# Todo list

# 1   Typing Rules

## 1.1   Literal

1. Integers:
$$\frac{i : \texttt{Integer}}{Integer[i] : \texttt{Literal Integer}} \tag{1}$$

2. Strings (Text):
$$\frac{s : \texttt{String}}{Str[s] : \texttt{Literal String}} \tag{2}$$

3. Real numbers:
$$\frac{d : \texttt{Double}}{Dbl[d] : \texttt{Literal Real}} \tag{3}$$

4. Whole numbered reals ($\mathbb{Z} \subset \mathbb{R}$):
$$\frac{d : \texttt{Integer}}{ExactDbl[d] : \texttt{Literal Real}} \tag{4}$$

5. Percentages:
$$\frac{n : \texttt{Integer} \quad d : \texttt{Integer}}{Perc[n, d] : \texttt{Literal Real}} \tag{5}$$

## 1.2   Miscellaneous

1. Completeness:
$$\frac{}{Complete[] : \texttt{Completeness}} \tag{6}$$

$$\frac{}{Incomplete[] : \texttt{Completeness}} \tag{7}$$

2. AssocOp:

  (a) Numerics:
$$\frac{x : \texttt{Numerics(T)}}{Add[] : \texttt{AssocOp x}} \tag{8}$$

$$\frac{x : \texttt{Numerics(T)}}{Mul[] : \texttt{AssocOp x}} \tag{9}$$

1

(b) Bool:

$$\overline{And[] : \texttt{AssocOp Bool}} \tag{10}$$

$$\overline{Or[] : \texttt{AssocOp Bool}} \tag{11}$$

3. UnaryOp:

(a) Numerics:

$$\frac{x : \texttt{NumericsWithNegation(T)}}{Neg[] : \texttt{UnaryOp x x}} \tag{12}$$

$$\frac{x : \texttt{NumericsWithNegation(T)}}{Abs[] : \texttt{UnaryOp x x}} \tag{13}$$

For Log, Ln, Sin, Cos, Tan, Sec, Csc, Cot, Arcsin, Arccos, Arctan, and Sqrt, please use the following template, replacing "$\$TRG$" with the desired operator:

$$\overline{\$TRG[] : \texttt{UnaryOp Real Real}} \tag{14}$$

(b) Vectors:

$$\frac{x : \texttt{NumericsWithNegation(T)}}{NegV[] : \texttt{UnaryOp [x] [x]}} \tag{15}$$

$$\frac{x : \texttt{Numerics(T)}}{Norm[] : \texttt{UnaryOp [x] Real}} \tag{16}$$

$$\frac{\texttt{x} : \tau}{Dim[] : \texttt{UnaryOp [x] Integer}} \tag{17}$$

(c) Booleans:

$$\overline{Not[] : \texttt{UnaryOp Bool Bool}} \tag{18}$$

4. BinaryOp:

(a) Arithmetic:

$$\overline{FracR[] : \texttt{BinaryOp Real Real Real}} \tag{19}$$

(b) Bool:

$$\overline{Impl[] : \texttt{BinaryOp Bool Bool Bool}} \tag{20}$$

$$\overline{Iff[] : \texttt{BinaryOp Bool Bool Bool}} \tag{21}$$

Discuss Numerics(T) and NumericsWithNegation(T)

Add "casting" between numerics

(c) Equality:

$$\frac{\text{x} : \tau}{Eq[] : \texttt{BinaryOp x x Bool}} \tag{22}$$

$$\frac{\text{x} : \tau}{NEq[] : \texttt{BinaryOp x x Bool}} \tag{23}$$

(d) Ordering:

$$\frac{x : \texttt{Numerics(T)}}{Lt[] : \texttt{BinaryOp x x Bool}} \tag{24}$$

$$\frac{x : \texttt{Numerics(T)}}{Gt[] : \texttt{BinaryOp x x Bool}} \tag{25}$$

$$\frac{x : \texttt{Numerics(T)}}{LEq[] : \texttt{BinaryOp x x Bool}} \tag{26}$$

$$\frac{x : \texttt{Numerics(T)}}{GEq[] : \texttt{BinaryOp x x Bool}} \tag{27}$$

(e) Indexing:

$$\frac{\text{x} : \tau}{Index[] : \texttt{BinaryOp [x] Integer x}} \tag{28}$$

(f) Vectors:

$$\frac{x : \texttt{Numerics(T)}}{Cross[] : \texttt{BinaryOp [x] [x] [x]}} \tag{29}$$

> discuss vectors in general

$$\frac{x : \texttt{Numerics(T)}}{Dot[] : \texttt{BinaryOp [x] [x] x}} \tag{30}$$

5. RTopology:

$$\frac{}{Discrete[] : \texttt{RTopology}} \tag{31}$$

$$\frac{}{Continuous[] : \texttt{RTopology}} \tag{32}$$

6. DomainDesc:

$$\frac{top : \tau_1 \quad bot : \tau_2 \quad s : \texttt{Symbol} \quad rtop : \texttt{RTopology}}{BoundedDD[s, rtop, top, bot] : \texttt{DomainDesc Discrete } \tau_1 \ \tau_2} \tag{33}$$

$$\frac{\texttt{topT} : \tau \quad \texttt{botT} : \tau \quad s : \texttt{Symbol} \quad rtop : \texttt{RTopology}}{AllDD[s, rtop] : \texttt{DomainDesc Continuous topT botT}} \tag{34}$$

7. Inclusive:
$$\frac{}{Inc[\,] : \texttt{Inclusive}} \tag{35}$$

$$\frac{}{Exc[\,] : \texttt{Inclusive}} \tag{36}$$

8. RealInterval:
$$\frac{\texttt{a} : \tau \quad \texttt{b} : \tau \quad top : \texttt{(Inclusive, a)} \quad bot : \texttt{(Inclusive, b)}}{Bounded[top, bot] : \texttt{RealInterval a b}} \tag{37}$$

$$\frac{\texttt{a} : \tau \quad \texttt{b} : \tau \quad top : \texttt{(Inclusive, a)}}{UpTo[top] : \texttt{RealInterval a b}} \tag{38}$$

$$\frac{\texttt{a} : \tau \quad \texttt{b} : \tau \quad bot : \texttt{(Inclusive, b)}}{UpFrom[bot] : \texttt{RealInterval a b}} \tag{39}$$

## 1.3 Expr

1. Literals:
$$\frac{\texttt{x} : \tau \quad l : \texttt{Literal x}}{Lit[l] : \texttt{Expr x}} \tag{40}$$

2. Associative Operations:
$$\frac{\texttt{x} : \tau \quad op : \texttt{AssocOp x} \quad args : \texttt{[Expr x]}}{Assoc[op, args] : \texttt{Expr x}} \tag{41}$$

3. Symbols:
$$\frac{\texttt{x} : \tau \quad u : \texttt{UID}}{C[u] : \texttt{Expr x}} \tag{42}$$

4. Function Call:  ─────────────────────  discuss functions in general

5. Case:
$$\frac{\texttt{x} : \tau \quad c : \texttt{Completeness} \quad ces : \texttt{[(Expr Bool, Expr x)]}}{Case[c, ces] : \texttt{Expr x}} \tag{43}$$

6. Matrices:
$$\frac{\texttt{x} : \tau \quad es : \texttt{[[Expr x]]}}{Matrix[es] : \texttt{Expr x}} \tag{44}$$

7. Unary Operations:
$$\frac{\texttt{x} : \tau \quad \texttt{y} : \tau \quad op : \texttt{UnaryOp x y} \quad e : \texttt{Expr x}}{Unary[op, e] : \texttt{Expr y}} \tag{45}$$

8. Binary Operations:

$$\frac{\texttt{x}:\tau \quad \texttt{y}:\tau \quad \texttt{z}:\tau \quad op:\texttt{BinaryOp x y z} \quad l:\texttt{Expr x} \quad r:\texttt{Expr y}}{Binary[op,l,r]:\texttt{Expr z}} \tag{46}$$

9. "Big" Operations:

$$\frac{\texttt{x}:\tau \quad op:\texttt{AssocOp x} \quad dom:\texttt{DomainDesc Discrete (Expr x) (Expr x)}}{BigOp[op,dom]:\texttt{Expr x}} \tag{47}$$

10. "Is in interval" operator:

$$\frac{\texttt{x}:\tau \quad u:\texttt{UID} \quad itvl:\texttt{RealInterval (Expr x) (Expr x)}}{RealI[u,itvl]:\texttt{Expr x}} \tag{48}$$

## 1.4  ModelExpr

1.
$$\frac{B \quad C}{A}$$

## 1.5  CodeExpr

1.
$$\frac{B \quad C}{A}$$