathsf{u}) \overset{\text{tex}}{\to}$ "

```
{\cal S}_{1}^{i.e.}(#1.
, #2.
, #3.
, #4.
)"]
```

$[\mathcal{S}_1^{\text{i.e.}}(*,*,*,*) \overset{\text{pyk}}{\rightarrow}$ "seqeval est one " term " name " sequent " end eval"]

$$\mathcal{S}_2^{\text{i.e.}}(*,*,*,*,*)$$

$[\mathcal{S}_2^{\text{i.e.}}(\mathsf{c},\mathsf{t},\mathsf{a},\mathsf{q},\mathsf{d}) \overset{\text{val}}{\rightarrow} \mathsf{c!t!a!q!}$
$\text{If}(\mathsf{d}, \text{error}_2(\lceil \text{"Referencing construct that has no statement def:"}\rceil, \mathsf{t}),$
$\text{If}(\neg \mathsf{d}^3 \overset{\mathsf{t}}{=} \mathsf{q}^2, \text{error}_2(\lceil \text{"Reference; conclusion do not match:"}\rceil, \mathsf{a}; \mathsf{q}^2),$
$\mathsf{q}^0 :: \mathsf{q}^1 :: \mathsf{a} :: \mathsf{T}))]$

```
[S_2^{i.e.}(c, t, a, q, d) →tex "
{\cal S}_{2}^{i.e.}(#1.
, #2.
, #3.
, #4.
, #5.
)"]
```

$[\mathcal{S}_2^{\text{i.e.}}(*,*,*,*,*) \overset{\text{pyk}}{\rightarrow}$ "seqeval est two " term " name " sequent " def " end eval"]

$$\mathcal{S}^{\forall}(*,*)$$

$[\mathcal{S}^{\forall}(\mathsf{c},\mathsf{t}) \overset{\text{val}}{\rightarrow} \mathcal{S}_1^{\forall}(\mathsf{c},\mathsf{t},\mathsf{t}^1, \mathcal{S}(\mathsf{c},\mathsf{t}^2)))]$

```
[S^∀(x, y) →tex "
{\cal S}^{\forall}(#1.
, #2.
)"]
```

$[\mathcal{S}^{\forall}(*,*) \overset{\text{pyk}}{\rightarrow}$ "seqeval all " term " end eval"]

$$\mathcal{S}_1^{\forall}(*,*,*,*)$$

$[\mathcal{S}_1^{\forall}(\mathsf{c},\mathsf{t},\mathsf{v},\mathsf{q}) \overset{\text{val}}{\rightarrow} \mathsf{c!t!v!}$
$\text{If}(\mathsf{q}^{\text{E}}, \mathsf{q},$
$\text{If}(\neg \mathsf{v}^{\mathcal{V}}, \text{error}_2(\lceil \text{"Metageneralization over non-metavariable:"}\rceil, \mathsf{t}),$

If(v free in q^0, $\mathrm{error}_2(\lceil$"Metageneralization over metavariable that occurs free in some premise:"$\rceil, \mathsf{t})$,
If(v free in q^1, $\mathrm{error}_2(\lceil$"Metageneralization over metavariable that occurs free in some side condition:"$\rceil, \mathsf{t})$,
$\mathsf{q}^0 :: \mathsf{q}^1 :: \mathsf{t}\text{-color}(\forall \mathsf{v}: \mathsf{q}^2) :: \mathsf{T}))))]$

$[\mathcal{S}_1^\forall(\mathsf{c}, \mathsf{t}, \mathsf{v}, \mathsf{q}) \overset{\text{tex}}{\to}$ "
$\{\backslash\mathrm{cal\ S}\}_{-}\{1\}\hat{\ }\{\backslash\mathrm{forall}\}(\#1.$
, #2.
, #3.
, #4.
)"]

$[\mathcal{S}_1^\forall(*, *, *, *) \overset{\text{pyk}}{\to}$ "seqeval all one " term " variable " sequent " end eval"]

$\mathcal{S}^;(*, *)$

$[\mathcal{S}^;(\mathsf{c}, \mathsf{t}) \overset{\text{val}}{\to} \mathcal{S}_1^;(\mathsf{c}, \mathsf{t}, \mathcal{S}(\mathsf{c}, \mathsf{t}^1))]$

$[\mathcal{S}^;(\mathsf{x}, \mathsf{y}) \overset{\text{tex}}{\to}$ "
$\{\backslash\mathrm{cal\ S}\}\hat{\ }\{;\}(\#1.$
, #2.
)"]

$[\mathcal{S}^;(*, *) \overset{\text{pyk}}{\to}$ "seqeval cut " term " end eval"]

$\mathcal{S}_1^;(*, *, *)$

$[\mathcal{S}_1^;(\mathsf{c}, \mathsf{t}, \mathsf{p}) \overset{\text{val}}{\to} \mathsf{c}!\mathsf{t}!$
If($\mathsf{p}^\mathrm{E}, \mathsf{p}, \mathcal{S}_2^;(\mathsf{c}, \mathsf{t}, \mathsf{p}, \mathcal{S}(\mathsf{c}, \mathsf{t}^2)))]$

$[\mathcal{S}_1^;(\mathsf{x}, \mathsf{y}, \mathsf{z}) \overset{\text{tex}}{\to}$ "
$\{\backslash\mathrm{cal\ S}\}_{-}\{1\}\hat{\ }\{;\}(\#1.$
, #2.
, #3.
)"]

$[\mathcal{S}_1^;(*, *, *) \overset{\text{pyk}}{\to}$ "seqeval cut one " term " forerunner " end eval"]

$\mathcal{S}_2^;(*, *, *, *)$

$[\mathcal{S}_2^;(\mathsf{c}, \mathsf{t}, \mathsf{p}, \mathsf{q}) \overset{\text{val}}{\to} \mathsf{c}!\mathsf{t}!\mathsf{p}!$
If($\mathsf{q}^\mathrm{E}, \mathsf{q}, \mathsf{p}^0 \cup \mathsf{q}^0 \backslash \{\mathsf{p}^2\} :: \mathsf{p}^1 \cup \mathsf{q}^1 :: \mathsf{q}^2 :: \mathsf{T})]$

$[\mathcal{S}_2^j(\mathsf{c},\mathsf{t},\mathsf{p},\mathsf{q}) \overset{\text{tex}}{\to} \text{``}$
$\{\backslash\text{cal S}\}\_\{2\}\char`^\{;\}(\#1.$
, #2.
, #3.
, #4.
$)"]$

$[\mathcal{S}_2^j(*,*,*,*) \overset{\text{pyk}}{\to} \text{``seqeval cut two " term " forerunner " sequent " end eval"}]$

$\mathcal{T}(*)$

$[\mathcal{T}(\mathsf{x}) \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t},\mathsf{s},\mathsf{c},\lceil[\mathcal{T}(\mathsf{x}) \overset{.}{=} \lambda\mathsf{c}.\mathcal{U}^{\mathrm{M}}(\mathcal{E}(\lceil\mathsf{x}\rceil,\mathsf{T},\mathsf{c}))]\rceil))]$

$[\mathcal{T}(\mathsf{x}) \overset{\text{tex}}{\to} \text{``}$
$\{\backslash\text{cal T}\}(\#1.$
$)"]$

$[\mathcal{T}(*) \overset{\text{pyk}}{\to} \text{``computably true " end true"}]$

$\text{claims}(*,*,*)$

$[\text{claims}(\mathsf{t},\mathsf{c},\mathsf{r}) \overset{\text{val}}{\to}$
$\text{If}(\text{claims}_2(\mathsf{t},\mathsf{c},\mathsf{r}),\mathsf{T},\text{claims}_2(\mathsf{t},\mathsf{c},\mathsf{c}[\mathsf{r}][\text{"bibliography"}]^1))]$

$[\text{claims}(\mathsf{t},\mathsf{c},\mathsf{r}) \overset{\text{tex}}{\to} \text{``}$
$\text{claims}(\#1.$
, #2.
, #3.
$)"]$

$[\text{claims}(*,*,*) \overset{\text{pyk}}{\to} \text{``claims " cache " ref " end claims"}]$

$\text{claims}_2(*,*,*)$

$[\text{claims}_2(\mathsf{t},\mathsf{c},\mathsf{r}) \overset{\text{val}}{\to} \text{If}(\neg\mathsf{r}^c,\mathsf{t}!\mathsf{c}!\mathsf{F},\mathsf{t} \in_c \mathsf{c}[\mathsf{r}][\text{"codex"}][\mathsf{r}][0][0][\text{"claim"}]^3)]$

$[\text{claims}_2(\mathsf{t},\mathsf{c},\mathsf{r}) \overset{\text{tex}}{\to} \text{``}$
$\text{claims}\_2(\#1.$
, #2.
, #3.
$)"]$

$[\text{claims}_2(*,*,*) \overset{\text{pyk}}{\to} \text{``claims two " cache " ref " end claims"}]$

\<proof\>

[\<proof\> $\overset{\text{val}}{\to}$ $\lceil$\<proof\>]]

[\<proof\> $\overset{\text{tex}}{\to}$ "
{\<}proof{\>}"]

[\<proof\> $\overset{\text{pyk}}{\to}$ "the proof aspect"]

proof

[proof $\overset{\text{msg}}{\to}$ \<proof\>]

[proof $\overset{\text{tex}}{\to}$ "
proof"]

[proof $\overset{\text{pyk}}{\to}$ "proof"]

[**Lemma** ∗: ∗]

[[**Lemma** x: y] $\overset{\text{macro}}{\to}$ $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil[[\textbf{Lemma } x: y] \overset{..}{=} [x \overset{\text{stmt}}{\to} y]]])$

[[**Lemma** x: y] $\overset{\text{tex}}{\to}$ "
[\mathbf{Lemma\ } #1.
\colon #2.
]"]

[[**Lemma** ∗: ∗] $\overset{\text{pyk}}{\to}$ "lemma " says " end lemma"]

[**Proof of** ∗: ∗]

[[**Proof of** x: y] $\overset{\text{macro}}{\to}$ $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil[[\textbf{Proof of } x: y] \overset{..}{=} [x \overset{\text{proof}}{\to} y]]])$

[[**Proof of** x: y] $\overset{\text{tex}}{\to}$ "
[\mathbf{Proof\ of\ }#1/tex name/tex.
\colon #2.
]"]

[[**Proof of** ∗: ∗] $\overset{\text{pyk}}{\to}$ "proof of " reads " end proof"]

[∗ **lemma** ∗: ∗]

[[x **lemma** y: z] $\overset{\text{macro}}{\rightarrow}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[[x **lemma** y: z] $\overset{\cdot}{=}$ [y $\overset{\text{stmt}}{=}$ x ⊢ z]]]⌉)]

[[x **lemma** y: z] $\overset{\text{tex}}{\rightarrow}$ "
[#1.
\mathbf{\ lemma\ } #2.
\colon #3.
]"]

[[∗ **lemma** ∗: ∗] $\overset{\text{pyk}}{\rightarrow}$ "in theory " lemma " says " end lemma"]

[∗ **antilemma** ∗: ∗]

[[x **antilemma** y: z] $\overset{\text{macro}}{\rightarrow}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[[x **antilemma** y: z] $\overset{\cdot}{=}$
[x **lemma** y: z ⊢ ⊥]]]⌉)]

[[x **antilemma** y: z] $\overset{\text{tex}}{\rightarrow}$ "
[#1.
\mathbf{\ antilemma\ } #2.
\colon #3.
]"]

[[∗ **antilemma** ∗: ∗] $\overset{\text{pyk}}{\rightarrow}$ "in theory " antilemma " says " end antilemma"]

[∗ **rule** ∗: ∗]

[[x **rule** y: z] $\overset{\text{macro}}{\rightarrow}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[[x **rule** y: z] $\overset{\cdot}{=}$
[x **lemma** y: z][**Proof of** y: Rule tactic]]]⌉)]

[[x **rule** y: z] $\overset{\text{tex}}{\rightarrow}$ "
[#1.
\mathbf{\ rule\ } #2.
\colon #3.
]"]

[[∗ **rule** ∗: ∗] $\overset{\text{pyk}}{\rightarrow}$ "in theory " rule " says " end rule"]

[∗ **antirule** ∗: ∗]

[[x **antirule** y: z] $\overset{\text{macro}}{\rightarrow}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[[x **antirule** y: z] $\overset{\cdot}{=}$ [x **rule** y: z ⊢
⊥]]]⌉)]

[[x **antirule** y: z] $\overset{\text{tex}}{\rightarrow}$ "
[#1.
\mathbf{\ antirule\ } #2.
\colon #3.
]"]

[[* **antirule** *: *] $\overset{\text{pyk}}{\rightarrow}$ "in theory " antirule " says " end antirule"]

verifier

[verifier $\overset{\text{val}}{\rightarrow}$ λt.λc.$\mathcal{V}_1$(c)]

[verifier $\overset{\text{pyk}}{\rightarrow}$ "verifier"]

$\mathcal{V}_1(*)$

[$\mathcal{V}_1$(c) $\overset{\text{val}}{\rightarrow}$
$\text{let}_1(\lambda$r.
$\text{let}_1(\lambda$x.
$\text{let}_1(\lambda$p.
$\text{let}_1(\lambda$d.
$\text{If}(\neg$d, d,
$\text{let}_1(\lambda$i.
$\text{If}(\neg$i^c, T,
$\text{error}_2(\lceil$"Circular proof. Circle
includes:"$\rceil$, p[i]^{0h})), $\mathcal{V}_5$(c, r, p, p))), $\mathcal{V}_3$(c, r, p, T)), $\mathcal{V}_2$(c, x)), c[r]["codex"][r]), c[0])]

[$\mathcal{V}_1$(c) $\overset{\text{tex}}{\rightarrow}$ "
{\cal V}_1(#1.
)"]

[$\mathcal{V}_1(*)$ $\overset{\text{pyk}}{\rightarrow}$ "verify one " end verify"]

$\mathcal{V}_2(*, *)$

[$\mathcal{V}_2$(c, p) $\overset{\text{val}}{\rightarrow}$ c!
If(p, T,
$\text{If}(\neg$p^{hc}, $\mathcal{V}_2$(c, p^h) :: $\mathcal{V}_2$(c, p^t), p^h ::
$\text{let}_1(\lambda$d.
If(d, T,
$\text{let}_1(\lambda$r.
If(r^E, $\text{error}_2(\lceil$"Error in proof of"$\rceil$, d$^2\lceil$"
"$\rceil^1$r), r), $\mathcal{S}$(c, $\mathcal{U}^M(\mathcal{E}$(d^3, T, c) ' c ' p)))), **aspect**($<$proof$>$, p^t)))))]

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$[\mathcal{V}_2(\mathsf{c},\mathsf{p}) \overset{\text{tex}}{\rightarrow}$ "
{\cal V}_2(#1.
, #2.
)"]

$[\mathcal{V}_2(*, *) \overset{\text{pyk}}{\rightarrow}$ "verify two " proofs " end verify"]

$$\mathcal{V}_3(*, *, *, *)$$

$[\mathcal{V}_3(\mathsf{c},\mathsf{r},\mathsf{p},\mathsf{d}) \overset{\text{val}}{\rightarrow} \mathsf{c}!\mathsf{r}!\mathsf{p}!$
$\text{If}(\neg\mathsf{d},\mathsf{d},$
$\text{If}(\mathsf{p},\mathsf{T},$
$\text{If}(\neg\mathsf{p}^{\text{hc}},\mathcal{V}_3(\mathsf{c},\mathsf{r},\mathsf{p}^{\text{t}},\mathcal{V}_3(\mathsf{c},\mathsf{r},\mathsf{p}^{\text{h}},\mathsf{T})),$
$\text{let}_1(\lambda\mathsf{i}.$
$\text{let}_1(\lambda\mathsf{q}.$
$\text{If}(\mathsf{q},\mathsf{T},$
$\text{If}(\mathsf{q}^{\text{E}},\mathsf{q},$
$\text{If}(\neg\mathsf{q}^1,\text{error}_2(\lceil\text{"Unchecked sidecondition:"}\rceil,\mathsf{q}^{1\text{h}}),$
$\text{let}_1(\lambda\mathsf{d}.$
$\text{If}(\mathsf{d},\text{error}_2(\lceil\text{"Proof of non-existent lemma:"}\rceil,\mathsf{q}^2),$
$\text{If}(\neg\mathsf{q}^2 \overset{\text{t}}{=} \mathsf{d}^3,\text{error}_2(\lceil\text{"Lemma/proof mismatch:"}\rceil,\mathsf{d}^2;\mathsf{q}^2),$
$\mathcal{V}_4(\mathsf{c},\mathsf{q}^0))),\mathbf{aspect}(<\text{stmt}>,\mathsf{c}[\mathsf{r}][\text{"codex"}][\mathsf{r}][\mathsf{i}])))),\mathsf{p}^{\text{t}}),\mathsf{p}^{\text{h}})))))]$

$[\mathcal{V}_3(\mathsf{c},\mathsf{r},\mathsf{p},\mathsf{d}) \overset{\text{tex}}{\rightarrow}$ "
{\cal V}_3(#1.
, #2.
, #3.
, #4.
)"]

$[\mathcal{V}_3(*, *, *, *) \overset{\text{pyk}}{\rightarrow}$ "verify three " ref " sequents " diagnose " end verify"]

$$\mathcal{V}_4(*, *)$$

$[\mathcal{V}_4(\mathsf{c},\mathsf{p}) \overset{\text{val}}{\rightarrow} \mathsf{c}!$
$\text{If}(\mathsf{p},\mathsf{T},$
$\text{let}_1(\lambda\mathsf{d}.$
$\text{If}(\neg\mathsf{d},\mathsf{d},$
$\text{let}_1(\lambda\mathsf{p}.$
$\text{let}_1(\lambda\mathsf{r}.$
$\text{let}_1(\lambda\mathsf{i}.$
$\text{If}(\neg\mathsf{c}[\mathsf{r}][\text{"diagnose"}],$
$\text{error}_2(\lceil\text{"Reference to erroneous page"}\rceil,\mathsf{p}),$

If($\neg$claims($\lceil$verifier$\rceil$, c, r),
error$_2$($\lceil$"Reference to unchecked lemma"$\rceil$, p),
If(**aspect**($<$proof$>$, p, c),
error$_2$($\lceil$"Reference to unproved lemma"$\rceil$, p), T))), p^i), p^r), p^h)), $\mathcal{V}_4$(c, p^t)))]

[$\mathcal{V}_4$(c, p) $\overset{\text{tex}}{\rightarrow}$ "
{\cal V}_4(#1.
, #2.
)"]

[$\mathcal{V}_4$(*, *) $\overset{\text{pyk}}{\rightarrow}$ "verify four " premises " end verify"]

$$\mathcal{V}_5(*, *, *, *)$$

[$\mathcal{V}_5$(c, r, a, q) $\overset{\text{val}}{\rightarrow}$ c!r!a!
If(q^c, q,
If(a, q,
If($\neg$a^{hc}, $\mathcal{V}_5$(c, r, a^t, $\mathcal{V}_5$(c, r, a^h, q)),
$\mathcal{V}_7$(c, r, a^h, q)))))]

[$\mathcal{V}_5$(c, r, a, q) $\overset{\text{tex}}{\rightarrow}$ "
{\cal V}_5(#1.
, #2.
, #3.
, #4.
)"]

[$\mathcal{V}_5$(*, *, *, *) $\overset{\text{pyk}}{\rightarrow}$ "verify five " ref " array " sequents " end verify"]

$$\mathcal{V}_6(*, *, *, *)$$

[$\mathcal{V}_6$(c, r, p, q) $\overset{\text{val}}{\rightarrow}$ c!r!p!
If(q^c, q,
If(p, q,
let$_1$(λq.
If(q^c, q,
If($\neg$r $\approx$ p^{hr}, q,
$\mathcal{V}_7$(c, r, p^{hi}, q))), $\mathcal{V}_6$(c, r, p^t, q)))))]

[$\mathcal{V}_6$(c, r, p, q) $\overset{\text{tex}}{\rightarrow}$ "
{\cal V}_6(#1.
, #2.
, #3.
, #4.

$)$"]

$[\mathcal{V}_6(*, *, *, *) \overset{\text{pyk}}{\to}$ "verify six " ref " list " sequents " end verify"]

$\mathcal{V}_7(*, *, *, *)$

$[\mathcal{V}_7(\mathsf{c}, \mathsf{r}, \mathsf{i}, \mathsf{q}) \overset{\text{val}}{\to} \mathsf{c}!\mathsf{r}!$
$\text{let}_1(\lambda\mathsf{v}.$
$\text{If}(\mathsf{v}, \mathsf{q},$
$\text{If}(\mathsf{v} \approx 0, \mathsf{i},$
$\text{If}(\mathsf{v} \approx 1, \mathsf{q},$
$\text{let}_1(\lambda\mathsf{q}.$
$\text{If}(\mathsf{q}^c, \mathsf{q}, \mathsf{q}[\mathsf{i}{\to}1]), \mathcal{V}_6(\mathsf{c}, \mathsf{r}, \mathsf{v}^0, \mathsf{q}[\mathsf{i}{\to}0])))))), \mathsf{q}[\mathsf{i}])]$
$[\mathcal{V}_7(\mathsf{c}, \mathsf{r}, \mathsf{i}, \mathsf{q}) \overset{\text{tex}}{\to}$ "
{\cal V}_7(#1.
, #2.
, #3.
, #4.
$)$"]
$[\mathcal{V}_7(*, *, *, *) \overset{\text{pyk}}{\to}$ "verify seven " ref " id " sequents " end verify"]

$\text{Cut}(*, *)$

$[\text{Cut}(\mathsf{a}, \mathsf{b}) \overset{\text{val}}{\to} \text{If}(\mathsf{b}, \mathsf{a}, \mathsf{a}; \mathsf{b})]$
$[\text{Cut}(\mathsf{a}, \mathsf{b}) \overset{\text{tex}}{\to}$ "
Cut(#1.
, #2.
$)$"]
$[\text{Cut}(*, *) \overset{\text{pyk}}{\to}$ "cut " and " end cut"]

$\text{Head}_\oplus(*)$

$[\text{Head}_\oplus(\mathsf{s}) \overset{\text{val}}{\to} \mathsf{s}^1 \vdash \mathsf{s}^2 \vdash \mathsf{s}^{1 I \rhd + \rhd}]$
$[\text{Head}_\oplus(\mathsf{s}) \overset{\text{tex}}{\to}$ "
Head_{\oplus} (#1.
$)$"]
$[\text{Head}_\oplus(*) \overset{\text{pyk}}{\to}$ "head " end head"]

$\mathrm{Tail}_{\oplus}(*)$

$[\mathrm{Tail}_{\oplus}(\mathsf{s}) \overset{\mathrm{val}}{\to} \mathsf{s}^1 \vdash \mathsf{s}^{2\mathrm{I}+\rhd}]$

$[\mathrm{Tail}_{\oplus}(\mathsf{s}) \overset{\mathrm{tex}}{\to}$ "
Tail_{\oplus} (#1.
)"]

$[\mathrm{Tail}_{\oplus}(*) \overset{\mathrm{pyk}}{\to}$ "tail " end tail"]

$\mathrm{rule}_1(*, *)$

$[\mathrm{rule}_1(\mathsf{s}, \mathsf{t}) \overset{\mathrm{val}}{\to}$
$\mathrm{If}(\mathsf{s} \overset{\mathrm{t}}{=} \mathsf{t}, \mathsf{T},$
$\mathrm{If}(\neg \mathsf{t} \overset{\mathrm{r}}{=} \lceil \mathsf{x} \oplus \mathsf{y} \rceil, 0,$
$\mathrm{let}_1(\lambda \mathsf{p}.$
$\mathrm{If}(\neg \mathsf{p}^c, \mathrm{Cut}(\mathrm{Head}_{\oplus}(\mathsf{t}), \mathsf{p}),$
$\mathrm{let}_1(\lambda \mathsf{p}.$
$\mathrm{If}(\neg \mathsf{p}^c, \mathrm{Cut}(\mathrm{Tail}_{\oplus}(\mathsf{t}), \mathsf{p}), 0), \mathrm{rule}_1(\mathsf{s}, \mathsf{t}^2))), \mathrm{rule}_1(\mathsf{s}, \mathsf{t}^1))))]$

$[\mathrm{rule}_1(\mathsf{s}, \mathsf{t}) \overset{\mathrm{tex}}{\to}$ "
rule_1(#1.
, #2.
)"]

$[\mathrm{rule}_1(*, *) \overset{\mathrm{pyk}}{\to}$ "rule one " theory " end rule"]

$\mathrm{rule}(*, *)$

$[\mathrm{rule}(\mathsf{c}, \mathsf{p}) \overset{\mathrm{val}}{\to} \mathsf{c}!$
$\mathrm{let}_1(\lambda \mathsf{s}.$
$\mathrm{If}(\mathsf{s}, \lceil$ "Rule has no statement aspect" $\rceil,$
$\mathrm{If}(\neg \mathsf{s} \overset{\mathrm{r}}{=} \lceil \mathsf{x} \vdash \mathsf{y} \rceil, \mathrm{error}_2(\lceil$ "Rule has invalid statement aspect" $\rceil), \mathsf{s}),$
$\mathrm{let}_1(\lambda \mathsf{t}.$
$\mathrm{If}(\mathsf{t}, \lceil$ "Theory has no statement aspect" $\rceil,$
$\mathrm{let}_1(\lambda \mathsf{r}.$
$\mathrm{If}(\mathsf{r}^c, \mathrm{error}_2(\lceil$ "The theory does not assert the given rule" $\rceil), \mathsf{s}; \mathsf{t}),$
$\mathsf{s}^1 \vdash$
$\mathrm{Cut}(\mathsf{s}^{1\mathrm{I}\rhd *}, \mathsf{r})), \mathrm{rule}_1(\mathsf{s}^2, \mathsf{t}))), \mathbf{aspect}(<\mathrm{stmt}>, \mathsf{s}^1, \mathsf{c})^3))), \mathbf{aspect}(<\mathrm{stmt}>, \mathsf{p}^t)^3)]$

$[\mathrm{rule}(\mathsf{c}, \mathsf{p}) \overset{\mathrm{tex}}{\to}$ "
rule(#1.
, #2.

)"]

$[\text{rule}(*, *) \overset{\text{pyk}}{\to} \text{"rule " subcodex " end rule"}]$

Rule tactic

$[\text{Rule tactic} \overset{\text{val}}{\to} \lambda\mathsf{c}.\lambda\mathsf{p}.\text{rule}(\mathsf{c}, \mathsf{p})]$

$[\text{Rule tactic} \overset{\text{tex}}{\to}$ "
Rule\ tactic"]

$[\text{Rule tactic} \overset{\text{pyk}}{\to}$ "rule tactic"]

$\text{Plus}(*, *)$

$[\text{Plus}(\mathsf{a}, \mathsf{b}) \overset{\text{val}}{\to} \text{If}(\mathsf{b}, \mathsf{a}, \mathsf{a} \oplus \mathsf{b})]$

$[\text{Plus}(\mathsf{a}, \mathsf{b}) \overset{\text{tex}}{\to}$ "
Plus(#1.
, #2.
)"]

$[\text{Plus}(*, *) \overset{\text{pyk}}{\to}$ "plus " and " end plus"]

$[\textbf{Theory} *]$

$[[\textbf{Theory n}] \overset{\text{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\text{theory}_2(\mathsf{t}, \mathsf{c})]$

$[[\textbf{Theory n}] \overset{\text{tex}}{\to}$ "
[\mathbf{Theory\ } #1.
]"]

$[[\textbf{Theory} *] \overset{\text{pyk}}{\to}$ "theory " end theory"]

$\text{theory}_2(*, *)$

$[\text{theory}_2(\mathsf{t}, \mathsf{c}) \overset{\text{val}}{\to}$
$\text{let}_1(\lambda\mathsf{n}.$
$\text{let}_1(\lambda\mathsf{s}.$
$\tilde{\mathcal{Q}}(\mathsf{t}, \lceil[\mathsf{n} \overset{\text{stmt}}{\to} \mathsf{x}]\rceil, \mathsf{s}), \lceil\mathsf{n}\rceil :: \mathsf{n} :: \lceil\mathsf{x}\rceil :: \text{theory}_3(\mathsf{c}, \mathsf{n}) :: \mathsf{T}), \mathsf{t}^1)]$

$[\text{theory}_2(\mathsf{t}, \mathsf{c}) \overset{\text{tex}}{\to}$ "
theory_2(#1.

, #2.
)"]

[theory$_2$(∗, ∗) $\overset{\text{pyk}}{\rightarrow}$ "theory two " cache " end theory"]

theory$_3$(∗, ∗)

[theory$_3$(c, n) $\overset{\text{val}}{\rightarrow}$ n!
let$_1$(λr.
theory$_4$(c[r]["codex"][r], n, T), c[0])]

[theory$_3$(c, n) $\overset{\text{tex}}{\rightarrow}$ "
theory_3(#1.
, #2.
)"]

[theory$_3$(∗, ∗) $\overset{\text{pyk}}{\rightarrow}$ "theory three " name " end theory"]

theory$_4$(∗, ∗, ∗)

[theory$_4$(c, n, s) $\overset{\text{val}}{\rightarrow}$ n!
If(c, s,
If($\neg$c^{hc}, theory$_4$(c^t, n, theory$_4$(c^h, n, s)),
If($\neg$**aspect**(<proof>, c^t)^3 $\overset{\text{t}}{=}$ ⌈Rule tactic⌉, s,
let$_1$(λd.
If($\neg$d^1 $\overset{\text{t}}{=}$ n, s,
Plus(d^2, s)), **aspect**(<stmt>, c^t)^3)))))]

[theory$_4$(c, n, s) $\overset{\text{tex}}{\rightarrow}$ "
theory_4(#1.
, #2.
, #3.
)"]

[theory$_4$(∗, ∗, ∗) $\overset{\text{pyk}}{\rightarrow}$ "theory four " name " sum " end theory"]

HeadNil″

[HeadNil″ $\overset{\text{proof}}{\rightarrow}$ Rule tactic]

[HeadNil″ $\overset{\text{stmt}}{\rightarrow}$ T$_E'$ ⊢ T^h = T]

[HeadNil″ $\overset{\text{tex}}{\rightarrow}$ "

HeadNil'""]

[HeadNil'' $\overset{\text{pyk}}{\rightarrow}$ "example axiom lemma primed"]

HeadPair''

[HeadPair'' $\overset{\text{proof}}{\rightarrow}$ Rule tactic]

[HeadPair'' $\overset{\text{stmt}}{\rightarrow}$ $T'_E \vdash \forall \underline{a} \colon \forall \underline{b} \colon \underline{a} \colon\colon \underline{b}^h = \underline{a}$]

[HeadPair'' $\overset{\text{tex}}{\rightarrow}$ "
HeadPair'""]

[HeadPair'' $\overset{\text{pyk}}{\rightarrow}$ "example scheme lemma primed"]

Transitivity''

[Transitivity'' $\overset{\text{proof}}{\rightarrow}$ Rule tactic]

[Transitivity'' $\overset{\text{stmt}}{\rightarrow}$ $T'_E \vdash \forall \underline{a} \colon \forall \underline{b} \colon \forall \underline{c} \colon \underline{a} = \underline{b} \vdash \underline{a} = \underline{c} \vdash \underline{b} = \underline{c}$]

[Transitivity'' $\overset{\text{tex}}{\rightarrow}$ "
Transitivity'""]

[Transitivity'' $\overset{\text{pyk}}{\rightarrow}$ "example rule lemma primed"]

Contra''

[Contra'' $\overset{\text{proof}}{\rightarrow}$ Rule tactic]

[Contra'' $\overset{\text{stmt}}{\rightarrow}$ $T'_E \vdash \mathsf{T} \colon\colon \mathsf{T} = \mathsf{T} \vdash \underline{\bot\bot}$]

[Contra'' $\overset{\text{tex}}{\rightarrow}$ "
Contra'""]

[Contra'' $\overset{\text{pyk}}{\rightarrow}$ "contraexample lemma primed"]

HeadNil

[HeadNil $\overset{\text{proof}}{\rightarrow}$ Rule tactic]

[HeadNil $\overset{\text{stmt}}{\rightarrow}$ $T_E \vdash \mathsf{T}^h = \mathsf{T}$]

[HeadNil $\overset{\text{tex}}{\rightarrow}$ "
HeadNil"]

[HeadNil $\overset{\text{pyk}}{\to}$ "example axiom lemma"]

HeadPair

[HeadPair $\overset{\text{proof}}{\to}$ Rule tactic]

[HeadPair $\overset{\text{stmt}}{\to}$ $T_E \vdash \forall \underline{a} \colon \forall \underline{b} \colon \underline{a} \colon\colon \underline{b}^h = \underline{a}$]

[HeadPair $\overset{\text{tex}}{\to}$ "
HeadPair"]

[HeadPair $\overset{\text{pyk}}{\to}$ "example scheme lemma"]

Transitivity

[Transitivity $\overset{\text{proof}}{\to}$ Rule tactic]

[Transitivity $\overset{\text{stmt}}{\to}$ $T_E \vdash \forall \underline{a} \colon \forall \underline{b} \colon \forall \underline{c} \colon \underline{a} = \underline{b} \vdash \underline{a} = \underline{c} \vdash \underline{b} = \underline{c}$]

[Transitivity $\overset{\text{tex}}{\to}$ "
Transitivity"]

[Transitivity $\overset{\text{pyk}}{\to}$ "example rule lemma"]

Contra

[Contra $\overset{\text{proof}}{\to}$ Rule tactic]

[Contra $\overset{\text{stmt}}{\to}$ $T_E \vdash \mathsf{T} \colon\colon \mathsf{T} = \mathsf{T} \vdash \perp\!\!\!\perp$]

[Contra $\overset{\text{tex}}{\to}$ "
Contra"]

[Contra $\overset{\text{pyk}}{\to}$ "contraexample lemma"]

T_E

[$T_E \overset{\text{stmt}}{\to} \forall \underline{a} \colon \forall \underline{b} \colon \underline{a} \colon\colon \underline{b}^h = \underline{a} \oplus \mathsf{T} \colon\colon \mathsf{T} = \mathsf{T} \vdash \perp\!\!\!\perp \oplus \mathsf{T}^h = \mathsf{T} \oplus \forall \underline{a} \colon \forall \underline{b} \colon \forall \underline{c} \colon \underline{a} = \underline{b} \vdash$
$\underline{a} = \underline{c} \vdash \underline{b} = \underline{c}$]

[$T_E \overset{\text{tex}}{\to}$ "
T_E"]

[$T_E \overset{\text{pyk}}{\to}$ "example theory"]

ragged right

[ragged right $\overset{\text{name}}{\rightarrow}$ "
ragged\ right"]

[ragged right $\overset{\text{tex}}{\rightarrow}$ "
\raggedright"]

[ragged right $\overset{\text{pyk}}{\rightarrow}$ "ragged right"]

ragged right expansion

[ragged right expansion $\overset{\text{name}}{\rightarrow}$ "
ragged\ right\ expansion\ "]

[ragged right expansion $\overset{\text{macro}}{\rightarrow}$ $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[$ragged right expansion $\overset{..}{=}$ ragged right$]])$)]

[ragged right expansion $\overset{\text{tex}}{\rightarrow}$ ""]

[ragged right expansion $\overset{\text{pyk}}{\rightarrow}$ "ragged right expansion"]

$\mathrm{parm}(*, *, *)$

$[\mathrm{parm}(t, s, n) \overset{\text{val}}{\rightarrow} n!$
$\mathrm{If}(t \overset{r}{=} \lceil \forall x{:}\, y \rceil, \forall n{:}\, \mathrm{parm}(t^2, t^1 :: n :: s, T + 2 * n),$
$\mathrm{let}_1(\lambda m.$
$\mathrm{If}(\neg m, m, t^R :: \mathrm{parm}^*(t^t, s, n)), \mathbf{lookup}(t, s, T))))]$

$[\mathrm{parm}(t, s, n) \overset{\text{tex}}{\rightarrow}$ "
$\mathrm{parm}(\#1.$
$, \#2.$
$, \#3.$
$)$"]

$[\mathrm{parm}(*, *, *) \overset{\text{pyk}}{\rightarrow}$ "parameter term " stack " seed " end parameter"]

$\mathrm{parm}^*(*, *, *)$

$[\mathrm{parm}^*(t, s, n) \overset{\text{val}}{\rightarrow} s!n!\mathrm{If}(t^a, T, \mathrm{parm}(t^h, s, n) :: \mathrm{parm}^*(t^t, s, n))]$

$[\mathrm{parm}^*(t, s, n) \overset{\text{tex}}{\rightarrow}$ "
$\mathrm{parm}\hat{\ }*(\#1.$
$, \#2.$

, #3.
)"]

$[\text{parm}^*(*, *, *) \xrightarrow{\text{pyk}} \text{"parameter term star " stack " seed " end parameter"}]$

$\text{inst}(*, *)$

$[\text{inst}(t, s) \xrightarrow{\text{val}} \text{If}(t^c, \text{inst}(s[t], s), t^R :: \text{inst}^*(t^t, s))]$

$[\text{inst}(t, s) \xrightarrow{\text{tex}} \text{"}$
inst(#1.
, #2.
)"]

$[\text{inst}(*, *) \xrightarrow{\text{pyk}} \text{"instantiate " with " end instantiate"}]$

$\text{inst}^*(*, *)$

$[\text{inst}^*(t, s) \xrightarrow{\text{val}} s!\text{If}(t^a, T, \text{inst}(t^h, s) :: \text{inst}^*(t^t, s))]$

$[\text{inst}^*(t, s) \xrightarrow{\text{tex}} \text{"}$
inst^*(#1.
, #2.
)"]

$[\text{inst}^*(*, *) \xrightarrow{\text{pyk}} \text{"instantiate star " with " end instantiate"}]$

$\text{occur}(*, *, *)$

$[\text{occur}(t, u, s) \xrightarrow{\text{val}} s!\text{If}(u^c, \text{If}(t \approx u, T, \text{occur}(t, s[u], s)), \text{occur}^*(t, u^t, s))]$

$[\text{occur}(t, u, s) \xrightarrow{\text{tex}} \text{"}$
occur(#1.
, #2.
, #3.
)"]

$[\text{occur}(*, *, *) \xrightarrow{\text{pyk}} \text{"occur " in " substitution " end occur"}]$

$\text{occur}^*(*, *, *)$

$[\text{occur}^*(t, u, s) \xrightarrow{\text{val}} t!s!\text{If}(u^a, F, \text{If}(\text{occur}(t, u^h, s), T, \text{occur}^*(t, u^t, s)))]$

$[\text{occur}^*(\mathsf{t}, \mathsf{u}, \mathsf{s}) \overset{\text{tex}}{\rightarrow}$ "
$\text{occur}\hat{\ }*(\#1.$
$, \#2.$
$, \#3.$
$)$"$]$

$[\text{occur}^*(*, *, *) \overset{\text{pyk}}{\rightarrow}$ "occur star " in " substitution " end occur"$]$

$\text{unify}(* = *, *)$

$[\text{unify}(\mathsf{t} = \mathsf{u}, \mathsf{s}) \overset{\text{val}}{\rightarrow} \mathsf{t}!\mathsf{u}!$
$\text{If}(\mathsf{s}^c, \mathsf{s},$
$\text{If}(\mathsf{t}^c, \text{unify}_2(\mathsf{t} = \mathsf{u}, \mathsf{s}),$
$\text{If}(\mathsf{u}^c, \text{unify}_2(\mathsf{u} = \mathsf{t}, \mathsf{s}),$
$\text{If}(\mathsf{t} \overset{\text{r}}{=} \mathsf{u}, \text{unify}^*(\mathsf{t}^t = \mathsf{u}^t, \mathsf{s}), 0)))))]$

$[\text{unify}(\mathsf{t} = \mathsf{u}, \mathsf{s}) \overset{\text{tex}}{\rightarrow}$ "
$\text{unify}(\#1.$
$= \#2.$
$, \#3.$
$)$"$]$

$[\text{unify}(* = *, *) \overset{\text{pyk}}{\rightarrow}$ "unify " with " substitution " end unify"$]$

$\text{unify}^*(* = *, *)$

$[\text{unify}^*(\mathsf{t} = \mathsf{u}, \mathsf{s}) \overset{\text{val}}{\rightarrow} \mathsf{u}!\text{If}(\mathsf{t}^a, \mathsf{s}, \text{unify}^*(\mathsf{t}^t = \mathsf{u}^t, \text{unify}(\mathsf{t}^h = \mathsf{u}^h, \mathsf{s})))]$

$[\text{unify}^*(\mathsf{t} = \mathsf{u}, \mathsf{s}) \overset{\text{tex}}{\rightarrow}$ "
$\text{unify}\hat{\ }*(\#1.$
$= \#2.$
$, \#3.$
$)$"$]$

$[\text{unify}^*(* = *, *) \overset{\text{pyk}}{\rightarrow}$ "unify star " with " substitution " end unify"$]$

$\text{unify}_2(* = *, *)$

$[\text{unify}_2(\mathsf{t} = \mathsf{u}, \mathsf{s}) \overset{\text{val}}{\rightarrow}$
$\text{If}(\mathsf{t} \approx \mathsf{u}, \mathsf{s},$
$\text{let}_1(\lambda \mathsf{t}'.$
$\text{If}(\neg \mathsf{t}', \text{unify}(\mathsf{t}' = \mathsf{u}, \mathsf{s}),$
$\text{If}(\text{occur}(\mathsf{t}, \mathsf{u}, \mathsf{s}), 0, \mathsf{s}[\mathsf{t} \rightarrow \mathsf{u}])), \mathsf{s}[\mathsf{t}]))]$

[unify$_2$(t = u, s) $\overset{\text{tex}}{\rightarrow}$ "
unify_2(#1.
=#2.
, #3.
)"]

[unify$_2$(* = *, *) $\overset{\text{pyk}}{\rightarrow}$ "unify two " with " substitution " end unify"]

L$_a$

[L$_a$ $\overset{\text{name}}{\rightarrow}$ "L_a"]

[L$_a$ $\overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_a \else
\if \relax \csname lgwella\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwella {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwella \fi "]

[L$_a$ $\overset{\text{pyk}}{\rightarrow}$ "ell a"]

L$_b$

[L$_b$ $\overset{\text{name}}{\rightarrow}$ "L_b"]

[L$_b$ $\overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_b \else
\if \relax \csname lgwellb\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellb {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellb \fi "]

[L$_b$ $\overset{\text{pyk}}{\rightarrow}$ "ell b"]

L$_c$

[L$_c$ $\overset{\text{name}}{\rightarrow}$ "L_c"]

[L$_c$ $\overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_c \else
\if \relax \csname lgwellc\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellc {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellc \fi "]

$[L_c \overset{\text{pyk}}{\rightarrow} \text{"ell c"}]$

L_d

$[L_d \overset{\text{name}}{\rightarrow} \text{"L\_d"}]$

$[L_d \overset{\text{tex}}{\rightarrow} \text{"}$
\if \relax \csname lgwprooflinep\endcsname L_d \else
\if \relax \csname lgwelld\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwelld {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwelld \fi "]

$[L_d \overset{\text{pyk}}{\rightarrow} \text{"ell d"}]$

L_e

$[L_e \overset{\text{name}}{\rightarrow} \text{"L\_e"}]$

$[L_e \overset{\text{tex}}{\rightarrow} \text{"}$
\if \relax \csname lgwprooflinep\endcsname L_e \else
\if \relax \csname lgwelle\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwelle {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwelle \fi "]

$[L_e \overset{\text{pyk}}{\rightarrow} \text{"ell e"}]$

L_f

$[L_f \overset{\text{name}}{\rightarrow} \text{"L\_f"}]$

$[L_f \overset{\text{tex}}{\rightarrow} \text{"}$
\if \relax \csname lgwprooflinep\endcsname L_f \else
\if \relax \csname lgwellf\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellf {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellf \fi "]

$[L_f \overset{\text{pyk}}{\rightarrow} \text{"ell f"}]$

L_g

$[L_g \overset{\text{name}}{\rightarrow} \text{``L\_g''}]$

$[L_g \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_g \else
\if \relax \csname lgwellg\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellg {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellg \fi "]

$[L_g \overset{\text{pyk}}{\rightarrow} \text{``ell g''}]$

L_h

$[L_h \overset{\text{name}}{\rightarrow} \text{``L\_h''}]$

$[L_h \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_h \else
\if \relax \csname lgwellh\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellh {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellh \fi "]

$[L_h \overset{\text{pyk}}{\rightarrow} \text{``ell h''}]$

L_i

$[L_i \overset{\text{name}}{\rightarrow} \text{``L\_i''}]$

$[L_i \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_i \else
\if \relax \csname lgwelli\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwelli {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwelli \fi "]

$[L_i \overset{\text{pyk}}{\rightarrow} \text{``ell i''}]$

L_j

$[L_j \overset{\text{name}}{\rightarrow} \text{``L\_j''}]$

$[L_j \overset{\text{tex}}{\rightarrow}$ "

\if \relax \csname lgwprooflinep\endcsname L_j \else
\if \relax \csname lgwellj\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellj {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellj \fi "]

$[L_j \overset{\text{pyk}}{\rightarrow} \text{"ell j"}]$

L_k

$[L_k \overset{\text{name}}{\rightarrow} \text{"L\_k"}]$

$[L_k \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_k \else
\if \relax \csname lgwellk\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellk {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellk \fi "]

$[L_k \overset{\text{pyk}}{\rightarrow} \text{"ell k"}]$

L_l

$[L_l \overset{\text{name}}{\rightarrow} \text{"L\_l"}]$

$[L_l \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_l \else
\if \relax \csname lgwelll\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwelll {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwelll \fi "]

$[L_l \overset{\text{pyk}}{\rightarrow} \text{"ell l"}]$

L_m

$[L_m \overset{\text{name}}{\rightarrow} \text{"L\_m"}]$

$[L_m \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_m \else
\if \relax \csname lgwellm\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellm {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellm \fi "]

$[L_m \overset{\text{pyk}}{\rightarrow}$ "ell m"]

L_n

$[L_n \overset{\text{name}}{\rightarrow}$ "L_n"]

$[L_n \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_n \else
\if \relax \csname lgwelln\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwelln {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwelln \fi "]

$[L_n \overset{\text{pyk}}{\rightarrow}$ "ell n"]

L_o

$[L_o \overset{\text{name}}{\rightarrow}$ "L_o"]

$[L_o \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_o \else
\if \relax \csname lgwello\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwello {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwello \fi "]

$[L_o \overset{\text{pyk}}{\rightarrow}$ "ell o"]

L_p

$[L_p \overset{\text{name}}{\rightarrow}$ "L_p"]

$[L_p \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_p \else
\if \relax \csname lgwellp\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellp {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellp \fi "]

$[L_p \overset{\text{pyk}}{\rightarrow}$ "ell p"]

L_q

$[L_q \overset{\text{name}}{\rightarrow} \text{``L\_q''}]$

$[L_q \overset{\text{tex}}{\rightarrow} ``$
\if \relax \csname lgwprooflinep\endcsname L_q \else
\if \relax \csname lgwellq\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellq {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellq \fi "]

$[L_q \overset{\text{pyk}}{\rightarrow} \text{``ell q''}]$

L_r

$[L_r \overset{\text{name}}{\rightarrow} \text{``L\_r''}]$

$[L_r \overset{\text{tex}}{\rightarrow} ``$
\if \relax \csname lgwprooflinep\endcsname L_r \else
\if \relax \csname lgwellr\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellr {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellr \fi "]

$[L_r \overset{\text{pyk}}{\rightarrow} \text{``ell r''}]$

L_s

$[L_s \overset{\text{name}}{\rightarrow} \text{``L\_s''}]$

$[L_s \overset{\text{tex}}{\rightarrow} ``$
\if \relax \csname lgwprooflinep\endcsname L_s \else
\if \relax \csname lgwells\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwells {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwells \fi "]

$[L_s \overset{\text{pyk}}{\rightarrow} \text{``ell s''}]$

L_t

$[L_t \overset{\text{name}}{\rightarrow} \text{``L\_t''}]$

$[L_t \overset{\text{tex}}{\rightarrow} ``$

\if \relax \csname lgwprooflinep\endcsname L_t \else
\if \relax \csname lgwellt\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellt {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellt \fi "]

$[L_t \overset{\text{pyk}}{\rightarrow} \text{"ell t"}]$

L_u

$[L_u \overset{\text{name}}{\rightarrow} \text{"L\_u"}]$

$[L_u \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_u \else
\if \relax \csname lgwellu\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellu {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellu \fi "]

$[L_u \overset{\text{pyk}}{\rightarrow} \text{"ell u"}]$

L_v

$[L_v \overset{\text{name}}{\rightarrow} \text{"L\_v"}]$

$[L_v \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_v \else
\if \relax \csname lgwellv\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellv {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellv \fi "]

$[L_v \overset{\text{pyk}}{\rightarrow} \text{"ell v"}]$

L_w

$[L_w \overset{\text{name}}{\rightarrow} \text{"L\_w"}]$

$[L_w \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_w \else
\if \relax \csname lgwellw\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellw {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellw \fi "]

$[L_w \overset{\text{pyk}}{\rightarrow} \text{``ell w''}]$

L_x

$[L_x \overset{\text{name}}{\rightarrow} \text{``L\_x''}]$

$[L_x \overset{\text{tex}}{\rightarrow} ``$
\if \relax \csname lgwprooflinep\endcsname L_x \else
\if \relax \csname lgwellx\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellx {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellx \fi ''$]$

$[L_x \overset{\text{pyk}}{\rightarrow} \text{``ell x''}]$

L_y

$[L_y \overset{\text{name}}{\rightarrow} \text{``L\_y''}]$

$[L_y \overset{\text{tex}}{\rightarrow} ``$
\if \relax \csname lgwprooflinep\endcsname L_y \else
\if \relax \csname lgwelly\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwelly {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwelly \fi ''$]$

$[L_y \overset{\text{pyk}}{\rightarrow} \text{``ell y''}]$

L_z

$[L_z \overset{\text{name}}{\rightarrow} \text{``L\_z''}]$

$[L_z \overset{\text{tex}}{\rightarrow} ``$
\if \relax \csname lgwprooflinep\endcsname L_z \else
\if \relax \csname lgwellz\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellz {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellz \fi ''$]$

$[L_z \overset{\text{pyk}}{\rightarrow} \text{``ell z''}]$

L_A

$[L_A \overset{\text{name}}{\rightarrow} \text{"L\_A"}]$

$[L_A \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_A \else
\if \relax \csname lgwellbiga\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbiga {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbiga \fi "]

$[L_A \overset{\text{pyk}}{\rightarrow} \text{"ell big a"}]$

L_B

$[L_B \overset{\text{name}}{\rightarrow} \text{"L\_B"}]$

$[L_B \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_B \else
\if \relax \csname lgwellbigb\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigb {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigb \fi "]

$[L_B \overset{\text{pyk}}{\rightarrow} \text{"ell big b"}]$

L_C

$[L_C \overset{\text{name}}{\rightarrow} \text{"L\_C"}]$

$[L_C \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_C \else
\if \relax \csname lgwellbigc\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigc {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigc \fi "]

$[L_C \overset{\text{pyk}}{\rightarrow} \text{"ell big c"}]$

L_D

$[L_D \overset{\text{name}}{\rightarrow} \text{"L\_D"}]$

$[L_D \overset{\text{tex}}{\rightarrow}$ "

\if \relax \csname lgwprooflinep\endcsname L_D \else
\if \relax \csname lgwellbigd\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigd {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigd \fi "]

$[\mathrm{L_D} \overset{\mathrm{pyk}}{\rightarrow}$ "ell big d"]

$\mathrm{L_E}$

$[\mathrm{L_E} \overset{\mathrm{name}}{\rightarrow}$ "L_E"]

$[\mathrm{L_E} \overset{\mathrm{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_E \else
\if \relax \csname lgwellbige\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbige {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbige \fi "]

$[\mathrm{L_E} \overset{\mathrm{pyk}}{\rightarrow}$ "ell big e"]

$\mathrm{L_F}$

$[\mathrm{L_F} \overset{\mathrm{name}}{\rightarrow}$ "L_F"]

$[\mathrm{L_F} \overset{\mathrm{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_F \else
\if \relax \csname lgwellbigf\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigf {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigf \fi "]

$[\mathrm{L_F} \overset{\mathrm{pyk}}{\rightarrow}$ "ell big f"]

$\mathrm{L_G}$

$[\mathrm{L_G} \overset{\mathrm{name}}{\rightarrow}$ "L_G"]

$[\mathrm{L_G} \overset{\mathrm{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_G \else
\if \relax \csname lgwellbigg\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigg {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigg \fi "]

[L$_\text{G}$ $\overset{\text{pyk}}{\rightarrow}$ "ell big g"]

L$_\text{H}$

[L$_\text{H}$ $\overset{\text{name}}{\rightarrow}$ "L_H"]

[L$_\text{H}$ $\overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_H \else
\if \relax \csname lgwellbigh\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigh {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigh \fi "]

[L$_\text{H}$ $\overset{\text{pyk}}{\rightarrow}$ "ell big h"]

L$_\text{I}$

[L$_\text{I}$ $\overset{\text{name}}{\rightarrow}$ "L_I"]

[L$_\text{I}$ $\overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_I \else
\if \relax \csname lgwellbigi\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigi {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigi \fi "]

[L$_\text{I}$ $\overset{\text{pyk}}{\rightarrow}$ "ell big i"]

L$_\text{J}$

[L$_\text{J}$ $\overset{\text{name}}{\rightarrow}$ "L_J"]

[L$_\text{J}$ $\overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_J \else
\if \relax \csname lgwellbigj\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigj {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigj \fi "]

[L$_\text{J}$ $\overset{\text{pyk}}{\rightarrow}$ "ell big j"]

L_K

[$L_K \overset{\text{name}}{\rightarrow}$ "L_K"]

[$L_K \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_K \else
\if \relax \csname lgwellbigk\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigk {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigk \fi "]

[$L_K \overset{\text{pyk}}{\rightarrow}$ "ell big k"]

L_L

[$L_L \overset{\text{name}}{\rightarrow}$ "L_L"]

[$L_L \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_L \else
\if \relax \csname lgwellbigl\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigl {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigl \fi "]

[$L_L \overset{\text{pyk}}{\rightarrow}$ "ell big l"]

L_M

[$L_M \overset{\text{name}}{\rightarrow}$ "L_M"]

[$L_M \overset{\text{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_M \else
\if \relax \csname lgwellbigm\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigm {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigm \fi "]

[$L_M \overset{\text{pyk}}{\rightarrow}$ "ell big m"]

L_N

[$L_N \overset{\text{name}}{\rightarrow}$ "L_N"]

[$L_N \overset{\text{tex}}{\rightarrow}$ "

\if \relax \csname lgwprooflinep\endcsname L_N \else
\if \relax \csname lgwellbign\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbign {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbign \fi "]

$[\mathrm{L_N} \overset{\mathrm{pyk}}{\rightarrow}$ "ell big n"]

$\mathrm{L_O}$

$[\mathrm{L_O} \overset{\mathrm{name}}{\rightarrow}$ "L_O"]

$[\mathrm{L_O} \overset{\mathrm{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_O \else
\if \relax \csname lgwellbigo\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigo {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigo \fi "]

$[\mathrm{L_O} \overset{\mathrm{pyk}}{\rightarrow}$ "ell big o"]

$\mathrm{L_P}$

$[\mathrm{L_P} \overset{\mathrm{name}}{\rightarrow}$ "L_P"]

$[\mathrm{L_P} \overset{\mathrm{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_P \else
\if \relax \csname lgwellbigp\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigp {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigp \fi "]

$[\mathrm{L_P} \overset{\mathrm{pyk}}{\rightarrow}$ "ell big p"]

$\mathrm{L_Q}$

$[\mathrm{L_Q} \overset{\mathrm{name}}{\rightarrow}$ "L_Q"]

$[\mathrm{L_Q} \overset{\mathrm{tex}}{\rightarrow}$ "
\if \relax \csname lgwprooflinep\endcsname L_Q \else
\if \relax \csname lgwellbigq\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigq {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigq \fi "]

[L_Q $\overset{\text{pyk}}{\to}$ "ell big q"]

L_R

[L_R $\overset{\text{name}}{\to}$ "L_R"]

[L_R $\overset{\text{tex}}{\to}$ "
\if \relax \csname lgwprooflinep\endcsname L_R \else
\if \relax \csname lgwellbigr\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigr {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigr \fi "]

[L_R $\overset{\text{pyk}}{\to}$ "ell big r"]

L_S

[L_S $\overset{\text{name}}{\to}$ "L_S"]

[L_S $\overset{\text{tex}}{\to}$ "
\if \relax \csname lgwprooflinep\endcsname L_S \else
\if \relax \csname lgwellbigs\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigs {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigs \fi "]

[L_S $\overset{\text{pyk}}{\to}$ "ell big s"]

L_T

[L_T $\overset{\text{name}}{\to}$ "L_T"]

[L_T $\overset{\text{tex}}{\to}$ "
\if \relax \csname lgwprooflinep\endcsname L_T \else
\if \relax \csname lgwellbigt\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigt {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigt \fi "]

[L_T $\overset{\text{pyk}}{\to}$ "ell big t"]

L_U

$[L_U \overset{\mathrm{name}}{\rightarrow} \text{``L\_U''}]$

$[L_U \overset{\mathrm{tex}}{\rightarrow}$ ``
\if \relax \csname lgwprooflinep\endcsname L_U \else
\if \relax \csname lgwellbigu\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigu {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigu \fi ''$]$

$[L_U \overset{\mathrm{pyk}}{\rightarrow} \text{``ell big u''}]$

L_V

$[L_V \overset{\mathrm{name}}{\rightarrow} \text{``L\_V''}]$

$[L_V \overset{\mathrm{tex}}{\rightarrow}$ ``
\if \relax \csname lgwprooflinep\endcsname L_V \else
\if \relax \csname lgwellbigv\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigv {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigv \fi ''$]$

$[L_V \overset{\mathrm{pyk}}{\rightarrow} \text{``ell big v''}]$

L_W

$[L_W \overset{\mathrm{name}}{\rightarrow} \text{``L\_W''}]$

$[L_W \overset{\mathrm{tex}}{\rightarrow}$ ``
\if \relax \csname lgwprooflinep\endcsname L_W \else
\if \relax \csname lgwellbigw\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigw {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigw \fi ''$]$

$[L_W \overset{\mathrm{pyk}}{\rightarrow} \text{``ell big w''}]$

L_X

$[L_X \overset{\mathrm{name}}{\rightarrow} \text{``L\_X''}]$

$[L_X \overset{\mathrm{tex}}{\rightarrow}$ ``

```
\if \relax \csname lgwprooflinep\endcsname L_X \else
\if \relax \csname lgwellbigx\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigx {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigx \fi "]
```

$[L_X \overset{\mathrm{pyk}}{\to} \text{"ell big x"}]$

L_Y

$[L_Y \overset{\mathrm{name}}{\to} \text{"L\_Y"}]$

$[L_Y \overset{\mathrm{tex}}{\to} \text{"}$
```
\if \relax \csname lgwprooflinep\endcsname L_Y \else
\if \relax \csname lgwellbigy\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigy {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigy \fi "]
```

$[L_Y \overset{\mathrm{pyk}}{\to} \text{"ell big y"}]$

L_Z

$[L_Z \overset{\mathrm{name}}{\to} \text{"L\_Z"}]$

$[L_Z \overset{\mathrm{tex}}{\to} \text{"}$
```
\if \relax \csname lgwprooflinep\endcsname L_Z \else
\if \relax \csname lgwellbigz\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigz {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigz \fi "]
```

$[L_Z \overset{\mathrm{pyk}}{\to} \text{"ell big z"}]$

$L_?$

$[L_? \overset{\mathrm{name}}{\to} \text{"L\_?"}]$

$[L_? \overset{\mathrm{tex}}{\to} \text{"}$
```
\if \relax \csname lgwprooflinep\endcsname L_? \else
\global \advance \lgwproofline by 1
L\ifnum \lgwproofline <10 0\fi \number \lgwproofline
\fi "]
```

$[L_? \overset{\mathrm{pyk}}{\to} \text{"ell dummy"}]$

Reflexivity

[Reflexivity $\overset{\text{proof}}{\to}$ $\lceil T_E \vdash \forall \underline{a} \colon \text{HeadPair}^{I \triangleright * \triangleright} @ \underline{a} @ \underline{a}; \text{Transitivity}^{I \triangleright * \triangleright} @ \underline{a} \colon\colon$
$\underline{a}^h @ \underline{a} @ \underline{a}^{\triangleright \triangleright}\rceil]$

[Reflexivity $\overset{\text{stmt}}{\to} T_E \vdash \forall \underline{a} \colon \underline{a} = \underline{a}]$

[Reflexivity $\overset{\text{tex}}{\to}$ "
Reflexivity"]

[Reflexivity $\overset{\text{pyk}}{\to}$ "sequent reflexivity"]

Reflexivity$_1$

[Reflexivity$_1$ $\overset{\text{proof}}{\to} \lambda c. \lambda x. \mathcal{P}(\lceil T_E \vdash \forall \underline{a} \colon \text{HeadPair} \gg \underline{a} \colon\colon \underline{a}^h = \underline{a}; \text{Transitivity} \triangleright \underline{a} \colon\colon$
$\underline{a}^h = \underline{a} \triangleright \underline{a} \colon\colon \underline{a}^h = \underline{a} \gg \underline{a} = \underline{a}\rceil, p_0, c)]$

[Reflexivity$_1$ $\overset{\text{stmt}}{\to} T_E \vdash \forall \underline{a} \colon \underline{a} = \underline{a}]$

[Reflexivity$_1$ $\overset{\text{tex}}{\to}$ "
Reflexivity_1"]

[Reflexivity$_1$ $\overset{\text{pyk}}{\to}$ "tactic reflexivity"]

Commutativity

[Commutativity $\overset{\text{proof}}{\to} \lceil T_E \vdash \forall \underline{a} \colon \forall \underline{b} \colon \underline{a} = \underline{b} \vdash$
$\text{Reflexivity}^{I \triangleright * \triangleright} @ \underline{a}; \text{Transitivity}^{I \triangleright * \triangleright} @ \underline{a} @ \underline{b} @ \underline{a}^{\triangleright \triangleright}\rceil]$

[Commutativity $\overset{\text{stmt}}{\to} T_E \vdash \forall \underline{a} \colon \forall \underline{b} \colon \underline{a} = \underline{b} \vdash \underline{b} = \underline{a}]$

[Commutativity $\overset{\text{tex}}{\to}$ "
Commutativity"]

[Commutativity $\overset{\text{pyk}}{\to}$ "sequent commutativity"]

Commutativity$_1$

[Commutativity$_1$ $\overset{\text{proof}}{\to} \lambda c. \lambda x. \mathcal{P}(\lceil T_E \vdash \forall \underline{a} \colon \forall \underline{b} \colon \underline{a} = \underline{b} \vdash \text{Reflexivity}_1 \gg \underline{a} = \underline{a}; \text{Transitivity} \triangleright \underline{a} = \underline{b} \triangleright \underline{a} = \underline{a} \gg \underline{b} = \underline{a}\rceil, p_0, c)]$

[Commutativity$_1$ $\overset{\text{stmt}}{\to} T_E \vdash \forall \underline{a} \colon \forall \underline{b} \colon \underline{a} = \underline{b} \vdash \underline{b} = \underline{a}]$

[Commutativity$_1$ $\overset{\text{tex}}{\to}$ "
Commutativity_1"]

[Commutativity₁ $\overset{\text{pyk}}{\to}$ "tactic commutativity"]

<tactic>

[<tactic> $\overset{\text{val}}{\to}$ ⌜<tactic>⌝]

[<tactic> $\overset{\text{tex}}{\to}$ "
{<}tactic{>}"]

[<tactic> $\overset{\text{pyk}}{\to}$ "the tactic aspect"]

tactic

[tactic $\overset{\text{msg}}{\to}$ <tactic>]

[tactic $\overset{\text{tex}}{\to}$ "
tactic"]

[tactic $\overset{\text{pyk}}{\to}$ "tactic"]

$\left[* \overset{\text{tactic}}{=} *\right]$

[[x $\overset{\text{tactic}}{=}$ y] $\overset{\text{macro}}{\to}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[[x $\overset{\text{tactic}}{=}$ y] $\overset{\cdot\cdot}{=}$ [(x)$^{\mathbf{p}}$ $\overset{\text{tactic}}{\to}$ y]]⌉])]

[[x $\overset{\text{tactic}}{=}$ y] $\overset{\text{tex}}{\to}$ "
[#1/tex name/tex.
\stackrel {tactic}{=}#2.
]"]

[[* $\overset{\text{tactic}}{=}$ *] $\overset{\text{pyk}}{\to}$ "tactic define " as " end define"]

$\mathcal{P}(*, *, *)$

[$\mathcal{P}$(t, s, c) $\overset{\text{val}}{\to}$ s!
let₁(λd.
If(d, t$^{\text{h}}$ :: $\mathcal{P}^*$(t$^{\text{t}}$, s, c),
$\mathcal{U}^{\text{M}}$($\mathcal{E}$(d³, T, c) ' t ' s ' c)), **aspect**(<tactic>, t, c))]

[$\mathcal{P}$(t, s, c) $\overset{\text{tex}}{\to}$ "
{\cal P}(#1.
, #2.
, #3.
)"]

$[\mathcal{P}(*, *, *) \overset{\text{pyk}}{\to} \text{"proof expand " state " cache " end expand"}]$

$\mathcal{P}^*(*, *, *)$

$[\mathcal{P}^*(\mathsf{t}, \mathsf{s}, \mathsf{c}) \overset{\text{val}}{\to} \mathsf{s}!\mathsf{c}!\mathsf{If}(\mathsf{t}, \mathsf{T}, \mathcal{P}(\mathsf{t}^h, \mathsf{s}, \mathsf{c}) :: \mathcal{P}^*(\mathsf{t}^t, \mathsf{s}, \mathsf{c}))]$

$[\mathcal{P}^*(\mathsf{t}, \mathsf{s}, \mathsf{c}) \overset{\text{tex}}{\to}$ "
{\cal P}^*(#1.
, #2.
, #3.
)"]

$[\mathcal{P}^*(*, *, *) \overset{\text{pyk}}{\to} \text{"proof expand list " state " cache " end expand"}]$

p_0

$[p_0 \overset{\text{val}}{\to} \mathcal{M}(\lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\mathcal{P}(\mathsf{t}, \mathsf{s}, \mathsf{c})) :: \mathsf{T}]$

$[p_0 \overset{\text{tex}}{\to}$ "
p_0"]

$[p_0 \overset{\text{pyk}}{\to} \text{"proof state"}]$

$\text{conclude}_1(*, *)$

$[\text{conclude}_1(\mathsf{t}, \mathsf{c}) \overset{\text{val}}{\to}$
$\text{let}_1(\lambda\mathsf{r}.$
$\mathsf{If}(\mathsf{r}^c, \text{error}_2(\lceil\text{"Unification failed"}\rceil, \mathsf{t}), \mathsf{r}), \text{conclude}_2(\mathsf{t}^1, \mathsf{t}^2, \mathsf{c}))]$

$[\text{conclude}_1(\mathsf{t}, \mathsf{c}) \overset{\text{tex}}{\to}$ "
conclude_1 (#1.
, #2.
)"]

$[\text{conclude}_1(*, *) \overset{\text{pyk}}{\to} \text{"conclude one " cache " end conclude"}]$

$\text{conclude}_2(*, *, *)$

$[\text{conclude}_2(\mathsf{a}, \mathsf{t}, \mathsf{c}) \overset{\text{val}}{\to} \mathsf{t}!$
$\mathsf{If}(\mathsf{a} \overset{\text{r}}{=} \lceil\mathsf{x} \triangleright \mathsf{y}\rceil, \text{conclude}_2(\mathsf{a}^1, \mathsf{a}\text{-color}(\mathsf{t} \triangleright \mathsf{a}^2), \mathsf{c}),$
$\mathsf{If}(\mathsf{a} \overset{\text{r}}{=} \lceil\mathsf{x} \triangleright\!\!\!\!\triangleright \mathsf{y}\rceil, \text{conclude}_2(\mathsf{a}^1, \mathsf{a}\text{-color}(\mathsf{t} \triangleright\!\!\!\!\triangleright \mathsf{a}^2), \mathsf{c}),$

If($a \stackrel{r}{=} \lceil x @ y \rceil$, conclude$_2$($a^1$, a-color($t @ a^2$), c),
If(**aspect**($<$proof$>$, a, c), error$_2$($\lceil$"Lemma expected"$\rceil$, a),
let$_1$(λd.
conclude$_3$(a-color(conclude$_4$($a^{I \triangleright * \triangleright}$, d^{32})), t, parm(d^{32}, T, 1), T), **aspect**($<$stmt$>$, a,

[conclude$_2$(a, t, c) $\stackrel{\text{tex}}{\rightarrow}$ "
conclude_2 (#1.
, #2.
, #3.
)"]

[conclude$_2$($*, *, *$) $\stackrel{\text{pyk}}{\rightarrow}$ "conclude two " proves " cache " end conclude"]

conclude$_3$($*, *, *, *$)

[conclude$_3$(a, t, l, s) $\stackrel{\text{val}}{\rightarrow}$ a!t!l!s!
If($l \stackrel{r}{=} \lceil x \vdash y \rceil$,
$t \stackrel{r}{=} \lceil x \triangleright y \rceil \begin{cases} \text{conclude}_3(a^{\triangleright}, t^1, l^2, \text{unify}(l^1 = t^2, s)) \\ \text{conclude}_3(a^{\triangleright}, t, l^2, s) \end{cases}$,

If($l \stackrel{r}{=} \lceil x \Vdash y \rceil$,
$t \stackrel{r}{=} \lceil x \triangleright\!\!\!\triangleright y \rceil \begin{cases} \text{conclude}_3(a^{\triangleright}, t^1, l^2, \text{unify}(l^1 = t^2, s)) \\ \text{conclude}_3(a^V, t, l^2, s) \end{cases}$,

If($l \stackrel{r}{=} \lceil \forall x: y \rceil$,
$t \stackrel{r}{=} \lceil x @ y \rceil \begin{cases} \text{conclude}_3(a @ t^2, t^1, l^2, \text{unify}(l^1 = t^2, s)) \\ \text{conclude}_3(a @ l^1, t, l^2, s) \end{cases}$,

let$_1$(λs.
If(s^c, s,
inst(a, s)), unify(l = t, s)))))]

[conclude$_3$(a, t, l, s) $\stackrel{\text{tex}}{\rightarrow}$ "
conclude_3 (#1.
, #2.
, #3.
, #4.
)"]

[conclude$_3$($*, *, *, *$) $\stackrel{\text{pyk}}{\rightarrow}$ "conclude three " proves " lemma " substitution " end conclude"]

conclude$_4$($*, *$)

[conclude$_4$(a, l) $\stackrel{\text{val}}{\rightarrow}$ a!l!
If($\neg l \stackrel{r}{=} \lceil \forall x: y \rceil$, a,

$\text{let}_1(\lambda v.\forall v\colon \text{conclude}_4(a @ v, l^2), \lceil \underline{*} \rceil^R :: l^1 :: \mathsf{T}))]$

$[\text{conclude}_4(a, l) \overset{\text{tex}}{\to} \text{``}$
conclude_4 (#1.
, #2.
)"]

$[\text{conclude}_4(*, *) \overset{\text{pyk}}{\to}$ "conclude four " lemma " end conclude"]

$*_-\{*\}$

$[*_-\{*\} \overset{\text{name}}{\to}$ "#1.
_\{#2.
\}"]

$[*_-\{*\} \overset{\text{tex}}{\to}$ "#1.
_{#2.
}"]

$[*_-\{*\} \overset{\text{pyk}}{\to}$ "" sub " end sub"]

$*/\text{indexintro}(*, *, *, *)$

$[x/\text{indexintro}(y, i, p, t) \overset{\text{name}}{\to}$ "#1.
/indexintro(#2.
, #3.
, #4.
, #5.
)"]

$[x/\text{indexintro}(y, i, p, t) \overset{\text{macro}}{\to} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil [x/\text{indexintro}(y, i, p, t) \overset{..}{=} x \$[y \overset{\text{tex}}{=} t]\$]\rceil))]$

$[x/\text{indexintro}(y, i, p, t) \overset{\text{tex}}{\to}$ "#1.%
\footnote{\$[#2/tex name/tex.
\stackrel {\mathrm {pyk}}{=} #4/tex name.
]\$}\index{#3.: #4. @#3.: \$[#2/tex name/tex.]\$ #4.}%
\index{pyk: #4. \$[#2/tex name/tex.]\$}%
\tex{
\$[#2/tex name/tex.
\stackrel {\mathrm {tex}}{=} #5/tex name.
]\$}"]

$[*/\text{indexintro}(*, *, *, *) \overset{\text{pyk}}{\to}$ "" intro " index " pyk " tex " end intro"]

$*/\mathrm{intro}(*, *, *)$

$[\mathsf{x}/\mathrm{intro}(\mathsf{y}, \mathsf{p}, \mathsf{t}) \overset{\mathrm{name}}{\to}$ "#1.
$/\mathrm{intro}(\#2.$
$, \#3.$
$, \#4.$
$)$"]

$[\mathsf{x}/\mathrm{intro}(\mathsf{y}, \mathsf{p}, \mathsf{t}) \overset{\mathrm{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathsf{x}/\mathrm{intro}(\mathsf{y}, \mathsf{p}, \mathsf{t}) \overset{..}{=} \mathsf{x}\ \$[\mathsf{y} \overset{\mathrm{tex}}{=} \mathsf{t}]\$\ ]\rceil)]$

$[\mathsf{x}/\mathrm{intro}(\mathsf{y}, \mathsf{p}, \mathsf{t}) \overset{\mathrm{tex}}{\to}$ "#1.%
\footnote{\$[#2/tex name/tex.
\stackrel {\mathrm {pyk}}{=} #3/tex name.
]\$}\index{\alpha #3. @\back \makebox[20mm][l]{\$[#2/tex
name/tex.]\$}#3.}%
\index{pyk: #3. \$[#2/tex name/tex.]\$}%
\tex{
\$[#2/tex name/tex.
\stackrel {\mathrm {tex}}{=} #4/tex name.
]\$}"]

$[*/\mathrm{intro}(*, *, *) \overset{\mathrm{pyk}}{\to}$ "" intro " pyk " tex " end intro"]

$*/\mathrm{bothintro}(*, *, *, *, *)$

$[\mathsf{x}/\mathrm{bothintro}(\mathsf{y}, \mathsf{i}, \mathsf{p}, \mathsf{t}, \mathsf{n}) \overset{\mathrm{name}}{\to}$ "#1.
$/\mathrm{bothintro}(\#2.$
$, \#3.$
$, \#4.$
$, \#5.$
$, \#6.$
$)$"]

$[\mathsf{x}/\mathrm{bothintro}(\mathsf{y}, \mathsf{i}, \mathsf{p}, \mathsf{t}, \mathsf{n}) \overset{\mathrm{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathsf{x}/\mathrm{bothintro}(\mathsf{y}, \mathsf{i}, \mathsf{p}, \mathsf{t}, \mathsf{n}) \overset{..}{=}$
$\mathsf{x}\ \$[\mathsf{y} \overset{\mathrm{tex}}{=} \mathsf{t}]\$\ \$[\mathsf{y} \overset{\mathrm{name}}{=} \mathsf{n}]\$\ ]\rceil)]$

$[\mathsf{x}/\mathrm{bothintro}(\mathsf{y}, \mathsf{i}, \mathsf{p}, \mathsf{t}, \mathsf{n}) \overset{\mathrm{tex}}{\to}$ "#1.%
\footnote{\$[#2/tex name/tex.
\stackrel {\mathrm {pyk}}{=} #4/tex name.
]\$}\index{#3.: #4. @#3.: \$[#2/tex name/tex.]\$ #4.}%
\index{pyk: #4. \$[#2/tex name/tex.]\$}%
\tex{
\$[#2/tex name/tex.
\stackrel {\mathrm {tex}}{=} #5/tex name.
]\$}
\tex{

$[\#2/\text{tex name/tex.}$
\stackrel {\mathrm {name}}{=} \#6/tex name.
]$\}$"]

$[*/\text{bothintro}(*, *, *, *, *) \overset{\mathrm{pyk}}{\to}$ """ intro " index " pyk " tex " name " end intro"]

$*/\mathrm{nameintro}(*, *, *, *)$

$[\mathsf{x}/\mathrm{nameintro}(\mathsf{y}, \mathsf{p}, \mathsf{t}, \mathsf{n}) \overset{\mathrm{name}}{\to}$ "#1.
/nameintro(#2.
, #3.
, #4.
, #5.
)"]

$[\mathsf{x}/\mathrm{nameintro}(\mathsf{y}, \mathsf{p}, \mathsf{t}, \mathsf{n}) \overset{\mathrm{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathsf{x}/\mathrm{nameintro}(\mathsf{y}, \mathsf{p}, \mathsf{t}, \mathsf{n}) \overset{.}{=}$
$\mathsf{x} \,\$[\mathsf{y} \overset{\mathrm{tex}}{=} \mathsf{t}]\$ \,\$[\mathsf{y} \overset{\mathrm{name}}{=} \mathsf{n}]\$ \,]\rceil)]$

$[\mathsf{x}/\mathrm{nameintro}(\mathsf{y}, \mathsf{p}, \mathsf{t}, \mathsf{n}) \overset{\mathrm{tex}}{\to}$ "#1.%
\footnote{$[\#2/\text{tex name/tex.}$
\stackrel {\mathrm {pyk}}{=} \#3/tex name.
]$\}$\index{\alpha #3. @\back \makebox[20mm][l]{$[\#2/tex
name/tex.]$}#3.}%
\index{pyk: #3. $[\#2/tex name/tex.]$}%
\tex{
$[\#2/tex name/tex.$
\stackrel {\mathrm {tex}}{=} \#4/tex name.
]$}
\tex{
$[\#2/tex name/tex.$
\stackrel {\mathrm {name}}{=} \#5/tex name.
]$}"]

$[*/\mathrm{nameintro}(*, *, *, *) \overset{\mathrm{pyk}}{\to}$ ""' intro " pyk " tex " name " end intro"]

$*'$

$[\mathsf{x}' \overset{\mathrm{tex}}{\to}$ "#1.'"]

$[*' \overset{\mathrm{pyk}}{\to}$ ""' prime"]

$*[\,*\,]$

$[\mathsf{a}[\mathsf{k}] \stackrel{\mathrm{val}}{\to} \mathbf{assoc}_1(\mathsf{a},\mathsf{k},\mathsf{k})]$

$[*[\,*\,] \stackrel{\mathrm{tex}}{\to}$ "#1.
{[}#2.
{]}"$]$

$[*[\,*\,] \stackrel{\mathrm{pyk}}{\to}$ "" assoc " end assoc"$]$

$*[*\longrightarrow*]$

$[\mathsf{a}[\mathsf{i}\to\mathsf{v}] \stackrel{\mathrm{val}}{\to} \mathsf{i}^{\mathrm{c}} \left\{ \begin{array}{l} \mathsf{v} \left\{ \begin{array}{l} \text{array-remove}(\mathsf{i},\mathsf{a},0) \\ \text{array-put}(\mathsf{i},\mathsf{v},\mathsf{a},0) \end{array} \right. \\ \mathsf{v}!\mathsf{a} \end{array} \right. \quad]$

$[\mathsf{a}[\mathsf{i}\to\mathsf{v}] \stackrel{\mathrm{tex}}{\to}$ "#1.
$[$ #2.
$\{\backslash$rightarrow$\}$ #3.
$]$"$]$

$[*[*\to*] \stackrel{\mathrm{pyk}}{\to}$ "" set " to " end set"$]$

$*[*\Longrightarrow*]$

$[\mathsf{a}[\mathsf{i}\Rightarrow\mathsf{v}] \stackrel{\mathrm{val}}{\to} \mathsf{i}^{\mathrm{a}} \left\{ \begin{array}{l} \mathsf{a}!\mathsf{v} \\ \mathsf{a}[\mathsf{i}^{\mathrm{h}}\to\mathsf{a}[\mathsf{i}^{\mathrm{h}}][\mathsf{i}^{\mathrm{t}}\Rightarrow\mathsf{v}]] \end{array} \right. \quad]$

$[\mathsf{a}[\mathsf{i}\Rightarrow\mathsf{v}] \stackrel{\mathrm{tex}}{\to}$ "#1.
$[$ #2.
$\{\backslash$Rightarrow$\}$ #3.
$]$"$]$

$[*[*\Rightarrow*] \stackrel{\mathrm{pyk}}{\to}$ "" set multi " to " end set"$]$

$*0$

$[\mathsf{x}0 \stackrel{\mathrm{val}}{\to} \mathsf{T} +2* \mathsf{x}]$

$[*0 \stackrel{\mathrm{tex}}{\to}$ "#1.
0"$]$

$[*0 \stackrel{\mathrm{pyk}}{\to}$ "" bit nil"$]$

∗1

$[\mathsf{x}1 \overset{\mathrm{val}}{\to} \mathsf{F} +2* \mathsf{x}]$

$[*1 \overset{\mathrm{tex}}{\to}$ "#1.
1"]

$[*1 \overset{\mathrm{pyk}}{\to}$ "" bit one"]

0b

$[0\mathsf{b} \overset{\mathrm{val}}{\to} 0]$

$[0\mathsf{b} \overset{\mathrm{tex}}{\to}$ "
$0 \mathrm {b}$"]

$[0\mathsf{b} \overset{\mathrm{pyk}}{\to}$ "binary"]

∗-color(∗)

$[\mathsf{a\text{-}color(t)} \overset{\mathrm{val}}{\to} \mathsf{t^d} \left\{ \begin{array}{l} \mathsf{t^r :: t^i :: a^d :: a\text{-}color^*(t^t)} \\ \mathsf{a!t} \end{array} \right.]$

$[\mathsf{x\text{-}color(y)} \overset{\mathrm{tex}}{\to}$ "#1.
\mbox {-color}(#2.
)"]

$[*\text{-}color(*) \overset{\mathrm{pyk}}{\to}$ "" color " end color"]

∗-color*(∗)

$[\mathsf{a\text{-}color^*(t)} \overset{\mathrm{val}}{\to} \mathsf{t} \left\{ \begin{array}{l} \mathsf{a!T} \\ \mathsf{a\text{-}color(t^h) :: a\text{-}color^*(t^t)} \end{array} \right.]$

$[\mathsf{x\text{-}color^*(y)} \overset{\mathrm{tex}}{\to}$ "#1.
\mbox {-color}^{\ast}(#2.
)"]

$[*\text{-}color^*(*) \overset{\mathrm{pyk}}{\to}$ "" color star " end color"]

∗$^\mathrm{H}$

$[\mathsf{x^H} \overset{\mathrm{val}}{\to} \mathsf{x}' \mathsf{T}]$

$[*^{\mathrm{H}} \overset{\mathrm{tex}}{\to} \text{``\#1.}$
$\{\}\text{\^{}H''}]$

$[*^{\mathrm{H}} \overset{\mathrm{pyk}}{\to} \text{``" raw head''}]$

$*^{\mathrm{T}}$

$[\mathsf{x}^{\mathrm{T}} \overset{\mathrm{val}}{\to} \mathsf{x} \text{'} \mathsf{F}]$

$[*^{\mathrm{T}} \overset{\mathrm{tex}}{\to} \text{``\#1.}$
$\{\}\text{\^{}T''}]$

$[*^{\mathrm{T}} \overset{\mathrm{pyk}}{\to} \text{``" raw tail''}]$

$*^{\mathrm{U}}$

$[\mathsf{x}^{\mathrm{U}} \overset{\mathrm{val}}{\to} \mathrm{if}(\mathsf{x}^{\mathrm{H}}, \mathsf{x}^{\mathrm{T}}, \mathsf{T})]$

$[*^{\mathrm{U}} \overset{\mathrm{tex}}{\to} \text{``\#1.}$
$\{\}\text{\^{}U''}]$

$[*^{\mathrm{U}} \overset{\mathrm{pyk}}{\to} \text{``" cardinal untag''}]$

$*^{\mathrm{h}}$

$[\mathsf{x}^{\mathrm{h}} \overset{\mathrm{val}}{\Rightarrow} \mathsf{x}^{\mathrm{MTH}}]$

$[*^{\mathrm{h}} \overset{\mathrm{tex}}{\to} \text{``\#1.}$
$\{\}\text{\^{}h''}]$

$[*^{\mathrm{h}} \overset{\mathrm{pyk}}{\to} \text{``" head''}]$

$*^{\mathrm{t}}$

$[\mathsf{x}^{\mathrm{t}} \overset{\mathrm{val}}{\Rightarrow} \mathrm{if}(\mathsf{x}^{\mathrm{d}}, \mathrm{if}(\mathsf{x}^{\mathrm{c}}, \mathsf{T} \underset{\because}{.} \mathsf{x}^{\mathrm{MTT}}, \mathsf{x}^{\mathrm{MTT}}), \mathsf{T})]$

$[*^{\mathrm{t}} \overset{\mathrm{tex}}{\to} \text{``\#1.}$
$\{\}\text{\^{}t''}]$

$[*^{\mathrm{t}} \overset{\mathrm{pyk}}{\to} \text{``" tail''}]$

$*^{\mathrm{s}}$

$[\mathsf{x}^{\mathrm{s}} \overset{\mathrm{val}}{\Rightarrow} \mathsf{x}^{\mathrm{MTB}}]$

$[*^{\mathrm{s}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\hat{\ }\mathrm{s}"]$

$[*^{\mathrm{s}} \overset{\mathrm{pyk}}{\to}$ "" is singular"]

$*^{\mathrm{c}}$

$[\mathsf{x}^{\mathrm{c}} \overset{\mathrm{val}}{\Rightarrow} \mathrm{if}(\mathsf{x}, \mathsf{F}, \mathsf{x}^{\mathrm{MHB}})]$

$[*^{\mathrm{c}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\hat{\ }\mathrm{c}"]$

$[*^{\mathrm{c}} \overset{\mathrm{pyk}}{\to}$ "" is cardinal"]

$*^{\mathrm{d}}$

$[\mathsf{x}^{\mathrm{d}} \overset{\mathrm{val}}{\Rightarrow} \mathsf{x}^{\mathrm{MHTHB}}]$

$[*^{\mathrm{d}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\hat{\ }\mathrm{d}"]$

$[*^{\mathrm{d}} \overset{\mathrm{pyk}}{\to}$ "" is data"]

$*^{\mathrm{a}}$

$[\mathsf{x}^{\mathrm{a}} \overset{\mathrm{val}}{\to} \neg \mathsf{x}^{\mathrm{d}} \vee \mathsf{x}^{\mathrm{c}} \vee \mathsf{x}^{\mathrm{s}}]$

$[*^{\mathrm{a}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\hat{\ }\mathrm{a}"]$

$[*^{\mathrm{a}} \overset{\mathrm{pyk}}{\to}$ "" is atomic"]

$*^{\mathrm{C}}$

$[\mathsf{x}^{\mathrm{C}} \overset{\mathrm{val}}{\to} \mathrm{if}(\mathsf{x}, \mathsf{T}, \mathsf{x}^{\mathrm{HB}} \underline{+2*} \mathsf{x}^{\mathrm{TC}})]$

$[*^{\mathrm{C}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\hat{\ }\mathrm{C}"]$

$[*^{\mathrm{C}} \overset{\mathrm{pyk}}{\to}$ "" cardinal retract"]

$*^{\mathrm{M}}$

$[\mathsf{x}^{\mathrm{M}} \overset{\mathrm{val}}{\Rightarrow} \mathrm{if}(\mathsf{x}, \mathsf{T}, \mathrm{if}(\mathsf{x}^{\mathrm{H}}, \mathsf{T}, \therefore \mathsf{x}^{\mathrm{TC}}, \mathrm{if}(\mathsf{x}^{\mathrm{HTH}}, \mathsf{x}^{\mathrm{THM}} \underline{::} \mathsf{x}^{\mathrm{TTM}}, \mathcal{M}(\mathsf{x}^{\mathrm{T}}))))]$

$[*^{\mathrm{M}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\,\hat{}\,\mathrm{M}$"$]$

$[*^{\mathrm{M}} \overset{\mathrm{pyk}}{\to}$ "" tagged retract"$]$

$*^{\mathrm{B}}$

$[\mathsf{x}^{\mathrm{B}} \overset{\mathrm{val}}{\to} \mathrm{if}(\mathsf{x}, \mathsf{T}, \mathsf{F})]$

$[*^{\mathrm{B}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\,\hat{}\,\mathrm{B}$"$]$

$[*^{\mathrm{B}} \overset{\mathrm{pyk}}{\to}$ "" boolean retract"$]$

$*^{\mathrm{r}}$

$[\mathsf{x}^{\mathrm{r}} \overset{\mathrm{val}}{\to} \mathsf{x}^{\mathrm{hh}}]$

$[\mathsf{x}^{\mathrm{r}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\,\hat{}\,\{\mathrm{r}\}$"$]$

$[*^{\mathrm{r}} \overset{\mathrm{pyk}}{\to}$ "" ref"$]$

$*^{\mathrm{i}}$

$[\mathsf{x}^{\mathrm{i}} \overset{\mathrm{val}}{\to} \mathsf{x}^{\mathrm{hth}}]$

$[\mathsf{x}^{\mathrm{i}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\,\hat{}\,\{\mathrm{i}\}$"$]$

$[*^{\mathrm{i}} \overset{\mathrm{pyk}}{\to}$ "" id"$]$

$*^{\mathrm{d}}$

$[\mathsf{x}^{\mathrm{d}} \overset{\mathrm{val}}{\to} \mathsf{x}^{\mathrm{htt}}]$

$[\mathsf{x}^{\mathrm{d}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\}\,\hat{}\,\{\mathrm{d}\}$"$]$

$[*^{\mathrm{d}} \overset{\mathrm{pyk}}{\to}$ "" debug"$]$

$*^R$

$[x^R \overset{\text{val}}{\to} x^r :: x^i :: \mathsf{T}]$

$[x^R \overset{\text{tex}}{\to}$ "#1.
$\{\}\hat{}\{R\}$"$]$

$[*^R \overset{\text{pyk}}{\to}$ "" root"$]$

$*^0$

$[x^0 \overset{\text{val}}{\to} x^h]$

$[x^0 \overset{\text{tex}}{\to}$ "#1.
$\{\}\hat{}\{0\}$"$]$

$[*^0 \overset{\text{pyk}}{\to}$ "" zeroth"$]$

$*^1$

$[x^1 \overset{\text{val}}{\to} x^{t0}]$

$[x^1 \overset{\text{tex}}{\to}$ "#1.
$\{\}\hat{}\{1\}$"$]$

$[*^1 \overset{\text{pyk}}{\to}$ "" first"$]$

$*^2$

$[x^2 \overset{\text{val}}{\to} x^{t1}]$

$[x^2 \overset{\text{tex}}{\to}$ "#1.
$\{\}\hat{}\{2\}$"$]$

$[*^2 \overset{\text{pyk}}{\to}$ "" second"$]$

$*^3$

$[x^3 \overset{\text{val}}{\to} x^{t2}]$

$[x^3 \overset{\text{tex}}{\to}$ "#1.
$\{\}\hat{}\{3\}$"$]$

$[*^3 \overset{\text{pyk}}{\to}$ "" third"$]$

$*^4$

$[x^4 \xrightarrow{\text{val}} x^{t3}]$

$[x^4 \xrightarrow{\text{tex}} \text{``}\#1.$
$\{\}\hat{}\{4\}\text{''}]$

$[*^4 \xrightarrow{\text{pyk}} \text{`` '' fourth''}]$

$*^5$

$[x^5 \xrightarrow{\text{val}} x^{t4}]$

$[x^5 \xrightarrow{\text{tex}} \text{``}\#1.$
$\{\}\hat{}\{5\}\text{''}]$

$[*^5 \xrightarrow{\text{pyk}} \text{`` '' fifth''}]$

$*^6$

$[x^6 \xrightarrow{\text{val}} x^{t5}]$

$[x^6 \xrightarrow{\text{tex}} \text{``}\#1.$
$\{\}\hat{}\{6\}\text{''}]$

$[*^6 \xrightarrow{\text{pyk}} \text{`` '' sixth''}]$

$*^7$

$[x^7 \xrightarrow{\text{val}} x^{t6}]$

$[x^7 \xrightarrow{\text{tex}} \text{``}\#1.$
$\{\}\hat{}\{7\}\text{''}]$

$[*^7 \xrightarrow{\text{pyk}} \text{`` '' seventh''}]$

$*^8$

$[x^8 \xrightarrow{\text{val}} x^{t7}]$

$[x^8 \xrightarrow{\text{tex}} \text{``}\#1.$
$\{\}\hat{}\{8\}\text{''}]$

$[*^8 \xrightarrow{\text{pyk}} \text{`` '' eighth''}]$

$*^9$

$[\mathsf{x}^9 \overset{\text{val}}{\to} \mathsf{x}^{\mathsf{t}8}]$

$[\mathsf{x}^9 \overset{\text{tex}}{\to}$ "#1.
$\{\}\hat{\ }\{9\}$"$]$

$[*^9 \overset{\text{pyk}}{\to}$ "" ninth"$]$

$*^{\text{E}}$

$[\mathsf{x}^{\text{E}} \overset{\text{val}}{\to} \mathsf{x} \overset{\text{r}}{=} \lceil \mathsf{xy} \rceil]$

$[\mathsf{x}^{\text{E}} \overset{\text{tex}}{\to}$ "#1.
$\{\} \hat{\ } \{\ \text{E}\ \}$"$]$

$[*^{\text{E}} \overset{\text{pyk}}{\to}$ "" is error"$]$

$*^{\mathcal{V}}$

$[\mathsf{t}^{\mathcal{V}} \overset{\text{val}}{\to} \mathsf{t} \overset{\text{r}}{=} \lceil \underline{\mathsf{a}} \rceil]$

$[\mathsf{t}^{\mathcal{V}} \overset{\text{tex}}{\to}$ "#1.
$\{\} \hat{\ } \{\backslash\text{cal V}\}$"$]$

$[*^{\mathcal{V}} \overset{\text{pyk}}{\to}$ "" is metavar"$]$

$*^{\mathcal{C}}$

$[\mathsf{t}^{\mathcal{C}} \overset{\text{val}}{\to} \text{If}(\mathsf{t}^{\mathcal{V}}, \mathsf{F}, \mathsf{t}^{\mathsf{t}\mathcal{C}^*})]$

$[\mathsf{t}^{\mathcal{C}} \overset{\text{tex}}{\to}$ "#1.
$\{\} \hat{\ } \{\backslash\text{cal C}\}$"$]$

$[*^{\mathcal{C}} \overset{\text{pyk}}{\to}$ "" is metaclosed"$]$

$*^{\mathcal{C}^*}$

$[\mathsf{t}^{\mathcal{C}^*} \overset{\text{val}}{\to} \text{If}(\mathsf{t}, \mathsf{T}, \text{If}(\mathsf{t}^{\text{h}\mathcal{C}}, \mathsf{t}^{\mathsf{t}\mathcal{C}^*}, \mathsf{F}))]$

$[\mathsf{t}^{\mathcal{C}^*} \overset{\text{tex}}{\to}$ "#1.
$\{\} \hat{\ } \{\{\backslash\text{cal C}\} \hat{\ } \{\ \backslash\text{ast }\}\}$"$]$

$[*^{\mathcal{C}^*} \overset{\text{pyk}}{\to}$ "" is metaclosed star"$]$

newline $*$

[newline x $\overset{\text{name}}{\rightarrow}$ "
newline\ #1."]

[newline x $\overset{\text{val}}{\rightarrow}$ x$^{\text{M}}$]

[newline x $\overset{\text{tex}}{\rightarrow}$ "
\newline #1."]

[newline $*$ $\overset{\text{pyk}}{\rightarrow}$ "newline """]

macro newline $*$

[macro newline x $\overset{\text{name}}{\rightarrow}$ "
macro\ newline\ #1."]

[macro newline x $\overset{\text{macro}}{\rightarrow}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, [[macro newline x $\overset{\cdot}{=}$ x]])]

[macro newline x $\overset{\text{tex}}{\rightarrow}$ "
\newline #1."]

[macro newline $*$ $\overset{\text{pyk}}{\rightarrow}$ "macro newline """]

$*$ ' $*$

Predef: apply

[$*$ ' $*$ $\overset{\text{tex}}{\rightarrow}$ "#1.
\mathbin {\mbox {'}}#2."]

[$*$ ' $*$ $\overset{\text{pyk}}{\rightarrow}$ "" apply """]

$*$ ' $*$

[f ' x $\overset{\text{val}}{\rightarrow}$ **apply**(f, x)]

[$*$ ' $*$ $\overset{\text{tex}}{\rightarrow}$ "#1.
\mathbin {\mbox {'}}#2."]

[$*$ ' $*$ $\overset{\text{pyk}}{\rightarrow}$ "" tagged apply """]

$*$ $\cdot$ $*$

[x $\cdot$ y $\overset{\text{val}}{\rightarrow}$ If(x$^{\text{c}}$ $\wedge$ y$^{\text{c}}$, x $\cdot_0$ y, T)]

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$[x \cdot y \overset{\text{tex}}{\to} \text{``\#1.}$
$\backslash\text{cdot } \#2.\text{''}]$

$[* \cdot * \overset{\text{pyk}}{\to} \text{``" times "''}]$

$* \cdot_0 *$

$[x \cdot_0 y \overset{\text{val}}{\to} y^s \left\{ \begin{array}{l} x!0 \\ y^h \left\{ \begin{array}{l} \mathsf{T} +2* \, x \cdot_0 y^t \\ (\mathsf{T} +2* \, x \cdot_0 y^t)^M +_0 x \end{array} \right. \end{array} \right. \quad]$

$[x \cdot_0 y \overset{\text{tex}}{\to} \text{``\#1.}$
$\backslash\text{cdot\_0 } \#2.\text{''}]$

$[* \cdot_0 * \overset{\text{pyk}}{\to} \text{``" times zero "''}]$

$* + *$

$[x + y \overset{\text{val}}{\to} \text{If}(x^c \wedge y^c, x +_0 y, \mathsf{T})]$

$[x + y \overset{\text{tex}}{\to} \text{``\#1.}$
$+ \#2.\text{''}]$

$[* + * \overset{\text{pyk}}{\to} \text{``" plus "''}]$

$* +_0 *$

$[x +_0 y \overset{\text{val}}{\to} x^s \left\{ \begin{array}{l} y \\ \\ y^s \left\{ \begin{array}{l} x \\ \\ x^h \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} \mathsf{T} +2* \, x^t +_0 y^t \\ \mathsf{F} +2* \, x^t +_0 y^t \end{array} \right. \\ y^h \left\{ \begin{array}{l} \mathsf{F} +2* \, x^t +_0 y^t \\ \mathsf{T} +2* \, x^t +_1 y^t \end{array} \right. \end{array} \right. \end{array} \right. \end{array} \right. \quad]$

$[x +_0 y \overset{\text{tex}}{\to} \text{``\#1.}$
$\backslash\text{mathop}\{+\_0\} \#2.\text{''}]$

$[* +_0 * \overset{\text{pyk}}{\to} \text{``" plus zero "''}]$

$* +_1 *$

$$[x +_1 y \stackrel{\text{val}}{\rightarrow} x^s \left\{ \begin{array}{l} y +_0 1 \\ y^s \left\{ \begin{array}{l} x +_0 1 \\ x^h \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} \mathsf{F} +2* x^t +_0 y^t \\ \mathsf{T} +2* x^t +_1 y^t \end{array} \right. \\ y^h \left\{ \begin{array}{l} \mathsf{T} +2* x^t +_1 y^t \\ \mathsf{F} +2* x^t +_1 y^t \end{array} \right. \end{array} \right. \end{array} \right. \end{array} \right. \quad]$$

$[x +_1 y \stackrel{\text{tex}}{\rightarrow}$ "#1.
\mathop{+_1} #2."$]$

$[* +_1 * \stackrel{\text{pyk}}{\rightarrow}$ "" plus one ""$]$

$* - *$

$[x - y \stackrel{\text{val}}{\rightarrow} \text{If}(x^c \wedge y^c, \text{If}(x < y, 0, x -_0 y), \mathsf{T})]$

$[x - y \stackrel{\text{tex}}{\rightarrow}$ "#1.
- #2."$]$

$[* - * \stackrel{\text{pyk}}{\rightarrow}$ "" minus ""$]$

$* -_0 *$

$$[x -_0 y \stackrel{\text{val}}{\rightarrow} y^s \left\{ \begin{array}{l} x \\ x^h \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} \mathsf{T} +2* x^t -_0 y^t \\ \mathsf{F} +2* x^t -_1 y^t \end{array} \right. \\ y^h \left\{ \begin{array}{l} \mathsf{F} +2* x^t -_0 y^t \\ \mathsf{T} +2* x^t -_0 y^t \end{array} \right. \end{array} \right. \end{array} \right. \quad]$$

$[x -_0 y \stackrel{\text{tex}}{\rightarrow}$ "#1.
\mathop{-_0} #2."$]$

$[* -_0 * \stackrel{\text{pyk}}{\rightarrow}$ "" minus zero ""$]$

$* -_1 *$

$$[x -_1 y \stackrel{\text{val}}{\rightarrow} y^s \left\{ \begin{array}{l} x -_0 1 \\ x^h \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} \mathsf{F} +2* x^t -_1 y^t \\ \mathsf{T} +2* x^t -_1 y^t \end{array} \right. \\ y^h \left\{ \begin{array}{l} \mathsf{T} +2* x^t -_0 y^t \\ \mathsf{F} +2* x^t -_1 y^t \end{array} \right. \end{array} \right. \end{array} \right. \quad]$$

$[x -_1 y \overset{\text{tex}}{\to}$ "#1.
\mathop{-_1} #2."$]$

$[* -_1 * \overset{\text{pyk}}{\to}$ "" minus one ""$]$

$$* \cup \left\{ * \right\}$$

$[x \cup \{y\} \overset{\text{val}}{\to} \text{If}(y \in_t x, x, y :: x)]$

$[x \cup \{y\} \overset{\text{tex}}{\to}$ "#1.
\cup \{ #2.
\}"$]$

$[* \cup \{*\} \overset{\text{pyk}}{\to}$ "" term plus " end plus"$]$

$$* \bigcup *$$

$[x \cup y \overset{\text{val}}{\to} \text{If}(x^a, y, x^t \cup y \cup \{x^h\})]$

$[x \cup y \overset{\text{tex}}{\to}$ "#1.
\cup #2."$]$

$[* \cup * \overset{\text{pyk}}{\to}$ "" term union ""$]$

$$* \backslash \left\{ * \right\}$$

$[x \backslash \{y\} \overset{\text{val}}{\to} \text{If}(x^a, y!\emptyset, \text{If}(y \overset{t}{=} x^h, x^t, x^h :: x^t \backslash \{y\})))]$

$[x \backslash \{y\} \overset{\text{tex}}{\to}$ "#1.
\backslash \{ #2.
\}"$]$

$[* \backslash \{*\} \overset{\text{pyk}}{\to}$ "" term minus " end minus"$]$

$$* \mathrel{\dot{.\,.}} *$$

$[y \mathrel{\dot{.\,.}} z \overset{\text{val}}{\Rightarrow} \lambda x.\text{if}(x, y, z)]$

$[* \mathrel{\dot{.\,.}} * \overset{\text{tex}}{\to}$ "#1.
\mathrel{ \dot{ . \, . } }#2."$]$

$[* \mathrel{\dot{.\,.}} * \overset{\text{pyk}}{\to}$ "" raw pair ""$]$

$* \underline{\ddot{\therefore}} *$

$[x \underline{\ddot{\therefore}} y \xrightarrow{\mathrm{val}} x : y : x \therefore y]$

$[* \underline{\ddot{\therefore}} * \xrightarrow{\mathrm{tex}}$ "#1.
\mathrel { \underline { \dot { . \, . } } }#2."$]$

$[* \underline{\ddot{\therefore}} * \xrightarrow{\mathrm{pyk}}$ "" eager pair ""$]$

$* \underline{::} *$

$[x \underline{::} y \xrightarrow{\mathrm{val}} (\underline{0} \therefore \underline{0} \therefore \mathsf{T})^{\mathrm{I}} \underline{::} x \underline{::} y]$

$[* \underline{::} * \xrightarrow{\mathrm{tex}}$ "#1.
\mathrel { \underline { : \, : } }#2."$]$

$[* \underline{::} * \xrightarrow{\mathrm{pyk}}$ "" tagged pair ""$]$

$* \underline{+2*} *$

$[x \underline{+2*} y \xrightarrow{\mathrm{val}} \mathrm{if}(x, \mathrm{if}(y, \mathsf{T}, x \underline{\therefore} y), x \underline{\therefore} y)]$

$[* \underline{+2*} * \xrightarrow{\mathrm{tex}}$ "#1.
\mathrel { \underline { {+} 2 \ast } }#2."$]$

$[* \underline{+2*} * \xrightarrow{\mathrm{pyk}}$ "" untagged double ""$]$

$* :: *$

$[x :: y \xRightarrow{\mathrm{val}} x^{\mathrm{M}} \underline{::} y^{\mathrm{M}}]$

$[x :: y \xrightarrow{\mathrm{tex}}$ "#1.
\mathrel { : \, : }#2."$]$

$[* :: * \xrightarrow{\mathrm{pyk}}$ "" pair ""$]$

$* +2* *$

$[x +2* y \xRightarrow{\mathrm{val}} \mathsf{T} \underline{\therefore} x^{\mathrm{B}} \underline{\therefore} y^{\mathrm{UC}}]$

$[* +2* * \xrightarrow{\mathrm{tex}}$ "#1.
\mathrel { {+} 2 \ast }#2."$]$

$[* +2* * \stackrel{\text{pyk}}{\rightarrow}$ "" double ""]

$*, *$

$[\mathsf{x}, \mathsf{y} \stackrel{\text{tex}}{\rightarrow}$ "#1.
, \linebreak [0] #2."]
$[*, * \stackrel{\text{pyk}}{\rightarrow}$ "" comma ""]

$* \stackrel{\text{B}}{\approx} *$

$[\mathsf{x} \stackrel{\text{B}}{\approx} \mathsf{y} \stackrel{\text{val}}{\rightarrow} \mathsf{x} \left\{ \begin{array}{l} \text{If}(\mathsf{y}, \mathsf{T}, \mathsf{F}) \\ \text{If}(\mathsf{y}, \mathsf{F}, \mathsf{T}) \end{array} \right]$

$[* \stackrel{\text{B}}{\approx} * \stackrel{\text{tex}}{\rightarrow}$ "#1.
\stackrel {B}{\approx }#2."]
$[* \stackrel{\text{B}}{\approx} * \stackrel{\text{pyk}}{\rightarrow}$ "" boolean equal ""]

$* \stackrel{\text{D}}{\approx} *$

$[\mathsf{x} \stackrel{\text{D}}{\approx} \mathsf{y} \stackrel{\text{val}}{\rightarrow} \mathsf{x}^c \left\{ \begin{array}{l} \text{If}(\mathsf{y}^c, \mathsf{x} \stackrel{\text{C}}{\approx} \mathsf{y}, \mathsf{F}) \\ \text{If}(\mathsf{y}^c, \mathsf{F}, \mathsf{x} \stackrel{\text{P}}{\approx} \mathsf{y}) \end{array} \right]$

$[* \stackrel{\text{D}}{\approx} * \stackrel{\text{tex}}{\rightarrow}$ "#1.
\stackrel {D}{\approx }#2."]
$[* \stackrel{\text{D}}{\approx} * \stackrel{\text{pyk}}{\rightarrow}$ "" data equal ""]

$* \stackrel{\text{C}}{\approx} *$

$[\mathsf{x} \stackrel{\text{C}}{\approx} \mathsf{y} \stackrel{\text{val}}{\rightarrow} \mathsf{x}^s \left\{ \begin{array}{l} \text{If}(\mathsf{y}^s, \mathsf{T}, \mathsf{F}) \\ \text{If}(\mathsf{y}^s, \mathsf{F}, \mathsf{x}^h \stackrel{\text{B}}{\approx} \mathsf{y}^h \wedge \mathsf{x}^t \stackrel{\text{C}}{\approx} \mathsf{y}^t) \end{array} \right]$

$[* \stackrel{\text{C}}{\approx} * \stackrel{\text{tex}}{\rightarrow}$ "#1.
\stackrel {C}{\approx }#2."]
$[* \stackrel{\text{C}}{\approx} * \stackrel{\text{pyk}}{\rightarrow}$ "" cardinal equal ""]

$$* \stackrel{\mathrm{P}}{\approx} *$$

$[\mathsf{x} \stackrel{\mathrm{P}}{\approx} \mathsf{y} \stackrel{\mathrm{val}}{\to} \mathsf{x}^{\mathrm{s}} \left\{ \begin{array}{l} \mathrm{If}(\mathsf{y}^{\mathrm{s}}, \mathsf{T}, \mathsf{F}) \\ \mathrm{If}(\mathsf{y}^{\mathrm{s}}, \mathsf{F}, \mathsf{x}^{\mathrm{h}} \approx \mathsf{y}^{\mathrm{h}} \wedge \mathsf{x}^{\mathrm{t}} \approx \mathsf{y}^{\mathrm{t}}) \end{array} \right.]$

$[* \stackrel{\mathrm{P}}{\approx} * \stackrel{\mathrm{tex}}{\to}$ "#1.
\stackrel {P}{\approx }#2."]

$[* \stackrel{\mathrm{P}}{\approx} * \stackrel{\mathrm{pyk}}{\to}$ "" peano equal ""]

$$* \approx *$$

$[\mathsf{x} \approx \mathsf{y} \stackrel{\mathrm{val}}{\Rightarrow} \mathsf{x}^{\mathrm{d}} \left\{ \begin{array}{l} \mathrm{If}(\mathsf{y}^{\mathrm{d}}, \mathsf{x} \stackrel{\mathrm{D}}{\approx} \mathsf{y}, \mathsf{F}) \\ \mathrm{If}(\mathsf{y}^{\mathrm{d}}, \mathsf{F}, \mathsf{T}) \end{array} \right.]$

$[* \approx * \stackrel{\mathrm{tex}}{\to}$ "#1.
\approx #2."]

$[* \approx * \stackrel{\mathrm{pyk}}{\to}$ "" tagged equal ""]

$$* = *$$

$[* = * \stackrel{\mathrm{tex}}{\to}$ "#1.
=#2."]

$[* = * \stackrel{\mathrm{pyk}}{\to}$ "" math equal ""]

$$* \stackrel{+}{\to} *$$

$[* \stackrel{+}{\to} * \stackrel{\mathrm{tex}}{\to}$ "#1.
\stackrel {+}{\rightarrow }#2."]

$[* \stackrel{+}{\to} * \stackrel{\mathrm{pyk}}{\to}$ "" reduce to ""]

$$* \stackrel{\mathrm{t}}{=} *$$

$[\mathsf{x} \stackrel{\mathrm{t}}{=} \mathsf{y} \stackrel{\mathrm{val}}{\to} \mathrm{If}(\mathsf{x} \stackrel{\mathrm{r}}{=} \mathsf{y}, \mathsf{x}^{\mathrm{t}} \stackrel{\mathrm{t}^*}{=} \mathsf{y}^{\mathrm{t}}, \mathsf{F})]$

$[* \stackrel{\mathrm{t}}{=} * \stackrel{\mathrm{tex}}{\to}$ "#1.
\stackrel {t}{=}#2."]

$[* \stackrel{\mathrm{t}}{=} * \stackrel{\mathrm{pyk}}{\to}$ "" term equal ""]

$* \overset{t^*}{=} *$

$[x \overset{t^*}{=} y \overset{\text{val}}{\to} x^a \begin{cases} \text{If}(y^a, \mathsf{T}, \mathsf{F}) \\ \text{If}(y^a, \mathsf{F}, \text{If}(x^h \overset{t}{=} y^h, x^t \overset{t^*}{=} y^t, \mathsf{F})) \end{cases}]$

$[* \overset{t^*}{=} * \overset{\text{tex}}{\to}$ "#1.
\stackrel {t^*}{=}#2."$]$

$[* \overset{t^*}{=} * \overset{\text{pyk}}{\to}$ "" term list equal ""$]$

$* \overset{r}{=} *$

$[x \overset{r}{=} y \overset{\text{val}}{\to} \text{If}(x^r \approx y^r, x^i \approx y^i, \mathsf{F})]$

$[x \overset{r}{=} y \overset{\text{tex}}{\to}$ "#1.
\stackrel{r}{=} #2."$]$

$[* \overset{r}{=} * \overset{\text{pyk}}{\to}$ "" term root equal ""$]$

$* \in_t *$

$[x \in_t y \overset{\text{val}}{\to} \text{If}(y^a, x!\mathsf{F}, \text{If}(x \overset{t}{=} y^h, \mathsf{T}, x \in_t y^t))]$

$[x \in_t y \overset{\text{tex}}{\to}$ "#1.
\in_t #2."$]$

$[* \in_t * \overset{\text{pyk}}{\to}$ "" term in ""$]$

$* \subseteq_T *$

$[x \subseteq_T y \overset{\text{val}}{\to} \text{If}(x^a, y!\mathsf{T}, \text{If}(x^h \in_t y, x^t \subseteq_T y, \mathsf{F}))]$

$[x \subseteq_T y \overset{\text{tex}}{\to}$ "#1.
\subseteq_T #2."$]$

$[* \subseteq_T * \overset{\text{pyk}}{\to}$ "" term subset ""$]$

$* \overset{T}{=} *$

$[x \overset{T}{=} y \overset{\text{val}}{\to} \text{If}(x \subseteq_T y, y \subseteq_T x, \mathsf{F})]$

$[x \overset{T}{=} y \overset{\text{tex}}{\to}$ "#1.
\stackrel{T}{=} #2."$]$

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$[* \overset{\mathrm{T}}{=} * \overset{\mathrm{pyk}}{\to}$ "" term set equal ""]

$* \overset{\mathrm{s}}{=} *$

$[x \overset{\mathrm{s}}{=} y \overset{\mathrm{val}}{\to} \mathrm{If}(\neg x^2 \overset{\mathrm{t}}{=} y^2, \mathsf{F}, \mathrm{If}(x^0 \overset{\mathrm{T}}{=} y^0, x^1 \overset{\mathrm{T}}{=} y^1, \mathsf{F}))]$

$[x \overset{\mathrm{s}}{=} y \overset{\mathrm{tex}}{\to}$ "#1.
\stackrel{s}{=} #2."]

$[* \overset{\mathrm{s}}{=} * \overset{\mathrm{pyk}}{\to}$ "" sequent equal ""]

$*$ free in $*$

$[\mathsf{v}$ free in $\mathsf{t} \overset{\mathrm{val}}{\to}$
$\mathrm{If}(\mathsf{v} \overset{\mathrm{t}}{=} \mathsf{t}, \mathsf{T},$
$\mathrm{If}(\neg \mathsf{t} \overset{\mathrm{r}}{=} \lceil \forall *{:} * \rceil, \mathsf{v}$ free in$^* \mathsf{t}^{\mathsf{t}},$
$\mathrm{If}(\mathsf{v} \overset{\mathrm{t}}{=} \mathsf{t}^1, \mathsf{F}, \mathsf{v}$ free in $\mathsf{t}^2)))]$

$[x$ free in $y \overset{\mathrm{tex}}{\to}$ "#1.
\mathrel {free\ in} #2."]

$[*$ free in $* \overset{\mathrm{pyk}}{\to}$ "" free in ""]

$*$ free in* $*$

$[\mathsf{v}$ free in$^* \mathsf{t} \overset{\mathrm{val}}{\to} \mathrm{If}(\mathsf{t}, \mathsf{v}!\mathsf{F}, \mathrm{If}(\mathsf{v}$ free in $\mathsf{t}^{\mathsf{h}}, \mathsf{T}, \mathsf{v}$ free in$^* \mathsf{t}^{\mathsf{t}}))]$

$[x$ free in$^* y \overset{\mathrm{tex}}{\to}$ "#1.
\mathrel {free\ in}ˆ{\ast} #2."]

$[*$ free in$^* * \overset{\mathrm{pyk}}{\to}$ "" free in star ""]

$*$ free for $*$ in $*$

$[\mathsf{a}$ free for x in $\mathsf{b} \overset{\mathrm{val}}{\to} \mathsf{a}!x!$
$\mathrm{If}(\mathsf{b}^{\mathcal{V}}, \mathsf{T},$
$\mathrm{If}(\neg \mathsf{b} \overset{\mathrm{r}}{=} \lceil \forall *{:} * \rceil, \mathsf{a}$ free for$^* x$ in $\mathsf{b}^{\mathsf{t}},$
$\mathrm{If}(x \overset{\mathrm{t}}{=} \mathsf{b}^1, \mathsf{T},$
$\mathrm{If}(\neg x$ free in $\mathsf{b}^2, \mathsf{T},$
$\mathrm{If}(\mathsf{b}^1$ free in $\mathsf{a}, \mathsf{F},$
a free for x in $\mathsf{b}^2)))))]$

[a free for x in b $\xrightarrow{\text{tex}}$ "#1.
\mathrel {free\ for} #2.
\mathrel {in} #3."]

[∗ free for ∗ in ∗ $\xrightarrow{\text{pyk}}$ "" free for " in ""]

∗ free for* ∗ in ∗

[a free for* x in b $\xrightarrow{\text{val}}$
If(b, a!x!T,
If(a free for x in b^h, a free for* x in b^t, F))]

[a free for* x in b $\xrightarrow{\text{tex}}$ "#1.
\mathrel {free\ for}ˆ{\ast} #2.
\mathrel {in} #3."]

[∗ free for* ∗ in ∗ $\xrightarrow{\text{pyk}}$ "" free for star " in ""]

∗ $\in_c$ ∗

[x $\in_c$ y $\xrightarrow{\text{val}}$ y $\overset{\text{r}}{=}$ $\lceil$x $\wedge_c$ y$\rceil$ $\begin{cases} \text{If}(x \in_c y^1, \mathsf{T}, x \in_c y^2) \\ x \overset{\text{t}}{=} y \end{cases}$]

[x $\in_c$ y $\xrightarrow{\text{tex}}$ "#1.
\in_c #2."]

[∗ $\in_c$ ∗ $\xrightarrow{\text{pyk}}$ "" claim in ""]

∗ < ∗

[x < y $\xrightarrow{\text{val}}$ If($x^c \wedge y^c$, x <' y, F)]

[x < y $\xrightarrow{\text{tex}}$ "#1.
< #2."]

[∗ < ∗ $\xrightarrow{\text{pyk}}$ "" less ""]

$* <' *$

$$[x <' y \xrightarrow{\text{val}} y^s \left\{ \begin{array}{l} x!F \\ x^s \left\{ \begin{array}{l} T \\ x^h \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} x^t <' y^t \\ x^t \leq' y^t \end{array} \right. \\ y^h \left\{ \begin{array}{l} x^t <' y^t \\ x^t <' y^t \end{array} \right. \end{array} \right. \end{array} \right. \end{array} \right. \quad]$$

$[x <' y \xrightarrow{\text{tex}} \text{``\#1.}$
$<' \ \#2.\text{''}]$

$[* <' * \xrightarrow{\text{pyk}} \text{`` less zero ''}]$

$* \leq' *$

$$[x \leq' y \xrightarrow{\text{val}} x^s \left\{ \begin{array}{l} y!T \\ y^s \left\{ \begin{array}{l} F \\ x^h \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} x^t \leq' y^t \\ x^t \leq' y^t \end{array} \right. \\ y^h \left\{ \begin{array}{l} x^t <' y^t \\ x^t \leq' y^t \end{array} \right. \end{array} \right. \end{array} \right. \end{array} \right. \quad]$$

$[x \leq' y \xrightarrow{\text{tex}} \text{``\#1.}$
$\backslash le' \ \#2.\text{''}]$

$[* \leq' * \xrightarrow{\text{pyk}} \text{`` less one ''}]$

$\neg *$

$[\neg x \xrightarrow{\text{val}} \text{If}(x, F, T)]$
$[\neg * \xrightarrow{\text{tex}} \text{``}$
$\{\backslash neg \ \}\#1.\text{''}]$
$[\neg * \xrightarrow{\text{pyk}} \text{``not ''}]$

$* \wedge *$

$[x \wedge y \xrightarrow{\text{val}} x \left\{ \begin{array}{l} \text{If}(y, T, F) \\ \text{If}(y, F, F) \end{array} \right. \ ]$

$[* \wedge * \xrightarrow{\text{tex}} \text{``\#1.}$
$\backslash wedge \ \#2.\text{''}]$

$[* \wedge * \overset{\mathrm{pyk}}{\rightarrow} \text{"" and ""}]$

$* \overset{..}{\wedge} *$

$[\mathsf{x} \overset{..}{\wedge} \mathsf{y} \overset{\mathrm{macro}}{\rightarrow} \lambda \mathsf{t}.\lambda \mathsf{s}.\lambda \mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil [\mathsf{x} \overset{..}{\wedge} \mathsf{y} \overset{.}{=} \mathrm{If}(\mathsf{x}, \mathsf{y}, \mathsf{F})] \rceil)]$

$[\mathsf{x} \overset{..}{\wedge} \mathsf{y} \overset{\mathrm{tex}}{\rightarrow} \text{``#1.}$
$\mathrm{mathrel}\{\backslash \mathrm{ddot}\{\backslash \mathrm{wedge}\}\} \ \#2.\text{''}]$

$[* \overset{..}{\wedge} * \overset{\mathrm{pyk}}{\rightarrow} \text{"" macro and ""}]$

$* \overset{\sim}{\wedge} *$

$[\mathsf{x} \overset{\sim}{\wedge} \mathsf{y} \overset{\mathrm{val}}{\rightarrow} \mathrm{if}(\mathsf{x}, \mathsf{y}, \mathsf{x})]$

$[\mathsf{x} \overset{\sim}{\wedge} \mathsf{y} \overset{\mathrm{tex}}{\rightarrow} \text{``#1.}$
$\mathrm{mathrel}\{\backslash \mathrm{tilde}\{\backslash \mathrm{wedge}\}\} \ \#2.\text{''}]$

$[* \overset{\sim}{\wedge} * \overset{\mathrm{pyk}}{\rightarrow} \text{"" simple and ""}]$

$* \wedge_{\mathrm{c}} *$

$[\mathsf{x} \wedge_{\mathrm{c}} \mathsf{y} \overset{\mathrm{val}}{\rightarrow} \lambda \mathsf{t}.\lambda \mathsf{c}.\mathsf{x} \, ' \, \mathsf{t} \, ' \, \mathsf{c} \overset{\sim}{\wedge} \mathsf{y} \, ' \, \mathsf{t} \, ' \, \mathsf{c}]$

$[\mathsf{x} \wedge_{\mathrm{c}} \mathsf{y} \overset{\mathrm{tex}}{\rightarrow} \text{``#1.}$
$\backslash \mathrm{wedge\_c} \ \#2.\text{''}]$

$[* \wedge_{\mathrm{c}} * \overset{\mathrm{pyk}}{\rightarrow} \text{"" claim and ""}]$

$* \vee *$

$[\mathsf{x} \vee \mathsf{y} \overset{\mathrm{val}}{\rightarrow} \mathsf{x} \left\{ \begin{array}{l} \mathrm{If}(\mathsf{y}, \mathsf{T}, \mathsf{T}) \\ \mathrm{If}(\mathsf{y}, \mathsf{T}, \mathsf{F}) \end{array} \right]$

$[* \vee * \overset{\mathrm{tex}}{\rightarrow} \text{``#1.}$
$\backslash \mathrm{vee} \ \#2.\text{''}]$

$[* \vee * \overset{\mathrm{pyk}}{\rightarrow} \text{"" or ""}]$

$* \parallel *$

$[* \parallel * \overset{\text{tex}}{\rightarrow} \text{``}\#1.$
$\text{\textbackslash parallel } \#2.\text{''}]$

$[* \parallel * \overset{\text{pyk}}{\rightarrow} \text{``" parallel "''}]$

$* \overset{..}{\vee} *$

$[\mathsf{x} \overset{..}{\vee} \mathsf{y} \overset{\text{macro}}{\rightarrow} \lambda \mathsf{t}.\lambda \mathsf{s}.\lambda \mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil [\mathsf{x} \overset{..}{\vee} \mathsf{y} \overset{.}{=} \text{If}(\mathsf{x}, \mathsf{T}, \mathsf{y})] \rceil)]$

$[\mathsf{x} \overset{..}{\vee} \mathsf{y} \overset{\text{tex}}{\rightarrow} \text{``}\#1.$
$\text{\textbackslash mathrel}\{\text{\textbackslash ddot}\{\text{\textbackslash vee}\}\} \ \#2.\text{''}]$

$[* \overset{..}{\vee} * \overset{\text{pyk}}{\rightarrow} \text{``" macro or "''}]$

$* \overset{..}{\Rightarrow} *$

$[\mathsf{x} \overset{..}{\Rightarrow} \mathsf{y} \overset{\text{macro}}{\rightarrow} \lambda \mathsf{t}.\lambda \mathsf{s}.\lambda \mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil [\mathsf{x} \overset{..}{\Rightarrow} \mathsf{y} \overset{.}{=} \text{If}(\mathsf{x}, \mathsf{y}, \mathsf{T})] \rceil)]$

$[\mathsf{x} \overset{..}{\Rightarrow} \mathsf{y} \overset{\text{tex}}{\rightarrow} \text{``}\#1.$
$\text{\textbackslash mathrel}\{\text{\textbackslash ddot}\{\text{\textbackslash Rightarrow}\}\} \ \#2.\text{''}]$

$[* \overset{..}{\Rightarrow} * \overset{\text{pyk}}{\rightarrow} \text{``" macro imply "''}]$

$* : *$

$[\mathsf{x} : \mathsf{y} \overset{\text{val}}{\rightarrow} \text{if}(\mathsf{x}, \mathsf{y}, \mathsf{y})]$

$[* : * \overset{\text{tex}}{\rightarrow} \text{``}\#1.$
$:\#2.\text{''}]$

$[* : * \overset{\text{pyk}}{\rightarrow} \text{``" guard "''}]$

$* \text{ spy } *$

$[\mathsf{x} \text{ spy } \mathsf{y} \overset{\text{val}}{\Rightarrow} \mathsf{x}!\mathsf{y}]$

$[\mathsf{x} \text{ spy } \mathsf{y} \overset{\text{tex}}{\rightarrow} \text{``}\#1.$
$\text{\textbackslash mathrel}\{\text{spy}\}\#2.\text{''}]$

$[* \text{ spy } * \overset{\text{pyk}}{\rightarrow} \text{``" spy "''}]$

$*!*$

$[\mathsf{x}!\mathsf{y} \overset{\mathrm{val}}{\Rightarrow} \mathrm{If}(\mathsf{x}, \mathsf{y}, \mathsf{y})]$

$[*!* \overset{\mathrm{tex}}{\to} \text{``\#1.}$
$!\#2.\text{''}]$

$[*!* \overset{\mathrm{pyk}}{\to} \text{``'' tagged guard ''}]$

$* \left\{ \begin{array}{l} * \\ * \end{array} \right.$

$[\mathsf{x} \left\{ \begin{array}{l} \mathsf{y} \\ \mathsf{z} \end{array} \right. \overset{\mathrm{val}}{\Rightarrow} \mathrm{If}(\mathsf{x}, \mathsf{y}, \mathsf{z})]$

$[* \left\{ \begin{array}{l} * \\ * \end{array} \right. \overset{\mathrm{tex}}{\to} \text{``\#1.}$
\left\{\protect \begin {array}{l}#2.
\\#3.
\protect \end {array}\right.\text{''}]$

$[* \left\{ \begin{array}{l} * \\ * \end{array} \right. \overset{\mathrm{pyk}}{\to} \text{``'' select '' else '' end select''}]$

$\lambda * .*$

Predef: lambda
$[\lambda * .* \overset{\mathrm{tex}}{\to} \text{``}$
\lambda \#1.
.\#2.\text{''}]$

$[\lambda * .* \overset{\mathrm{pyk}}{\to} \text{``lambda '' dot ''''}]$

$\Lambda * .*$

$[\Lambda\mathsf{x}.\mathsf{y} \overset{\mathrm{macro}}{\to} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil [\Lambda\mathsf{x}.\mathsf{y} \overset{.}{=} \Lambda\lambda\mathsf{x}.\mathsf{y}] \rceil)]$

$[\Lambda\mathsf{x}.\mathsf{y} \overset{\mathrm{tex}}{\to} \text{``}$
\Lambda \#1.
. \#2.\text{''}]$

$[\Lambda * .* \overset{\mathrm{pyk}}{\to} \text{``tagged lambda '' dot ''''}]$

Λ∗

[Λx $\overset{\text{val}}{\Rightarrow} \mathcal{M}(\lambda u.\mathcal{U}(x \,{}' \mathcal{M}(u)))$]

[Λ∗ $\overset{\text{tex}}{\rightarrow}$ "
\Lambda #1."]

[Λ∗ $\overset{\text{pyk}}{\rightarrow}$ "tagging ""]

if ∗ then ∗ else ∗

[if x then y else z $\overset{\text{macro}}{\rightarrow} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil[\text{if } x \text{ then } y \text{ else } z \doteq \text{If}(x, y, z)]\rceil)$]

[if x then y else z $\overset{\text{tex}}{\rightarrow}$ "
{\bf if} \ #1.
\ {\bf then} \ #2.
\ {\bf else} \ #3."]

[if ∗ then ∗ else ∗ $\overset{\text{pyk}}{\rightarrow}$ "open if " then " else ""]

let ∗ = ∗ in ∗

[let x = y in z $\overset{\text{macro}}{\rightarrow} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil[\text{let } x = y \text{ in } z \doteq \text{let}_1(\lambda x.z, y)]\rceil)$]

[let x = y in z $\overset{\text{tex}}{\rightarrow}$ "
\mathbf{let\ } #1.
= #2.
\mathbf{\ in\ } #3."]

[let ∗ = ∗ in ∗ $\overset{\text{pyk}}{\rightarrow}$ "let " be " in ""]

let ∗ $\overset{..}{=}$ ∗ in ∗

[let x $\doteq$ y in z $\overset{\text{macro}}{\rightarrow} \lambda t.\lambda s.\lambda c.$
$\tilde{\mathcal{M}}(t^3, s, c[t^{1r} :: \text{"codex"} :: t^{1r} :: t^{1i} :: 0 :: \text{"macro"} :: \mathsf{T} \Rightarrow \tilde{\mathcal{M}}_3(t)])$]

[let x $\doteq$ y in z $\overset{\text{tex}}{\rightarrow}$ "
\mathbf{let\ } #1.
\mathrel{\ddot{=}} #2.
\mathrel{\ in\ } #3."]

[let ∗ $\overset{..}{=}$ ∗ in ∗ $\overset{\text{pyk}}{\rightarrow}$ "let " abbreviate " in ""]

$*^{\mathrm{I}}$

$[x^{\mathrm{I}} \overset{\mathrm{val}}{\to} \lceil x^{\mathrm{I}} \rceil^{\mathrm{R}} :: x :: \mathsf{T}]$

$[x^{\mathrm{I}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\} \; \hat{} \; \{ \; \mathrm{I} \; \}$"$]$

$[*^{\mathrm{I}} \overset{\mathrm{pyk}}{\to}$ "" init"$]$

$*^{\rhd}$

$[x^{\rhd} \overset{\mathrm{val}}{\to} \lceil x^{\rhd} \rceil^{\mathrm{R}} :: x :: \mathsf{T}]$

$[x^{\rhd} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\} \; \hat{} \; \{ \; \backslash \mathrm{rhd} \; \}$"$]$

$[*^{\rhd} \overset{\mathrm{pyk}}{\to}$ "" modus"$]$

$*^{\mathrm{V}}$

$[x^{\mathrm{V}} \overset{\mathrm{val}}{\to} \lceil x^{\mathrm{V}} \rceil^{\mathrm{R}} :: x :: \mathsf{T}]$

$[x^{\mathrm{V}} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\} \; \hat{} \; \{ \; \mathrm{V} \; \}$ "$]$

$[*^{\mathrm{V}} \overset{\mathrm{pyk}}{\to}$ "" verify"$]$

$*^{+}$

$[x^{+} \overset{\mathrm{val}}{\to} \lceil x^{+} \rceil^{\mathrm{R}} :: x :: \mathsf{T}]$

$[x^{+} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\} \; \hat{} \; \{ \; + \; \}$ "$]$

$[*^{+} \overset{\mathrm{pyk}}{\to}$ "" curry plus"$]$

$*^{-}$

$[x^{-} \overset{\mathrm{val}}{\to} \lceil x^{-} \rceil^{\mathrm{R}} :: x :: \mathsf{T}]$

$[x^{-} \overset{\mathrm{tex}}{\to}$ "#1.
$\{\} \; \hat{} \; \{ \; - \; \}$ "$]$

$[*^{-} \overset{\mathrm{pyk}}{\to}$ "" curry minus"$]$

$\ast^{\ast}$

$[x^{\ast} \overset{\mathrm{val}}{\to} \lceil x^{\ast} \rceil^{\mathrm{R}} :: x :: \mathsf{T}]$

$[x^{\ast} \overset{\mathrm{tex}}{\to}$ "#1.
{} ^ { \ast } "]

$[\ast^{\ast} \overset{\mathrm{pyk}}{\to}$ "" dereference"]

$\ast \,@\, \ast$

$[x @ y \overset{\mathrm{val}}{\to} \lceil x @ y \rceil^{\mathrm{R}} :: x :: y :: \mathsf{T}]$

$[x @ y \overset{\mathrm{tex}}{\to}$ "#1.
\mathop {\char64} #2."]

$[\ast @ \ast \overset{\mathrm{pyk}}{\to}$ "" at ""]

$\ast \rhd \ast$

$[x \rhd y \overset{\mathrm{val}}{\to} \lceil x \rhd y \rceil^{\mathrm{R}} :: x :: y :: \mathsf{T}]$

$[x \rhd y \overset{\mathrm{tex}}{\to}$ "#1.
\rhd #2."]

$[\ast \rhd \ast \overset{\mathrm{pyk}}{\to}$ "" modus ponens ""]

$\ast \,\vartriangleright\!\!\!\vartriangleright\, \ast$

$[x \,\vartriangleright\!\!\!\vartriangleright\, y \overset{\mathrm{val}}{\to} \lceil x \,\vartriangleright\!\!\!\vartriangleright\, y \rceil^{\mathrm{R}} :: x :: y :: \mathsf{T}]$

$[x \,\vartriangleright\!\!\!\vartriangleright\, y \overset{\mathrm{tex}}{\to}$ "#1.
\mathrel {\makebox [0mm][l]{$\rhd $}\, {\rhd }} #2."]

$[\ast \,\vartriangleright\!\!\!\vartriangleright\, \ast \overset{\mathrm{pyk}}{\to}$ "" modus probans ""]

$\ast \gg \ast$

$[x \gg y \overset{\mathrm{tactic}}{\to} \lambda \mathsf{t}.\lambda \mathsf{s}.\lambda \mathsf{c}.\mathrm{conclude}_1(\mathsf{t}, \mathsf{c})]$

$[x \gg y \overset{\mathrm{tex}}{\to}$ "#1.
\gg #2."]

$[\ast \gg \ast \overset{\mathrm{pyk}}{\to}$ "" conclude ""]

$* \vdash *$

$[x \vdash y \overset{\mathrm{val}}{\to} \lceil x \vdash y \rceil^{\mathrm{R}} :: x :: y :: \mathsf{T}]$

$[x \vdash y \overset{\mathrm{tex}}{\to}$ "#1.
\vdash #2."]

$[* \vdash * \overset{\mathrm{pyk}}{\to}$ "" infer ""]

$* \Vdash *$

$[x \Vdash y \overset{\mathrm{val}}{\to} \lceil x \Vdash y \rceil^{\mathrm{R}} :: x :: y :: \mathsf{T}]$

$[x \Vdash y \overset{\mathrm{tex}}{\to}$ "#1.
\mathrel {\makebox [0mm][l]{$\vdash $}\, {\vdash }} #2."]

$[* \Vdash * \overset{\mathrm{pyk}}{\to}$ "" endorse ""]

$* \text{ i.e. } *$

$[x \text{ i.e. } y \overset{\mathrm{val}}{\to} \lceil x \text{ i.e. } y \rceil^{\mathrm{R}} :: x :: y :: \mathsf{T}]$

$[x \text{ i.e. } y \overset{\mathrm{tex}}{\to}$ "#1.
\mathrel {i.e.} #2."]

$[* \text{ i.e. } * \overset{\mathrm{pyk}}{\to}$ "" id est ""]

$\forall *: *$

$[\forall x: y \overset{\mathrm{val}}{\to} \lceil \forall x: y \rceil^{\mathrm{R}} :: x :: y :: \mathsf{T}]$

$[\forall x: y \overset{\mathrm{tex}}{\to}$ "
\forall #1.
\colon #2."]

$[\forall *: * \overset{\mathrm{pyk}}{\to}$ "all " indeed ""]

$* \oplus *$

$[x \oplus y \overset{\mathrm{val}}{\to} \lceil x \oplus y \rceil^{\mathrm{R}} :: x :: y :: \mathsf{T}]$

$[x \oplus y \overset{\mathrm{tex}}{\to}$ "#1.
\mathrel {\oplus} #2."]

$[* \oplus * \overset{\text{pyk}}{\rightarrow}$ "" rule plus ""]

$*; *$

$[\mathsf{x}; \mathsf{y} \overset{\text{val}}{\rightarrow} \lceil \mathsf{x}; \mathsf{y} \rceil^{\text{R}} :: \mathsf{x} :: \mathsf{y} :: \mathsf{T}]$

$[\mathsf{x}; \mathsf{y} \overset{\text{tex}}{\rightarrow}$ "#1.
; #2."]

$[*; * \overset{\text{pyk}}{\rightarrow}$ "" cut ""]

$* \text{ proves } *$

$[\mathsf{p} \text{ proves } \mathsf{t} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathsf{p} \text{ proves } \mathsf{t} \overset{..}{=} \text{proof}(\lceil \mathsf{p} \rceil, \lceil \mathsf{t} \rceil, \text{self})]\rceil)]$

$[\mathsf{p} \text{ proves } \mathsf{t} \overset{\text{tex}}{\rightarrow}$ "#1.
\ proves\ #2."]

$[* \text{ proves } * \overset{\text{pyk}}{\rightarrow}$ "" proves ""]

$* \text{ proof of } * : *$

$[\mathsf{t} \text{ \textbf{proof of} } \mathsf{s} : \mathsf{p} \overset{\text{name}}{\rightarrow}$ "#1.
\mathbf{\ proof\ of\ } #2.
: #3."]

$[\mathsf{t} \text{ \textbf{proof of} } \mathsf{s} : \mathsf{p} \overset{\text{macro}}{\rightarrow} \lambda\mathsf{t}.\lambda\mathsf{s}.\lambda\mathsf{c}.\tilde{\mathcal{M}}_4(\mathsf{t}, \mathsf{s}, \mathsf{c}, \lceil[\mathsf{t} \text{ \textbf{proof of} } \mathsf{s} : \mathsf{p} \overset{..}{=}$
$[\textbf{Proof of } \mathsf{s}: \lambda\mathsf{c}.\lambda\mathsf{x}.\mathcal{P}(\lceil \mathsf{t} \vdash \mathsf{p} \rceil, \mathrm{p}_0, \mathsf{c})]]\rceil)]$

$[\mathsf{t} \text{ \textbf{proof of} } \mathsf{s} : \mathsf{p} \overset{\text{tex}}{\rightarrow}$ "
\if\relax\csname lgwprooflinep\endcsname
\def\lgwprooflinep{x}
\newcount\lgwproofline
\fi
\begingroup
\def\insideproof{x}
\lgwproofline=0 #1.
\mathbf {\ proof\ of\ } #2.
\colon #3.
\gdef\lgwella{\relax}
\gdef\lgwellb{\relax}
\gdef\lgwellc{\relax}
\gdef\lgwelld{\relax}
\gdef\lgwelle{\relax}

```
\gdef\lgwellf{\relax}
\gdef\lgwellg{\relax}
\gdef\lgwellh{\relax}
\gdef\lgwelli{\relax}
\gdef\lgwellj{\relax}
\gdef\lgwellk{\relax}
\gdef\lgwelll{\relax}
\gdef\lgwellm{\relax}
\gdef\lgwelln{\relax}
\gdef\lgwello{\relax}
\gdef\lgwellp{\relax}
\gdef\lgwellq{\relax}
\gdef\lgwellr{\relax}
\gdef\lgwells{\relax}
\gdef\lgwellt{\relax}
\gdef\lgwellu{\relax}
\gdef\lgwellv{\relax}
\gdef\lgwellw{\relax}
\gdef\lgwellx{\relax}
\gdef\lgwelly{\relax}
\gdef\lgwellz{\relax}
\gdef\lgwellbiga{\relax}
\gdef\lgwellbigb{\relax}
\gdef\lgwellbigc{\relax}
\gdef\lgwellbigd{\relax}
\gdef\lgwellbige{\relax}
\gdef\lgwellbigf{\relax}
\gdef\lgwellbigg{\relax}
\gdef\lgwellbigh{\relax}
\gdef\lgwellbigi{\relax}
\gdef\lgwellbigj{\relax}
\gdef\lgwellbigk{\relax}
\gdef\lgwellbigl{\relax}
\gdef\lgwellbigm{\relax}
\gdef\lgwellbign{\relax}
\gdef\lgwellbigo{\relax}
\gdef\lgwellbigp{\relax}
\gdef\lgwellbigq{\relax}
\gdef\lgwellbigr{\relax}
\gdef\lgwellbigs{\relax}
\gdef\lgwellbigt{\relax}
\gdef\lgwellbigu{\relax}
\gdef\lgwellbigv{\relax}
\gdef\lgwellbigw{\relax}
\gdef\lgwellbigx{\relax}
\gdef\lgwellbigy{\relax}
```

```
\gdef\lgwellbigz{\relax}
\endgroup "]
```

[∗ **proof of** ∗ : ∗ $\overset{\text{pyk}}{\to}$ """ proof of " reads ""]

Line ∗ : ∗ ≫ ∗; ∗

[Line l : a ≫ i; p $\overset{\text{name}}{\to}$ "
Line \, #1.
: #2.
\gg #3.
; #4."]

[Line l : a ≫ i; p $\overset{\text{macro}}{\to}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[Line l : a ≫ i; p $\doteq$ (a ≫ i; **let** l $\doteq$ i in
p)]⌉])]

[Line l : a ≫ i; p $\overset{\text{tex}}{\to}$ "
\newline \makebox [0.1\textwidth]{}%
\parbox [b]{0.4\textwidth }{\raggedright
\setlength {\parindent }{-0.1\textwidth }%
\makebox [0.1\textwidth][l]{$#1.
$:}$#2.
{}\gg {}$}\quad
\parbox [t]{0.4\textwidth }{$#3.
$\hfill \makebox [0mm][l]{\quad ;}}#4."]

[Line ∗ : ∗ ≫ ∗; ∗ $\overset{\text{pyk}}{\to}$ "line " because " indeed " end line ""]

Last line ∗ ≫ ∗ □

[Last line a ≫ i □ $\overset{\text{name}}{\to}$ "
Last\ line \, #1.
\gg #2.
\, \Box"]

[Last line a ≫ i □ $\overset{\text{macro}}{\to}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[Last line a ≫ i □ $\doteq$ (a ≫ i)]⌉])]

[Last line a ≫ i □ $\overset{\text{tex}}{\to}$ "
\newline \makebox [0.1\textwidth]{}%
\parbox [b]{0.4\textwidth }{\raggedright
\setlength {\parindent }{-0.1\textwidth }%
\makebox [0.1\textwidth][l]{$
\if \relax \csname lgwprooflinep\endcsname L_? \else
\global \advance \lgwproofline by 1
L\ifnum \lgwproofline <10 0\fi \number \lgwproofline
\fi
```

$:\}$\$#1.
$\{\}\gg \{\}$\$}\quad
\parbox [t]{0.4\textwidth }{\$#2.
\$\hfill \makebox [0mm][l]{\quad \makebox[0mm]{\$\Box\$}}}}"]

[Last line $* \gg * \Box \xrightarrow{\text{pyk}}$ "because " indeed " qed"]

Line $*$: Premise $\gg *; *$

[Line I : Premise $\gg$ i; p $\xrightarrow{\text{name}}$ "
Line \, #1.
: Premise \gg #2.
; #3."]

[Line I : Premise $\gg$ i; p $\xrightarrow{\text{macro}}$ $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil[\text{Line I : Premise} \gg \text{i; p} \doteq (\text{i} \vdash$ **let** I $\doteq$ i in p)]\rceil)]$

[Line I : Premise $\gg$ i; p $\xrightarrow{\text{tex}}$ "
\newline \makebox [0.1\textwidth][l]{\$#1.
\$:}\makebox [0.4\textwidth][l]{\$Premise{}\gg{}\$}\quad
\parbox [t]{0.4\textwidth }{\$#2.
\$\hfill \makebox [0mm][l]{\quad ; }}#3."]

[Line $*$: Premise $\gg *; * \xrightarrow{\text{pyk}}$ "line " premise " end line ""]

Line $*$: **Side-condition** $\gg *; *$

[Line I : Side-condition $\gg$ i; p $\xrightarrow{\text{name}}$ "
Line \, #1.
: \mbox{Side-condition} \gg #2.
; #3."]

[Line I : Side-condition $\gg$ i; p $\xrightarrow{\text{macro}}$ $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \lceil[\text{Line I :}$
Side-condition $\gg$ i; p $\doteq (\text{i} \Vdash$ **let** I $\doteq$ i in p)]\rceil)]$

[Line I : Side-condition $\gg$ i; p $\xrightarrow{\text{tex}}$ "
\newline \makebox [0.1\textwidth][l]{\$#1.
\$:}\makebox [0.4\textwidth][l]{%
\$\mbox{Side-condition}{}\gg{}\$}\quad
\parbox [t]{0.4\textwidth }{\$#2.
\$\hfill \makebox [0mm][l]{\quad ; }}#3."]

[Line $*$: Side-condition $\gg *; * \xrightarrow{\text{pyk}}$ "line " side condition " end line ""]

Arbitrary ≫ ∗; ∗

[Arbitrary ≫ i; p $\stackrel{\text{name}}{\rightarrow}$ "
Arbitrary \gg #1.
; #2."]

[Arbitrary ≫ i; p $\stackrel{\text{macro}}{\rightarrow}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[Arbitrary ≫ i; p $\doteq$ (∀i: p)]⌉)]

[Arbitrary ≫ i; p $\stackrel{\text{tex}}{\rightarrow}$ "
\newline \makebox [0.1\textwidth][l]{$
\if \relax \csname lgwprooflinep\endcsname L_? \else
\global \advance \lgwproofline by 1
L\ifnum \lgwproofline <10 0\fi \number \lgwproofline
\fi
$:}\makebox [0.4\textwidth][l]{$Arbitrary{}\gg{}$}\quad
\parbox [t]{0.4\textwidth }{$#1.
$\hfill \makebox [0mm][l]{\quad ; }}#2."]

[Arbitrary ≫ ∗; ∗ $\stackrel{\text{pyk}}{\rightarrow}$ "arbitrary " end line ""]

Local ≫ ∗ = ∗; ∗

[Local ≫ a = i; p $\stackrel{\text{name}}{\rightarrow}$ "
Local \gg #1.
= #2.
; #3."]

[Local ≫ a = i; p $\stackrel{\text{macro}}{\rightarrow}$ λt.λs.λc.$\tilde{\mathcal{M}}_4$(t, s, c, ⌈[Local ≫ a = i; p $\doteq$ (**let** a $\doteq$ i in
p)]⌉)]

[Local ≫ a = i; p $\stackrel{\text{tex}}{\rightarrow}$ "
\newline\makebox[0.1\textwidth][l]{$
\if \relax \csname lgwprooflinep\endcsname L_? \else
\global \advance \lgwproofline by 1
L\ifnum \lgwproofline <10 0\fi \number \lgwproofline
\fi
$:}%
\makebox[0.4\textwidth][l]{$Local{}\gg{}$}%
\quad%
\parbox[t]{0.4\textwidth}{$#1.
= #2.
$\hfill\makebox[0mm][l]{\quad ; }}#3."]

[Local ≫ ∗ = ∗; ∗ $\stackrel{\text{pyk}}{\rightarrow}$ "locally define " as " end line ""]

$*\&*$

$[*\&* \overset{\text{name}}{\rightarrow} \text{``#1.}$
$\backslash\& \ #2.\text{''}]$

$[*\&* \overset{\text{tex}}{\rightarrow} \text{``#1.}$
$\&#2.\text{''}]$

$[*\&* \overset{\text{pyk}}{\rightarrow} \text{`` " tab " ''}]$

$*\backslash\backslash*$

$[*\backslash\backslash* \overset{\text{name}}{\rightarrow} \text{``#1.}$
$\backslash backslash \ \backslash backslash \ #2.\text{''}]$

$[*\backslash\backslash* \overset{\text{tex}}{\rightarrow} \text{``#1.}$
$\backslash\backslash \ #2.\text{''}]$

$[*\backslash\backslash* \overset{\text{pyk}}{\rightarrow} \text{`` " row " ''}]$