

# Logiweb codex of base

## Up Help

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

\* , \* ,  $(*)^t$ , string(\*) + \* , string(\*) ++ \* , pyk,  $[* \rightarrow *]$ , \* linebreak[4] \* ,

bracket \* end bracket, big bracket \* end bracket, \$ \* \$ , **flush left** [\*] , x , y , z ,

tex, name, prio, T, if(\*, \*, \*) ,  $[* \Rightarrow *]$ , 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\* ,  $[* , \backslash * , ]*$  , ^ \* , \_ \* , ' \* , 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\* , { \* ,

| \* , } \* , ~ \* , claim,  $\perp$ , 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,  $\langle * | * := * \rangle$ ,  $\mathcal{M}(*)$ ,  $\tilde{U}(*)$ ,  $U(*)$ ,  $U^M(*)$ ,

**apply**(\* , \*), **apply**<sub>1</sub>(\* , \*), identifier(\*), identifier<sub>1</sub>(\* , \*), array-plus(\* , \*), array-

remove(\* , \* , \*), array-put(\* , \* , \* , \*), array-add(\* , \* , \* , \* , \*), bit(\* , \*), bit<sub>1</sub>(\* , \*),

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<sub>0</sub>,

**zip**(\* , \*), **assoc**<sub>1</sub>(\* , \* , \*),  $(*)^P$ , self,  $[* \doteq *]$ ,  $[* \dot{=} *]$ ,  $[* \dot{=} *]$ ,  $[* \stackrel{\text{pyk}}{=} *]$ ,  $[* \stackrel{\text{tex}}{=} *]$ ,

$[* \stackrel{\text{name}}{=} *]$ , **Priority table**[\*],  $\tilde{\mathcal{M}}_1$ ,  $\tilde{\mathcal{M}}_2(*)$ ,  $\tilde{\mathcal{M}}_3(*)$ ,  $\tilde{\mathcal{M}}_4(* , * , * , *)$ ,  $\tilde{\mathcal{M}}(* , * , *)$ ,

$\tilde{Q}(* , * , *)$ ,  $\tilde{Q}_2(* , * , *)$ ,  $\tilde{Q}_3(* , * , * , *)$ ,  $\tilde{Q}^(* , * , *)$ , (\*), (\*), display(\*),

statement(\*),  $[* ]^+$ ,  $[* ]^-$ , **aspect**(\* , \*), **aspect**(\* , \* , \*),  $(*)^v$ , **tuple**<sub>1</sub>(\*),

**tuple**<sub>2</sub>(\*), let<sub>2</sub>(\* , \*), let<sub>1</sub>(\* , \*),  $[* \stackrel{\text{claim}}{=} *]$ , checker, **check**(\* , \*), **check**<sub>2</sub>(\* , \* , \*),

**check**<sub>3</sub>(\* , \* , \*), **check**<sup>\*</sup>(\* , \*), **check**<sub>2</sub><sup>\*</sup>(\* , \* , \*),  $[* ]^+$ ,  $[* ]^-$ ,  $[* ]^o$ , msg,  $[* \stackrel{\text{msg}}{=} *]$ ,

<stmt>, stmt,  $[* \stackrel{\text{stmt}}{=} *]$ , HeadNil', HeadPair', Transitivity',  $\perp\perp$ , Contra',  $T'_E$ ,

L<sub>1</sub>, ⊆, 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,  $\langle * | * := * \rangle$ ,  $\langle *^* | * := * \rangle$ ,  $\emptyset$ , Remainder,  $(*)^v$ , intro(\* , \* , \* , \*) ,

intro(\* , \* , \*) , error(\* , \*) , error<sub>2</sub>(\* , \*) , proof(\* , \* , \*) , proof<sub>2</sub>(\* , \*) ,  $\mathcal{S}(* , *)$ ,

$\mathcal{S}^I(* , *)$ ,  $\mathcal{S}^{\triangleright}(* , *)$ ,  $\mathcal{S}_1^{\triangleright}(* , * , *)$ ,  $\mathcal{S}^E(* , *)$ ,  $\mathcal{S}_1^E(* , * , *)$ ,  $\mathcal{S}^+(* , *)$ ,  $\mathcal{S}_1^+(* , * , *)$ ,

$\mathcal{S}^-(* , *)$ ,  $\mathcal{S}_1^-(* , * , *)$ ,  $\mathcal{S}^*(*)$ ,  $\mathcal{S}_1^*(*)$ ,  $\mathcal{S}_2^*(*)$ ,  $\mathcal{S}^{\otimes}(* , *)$ ,  $\mathcal{S}_1^{\otimes}(* , * , *)$ ,

$\mathcal{S}^{\ddagger}(* , *)$ ,  $\mathcal{S}_1^{\ddagger}(* , * , * , *)$ ,  $\mathcal{S}^{\ddagger\ddagger}(* , *)$ ,  $\mathcal{S}_1^{\ddagger\ddagger}(* , * , * , *)$ ,  $\mathcal{S}^{\text{i.e.}}(* , *)$ ,  $\mathcal{S}_1^{\text{i.e.}}(* , * , * , *)$ ,

$\mathcal{S}_2^{\text{i.e.}}(* , * , * , * , *)$ ,  $\mathcal{S}^{\forall}(* , *)$ ,  $\mathcal{S}_1^{\forall}(* , * , * , *)$ ,  $\mathcal{S}^i(* , *)$ ,  $\mathcal{S}_1^i(* , * , * , *)$ ,  $\mathcal{S}_2^i(* , * , * , *)$ , T(\*),

claims(\* , \* , \*) , claims<sub>2</sub>(\* , \* , \*) , <proof>, proof, [**Lemma** \* : \*], [**Proof of** \* : \*],

[\* lemma \* : \*], [\* antilemma \* : \*], [\* rule \* : \*], [\* antirule \* : \*], verifier,

V<sub>1</sub>(\*), V<sub>2</sub>(\* , \*) , V<sub>3</sub>(\* , \* , \* , \*) , V<sub>4</sub>(\* , \*) , V<sub>5</sub>(\* , \* , \* , \*) , V<sub>6</sub>(\* , \* , \* , \*) , V<sub>7</sub>(\* , \* , \* , \*) ,

Cut(\* , \*) , Head $\oplus$ (\*), Tail $\oplus$ (\*), rule<sub>1</sub>(\* , \*) , rule(\* , \*) , Rule tactic, Plus(\* , \*) ,



**abstract**(\* , \* , \* , \* ), [[\* ]], [ $\mathcal{M}$ (\* , \* , \* )], [ $\mathcal{M}_2$ (\* , \* , \* , \* )], [ $\mathcal{M}^*$ (\* , \* , \* )], [macro],  
[s<sub>0</sub>], [**zip**(\* , \* )], [**assoc**<sub>1</sub>(\* , \* , \* )], [(\*)<sup>P</sup>], [self], [[\*  $\doteq$  \*]], [[\*  $\doteq$  \*]], [[\*  $\doteq$  \*]],  
[[\*  $\stackrel{\text{pyk}}{=}$  \*]], [[\*  $\stackrel{\text{tex}}{=}$  \*]], [[\*  $\stackrel{\text{name}}{=}$  \*]], [**Priority table**[\* ]], [ $\tilde{\mathcal{M}}_1$ ], [ $\tilde{\mathcal{M}}_2$ (\* )], [ $\tilde{\mathcal{M}}_3$ (\* )],  
[ $\tilde{\mathcal{M}}_4$ (\* , \* , \* , \* )], [ $\mathcal{M}$ (\* , \* , \* )], [ $\tilde{\mathcal{Q}}$ (\* , \* , \* )], [ $\tilde{\mathcal{Q}}_2$ (\* , \* , \* )], [ $\tilde{\mathcal{Q}}_3$ (\* , \* , \* , \* )], [ $\tilde{\mathcal{Q}}^*$ (\* , \* , \* )],  
[(\*)], [(\*)], [display(\* )], [statement(\* )], [[\* ]], [[\* ]<sup>-</sup>], [**aspect**(\* , \* )],  
**aspect**(\* , \* , \* ), [(\*)], [**tuple**<sub>1</sub>(\* )], [**tuple**<sub>2</sub>(\* )], [let<sub>2</sub>(\* , \* )], [let<sub>1</sub>(\* , \* )],  
[[\*  $\stackrel{\text{claim}}{=}$  \*]], [checker], [**check**(\* , \* )], [**check**<sub>2</sub>(\* , \* , \* )], [**check**<sub>3</sub>(\* , \* , \* )],  
**check**<sup>\*</sup>(\* , \* )], [**check**<sub>2</sub><sup>\*</sup>(\* , \* , \* )], [[\* ]], [[\* ]<sup>-</sup>], [[\* ]<sup>o</sup>], [msg], [[\*  $\stackrel{\text{msg}}{=}$  \*]], [<stmt>],  
[stmt], [[\*  $\stackrel{\text{stmt}}{=}$  \*]], [HeadNil'], [HeadPair'], [Transitivity'], [⊥], [Contra'], [T<sub>E</sub>'],  
[L<sub>1</sub>], [\* ], [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], [( \* | \* := \* )], [( \* \* | \* := \* )], [∅], [Remainder],  
[( \* )<sup>v</sup>], [intro(\* , \* , \* , \* )], [intro(\* , \* , \* )], [error(\* , \* )], [error<sub>2</sub>(\* , \* )], [proof(\* , \* , \* )],  
[proof<sub>2</sub>(\* , \* )], [S(\* , \* )], [S<sup>I</sup>(\* , \* )], [S<sup>D</sup>(\* , \* )], [S<sup>I</sup><sup>D</sup>(\* , \* , \* )], [S<sup>E</sup>(\* , \* )], [S<sup>I</sup><sup>E</sup>(\* , \* , \* )],  
[S<sup>+</sup>(\* , \* )], [S<sup>+</sup><sub>1</sub>(\* , \* , \* )], [S<sup>-</sup>(\* , \* )], [S<sup>-</sup><sub>1</sub>(\* , \* , \* )], [S<sup>\*</sup>(\* , \* )], [S<sup>+</sup><sub>1</sub>(\* , \* , \* )],  
[S<sup>\*</sup><sub>2</sub>(\* , \* , \* , \* )], [S<sup>⊗</sup>(\* , \* )], [S<sup>⊗</sup><sub>1</sub>(\* , \* , \* )], [S<sup>+</sup>(\* , \* )], [S<sup>+</sup><sub>1</sub>(\* , \* , \* , \* )], [S<sup>+</sup><sub>1</sub>(\* , \* )],  
[S<sup>+</sup><sub>1</sub>(\* , \* , \* , \* )], [S<sup>i.e.</sup>(\* , \* )], [S<sup>i.e.</sup><sub>1</sub>(\* , \* , \* , \* )], [S<sup>i.e.</sup><sub>2</sub>(\* , \* , \* , \* )], [S<sup>v</sup>(\* , \* )],  
[S<sup>v</sup><sub>1</sub>(\* , \* , \* , \* )], [S<sup>i</sup>(\* , \* )], [S<sup>i</sup><sub>1</sub>(\* , \* , \* )], [S<sup>i</sup><sub>2</sub>(\* , \* , \* , \* )], [T(\* )], [claims(\* , \* , \* )],  
[claims<sub>2</sub>(\* , \* , \* )], [<proof>], [proof], [[**Lemma** \* : \* ]], [[**Proof of** \* : \* ]],  
[[ \* **lemma** \* : \* ]], [[ \* **antilemma** \* : \* ]], [[ \* **rule** \* : \* ]], [[ \* **antirule** \* : \* ]],  
[verifier], [V<sub>1</sub>(\* )], [V<sub>2</sub>(\* , \* )], [V<sub>3</sub>(\* , \* , \* , \* )], [V<sub>4</sub>(\* , \* )], [V<sub>5</sub>(\* , \* , \* , \* )], [V<sub>6</sub>(\* , \* , \* , \* )],  
[V<sub>7</sub>(\* , \* , \* , \* )], [Cut(\* , \* )], [Head<sub>⊕</sub>(\* )], [Tail<sub>⊕</sub>(\* )], [rule<sub>1</sub>(\* , \* )], [rule(\* , \* )],  
[Rule tactic], [Plus(\* , \* )], [[**Theory** \* ]], [theory<sub>2</sub>(\* , \* )], [theory<sub>3</sub>(\* , \* )],  
[theory<sub>4</sub>(\* , \* , \* )], [HeadNil''], [HeadPair''], [Transitivity''], [Contra''], [HeadNil],  
[HeadPair], [Transitivity], [Contra], [T<sub>E</sub>], [ragged right],  
[ragged right expansion ], [parm(\* , \* , \* )], [parm<sup>\*</sup>(\* , \* , \* )], [inst(\* , \* )],  
[inst<sup>\*</sup>(\* , \* )], [occur(\* , \* , \* )], [occur<sup>\*</sup>(\* , \* , \* )], [unify(\* = \* , \* )], [unify<sup>\*</sup>(\* = \* , \* )],  
[unify<sub>2</sub>(\* = \* , \* )], [L<sub>a</sub>], [L<sub>b</sub>], [L<sub>c</sub>], [L<sub>d</sub>], [L<sub>e</sub>], [L<sub>f</sub>], [L<sub>g</sub>], [L<sub>h</sub>], [L<sub>i</sub>], [L<sub>j</sub>], [L<sub>k</sub>], [L<sub>l</sub>], [L<sub>m</sub>],  
[L<sub>n</sub>], [L<sub>o</sub>], [L<sub>p</sub>], [L<sub>q</sub>], [L<sub>r</sub>], [L<sub>s</sub>], [L<sub>t</sub>], [L<sub>u</sub>], [L<sub>v</sub>], [L<sub>w</sub>], [L<sub>x</sub>], [L<sub>y</sub>], [L<sub>z</sub>], [L<sub>A</sub>], [L<sub>B</sub>], [L<sub>C</sub>],  
[L<sub>D</sub>], [L<sub>E</sub>], [L<sub>F</sub>], [L<sub>G</sub>], [L<sub>H</sub>], [L<sub>I</sub>], [L<sub>J</sub>], [L<sub>K</sub>], [L<sub>L</sub>], [L<sub>M</sub>], [L<sub>N</sub>], [L<sub>O</sub>], [L<sub>P</sub>], [L<sub>Q</sub>], [L<sub>R</sub>],  
[L<sub>S</sub>], [L<sub>T</sub>], [L<sub>U</sub>], [L<sub>V</sub>], [L<sub>W</sub>], [L<sub>X</sub>], [L<sub>Y</sub>], [L<sub>Z</sub>], [L<sub>?</sub>], [Reflexivity], [Reflexivity<sub>1</sub>],  
[Commutativity], [Commutativity<sub>1</sub>], [<tactic>], [tactic], [[\*  $\stackrel{\text{tactic}}{=}$  \*]], [P(\* , \* , \* )],  
[P<sup>\*</sup>(\* , \* , \* )], [p<sub>0</sub>], [conclude<sub>1</sub>(\* , \* )], [conclude<sub>2</sub>(\* , \* , \* )], [conclude<sub>3</sub>(\* , \* , \* , \* )],  
[conclude<sub>4</sub>(\* , \* )];

### Preassociative

[\* { \* }], [\* /indexintro(\* , \* , \* , \* )], [\* /intro(\* , \* , \* )], [\* /bothintro(\* , \* , \* , \* , \* )],  
[\* /nameintro(\* , \* , \* , \* )], [\* '], [\* [\* ]], [\* [\* → \* ]], [\* [\* ⇒ \* ]], [\* 0], [\* 1], [0b], [\* -color(\* )],  
[\* -color<sup>\*</sup>(\* )], [\* <sup>H</sup>], [\* <sup>T</sup>], [\* <sup>U</sup>], [\* <sup>h</sup>], [\* <sup>t</sup>], [\* <sup>s</sup>], [\* <sup>c</sup>], [\* <sup>d</sup>], [\* <sup>a</sup>], [\* <sup>C</sup>], [\* <sup>M</sup>], [\* <sup>B</sup>], [\* <sup>r</sup>], [\* <sup>i</sup>],  
[\* <sup>d</sup>], [\* <sup>R</sup>], [\* <sup>0</sup>], [\* <sup>1</sup>], [\* <sup>2</sup>], [\* <sup>3</sup>], [\* <sup>4</sup>], [\* <sup>5</sup>], [\* <sup>6</sup>], [\* <sup>7</sup>], [\* <sup>8</sup>], [\* <sup>9</sup>], [\* <sup>E</sup>], [\* <sup>v</sup>], [\* <sup>C</sup>], [\* <sup>C\*</sup>];

### Preassociative

[" \* "], [], [(\*)<sup>t</sup>], [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 \* ], [ [ \* ], [ \ \* ], [ ] \* ], [ ^ \* ],

[-\*], [‘\*], [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**

[\* · \*], [\* ·<sub>0</sub> \*];

**Preassociative**

[\* + \*], [\* +<sub>0</sub> \*], [\* +<sub>1</sub> \*], [\* - \*], [\* -<sub>0</sub> \*], [\* -<sub>1</sub> \*];

**Preassociative**

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

**Postassociative**

[\* . : \*], [\* . :<sub>1</sub> \*], [\* : : \*], [\* +2\* \*], [\* : : \*], [\* +2\* \*];

**Postassociative**

[\* , \*];

**Preassociative**

[\*  $\overset{B}{\sim}$  \*], [\*  $\overset{D}{\sim}$  \*], [\*  $\overset{C}{\sim}$  \*], [\*  $\overset{P}{\sim}$  \*], [\*  $\overset{Q}{\sim}$  \*], [\* = \*], [\*  $\overset{\dagger}{\rightarrow}$  \*], [\*  $\overset{t}{\leftarrow}$  \*], [\*  $\overset{t^*}{\leftarrow}$  \*], [\*  $\overset{r}{\leftarrow}$  \*],  
 [\*  $\in_t$  \*], [\*  $\subseteq_T$  \*], [\*  $\overset{T}{\equiv}$  \*], [\*  $\overset{s}{\equiv}$  \*], [\* free in \*], [\* free in\* \*], [\* free for \* in \*],  
 [\* free for\* \* in \*], [\*  $\in_c$  \*], [\* < \*], [\* <’ \*], [\*  $\leq'$  \*];

**Preassociative**

[¬\*];

**Preassociative**

[\* ∧ \*], [\*  $\overset{\sim}{\wedge}$  \*], [\*  $\overset{\sim}{\wedge}$  \*], [\*  $\wedge_c$  \*];

**Preassociative**

[\* ∨ \*], [\* || \*], [\*  $\overset{\sim}{\vee}$  \*];

**Postassociative**

[\*  $\overset{\sim}{\Rightarrow}$  \*];

**Postassociative**

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

**Preassociative**

[\*  $\left\{ \begin{array}{l} * \\ * \end{array} \right.$ ];

**Preassociative**

[λ \* . \*], [Λ \* . \*], [Λ \*], [if \* then \* else \*], [let \* = \* in \*], [let \*  $\overset{\sim}{=}$  \* in \*];

**Preassociative**

[\*<sup>I</sup>], [\*<sup>▷</sup>], [\*<sup>V</sup>], [\*<sup>+</sup>], [\*<sup>-</sup>], [\*<sup>\*</sup>];

**Preassociative**

[\* @ \*], [\* ▷ \*], [\*  $\overset{\sim}{\triangleright}$  \*], [\*  $\gg$  \*];

**Postassociative**

[\* ⊢ \*], [\* ⊢\* \*], [\* i.e. \*];

**Preassociative**

[∀\* : \*];

**Postassociative**

[\* ⊕ \*];

## Postassociative

[\*, \*];

## Preassociative

[\* proves \*];

## Preassociative

[\* **proof of** \* : \*], [Line \* : \*  $\gg$  \*; \*], [Last line \*  $\gg$  \*  $\square$ ],  
[Line \* : Premise  $\gg$  \*; \*], [Line \* : Side-condition  $\gg$  \*; \*], [Arbitrary  $\gg$  \*; \*],  
[Local  $\gg$  \* = \*; \*];

## Postassociative

[\* , \*], [\* [\* ]\*];

## Preassociative

[\*&\*];

## Preassociative

[\* \\ \*], [\* linebreak[4] \*];]

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

[base  $\xrightarrow{\text{claim}}$  checker  $\wedge_c$  verifier]

[base  $\xrightarrow{\text{pyk}}$  “base”]

[\*  $\bowtie$  \*]

Predef: proclaim

```
[[x  $\bowtie$  y]  $\xrightarrow{\text{tex}}$  “  
[#1/tex name/tex.  
\bowtie#2.  
]”]
```

[[\*  $\bowtie$  \*]  $\xrightarrow{\text{pyk}}$  “proclaim " as " end proclaim”]

“ \* ”

Predef: hide

```
[“x”  $\xrightarrow{\text{name}}$  “  
\mbox{“}#1.  
\mbox{”}”]
```

[“x”  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.t$ ]

[“x”  $\xrightarrow{\text{tex}}$  “#1.”]

[“ \* ”  $\xrightarrow{\text{pyk}}$  “unicode start of text " end unicode text”]

[ $\xrightarrow{\text{tex}}$  “”]

[ $\xrightarrow{\text{pyk}}$  “unicode end of text”]

\* , \*

[ $x, y \xrightarrow{\text{name}}$  “#1.  
 $\mathrel{\{\}}\#2.$ ”]

[ $x, y \xrightarrow{\text{val}}$  “[\*\*]<sup>R</sup> :: x :: y :: T

[ $x, y \xrightarrow{\text{tex}}$  “#1.#2.”]

[ $*, * \xrightarrow{\text{pyk}}$  “” , ””]

\* [ \* ] \*

[ $x[y]z \xrightarrow{\text{name}}$  “#1.  
{ } #2.  
{ } #3.”]

[ $x[y]z \xrightarrow{\text{tex}}$  “#1.#2.#3.”]

[ $* [ * ] * \xrightarrow{\text{pyk}}$  “” [ ” ] ””]

## Preassociative \*; \*

Predef: pre

[**Preassociative**  $x; y \xrightarrow{\text{name}}$  “  
 $\mathbf{\{Preassociative\}}$ ”, #1.  
; #2.”]

[**Preassociative**  $x; y \xrightarrow{\text{tex}}$  “  
 $\mathbf{\{Preassociative\}}$  \newline #1.  
; #2.”]

[**Preassociative** \*; \*  $\xrightarrow{\text{pyk}}$  “preassociative " greater than ””]

## Postassociative \*; \*

Predef: post

[**Postassociative** x; y  $\xrightarrow{\text{name}}$  “  
 $\mathbf{\{Postassociative\}}$ ”, #1.  
; #2.”]

[**Postassociative** x; y  $\xrightarrow{\text{tex}}$  “  
 $\mathbf{\{Postassociative\}}$  \newline #1.  
; #2.”]

[**Postassociative** \*; \*  $\xrightarrow{\text{pyk}}$  “postassociative " greater than " ]

[\*], \*

[[x], y  $\xrightarrow{\text{name}}$  “  
[#1.  
], \linebreak [0] #2.”]

[[x], y  $\xrightarrow{\text{tex}}$  “  
[#1/tex name/tex.  
], \linebreak [0] #2.”]

[[\*], \*  $\xrightarrow{\text{pyk}}$  “priority " equal " ]

priority \* end

[priority x end  $\xrightarrow{\text{name}}$  “  
 $\mathbf{\{priority\}}$  \, #1.  
\\, \mathbf{\{end\}}”]

[priority x end  $\xrightarrow{\text{tex}}$  “  
[#1/tex name/tex.  
]”]

[priority \* end  $\xrightarrow{\text{pyk}}$  “priority " end priority”]

\*

[  
x  $\xrightarrow{\text{name}}$  “  
\newline #1.”]

[  
x  $\xrightarrow{\text{tex}}$  “  
#1.”]

[  
\*  $\xrightarrow{\text{pyk}}$  “unicode newline ”]

\*

[\*  $\xrightarrow{\text{tex}}$  “  
\ast ”]

[\*  $\xrightarrow{\text{pyk}}$  “x”]

(\*)<sup>t</sup>

[(x)<sup>t</sup>  $\xrightarrow{\text{name}}$  “  
(#1.  
)<sup>^</sup>{\bf t}”]

[(x)<sup>t</sup>  $\xrightarrow{\text{val}}$  [\*]<sup>R</sup> :: x :: T]

[(x)<sup>t</sup>  $\xrightarrow{\text{tex}}$  “#1/tex name.”]

[(\*)<sup>t</sup>  $\xrightarrow{\text{pyk}}$  “text " end text”]

**string**(\*) + \*

[string(x) + y  $\xrightarrow{\text{name}}$  “  
\mbox{string}(#1.  
)+#2.”]

[string(x) + y  $\xrightarrow{\text{tex}}$  “  
\mathrm{#1/tex name.  
}+\newline#2.”]

[string(\*) + \*  $\xrightarrow{\text{pyk}}$  “text " plus ”]

**string**(\*) ++ \*

[string(x) ++ y  $\xrightarrow{\text{name}}$  “\mbox{string}(#1.  
)\mathrel{++}#2.”]

[string(x) ++ y  $\xrightarrow{\text{tex}}$  “  
\mathrm{#1/tex name.  
}\};{++}\newline{\}\quad#2.”]



[string(\*) ++ \*  $\xrightarrow{\text{pyk}}$  “text " plus indent ""]

## pyk

Predef: pyk

[pyk  $\xrightarrow{\text{tex}}$  “  
 $\mathrm{\{pyk\}}$ ”]

[pyk  $\xrightarrow{\text{pyk}}$  “pyk”]

[\*  $\xrightarrow{*}$  \*]

Predef: define

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

[[\*  $\xrightarrow{*}$  \*]  $\xrightarrow{\text{pyk}}$  “define " of " as " end define”]

\* linebreak[4] \*

[x linebreak[4] y  $\xrightarrow{\text{name}}$  “#1.  
 $\mathrel{\{linebreak[4]\}} \#2.$ ”]

[x linebreak[4] y  $\xrightarrow{\text{tex}}$  “#1.  
 $\linebreak[4] \#2.$ ”]

[\* linebreak[4] \*  $\xrightarrow{\text{pyk}}$  “" linebreak "”]

## bracket \* end bracket

[bracket x end bracket  $\xrightarrow{\text{name}}$  “  
 $\mbox{\{bracket \$\#1.\$ end bracket\}}$ ”]

[bracket x end bracket  $\xrightarrow{\text{tex}}$  “ $\{[\#1.]$ ”]

[bracket \* end bracket  $\xrightarrow{\text{pyk}}$  “bracket " end bracket”]

## big bracket \* end bracket

[big bracket x end bracket  $\xrightarrow{\text{name}}$  “

\mbox{big bracket \$#1.\$ end bracket}”]

[big bracket x end bracket  $\xrightarrow{\text{tex}}$  “ $\left[ \#1. \right]$ ”]

[big bracket \* end bracket  $\xrightarrow{\text{pyk}}$  “big bracket " end bracket”]

$\$ * \$$

[ $\$x\$$   $\xrightarrow{\text{name}}$  “

\ \#1.\\$ \linebreak[0]\ ”]

[ $\$x\$$   $\xrightarrow{\text{tex}}$  “ $\#1.\$$ ”]

[ $\$ * \$$   $\xrightarrow{\text{pyk}}$  “math " end math”]

## flush left [\*]

[flush left [x]  $\xrightarrow{\text{name}}$  “

\mathbf{flush\ left\ } [ \#1.

]”]

[flush left [x]  $\xrightarrow{\text{tex}}$  “

\begin {flushleft} \#1.

\end {flushleft}”]

[flush left [\*]  $\xrightarrow{\text{pyk}}$  “flush left " end left”]

x

[x  $\xrightarrow{\text{tex}}$  “

\mathsf{x}”]

[x  $\xrightarrow{\text{pyk}}$  “var x”]

y

[y  $\xrightarrow{\text{tex}}$  “

\mathsf{y}”]

[y  $\xrightarrow{\text{pyk}}$  “var y”]

## Z

[z  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathrm{z}$ ”]

[z  $\xrightarrow{\text{pyk}}$  “var z”]

## tex

Predef: tex

[tex  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathrm{tex}$ ”]

[tex  $\xrightarrow{\text{pyk}}$  “tex”]

## name

Predef: texname

[name  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathrm{name}$ ”]

[name  $\xrightarrow{\text{pyk}}$  “tex name”]

## prio

Predef: priority

[prio  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathrm{prio}$ ”]

[prio  $\xrightarrow{\text{pyk}}$  “priority”]

## T

Predef: true

[T  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathrm{T}$ ”]

[T  $\xrightarrow{\text{pyk}}$  “true”]

if(\*, \*, \*)

Predef: if

```
[if(*, *, *)  $\xrightarrow{\text{tex}}$  “  
\mathrm {if}(\#1.  
, \linebreak [0]\#2.  
, \linebreak [0]\#3.  
)”]
```

```
[if(*, *, *)  $\xrightarrow{\text{pyk}}$  “if " then " else " end if”]
```

[\*  $\xRightarrow{*}$  \*]

Predef: introduce

```
[[*  $\xRightarrow{*}$  *]  $\xrightarrow{\text{tex}}$  “  
[\#2/tex name/tex.  
\stackrel{\#1.  
}{\Rightarrow} \#3.  
]”]
```

```
[[*  $\xRightarrow{*}$  *]  $\xrightarrow{\text{pyk}}$  “introduce " of " as " end introduce”]
```

val

Predef: value

```
[val  $\xrightarrow{\text{tex}}$  “  
\mathrm {val}”]
```

```
[val  $\xrightarrow{\text{pyk}}$  “value”]
```

\*

```
[x  $\xrightarrow{\text{name}}$  “  
\linebreak [0]\ \hspace{2.0em}\#1.”]
```

```
[x  $\xrightarrow{\text{tex}}$  “ \#1.”]
```

```
[*  $\xrightarrow{\text{pyk}}$  “unicode space ”]
```

!\*

[!x  $\xrightarrow{\text{tex}}$  “!#1.”]

[!\*  $\xrightarrow{\text{pyk}}$  “unicode exclamation mark ”]

"\*

["x  $\xrightarrow{\text{name}}$  “  
\mbox {\tt \char34}#1.”]

["x  $\xrightarrow{\text{tex}}$  “" #1.”]

["\*  $\xrightarrow{\text{pyk}}$  “unicode quotation mark ”]

#\*

[#x  $\xrightarrow{\text{name}}$  “  
\#.#1.”]

[#x  $\xrightarrow{\text{tex}}$  “#.#1.”]

[#\*  $\xrightarrow{\text{pyk}}$  “unicode number sign ”]

\$\*

[\$x  $\xrightarrow{\text{name}}$  “  
\\$#1.”]

[\$x  $\xrightarrow{\text{tex}}$  “\$#1.”]

[\$\*  $\xrightarrow{\text{pyk}}$  “unicode dollar sign ”]

%\*

[%x  $\xrightarrow{\text{name}}$  “  
\%#1.”]

[%x  $\xrightarrow{\text{tex}}$  “%#1.”]

[%\*  $\xrightarrow{\text{pyk}}$  “unicode percent ”]

&\*

[&x  $\xrightarrow{\text{name}}$  “  
\&#1.”]

[&x  $\xrightarrow{\text{tex}}$  “&#1.”]

[&\*  $\xrightarrow{\text{pyk}}$  “unicode ampersand ”]

'\*

[x  $\xrightarrow{\text{name}}$  “  
\mbox {'}#1.”]

[x  $\xrightarrow{\text{tex}}$  “' #1.”]

[\*  $\xrightarrow{\text{pyk}}$  “unicode apostrophe ”]

(\*

[(x  $\xrightarrow{\text{tex}}$  “(#1.”]

[(\*  $\xrightarrow{\text{pyk}}$  “unicode left parenthesis ”]

)\*

[(x  $\xrightarrow{\text{tex}}$  “)#1.”]

[(\*)  $\xrightarrow{\text{pyk}}$  “unicode right parenthesis ”]

\*\*

[\*x  $\xrightarrow{\text{name}}$  “  
{\*}#1.”]

[\*x  $\xrightarrow{\text{tex}}$  “\*#1.”]

[\*\*  $\xrightarrow{\text{pyk}}$  “unicode asterisk ”]

+\*

[+x  $\xrightarrow{\text{name}}$  “  
{+}#1.”]

[+x  $\xrightarrow{\text{tex}}$  “+ #1.”]

[+\*  $\xrightarrow{\text{pyk}}$  “unicode plus sign ”]

,\*

[,x  $\xrightarrow{\text{tex}}$  “, #1.”]

[,\*  $\xrightarrow{\text{pyk}}$  “unicode comma ”]

-\*

[-x  $\xrightarrow{\text{name}}$  “  
\mbox{-}#1.”]

[-x  $\xrightarrow{\text{tex}}$  “- #1.”]

[-\*  $\xrightarrow{\text{pyk}}$  “unicode hyphen ”]

.\*

[.x  $\xrightarrow{\text{tex}}$  “. #1.”]

[.\*  $\xrightarrow{\text{pyk}}$  “unicode period ”]

/\*

[/x  $\xrightarrow{\text{tex}}$  “/ #1.”]

[/\*  $\xrightarrow{\text{pyk}}$  “unicode slash ”]

0\*

[0x  $\xrightarrow{\text{tex}}$  “0 #1.”]

[0\*  $\xrightarrow{\text{pyk}}$  “unicode zero ”]

1\*

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

[1\*  $\xrightarrow{\text{pyk}}$  "unicode one ""]

2\*

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

[2\*  $\xrightarrow{\text{pyk}}$  "unicode two ""]

3\*

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

[3\*  $\xrightarrow{\text{pyk}}$  "unicode three ""]

4\*

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

[4\*  $\xrightarrow{\text{pyk}}$  "unicode four ""]

5\*

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

[5\*  $\xrightarrow{\text{pyk}}$  "unicode five ""]

6\*

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

[6\*  $\xrightarrow{\text{pyk}}$  "unicode six ""]

7\*

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



[7\*  $\xrightarrow{\text{pyk}}$  “unicode seven ”]

8\*

[8x  $\xrightarrow{\text{tex}}$  “8#1.”]

[8\*  $\xrightarrow{\text{pyk}}$  “unicode eight ”]

9\*

[9x  $\xrightarrow{\text{tex}}$  “9#1.”]

[9\*  $\xrightarrow{\text{pyk}}$  “unicode nine ”]

:\*

[ :x  $\xrightarrow{\text{name}}$  “  
{:}#1.”]

[ :x  $\xrightarrow{\text{tex}}$  “:#1.”]

[ :\*  $\xrightarrow{\text{pyk}}$  “unicode colon ”]

;\*

[ ;x  $\xrightarrow{\text{tex}}$  “; #1.”]

[ ;\*  $\xrightarrow{\text{pyk}}$  “unicode semicolon ”]

<\*

[ <x  $\xrightarrow{\text{name}}$  “  
{<}#1.”]

[ <x  $\xrightarrow{\text{tex}}$  “<#1.”]

[ <\*  $\xrightarrow{\text{pyk}}$  “unicode less than ”]

=\*

[=x  $\xrightarrow{\text{name}}$  “  
{=}#1.”]

[=x  $\xrightarrow{\text{tex}}$  “=#1.”]

[=\*  $\xrightarrow{\text{pyk}}$  “unicode equal sign ”]

>\*

[>x  $\xrightarrow{\text{name}}$  “  
{>}#1.”]

[>x  $\xrightarrow{\text{tex}}$  “>#1.”]

[>\*  $\xrightarrow{\text{pyk}}$  “unicode greater than ”]

?\*

[?x  $\xrightarrow{\text{tex}}$  “?#1.”]

[?\*  $\xrightarrow{\text{pyk}}$  “unicode question mark ”]

@\*

[@x  $\xrightarrow{\text{tex}}$  “@#1.”]

[@\*  $\xrightarrow{\text{pyk}}$  “unicode commercial at ”]

A\*

[Ax  $\xrightarrow{\text{tex}}$  “A#1.”]

[A\*  $\xrightarrow{\text{pyk}}$  “unicode capital a ”]

B\*

[Bx  $\xrightarrow{\text{tex}}$  “B#1.”]

[B\*  $\xrightarrow{\text{pyk}}$  “unicode capital b ”]

C\*

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

[C\*  $\xrightarrow{\text{pyk}}$  "unicode capital c ""]

D\*

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

[D\*  $\xrightarrow{\text{pyk}}$  "unicode capital d ""]

E\*

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

[E\*  $\xrightarrow{\text{pyk}}$  "unicode capital e ""]

F\*

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

[F\*  $\xrightarrow{\text{pyk}}$  "unicode capital f ""]

G\*

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

[G\*  $\xrightarrow{\text{pyk}}$  "unicode capital g ""]

H\*

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

[H\*  $\xrightarrow{\text{pyk}}$  "unicode capital h ""]

I\*

[Ix  $\xrightarrow{\text{tex}}$  "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  $\xrightarrow{\text{tex}}$  "P#1."]

[P\*  $\xrightarrow{\text{pyk}}$  "unicode capital p ""]

Q\*

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

[Q\*  $\xrightarrow{\text{pyk}}$  "unicode capital q ""]

R\*

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

[R\*  $\xrightarrow{\text{pyk}}$  "unicode capital r ""]

S\*

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

[S\*  $\xrightarrow{\text{pyk}}$  "unicode capital s ""]

T\*

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

[T\*  $\xrightarrow{\text{pyk}}$  "unicode capital t ""]

U\*

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

[U\*  $\xrightarrow{\text{pyk}}$  "unicode capital u ""]

V\*

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

[V\*  $\xrightarrow{\text{pyk}}$  “unicode capital v ”]

W\*

[Wx  $\xrightarrow{\text{tex}}$  “W#1.”]

[W\*  $\xrightarrow{\text{pyk}}$  “unicode capital w ”]

X\*

[Xx  $\xrightarrow{\text{tex}}$  “X#1.”]

[X\*  $\xrightarrow{\text{pyk}}$  “unicode capital x ”]

Y\*

[Yx  $\xrightarrow{\text{tex}}$  “Y#1.”]

[Y\*  $\xrightarrow{\text{pyk}}$  “unicode capital y ”]

Z\*

[Zx  $\xrightarrow{\text{tex}}$  “Z#1.”]

[Z\*  $\xrightarrow{\text{pyk}}$  “unicode capital z ”]

[\*

[[x  $\xrightarrow{\text{tex}}$  “[#1.”]

[[\*  $\xrightarrow{\text{pyk}}$  “unicode left bracket ”]

\\*

[\x  $\xrightarrow{\text{name}}$  “  
\mbox {\$\backslash}\$}#1.”]

[\x  $\xrightarrow{\text{tex}}$  “\#1.”]

[\\*  $\xrightarrow{\text{pyk}}$  “unicode backslash ”]

]\*

[x  $\xrightarrow{\text{tex}}$  “]#1.”]

[\*  $\xrightarrow{\text{pyk}}$  “unicode right bracket ”]

^\*

[^x  $\xrightarrow{\text{name}}$  “  
{\char94}#1.”]

[^x  $\xrightarrow{\text{tex}}$  “^#1.”]

[^\*  $\xrightarrow{\text{pyk}}$  “unicode circumflex ”]

\_\*

[\_x  $\xrightarrow{\text{name}}$  “  
\\_#1.”]

[\_x  $\xrightarrow{\text{tex}}$  “\_#1.”]

[\_\*  $\xrightarrow{\text{pyk}}$  “unicode underscore ”]

‘\*

[‘x  $\xrightarrow{\text{name}}$  “  
\mbox {‘}#1.”]

[‘x  $\xrightarrow{\text{tex}}$  “‘#1.”]

[‘\*  $\xrightarrow{\text{pyk}}$  “unicode grave accent ”]

a\*

[ax  $\xrightarrow{\text{tex}}$  “a#1.”]

[a\*  $\xrightarrow{\text{pyk}}$  “unicode small a ”]

b\*

[bx  $\xrightarrow{\text{tex}}$  “b#1.”]

$[b* \xrightarrow{\text{pyk}} \text{"unicode small b "}]$

**c\***

$[cx \xrightarrow{\text{tex}} \text{"c\#1."}]$

$[c* \xrightarrow{\text{pyk}} \text{"unicode small c "}]$

**d\***

$[dx \xrightarrow{\text{tex}} \text{"d\#1."}]$

$[d* \xrightarrow{\text{pyk}} \text{"unicode small d "}]$

**e\***

$[ex \xrightarrow{\text{tex}} \text{"e\#1."}]$

$[e* \xrightarrow{\text{pyk}} \text{"unicode small e "}]$

**f\***

$[fx \xrightarrow{\text{tex}} \text{"f\#1."}]$

$[f* \xrightarrow{\text{pyk}} \text{"unicode small f "}]$

**g\***

$[gx \xrightarrow{\text{tex}} \text{"g\#1."}]$

$[g* \xrightarrow{\text{pyk}} \text{"unicode small g "}]$

**h\***

$[hx \xrightarrow{\text{tex}} \text{"h\#1."}]$

$[h* \xrightarrow{\text{pyk}} \text{"unicode small h "}]$



**i\***

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

[i\*  $\xrightarrow{\text{pyk}}$  "unicode small i ""]

**j\***

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

[j\*  $\xrightarrow{\text{pyk}}$  "unicode small j ""]

**k\***

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

[k\*  $\xrightarrow{\text{pyk}}$  "unicode small k ""]

**l\***

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

[l\*  $\xrightarrow{\text{pyk}}$  "unicode small l ""]

**m\***

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

[m\*  $\xrightarrow{\text{pyk}}$  "unicode small m ""]

**n\***

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

[n\*  $\xrightarrow{\text{pyk}}$  "unicode small n ""]

**O\***

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

$[o^* \xrightarrow{\text{pyk}} \text{“unicode small o ”}]$

**p\***

$[px \xrightarrow{\text{tex}} \text{“p\#1.”}]$

$[p^* \xrightarrow{\text{pyk}} \text{“unicode small p ”}]$

**q\***

$[qx \xrightarrow{\text{tex}} \text{“q\#1.”}]$

$[q^* \xrightarrow{\text{pyk}} \text{“unicode small q ”}]$

**r\***

$[rx \xrightarrow{\text{tex}} \text{“r\#1.”}]$

$[r^* \xrightarrow{\text{pyk}} \text{“unicode small r ”}]$

**s\***

$[sx \xrightarrow{\text{tex}} \text{“s\#1.”}]$

$[s^* \xrightarrow{\text{pyk}} \text{“unicode small s ”}]$

**t\***

$[tx \xrightarrow{\text{tex}} \text{“t\#1.”}]$

$[t^* \xrightarrow{\text{pyk}} \text{“unicode small t ”}]$

**u\***

$[ux \xrightarrow{\text{tex}} \text{“u\#1.”}]$

$[u^* \xrightarrow{\text{pyk}} \text{“unicode small u ”}]$

V\*

[vx  $\xrightarrow{\text{tex}}$  “v#1.”]

[v\*  $\xrightarrow{\text{pyk}}$  “unicode small v ”]

W\*

[wx  $\xrightarrow{\text{tex}}$  “w#1.”]

[w\*  $\xrightarrow{\text{pyk}}$  “unicode small w ”]

X\*

[xx  $\xrightarrow{\text{tex}}$  “x#1.”]

[x\*  $\xrightarrow{\text{pyk}}$  “unicode small x ”]

Y\*

[yx  $\xrightarrow{\text{tex}}$  “y#1.”]

[y\*  $\xrightarrow{\text{pyk}}$  “unicode small y ”]

Z\*

[zx  $\xrightarrow{\text{tex}}$  “z#1.”]

[z\*  $\xrightarrow{\text{pyk}}$  “unicode small z ”]

{\*

[{x  $\xrightarrow{\text{name}}$  “  
\{#1.”]

[{x  $\xrightarrow{\text{tex}}$  “{#1.”]

[{\*  $\xrightarrow{\text{pyk}}$  “unicode left brace ”]

|\*

[|x  $\xrightarrow{\text{tex}}$  “|#1.”]

[|\*  $\xrightarrow{\text{pyk}}$  “unicode vertical line ”]

}\*

[}x  $\xrightarrow{\text{name}}$  “  
\}#1.”]

[}x  $\xrightarrow{\text{tex}}$  “}#1.”]

[}\*  $\xrightarrow{\text{pyk}}$  “unicode right brace ”]

~\*

[~x  $\xrightarrow{\text{name}}$  “  
\char126 #1.”]

[~x  $\xrightarrow{\text{tex}}$  “~#1.”]

[~\*  $\xrightarrow{\text{pyk}}$  “unicode tilde ”]

## claim

Predef: claim

[claim  $\xrightarrow{\text{tex}}$  “  
\mathrm {claim}”]

[claim  $\xrightarrow{\text{pyk}}$  “claim”]

⊥

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

[⊥  $\xrightarrow{\text{tex}}$  “  
\bot ”]

[⊥  $\xrightarrow{\text{pyk}}$  “bottom”]

**f**(\*)

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

[f(\*)  $\xrightarrow{\text{tex}}$  “

f(#1.

)”]

[f(\*)  $\xrightarrow{\text{pyk}}$  “function f of " end function”]

(\*)<sup>I</sup>

[(x)<sup>I</sup>  $\xrightarrow{\text{val}}$  x]

[(\*)<sup>I</sup>  $\xrightarrow{\text{tex}}$  “

(#1.

){}^{\{I\}} ”]

[(\*)<sup>I</sup>  $\xrightarrow{\text{pyk}}$  “identity " end identity”]

**F**

[F  $\xrightarrow{\text{val}}$  T ∴ T]

[F  $\xrightarrow{\text{tex}}$  “

\mathsf {F}”]

[F  $\xrightarrow{\text{pyk}}$  “false”]

0

[0  $\xrightarrow{\text{val}}$  T]

[0  $\xrightarrow{\text{tex}}$  “

\underline {0}”]

[0  $\xrightarrow{\text{pyk}}$  “untagged zero”]

1

[1  $\xrightarrow{\text{val}}$  F +2\* 0]

[1  $\xrightarrow{\text{tex}}$  “  
`\underline {1}`”]

[1  $\xrightarrow{\text{pyk}}$  “untagged one”]

2

[2  $\xrightarrow{\text{val}}$  T +2\* 1]

[2  $\xrightarrow{\text{tex}}$  “  
`\underline {2}`”]

[2  $\xrightarrow{\text{pyk}}$  “untagged two”]

3

[3  $\xrightarrow{\text{val}}$  F +2\* 1]

[3  $\xrightarrow{\text{tex}}$  “  
`\underline {3}`”]

[3  $\xrightarrow{\text{pyk}}$  “untagged three”]

4

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

[4  $\xrightarrow{\text{tex}}$  “  
`\underline {4}`”]

[4  $\xrightarrow{\text{pyk}}$  “untagged four”]

5

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

[5  $\xrightarrow{\text{tex}}$  “  
`\underline {5}`”]

[5  $\xrightarrow{\text{pyk}}$  “untagged five”]

## 6

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

[6  $\xrightarrow{\text{tex}}$  “  
\underline {6}”]

[6  $\xrightarrow{\text{pyk}}$  “untagged six”]

## 7

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

[7  $\xrightarrow{\text{tex}}$  “  
\underline {7}”]

[7  $\xrightarrow{\text{pyk}}$  “untagged seven”]

## 8

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

[8  $\xrightarrow{\text{tex}}$  “  
\underline {8}”]

[8  $\xrightarrow{\text{pyk}}$  “untagged eight”]

## 9

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

[9  $\xrightarrow{\text{tex}}$  “  
\underline {9}”]

[9  $\xrightarrow{\text{pyk}}$  “untagged nine”]

## 0

[0  $\xrightarrow{\text{val}}$  T ∴ T]

[0  $\xrightarrow{\text{tex}}$  “  
0”]

[0  $\xrightarrow{\text{pyk}}$  “zero”]

1

[1  $\xrightarrow{\text{val}}$  F +2\* 0]

[1  $\xrightarrow{\text{tex}}$  “  
1”]

[1  $\xrightarrow{\text{pyk}}$  “one”]

2

[2  $\xrightarrow{\text{val}}$  T +2\* 1]

[2  $\xrightarrow{\text{tex}}$  “  
2”]

[2  $\xrightarrow{\text{pyk}}$  “two”]

3

[3  $\xrightarrow{\text{val}}$  F +2\* 1]

[3  $\xrightarrow{\text{tex}}$  “  
3”]

[3  $\xrightarrow{\text{pyk}}$  “three”]

4

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

[4  $\xrightarrow{\text{tex}}$  “  
4”]

[4  $\xrightarrow{\text{pyk}}$  “four”]

5

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



[5  $\xrightarrow{\text{tex}}$  “  
5”]

[5  $\xrightarrow{\text{pyk}}$  “five”]

6

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

[6  $\xrightarrow{\text{tex}}$  “  
6”]

[6  $\xrightarrow{\text{pyk}}$  “six”]

7

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

[7  $\xrightarrow{\text{tex}}$  “  
7”]

[7  $\xrightarrow{\text{pyk}}$  “seven”]

8

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

[8  $\xrightarrow{\text{tex}}$  “  
8”]

[8  $\xrightarrow{\text{pyk}}$  “eight”]

9

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

[9  $\xrightarrow{\text{tex}}$  “  
9”]

[9  $\xrightarrow{\text{pyk}}$  “nine”]

**a**

[a  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{a\}$ ”]

[a  $\xrightarrow{\text{pyk}}$  “var a”]

**b**

[b  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{b\}$ ”]

[b  $\xrightarrow{\text{pyk}}$  “var b”]

**c**

[c  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{c\}$ ”]

[c  $\xrightarrow{\text{pyk}}$  “var c”]

**d**

[d  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{d\}$ ”]

[d  $\xrightarrow{\text{pyk}}$  “var d”]

**e**

[e  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{e\}$ ”]

[e  $\xrightarrow{\text{pyk}}$  “var e”]

**f**

[f  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{f\}$ ”]

[f  $\xrightarrow{\text{pyk}}$  “var f”]

## g

[g  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathsf{g}$ ”]

[g  $\xrightarrow{\text{pyk}}$  “var g”]

## h

[h  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathsf{h}$ ”]

[h  $\xrightarrow{\text{pyk}}$  “var h”]

## i

[i  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathsf{i}$ ”]

[i  $\xrightarrow{\text{pyk}}$  “var i”]

## j

[j  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathsf{j}$ ”]

[j  $\xrightarrow{\text{pyk}}$  “var j”]

## k

[k  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathsf{k}$ ”]

[k  $\xrightarrow{\text{pyk}}$  “var k”]

## l

[l  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathsf{l}$ ”]

[l  $\xrightarrow{\text{pyk}}$  “var l”]

## m

[m  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{m\}$ ”]

[m  $\xrightarrow{\text{pyk}}$  “var m”]

## n

[n  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{n\}$ ”]

[n  $\xrightarrow{\text{pyk}}$  “var n”]

## o

[o  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{o\}$ ”]

[o  $\xrightarrow{\text{pyk}}$  “var o”]

## p

[p  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{p\}$ ”]

[p  $\xrightarrow{\text{pyk}}$  “var p”]

## q

[q  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{q\}$ ”]

[q  $\xrightarrow{\text{pyk}}$  “var q”]

## r

[r  $\xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{r\}$ ”]

[r  $\xrightarrow{\text{pyk}}$  “var r”]

## S

[ $\text{s} \xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{s\}$ ”]

[ $\text{s} \xrightarrow{\text{pyk}}$  “var s”]

## t

[ $\text{t} \xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{t\}$ ”]

[ $\text{t} \xrightarrow{\text{pyk}}$  “var t”]

## u

[ $\text{u} \xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{u\}$ ”]

[ $\text{u} \xrightarrow{\text{pyk}}$  “var u”]

## v

[ $\text{v} \xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{v\}$ ”]

[ $\text{v} \xrightarrow{\text{pyk}}$  “var v”]

## w

[ $\text{w} \xrightarrow{\text{tex}}$  “  
 $\backslash\text{mathsf}\{w\}$ ”]

[ $\text{w} \xrightarrow{\text{pyk}}$  “var w”]

$(*)^M$

[ $(x)^M \xrightarrow{\text{val}} x^M$ ]

[ $(*)^M \xrightarrow{\text{tex}}$  “

(#1.

)^M”]

[(\*)<sup>M</sup> <sup>pyk</sup> “tagged parenthesis " end tagged”]

If(\*, \*, \*)

[If(x, y, z) <sup>val</sup> if(x<sup>M</sup>, y<sup>M</sup>, z<sup>M</sup>)]

[If(\*, \*, \*) <sup>tex</sup> “  
\mathrm {If}(\#1.  
, \linebreak [0]#2.  
, \linebreak [0]#3.  
)”]

[If(\*, \*, \*) <sup>pyk</sup> “tagged if " then " else " end if”]

array{\*} \* end array

[array{\*} \* end array <sup>name</sup> “\mathrm {array}\{\#1.  
\}\#2.  
\mathrm {end\ array}”]

[array{\*} \* end array <sup>tex</sup> “  
\begin {array}\{\#1.  
\}\#2.  
\end {array}”]

[array{\*} \* end array <sup>pyk</sup> “array " is " end array”]

l

[l <sup>tex</sup> “  
l”]

[l <sup>pyk</sup> “left”]

c

[c <sup>tex</sup> “  
c”]

[c <sup>pyk</sup> “center”]

**I**

[r  $\xrightarrow{\text{tex}}$  “  
r”]

[r  $\xrightarrow{\text{pyk}}$  “right”]

**empty**

[empty  $\xrightarrow{\text{name}}$  “  
\mathrm {empty}”]

[empty  $\xrightarrow{\text{tex}}$  “  
”]

[empty  $\xrightarrow{\text{pyk}}$  “empty”]

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

[ $\langle * \mid * := * \rangle$   $\xrightarrow{\text{tex}}$  “  
\langle #1.  
\, \{ \} #2.  
\{ := \} \, \, #3.  
\rangle ”]

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

$\mathcal{M}(*)$

[ $\mathcal{M}(x)$   $\xrightarrow{\text{val}}$   $(\underline{0} \dot{\vdash} \underline{1} \dot{\vdash} T)^I \dot{\vdash} x$ ]

[ $\mathcal{M}(*)$   $\xrightarrow{\text{tex}}$  “  
\cal M}{#1.  
)”]

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

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

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

$[\tilde{\mathcal{U}}(*) \xrightarrow{\text{tex}} “$   
 $\backslash\tilde{\text{cal}} \{\{\backslash\text{cal } \mathcal{U}\}\}(\#1.$   
 $)”]$

$[\tilde{\mathcal{U}}(*) \xrightarrow{\text{pyk}} “\text{raw map untag " end untag}”]$

$\mathcal{U}(*)$

$[\mathcal{U}(x) \xrightarrow{\text{val}} \tilde{\mathcal{U}}(x^M)]$

$[\mathcal{U}(*) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } \mathcal{U}\}(\#1.$   
 $)”]$

$[\mathcal{U}(*) \xrightarrow{\text{pyk}} “\text{map untag " end untag}”]$

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

$[\mathcal{U}^M(x) \xrightarrow{\text{val}} \mathcal{U}(x)^M]$

$[\mathcal{U}^M(*) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } \mathcal{U}\}^M(\#1.$   
 $)”]$

$[\mathcal{U}^M(*) \xrightarrow{\text{pyk}} “\text{normalizing untag " end untag}”]$

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

$[\mathbf{apply}(f, x) \xrightarrow{\text{val}} \mathbf{apply}_1(f^M, x^M)]$

$[\mathbf{apply}(*, *) \xrightarrow{\text{tex}} “$   
 $\backslash\mathbf{mathbf} \{\mathbf{apply}\}(\#1.$   
 $, \#2.$   
 $)”]$

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

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

$[\mathbf{apply}_1(f, x) \xrightarrow{\text{val}} \text{fd} \left\{ \begin{array}{l} \text{If}(x^d, f, f) \\ \text{If}(x^d, \mathcal{M}(f^T, x), \mathcal{M}(f^T, (x^T)^I)) \end{array} \right. ]$



[**apply**<sub>1</sub>(\*,\*)  $\xrightarrow{\text{tex}}$  “  
 $\backslash\mathbf{apply}\_1(\#1.$   
 $\#2.$   
 $)$ ”]

[**apply**<sub>1</sub>(\*,\*)  $\xrightarrow{\text{pyk}}$  “apply one " to " end apply”]

identifier(\*)

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

[identifier(x)  $\xrightarrow{\text{tex}}$  “  
 identifier( #1.  
 $)$ ”]

[identifier(\*)  $\xrightarrow{\text{pyk}}$  “identifier " end identifier”]

identifier<sub>1</sub>(\*,\*)

[identifier<sub>1</sub>(x,y)  $\xrightarrow{\text{val}}$  If( $x^6, y,$   
 $x^0 + 2*x^1 + 2*x^2 + 2*x^3 + 2*x^4 + 2*x^5 + 2*F + 2*T + 2*y$ )]

[identifier<sub>1</sub>(x,y)  $\xrightarrow{\text{tex}}$  “  
 identifier\_{1}( #1.  
 $\#2.$   
 $)$ ”]

[identifier<sub>1</sub>(\*,\*)  $\xrightarrow{\text{pyk}}$  “identifier one " plus id " end identifier”]

array-plus(\*,\*)

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

[array-plus(x,y)  $\xrightarrow{\text{tex}}$  “  
 array\mbox{-}\linebreak[0]plus( #1.  
 $\#2.$   
 $)$ ”]

[array-plus(\*,\*)  $\xrightarrow{\text{pyk}}$  “array plus " and " end plus”]

array-remove(\*, \*, \*)

[array-remove(i, a, l)  $\xrightarrow{\text{val}}$   
 $!!!\mathbf{a}^a \left\{ \begin{array}{l} \mathbf{T} \\ \mathbf{a}^{hc} \left\{ \begin{array}{l} \mathbf{a}^h \approx i \left\{ \begin{array}{l} \mathbf{T} \\ \mathbf{a} \end{array} \right. \\ \text{bit}(l, i) \left\{ \begin{array}{l} \text{array-plus}(\text{array-remove}(i, \mathbf{a}^h, l + 1), \mathbf{a}^t) \\ \text{array-plus}(\mathbf{a}^h, \text{array-remove}(i, \mathbf{a}^t, l + 1)) \end{array} \right. \end{array} \right. \end{array} \right. \right. ]$

[array-remove(i, a, l)  $\xrightarrow{\text{tex}}$  “  
array\mbox{-}\linebreak[0]remove( #1.  
, #2.  
, #3.  
)”]

[array-remove(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  “array remove " array " level " end remove”]

array-put(\*, \*, \*, \*)

[array-put(i, v, a, l)  $\xrightarrow{\text{val}}$   
 $!!\mathbf{a}^a \left\{ \begin{array}{l} i :: \mathbf{v} \\ \mathbf{a}^{hc} \left\{ \begin{array}{l} \mathbf{a}^h \approx i \left\{ \begin{array}{l} i :: \mathbf{v} \\ \text{array-add}(i, \mathbf{v}, \mathbf{a}^h, \mathbf{a}^t, l) \end{array} \right. \\ \text{bit}(l, i) \left\{ \begin{array}{l} \text{array-put}(i, \mathbf{v}, \mathbf{a}^h, l + 1) :: \mathbf{a}^t \\ \mathbf{a}^h :: \text{array-put}(i, \mathbf{v}, \mathbf{a}^t, l + 1) \end{array} \right. \end{array} \right. \end{array} \right. \right. ]$

[array-put(i, v, a, l)  $\xrightarrow{\text{tex}}$  “  
array\mbox{-}\linebreak[0]put( #1.  
, #2.  
, #3.  
, #4.  
)”]

[array-put(\*, \*, \*, \*)  $\xrightarrow{\text{pyk}}$  “array put " value " array " level " end put”]

array-add(\*, \*, \*, \*, \*)

[array-add(i, v, i', v', l)  $\xrightarrow{\text{val}}$   
 $\text{bit}(l, i) \left\{ \begin{array}{l} \text{bit}(l, i') \left\{ \begin{array}{l} \text{array-add}(i, \mathbf{v}, i', \mathbf{v}', l + 1) :: \mathbf{T} \\ (i :: \mathbf{v})^M :: (i' :: \mathbf{v}')^M \end{array} \right. \\ \text{bit}(l, i') \left\{ \begin{array}{l} (i' :: \mathbf{v}')^M :: (i :: \mathbf{v})^M \\ \mathbf{T} :: \text{array-add}(i, \mathbf{v}, i', \mathbf{v}', l + 1) \end{array} \right. \end{array} \right. \right. ]$

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

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

bit(\*, \*)

[bit(x, y)  $\xrightarrow{\text{val}}$  If( $x^c \wedge y^c$ , bit<sub>1</sub>(x, y), T)]

[bit(x, y)  $\xrightarrow{\text{tex}}$  “  
bit( #1.  
, #2.  
)”]

[bit(\*, \*)  $\xrightarrow{\text{pyk}}$  “bit " of " end bit”]

bit<sub>1</sub>(\*, \*)

[bit<sub>1</sub>(x, y)  $\xrightarrow{\text{val}}$  If( $x^s, y^h$ , bit(x - 1, y<sup>t</sup>))]

[bit<sub>1</sub>(x, y)  $\xrightarrow{\text{tex}}$  “  
bit\_1( #1.  
, #2.  
)”]

[bit<sub>1</sub>(\*, \*)  $\xrightarrow{\text{pyk}}$  “bit one " of " end bit”]

rack

[rack  $\xrightarrow{\text{val}}$  base[base[0]]]

[rack  $\xrightarrow{\text{tex}}$  “  
rack”]

[rack  $\xrightarrow{\text{pyk}}$  “example rack”]

"vector"

["vector"  $\xrightarrow{\text{val}}$  identifier(["vector"])]

["vector"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\{vector\}}\mbox{\tt \char34}$ ”]

["vector"  $\xrightarrow{\text{pyk}}$  “vector hook”]

"bibliography"

["bibliography"  $\xrightarrow{\text{val}}$  identifier(["bibliography"])]

["bibliography"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\{bibliography\}}\mbox{\tt \char34}$ ”]

["bibliography"  $\xrightarrow{\text{pyk}}$  “bibliography hook”]

"dictionary"

["dictionary"  $\xrightarrow{\text{val}}$  identifier(["dictionary"])]

["dictionary"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\{dictionary\}}\mbox{\tt \char34}$ ”]

["dictionary"  $\xrightarrow{\text{pyk}}$  “dictionary hook”]

"body"

["body"  $\xrightarrow{\text{val}}$  identifier(["body"])]

["body"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\{body\}}\mbox{\tt \char34}$ ”]

["body"  $\xrightarrow{\text{pyk}}$  “body hook”]

"codex"

["codex"  $\xrightarrow{\text{val}}$  identifier(["codex"])]

["codex"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\{codex\}}\mbox{\tt \char34}$ ”]

["codex"  $\xrightarrow{\text{pyk}}$  "codex hook"]

## "expansion"

["expansion"  $\xrightarrow{\text{val}}$  identifier(["expansion"])]

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

["expansion"  $\xrightarrow{\text{pyk}}$  "expansion hook"]

## "code"

["code"  $\xrightarrow{\text{val}}$  identifier(["code"])]

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

["code"  $\xrightarrow{\text{pyk}}$  "code hook"]

## "cache"

["cache"  $\xrightarrow{\text{val}}$  identifier(["cache"])]

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

["cache"  $\xrightarrow{\text{pyk}}$  "cache hook"]

## "diagnose"

["diagnose"  $\xrightarrow{\text{val}}$  identifier(["diagnose"])]

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

["diagnose"  $\xrightarrow{\text{pyk}}$  "diagnose hook"]

## "pyk"

["pyk"  $\xrightarrow{\text{val}}$  identifier(["pyk"])]

["pyk"  $\xrightarrow{\text{tex}}$  " $\mbox{\char34}\mathrm{pyk}\mbox{\char34}$ "]  
["pyk"  $\xrightarrow{\text{pyk}}$  "pyk aspect"]

"tex"

["tex"  $\xrightarrow{\text{val}}$  identifier(["tex"])]  
["tex"  $\xrightarrow{\text{tex}}$  " $\mbox{\char34}\mathrm{tex}\mbox{\char34}$ "]  
["tex"  $\xrightarrow{\text{pyk}}$  "tex aspect"]

"texname"

["texname"  $\xrightarrow{\text{val}}$  identifier(["texname"])]  
["texname"  $\xrightarrow{\text{tex}}$  " $\mbox{\char34}\mathrm{texname}\mbox{\char34}$ "]  
["texname"  $\xrightarrow{\text{pyk}}$  "texname aspect"]

"value"

["value"  $\xrightarrow{\text{val}}$  identifier(["value"])]  
["value"  $\xrightarrow{\text{tex}}$  " $\mbox{\char34}\mathrm{value}\mbox{\char34}$ "]  
["value"  $\xrightarrow{\text{pyk}}$  "value aspect"]

"message"

["message"  $\xrightarrow{\text{val}}$  identifier(["message"])]  
["message"  $\xrightarrow{\text{tex}}$  " $\mbox{\char34}\mathrm{message}\mbox{\char34}$ "]  
["message"  $\xrightarrow{\text{pyk}}$  "message aspect"]

## "macro"

["macro"  $\xrightarrow{\text{val}}$  identifier(["macro"])]

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

["macro"  $\xrightarrow{\text{pyk}}$  "macro aspect"]

## "definition"

["definition"  $\xrightarrow{\text{val}}$  identifier(["definition"])]

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

["definition"  $\xrightarrow{\text{pyk}}$  "definition aspect"]

## "unpack"

["unpack"  $\xrightarrow{\text{val}}$  identifier(["unpack"])]

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

["unpack"  $\xrightarrow{\text{pyk}}$  "unpack aspect"]

## "claim"

["claim"  $\xrightarrow{\text{val}}$  identifier(["claim"])]

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

["claim"  $\xrightarrow{\text{pyk}}$  "claim aspect"]

## "priority"

["priority"  $\xrightarrow{\text{val}}$  identifier(["priority"])]

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

["priority"  $\xrightarrow{\text{pyk}}$  "priority aspect"]

"lambda"

["lambda"  $\xrightarrow{\text{val}}$  identifier(["lambda"])]

["lambda"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\lambda}\mbox{\tt \char34}$ ”]

["lambda"  $\xrightarrow{\text{pyk}}$  “lambda identifier”]

"apply"

["apply"  $\xrightarrow{\text{val}}$  identifier(["apply"])]

["apply"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\text{apply}}\mbox{\tt \char34}$ ”]

["apply"  $\xrightarrow{\text{pyk}}$  “apply identifier”]

"true"

["true"  $\xrightarrow{\text{val}}$  identifier(["true"])]

["true"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\text{true}}\mbox{\tt \char34}$ ”]

["true"  $\xrightarrow{\text{pyk}}$  “true identifier”]

"if"

["if"  $\xrightarrow{\text{val}}$  identifier(["if"])]

["if"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\text{if}}\mbox{\tt \char34}$ ”]

["if"  $\xrightarrow{\text{pyk}}$  “if identifier”]

"quote"

["quote"  $\xrightarrow{\text{val}}$  identifier(["quote"])]

["quote"  $\xrightarrow{\text{tex}}$  “

$\mbox{\tt \char34}\mathrm{\text{quote}}\mbox{\tt \char34}$ ”]

["quote"  $\xrightarrow{\text{pyk}}$  “quote identifier”]



## "proclaim"

`["proclaim"  $\xrightarrow{\text{val}}$  identifier(["proclaim"])]`

`["proclaim"  $\xrightarrow{\text{tex}}$  "  
\mbox {\tt \char34}\mathrm {proclaim}\mbox {\tt \char34}"]`

`["proclaim"  $\xrightarrow{\text{pyk}}$  "proclaim identifier"]`

## "define"

`["define"  $\xrightarrow{\text{val}}$  identifier(["define"])]`

`["define"  $\xrightarrow{\text{tex}}$  "  
\mbox {\tt \char34}\mathrm {define}\mbox {\tt \char34}"]`

`["define"  $\xrightarrow{\text{pyk}}$  "define identifier"]`

## "introduce"

`["introduce"  $\xrightarrow{\text{val}}$  identifier(["introduce"])]`

`["introduce"  $\xrightarrow{\text{tex}}$  "  
\mbox {\tt \char34}\mathrm {introduce}\mbox {\tt \char34}"]`

`["introduce"  $\xrightarrow{\text{pyk}}$  "introduce identifier"]`

## "hide"

`["hide"  $\xrightarrow{\text{val}}$  identifier(["hide"])]`

`["hide"  $\xrightarrow{\text{tex}}$  "  
\mbox {\tt \char34}\mathrm {hide}\mbox {\tt \char34}"]`

`["hide"  $\xrightarrow{\text{pyk}}$  "hide identifier"]`

## "pre"

`["pre"  $\xrightarrow{\text{val}}$  identifier(["pre"])]`

`["pre"  $\xrightarrow{\text{tex}}$  "  
\mbox {\tt \char34}\mathrm {pre}\mbox {\tt \char34}"]`

`["pre"  $\xrightarrow{\text{pyk}}$  "pre identifier"]`

"post"

[ "post"  $\xrightarrow{\text{val}}$  identifier(["post"]) ]

[ "post"  $\xrightarrow{\text{tex}}$  "  
\mbox {\tt \char34}\mathrm {post}\mbox {\tt \char34}" ]

[ "post"  $\xrightarrow{\text{pyk}}$  "post identifier" ]

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

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

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

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

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

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

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

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

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

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

$[\mathcal{E}_3(*, *, *, *) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal E}\}_3(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $, \#4.$   
 $)”]$

$[\mathcal{E}_3(*, *, *, *) \xrightarrow{\text{pyk}} “\text{eval three " function " stack " cache " end eval”]$

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

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

$[\mathcal{E}_4(*, *, *, *) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal E}\}_4(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $, \#4.$   
 $)”]$

$[\mathcal{E}_4(*, *, *, *) \xrightarrow{\text{pyk}} “\text{eval four " arguments " stack " cache " end eval”]$

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

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

$[\mathbf{lookup}(*, *, *) \xrightarrow{\text{tex}} “$   
 $\backslash\text{mathbf} \{\mathbf{lookup}\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$

$[\mathbf{lookup}(*, *, *) \xrightarrow{\text{pyk}} “\text{lookup " stack " default " end lookup”]$

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

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

$[\mathbf{abstract}(*, *, *, *) \xrightarrow{\text{tex}} “$   
 $\backslash\text{mathbf} \{\mathbf{abstract}\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$

, #4.  
)”]

[**abstract**(\*, \*, \*, \*)  $\xrightarrow{\text{pyk}}$  “abstract " term " stack " cache " end abstract”]

[\*]

Predef: quote

[[\*]  $\xrightarrow{\text{tex}}$  “  
\lceil #1.  
\rceil ”]

[[\*]  $\xrightarrow{\text{pyk}}$  “quote " end quote”]

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

[ $\mathcal{M}(t, s, c) \xrightarrow{\text{val}}$  **s!**c!If( $t^{\text{is}}$ ,  $t$ ,  $\mathcal{M}_2(t, \text{aspect}(\text{"macro"}, t, c), s, c)$ )]

[ $\mathcal{M}(*, *, *) \xrightarrow{\text{tex}}$  “  
\cal M}{#1.  
, #2.  
, #3.  
)”]

[ $\mathcal{M}(*, *, *) \xrightarrow{\text{pyk}}$  “expand " state " cache " end expand”]

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

[ $\mathcal{M}_2(t, d, s, c) \xrightarrow{\text{val}}$   $d \left\{ \begin{array}{l} t^{\text{h}} :: \mathcal{M}^*(t^{\text{t}}, s, c) \\ \mathcal{U}^{\text{M}}(\mathcal{E}(d^3, T, c), t, s, c) \end{array} \right.$  ]

[ $\mathcal{M}_2(*, *, *, *) \xrightarrow{\text{tex}}$  “  
\cal M}\_2}{#1.  
, #2.  
, #3.  
, #4.  
)”]

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

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

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

$[\mathcal{M}^*(*, *, *) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal M}\}^*(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$

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

macro

Predef: macro

$[\text{macro} \xrightarrow{\text{tex}} “$   
 $\backslash\text{mathrm}\{\text{macro}\}”]$   
 $[\text{macro} \xrightarrow{\text{pyk}} “\text{macro}”]$

S<sub>0</sub>

$[s_0 \xrightarrow{\text{val}} \mathcal{M}(\lambda t. \lambda s. \lambda c. \mathcal{M}(t, s, c)) :: T]$   
 $[s_0 \xrightarrow{\text{tex}} “$   
 $s\_0”]$   
 $[s_0 \xrightarrow{\text{pyk}} “\text{macro state}”]$

zip(\*, \*)

$[\text{zip}(p, a) \xrightarrow{\text{val}} \text{a!If}(p, T, (p^h :: a^h)^M :: \text{zip}(p^t, a^t))]$   
 $[\text{zip}(*, *) \xrightarrow{\text{tex}} “$   
 $\backslash\text{mathbf}\{\text{zip}\}(\#1.$   
 $, \#2.$   
 $)”]$   
 $[\text{zip}(*, *) \xrightarrow{\text{pyk}} “\text{zip " with " end zip”}]$

**assoc<sub>1</sub>**(\*, \*, \*)

[**assoc<sub>1</sub>**(a, d, i)  $\xrightarrow{\text{val}}$  a<sup>a</sup>  $\left\{ \begin{array}{l} \text{d!i!T} \\ \text{a}^{\text{hc}} \left\{ \begin{array}{l} i \approx \text{a}^{\text{h}} \left\{ \begin{array}{l} \text{d!a}^{\text{t}} \\ \text{d!T} \end{array} \right. \\ \text{d}^{\text{h}} \left\{ \begin{array}{l} \text{assoc}_1(\text{a}^{\text{h}}, \text{d}^{\text{t}}, i) \\ \text{assoc}_1(\text{a}^{\text{t}}, \text{d}^{\text{t}}, i) \end{array} \right. \end{array} \right. \end{array} \right. \right]$

[**assoc<sub>1</sub>**(\*, \*, \*)  $\xrightarrow{\text{tex}}$  “  
\mathbf {assoc} .1(#1.  
, #2.  
, #3.  
)”]

[**assoc<sub>1</sub>**(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  “assoc one " address " index " end assoc”]

**(\*)<sup>P</sup>**

[(**x**)<sup>P</sup>  $\xrightarrow{\text{macro}}$  λt.λs.λc.t<sup>1</sup>]

[(**\***)<sup>P</sup>  $\xrightarrow{\text{tex}}$  “(#1.  
)^{\mathbf {p}}”]

[(**\***)<sup>P</sup>  $\xrightarrow{\text{pyk}}$  “protect " end protect”]

**self**

[**self**  $\xrightarrow{\text{macro}}$  λt.λs.λc.(c[0] :: 0 :: t<sup>d</sup>)<sup>I</sup> :: T]

[**self**  $\xrightarrow{\text{pyk}}$  “self”]

[\*  $\ddot{=}$  \*]

[**[x  $\ddot{=}$  y]**  $\xrightarrow{\text{macro}}$  λt.λs.λc.  $\tilde{\mathcal{M}}_3(t)$ ]

[**[\*  $\ddot{=}$  \*]**  $\xrightarrow{\text{tex}}$  “  
#1/tex name/tex.  
\mathrel {\ddot{=} }#2.  
”]

[**[\*  $\ddot{=}$  \*]**  $\xrightarrow{\text{pyk}}$  “macro define " as " end define”]

[\*  $\doteq$  \*]

[[x  $\doteq$  y]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[x \doteq y] \doteq [(x)^{\mathbf{P}} \xrightarrow{\text{val}} y]])]$

[[\*  $\doteq$  \*]  $\xrightarrow{\text{tex}}$  “

[#1/tex name/tex.

\mathrel {\dot {=}} #2.

]”]

[[\*  $\doteq$  \*]  $\xrightarrow{\text{pyk}}$  “value define " as " end define”]

[\*  $\acute{=}$  \*]

[[x  $\acute{=}$  y]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[x \acute{=} y] \doteq [(x)^{\mathbf{P}} \xrightarrow{\text{val}} y]])]$

[[\*  $\acute{=}$  \*]  $\xrightarrow{\text{tex}}$  “

[#1/tex name/tex.

\mathrel {\acute {=}} #2.

]”]

[[\*  $\acute{=}$  \*]  $\xrightarrow{\text{pyk}}$  “intro define " as " end define”]

[\*  $\stackrel{\text{pyk}}{=}$  \*]

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

[[\*  $\stackrel{\text{pyk}}{=}$  \*]  $\xrightarrow{\text{tex}}$  “

[#1/tex name/tex.

\stackrel{\text{pyk}}{\mathrel {=}} #2/tex name.

]”]

[[\*  $\stackrel{\text{pyk}}{=}$  \*]  $\xrightarrow{\text{pyk}}$  “pyk define " as " end define”]

[\*  $\stackrel{\text{tex}}{=}$  \*]

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

[[\*  $\stackrel{\text{tex}}{=}$  \*]  $\xrightarrow{\text{tex}}$  “

[#1/tex name/tex.

\stackrel{\text{tex}}{\mathrel {=}} #2/tex name.

]”]

[[\*  $\stackrel{\text{tex}}{=}$  \*]  $\xrightarrow{\text{pyk}}$  “tex define " as " end define”]

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

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

[[\*  $\stackrel{\text{name}}{=}$  \*]  $\xrightarrow{\text{tex}}$  “

[#1/tex name/tex.

\stackrel{\text{#1}}{\mathbf{\{ \mathrm{\{name\}}\}}} \{=\} \text{\#2/tex name.}

]”]

[[\*  $\stackrel{\text{name}}{=}$  \*]  $\xrightarrow{\text{pyk}}$  “tex name define " as " end define”]

## Priority table[\*]

[**Priority table**[ $x$ ]  $\xrightarrow{\text{name}}$  “

\mathbf{\{Priority\ table\}} [ \text{\#1.}

]”]

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

[**Priority table**[ $x$ ]  $\xrightarrow{\text{tex}}$  “

\mathbf{\{Priority\ table\}} \text{\#1.}

\mathbf{\{End\ table\}}”]

[**Priority table**[\*]  $\xrightarrow{\text{pyk}}$  “priority table " end table”]

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

[ $\tilde{\mathcal{M}}_1 \xrightarrow{\text{val}}$  [ [ $x \xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [d])$  ] ] ]]

[ $\tilde{\mathcal{M}}_1 \xrightarrow{\text{tex}}$  “

\tilde{\{\{\cal M\}}\_1}”]

[ $\tilde{\mathcal{M}}_1 \xrightarrow{\text{pyk}}$  “macro define one”]

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

[ $\tilde{\mathcal{M}}_2(t) \xrightarrow{\text{val}}$  ([ $x :: t^1$ ]<sup>M</sup> :: ([ $d$ ] :: t)<sup>M</sup> :: T]

[ $\tilde{\mathcal{M}}_2(*) \xrightarrow{\text{tex}}$  “

\tilde{\{\{\cal M\}}\_2(\text{\#1.}

)”]

[ $\tilde{\mathcal{M}}_2(*) \xrightarrow{\text{pyk}}$  “macro define two " end define”]



$\tilde{\mathcal{M}}_3(*)$  $[\tilde{\mathcal{M}}_3(t) \xrightarrow{\text{val}} \tilde{\mathcal{Q}}(t, \tilde{\mathcal{M}}_1, \tilde{\mathcal{M}}_2(t))]$  $[\tilde{\mathcal{M}}_3(*) \xrightarrow{\text{tex}} “$   
 $\backslash\tilde{\text{tilde}} \{\{\backslash\text{cal M}\}\}_3(\#1.$   
 $)”]$  $[\tilde{\mathcal{M}}_3(*) \xrightarrow{\text{pyk}} “\text{macro define three " end define”}]$  $\tilde{\mathcal{M}}_4(*, *, *, *)$  $[\tilde{\mathcal{M}}_4(t, s, c, d) \xrightarrow{\text{val}} \tilde{\mathcal{M}}(\tilde{\mathcal{Q}}(t, d^2, \mathbf{zip}(d^{1t}, t^t)), s, c)]$  $[\tilde{\mathcal{M}}_4(*, *, *, *) \xrightarrow{\text{tex}} “$   
 $\backslash\tilde{\text{tilde}} \{\{\backslash\text{cal M}\}\}_4(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $, \#4.$   
 $)”]$  $[\tilde{\mathcal{M}}_4(*, *, *, *) \xrightarrow{\text{pyk}} “\text{macro define four " state " cache " definition " end define”}]$  $\tilde{\mathcal{M}}(*, *, *)$  $[\tilde{\mathcal{M}}(t, s, c) \xrightarrow{\text{val}} \mathcal{U}(s^h \text{ ' } t \text{ ' } s \text{ ' } c)]$  $[\tilde{\mathcal{M}}(*, *, *) \xrightarrow{\text{tex}} “$   
 $\backslash\tilde{\text{tilde}} \{\{\backslash\text{cal M}\}\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$  $[\tilde{\mathcal{M}}(*, *, *) \xrightarrow{\text{pyk}} “\text{state expand " state " cache " end expand”}]$  $\tilde{\mathcal{Q}}(*, *, *)$  $[\tilde{\mathcal{Q}}(r, t, s) \xrightarrow{\text{val}} \tilde{\mathcal{Q}}_2(r^d, t, s)]$  $[\tilde{\mathcal{Q}}(*, *, *) \xrightarrow{\text{tex}} “$   
 $\backslash\tilde{\text{tilde}} \{\{\backslash\text{cal Q}\}\}(\#1.$   
 $, \#2.$

, #3.  
)”]

$[\tilde{Q}_2(*, *, *) \xrightarrow{\text{pyk}} \text{“quote expand " term " stack " end expand”}]$

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

$[\tilde{Q}_2(r, t, s) \xrightarrow{\text{val}} \tilde{Q}_3(r, t, s, \text{lookup}(t, s, T))]$

$[\tilde{Q}_2(*, *, *) \xrightarrow{\text{tex}} \text{“}$   
 $\tilde{\text{tilde}} \{ \{ \backslash \text{cal Q} \} \}_2(\#1.$   
, #2.  
, #3.  
)”]

$[\tilde{Q}_2(*, *, *) \xrightarrow{\text{pyk}} \text{“quote expand two " term " stack " end expand”}]$

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

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

$[\tilde{Q}_3(*, *, *, *) \xrightarrow{\text{tex}} \text{“}$   
 $\tilde{\text{tilde}} \{ \{ \backslash \text{cal Q} \} \}_3(\#1.$   
, #2.  
, #3.  
, #4.  
)”]

$[\tilde{Q}_3(*, *, *, *) \xrightarrow{\text{pyk}} \text{“quote expand three " term " stack " value " end expand”}]$

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

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

$[\tilde{Q}^*(*, *, *) \xrightarrow{\text{tex}} \text{“}$   
 $\tilde{\text{tilde}} \{ \{ \backslash \text{cal Q} \} \}^*(\#1.$   
, #2.  
, #3.  
)”]

$[\tilde{Q}^*(*, *, *) \xrightarrow{\text{pyk}} \text{“quote expand star " term " stack " end expand”}]$

(\*)

$[(x) \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[(x) \doteq x]])]$

$[(*) \xrightarrow{\text{tex}} “$   
(#1.  
)”]

$[(*) \xrightarrow{\text{pyk}} “\text{parenthesis " end parenthesis}”]$

(\*)

$[(x) \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[(x) \doteq x]])]$

$[(x) \xrightarrow{\text{tex}} “$   
 $\backslash\text{left( \#1.}$   
 $\backslash\text{right) ”]$

$[(*) \xrightarrow{\text{pyk}} “\text{big parenthesis " end parenthesis}”]$

display(\*)

$[\text{display}(x) \xrightarrow{\text{name}} “$   
 $\text{display}(\#1.$   
)”]

$[\text{display}(x) \xrightarrow{\text{tex}} “$

$\backslash\text{addvspace}\{\backslash\text{abovedisplayskip}\}$

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

$\backslash\text{setlength}\{\backslash\text{leftskip}\}\{0\text{mm}\}$   
 $\backslash\text{addvspace}\{\backslash\text{belowdisplayskip}\}$

”]

$[\text{display}(*) \xrightarrow{\text{pyk}} “\text{display " end display}”]$

statement(\*)

[statement(x)  $\xrightarrow{\text{name}}$  “  
statement(#1.  
)”]

[statement(x)  $\xrightarrow{\text{tex}}$  “

\addvspace{\abovedisplayskip}

\setlength{\leftskip}{0mm}\noindent #1.

\everypar{\setlength{\parindent}{\docparindent}}

\setlength{\parindent}{0mm}

\setlength{\leftskip}{0mm}

\addvspace{\belowdisplayskip}

”]

[statement(\*)  $\xrightarrow{\text{pyk}}$  “statement " end statement”]

[\*].

[[x]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[x] \doteq [[x] \text{ spy } x]])$ ]]

[[x]  $\xrightarrow{\text{tex}}$  “

[#1.  
]^{\cdot}”]

[[\*]  $\xrightarrow{\text{pyk}}$  “spying test " end test”]

[\*]<sup>-</sup>

[[x]<sup>-</sup>  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[x]<sup>-</sup> \doteq [[x] \text{ spy } x]<sup>-</sup>]])$ ]]

[[x]<sup>-</sup>  $\xrightarrow{\text{tex}}$  “

[#1.  
]^{"-}”]

[[\*]<sup>-</sup>  $\xrightarrow{\text{pyk}}$  “false spying test " end test”]

**aspect**(\*, \*)

[**aspect**(a, c)  $\xrightarrow{\text{val}}$  a<sup>c</sup> { c[0][a]  
c[a<sup>r</sup>][a<sup>i</sup>] } ]

[**aspect**(a, c)  $\xrightarrow{\text{tex}}$  “  
\mathbf{aspect}( #1.  
, #2.  
)” ]

[**aspect**(\*, \*)  $\xrightarrow{\text{pyk}}$  “aspect " subcodex " end aspect”]

**aspect**(\*, \*, \*)

[**aspect**(a, t, c)  $\xrightarrow{\text{val}}$  **aspect**(a, c[t<sup>r</sup>][“codex”][t<sup>r</sup>][t<sup>i</sup>])]

[**aspect**(\*, \*, \*)  $\xrightarrow{\text{tex}}$  “  
\mathbf{aspect}( #1.  
, #2.  
, #3.  
)” ]

[**aspect**(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  “aspect " term " cache " end aspect”]

⟨\*⟩

[⟨x⟩  $\xrightarrow{\text{macro}}$  λt.λs.λc.  $\tilde{\mathcal{M}}$ (**tuple**<sub>1</sub>(t), s, c)]

[⟨\*⟩  $\xrightarrow{\text{tex}}$  “  
\langle #1.  
\rangle ” ]

[⟨\*⟩  $\xrightarrow{\text{pyk}}$  “tuple " end tuple”]

**tuple**<sub>1</sub>(\*)

[**tuple**<sub>1</sub>(t)  $\xrightarrow{\text{val}}$  t<sup>1</sup>  $\stackrel{r}{=} [x, y]$  {  $\tilde{\mathcal{Q}}$ (t, [x :: ⟨y⟩], **tuple**<sub>2</sub>(t<sup>1</sup>))  
 $\tilde{\mathcal{Q}}$ (t, [x :: T], [x] :: t<sup>1</sup> :: T) } ]

[**tuple**<sub>1</sub>(\*)  $\xrightarrow{\text{tex}}$  “  
\mathbf{tuple}\_1( #1.  
)” ]

[**tuple**<sub>1</sub>(\*)  $\xrightarrow{\text{pyk}}$  “tuple one " end tuple”]

**tuple<sub>2</sub>(\*)**

[**tuple<sub>2</sub>(t)**  $\xrightarrow{\text{val}}$  [x] :: t<sup>1</sup> :: [y] :: t<sup>2</sup> :: T]

[**tuple<sub>2</sub>(\*)**  $\xrightarrow{\text{tex}}$  “  
\mathbf {tuple}\_2( #1.  
)”]

[**tuple<sub>2</sub>(\*)**  $\xrightarrow{\text{pyk}}$  “tuple two " end tuple”]

**let<sub>2</sub>(\*, \*)**

[let<sub>2</sub>(f, y)  $\xrightarrow{\text{val}}$  (y!f ' y)I]

[let<sub>2</sub>(f, y)  $\xrightarrow{\text{tex}}$  “  
let\_2( #1.  
, #2.  
)”]

[let<sub>2</sub>(\*, \*)  $\xrightarrow{\text{pyk}}$  “let two " apply " end let”]

**let<sub>1</sub>(\*, \*)**

[let<sub>1</sub>(f, y)  $\xrightarrow{\text{val}}$  let<sub>2</sub>(f, y<sup>M</sup>)<sup>M</sup>]

[let<sub>1</sub>(f, y)  $\xrightarrow{\text{tex}}$  “  
let\_1( #1.  
, #2.  
)”]

[let<sub>1</sub>(\*, \*)  $\xrightarrow{\text{pyk}}$  “let one " apply " end let”]

[\*  $\stackrel{\text{claim}}{=}^*$  \*]

[[x  $\stackrel{\text{claim}}{=}^*$  y]  $\xrightarrow{\text{macro}}$  λt.λs.λc.  $\tilde{\mathcal{M}}_4(t, s, c, [[x \stackrel{\text{claim}}{=}^* y] \doteq [x \xrightarrow{\text{claim}} y]])$ ]]

[[\*  $\stackrel{\text{claim}}{=}^*$  \*]  $\xrightarrow{\text{tex}}$  “  
[#1/tex name/tex.  
\stackrel{claim}{=}#2.  
”]

[[\*  $\stackrel{\text{claim}}{=}^*$  \*]  $\xrightarrow{\text{pyk}}$  “claim define " as " end define”]

# checker

[checker  $\xrightarrow{\text{val}}$   $\lambda t. \lambda c. \mathbf{check}(t, c)$ ]

[checker  $\xrightarrow{\text{pyk}}$  “checker”]

## check(\*, \*)

[**check**(t, c)  $\xrightarrow{\text{val}}$  If( $t^{\text{is}}$ , c! $T$ , **check**<sub>2</sub>(t, c, **aspect**(“claim”, t, c)))]

[**check**(\*, \*)  $\xrightarrow{\text{tex}}$  “  
 $\backslash \mathbf{check}$ {check}( #1.  
, #2.  
)”]

[**check**(\*, \*)  $\xrightarrow{\text{pyk}}$  “check " cache " end check”]

## check<sub>2</sub>(\*, \*, \*)

[**check**<sub>2</sub>(t, c, d)  $\xrightarrow{\text{val}}$  d { **check**<sub>3</sub>(t, c, **aspect**(“definition”, t, c)) }  
 $\mathcal{U}^M(\mathcal{E}(d^3, T, c) \text{ ‘ t ‘ c})$  ]

[**check**<sub>2</sub>(\*, \*, \*)  $\xrightarrow{\text{tex}}$  “  
 $\backslash \mathbf{check}$ {check}\_2( #1.  
, #2.  
, #3.  
)”]

[**check**<sub>2</sub>(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  “check two " cache " def " end check”]

## check<sub>3</sub>(\*, \*, \*)

[**check**<sub>3</sub>(t, c, d)  $\xrightarrow{\text{val}}$  If(d, **check**<sup>\*</sup>(t<sup>t</sup>, c), t! $c!$ T)]

[**check**<sub>3</sub>(\*, \*, \*)  $\xrightarrow{\text{tex}}$  “  
 $\backslash \mathbf{check}$ {check}\_3( #1.  
, #2.  
, #3.  
)”]

[**check**<sub>3</sub>(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  “check three " cache " def " end check”]

## check\*(\*, \*)

```
[check*(t, c)  $\xrightarrow{\text{val}}$  If(t, c!T, check*_2(tt, c, check(th, c)))]  
[check*(*, *)  $\xrightarrow{\text{tex}}$  “  
\mathbf{check}^*_*( #1.  
, #2.  
)”]  
[check*(*, *)  $\xrightarrow{\text{pyk}}$  “check list " cache " end check”]
```

## check\*\_2(\*, \*, \*)

```
[check*_2(t, c, v)  $\xrightarrow{\text{val}}$  If(-v, t!c!v, check*(t, c))]  
[check*_2(*, *, *)  $\xrightarrow{\text{tex}}$  “  
\mathbf{check}^*_*_2( #1.  
, #2.  
, #3.  
)”]  
[check*_2(*, *, *)  $\xrightarrow{\text{pyk}}$  “check list two " cache " value " end check”]
```

[\*].

```
[[t].  $\xrightarrow{\text{claim}}$   $\lambda t.\lambda c.\text{if}(\mathcal{U}(\mathcal{E}(t^1, T, c)), T, t)$ ]  
[[*].  $\xrightarrow{\text{tex}}$  “  
\relax [ #1.  
\relax ]^{\dot{}} ”]  
[[*].  $\xrightarrow{\text{pyk}}$  “test " end test”]
```

[\*]<sup>-</sup>

```
[[x]-  $\xrightarrow{\text{claim}}$   $\lambda t.\lambda c.\text{if}(\mathcal{U}(\mathcal{E}(t^1, T, c)), t, T)$ ]  
[[x]-  $\xrightarrow{\text{tex}}$  “  
\relax [ #1.  
\relax ]^{\{-}}[[*]-  $\xrightarrow{\text{pyk}}$  “false test " end test”]
```



$[*]^\circ$

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

$[[*]^\circ \xrightarrow{\text{tex}} \text{“}$

$\backslash\text{relax} [ \#1.$

$\backslash\text{relax} ]^{\wedge}\{\backslash\text{circ}\} \text{”}]$

$[[*]^\circ \xrightarrow{\text{pyk}} \text{“raw test " end test”}]$

msg

Predef: message

$[\text{msg} \xrightarrow{\text{tex}} \text{“}$

$\text{msg”}]$

$[\text{msg} \xrightarrow{\text{pyk}} \text{“message”}]$

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

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

$[[x \stackrel{\text{msg}}{=} y] \xrightarrow{\text{tex}} \text{“}$

$[\#1/\text{tex name}/\text{tex}.$

$\backslash\text{stackrel} \{\text{msg}\}\{=\} \#2.$

$]\text{”}]$

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

<stmt>

$[\langle\text{stmt}\rangle \xrightarrow{\text{val}} [\langle\text{stmt}\rangle]]$

$[\langle\text{stmt}\rangle \xrightarrow{\text{tex}} \text{“}$

$\{\langle\ \rangle\text{stmt}\{\ \}\text{”}]$

$[\langle\text{stmt}\rangle \xrightarrow{\text{pyk}} \text{“the statement aspect”}]$

stmt

$[\text{stmt} \xrightarrow{\text{msg}} \langle\text{stmt}\rangle]$

[stmt  $\xrightarrow{\text{tex}}$  “  
stmt”]

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

[\*  $\stackrel{\text{stmt}}{=}$  \*]

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

[[x  $\stackrel{\text{stmt}}{=}$  y]  $\xrightarrow{\text{tex}}$  “

[#1/tex name/tex.

\stackrel{rel}{\{stmt\}}\{=\}\#2.

]”]

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

## HeadNil'

[HeadNil'  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\text{HeadNil}' \doteq \mathbf{T}^{\mathbf{h}} = \mathbf{T}]])]$

[HeadNil'  $\xrightarrow{\text{tex}}$  “

HeadNil'”]

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

## HeadPair'

[HeadPair'  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\text{HeadPair}' \doteq \forall \mathcal{A}:\forall \mathcal{B}:(\mathcal{A} :: \mathcal{B})^{\mathbf{h}} = \mathcal{A}]])]$

[HeadPair'  $\xrightarrow{\text{tex}}$  “

HeadPair'”]

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

## Transitivity'

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

[Transitivity'  $\xrightarrow{\text{tex}}$  “

Transitivity'”]

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

$\perp$

$[\perp \xrightarrow{\text{val}} [\perp]^R :: \mathbf{T}]$

$[\perp \xrightarrow{\text{tex}} “\makebox [0mm][l]{\$\bot \$}\, , \{\bot \}”]$

$[\perp \xrightarrow{\text{pyk}} “\text{absurdity}”]$

Contra'

$[\text{Contra}' \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\text{Contra}' \doteq \mathbf{T} :: \mathbf{T} = \mathbf{T} \vdash \perp]])]$

$[\text{Contra}' \xrightarrow{\text{tex}} “\text{Contra}'”]$

$[\text{Contra}' \xrightarrow{\text{pyk}} “\text{contraexample}”]$

$\mathbf{T}'_E$

$[\mathbf{T}'_E \xrightarrow{\text{stmt}} \mathbf{T}^h = \mathbf{T} \oplus \forall \underline{\mathbf{a}}: \forall \underline{\mathbf{b}}: \underline{\mathbf{a}} :: \underline{\mathbf{b}}^h = \underline{\mathbf{a}} \oplus \forall \underline{\mathbf{a}}: \forall \underline{\mathbf{b}}: \forall \underline{\mathbf{c}}: \underline{\mathbf{a}} = \underline{\mathbf{b}} \vdash \underline{\mathbf{a}} = \underline{\mathbf{c}} \vdash \underline{\mathbf{b}} = \underline{\mathbf{c}} \oplus \mathbf{T} :: \mathbf{T} = \mathbf{T} \vdash \perp]$

$[\mathbf{T}'_E \xrightarrow{\text{tex}} “\mathbf{T}'_{\{E\}}”]$

$[\mathbf{T}'_E \xrightarrow{\text{pyk}} “\text{example theory primed}”]$

$\mathbf{L}_1$

$[\mathbf{L}_1 \xrightarrow{\text{stmt}} \mathbf{T}'_E \vdash \forall \underline{\mathbf{a}}: \forall \underline{\mathbf{b}}: \underline{\mathbf{a}} = \underline{\mathbf{b}} \vdash \underline{\mathbf{b}} = \underline{\mathbf{a}}]$

$[\mathbf{L}_1 \xrightarrow{\text{tex}} “\mathbf{L}_{\{1\}}”]$

$[\mathbf{L}_1 \xrightarrow{\text{pyk}} “\text{example lemma}”]$

$\ast$

$[\ast \xrightarrow{\text{tex}} “\underline{\{ \#1. \}}”]$

$[\ast \xrightarrow{\text{pyk}} “\text{metavar " end metavar}”]$

# $\mathcal{A}$

$[\mathcal{A} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{A} \ddot{=} \underline{a}]])]$

$[\mathcal{A} \xrightarrow{\text{tex}} “\{\backslash\text{cal A}\}”]$

$[\mathcal{A} \xrightarrow{\text{pyk}} “\text{meta a}”]$

# $\mathcal{B}$

$[\mathcal{B} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{B} \ddot{=} \underline{b}]])]$

$[\mathcal{B} \xrightarrow{\text{tex}} “\{\backslash\text{cal B}\}”]$

$[\mathcal{B} \xrightarrow{\text{pyk}} “\text{meta b}”]$

# $\mathcal{C}$

$[\mathcal{C} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{C} \ddot{=} \underline{c}]])]$

$[\mathcal{C} \xrightarrow{\text{tex}} “\{\backslash\text{cal C}\}”]$

$[\mathcal{C} \xrightarrow{\text{pyk}} “\text{meta c}”]$

# $\mathcal{D}$

$[\mathcal{D} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{D} \ddot{=} \underline{d}]])]$

$[\mathcal{D} \xrightarrow{\text{tex}} “\{\backslash\text{cal D}\}”]$

$[\mathcal{D} \xrightarrow{\text{pyk}} “\text{meta d}”]$

# $\mathcal{E}$

$[\mathcal{E} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{E} \ddot{=} \underline{e}]])]$

$[\mathcal{E} \xrightarrow{\text{tex}} “\{\backslash\text{cal E}\}”]$

$[\mathcal{E} \xrightarrow{\text{pyk}} “\text{meta e}”]$

# $\mathcal{F}$

$[\mathcal{F} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{F} \ddot{=} \underline{f}]])]$

$[\mathcal{F} \xrightarrow{\text{tex}} “\{\backslash\text{cal F}\}”]$

$[\mathcal{F} \xrightarrow{\text{pyk}} “\text{meta f}”]$

$\mathcal{G}$

$[\mathcal{G} \xrightarrow{\text{macro}} \lambda\text{t}.\lambda\text{s}.\lambda\text{c}.\tilde{\mathcal{M}}_4(\text{t}, \text{s}, \text{c}, [[\mathcal{G} \doteq \underline{\text{g}}]])]$

$[\mathcal{G} \xrightarrow{\text{tex}} “\{\backslash\text{cal G}\}”]$

$[\mathcal{G} \xrightarrow{\text{pyk}} “\text{meta g}”]$

$\mathcal{H}$

$[\mathcal{H} \xrightarrow{\text{macro}} \lambda\text{t}.\lambda\text{s}.\lambda\text{c}.\tilde{\mathcal{M}}_4(\text{t}, \text{s}, \text{c}, [[\mathcal{H} \doteq \underline{\text{h}}]])]$

$[\mathcal{H} \xrightarrow{\text{tex}} “\{\backslash\text{cal H}\}”]$

$[\mathcal{H} \xrightarrow{\text{pyk}} “\text{meta h}”]$

$\mathcal{I}$

$[\mathcal{I} \xrightarrow{\text{macro}} \lambda\text{t}.\lambda\text{s}.\lambda\text{c}.\tilde{\mathcal{M}}_4(\text{t}, \text{s}, \text{c}, [[\mathcal{I} \doteq \underline{\text{i}}]])]$

$[\mathcal{I} \xrightarrow{\text{tex}} “\{\backslash\text{cal I}\}”]$

$[\mathcal{I} \xrightarrow{\text{pyk}} “\text{meta i}”]$

$\mathcal{J}$

$[\mathcal{J} \xrightarrow{\text{macro}} \lambda\text{t}.\lambda\text{s}.\lambda\text{c}.\tilde{\mathcal{M}}_4(\text{t}, \text{s}, \text{c}, [[\mathcal{J} \doteq \underline{\text{j}}]])]$

$[\mathcal{J} \xrightarrow{\text{tex}} “\{\backslash\text{cal J}\}”]$

$[\mathcal{J} \xrightarrow{\text{pyk}} “\text{meta j}”]$

$\mathcal{K}$

$[\mathcal{K} \xrightarrow{\text{macro}} \lambda\text{t}.\lambda\text{s}.\lambda\text{c}.\tilde{\mathcal{M}}_4(\text{t}, \text{s}, \text{c}, [[\mathcal{K} \doteq \underline{\text{k}}]])]$

$[\mathcal{K} \xrightarrow{\text{tex}} “\{\backslash\text{cal K}\}”]$

$[\mathcal{K} \xrightarrow{\text{pyk}} “\text{meta k}”]$

$\mathcal{L}$

$[\mathcal{L} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{L} \doteq \underline{l}]])]$

$[\mathcal{L} \xrightarrow{\text{tex}} “\{\backslash\text{cal L}\}”]$

$[\mathcal{L} \xrightarrow{\text{pyk}} “\text{meta l}”]$

$\mathcal{M}$

$[\mathcal{M} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{M} \doteq \underline{m}]])]$

$[\mathcal{M} \xrightarrow{\text{tex}} “\{\backslash\text{cal M}\}”]$

$[\mathcal{M} \xrightarrow{\text{pyk}} “\text{meta m}”]$

$\mathcal{N}$

$[\mathcal{N} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{N} \doteq \underline{n}]])]$

$[\mathcal{N} \xrightarrow{\text{tex}} “\{\backslash\text{cal N}\}”]$

$[\mathcal{N} \xrightarrow{\text{pyk}} “\text{meta n}”]$

$\mathcal{O}$

$[\mathcal{O} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{O} \doteq \underline{o}]])]$

$[\mathcal{O} \xrightarrow{\text{tex}} “\{\backslash\text{cal O}\}”]$

$[\mathcal{O} \xrightarrow{\text{pyk}} “\text{meta o}”]$

$\mathcal{P}$

$[\mathcal{P} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{P} \doteq \underline{p}]])]$

$[\mathcal{P} \xrightarrow{\text{tex}} “\{\backslash\text{cal P}\}”]$

$[\mathcal{P} \xrightarrow{\text{pyk}} “\text{meta p}”]$

$\mathcal{Q}$

$[\mathcal{Q} \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{Q} \doteq \underline{q}]])]$

$[Q \xrightarrow{\text{tex}} “\{\backslash\text{cal Q}\}”]$

$[Q \xrightarrow{\text{pyk}} “\text{meta q}”]$

## $\mathcal{R}$

$[\mathcal{R} \xrightarrow{\text{macro}} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{R} \doteq r]])]$

$[\mathcal{R} \xrightarrow{\text{tex}} “\{\backslash\text{cal R}\}”]$

$[\mathcal{R} \xrightarrow{\text{pyk}} “\text{meta r}”]$

## $\mathcal{S}$

$[\mathcal{S} \xrightarrow{\text{macro}} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{S} \doteq s]])]$

$[\mathcal{S} \xrightarrow{\text{tex}} “\{\backslash\text{cal S}\}”]$

$[\mathcal{S} \xrightarrow{\text{pyk}} “\text{meta s}”]$

## $\mathcal{T}$

$[\mathcal{T} \xrightarrow{\text{macro}} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{T} \doteq t]])]$

$[\mathcal{T} \xrightarrow{\text{tex}} “\{\backslash\text{cal T}\}”]$

$[\mathcal{T} \xrightarrow{\text{pyk}} “\text{meta t}”]$

## $\mathcal{U}$

$[\mathcal{U} \xrightarrow{\text{macro}} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{U} \doteq u]])]$

$[\mathcal{U} \xrightarrow{\text{tex}} “\{\backslash\text{cal U}\}”]$

$[\mathcal{U} \xrightarrow{\text{pyk}} “\text{meta u}”]$

## $\mathcal{V}$

$[\mathcal{V} \xrightarrow{\text{macro}} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{V} \doteq v]])]$

$[\mathcal{V} \xrightarrow{\text{tex}} “\{\backslash\text{cal V}\}”]$

$[\mathcal{V} \xrightarrow{\text{pyk}} “\text{meta v}”]$

$\mathcal{W}$

$[\mathcal{W}^{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{W} \doteq \underline{w}]])]$

$[\mathcal{W}^{\text{tex}} \text{“}\{\backslash\text{cal W}\}”]$

$[\mathcal{W}^{\text{pyk}} \text{“meta w”}]$

$\mathcal{X}$

$[\mathcal{X}^{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{X} \doteq \underline{x}]])]$

$[\mathcal{X}^{\text{tex}} \text{“}\{\backslash\text{cal X}\}”]$

$[\mathcal{X}^{\text{pyk}} \text{“meta x”}]$

$\mathcal{Y}$

$[\mathcal{Y}^{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{Y} \doteq \underline{y}]])]$

$[\mathcal{Y}^{\text{tex}} \text{“}\{\backslash\text{cal Y}\}”]$

$[\mathcal{Y}^{\text{pyk}} \text{“meta y”}]$

$\mathcal{Z}$

$[\mathcal{Z}^{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{Z} \doteq \underline{z}]])]$

$[\mathcal{Z}^{\text{tex}} \text{“}\{\backslash\text{cal Z}\}”]$

$[\mathcal{Z}^{\text{pyk}} \text{“meta z”}]$

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

$[\langle a \mid x := b \rangle \xrightarrow{\text{val}} x!b!]$

$\text{If}(a^{\vee}, \text{If}(a \stackrel{t}{=} x, b, a),$

$\text{If}(\neg a \stackrel{r}{=} [\forall *: *], a^h :: \langle * a^t \mid x := b \rangle,$

$\text{If}(a^1 \stackrel{t}{=} x, a,$

$a^0 :: a^1 :: \langle a^2 \mid x := b \rangle :: T))]$

$[\langle a \mid x := b \rangle \xrightarrow{\text{tex}} \text{“}$

$\backslash\text{angle \#1.}$

$\backslash, \{\backslash\text{protect}\backslash\text{vert}\}\#2.$



{:=}\, #3.

\rangle ”]

[(\* | \* := \*)  $\xrightarrow{\text{pyk}}$  “sub " set " to " end sub”]

$\langle * * | * := * \rangle$

[(\* a | x := b)  $\xrightarrow{\text{val}}$  x!b!If(a, T,  $\langle a^h | x := b \rangle$  ::  $\langle * a^t | x := b \rangle$ )]

[(\* a | x := b)  $\xrightarrow{\text{tex}}$  “

\rangle ^ { \ast } #1.

\, { \protect \vert } #2.

{:=}\, #3.

\rangle ”]

[(\* \* | \* := \*)  $\xrightarrow{\text{pyk}}$  “sub star " set " to " end sub”]

$\emptyset$

[ $\emptyset \xrightarrow{\text{val}}$  T]

[ $\emptyset \xrightarrow{\text{tex}}$  “

\emptysetset ”]

[ $\emptyset \xrightarrow{\text{pyk}}$  “the empty set”]

## Remainder

[Remainder  $\xrightarrow{\text{macro}}$   $\lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\text{Remainder} \doteq \text{HeadPair}' \oplus \text{Transitivity}' \oplus \text{Contra}']])$ ]

[Remainder  $\xrightarrow{\text{tex}}$  “

Remainder”]

[Remainder  $\xrightarrow{\text{pyk}}$  “example remainder”]

$(*)^{\mathbf{v}}$

[ $(x)^{\mathbf{v}} \xrightarrow{\text{name}}$  “

( #1.

) ^ { \bf v } ”]

[ $(x)^{\mathbf{v}} \xrightarrow{\text{macro}}$   $\lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[(x)^{\mathbf{v}} \doteq x]])$ ]

$[(x)^v \xrightarrow{\text{tex}} \text{"\#1/tex name."}]$

$[(*)^v \xrightarrow{\text{pyk}} \text{"make visible " end visible"}]$

$\text{intro}(*, *, *, *)$

$[\text{intro}(x, i, p, t) \xrightarrow{\text{name}} \text{"}$   
 $\text{intro}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $, \#4.$   
 $)]$

$[\text{intro}(x, i, p, t) \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, \llbracket \text{intro}(x, i, p, t) \ddot{=} \$[x \stackrel{\text{tex}}{=} t] \$ \rrbracket )]$

$[\text{intro}(x, i, p, t) \xrightarrow{\text{tex}} \text{"\index{\#2.: \#3. @\#2.: \$[\#1/tex name/tex.] \$ \#3.} \%}$   
 $\backslash \text{index}\{\text{pyk: \#3. \$[\#1/tex name/tex.]} \$\} \%}$   
 $\backslash \text{tex}\{$   
 $\$[\#1/tex name/tex.$   
 $\backslash \text{stackrel}\{\backslash \text{mathrm}\{\text{tex}\}\}\{=\} \#4/\text{tex name.}$   
 $]\$ \$[ \#1/\text{tex name/tex.} \%$   
 $]\$ \backslash \text{footnote}\{\$[\#1/tex name/tex.$   
 $\backslash \text{stackrel}\{\backslash \text{mathrm}\{\text{pyk}\}\}\{=\} \#3/\text{tex name.}$   
 $]\$ \}"]$

$[\text{intro}(*, *, *, *) \xrightarrow{\text{pyk}} \text{"intro " index " pyk " tex " end intro"}]$

$\text{intro}(*, *, *)$

$[\text{intro}(x, p, t) \xrightarrow{\text{name}} \text{"}$   
 $\text{intro}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)]$

$[\text{intro}(x, p, t) \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, \llbracket \text{intro}(x, p, t) \ddot{=} \$[x \stackrel{\text{tex}}{=} t] \$ \rrbracket )]$

$[\text{intro}(x, p, t) \xrightarrow{\text{tex}} \text{"\index{\alpha \#2. @\backslash \makebox[20mm][l]\{ \$[\#1/tex}$   
 $\text{name/tex.]} \$\} \#2.} \%}$   
 $\backslash \text{index}\{\text{pyk: \#2. \$[\#1/tex name/tex.]} \$\} \%}$   
 $\backslash \text{tex}\{$   
 $\$[\#1/tex name/tex.$   
 $\backslash \text{stackrel}\{\backslash \text{mathrm}\{\text{tex}\}\}\{=\} \#3/\text{tex name.}$   
 $]\$ \$[ \#1/\text{tex name/tex.} \%$   
 $]\$ \backslash \text{footnote}\{\$[\#1/tex name/tex.$

$\backslash\text{stackrel}\{\backslash\text{mathrm}\{\text{pyk}\}\}\{=\}\#\text{2}/\text{tex name.}$   
]\$""]

[intro(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  "intro " pyk " tex " end intro"]

error(\*, \*)

[error(m, t)  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, \llbracket[\text{error}(m, t) \doteq \text{error}_2(\llbracket m \rrbracket, t)\rrbracket]\rrbracket)$ ]

[error(m, t)  $\xrightarrow{\text{tex}}$  "  
error(#1/tex name.  
, #2.  
)"]

[error(\*, \*)  $\xrightarrow{\text{pyk}}$  "error " term " end error"]

error<sub>2</sub>(\*, \*)

[error<sub>2</sub>(m, t)  $\xrightarrow{\text{val}}$  t-color(m<sup>1</sup>["  
"]<sup>1</sup>t)]

[error<sub>2</sub>(m, t)  $\xrightarrow{\text{tex}}$  "  
error\_{2}(\#1/tex name.  
, #2.  
)"]

[error<sub>2</sub>(\*, \*)  $\xrightarrow{\text{pyk}}$  "error two " term " end error"]

proof(\*, \*, \*)

[proof(p, t, c)  $\xrightarrow{\text{val}}$  proof<sub>2</sub>(S(c, p), t)]

[proof(p, t, c)  $\xrightarrow{\text{tex}}$  "  
proof( #1.  
, #2.  
, #3.  
)"]

[proof(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  "proof " term " cache " end proof"]

$\text{proof}_2(*, *)$

$[\text{proof}_2(\mathbf{q}, \mathbf{t}) \xrightarrow{\text{val}} \mathbf{t}!$   
 If( $\mathbf{q}^E, \mathbf{q}$ ,  
 If( $-\mathbf{q}^0, \text{error}_2([\text{"Proof has at least one unresolved premise. Lemma; premise reads:"}] , \mathbf{t}; \mathbf{q}^{0h})$ ),  
 If( $-\mathbf{q}^1, \text{error}_2([\text{"Proof has at least one unresolved side condition. Lemma; condition reads:"}] , \mathbf{t}; \mathbf{q}^{1h})$ ),  
 If( $\mathbf{q}^2 \stackrel{t}{=} \mathbf{t}, \mathbf{T}$ ,  
 $\text{error}_2([\text{"Lemma does not match conclusion. Lemma; conclusion reads:"}] , \mathbf{t}; \mathbf{q}^2)))]$   
 $[\text{proof}_2(\mathbf{q}, \mathbf{t}) \xrightarrow{\text{tex}} \text{"$   
 $\text{proof}_{-}\{2\}(\#1.$   
 $, \#2.$   
 $)"]$   
 $[\text{proof}_2(*, *) \xrightarrow{\text{pyk}} \text{"proof two " term " end proof"}]$

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

$[\mathcal{S}(\mathbf{c}, \mathbf{t}) \xrightarrow{\text{val}} \mathbf{c}!$   
 If( $\mathbf{t}^E, \mathbf{t}$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [*^I], \mathcal{S}^I(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [*^\triangleright], \mathcal{S}^\triangleright(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [*^V], \mathcal{S}^E(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [*^+], \mathcal{S}^+(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [*^-], \mathcal{S}^-(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [*^*], \mathcal{S}^*(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [* @ *], \mathcal{S}^@(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [* \vdash *], \mathcal{S}^\vdash(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [* \Vdash *], \mathcal{S}^{\Vdash}(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [* \text{ i.e. } *], \mathcal{S}^{\text{i.e.}}(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [\forall *: *], \mathcal{S}^\forall(\mathbf{c}, \mathbf{t})$ ,  
 If( $\mathbf{t} \stackrel{r}{=} [*; *], \mathcal{S}^;(\mathbf{c}, \mathbf{t})$ ,  
 $\text{error}_2([\text{"Unknown sequent operator:"}] , \mathbf{t})))]$   
 $[\mathcal{S}(\mathbf{x}, \mathbf{y}) \xrightarrow{\text{tex}} \text{"$   
 $\{\text{cal } \mathcal{S}\}(\#1.$   
 $, \#2.$   
 $)"]$   
 $[\mathcal{S}(*, *) \xrightarrow{\text{pyk}} \text{"sequent eval " term " end eval"}]$

$\mathcal{S}^I(*, *)$  $[\mathcal{S}^I(c, t) \xrightarrow{\text{val}} \text{c!}\emptyset :: \emptyset :: \text{t-color}(t^1 \vdash t^1) :: \top]$  $[\mathcal{S}^I(x, y) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } S\}^{\wedge}\{I\}(\#1.$   
 $, \#2.$   
 $)”]$  $[\mathcal{S}^I(*, *) \xrightarrow{\text{pyk}} “\text{seqeval init " term " end eval”}]$  $\mathcal{S}^{\triangleright}(*, *)$  $[\mathcal{S}^{\triangleright}(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^{\triangleright}(c, t, \mathcal{S}(c, t^1))]$  $[\mathcal{S}^{\triangleright}(x, y) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } S\}^{\wedge}\{\backslash\text{rhd}\}(\#1.$   
 $, \#2.$   
 $)”]$  $[\mathcal{S}^{\triangleright}(*, *) \xrightarrow{\text{pyk}} “\text{seqeval modus " term " end eval”}]$  $\mathcal{S}_1^{\triangleright}(*, *, *)$  $[\mathcal{S}_1^{\triangleright}(c, t, q) \xrightarrow{\text{val}} \text{c!t!}$  $\text{If}(q^E, q,$  $\text{If}(q^2 \stackrel{r}{=} [* \vdash *], q^0 \cup \{q^{21}\} :: q^1 :: q^{22} :: \top,$  $\text{If}(q^2 \stackrel{r}{=} [* \Vdash *], q^0 :: q^1 \cup \{q^{21}\} :: q^{22} :: \top,$  $\text{error}_2([\text{“The modus operation requires the conclusion of its argument to be an inference or an endorsement”}, t)))]$  $[\mathcal{S}_1^{\triangleright}(x, y, z) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } S\}_{-}\{1\}^{\wedge}\{\backslash\text{rhd}\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$  $[\mathcal{S}_1^{\triangleright}(*, *, *) \xrightarrow{\text{pyk}} “\text{seqeval modus one " term " sequent " end eval”}]$  $\mathcal{S}^E(*, *)$  $[\mathcal{S}^E(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^E(c, t, \mathcal{S}(c, t^1))]$

$[\mathcal{S}^E(x, y) \xrightarrow{\text{tex}} "$   
 $\{\backslash \text{cal } S\}^{\wedge} \{E\}(\#1.$   
 $, \#2.$   
 $)"]$

$[\mathcal{S}^E(*, *) \xrightarrow{\text{pyk}} \text{"seqeval verify " term " end eval"}]$

$\mathcal{S}_1^E(*, *, *)$

$[\mathcal{S}_1^E(c, t, q) \xrightarrow{\text{val}} \text{c!t!}$

$\text{If}(q^E, q,$

$\text{If}(\neg q^2 \stackrel{r}{=} [* \vdash *], \text{error}_2([\text{"The verify operation requires the conclusion of its"}], t),$

$\text{If}(\mathcal{U}^M(\mathcal{E}(q^{21}, T, c) \text{ ' } c), q^0 :: q^1 :: q^{22} :: T,$

$\text{error}_2([\text{"False side condition:"}], t)))]$

$[\mathcal{S}_1^E(x, y, z) \xrightarrow{\text{tex}} "$

$\{\backslash \text{cal } S\}_{-1}^{\wedge} \{E\}(\#1.$

$, \#2.$

$, \#3.$

$)"]$

$[\mathcal{S}_1^E(*, *, *) \xrightarrow{\text{pyk}} \text{"seqeval verify one " term " sequent " end eval"}]$

$\mathcal{S}^+(*, *)$

$[\mathcal{S}^+(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^+(c, t, \mathcal{S}(c, t^1))]$

$[\mathcal{S}^+(x, y) \xrightarrow{\text{tex}} "$

$\{\backslash \text{cal } S\}^{\wedge} \{+\}(\#1.$

$, \#2.$

$)"]$

$[\mathcal{S}^+(*, *) \xrightarrow{\text{pyk}} \text{"sequent eval plus " term " end eval"}]$

$\mathcal{S}_1^+(*, *, *)$

$[\mathcal{S}_1^+(c, t, q) \xrightarrow{\text{val}} \text{c!t!}$

$\text{If}(q^E, q,$

$\text{If}(q^2 \stackrel{r}{=} [* \vdash *] \wedge q^{22} \stackrel{r}{=} [* \vdash *],$

$q^0 :: q^1 :: t\text{-color}(q^{21} \oplus q^{221} \vdash q^{222}) :: T,$

$\text{error}_2([\text{"Term; conclusion not fit for decurrying:"}], t; q^2)))]$

$[\mathcal{S}_1^+(x, y, z) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } \mathcal{S}\}_{-}\{1\}^{\wedge}\{+\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$

$[\mathcal{S}_1^+(*, *, *) \xrightarrow{\text{pyk}} “\text{sequeval plus one " term " sequent " end eval”}]$

$\mathcal{S}^-(*, *)$

$[\mathcal{S}^-(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^-(c, t, \mathcal{S}(c, t^1))]$

$[\mathcal{S}^-(x, y) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } \mathcal{S}\}^{\wedge}\{-\}(\#1.$   
 $, \#2.$   
 $)”]$

$[\mathcal{S}^-(*, *) \xrightarrow{\text{pyk}} “\text{sequeval minus " term " end eval”}]$

$\mathcal{S}_1^-(*, *, *)$

$[\mathcal{S}_1^-(c, t, q) \xrightarrow{\text{val}} \text{clt!}$

If( $q^E, q,$

If( $q^2 \stackrel{r}{=} [* \vdash *] \wedge q^{21} \stackrel{r}{=} [* \oplus *],$

$q^0 :: q^1 :: t\text{-color}(q^{211} \vdash q^{212} \vdash q^{22}) :: T,$

$\text{error}_2([\text{“Term; conclusion not fit for decurrying:”}, t; q^2]))]$

$[\mathcal{S}_1^-(x, y, z) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } \mathcal{S}\}_{-}\{1\}^{\wedge}\{-\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$

$[\mathcal{S}_1^-(*, *, *) \xrightarrow{\text{pyk}} “\text{sequeval minus one " term " sequent " end eval”}]$

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

$[\mathcal{S}^*(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^*(c, t, \mathcal{S}(c, t^1))]$

$[\mathcal{S}^*(x, y) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal } \mathcal{S}\}^{\wedge}\{\backslash\text{ast}\}(\#1.$   
 $, \#2.$   
 $)”]$

$[\mathcal{S}^*(*,*) \xrightarrow{\text{pyk}} \text{"seqeval deref " term " end eval"}]$

$\mathcal{S}_1^*(*,*,*)$

$[\mathcal{S}_1^*(c, t, q) \xrightarrow{\text{val}} c!t!]$

If( $q^E, q,$

$\mathcal{S}_2^*(c, t, q, \text{aspect}(\langle \text{stmt} \rangle, q^2, c)))]$

$[\mathcal{S}_1^*(x, y, z) \xrightarrow{\text{tex}} \text{"}$

$\{\backslash \text{cal S}\}_{-1}^{\wedge \backslash \text{ast}}(\#1.$

, #2.

, #3.

)"]

$[\mathcal{S}_1^*(*,*,*) \xrightarrow{\text{pyk}} \text{"seqeval deref one " term " sequent " end eval"}]$

$\mathcal{S}_2^*(*,*,*,*)$

$[\mathcal{S}_2^*(c, t, q, d) \xrightarrow{\text{val}} c!t!q!]$

If( $d, \text{error}_2([\text{"Dereferencing construct that has no statement def:"}], t),$

$q^0 :: q^1 :: d^3 :: T)$

$[\mathcal{S}_2^*(c, t, q, d) \xrightarrow{\text{tex}} \text{"}$

$\{\backslash \text{cal S}\}_{-2}^{\wedge \backslash \text{ast}}(\#1.$

, #2.

, #3.

, #4.

)"]

$[\mathcal{S}_2^*(*,*,*,*) \xrightarrow{\text{pyk}} \text{"seqeval deref two " term " sequent " def " end eval"}]$

$\mathcal{S}^\textcircled{\text{a}}(*,*)$

$[\mathcal{S}^\textcircled{\text{a}}(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^\textcircled{\text{a}}(c, t, \mathcal{S}(c, t^1))]$

$[\mathcal{S}^\textcircled{\text{a}}(x, y) \xrightarrow{\text{tex}} \text{"}$

$\{\backslash \text{cal S}\}^{\wedge \backslash \text{char64}}(\#1.$

, #2.

)"]

$[\mathcal{S}^\textcircled{\text{a}}(*,*) \xrightarrow{\text{pyk}} \text{"seqeval at " term " end eval"}]$



$\mathcal{S}_1^{\textcircled{a}}(*, *, *)$  $[\mathcal{S}_1^{\textcircled{a}}(c, t, q) \xrightarrow{\text{val}} \text{c!t!}$  $\text{If}(q^E, q,$  $\text{If}(-q^2 \stackrel{r}{=} [\forall *: *], \text{error}_2([\text{“Quantifier elimination requires the conclusion of its argument to be a quantifier:”}], t),$  $\text{If}(-t^2 \text{ free for } q^{21} \text{ in } q^{22}, \text{error}_2([\text{“Quantifier elimination leads to variable clash:”}], t),$  $q^0 :: q^1 :: \langle q^{22} | q^{21} := t^2 \rangle :: T)))]$  $[\mathcal{S}_1^{\textcircled{a}}(c, t, q) \xrightarrow{\text{tex}} \text{“}$  $\{\backslash \text{cal } S\}_{-}\{1\}^{\wedge} \{\backslash \text{char64}\}(\#1.$  $, \#2.$  $, \#3.$  $\text{”)”]$  $[\mathcal{S}_1^{\textcircled{a}}(*, *, *) \xrightarrow{\text{pyk}} \text{“seqeval at one " term " sequent " end eval”}]$  $\mathcal{S}^{\text{+}}(*, *)$  $[\mathcal{S}^{\text{+}}(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^{\text{+}}(c, t, t^1, \mathcal{S}(c, t^2))]$  $[\mathcal{S}^{\text{+}}(x, y) \xrightarrow{\text{tex}} \text{“}$  $\{\backslash \text{cal } S\}^{\wedge} \{\backslash \text{vdash}\}(\#1.$  $, \#2.$  $\text{”)”]$  $[\mathcal{S}^{\text{+}}(*, *) \xrightarrow{\text{pyk}} \text{“seqeval infer " term " end eval”}]$  $\mathcal{S}_1^{\text{+}}(*, *, *, *)$  $[\mathcal{S}_1^{\text{+}}(c, t, p, q) \xrightarrow{\text{val}} \text{c!t!p!}$  $\text{If}(q^E, q,$  $q^0 \backslash \{p\} :: q^1 :: \text{t-color}(p \vdash q^2) :: T)]$  $[\mathcal{S}_1^{\text{+}}(x, y, z, u) \xrightarrow{\text{tex}} \text{“}$  $\{\backslash \text{cal } S\}_{-}\{1\}^{\wedge} \{\backslash \text{vdash}\}(\#1.$  $, \#2.$  $, \#3.$  $, \#4.$  $\text{”)”]$  $[\mathcal{S}_1^{\text{+}}(*, *, *, *) \xrightarrow{\text{pyk}} \text{“seqeval infer one " term " premise " sequent " end eval”}]$

$\mathcal{S}^{\#}(*, *)$

$[\mathcal{S}^{\#}(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^{\#}(c, t, t^1, \mathcal{S}(c, t^2))]$

$[\mathcal{S}^{\#}(x, y) \xrightarrow{\text{tex}} \text{“}$   
 $\{\text{cal S}\}^{\wedge}\{\text{makebox [0mm][l]\scriptsize $\vdash$}\}, \{\vdash\}\}(\#1.$   
 $, \#2.$   
 $\text{)”}]$

$[\mathcal{S}^{\#}(*, *) \xrightarrow{\text{pyk}} \text{“sequeval endorse " term " end eval”}]$

$\mathcal{S}_1^{\#}(*, *, *, *)$

$[\mathcal{S}_1^{\#}(c, t, p, q) \xrightarrow{\text{val}} \text{c!t!p!}$

$\text{If}(q^E, q,$   
 $q^0 :: q^1 \setminus \{p\} :: \text{t-color}(p \Vdash q^2) :: T)]$

$[\mathcal{S}_1^{\#}(x, y, z, u) \xrightarrow{\text{tex}} \text{“}$   
 $\{\text{cal S}\}^{\wedge}\{1\}^{\wedge}\{\text{makebox [0mm][l]\scriptsize $\vdash$}\}, \{\vdash\}\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $, \#4.$   
 $\text{)”}]$

$[\mathcal{S}_1^{\#}(*, *, *, *) \xrightarrow{\text{pyk}} \text{“sequeval endorse one " term " side " sequent " end eval”}]$

$\mathcal{S}^{\text{i.e.}}(*, *)$

$[\mathcal{S}^{\text{i.e.}}(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^{\text{i.e.}}(c, t, t^2, \mathcal{S}(c, t^1))]$

$[\mathcal{S}^{\text{i.e.}}(x, y) \xrightarrow{\text{tex}} \text{“}$   
 $\{\text{cal S}\}^{\wedge}\{\text{i.e.}\}(\#1.$   
 $, \#2.$   
 $\text{)”}]$

$[\mathcal{S}^{\text{i.e.}}(*, *) \xrightarrow{\text{pyk}} \text{“sequeval est " term " end eval”}]$

$\mathcal{S}_1^{\text{i.e.}}(*, *, *, *)$

$[\mathcal{S}_1^{\text{i.e.}}(c, t, a, q) \xrightarrow{\text{val}} \text{c!t!a!}$

$\text{If}(q^E, q, \mathcal{S}_2^{\text{i.e.}}(c, t, a, q, \text{aspect}(\langle \text{stmt} \rangle, a, c)))]$

$[\mathcal{S}_1^{\text{i.e.}}(x, y, z, u) \xrightarrow{\text{tex}} \text{“}$

{\cal S}\_{-1}^{i.e.}(\#1.  
, \#2.  
, \#3.  
, \#4.  
)"]

[S\_{1.e.}(\*, \*, \*, \*) \xrightarrow{pyk} "seqeval est one " term " name " sequent " end eval"]

S\_2^{i.e.}(\*, \*, \*, \*, \*)

[S\_2^{i.e.}(c, t, a, q, d) \xrightarrow{val} c!t!a!q!  
If(d, error\_2(["Referencing construct that has no statement def:"], t),  
If(-d^3 \stackrel{t}{=} q^2, error\_2(["Reference; conclusion do not match:"], a; q^2),  
q^0 :: q^1 :: a :: T))]

[S\_2^{i.e.}(c, t, a, q, d) \xrightarrow{tex} "  
{\cal S}\_{-2}^{i.e.}(\#1.  
, \#2.  
, \#3.  
, \#4.  
, \#5.  
)"]

[S\_2^{i.e.}(\*, \*, \*, \*, \*) \xrightarrow{pyk} "seqeval est two " term " name " sequent " def " end eval"]

S^\forall(\*, \*)

[S^\forall(c, t) \xrightarrow{val} S\_1^\forall(c, t, t^1, S(c, t^2))]

[S^\forall(x, y) \xrightarrow{tex} "  
{\cal S}^\forall\{\forall\text{forall}\}(\#1.  
, \#2.  
)"]

[S^\forall(\*, \*) \xrightarrow{pyk} "seqeval all " term " end eval"]

S\_1^\forall(\*, \*, \*, \*)

[S\_1^\forall(c, t, v, q) \xrightarrow{val} c!t!v!  
If(q^E, q,  
If(-v^\forall, error\_2(["Metageneralization over non-metavariable:"], t),

If( $v$  free in  $q^0$ ,  $\text{error}_2(\lceil \text{“Metageneralization over metavariable that occurs free in some premise:”} \rceil, t)$ ,

If( $v$  free in  $q^1$ ,  $\text{error}_2(\lceil \text{“Metageneralization over metavariable that occurs free in some side condition:”} \rceil, t)$ ,

$q^0 :: q^1 :: t\text{-color}(\forall v: q^2 :: T))))]$

$[\mathcal{S}_1^\forall(c, t, v, q) \xrightarrow{\text{tex}} \text{“}$   
 $\{\text{cal } S\}\text{-}\{1\}^{\wedge}\{\text{forall}\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $, \#4.$   
 $\text{”)”]$

$[\mathcal{S}_1^\forall(*, *, *, *) \xrightarrow{\text{pyk}} \text{“seqeval all one " term " variable " sequent " end eval”}]$

$\mathcal{S}^i(*, *)$

$[\mathcal{S}^i(c, t) \xrightarrow{\text{val}} \mathcal{S}_1^i(c, t, \mathcal{S}(c, t^1))]$

$[\mathcal{S}^i(x, y) \xrightarrow{\text{tex}} \text{“}$   
 $\{\text{cal } S\}^{\wedge}\{;\}(\#1.$   
 $, \#2.$   
 $\text{”)”]$

$[\mathcal{S}^i(*, *) \xrightarrow{\text{pyk}} \text{“seqeval cut " term " end eval”}]$

$\mathcal{S}_1^i(*, *, *)$

$[\mathcal{S}_1^i(c, t, p) \xrightarrow{\text{val}} c!t!$   
 $\text{If}(p^E, p, \mathcal{S}_2^i(c, t, p, \mathcal{S}(c, t^2)))]$

$[\mathcal{S}_1^i(x, y, z) \xrightarrow{\text{tex}} \text{“}$   
 $\{\text{cal } S\}\text{-}\{1\}^{\wedge}\{;\}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $\text{”)”]$

$[\mathcal{S}_1^i(*, *, *) \xrightarrow{\text{pyk}} \text{“seqeval cut one " term " forerunner " end eval”}]$

$\mathcal{S}_2^i(*, *, *, *)$

$[\mathcal{S}_2^i(c, t, p, q) \xrightarrow{\text{val}} c!t!p!$   
 $\text{If}(q^E, q, p^0 \cup q^0 \setminus \{p^2\} :: p^1 \cup q^1 :: q^2 :: T)]$

$[\mathcal{S}_2^i(c, t, p, q) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal S}\}_- \{2\}^{\wedge} \{;\} (\#1.$   
 $, \#2.$   
 $, \#3.$   
 $, \#4.$   
 $)”]$

$[\mathcal{S}_2^i(*, *, *, *) \xrightarrow{\text{pyk}} “\text{sequeval cut two " term " forerunner " sequent " end eval”}]$

$\mathcal{T}(*)$

$[\mathcal{T}(x) \xrightarrow{\text{macro}} \text{lt.l}\lambda\text{s.l}\lambda\text{c}.\tilde{\mathcal{M}}_4(t, s, c, [[\mathcal{T}(x) \doteq \lambda\text{c}.\mathcal{U}^M(\mathcal{E}([\text{x}], \text{T}, c))]])]$

$[\mathcal{T}(x) \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{cal T}\}(\#1.$   
 $)”]$

$[\mathcal{T}(* ) \xrightarrow{\text{pyk}} “\text{computably true " end true”}]$

$\text{claims}(*, *, *)$

$[\text{claims}(t, c, r) \xrightarrow{\text{val}}$   
 $\text{If}(\text{claims}_2(t, c, r), \text{T}, \text{claims}_2(t, c, c[r][\text{"bibliography"}]^1))]$

$[\text{claims}(t, c, r) \xrightarrow{\text{tex}} “$   
 $\text{claims}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$

$[\text{claims}(*, *, *) \xrightarrow{\text{pyk}} “\text{claims " cache " ref " end claims”}]$

$\text{claims}_2(*, *, *)$

$[\text{claims}_2(t, c, r) \xrightarrow{\text{val}} \text{If}(\neg r^c, t!c!F, t \in_c c[r][\text{"codex"}][r][0][0][\text{"claim"}]^3)]$

$[\text{claims}_2(t, c, r) \xrightarrow{\text{tex}} “$   
 $\text{claims}_2(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$

$[\text{claims}_2(*, *, *) \xrightarrow{\text{pyk}} “\text{claims two " cache " ref " end claims”}]$

<proof>

[<proof>  $\xrightarrow{\text{val}}$  [<proof>]]

[<proof>  $\xrightarrow{\text{tex}}$  “  
{<}proof{>}”]

[<proof>  $\xrightarrow{\text{pyk}}$  “the proof aspect”]

proof

[proof  $\xrightarrow{\text{msg}}$  <proof>]

[proof  $\xrightarrow{\text{tex}}$  “  
proof”]

[proof  $\xrightarrow{\text{pyk}}$  “proof”]

[**Lemma** \*: \*]

[[**Lemma** x:y]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t,s,c,[[[**Lemma** x:y] \doteq [x \xrightarrow{\text{stmt}} y]])$ )]

[[**Lemma** x:y]  $\xrightarrow{\text{tex}}$  “  
[ \mathbf{Lemma} \ ] #1.  
\colon #2.  
]”]

[[**Lemma** \*: \*]  $\xrightarrow{\text{pyk}}$  “lemma " says " end lemma”]

[**Proof of** \*: \*]

[[**Proof of** x:y]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t,s,c,[[[**Proof of** x:y] \doteq [x \xrightarrow{\text{proof}} y]])$ )]

[[**Proof of** x:y]  $\xrightarrow{\text{tex}}$  “  
[ \mathbf{Proof} \ of \ ] #1/tex name/tex.  
\colon #2.  
]”]

[[**Proof of** \*: \*]  $\xrightarrow{\text{pyk}}$  “proof of " reads " end proof”]

[\* lemma \*: \*]

[[x lemma y: z]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[ [x lemma y: z] \doteq [y \stackrel{\text{stmt}}{=} x \vdash z] ] ] ] ]$

[[x lemma y: z]  $\xrightarrow{\text{tex}}$  “

[ #1.

$\backslash\text{mathbf}\{\backslash lemma\}$  } #2.

$\backslash\text{colon}$  #3.

]”]

[[\* lemma \*: \*]  $\xrightarrow{\text{pyk}}$  “in theory " lemma " says " end lemma”]

[\* antilemma \*: \*]

[[x antilemma y: z]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[ [x antilemma y: z] \doteq [x lemma y: z \vdash \perp] ] ] ] ]$

[[x antilemma y: z]  $\xrightarrow{\text{tex}}$  “

[ #1.

$\backslash\text{mathbf}\{\backslash antilemma\}$  } #2.

$\backslash\text{colon}$  #3.

]”]

[[\* antilemma \*: \*]  $\xrightarrow{\text{pyk}}$  “in theory " antilemma " says " end antilemma”]

[\* rule \*: \*]

[[x rule y: z]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[ [x rule y: z] \doteq [x lemma y: z][\text{Proof of } y: \text{Rule tactic}] ] ] ] ]$

[[x rule y: z]  $\xrightarrow{\text{tex}}$  “

[ #1.

$\backslash\text{mathbf}\{\backslash rule\}$  } #2.

$\backslash\text{colon}$  #3.

]”]

[[\* rule \*: \*]  $\xrightarrow{\text{pyk}}$  “in theory " rule " says " end rule”]

[\* antirule \*: \*]

[[x antirule y: z]  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[ [x antirule y: z] \doteq [x rule y: z \vdash \perp] ] ] ] ]$

[[x **antirule** y: z]  $\xrightarrow{\text{tex}}$  “  
 [ #1.  
 \mathbf{\ antirule\ } #2.  
 \colon #3.  
 ]”]

[[\* **antirule** \*: \*]  $\xrightarrow{\text{pyk}}$  “in theory " antirule " says " end antirule”]

## verifier

[verifier  $\xrightarrow{\text{val}}$   $\lambda t. \lambda c. \mathcal{V}_1(c)$ ]

[verifier  $\xrightarrow{\text{pyk}}$  “verifier”]

## $\mathcal{V}_1(*)$

[ $\mathcal{V}_1(c)$   $\xrightarrow{\text{val}}$

let<sub>1</sub>( $\lambda r.$

let<sub>1</sub>( $\lambda x.$

let<sub>1</sub>( $\lambda p.$

let<sub>1</sub>( $\lambda d.$

If( $\neg d, d,$

let<sub>1</sub>( $\lambda i.$

If( $\neg i^c, T,$

error<sub>2</sub>([“Circular proof. Circle

includes:”], p[i]<sup>0h</sup>),  $\mathcal{V}_5(c, r, p, p)$ ),  $\mathcal{V}_3(c, r, p, T)$ ),  $\mathcal{V}_2(c, x)$ ), c[r][“codex”][r], c[0]]]

[ $\mathcal{V}_1(c)$   $\xrightarrow{\text{tex}}$  “

{\cal V} #1.

)”]

[ $\mathcal{V}_1(*)$   $\xrightarrow{\text{pyk}}$  “verify one " end verify”]

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

[ $\mathcal{V}_2(c, p)$   $\xrightarrow{\text{val}}$  c!

If(p, T,

If( $\neg p^{\text{hc}}, \mathcal{V}_2(c, p^{\text{h}}) :: \mathcal{V}_2(c, p^{\text{t}}), p^{\text{h}} ::$

let<sub>1</sub>( $\lambda d.$

If(d, T,

let<sub>1</sub>( $\lambda r.$

If( $r^{\text{E}}, \text{error}_2$ ([“Error in proof of”], d<sup>2</sup>[“

”]<sup>1r</sup>, r),  $\mathcal{S}(c, \mathcal{U}^{\text{M}}(\mathcal{E}(d^3, T, c) \text{ ‘ c ‘ p}))))$ , **aspect**(<proof>, p<sup>t</sup>)))]]



$[\mathcal{V}_2(c, p) \xrightarrow{\text{tex}} \{ \text{cal V} \} \_2( \#1. \\ , \#2. \\ )"]$

$[\mathcal{V}_2(*, *) \xrightarrow{\text{pyk}} \text{"verify two " proofs " end verify"}]$

$\mathcal{V}_3(*, *, *, *)$

$[\mathcal{V}_3(c, r, p, d) \xrightarrow{\text{val}} c!r!p! \\ \text{If}(\neg d, d, \\ \text{If}(p, T, \\ \text{If}(\neg p^{\text{hc}}, \mathcal{V}_3(c, r, p^t, \mathcal{V}_3(c, r, p^h, T))), \\ \text{let}_1(\lambda i. \\ \text{let}_1(\lambda q. \\ \text{If}(q, T, \\ \text{If}(q^E, q, \\ \text{If}(\neg q^1, \text{error}_2([\text{"Unchecked sidecondition:"}], q^{1h}), \\ \text{let}_1(\lambda d. \\ \text{If}(d, \text{error}_2([\text{"Proof of non-existent lemma:"}], q^2), \\ \text{If}(\neg q^2 \stackrel{t}{=} d^3, \text{error}_2([\text{"Lemma/proof mismatch:"}], d^2; q^2), \\ \mathcal{V}_4(c, q^0))), \text{aspect}(\langle \text{stmt} \rangle, c[r][\text{"codex"}][r][i])))], p^t, p^h)))]$

$[\mathcal{V}_3(c, r, p, d) \xrightarrow{\text{tex}} \{ \text{cal V} \} \_3( \#1. \\ , \#2. \\ , \#3. \\ , \#4. \\ )"]$

$[\mathcal{V}_3(*, *, *, *) \xrightarrow{\text{pyk}} \text{"verify three " ref " sequents " diagnose " end verify"}]$

$\mathcal{V}_4(*, *)$

$[\mathcal{V}_4(c, p) \xrightarrow{\text{val}} c! \\ \text{If}(p, T, \\ \text{let}_1(\lambda d. \\ \text{If}(\neg d, d, \\ \text{let}_1(\lambda p. \\ \text{let}_1(\lambda r. \\ \text{let}_1(\lambda i. \\ \text{If}(\neg c[r][\text{"diagnose"}], \\ \text{error}_2([\text{"Reference to erroneous page"}], p),$

If( $\neg$ claims( $\lceil$ verifier $\rceil$ ,  $c$ ,  $r$ ),  
 error<sub>2</sub>( $\lceil$ “Reference to unchecked lemma” $\rceil$ ,  $p$ ),  
 If(**aspect**(<proof>,  $p$ ,  $c$ ),  
 error<sub>2</sub>( $\lceil$ “Reference to unproved lemma” $\rceil$ ,  $p$ ),  $\top$ )),  $p^i$ ),  $p^r$ ),  $p^h$ )),  $\mathcal{V}_4(c, p^t)$ ))]

$[\mathcal{V}_4(c, p) \xrightarrow{\text{tex}}$  “  
 $\{\backslash\text{cal V}\}_4$ ( #1.  
 , #2.  
 )”]

$[\mathcal{V}_4(*, *) \xrightarrow{\text{pyk}}$  “verify four " premises " end verify”]

$\mathcal{V}_5(*, *, *, *)$

$[\mathcal{V}_5(c, r, a, q) \xrightarrow{\text{val}}$  c!r!a!  
 If( $q^c$ ,  $q$ ,  
 If( $a$ ,  $q$ ,  
 If( $\neg a^{\text{hc}}$ ,  $\mathcal{V}_5(c, r, a^t, \mathcal{V}_5(c, r, a^h, q))$ ),  
 $\mathcal{V}_7(c, r, a^h, q)$ )))]

$[\mathcal{V}_5(c, r, a, q) \xrightarrow{\text{tex}}$  “  
 $\{\backslash\text{cal V}\}_5$ ( #1.  
 , #2.  
 , #3.  
 , #4.  
 )”]

$[\mathcal{V}_5(*, *, *, *) \xrightarrow{\text{pyk}}$  “verify five " ref " array " sequents " end verify”]

$\mathcal{V}_6(*, *, *, *)$

$[\mathcal{V}_6(c, r, p, q) \xrightarrow{\text{val}}$  c!r!p!  
 If( $q^c$ ,  $q$ ,  
 If( $p$ ,  $q$ ,  
 let<sub>1</sub>( $\lambda q$ .  
 If( $q^c$ ,  $q$ ,  
 If( $\neg r \approx p^{\text{hr}}$ ,  $q$ ,  
 $\mathcal{V}_7(c, r, p^{\text{hi}}, q)$ )),  $\mathcal{V}_6(c, r, p^t, q)$ )))]

$[\mathcal{V}_6(c, r, p, q) \xrightarrow{\text{tex}}$  “  
 $\{\backslash\text{cal V}\}_6$ ( #1.  
 , #2.  
 , #3.  
 , #4.

)”]

$[\mathcal{V}_6(*, *, *, *) \xrightarrow{\text{pyk}} \text{“verify six " ref " list " sequents " end verify”}]$

$\mathcal{V}_7(*, *, *, *)$

$[\mathcal{V}_7(c, r, i, q) \xrightarrow{\text{val}} \text{c!r!}$

$\text{let}_1(\lambda v.$

$\text{If}(v, q,$

$\text{If}(v \approx 0, i,$

$\text{If}(v \approx 1, q,$

$\text{let}_1(\lambda q.$

$\text{If}(q^c, q, q[i \rightarrow 1]), \mathcal{V}_6(c, r, v^0, q[i \rightarrow 0])))$ ),  $q[i]$ ]

$[\mathcal{V}_7(c, r, i, q) \xrightarrow{\text{tex}} \text{“}$

$\{\text{cal V}\}_7(\#1.$

$, \#2.$

$, \#3.$

$, \#4.$

$\text{”)”]$

$[\mathcal{V}_7(*, *, *, *) \xrightarrow{\text{pyk}} \text{“verify seven " ref " id " sequents " end verify”}]$

$\text{Cut}(*, *)$

$[\text{Cut}(a, b) \xrightarrow{\text{val}} \text{If}(b, a, a; b)]$

$[\text{Cut}(a, b) \xrightarrow{\text{tex}} \text{“}$

$\text{Cut}(\#1.$

$, \#2.$

$\text{”)”]$

$[\text{Cut}(*, *) \xrightarrow{\text{pyk}} \text{“cut " and " end cut”}]$

$\text{Head}_{\oplus}(*)$

$[\text{Head}_{\oplus}(s) \xrightarrow{\text{val}} s^1 \vdash s^2 \vdash s^{1\triangleright + \triangleright}]$

$[\text{Head}_{\oplus}(s) \xrightarrow{\text{tex}} \text{“}$

$\text{Head}_{\oplus}(\#1.$

$\text{”)”]$

$[\text{Head}_{\oplus}(*) \xrightarrow{\text{pyk}} \text{“head " end head”}]$

$\text{Tail}_{\oplus}(* )$

$[\text{Tail}_{\oplus}(s) \xrightarrow{\text{val}} s^1 \vdash s^{2I+\triangleright}]$

$[\text{Tail}_{\oplus}(s) \xrightarrow{\text{tex}} \text{“Tail}_{\oplus}\{\backslash\text{oplus}\} (\#1.$   
 $\text{)”}]$

$[\text{Tail}_{\oplus}(*) \xrightarrow{\text{pyk}} \text{“tail " end tail”}]$

$\text{rule}_1(*, *)$

$[\text{rule}_1(s, t) \xrightarrow{\text{val}}$   
 $\text{If}(s \stackrel{t}{=} t, T,$   
 $\text{If}(\neg t \stackrel{r}{=} [x \oplus y], 0,$   
 $\text{let}_1(\lambda p.$   
 $\text{If}(\neg p^c, \text{Cut}(\text{Head}_{\oplus}(t), p),$   
 $\text{let}_1(\lambda p.$   
 $\text{If}(\neg p^c, \text{Cut}(\text{Tail}_{\oplus}(t), p), 0), \text{rule}_1(s, t^2))), \text{rule}_1(s, t^1)))]$

$[\text{rule}_1(s, t) \xrightarrow{\text{tex}} \text{“}$   
 $\text{rule}_1(\#1.$   
 $, \#2.$   
 $\text{)”}]$

$[\text{rule}_1(*, *) \xrightarrow{\text{pyk}} \text{“rule one " theory " end rule”}]$

$\text{rule}(*, *)$

$[\text{rule}(c, p) \xrightarrow{\text{val}} c!$   
 $\text{let}_1(\lambda s.$   
 $\text{If}(s, [ \text{“Rule has no statement aspect”} ],$   
 $\text{If}(\neg s \stackrel{r}{=} [x \vdash y], \text{error}_2([ \text{“Rule has invalid statement aspect”} ], s),$   
 $\text{let}_1(\lambda t.$   
 $\text{If}(t, [ \text{“Theory has no statement aspect”} ],$   
 $\text{let}_1(\lambda r.$   
 $\text{If}(r^c, \text{error}_2([ \text{“The theory does not assert the given rule”} ], s; t),$   
 $s^1 \vdash$   
 $\text{Cut}(s^{1I\triangleright*}, r), \text{rule}_1(s^2, t)), \mathbf{aspect}(\langle \text{stmt} \rangle, s^1, c^3)), \mathbf{aspect}(\langle \text{stmt} \rangle, p^t)^3)]$

$[\text{rule}(c, p) \xrightarrow{\text{tex}} \text{“}$   
 $\text{rule}(\#1.$   
 $, \#2.$   
 $\text{)”}]$

)”]

[rule(\*, \*)  $\xrightarrow{\text{pyk}}$  “rule " subcodex " end rule”]

## Rule tactic

[Rule tactic  $\xrightarrow{\text{val}}$   $\lambda c. \lambda p. \text{rule}(c, p)$ ]

[Rule tactic  $\xrightarrow{\text{tex}}$  “  
Rule\ tactic”]

[Rule tactic  $\xrightarrow{\text{pyk}}$  “rule tactic”]

## Plus(\*, \*)

[Plus(a, b)  $\xrightarrow{\text{val}}$  If(b, a, a  $\oplus$  b)]

[Plus(a, b)  $\xrightarrow{\text{tex}}$  “  
Plus( #1.  
, #2.  
)”]

[Plus(\*, \*)  $\xrightarrow{\text{pyk}}$  “plus " and " end plus”]

## [Theory \*]

[[Theory n]  $\xrightarrow{\text{macro}}$   $\lambda t. \lambda s. \lambda c. \text{theory}_2(t, c)$ ]

[[Theory n]  $\xrightarrow{\text{tex}}$  “  
[\mathbf{Theory} \ ] #1.  
”]

[[Theory \*]  $\xrightarrow{\text{pyk}}$  “theory " end theory”]

## theory<sub>2</sub>(\*, \*)

[theory<sub>2</sub>(t, c)  $\xrightarrow{\text{val}}$

let<sub>1</sub>( $\lambda n.$

let<sub>1</sub>( $\lambda s.$

$\tilde{Q}(t, [[n \xrightarrow{\text{stmt}} x], s), [n] :: n :: [x] :: \text{theory}_3(c, n) :: T, t^1)$ ]

[theory<sub>2</sub>(t, c)  $\xrightarrow{\text{tex}}$  “

theory<sub>2</sub>( #1.

, #2.  
)”]

[theory<sub>2</sub>(\*, \*)<sup>pyk</sup> → “theory two " cache " end theory”]

theory<sub>3</sub>(\*, \*)

[theory<sub>3</sub>(c, n) <sup>val</sup> → n!  
let<sub>1</sub>(λr.  
theory<sub>4</sub>(c[r][“codex”][r], n, T), c[0])]

[theory<sub>3</sub>(c, n) <sup>tex</sup> → “  
theory\_3( #1.  
, #2.  
)”]

[theory<sub>3</sub>(\*, \*)<sup>pyk</sup> → “theory three " name " end theory”]

theory<sub>4</sub>(\*, \*, \*)

[theory<sub>4</sub>(c, n, s) <sup>val</sup> → n!  
If(c, s,  
If(-c<sup>hc</sup>, theory<sub>4</sub>(c<sup>t</sup>, n, theory<sub>4</sub>(c<sup>h</sup>, n, s)),  
If(-**aspect**(<proof>, c<sup>t</sup>)<sup>3</sup> <sup>t</sup> = [Rule tactic], s,  
let<sub>1</sub>(λd.  
If(-d<sup>1</sup> <sup>t</sup> = n, s,  
Plus(d<sup>2</sup>, s), **aspect**(<stmt>, c<sup>t</sup>)<sup>3</sup>))))]

[theory<sub>4</sub>(c, n, s) <sup>tex</sup> → “  
theory\_4( #1.  
, #2.  
, #3.  
)”]

[theory<sub>4</sub>(\*, \*, \*)<sup>pyk</sup> → “theory four " name " sum " end theory”]

HeadNil''

[HeadNil'' <sup>proof</sup> → Rule tactic]

[HeadNil'' <sup>stmt</sup> → T'<sub>E</sub> ⊢ T<sup>h</sup> = T]

[HeadNil'' <sup>tex</sup> → “

HeadNil''"]

[HeadNil''  $\xrightarrow{\text{pyk}}$  "example axiom lemma primed"]

## HeadPair''

[HeadPair''  $\xrightarrow{\text{proof}}$  Rule tactic]

[HeadPair''  $\xrightarrow{\text{stmt}}$   $T'_E \vdash \forall \underline{a}: \forall \underline{b}: \underline{a} :: \underline{b}^h = \underline{a}$ ]

[HeadPair''  $\xrightarrow{\text{tex}}$  "  
HeadPair''"]

[HeadPair''  $\xrightarrow{\text{pyk}}$  "example scheme lemma primed"]

## Transitivity''

[Transitivity''  $\xrightarrow{\text{proof}}$  Rule tactic]

[Transitivity''  $\xrightarrow{\text{stmt}}$   $T'_E \vdash \forall \underline{a}: \forall \underline{b}: \forall \underline{c}: \underline{a} = \underline{b} \vdash \underline{a} = \underline{c} \vdash \underline{b} = \underline{c}$ ]

[Transitivity''  $\xrightarrow{\text{tex}}$  "  
Transitivity''"]

[Transitivity''  $\xrightarrow{\text{pyk}}$  "example rule lemma primed"]

## Contra''

[Contra''  $\xrightarrow{\text{proof}}$  Rule tactic]

[Contra''  $\xrightarrow{\text{stmt}}$   $T'_E \vdash T :: T = T \vdash \perp$ ]

[Contra''  $\xrightarrow{\text{tex}}$  "  
Contra''"]

[Contra''  $\xrightarrow{\text{pyk}}$  "contraexample lemma primed"]

## HeadNil

[HeadNil  $\xrightarrow{\text{proof}}$  Rule tactic]

[HeadNil  $\xrightarrow{\text{stmt}}$   $T_E \vdash T^h = T$ ]

[HeadNil  $\xrightarrow{\text{tex}}$  "  
HeadNil"]

[HeadNil  $\xrightarrow{\text{pyk}}$  “example axiom lemma”]

## HeadPair

[HeadPair  $\xrightarrow{\text{proof}}$  Rule tactic]

[HeadPair  $\xrightarrow{\text{stmt}}$   $T_E \vdash \forall \underline{a}: \forall \underline{b}: \underline{a} :: \underline{b}^h = \underline{a}$ ]

[HeadPair  $\xrightarrow{\text{tex}}$  “  
HeadPair”]

[HeadPair  $\xrightarrow{\text{pyk}}$  “example scheme lemma”]

## Transitivity

[Transitivity  $\xrightarrow{\text{proof}}$  Rule tactic]

[Transitivity  $\xrightarrow{\text{stmt}}$   $T_E \vdash \forall \underline{a}: \forall \underline{b}: \forall \underline{c}: \underline{a} = \underline{b} \vdash \underline{a} = \underline{c} \vdash \underline{b} = \underline{c}$ ]

[Transitivity  $\xrightarrow{\text{tex}}$  “  
Transitivity”]

[Transitivity  $\xrightarrow{\text{pyk}}$  “example rule lemma”]

## Contra

[Contra  $\xrightarrow{\text{proof}}$  Rule tactic]

[Contra  $\xrightarrow{\text{stmt}}$   $T_E \vdash T :: T = T \vdash \perp$ ]

[Contra  $\xrightarrow{\text{tex}}$  “  
Contra”]

[Contra  $\xrightarrow{\text{pyk}}$  “contraexample lemma”]

## $T_E$

[ $T_E \xrightarrow{\text{stmt}}$   $\forall \underline{a}: \forall \underline{b}: \underline{a} :: \underline{b}^h = \underline{a} \oplus T :: T = T \vdash \perp \oplus T^h = T \oplus \forall \underline{a}: \forall \underline{b}: \forall \underline{c}: \underline{a} = \underline{b} \vdash \underline{a} = \underline{c} \vdash \underline{b} = \underline{c}$ ]

[ $T_E \xrightarrow{\text{tex}}$  “  
 $T_E$ ”]

[ $T_E \xrightarrow{\text{pyk}}$  “example theory”]



## ragged right

[ragged right  $\xrightarrow{\text{name}}$  “  
ragged\ right”]

[ragged right  $\xrightarrow{\text{tex}}$  “  
\raggedright”]

[ragged right  $\xrightarrow{\text{pyk}}$  “ragged right”]

## ragged right expansion

[ragged right expansion  $\xrightarrow{\text{name}}$  “  
ragged\ right\ expansion\ ”]

[ragged right expansion  $\xrightarrow{\text{macro}}$   $\lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\text{ragged right expansion} \hat{=} \text{ragged right}]])$ ]

[ragged right expansion  $\xrightarrow{\text{tex}}$  “”]

[ragged right expansion  $\xrightarrow{\text{pyk}}$  “ragged right expansion”]

## parm(\*, \*, \*)

[parm(t, s, n)  $\xrightarrow{\text{val}}$  n!]

If(t  $\hat{=} [\forall x: y], \forall n: \text{parm}(t^2, t^1 :: n :: s, T + 2 * n),$

let<sub>1</sub>( $\lambda m.$

If( $-m, m, t^R :: \text{parm}^*(t^t, s, n), \text{lookup}(t, s, T)$ )))]

[parm(t, s, n)  $\xrightarrow{\text{tex}}$  “

parm(#1.

, #2.

, #3.

)”]

[parm(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  “parameter term " stack " seed " end parameter”]

## parm\*(\*, \*, \*)

[parm\*(t, s, n)  $\xrightarrow{\text{val}}$  s!n!If( $t^a, T, \text{parm}(t^h, s, n) :: \text{parm}^*(t^t, s, n)$ )]

[parm\*(t, s, n)  $\xrightarrow{\text{tex}}$  “

parm^\*(#1.

, #2.

, #3.  
 )”]  

$$[\text{parm}^*(*, *, *) \xrightarrow{\text{pyk}} \text{“parameter term star " stack " seed " end parameter”}]$$

$\text{inst}^*(*, *)$

$$[\text{inst}(t, s) \xrightarrow{\text{val}} \text{If}(t^c, \text{inst}(s[t], s), t^R :: \text{inst}^*(t^t, s))]$$

$$[\text{inst}(t, s) \xrightarrow{\text{tex}} \text{“}$$
  
 $\text{inst}(\#1.$   
 $, \#2.$   
 $)”]$

$$[\text{inst}(*, *) \xrightarrow{\text{pyk}} \text{“instantiate " with " end instantiate”}]$$

$\text{inst}^*(*, *)$

$$[\text{inst}^*(t, s) \xrightarrow{\text{val}} \text{s!If}(t^a, T, \text{inst}(t^h, s) :: \text{inst}^*(t^t, s))]$$

$$[\text{inst}^*(t, s) \xrightarrow{\text{tex}} \text{“}$$
  
 $\text{inst}^*(\#1.$   
 $, \#2.$   
 $)”]$

$$[\text{inst}^*(*, *) \xrightarrow{\text{pyk}} \text{“instantiate star " with " end instantiate”}]$$

$\text{occur}^*(*, *, *)$

$$[\text{occur}(t, u, s) \xrightarrow{\text{val}} \text{s!If}(u^c, \text{If}(t \approx u, T, \text{occur}(t, s[u], s)), \text{occur}^*(t, u^t, s))]$$

$$[\text{occur}(t, u, s) \xrightarrow{\text{tex}} \text{“}$$
  
 $\text{occur}(\#1.$   
 $, \#2.$   
 $, \#3.$   
 $)”]$

$$[\text{occur}(*, *, *) \xrightarrow{\text{pyk}} \text{“occur " in " substitution " end occur”}]$$

$\text{occur}^*(*, *, *)$

$$[\text{occur}^*(t, u, s) \xrightarrow{\text{val}} \text{t!s!If}(u^a, F, \text{If}(\text{occur}(t, u^h, s), T, \text{occur}^*(t, u^t, s)))]$$

[occur\*(t, u, s)  $\xrightarrow{\text{tex}}$  "  
 occur\*(#1.  
 , #2.  
 , #3.  
 )"]

[occur\*(\*, \*, \*)  $\xrightarrow{\text{pyk}}$  "occur star " in " substitution " end occur"]

unify(\* = \*, \*)

[unify(t = u, s)  $\xrightarrow{\text{val}}$  t!u!  
 If(s<sup>c</sup>, s,  
 If(t<sup>c</sup>, unify<sub>2</sub>(t = u, s),  
 If(u<sup>c</sup>, unify<sub>2</sub>(u = t, s),  
 If(t  $\stackrel{r}{=} u$ , unify\*(t<sup>t</sup> = u<sup>t</sup>, s), 0)))]

[unify(t = u, s)  $\xrightarrow{\text{tex}}$  "  
 unify(#1.  
 = #2.  
 , #3.  
 )"]

[unify(\* = \*, \*)  $\xrightarrow{\text{pyk}}$  "unify " with " substitution " end unify"]

unify\*(\*)

[unify\*(t = u, s)  $\xrightarrow{\text{val}}$  u!If(t<sup>a</sup>, s, unify\*(t<sup>t</sup> = u<sup>t</sup>, unify(t<sup>h</sup> = u<sup>h</sup>, s)))]

[unify\*(t = u, s)  $\xrightarrow{\text{tex}}$  "  
 unify\*(#1.  
 = #2.  
 , #3.  
 )"]

[unify\*(\*)  $\xrightarrow{\text{pyk}}$  "unify star " with " substitution " end unify"]

unify<sub>2</sub>(\*)

[unify<sub>2</sub>(t = u, s)  $\xrightarrow{\text{val}}$   
 If(t  $\approx$  u, s,  
 let<sub>1</sub>(λt'.  
 If(-t', unify(t' = u, s),  
 If(occur(t, u, s), 0, s[t→u]), s[t]))]

```
[unify2(t = u, s)  $\xrightarrow{\text{tex}}$  “
unify_2(#1.
=#2.
, #3.
)”]
```

```
[unify2(* = *, *)  $\xrightarrow{\text{pyk}}$  “unify two " with " substitution " end unify”]
```

$L_a$

```
[La  $\xrightarrow{\text{name}}$  “L_a”]
```

```
[La  $\xrightarrow{\text{tex}}$  “
\if \relax \csname lgwprooflinep\endcsname L_a \else
\if \relax \csname lgwella\endcsname
\global \advance \lgwproofline by 1
\undef \lgwella {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwella \fi ”]
```

```
[La  $\xrightarrow{\text{pyk}}$  “ell a”]
```

$L_b$

```
[Lb  $\xrightarrow{\text{name}}$  “L_b”]
```

```
[Lb  $\xrightarrow{\text{tex}}$  “
\if \relax \csname lgwprooflinep\endcsname L_b \else
\if \relax \csname lgwellb\endcsname
\global \advance \lgwproofline by 1
\undef \lgwellb {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellb \fi ”]
```

```
[Lb  $\xrightarrow{\text{pyk}}$  “ell b”]
```

$L_c$

```
[Lc  $\xrightarrow{\text{name}}$  “L_c”]
```

```
[Lc  $\xrightarrow{\text{tex}}$  “
\if \relax \csname lgwprooflinep\endcsname L_c \else
\if \relax \csname lgwellc\endcsname
\global \advance \lgwproofline by 1
\undef \lgwellc {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellc \fi ”]
```

[L<sub>c</sub>  $\xrightarrow{\text{pyk}}$  “ell c”]

L<sub>d</sub>

[L<sub>d</sub>  $\xrightarrow{\text{name}}$  “L\_d”]

[L<sub>d</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>d</sub>  $\xrightarrow{\text{pyk}}$  “ell d”]

L<sub>e</sub>

[L<sub>e</sub>  $\xrightarrow{\text{name}}$  “L\_e”]

[L<sub>e</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>e</sub>  $\xrightarrow{\text{pyk}}$  “ell e”]

L<sub>f</sub>

[L<sub>f</sub>  $\xrightarrow{\text{name}}$  “L\_f”]

[L<sub>f</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>f</sub>  $\xrightarrow{\text{pyk}}$  “ell f”]

$L_g$

$[L_g \xrightarrow{\text{name}} \text{"L\_g"}]$

$[L_g \xrightarrow{\text{tex}} \text{"}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwprooflinep}\backslash\text{endcsname } L_g \backslash\text{else}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwellg}\backslash\text{endcsname}$

$\backslash\text{global } \backslash\text{advance } \backslash\text{lgwproofline by } 1$

$\backslash\text{xdef } \backslash\text{lgwellg } \{L\backslash\text{ifnum } \backslash\text{lgwproofline } <10\ 0\backslash\text{fi } \backslash\text{number } \backslash\text{lgwproofline } \}$

$\backslash\text{fi } \backslash\text{lgwellg } \backslash\text{fi } \text{"}$

$[L_g \xrightarrow{\text{pyk}} \text{"ell g"}]$

$L_h$

$[L_h \xrightarrow{\text{name}} \text{"L\_h"}]$

$[L_h \xrightarrow{\text{tex}} \text{"}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwprooflinep}\backslash\text{endcsname } L_h \backslash\text{else}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwellh}\backslash\text{endcsname}$

$\backslash\text{global } \backslash\text{advance } \backslash\text{lgwproofline by } 1$

$\backslash\text{xdef } \backslash\text{lgwellh } \{L\backslash\text{ifnum } \backslash\text{lgwproofline } <10\ 0\backslash\text{fi } \backslash\text{number } \backslash\text{lgwproofline } \}$

$\backslash\text{fi } \backslash\text{lgwellh } \backslash\text{fi } \text{"}$

$[L_h \xrightarrow{\text{pyk}} \text{"ell h"}]$

$L_i$

$[L_i \xrightarrow{\text{name}} \text{"L\_i"}]$

$[L_i \xrightarrow{\text{tex}} \text{"}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwprooflinep}\backslash\text{endcsname } L_i \backslash\text{else}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwelli}\backslash\text{endcsname}$

$\backslash\text{global } \backslash\text{advance } \backslash\text{lgwproofline by } 1$

$\backslash\text{xdef } \backslash\text{lgwelli } \{L\backslash\text{ifnum } \backslash\text{lgwproofline } <10\ 0\backslash\text{fi } \backslash\text{number } \backslash\text{lgwproofline } \}$

$\backslash\text{fi } \backslash\text{lgwelli } \backslash\text{fi } \text{"}$

$[L_i \xrightarrow{\text{pyk}} \text{"ell i"}]$

$L_j$

$[L_j \xrightarrow{\text{name}} \text{"L\_j"}]$

$[L_j \xrightarrow{\text{tex}} \text{"}$

```

\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  $\xrightarrow{\text{pyk}}$  “ell j”]

```

$L_k$

```

[L_k  $\xrightarrow{\text{name}}$  “L_k”]
[L_k  $\xrightarrow{\text{tex}}$  “
\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  $\xrightarrow{\text{pyk}}$  “ell k”]

```

$L_l$

```

[L_l  $\xrightarrow{\text{name}}$  “L_l”]
[L_l  $\xrightarrow{\text{tex}}$  “
\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  $\xrightarrow{\text{pyk}}$  “ell l”]

```

$L_m$

```

[L_m  $\xrightarrow{\text{name}}$  “L_m”]
[L_m  $\xrightarrow{\text{tex}}$  “
\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<sub>m</sub>  $\xrightarrow{\text{pyk}}$  “ell m”]

L<sub>n</sub>

[L<sub>n</sub>  $\xrightarrow{\text{name}}$  “L\_n”]

[L<sub>n</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>n</sub>  $\xrightarrow{\text{pyk}}$  “ell n”]

L<sub>o</sub>

[L<sub>o</sub>  $\xrightarrow{\text{name}}$  “L\_o”]

[L<sub>o</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>o</sub>  $\xrightarrow{\text{pyk}}$  “ell o”]

L<sub>p</sub>

[L<sub>p</sub>  $\xrightarrow{\text{name}}$  “L\_p”]

[L<sub>p</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>p</sub>  $\xrightarrow{\text{pyk}}$  “ell p”]



$L_q$

$[L_q \xrightarrow{\text{name}} "L\_q"]$

$[L_q \xrightarrow{\text{tex}} "$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwprooflinep}\backslash\text{endcsname } L\_q \backslash\text{else}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwellq}\backslash\text{endcsname}$

$\backslash\text{global } \backslash\text{advance } \backslash\text{lgwproofline by } 1$

$\backslash\text{xdef } \backslash\text{lgwellq } \{L\backslash\text{ifnum } \backslash\text{lgwproofline } <10\ 0\backslash\text{fi } \backslash\text{number } \backslash\text{lgwproofline } \}$

$\backslash\text{fi } \backslash\text{lgwellq } \backslash\text{fi } "$

$[L_q \xrightarrow{\text{pyk}} "ell\ q"]$

$L_r$

$[L_r \xrightarrow{\text{name}} "L\_r"]$

$[L_r \xrightarrow{\text{tex}} "$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwprooflinep}\backslash\text{endcsname } L\_r \backslash\text{else}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwellr}\backslash\text{endcsname}$

$\backslash\text{global } \backslash\text{advance } \backslash\text{lgwproofline by } 1$

$\backslash\text{xdef } \backslash\text{lgwellr } \{L\backslash\text{ifnum } \backslash\text{lgwproofline } <10\ 0\backslash\text{fi } \backslash\text{number } \backslash\text{lgwproofline } \}$

$\backslash\text{fi } \backslash\text{lgwellr } \backslash\text{fi } "$

$[L_r \xrightarrow{\text{pyk}} "ell\ r"]$

$L_s$

$[L_s \xrightarrow{\text{name}} "L\_s"]$

$[L_s \xrightarrow{\text{tex}} "$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwprooflinep}\backslash\text{endcsname } L\_s \backslash\text{else}$

$\backslash\text{if } \backslash\text{relax } \backslash\text{csname } \text{lgwells}\backslash\text{endcsname}$

$\backslash\text{global } \backslash\text{advance } \backslash\text{lgwproofline by } 1$

$\backslash\text{xdef } \backslash\text{lgwells } \{L\backslash\text{ifnum } \backslash\text{lgwproofline } <10\ 0\backslash\text{fi } \backslash\text{number } \backslash\text{lgwproofline } \}$

$\backslash\text{fi } \backslash\text{lgwells } \backslash\text{fi } "$

$[L_s \xrightarrow{\text{pyk}} "ell\ s"]$

$L_t$

$[L_t \xrightarrow{\text{name}} "L\_t"]$

$[L_t \xrightarrow{\text{tex}} "$

```

\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  $\xrightarrow{\text{pyk}}$  “ell t”]

```

**L<sub>u</sub>**

```

[L_u  $\xrightarrow{\text{name}}$  “L_u”]

[L_u  $\xrightarrow{\text{tex}}$  “
\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  $\xrightarrow{\text{pyk}}$  “ell u”]

```

**L<sub>v</sub>**

```

[L_v  $\xrightarrow{\text{name}}$  “L_v”]

[L_v  $\xrightarrow{\text{tex}}$  “
\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  $\xrightarrow{\text{pyk}}$  “ell v”]

```

**L<sub>w</sub>**

```

[L_w  $\xrightarrow{\text{name}}$  “L_w”]

[L_w  $\xrightarrow{\text{tex}}$  “
\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<sub>w</sub>  $\xrightarrow{\text{pyk}}$  “ell w”]

L<sub>x</sub>

[L<sub>x</sub>  $\xrightarrow{\text{name}}$  “L<sub>x</sub>”]

[L<sub>x</sub>  $\xrightarrow{\text{tex}}$  “

\if \relax \csname lgwprooflinep\endcsname L<sub>x</sub> \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<sub>x</sub>  $\xrightarrow{\text{pyk}}$  “ell x”]

L<sub>y</sub>

[L<sub>y</sub>  $\xrightarrow{\text{name}}$  “L<sub>y</sub>”]

[L<sub>y</sub>  $\xrightarrow{\text{tex}}$  “

\if \relax \csname lgwprooflinep\endcsname L<sub>y</sub> \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<sub>y</sub>  $\xrightarrow{\text{pyk}}$  “ell y”]

L<sub>z</sub>

[L<sub>z</sub>  $\xrightarrow{\text{name}}$  “L<sub>z</sub>”]

[L<sub>z</sub>  $\xrightarrow{\text{tex}}$  “

\if \relax \csname lgwprooflinep\endcsname L<sub>z</sub> \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<sub>z</sub>  $\xrightarrow{\text{pyk}}$  “ell z”]

L<sub>A</sub>

[L<sub>A</sub>  $\xrightarrow{\text{name}}$  “L\_A”]

[L<sub>A</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>A</sub>  $\xrightarrow{\text{pyk}}$  “ell big a”]

L<sub>B</sub>

[L<sub>B</sub>  $\xrightarrow{\text{name}}$  “L\_B”]

[L<sub>B</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>B</sub>  $\xrightarrow{\text{pyk}}$  “ell big b”]

L<sub>C</sub>

[L<sub>C</sub>  $\xrightarrow{\text{name}}$  “L\_C”]

[L<sub>C</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>C</sub>  $\xrightarrow{\text{pyk}}$  “ell big c”]

L<sub>D</sub>

[L<sub>D</sub>  $\xrightarrow{\text{name}}$  “L\_D”]

[L<sub>D</sub>  $\xrightarrow{\text{tex}}$  “

```

\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 ”}
[L_D  $\xrightarrow{\text{pyk}}$  “ell big d”]

```

## L<sub>E</sub>

```

[L_E  $\xrightarrow{\text{name}}$  “L_E”]
[L_E  $\xrightarrow{\text{tex}}$  “
\if \relax \csname lgwprooflinep\endcsname L_E \else
\if \relax \csname lgwellbigd\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbigd {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigd \fi ”}
[L_E  $\xrightarrow{\text{pyk}}$  “ell big e”]

```

## L<sub>F</sub>

```

[L_F  $\xrightarrow{\text{name}}$  “L_F”]
[L_F  $\xrightarrow{\text{tex}}$  “
\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 ”}
[L_F  $\xrightarrow{\text{pyk}}$  “ell big f”]

```

## L<sub>G</sub>

```

[L_G  $\xrightarrow{\text{name}}$  “L_G”]
[L_G  $\xrightarrow{\text{tex}}$  “
\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<sub>G</sub>  $\xrightarrow{\text{pyk}}$  “ell big g”]

## L<sub>H</sub>

[L<sub>H</sub>  $\xrightarrow{\text{name}}$  “L\_H”]

[L<sub>H</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>H</sub>  $\xrightarrow{\text{pyk}}$  “ell big h”]

## L<sub>I</sub>

[L<sub>I</sub>  $\xrightarrow{\text{name}}$  “L\_I”]

[L<sub>I</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>I</sub>  $\xrightarrow{\text{pyk}}$  “ell big i”]

## L<sub>J</sub>

[L<sub>J</sub>  $\xrightarrow{\text{name}}$  “L\_J”]

[L<sub>J</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>J</sub>  $\xrightarrow{\text{pyk}}$  “ell big j”]

## L<sub>K</sub>

[L<sub>K</sub>  $\xrightarrow{\text{name}}$  “L\_K”]

[L<sub>K</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>K</sub>  $\xrightarrow{\text{pyk}}$  “ell big k”]

## L<sub>L</sub>

[L<sub>L</sub>  $\xrightarrow{\text{name}}$  “L\_L”]

[L<sub>L</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>L</sub>  $\xrightarrow{\text{pyk}}$  “ell big l”]

## L<sub>M</sub>

[L<sub>M</sub>  $\xrightarrow{\text{name}}$  “L\_M”]

[L<sub>M</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>M</sub>  $\xrightarrow{\text{pyk}}$  “ell big m”]

## L<sub>N</sub>

[L<sub>N</sub>  $\xrightarrow{\text{name}}$  “L\_N”]

[L<sub>N</sub>  $\xrightarrow{\text{tex}}$  “

```

\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 ”]
[L_N  $\xrightarrow{\text{pyk}}$  “ell big n”]

```

L<sub>O</sub>

```

[L_O  $\xrightarrow{\text{name}}$  “L_O”]
[L_O  $\xrightarrow{\text{tex}}$  “
\if \relax \csname lgwprooflinep\endcsname L_O \else
\if \relax \csname lgwellbig0\endcsname
\global \advance \lgwproofline by 1
\xdef \lgwellbig0 {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbig0 \fi ”]
[L_O  $\xrightarrow{\text{pyk}}$  “ell big o”]

```

L<sub>P</sub>

```

[L_P  $\xrightarrow{\text{name}}$  “L_P”]
[L_P  $\xrightarrow{\text{tex}}$  “
\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 ”]
[L_P  $\xrightarrow{\text{pyk}}$  “ell big p”]

```

L<sub>Q</sub>

```

[L_Q  $\xrightarrow{\text{name}}$  “L_Q”]
[L_Q  $\xrightarrow{\text{tex}}$  “
\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<sub>Q</sub>  $\xrightarrow{\text{pyk}}$  “ell big q”]

L<sub>R</sub>

[L<sub>R</sub>  $\xrightarrow{\text{name}}$  “L\_R”]

[L<sub>R</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>R</sub>  $\xrightarrow{\text{pyk}}$  “ell big r”]

L<sub>S</sub>

[L<sub>S</sub>  $\xrightarrow{\text{name}}$  “L\_S”]

[L<sub>S</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>S</sub>  $\xrightarrow{\text{pyk}}$  “ell big s”]

L<sub>T</sub>

[L<sub>T</sub>  $\xrightarrow{\text{name}}$  “L\_T”]

[L<sub>T</sub>  $\xrightarrow{\text{tex}}$  “  
\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<sub>T</sub>  $\xrightarrow{\text{pyk}}$  “ell big t”]

## L<sub>U</sub>

[L<sub>U</sub>  $\xrightarrow{\text{name}}$  “L-U”]

[L<sub>U</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>U</sub>  $\xrightarrow{\text{pyk}}$  “ell big u”]

## L<sub>V</sub>

[L<sub>V</sub>  $\xrightarrow{\text{name}}$  “L-V”]

[L<sub>V</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>V</sub>  $\xrightarrow{\text{pyk}}$  “ell big v”]

## L<sub>W</sub>

[L<sub>W</sub>  $\xrightarrow{\text{name}}$  “L-W”]

[L<sub>W</sub>  $\xrightarrow{\text{tex}}$  “

\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<sub>W</sub>  $\xrightarrow{\text{pyk}}$  “ell big w”]

## L<sub>X</sub>

[L<sub>X</sub>  $\xrightarrow{\text{name}}$  “L-X”]

[L<sub>X</sub>  $\xrightarrow{\text{tex}}$  “

```

\if \relax \csname lgwprooflinep\endcsname L_X \else
\if \relax \csname lgwellbigx\endcsname
\global \advance \lgwproofline by 1
\edef \lgwellbigx {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigx \fi ”]
[L_X pyk → “ell big x”]

```

## L<sub>Y</sub>

```

[L_Y name → “L_Y”]
[L_Y tex → “
\if \relax \csname lgwprooflinep\endcsname L_Y \else
\if \relax \csname lgwellbigy\endcsname
\global \advance \lgwproofline by 1
\edef \lgwellbigy {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigy \fi ”]
[L_Y pyk → “ell big y”]

```

## L<sub>Z</sub>

```

[L_Z name → “L_Z”]
[L_Z tex → “
\if \relax \csname lgwprooflinep\endcsname L_Z \else
\if \relax \csname lgwellbigz\endcsname
\global \advance \lgwproofline by 1
\edef \lgwellbigz {L\ifnum \lgwproofline <10 0\fi \number \lgwproofline }
\fi \lgwellbigz \fi ”]
[L_Z pyk → “ell big z”]

```

## L<sub>?</sub>

```

[L_? name → “L_?”]
[L_? tex → “
\if \relax \csname lgwprooflinep\endcsname L_? \else
\global \advance \lgwproofline by 1
L\ifnum \lgwproofline <10 0\fi \number \lgwproofline
\fi ”]
[L_? pyk → “ell dummy”]

```

## Reflexivity

[Reflexivity  $\xrightarrow{\text{proof}}$   $[\text{T}_E \vdash \forall \underline{a}: \text{HeadPair}^{I \triangleright * \triangleright} @ \underline{a} @ \underline{a}; \text{Transitivity}^{I \triangleright * \triangleright} @ \underline{a} :: \underline{a}^h @ \underline{a} @ \underline{a}^{\triangleright \triangleright}]$ ]

[Reflexivity  $\xrightarrow{\text{stmt}}$   $\text{T}_E \vdash \forall \underline{a}: \underline{a} = \underline{a}$ ]

[Reflexivity  $\xrightarrow{\text{tex}}$  “  
Reflexivity”]

[Reflexivity  $\xrightarrow{\text{pyk}}$  “sequent reflexivity”]

## Reflexivity<sub>1</sub>

[Reflexivity<sub>1</sub>  $\xrightarrow{\text{proof}}$   $\lambda c. \lambda x. \mathcal{P}([\text{T}_E \vdash \forall \underline{a}: \text{HeadPair} \gg \underline{a} :: \underline{a}^h = \underline{a}; \text{Transitivity} \triangleright \underline{a} :: \underline{a}^h = \underline{a} \triangleright \underline{a} :: \underline{a}^h = \underline{a} \gg \underline{a} = \underline{a}], p_0, c)$ ]

[Reflexivity<sub>1</sub>  $\xrightarrow{\text{stmt}}$   $\text{T}_E \vdash \forall \underline{a}: \underline{a} = \underline{a}$ ]

[Reflexivity<sub>1</sub>  $\xrightarrow{\text{tex}}$  “  
Reflexivity<sub>1</sub>”]

[Reflexivity<sub>1</sub>  $\xrightarrow{\text{pyk}}$  “tactic reflexivity”]

## Commutativity

[Commutativity  $\xrightarrow{\text{proof}}$   $[\text{T}_E \vdash \forall \underline{a}: \forall \underline{b}: \underline{a} = \underline{b} \vdash \text{Reflexivity}^{I \triangleright * \triangleright} @ \underline{a}; \text{Transitivity}^{I \triangleright * \triangleright} @ \underline{a} @ \underline{b} @ \underline{a}^{\triangleright \triangleright}]$ ]

[Commutativity  $\xrightarrow{\text{stmt}}$   $\text{T}_E \vdash \forall \underline{a}: \forall \underline{b}: \underline{a} = \underline{b} \vdash \underline{b} = \underline{a}$ ]

[Commutativity  $\xrightarrow{\text{tex}}$  “  
Commutativity”]

[Commutativity  $\xrightarrow{\text{pyk}}$  “sequent commutativity”]

## Commutativity<sub>1</sub>

[Commutativity<sub>1</sub>  $\xrightarrow{\text{proof}}$   $\lambda c. \lambda x. \mathcal{P}([\text{T}_E \vdash \forall \underline{a}: \forall \underline{b}: \underline{a} = \underline{b} \vdash \text{Reflexivity}_1 \gg \underline{a} = \underline{a}; \text{Transitivity} \triangleright \underline{a} = \underline{b} \triangleright \underline{a} = \underline{a} \gg \underline{b} = \underline{a}], p_0, c)$ ]

[Commutativity<sub>1</sub>  $\xrightarrow{\text{stmt}}$   $\text{T}_E \vdash \forall \underline{a}: \forall \underline{b}: \underline{a} = \underline{b} \vdash \underline{b} = \underline{a}$ ]

[Commutativity<sub>1</sub>  $\xrightarrow{\text{tex}}$  “  
Commutativity<sub>1</sub>”]

[Commutativity<sub>1</sub>  $\xrightarrow{\text{pyk}}$  “tactic commutativity”]

<tactic>

[<tactic>  $\xrightarrow{\text{val}}$  [<tactic>]]

[<tactic>  $\xrightarrow{\text{tex}}$  “  
{<}tactic{>}”]

[<tactic>  $\xrightarrow{\text{pyk}}$  “the tactic aspect”]

tactic

[tactic  $\xrightarrow{\text{msg}}$  <tactic>]

[tactic  $\xrightarrow{\text{tex}}$  “  
tactic”]

[tactic  $\xrightarrow{\text{pyk}}$  “tactic”]

[\*  $\stackrel{\text{tactic}}{=}$  \*]

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

[[x  $\stackrel{\text{tactic}}{=}$  y]  $\xrightarrow{\text{tex}}$  “  
[#1/tex name/tex.  
\stackrel{tactic}{=}#2.  
]”]

[[\*  $\stackrel{\text{tactic}}{=}$  \*]  $\xrightarrow{\text{pyk}}$  “tactic define " as " end define”]

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

[ $\mathcal{P}(t, s, c) \xrightarrow{\text{val}}$  s!  
let<sub>1</sub>( $\lambda d.$   
If( $d, t^h :: \mathcal{P}^*(t^t, s, c),$   
 $\mathcal{U}^M(\mathcal{E}(d^3, T, c) \text{ ‘ } t \text{ ‘ } s \text{ ‘ } c)$ ), **aspect**(<tactic>, t, c))]

[ $\mathcal{P}(t, s, c) \xrightarrow{\text{tex}}$  “  
{\cal P}( #1.  
, #2.  
, #3.  
)”]

$[\mathcal{P}(*, *, *) \xrightarrow{\text{pyk}} \text{"proof expand " state " cache " end expand"}]$

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

$[\mathcal{P}^*(t, s, c) \xrightarrow{\text{val}} \text{s!c!If}(t, T, \mathcal{P}(t^h, s, c) :: \mathcal{P}^*(t^t, s, c))]$

$[\mathcal{P}^*(t, s, c) \xrightarrow{\text{tex}} \text{"}$   
 $\{\backslash\text{cal P}\}^*( \#1.$   
 $, \#2.$   
 $, \#3.$   
 $)"]]$

$[\mathcal{P}^*(*, *, *) \xrightarrow{\text{pyk}} \text{"proof expand list " state " cache " end expand"}]$

$P_0$

$[p_0 \xrightarrow{\text{val}} \mathcal{M}(\lambda t. \lambda s. \lambda c. \mathcal{P}(t, s, c)) :: T]$

$[p_0 \xrightarrow{\text{tex}} \text{"}$   
 $p-0"]]$

$[p_0 \xrightarrow{\text{pyk}} \text{"proof state"}]$

$\text{conclude}_1(*, *)$

$[\text{conclude}_1(t, c) \xrightarrow{\text{val}}$

$\text{let}_1(\lambda r.$

$\text{If}(r^c, \text{error}_2([\text{"Unification failed"}], t), r), \text{conclude}_2(t^1, t^2, c))]$

$[\text{conclude}_1(t, c) \xrightarrow{\text{tex}} \text{"}$

$\text{conclude}_1 ( \#1.$

$, \#2.$

$)"]]$

$[\text{conclude}_1(*, *) \xrightarrow{\text{pyk}} \text{"conclude one " cache " end conclude"}]$

$\text{conclude}_2(*, *, *)$

$[\text{conclude}_2(a, t, c) \xrightarrow{\text{val}} t!$

$\text{If}(a \stackrel{r}{=} [x \triangleright y], \text{conclude}_2(a^1, a\text{-color}(t \triangleright a^2), c),$

$\text{If}(a \stackrel{r}{=} [x \triangleright\triangleright y], \text{conclude}_2(a^1, a\text{-color}(t \triangleright\triangleright a^2), c),$

If( $a \stackrel{r}{=} [x @ y]$ ,  $\text{conclude}_2(a^1, a\text{-color}(t @ a^2), c)$ ,  
 If(**aspect**( $\langle \text{proof} \rangle$ ,  $a, c$ ),  $\text{error}_2(\lceil \text{"Lemma expected"} \rceil, a)$ ,  
 $\text{let}_1(\lambda d.$   
 $\text{conclude}_3(a\text{-color}(\text{conclude}_4(a^{I \triangleright * \triangleright}, d^{32})), t, \text{parm}(d^{32}, T, 1), T)$ , **aspect**( $\langle \text{stmt} \rangle$ ,  $a,$   
 $[\text{conclude}_2(a, t, c) \xrightarrow{\text{tex}} \text{"$   
 $\text{conclude}_2 ( \#1.$   
 $, \#2.$   
 $, \#3.$   
 $)]$   
 $[\text{conclude}_2(*, *, *) \xrightarrow{\text{pyk}} \text{"conclude two " proves " cache " end conclude"}]$

$\text{conclude}_3(*, *, *, *)$

$[\text{conclude}_3(a, t, l, s) \xrightarrow{\text{val}} a!t!!s!$   
 If( $l \stackrel{r}{=} [x \vdash y]$ ,  
 $t \stackrel{r}{=} [x \triangleright y] \left\{ \begin{array}{l} \text{conclude}_3(a^\triangleright, t^1, l^2, \text{unify}(l^1 = t^2, s)) \\ \text{conclude}_3(a^\triangleright, t, l^2, s) \end{array} \right. ,$   
 If( $l \stackrel{r}{=} [x \# y]$ ,  
 $t \stackrel{r}{=} [x \triangleright y] \left\{ \begin{array}{l} \text{conclude}_3(a^\triangleright, t^1, l^2, \text{unify}(l^1 = t^2, s)) \\ \text{conclude}_3(a^V, t, l^2, s) \end{array} \right. ,$   
 If( $l \stackrel{r}{=} [\forall x: y]$ ,  
 $t \stackrel{r}{=} [x @ y] \left\{ \begin{array}{l} \text{conclude}_3(a @ t^2, t^1, l^2, \text{unify}(l^1 = t^2, s)) \\ \text{conclude}_3(a @ l^1, t, l^2, s) \end{array} \right. ,$   
 $\text{let}_1(\lambda s.$   
 If( $s^c, s,$   
 $\text{inst}(a, s), \text{unify}(l = t, s))))]$   
 $[\text{conclude}_3(a, t, l, s) \xrightarrow{\text{tex}} \text{"$   
 $\text{conclude}_3 ( \#1.$   
 $, \#2.$   
 $, \#3.$   
 $, \#4.$   
 $)]$   
 $[\text{conclude}_3(*, *, *, *) \xrightarrow{\text{pyk}} \text{"conclude three " proves " lemma " substitution " end$   
 $\text{conclude"}]$

$\text{conclude}_4(*, *)$

$[\text{conclude}_4(a, l) \xrightarrow{\text{val}} a!!!$   
 If( $\neg l \stackrel{r}{=} [\forall x: y]$ ,  $a,$

let<sub>1</sub>( $\lambda v. \forall v: \text{conclude}_4(\mathbf{a} @ v, l^2), [*_]^R :: l^1 :: T$ )])

[conclude<sub>4</sub>(a, l)  $\xrightarrow{\text{tex}}$  “  
conclude\_4 ( #1.  
, #2.  
)”]

[conclude<sub>4</sub>(\*, \*)  $\xrightarrow{\text{pyk}}$  “conclude four " lemma " end conclude”]

\*\_{\{\*\}}

[\*\_{\{\*\}}  $\xrightarrow{\text{name}}$  “#1.  
\\_{\{#2.  
\}”]

[\*\_{\{\*\}}  $\xrightarrow{\text{tex}}$  “#1.  
-{\#2.  
}”]

[\*\_{\{\*\}}  $\xrightarrow{\text{pyk}}$  “" sub " end sub”]

\*/indexintro(\*, \*, \*, \*)

[x/indexintro(y, i, p, t)  $\xrightarrow{\text{name}}$  “#1.  
/indexintro(#2.  
, #3.  
, #4.  
, #5.  
)”]

[x/indexintro(y, i, p, t)  $\xrightarrow{\text{macro}}$   $\lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[x/indexintro(y, i, p, t) \doteq$   
 $\times \$[y \stackrel{\text{tex}}{=} t] \$ ]])$ ]

[x/indexintro(y, i, p, t)  $\xrightarrow{\text{tex}}$  “#1.%  
\footnote{\\$[#2/tex name/tex.  
\stackrel{\text{pyk}}{\mathrm{pyk}}\{=\} #4/tex name.  
]\$} \index{\#3.: #4. @\#3.: \\$[#2/tex name/tex.]\$ #4.}%  
\index{\text{pyk}: #4. \\$[#2/tex name/tex.]\$}%  
\tex{\\$[#2/tex name/tex.  
\stackrel{\text{tex}}{\mathrm{tex}}\{=\} #5/tex name.  
]\$}”]

[\*/indexintro(\*, \*, \*, \*)  $\xrightarrow{\text{pyk}}$  “" intro " index " pyk " tex " end intro”]



`*/intro(*, *, *)`

```
[x/intro(y, p, t)  $\xrightarrow{\text{name}}$  "#1.  
/intro(#2.  
, #3.  
, #4.  
)"]
```

```
[x/intro(y, p, t)  $\xrightarrow{\text{macro}}$  \t.\l.s.\l.c.\tilde{\mathcal{M}}_4(t, s, c, [[x/intro(y, p, t) \doteq x $[y \stackrel{\text{tex}}{=} t]$ ]])]
```

```
[x/intro(y, p, t)  $\xrightarrow{\text{tex}}$  "#1.%  
\footnote{${#2/tex name/tex.  
\stackrel{\text{rel}}{\mathrm}{pyk}}{=} #3/tex name.  
]} \index{\alpha #3. @\backslash\makebox[20mm]{l}{${#2/tex  
name/tex.}]$} #3.}%  
\index{pyk: #3. ${#2/tex name/tex.}]$}%  
\tex{  
${#2/tex name/tex.  
\stackrel{\text{rel}}{\mathrm}{tex}}{=} #4/tex name.  
}$"]
```

```
[*/intro(*, *, *)  $\xrightarrow{\text{pyk}}$  "\" intro " pyk " tex " end intro"]
```

`*/bothintro(*, *, *, *, *)`

```
[x/bothintro(y, i, p, t, n)  $\xrightarrow{\text{name}}$  "#1.  
/bothintro(#2.  
, #3.  
, #4.  
, #5.  
, #6.  
)"]
```

```
[x/bothintro(y, i, p, t, n)  $\xrightarrow{\text{macro}}$  \t.\l.s.\l.c.\tilde{\mathcal{M}}_4(t, s, c, [[x/bothintro(y, i, p, t, n) \doteq  
x $[y \stackrel{\text{tex}}{=} t]$ $[y \stackrel{\text{name}}{=} n]$ ]])]
```

```
[x/bothintro(y, i, p, t, n)  $\xrightarrow{\text{tex}}$  "#1.%  
\footnote{${#2/tex name/tex.  
\stackrel{\text{rel}}{\mathrm}{pyk}}{=} #4/tex name.  
]} \index{#3.: #4. @#3.: ${#2/tex name/tex.}]$ #4.}%  
\index{pyk: #4. ${#2/tex name/tex.}]$}%  
\tex{  
${#2/tex name/tex.  
\stackrel{\text{rel}}{\mathrm}{tex}}{=} #5/tex name.  
}$  
\tex{
```

$\$[\#2/\text{tex name}/\text{tex}.$

$\backslash\text{stackrel}\{\backslash\text{mathrm}\{\text{name}\}\}\{=\}\#6/\text{tex name}.$

$]\$”]$

$[*/\text{bothintro}(*, *, *, *, *) \xrightarrow{\text{pyk}} \text{“} \text{“ intro " index " pyk " tex " name " end intro”}]$

$*/\text{nameintro}(*, *, *, *, *)$

$[x/\text{nameintro}(y, p, t, n) \xrightarrow{\text{name}} \text{“}\#1.$

$/\text{nameintro}(\#2.$

$, \#3.$

$, \#4.$

$, \#5.$

$)”]$

$[x/\text{nameintro}(y, p, t, n) \xrightarrow{\text{macro}} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[x/\text{nameintro}(y, p, t, n) \doteq$

$\times \$[y \stackrel{\text{tex}}{=} t] \$ \$[y \stackrel{\text{name}}{=} n] \$ ])]$

$[x/\text{nameintro}(y, p, t, n) \xrightarrow{\text{tex}} \text{“}\#1.\%$

$\backslash\text{footnote}\{ \$[\#2/\text{tex name}/\text{tex}.$

$\backslash\text{stackrel}\{\backslash\text{mathrm}\{\text{pyk}\}\}\{=\}\#3/\text{tex name}.$

$]\$}\backslash\text{index}\{\backslash\alpha \#3. @\backslash\backslash\text{makebox}[20\text{mm}][l]\{ \$[\#2/\text{tex$

$\text{name}/\text{tex}.\] \$}\#3.\}\%$

$\backslash\text{index}\{\text{pyk: } \#3. \$[\#2/\text{tex name}/\text{tex}.\] \$}\%$

$\backslash\text{tex}\{$

$\$[\#2/\text{tex name}/\text{tex}.$

$\backslash\text{stackrel}\{\backslash\text{mathrm}\{\text{tex}\}\}\{=\}\#4/\text{tex name}.$

$]\$}$

$\backslash\text{tex}\{$

$\$[\#2/\text{tex name}/\text{tex}.$

$\backslash\text{stackrel}\{\backslash\text{mathrm}\{\text{name}\}\}\{=\}\#5/\text{tex name}.$

$]\$”]$

$[*/\text{nameintro}(*, *, *, *, *) \xrightarrow{\text{pyk}} \text{“} \text{“ intro " pyk " tex " name " end intro”}]$

$*'$

$[x' \xrightarrow{\text{tex}} \text{“}\#1.”]$

$[*' \xrightarrow{\text{pyk}} \text{“} \text{“ prime”}]$

\* [ \* ]

[a[k]  $\xrightarrow{\text{val}}$  **assoc**<sub>1</sub>(a, k, k)]

[\* [ \* ]  $\xrightarrow{\text{tex}}$  “#1.

{ } #2.

{ } ”]

[\* [ \* ]  $\xrightarrow{\text{pyk}}$  “ **assoc**  end **assoc**”]

\* [ \*  $\rightarrow$  \* ]

[a[i  $\rightarrow$  v]  $\xrightarrow{\text{val}}$  i<sup>c</sup>  $\left\{ \begin{array}{l} v \left\{ \begin{array}{l} \text{array-remove}(i, a, 0) \\ \text{array-put}(i, v, a, 0) \end{array} \right. \\ v!a \end{array} \right. \right]$

[a[i  $\rightarrow$  v]  $\xrightarrow{\text{tex}}$  “#1.

[ #2.

{ \rightarrow } #3.

]”]

[\* [ \*  $\rightarrow$  \* ]  $\xrightarrow{\text{pyk}}$  “ **set**  to  end **set**”]

\* [ \*  $\Rightarrow$  \* ]

[a[i  $\Rightarrow$  v]  $\xrightarrow{\text{val}}$  i<sup>a</sup>  $\left\{ \begin{array}{l} a!v \\ a[i^h \rightarrow a[i^h][i^t \Rightarrow v]] \end{array} \right. \right]$

[a[i  $\Rightarrow$  v]  $\xrightarrow{\text{tex}}$  “#1.

[ #2.

{ \Rightarrow } #3.

]”]

[\* [ \*  $\Rightarrow$  \* ]  $\xrightarrow{\text{pyk}}$  “ **set multi**  to  end **set**”]

\* 0

[x0  $\xrightarrow{\text{val}}$  **T** + 2 \* x]

[\* 0  $\xrightarrow{\text{tex}}$  “#1.

0”]

[\* 0  $\xrightarrow{\text{pyk}}$  “ **bit nil**”]

**\*1**

[x1  $\xrightarrow{\text{val}}$  F +2\* x]

[\*1  $\xrightarrow{\text{tex}}$  “#1.  
1”]

[\*1  $\xrightarrow{\text{pyk}}$  “" bit one”]

**0b**

[0b  $\xrightarrow{\text{val}}$  0]

[0b  $\xrightarrow{\text{tex}}$  “  
0 \mathrm {b}”]

[0b  $\xrightarrow{\text{pyk}}$  “binary”]

**\*-color(\*)**

[a-color(t)  $\xrightarrow{\text{val}}$  t<sup>d</sup> { t<sup>r</sup> :: t<sup>i</sup> :: a<sup>d</sup> :: a-color\*(t<sup>t</sup>) }  
a!t ]

[x-color(y)  $\xrightarrow{\text{tex}}$  “#1.  
\mbox {-color}( #2.  
)”]

[\*-color(\*)  $\xrightarrow{\text{pyk}}$  “" color " end color”]

**\*-color\*(\*)**

[a-color\*(t)  $\xrightarrow{\text{val}}$  t { a!T  
a-color(t<sup>h</sup>) :: a-color\*(t<sup>t</sup>) } ]

[x-color\*(y)  $\xrightarrow{\text{tex}}$  “#1.  
\mbox {-color}^{\ast}( #2.  
)”]

[\*-color\*(\*)  $\xrightarrow{\text{pyk}}$  “" color star " end color”]

**\*<sup>H</sup>**

[x<sup>H</sup>  $\xrightarrow{\text{val}}$  x ' T]

$[*^H \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\}^H]$

$[*^H \xrightarrow{\text{pyk}} \text{" raw head"}]$

$*^T$

$[x^T \xrightarrow{\text{val}} x' F]$

$[*^T \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\}^T]$

$[*^T \xrightarrow{\text{pyk}} \text{" raw tail"}]$

$*^U$

$[x^U \xrightarrow{\text{val}} \text{if}(x^H, x^T, T)]$

$[*^U \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\}^U]$

$[*^U \xrightarrow{\text{pyk}} \text{" cardinal untag"}]$

$*^h$

$[x^h \xrightarrow{\text{val}} x^{MTH}]$

$[*^h \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\}^h]$

$[*^h \xrightarrow{\text{pyk}} \text{" head"}]$

$*^t$

$[x^t \xrightarrow{\text{val}} \text{if}(x^d, \text{if}(x^c, T \dot{\vdash} x^{MTT}, x^{MTT}), T)]$

$[*^t \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\}^t]$

$[*^t \xrightarrow{\text{pyk}} \text{" tail"}]$

\*<sup>S</sup>

[ $x^s \xrightarrow{\text{val}} x^{\text{MTB}}$ ]

[\*<sup>s</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ s”]

[\*<sup>s</sup>  $\xrightarrow{\text{pyk}}$  “n is singular”]

\*<sup>C</sup>

[ $x^c \xrightarrow{\text{val}} \text{if}(x, F, x^{\text{MHB}})$ ]

[\*<sup>c</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ c”]

[\*<sup>c</sup>  $\xrightarrow{\text{pyk}}$  “n is cardinal”]

\*<sup>d</sup>

[ $x^d \xrightarrow{\text{val}} x^{\text{MHTHB}}$ ]

[\*<sup>d</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ d”]

[\*<sup>d</sup>  $\xrightarrow{\text{pyk}}$  “n is data”]

\*<sup>a</sup>

[ $x^a \xrightarrow{\text{val}} \neg x^d \vee x^c \vee x^s$ ]

[\*<sup>a</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ a”]

[\*<sup>a</sup>  $\xrightarrow{\text{pyk}}$  “n is atomic”]

\*<sup>C</sup>

[ $x^C \xrightarrow{\text{val}} \text{if}(x, T, x^{\text{HB}} \pm 2* x^{\text{TC}})$ ]

[\*<sup>C</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ C”]

[\*<sup>C</sup>  $\xrightarrow{\text{pyk}}$  “n cardinal retract”]

\*M

[x<sup>M</sup>  $\xrightarrow{\text{val}}$  if(x, T, if(x<sup>H</sup>, T  $\dot{::}$  x<sup>TC</sup>, if(x<sup>HTH</sup>, x<sup>THM</sup>  $\dot{::}$  x<sup>TTM</sup>,  $\mathcal{M}(x^T)$ )))]

[\*M  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ M”]

[\*M  $\xrightarrow{\text{pyk}}$  “# tagged retract”]

\*B

[x<sup>B</sup>  $\xrightarrow{\text{val}}$  if(x, T, F)]

[\*B  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ B”]

[\*B  $\xrightarrow{\text{pyk}}$  “# boolean retract”]

\*r

[x<sup>r</sup>  $\xrightarrow{\text{val}}$  x<sup>hh</sup>]

[x<sup>r</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ {r}”]

[\*r  $\xrightarrow{\text{pyk}}$  “# ref”]

\*i

[x<sup>i</sup>  $\xrightarrow{\text{val}}$  x<sup>hth</sup>]

[x<sup>i</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ {i}”]

[\*i  $\xrightarrow{\text{pyk}}$  “# id”]

\*d

[x<sup>d</sup>  $\xrightarrow{\text{val}}$  x<sup>htt</sup>]

[x<sup>d</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ {d}”]

[\*d  $\xrightarrow{\text{pyk}}$  “# debug”]

\*R

[x<sup>R</sup>  $\xrightarrow{\text{val}}$  x<sup>r</sup> :: x<sup>i</sup> :: T]

[x<sup>R</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ {R}”]

[\*<sup>R</sup>  $\xrightarrow{\text{pyk}}$  “n root”]

\*0

[x<sup>0</sup>  $\xrightarrow{\text{val}}$  x<sup>h</sup>]

[x<sup>0</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ {0}”]

[\*<sup>0</sup>  $\xrightarrow{\text{pyk}}$  “n zeroth”]

\*1

[x<sup>1</sup>  $\xrightarrow{\text{val}}$  x<sup>t0</sup>]

[x<sup>1</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ {1}”]

[\*<sup>1</sup>  $\xrightarrow{\text{pyk}}$  “n first”]

\*2

[x<sup>2</sup>  $\xrightarrow{\text{val}}$  x<sup>t1</sup>]

[x<sup>2</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ {2}”]

[\*<sup>2</sup>  $\xrightarrow{\text{pyk}}$  “n second”]

\*3

[x<sup>3</sup>  $\xrightarrow{\text{val}}$  x<sup>t2</sup>]

[x<sup>3</sup>  $\xrightarrow{\text{tex}}$  “#1.  
{ } ^ {3}”]

[\*<sup>3</sup>  $\xrightarrow{\text{pyk}}$  “n third”]



\*4

$[x^4 \xrightarrow{\text{val}} x^t3]$

$[x^4 \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\{\}^{\{4\}}"]$

$[*4 \xrightarrow{\text{pyk}} \text{" fourth"}]$

\*5

$[x^5 \xrightarrow{\text{val}} x^t4]$

$[x^5 \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\{\}^{\{5\}}"]$

$[*5 \xrightarrow{\text{pyk}} \text{" fifth"}]$

\*6

$[x^6 \xrightarrow{\text{val}} x^t5]$

$[x^6 \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\{\}^{\{6\}}"]$

$[*6 \xrightarrow{\text{pyk}} \text{" sixth"}]$

\*7

$[x^7 \xrightarrow{\text{val}} x^t6]$

$[x^7 \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\{\}^{\{7\}}"]$

$[*7 \xrightarrow{\text{pyk}} \text{" seventh"}]$

\*8

$[x^8 \xrightarrow{\text{val}} x^t7]$

$[x^8 \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\{\}^{\{8\}}"]$

$[*8 \xrightarrow{\text{pyk}} \text{" eighth"}]$

\*9

$[x^9 \xrightarrow{\text{val}} x^{t8}]$

$[x^9 \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{9\}"]$

$[*9 \xrightarrow{\text{pyk}} \text{" ninth"}]$

\*E

$[x^E \xrightarrow{\text{val}} x \stackrel{r}{=} [xy]]$

$[x^E \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{ E \}"]$

$[*E \xrightarrow{\text{pyk}} \text{" is error"}]$

\*V

$[t^V \xrightarrow{\text{val}} t \stackrel{r}{=} [\underline{a}]]$

$[t^V \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{\backslash\text{cal V}\}"]$

$[*V \xrightarrow{\text{pyk}} \text{" is metavar"}]$

\*C

$[t^C \xrightarrow{\text{val}} \text{If}(t^V, F, t^{tC^*})]$

$[t^C \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{\backslash\text{cal C}\}"]$

$[*C \xrightarrow{\text{pyk}} \text{" is metaclosed"}]$

\*C\*

$[t^{C^*} \xrightarrow{\text{val}} \text{If}(t, T, \text{If}(t^{tC}, t^{tC^*}, F))]$

$[t^{C^*} \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{\{\backslash\text{cal C}\} \wedge \{\backslash\text{ast}\}\}"]$

$[*C^* \xrightarrow{\text{pyk}} \text{" is metaclosed star"}]$

newline \*

[newline x  $\xrightarrow{\text{name}}$  “  
newline\ #1.”]

[newline x  $\xrightarrow{\text{val}}$  x<sup>M</sup>]

[newline x  $\xrightarrow{\text{tex}}$  “  
\newline #1.”]

[newline \*  $\xrightarrow{\text{pyk}}$  “newline ”]

macro newline \*

[macro newline x  $\xrightarrow{\text{name}}$  “  
macro\ newline\ #1.”]

[macro newline x  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\text{macro newline } x \doteq x]])$ ]

[macro newline x  $\xrightarrow{\text{tex}}$  “  
\newline #1.”]

[macro newline \*  $\xrightarrow{\text{pyk}}$  “macro newline ”]

\* ’ \*

Predef: apply

[\* ’  $\xrightarrow{\text{tex}}$  “#1.  
\mathbin {\mbox {’}}#2.”]

[\* ’  $\xrightarrow{\text{pyk}}$  “" apply ”]

\* ‘ \*

[f ‘ x  $\xrightarrow{\text{val}}$  **apply**(f, x)]

[\* ‘  $\xrightarrow{\text{tex}}$  “#1.  
\mathbin {\mbox {’}}#2.”]

[\* ‘  $\xrightarrow{\text{pyk}}$  “" tagged apply ”]

\* · \*

[x · y  $\xrightarrow{\text{val}}$  If(x<sup>c</sup> ∧ y<sup>c</sup>, x ·<sub>0</sub> y, T)]

[x · y  $\xrightarrow{\text{tex}}$  “#1.  
 $\backslash\text{cdot}$  #2.”]

[\* · \*  $\xrightarrow{\text{pyk}}$  “” times ””]

\* · 0 \*

[x · 0 y  $\xrightarrow{\text{val}}$  y<sup>s</sup>  $\left\{ \begin{array}{l} x!0 \\ y^h \left\{ \begin{array}{l} T + 2 * x \cdot 0 y^t \\ (T + 2 * x \cdot 0 y^t)^M + 0 x \end{array} \right. \end{array} \right.$  ]

[x · 0 y  $\xrightarrow{\text{tex}}$  “#1.  
 $\backslash\text{cdot}_0$  #2.”]

[\* · 0 \*  $\xrightarrow{\text{pyk}}$  “” times zero ””]

\* + \*

[x + y  $\xrightarrow{\text{val}}$  If(x<sup>c</sup> ∧ y<sup>c</sup>, x + 0 y, T)]

[x + y  $\xrightarrow{\text{tex}}$  “#1.  
 + #2.”]

[\* + \*  $\xrightarrow{\text{pyk}}$  “” plus ””]

\* + 0 \*

[x + 0 y  $\xrightarrow{\text{val}}$  x<sup>s</sup>  $\left\{ \begin{array}{l} y \\ y^s \left\{ \begin{array}{l} x \\ x^h \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} T + 2 * x^t + 0 y^t \\ F + 2 * x^t + 0 y^t \\ F + 2 * x^t + 0 y^t \\ T + 2 * x^t + 1 y^t \end{array} \right. \end{array} \right. \end{array} \right. \end{array} \right.$  ]

[x + 0 y  $\xrightarrow{\text{tex}}$  “#1.  
 $\backslash\text{mathop}\{+_0\}$  #2.”]

[\* + 0 \*  $\xrightarrow{\text{pyk}}$  “” plus zero ””]

\* +1 \*

$$[x +_1 y \xrightarrow{\text{val}} x^s \left\{ \begin{array}{l} y +_0 1 \\ y^s \end{array} \right\} x +_0 1 \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} F + 2* x^t +_0 y^t \\ T + 2* x^t +_1 y^t \end{array} \right\} \\ y^h \left\{ \begin{array}{l} T + 2* x^t +_1 y^t \\ F + 2* x^t +_1 y^t \end{array} \right\} \end{array} \right\} ]$$

[x +\_1 y \xrightarrow{\text{tex}} "#1.  
\mathop{+}\_1} #2."]

[\* +\_1 \* \xrightarrow{\text{pyk}} "# plus one "]

\* - \*

$$[x - y \xrightarrow{\text{val}} \text{If}(x^c \wedge y^c, \text{If}(x < y, 0, x -_0 y), T)]$$

[x - y \xrightarrow{\text{tex}} "#1.  
- #2."]

[\* - \* \xrightarrow{\text{pyk}} "# minus "]

\* -\_0 \*

$$[x -_0 y \xrightarrow{\text{val}} y^s \left\{ \begin{array}{l} x \\ x^h \end{array} \right\} \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} T + 2* x^t -_0 y^t \\ F + 2* x^t -_1 y^t \end{array} \right\} \\ y^h \left\{ \begin{array}{l} F + 2* x^t -_0 y^t \\ T + 2* x^t -_0 y^t \end{array} \right\} \end{array} \right\} ]$$

[x -\_0 y \xrightarrow{\text{tex}} "#1.  
\mathop{-}\_0} #2."]

[\* -\_0 \* \xrightarrow{\text{pyk}} "# minus zero "]

\* -\_1 \*

$$[x -_1 y \xrightarrow{\text{val}} y^s \left\{ \begin{array}{l} x -_0 1 \\ x^h \end{array} \right\} \left\{ \begin{array}{l} y^h \left\{ \begin{array}{l} F + 2* x^t -_1 y^t \\ T + 2* x^t -_1 y^t \end{array} \right\} \\ y^h \left\{ \begin{array}{l} T + 2* x^t -_0 y^t \\ F + 2* x^t -_1 y^t \end{array} \right\} \end{array} \right\} ]$$

[x -\_1 y  $\xrightarrow{\text{tex}}$  “#1.  
\mathop{-}\_1} #2.”]

[\* -\_1 \*  $\xrightarrow{\text{pyk}}$  “" minus one "”]

\*  $\cup$  { \* }

[x  $\cup$  { y }  $\xrightarrow{\text{val}}$  If(y  $\in_t$  x, x, y :: x)]

[x  $\cup$  { y }  $\xrightarrow{\text{tex}}$  “#1.  
\cup \{ #2.  
\}”]

[\*  $\cup$  { \* }  $\xrightarrow{\text{pyk}}$  “" term plus " end plus”]

\*  $\cup$  \*

[x  $\cup$  y  $\xrightarrow{\text{val}}$  If(x<sup>a</sup>, y, x<sup>t</sup>  $\cup$  y  $\cup$  { x<sup>h</sup> })]

[x  $\cup$  y  $\xrightarrow{\text{tex}}$  “#1.  
\cup #2.”]

[\*  $\cup$  \*  $\xrightarrow{\text{pyk}}$  “" term union "”]

\* \{ \* }

[x \{ y }  $\xrightarrow{\text{val}}$  If(x<sup>a</sup>, y! $\emptyset$ , If(y  $\stackrel{t}{=} x^h$ , x<sup>t</sup>, x<sup>h</sup> :: x<sup>t</sup> \{ y } ))]

[x \{ y }  $\xrightarrow{\text{tex}}$  “#1.  
\backslash \{ #2.  
\}”]

[\* \{ \* }  $\xrightarrow{\text{pyk}}$  “" term minus " end minus”]

\*  $\cdot$  \* \*

[y  $\cdot$  z  $\xrightarrow{\text{val}}$   $\lambda x.$ if(x, y, z)]

[\*  $\cdot$  \*  $\xrightarrow{\text{tex}}$  “#1.  
\mathrel { \dot { . \, \, . } } #2.”]

[\*  $\cdot$  \*  $\xrightarrow{\text{pyk}}$  “" raw pair "”]

\* . \*

[x . y  $\xrightarrow{\text{val}}$  x : y : x . y]

[\* . \*  $\xrightarrow{\text{tex}}$  “#1.

\mathrel { \underline { \dot { . \, . } } } #2.”]

[\* . \*  $\xrightarrow{\text{pyk}}$  “" eager pair ""]

\* : \*

[x : y  $\xrightarrow{\text{val}}$  (0 : 0 : T)<sup>I</sup> : x : y]

[\* : \*  $\xrightarrow{\text{tex}}$  “#1.

\mathrel { \underline { : \, \, : } } #2.”]

[\* : \*  $\xrightarrow{\text{pyk}}$  “" tagged pair ""]

\* +2 \*

[x +2 y  $\xrightarrow{\text{val}}$  if(x, if(y, T, x : y), x : y)]

[\* +2 \*  $\xrightarrow{\text{tex}}$  “#1.

\mathrel { \underline { {+} 2 \ast } } #2.”]

[\* +2 \*  $\xrightarrow{\text{pyk}}$  “" untagged double ""]

\* : \*

[x : y  $\xrightarrow{\text{val}}$  x<sup>M</sup> : y<sup>M</sup>]

[x : y  $\xrightarrow{\text{tex}}$  “#1.

\mathrel { : \, \, : } #2.”]

[\* : \*  $\xrightarrow{\text{pyk}}$  “" pair ""]

\* +2 \*

[x +2 y  $\xrightarrow{\text{val}}$  T : x<sup>B</sup> : y<sup>UC</sup>]

[\* +2 \*  $\xrightarrow{\text{tex}}$  “#1.

\mathrel { {+} 2 \ast } #2.”]

[\* +2\* \*  $\xrightarrow{\text{pyk}}$  " double "]

\*, \*

[x, y  $\xrightarrow{\text{tex}}$  "#1.  
, \linebreak [0] #2."]

[\*, \*  $\xrightarrow{\text{pyk}}$  " comma "]

\*  $\stackrel{\text{B}}{\approx}$  \*

[x  $\stackrel{\text{B}}{\approx}$  y  $\xrightarrow{\text{val}}$  x  $\left\{ \begin{array}{l} \text{If}(y, \text{T}, \text{F}) \\ \text{If}(y, \text{F}, \text{T}) \end{array} \right.$  ]

[\*  $\stackrel{\text{B}}{\approx}$  \*  $\xrightarrow{\text{tex}}$  "#1.  
\stackrel{\text{B}}{\approx} \{\text{B}\} \{\backslash\text{approx}\} \#2."]

[\*  $\stackrel{\text{B}}{\approx}$  \*  $\xrightarrow{\text{pyk}}$  " boolean equal "]

\*  $\stackrel{\text{D}}{\approx}$  \*

[x  $\stackrel{\text{D}}{\approx}$  y  $\xrightarrow{\text{val}}$  x<sup>c</sup>  $\left\{ \begin{array}{l} \text{If}(y^c, x \stackrel{\text{C}}{\approx} y, \text{F}) \\ \text{If}(y^c, \text{F}, x \stackrel{\text{P}}{\approx} y) \end{array} \right.$  ]

[\*  $\stackrel{\text{D}}{\approx}$  \*  $\xrightarrow{\text{tex}}$  "#1.  
\stackrel{\text{D}}{\approx} \{\text{D}\} \{\backslash\text{approx}\} \#2."]

[\*  $\stackrel{\text{D}}{\approx}$  \*  $\xrightarrow{\text{pyk}}$  " data equal "]

\*  $\stackrel{\text{C}}{\approx}$  \*

[x  $\stackrel{\text{C}}{\approx}$  y  $\xrightarrow{\text{val}}$  x<sup>s</sup>  $\left\{ \begin{array}{l} \text{If}(y^s, \text{T}, \text{F}) \\ \text{If}(y^s, \text{F}, x^h \stackrel{\text{B}}{\approx} y^h \wedge x^t \stackrel{\text{C}}{\approx} y^t) \end{array} \right.$  ]

[\*  $\stackrel{\text{C}}{\approx}$  \*  $\xrightarrow{\text{tex}}$  "#1.  
\stackrel{\text{C}}{\approx} \{\text{C}\} \{\backslash\text{approx}\} \#2."]

[\*  $\stackrel{\text{C}}{\approx}$  \*  $\xrightarrow{\text{pyk}}$  " cardinal equal "]



\*  $\overset{P}{\approx}$  \*

[ $x \overset{P}{\approx} y \xrightarrow{\text{val}} x^s \left\{ \begin{array}{l} \text{If}(y^s, T, F) \\ \text{If}(y^s, F, x^h \approx y^h \wedge x^t \approx y^t) \end{array} \right\}$  ]

[\*  $\overset{P}{\approx}$  \*  $\xrightarrow{\text{tex}}$  “#1.  
\stackrel{P}{\approx} {P}{\{\backslashapprox \}#2.”]

[\*  $\overset{P}{\approx}$  \*  $\xrightarrow{\text{pyk}}$  “" peano equal ""]

\*  $\approx$  \*

[ $x \approx y \xrightarrow{\text{val}} x^d \left\{ \begin{array}{l} \text{If}(y^d, x \overset{D}{\approx} y, F) \\ \text{If}(y^d, F, T) \end{array} \right\}$  ]

[\*  $\approx$  \*  $\xrightarrow{\text{tex}}$  “#1.  
\approx #2.”]

[\*  $\approx$  \*  $\xrightarrow{\text{pyk}}$  “" tagged equal ""]

\* = \*

[\* = \*  $\xrightarrow{\text{tex}}$  “#1.  
=#2.”]

[\* = \*  $\xrightarrow{\text{pyk}}$  “" math equal ""]

\*  $\xrightarrow{+}$  \*

[\*  $\xrightarrow{+}$  \*  $\xrightarrow{\text{tex}}$  “#1.  
\stackrel{+}{\rightarrow} {+}{\{\rightarrow \}#2.”]

[\*  $\xrightarrow{+}$  \*  $\xrightarrow{\text{pyk}}$  “" reduce to ""]

\*  $\overset{t}{=}$  \*

[ $x \overset{t}{=} y \xrightarrow{\text{val}} \text{If}(x \overset{r}{=} y, x^t \overset{t^*}{=} y^t, F)$ ]

[\*  $\overset{t}{=}$  \*  $\xrightarrow{\text{tex}}$  “#1.  
\stackrel{t}{=} {t}{\{=\}#2.”]

[\*  $\overset{t}{=}$  \*  $\xrightarrow{\text{pyk}}$  “" term equal ""]

\*  $\stackrel{t^*}{=}$  \*

[ $x \stackrel{t^*}{=} y \xrightarrow{\text{val}} x^a \left\{ \begin{array}{l} \text{If}(y^a, T, F) \\ \text{If}(y^a, F, \text{If}(x^h \stackrel{t}{=} y^h, x^t \stackrel{t^*}{=} y^t, F)) \end{array} \right\}$  ]

[\*  $\stackrel{t^*}{=} *$   $\xrightarrow{\text{tex}}$  “#1.  
 $\backslash\text{stackrel}\{t^*\}\{=\}\#2.$ ”]

[\*  $\stackrel{t^*}{=} *$   $\xrightarrow{\text{pyk}}$  “" term list equal ""]

\*  $\stackrel{r}{=}$  \*

[ $x \stackrel{r}{=} y \xrightarrow{\text{val}} \text{If}(x^r \approx y^r, x^i \approx y^i, F)$ ]

[ $x \stackrel{r}{=} y \xrightarrow{\text{tex}}$  “#1.  
 $\backslash\text{stackrel}\{r\}\{=\}\#2.$ ”]

[\*  $\stackrel{r}{=} *$   $\xrightarrow{\text{pyk}}$  “" term root equal ""]

\*  $\in_t$  \*

[ $x \in_t y \xrightarrow{\text{val}} \text{If}(y^a, x!F, \text{If}(x \stackrel{t}{=} y^h, T, x \in_t y^t))$ ]

[ $x \in_t y \xrightarrow{\text{tex}}$  “#1.  
 $\backslash\text{in}_t \#2.$ ”]

[\*  $\in_t *$   $\xrightarrow{\text{pyk}}$  “" term in ""]

\*  $\subseteq_T$  \*

[ $x \subseteq_T y \xrightarrow{\text{val}} \text{If}(x^a, y!T, \text{If}(x^h \in_t y, x^t \subseteq_T y, F))$ ]

[ $x \subseteq_T y \xrightarrow{\text{tex}}$  “#1.  
 $\backslash\text{subseteq}_T \#2.$ ”]

[\*  $\subseteq_T *$   $\xrightarrow{\text{pyk}}$  “" term subset ""]

\*  $\stackrel{T}{=}$  \*

[ $x \stackrel{T}{=} y \xrightarrow{\text{val}} \text{If}(x \subseteq_T y, y \subseteq_T x, F)$ ]

[ $x \stackrel{T}{=} y \xrightarrow{\text{tex}}$  “#1.  
 $\backslash\text{stackrel}\{T\}\{=\}\#2.$ ”]

[\*  $\stackrel{T}{=} * \xrightarrow{\text{pyk}}$  “ term set equal ”]

\*  $\stackrel{S}{=} *$

[x  $\stackrel{s}{=} y \xrightarrow{\text{val}}$  If( $\neg x^2 \stackrel{t}{=} y^2, F, \text{If}(x^0 \stackrel{T}{=} y^0, x^1 \stackrel{T}{=} y^1, F)$ )]

[x  $\stackrel{s}{=} y \xrightarrow{\text{tex}}$  “#1.  
\stackrel{s}{=} {=} #2.”]

[\*  $\stackrel{s}{=} * \xrightarrow{\text{pyk}}$  “ sequent equal ”]

\* free in \*

[v free in t  $\xrightarrow{\text{val}}$   
If(v  $\stackrel{t}{=} t, T,$   
If( $\neg t \stackrel{r}{=} [\nabla *: *], v$  free in\* t<sup>t</sup>,  
If(v  $\stackrel{t}{=} t^1, F, v$  free in t<sup>2</sup>)))]

[x free in y  $\xrightarrow{\text{tex}}$  “#1.  
\mathrel {free\ in} #2.”]

[\* free in \*  $\xrightarrow{\text{pyk}}$  “ free in ”]

\* free in\* \*

[v free in\* t  $\xrightarrow{\text{val}}$  If(t, v!F, If(v free in t<sup>h</sup>, T, v free in\* t<sup>t</sup>))]

[x free in\* y  $\xrightarrow{\text{tex}}$  “#1.  
\mathrel {free\ in}^{\ast} #2.”]

[\* free in\* \*  $\xrightarrow{\text{pyk}}$  “ free in star ”]

\* free for \* in \*

[a free for x in b  $\xrightarrow{\text{val}}$  a!x!  
If(b<sup>v</sup>, T,  
If( $\neg b \stackrel{r}{=} [\nabla *: *], a$  free for\* x in b<sup>t</sup>,  
If(x  $\stackrel{t}{=} b^1, T,$   
If( $\neg x$  free in b<sup>2</sup>, T,  
If(b<sup>1</sup> free in a, F,  
a free for x in b<sup>2</sup>)))))]

[a free for x in b  $\xrightarrow{\text{tex}}$  "#1.  
 $\backslash\text{mathrel}\{\text{free}\backslash\text{for}\}$  #2.  
 $\backslash\text{mathrel}\{\text{in}\}$  #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! $\backslash$ T,  
 If(a free for x in b<sup>h</sup>, a free for\* x in b<sup>t</sup>, F))]

[a free for\* x in b  $\xrightarrow{\text{tex}}$  "#1.  
 $\backslash\text{mathrel}\{\text{free}\backslash\text{for}\}^{\{\backslash\text{ast}\}}$  #2.  
 $\backslash\text{mathrel}\{\text{in}\}$  #3.]

[\* free for\* \* in \*  $\xrightarrow{\text{pyk}}$  "# free for star " in ""]

\*  $\in_c$  \*

[ $x \in_c y \xrightarrow{\text{val}} y \stackrel{r}{=} [x \wedge_c y] \left\{ \begin{array}{l} \text{If}(x \in_c y^1, \top, x \in_c y^2) \\ x \stackrel{t}{=} y \end{array} \right. ]$

[ $x \in_c y \xrightarrow{\text{tex}}$  "#1.  
 $\backslash\text{in}_c$  #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 ""]

\* <' \*

$$[x <' y \xrightarrow{\text{val}} y^s \left\{ \begin{array}{l} x!F \\ x^s \end{array} \right\} \left\{ \begin{array}{l} T \\ x^h \end{array} \right\} \left\{ \begin{array}{l} y^h \\ y^h \end{array} \right\} \left\{ \begin{array}{l} x^t <' y^t \\ x^t \leq' y^t \\ x^t <' y^t \\ x^t <' y^t \end{array} \right\} ]$$

[x <' y  $\xrightarrow{\text{tex}}$  “#1.  
<' #2.”]

[\* <' \*  $\xrightarrow{\text{pyk}}$  “less zero ”]

\* ≤' \*

$$[x \leq' y \xrightarrow{\text{val}} x^s \left\{ \begin{array}{l} y!T \\ y^s \end{array} \right\} \left\{ \begin{array}{l} F \\ x^h \end{array} \right\} \left\{ \begin{array}{l} y^h \\ y^h \end{array} \right\} \left\{ \begin{array}{l} x^t \leq' y^t \\ x^t \leq' y^t \\ x^t <' y^t \\ x^t \leq' y^t \end{array} \right\} ]$$

[x ≤' y  $\xrightarrow{\text{tex}}$  “#1.  
\le' #2.”]

[\* ≤' \*  $\xrightarrow{\text{pyk}}$  “less one ”]

¬\*

[¬x  $\xrightarrow{\text{val}}$  If(x, F, T)]

[¬\*  $\xrightarrow{\text{tex}}$  “  
\neg #1.”]

[¬\*  $\xrightarrow{\text{pyk}}$  “not ”]

\* ∧ \*

[x ∧ y  $\xrightarrow{\text{val}}$  x  $\left\{ \begin{array}{l} \text{If}(y, T, F) \\ \text{If}(y, F, F) \end{array} \right\}$  ]

[\* ∧ \*  $\xrightarrow{\text{tex}}$  “#1.  
\wedge #2.”]

[\*  $\wedge$  \*  $\xrightarrow{\text{pyk}}$  " and "]

\*  $\ddot{\wedge}$  \*

[x  $\ddot{\wedge}$  y  $\xrightarrow{\text{macro}}$   $\lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[x \ddot{\wedge} y \doteq \text{If}(x, y, F)])]$ ]

[x  $\ddot{\wedge}$  y  $\xrightarrow{\text{tex}}$  "#1.  
 $\mathrel{\{\ddot{\wedge}\}} \#2.$ "]

[\*  $\ddot{\wedge}$  \*  $\xrightarrow{\text{pyk}}$  " macro and "]

\*  $\tilde{\wedge}$  \*

[x  $\tilde{\wedge}$  y  $\xrightarrow{\text{val}}$   $\text{if}(x, y, x)$ ]

[x  $\tilde{\wedge}$  y  $\xrightarrow{\text{tex}}$  "#1.  
 $\mathrel{\{\tilde{\wedge}\}} \#2.$ "]

[\*  $\tilde{\wedge}$  \*  $\xrightarrow{\text{pyk}}$  " simple and "]

\*  $\wedge_c$  \*

[x  $\wedge_c$  y  $\xrightarrow{\text{val}}$   $\lambda t. \lambda c. x ' t ' c \tilde{\wedge} y ' t ' c$ ]

[x  $\wedge_c$  y  $\xrightarrow{\text{tex}}$  "#1.  
 $\wedge_{c} \#2.$ "]

[\*  $\wedge_c$  \*  $\xrightarrow{\text{pyk}}$  " claim and "]

\*  $\vee$  \*

[x  $\vee$  y  $\xrightarrow{\text{val}}$   $x \left\{ \begin{array}{l} \text{If}(y, T, T) \\ \text{If}(y, T, F) \end{array} \right.$  ]

[\*  $\vee$  \*  $\xrightarrow{\text{tex}}$  "#1.  
 $\vee \#2.$ "]

[\*  $\vee$  \*  $\xrightarrow{\text{pyk}}$  " or "]

\* || \*

[\* || \*  $\xrightarrow{\text{tex}}$  “#1.  
\parallel #2.”]

[\* || \*  $\xrightarrow{\text{pyk}}$  “" parallel "”]

\*  $\ddot{\vee}$  \*

[x  $\ddot{\vee}$  y  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[x \ddot{\vee} y \doteq \text{If}(x, T, y)])]$ ]

[x  $\ddot{\vee}$  y  $\xrightarrow{\text{tex}}$  “#1.  
\mathrel{\{\ddot{\vee}\}} #2.”]

[\*  $\ddot{\vee}$  \*  $\xrightarrow{\text{pyk}}$  “" macro or "”]

\*  $\ddot{\Rightarrow}$  \*

[x  $\ddot{\Rightarrow}$  y  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[x \ddot{\Rightarrow} y \doteq \text{If}(x, y, T)])]$ ]

[x  $\ddot{\Rightarrow}$  y  $\xrightarrow{\text{tex}}$  “#1.  
\mathrel{\{\ddot{\Rightarrow}\}} #2.”]

[\*  $\ddot{\Rightarrow}$  \*  $\xrightarrow{\text{pyk}}$  “" macro imply "”]

\* : \*

[x : y  $\xrightarrow{\text{val}}$  if(x, y, y)]

[\* : \*  $\xrightarrow{\text{tex}}$  “#1.  
:#2.”]

[\* : \*  $\xrightarrow{\text{pyk}}$  “" guard "”]

\* spy \*

[x spy y  $\xrightarrow{\text{val}}$  x!y]

[x spy y  $\xrightarrow{\text{tex}}$  “#1.  
\mathrel{\{spy\}}#2.”]

[\* spy \*  $\xrightarrow{\text{pyk}}$  “" spy "”]

\*!\*

[x!y  $\xRightarrow{\text{val}}$  If(x, y, y)]

[\*!\*  $\xrightarrow{\text{tex}}$  “#1.  
!#2.”]

[\*!\*  $\xrightarrow{\text{pyk}}$  “" tagged guard ""]

\*  $\left\{ \begin{array}{l} * \\ * \end{array} \right.$

[x  $\left\{ \begin{array}{l} y \\ z \end{array} \right.$   $\xRightarrow{\text{val}}$  If(x, y, z)]

[\*  $\left\{ \begin{array}{l} * \\ * \end{array} \right.$   $\xrightarrow{\text{tex}}$  “#1.

\left\{\protect \begin {array}{1}#2.

\#\#3.

\protect \end {array}\right.”]

[\*  $\left\{ \begin{array}{l} * \\ * \end{array} \right.$   $\xrightarrow{\text{pyk}}$  “" select " else " end select”]

$\lambda$  \* .\*

Predef: lambda

[ $\lambda$  \* .\*  $\xrightarrow{\text{tex}}$  “

\lambda #1.

.#2.”]

[ $\lambda$  \* .\*  $\xrightarrow{\text{pyk}}$  “lambda " dot ""]

$\Lambda$  \* .\*

[ $\Lambda$ x.y  $\xrightarrow{\text{macro}}$   $\lambda$ t. $\lambda$ s. $\lambda$ c. $\tilde{\mathcal{M}}_4$ (t, s, c, [[ $\Lambda$ x.y  $\doteq$   $\Lambda$  $\lambda$ x.y]])]

[ $\Lambda$ x.y  $\xrightarrow{\text{tex}}$  “

\Lambda #1.

. #2.”]

[ $\Lambda$  \* .\*  $\xrightarrow{\text{pyk}}$  “tagged lambda " dot ""]



$\Lambda^*$

$[\Lambda x \xrightarrow{\text{val}} \mathcal{M}(\lambda u. \mathcal{U}(x, \mathcal{M}(u)))]$

$[\Lambda^* \xrightarrow{\text{tex}} “$   
 $\backslash\text{Lambda \#1.}”]$

$[\Lambda^* \xrightarrow{\text{pyk}} “\text{tagging } ”]$

**if \* then \* else \***

$[\text{if } x \text{ then } y \text{ else } z \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\text{if } x \text{ then } y \text{ else } z \doteq \text{If}(x, y, z)])])]$

$[\text{if } x \text{ then } y \text{ else } z \xrightarrow{\text{tex}} “$   
 $\{\backslash\text{bf if}\} \backslash \#1.$   
 $\backslash \{\backslash\text{bf then}\} \backslash \#2.$   
 $\backslash \{\backslash\text{bf else}\} \backslash \#3.”]$

$[\text{if } * \text{ then } * \text{ else } * \xrightarrow{\text{pyk}} “\text{open if } ” \text{ then } ” \text{ else } ”]$

**let \* = \* in \***

$[\text{let } x = y \text{ in } z \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c. \tilde{\mathcal{M}}_4(t, s, c, [[\text{let } x = y \text{ in } z \doteq \text{let}_1(\lambda x. z, y)])])]$

$[\text{let } x = y \text{ in } z \xrightarrow{\text{tex}} “$   
 $\backslash\text{mathbf}\{\text{let}\} \backslash \#1.$   
 $= \#2.$   
 $\backslash\text{mathbf}\{\backslash \text{ in}\} \backslash \#3.”]$

$[\text{let } * = * \text{ in } * \xrightarrow{\text{pyk}} “\text{let } ” \text{ be } ” \text{ in } ”]$

**let \*  $\doteq$  \* in \***

$[\text{let } x \doteq y \text{ in } z \xrightarrow{\text{macro}} \lambda t. \lambda s. \lambda c.$   
 $\tilde{\mathcal{M}}(t^3, s, c[t^{1r} :: \text{"codex"} :: t^{1r} :: t^{1i} :: 0 :: \text{"macro"} :: \text{T} \Rightarrow \tilde{\mathcal{M}}_3(t)])]$

$[\text{let } x \doteq y \text{ in } z \xrightarrow{\text{tex}} “$   
 $\backslash\text{mathbf}\{\text{let}\} \backslash \#1.$   
 $\backslash\text{mathrel}\{\backslash\text{ddot}\{=\}\} \backslash \#2.$   
 $\backslash\text{mathrel}\{\backslash \text{ in}\} \backslash \#3.”]$

$[\text{let } * \doteq * \text{ in } * \xrightarrow{\text{pyk}} “\text{let } ” \text{ abbreviate } ” \text{ in } ”]$

\*I

$[x^I \xrightarrow{\text{val}} [x^I]^R :: x :: T]$

$[x^I \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{ I \} \text{"}]$

$[*I \xrightarrow{\text{pyk}} \text{"init"}]$

\*▷

$[x^\triangleright \xrightarrow{\text{val}} [x^\triangleright]^R :: x :: T]$

$[x^\triangleright \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{ \text{\rhd} \} \text{"}]$

$[*^\triangleright \xrightarrow{\text{pyk}} \text{"modus"}]$

\*V

$[x^V \xrightarrow{\text{val}} [x^V]^R :: x :: T]$

$[x^V \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{ V \} \text{"}]$

$[*V \xrightarrow{\text{pyk}} \text{"verify"}]$

\*+

$[x^+ \xrightarrow{\text{val}} [x^+]^R :: x :: T]$

$[x^+ \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{ + \} \text{"}]$

$[*^+ \xrightarrow{\text{pyk}} \text{"curry plus"}]$

\*-

$[x^- \xrightarrow{\text{val}} [x^-]^R :: x :: T]$

$[x^- \xrightarrow{\text{tex}} \text{"\#1.} \\ \{\} \wedge \{ - \} \text{"}]$

$[*^- \xrightarrow{\text{pyk}} \text{"curry minus"}]$

\* \*

$[x^* \xrightarrow{\text{val}} [x^*]^R :: x :: T]$

$[x^* \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\{\} \wedge \{\backslash\text{ast}\} \text{"}]$

$[x^* \xrightarrow{\text{pyk}} \text{" dereference"}]$

\* @ \*

$[x @ y \xrightarrow{\text{val}} [x @ y]^R :: x :: y :: T]$

$[x @ y \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\backslash\text{mathop} \{\backslash\text{char64}\} \text{\#2.} \text{"}]$

$[x @ y \xrightarrow{\text{pyk}} \text{" at "}]$

\* ▷ \*

$[x ▷ y \xrightarrow{\text{val}} [x ▷ y]^R :: x :: y :: T]$

$[x ▷ y \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\backslash\text{rhd} \text{\#2.} \text{"}]$

$[x ▷ y \xrightarrow{\text{pyk}} \text{" modus ponens "}]$

\* ▷▷ \*

$[x ▷▷ y \xrightarrow{\text{val}} [x ▷▷ y]^R :: x :: y :: T]$

$[x ▷▷ y \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\backslash\text{mathrel} \{\backslash\text{makebox} [0\text{mm}][l]\{\backslash\text{rhd} \$\}\backslash, \{\backslash\text{rhd} \}\} \text{\#2.} \text{"}]$

$[x ▷▷ y \xrightarrow{\text{pyk}} \text{" modus probans "}]$

\* ≫ \*

$[x ≫ y \xrightarrow{\text{tactic}} \lambda t. \lambda s. \lambda c. \text{conclude}_1(t, c)]$

$[x ≫ y \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\backslash\text{gg} \text{\#2.} \text{"}]$

$[x ≫ y \xrightarrow{\text{pyk}} \text{" conclude "}]$

\* ⊢ \*

$[x \vdash y \xrightarrow{\text{val}} [x \vdash y]^R :: x :: y :: T]$

$[x \vdash y \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\vdash \text{"\#2."}]$

$[* \vdash * \xrightarrow{\text{pyk}} \text{"infer "}]$

\* ⊨ \*

$[x \Vdash y \xrightarrow{\text{val}} [x \Vdash y]^R :: x :: y :: T]$

$[x \Vdash y \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\mathrel{\{ \makebox [0mm] [1] { \$ \vdash \$ } \}, \{ \vdash \}} \text{"\#2."}]$

$[* \Vdash * \xrightarrow{\text{pyk}} \text{"endorse "}]$

\* i.e. \*

$[x \text{ i.e. } y \xrightarrow{\text{val}} [x \text{ i.e. } y]^R :: x :: y :: T]$

$[x \text{ i.e. } y \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\mathrel{\{ \text{i.e.} \}} \text{"\#2."}]$

$[* \text{ i.e. } * \xrightarrow{\text{pyk}} \text{"id est "}]$

∀\*: \*

$[\forall x: y \xrightarrow{\text{val}} [\forall x: y]^R :: x :: y :: T]$

$[\forall x: y \xrightarrow{\text{tex}} \text{"}$   
 $\text{forall \#1.}$   
 $\text{colon \#2."}]$

$[\forall *: * \xrightarrow{\text{pyk}} \text{"all " indeed "}]$

\* ⊕ \*

$[x \oplus y \xrightarrow{\text{val}} [x \oplus y]^R :: x :: y :: T]$

$[x \oplus y \xrightarrow{\text{tex}} \text{"\#1.}$   
 $\mathrel{\{ \oplus \}} \text{"\#2."}]$

[\*  $\oplus$  \*  $\xrightarrow{\text{pyk}}$  “ rule plus ”]

\*; \*

[x; y  $\xrightarrow{\text{val}}$  [x; y]<sup>R</sup> :: x :: y :: T]

[x; y  $\xrightarrow{\text{tex}}$  “#1.  
; #2.”]

[\*; \*  $\xrightarrow{\text{pyk}}$  “ cut ”]

\* proves \*

[p proves t  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[p \text{ proves } t \doteq \text{proof}([p], [t], \text{self})]])$ )]

[p proves t  $\xrightarrow{\text{tex}}$  “#1.  
\ proves\ #2.”]

[\* proves \*  $\xrightarrow{\text{pyk}}$  “ proves ”]

\* **proof of** \* : \*

[t **proof of** s : p  $\xrightarrow{\text{name}}$  “#1.  
\mathbf{\ proof\ of\ } #2.  
: #3.”]

[t **proof of** s : p  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[t \text{ proof of } s : p \doteq \text{Proof of } s : \lambda c.\lambda x.\mathcal{P}([t \vdash p], p_0, c)])$ )]

[t **proof of** s : p  $\xrightarrow{\text{tex}}$  “  
\if\relax\cname lgwproofline\endcname  
\def\lgwproofline{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 * : *  $\xrightarrow{\text{pyk}}$  “" proof of " reads ""]
```

Line \* : \*  $\gg$  \*; \*

```
[Line l : a  $\gg$  i; p  $\xrightarrow{\text{name}}$  “
```

```
Line \, #1.
```

```
: #2.
```

```
\gg #3.
```

```
; #4.”]
```

```
[Line l : a  $\gg$  i; p  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\text{Line l : a } \gg i; p \doteq (a \gg i; \text{let l } \doteq i \text{ in } p)])])]$ 
```

```
[Line l : a  $\gg$  i; p  $\xrightarrow{\text{tex}}$  “
```

```
\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 * : *  $\gg$  *; *  $\xrightarrow{\text{pyk}}$  “line " because " indeed " end line ""]
```

Last line \*  $\gg$  \*  $\square$

```
[Last line a  $\gg$  i  $\square \xrightarrow{\text{name}}$  “
```

```
Last\ line \, #1.
```

```
\gg #2.
```

```
\, \Box”]
```

```
[Last line a  $\gg$  i  $\square \xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\text{Last line a } \gg i \square \doteq (a \gg i)])])]$ 
```

```
[Last line a  $\gg$  i  $\square \xrightarrow{\text{tex}}$  “
```

```
\newline \makebox [0.1\textwidth]{}%
```

```
\parbox [b]{0.4\textwidth}{\raggedright
```

```
\setlength {\parindent}{-0.1\textwidth} %
```

```
\makebox [0.1\textwidth][l]{\$
```

```
\if \relax \csname lgwproofline\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 * >> * \xrightarrow{pyk} "because " indeed " qed"]

```

## Line \* : Premise >> \*; \*

```

[Line l : Premise >> i; p \xrightarrow{name} "
Line \, #1.
: Premise \gg #2.
; #3." ]
[Line l : Premise >> i; p \xrightarrow{macro} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[Line l : Premise >> i; p \doteq (i \vdash \mathbf{let} l \doteq i \text{ in } p)])]]

```

```

[Line l : Premise >> i; p \xrightarrow{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 >> *; * \xrightarrow{pyk} "line " premise " end line "]

```

## Line \* : Side-condition >> \*; \*

```

[Line l : Side-condition >> i; p \xrightarrow{name} "
Line \, #1.
: \mbox{Side-condition} \gg #2.
; #3." ]
[Line l : Side-condition >> i; p \xrightarrow{macro} \lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[Line l : Side-condition >> i; p \doteq (i \vdash \mathbf{let} l \doteq i \text{ in } p)])]]

```

```

[Line l : Side-condition >> i; p \xrightarrow{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 >> *; * \xrightarrow{pyk} "line " side condition " end line "]

```



Arbitrary  $\gg$  \*; \*

```
[Arbitrary  $\gg$  i; p  $\xrightarrow{\text{name}}$  “  
Arbitrary \gg #1.  
; #2.”]
```

```
[Arbitrary  $\gg$  i; p  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\text{Arbitrary} \gg i; p \ddot{=} (\forall i: p)])]$ )]
```

```
[Arbitrary  $\gg$  i; p  $\xrightarrow{\text{tex}}$  “  
\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  $\gg$  *; *  $\xrightarrow{\text{pyk}}$  “arbitrary " end line ""]
```

Local  $\gg$  \* = \*; \*

```
[Local  $\gg$  a = i; p  $\xrightarrow{\text{name}}$  “  
Local \gg #1.  
= #2.  
; #3.”]
```

```
[Local  $\gg$  a = i; p  $\xrightarrow{\text{macro}}$   $\lambda t.\lambda s.\lambda c.\tilde{\mathcal{M}}_4(t, s, c, [[\text{Local} \gg a = i; p \ddot{=} (\text{let } a \ddot{=} i \text{ in } p)])]$ )]
```

```
[Local  $\gg$  a = i; p  $\xrightarrow{\text{tex}}$  “  
\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  $\gg$  * = *; *  $\xrightarrow{\text{pyk}}$  “locally define " as " end line ""]
```

\*&\*

[\*&\*  $\xrightarrow{\text{name}}$  “#1.  
\& #2.”]

[\*&\*  $\xrightarrow{\text{tex}}$  “#1.  
&#2.”]

[\*&\*  $\xrightarrow{\text{pyk}}$  “" tab "”]

\*\\\*

[\*\\\*  $\xrightarrow{\text{name}}$  “#1.  
\backslash \backslash #2.”]

[\*\\\*  $\xrightarrow{\text{tex}}$  “#1.  
\\ #2.”]

[\*\\\*  $\xrightarrow{\text{pyk}}$  “" row "”]

*The pyk compiler, version 0.grue.20060417+ by Klaus Grue  
GRD-2006-05-04.UTC:15:30:23.702808 = MJD-53859.TAI:15:30:56.702808 =  
LGT-4653473456702808e-6*