

# The Language hardtyped

BNF-converter

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This document was automatically generated by the *BNF-Converter*. It was generated together with the lexer, the parser, and the abstract syntax module, which guarantees that the document matches with the implementation of the language (provided no hand-hacking has taken place).

## The lexical structure of hardtyped

### Identifiers

Identifiers  $\langle Ident \rangle$  are unquoted strings beginning with a letter, followed by any combination of letters, digits, and the characters `_` `'`, reserved words excluded.

### Literals

Double-precision float literals  $\langle Double \rangle$  have the structure indicated by the regular expression  $\langle digit \rangle + \cdot \langle digit \rangle + (\text{'e'-'?'}\langle digit \rangle +)?$  i.e. two sequences of digits separated by a decimal point, optionally followed by an unsigned or negative exponent.

Integer literals  $\langle Int \rangle$  are nonempty sequences of digits.

String literals  $\langle String \rangle$  have the form `"x"`, where *x* is any sequence of any characters except `"` unless preceded by `\`.

Bool literals are recognized by the regular expression `{"true"} | {"false"}`

Unit literals are recognized by the regular expression `{"unit"}`

Print literals are recognized by the regular expression `{"print"}`

ReadReal literals are recognized by the regular expression `{"readReal"}`

ReadInt literals are recognized by the regular expression `{"readInt"}`

ReadString literals are recognized by the regular expression `{"readString"}`

ReadBool literals are recognized by the regular expression `{"readBool"}`

## Reserved words and symbols

The set of reserved words is the set of terminals appearing in the grammar. Those reserved words that consist of non-letter characters are called symbols, and they are treated in a different way from those that are similar to identifiers. The lexer follows rules familiar from languages like Haskell, C, and Java, including longest match and spacing conventions.

The reserved words used in hardtyped are the following:

Any	Bool	Int
Real	String	Unit
and	as	in
let	letrec	lettype
not	or	

The symbols used in hardtyped are the following:

;	(	)
-	=	:
/\	{	}
->	.	,
	:	+
-	*	/
>	>=	==
!=	<=	<

## Comments

Single-line comments begin with `//`.

Multiple-line comments are enclosed with `/*` and `*/`.

## The syntactic structure of hardtyped

Non-terminals are enclosed between  $\langle$  and  $\rangle$ . The symbols  $::=$  (production),  $|$  (union) and  $\epsilon$  (empty rule) belong to the BNF notation. All other symbols are terminals.

$$\begin{aligned} \langle ListExpr \rangle & ::= \langle Expr \rangle ; \\ & | \quad \langle Expr \rangle ; \langle ListExpr \rangle \end{aligned}$$

$$\begin{aligned}
\langle \text{Expr} \rangle &::= \langle \text{Expr1} \rangle \\
&| \quad - | \langle \text{String} \rangle \text{ as } \langle \text{Ident} \rangle \\
&| \quad - | \langle \text{String} \rangle \\
&| \quad \text{let } \langle \text{VarDec} \rangle = \langle \text{Expr1} \rangle \\
&| \quad \text{let } \langle \text{VarDec} \rangle = \langle \text{Expr1} \rangle \text{ in } \langle \text{Expr1} \rangle \\
&| \quad \text{letrec } \langle \text{VarDec} \rangle = \langle \text{Expr1} \rangle \\
&| \quad \text{letrec } \langle \text{VarDec} \rangle = \langle \text{Expr1} \rangle \text{ in } \langle \text{Expr1} \rangle \\
&| \quad \text{lettype } \langle \text{VarDec} \rangle = \langle \text{Type} \rangle \\
&| \quad \text{lettype } \langle \text{VarDec} \rangle = \langle \text{Type} \rangle \text{ in } \langle \text{Expr1} \rangle \\
&| \quad \langle \text{ListIfExpr} \rangle \langle \text{ElseExpr} \rangle \\
\langle \text{Expr1} \rangle &::= \langle \text{Expr2} \rangle \\
&| \quad /\backslash \langle \text{ListFuncArg} \rangle \{ \langle \text{ListExpr} \rangle \} \\
&| \quad \langle \text{Print} \rangle ( \langle \text{Expr} \rangle ) \\
&| \quad \langle \text{ReadReal} \rangle ( \langle \text{ListExprSequence} \rangle ) \\
&| \quad \langle \text{ReadInt} \rangle ( \langle \text{ListExprSequence} \rangle ) \\
&| \quad \langle \text{ReadString} \rangle ( \langle \text{ListExprSequence} \rangle ) \\
&| \quad \langle \text{ReadBool} \rangle ( \langle \text{ListExprSequence} \rangle ) \\
\langle \text{Expr2} \rangle &::= \langle \text{Expr3} \rangle \\
&| \quad /\backslash \langle \text{ListFuncArg} \rangle \{ \langle \text{ListExpr} \rangle \} ( \langle \text{ListExprSequence} \rangle ) \\
&| \quad /\backslash \langle \text{ListFuncArg} \rangle \{ \langle \text{ListExpr} \rangle \} \rightarrow \langle \text{Type} \rangle \\
&| \quad \langle \text{Op} \rangle \\
\langle \text{Expr3} \rangle &::= \langle \text{Expr4} \rangle \\
&| \quad \langle \text{Expr4} \rangle ( \langle \text{ListExprSequence} \rangle ) \\
&| \quad \langle \text{Integer} \rangle \\
&| \quad \langle \text{Double} \rangle \\
&| \quad \langle \text{String} \rangle \\
&| \quad \langle \text{Bool} \rangle \\
&| \quad \langle \text{Unit} \rangle \\
&| \quad \{ \langle \text{ListRecordElem} \rangle \} \\
\langle \text{Expr4} \rangle &::= \langle \text{Expr5} \rangle \\
&| \quad \langle \text{Ident} \rangle \\
&| \quad \langle \text{Ident} \rangle \rightarrow \langle \text{Expr4} \rangle \\
&| \quad \langle \text{Expr4} \rangle . \langle \text{Expr4} \rangle \\
\langle \text{Expr5} \rangle &::= ( \langle \text{Expr} \rangle ) \\
&| \quad ( \langle \text{ListExpr} \rangle ) \\
\langle \text{VarDec} \rangle &::= \langle \text{Ident} \rangle : \langle \text{Type} \rangle \\
&| \quad \langle \text{Ident} \rangle \\
\langle \text{ExprSequence} \rangle &::= \langle \text{Expr} \rangle
\end{aligned}$$

$$\begin{aligned}
\langle \text{ListExprSequence} \rangle &::= \epsilon \\
&| \langle \text{ExprSequence} \rangle \\
&| \langle \text{ExprSequence} \rangle , \langle \text{ListExprSequence} \rangle \\
\langle \text{FuncArg} \rangle &::= \langle \text{Ident} \rangle : \langle \text{Type} \rangle \\
\langle \text{ListFuncArg} \rangle &::= \langle \text{FuncArg} \rangle . \\
&| \langle \text{FuncArg} \rangle . \langle \text{ListFuncArg} \rangle \\
\langle \text{IfExpr} \rangle &::= | ( \langle \text{Expr2} \rangle ) : \langle \text{Expr} \rangle \\
\langle \text{ListIfExpr} \rangle &::= \epsilon \\
&| \langle \text{IfExpr} \rangle \langle \text{ListIfExpr} \rangle \\
\langle \text{ElseExpr} \rangle &::= | : \langle \text{Expr} \rangle \\
\langle \text{Op} \rangle &::= \langle \text{Op1} \rangle \\
&| \langle \text{Expr3} \rangle \text{ or } \langle \text{Expr3} \rangle \\
\langle \text{Op1} \rangle &::= \langle \text{Op2} \rangle \\
&| \langle \text{Expr3} \rangle \text{ and } \langle \text{Expr3} \rangle \\
\langle \text{Op2} \rangle &::= \langle \text{Op3} \rangle \\
&| \text{not } \langle \text{Expr3} \rangle \\
\langle \text{Op3} \rangle &::= \langle \text{Op4} \rangle \\
&| \langle \text{Expr3} \rangle > \langle \text{Expr3} \rangle \\
&| \langle \text{Expr3} \rangle \geq \langle \text{Expr3} \rangle \\
&| \langle \text{Expr3} \rangle == \langle \text{Expr3} \rangle \\
&| \langle \text{Expr3} \rangle != \langle \text{Expr3} \rangle \\
&| \langle \text{Expr3} \rangle \leq \langle \text{Expr3} \rangle \\
&| \langle \text{Expr3} \rangle < \langle \text{Expr3} \rangle \\
\langle \text{Op4} \rangle &::= \langle \text{Op5} \rangle \\
&| \langle \text{Expr3} \rangle + \langle \text{Expr3} \rangle \\
&| \langle \text{Expr3} \rangle - \langle \text{Expr3} \rangle \\
\langle \text{Op5} \rangle &::= \langle \text{Op6} \rangle \\
&| \langle \text{Expr3} \rangle * \langle \text{Expr3} \rangle \\
&| \langle \text{Expr3} \rangle / \langle \text{Expr3} \rangle \\
\langle \text{Op6} \rangle &::= ( \langle \text{Op} \rangle ) \\
&| + \langle \text{Expr3} \rangle \\
&| - \langle \text{Expr3} \rangle \\
\langle \text{RecordElem} \rangle &::= \langle \text{Ident} \rangle = \langle \text{Expr3} \rangle
\end{aligned}$$

$$\begin{aligned}
\langle ListRecordElem \rangle & ::= \epsilon \\
& \quad | \quad \langle RecordElem \rangle \\
& \quad | \quad \langle RecordElem \rangle , \langle ListRecordElem \rangle \\
\langle Type \rangle & ::= \langle Type1 \rangle \\
\langle Type1 \rangle & ::= \langle Type2 \rangle \\
& \quad | \quad \langle Type1 \rangle \rightarrow \langle Type2 \rangle \\
\langle Type2 \rangle & ::= \langle Type3 \rangle \\
& \quad | \quad \langle Ident \rangle \\
& \quad | \quad \text{Int} \\
& \quad | \quad \text{Real} \\
& \quad | \quad \text{Bool} \\
& \quad | \quad \text{String} \\
& \quad | \quad \text{Unit} \\
& \quad | \quad \text{Any} \\
& \quad | \quad \{ \langle ListRecordElemType \rangle \} \\
\langle Type3 \rangle & ::= ( \langle Type \rangle ) \\
\langle RecordElemType \rangle & ::= \langle Ident \rangle : \langle Type \rangle \\
\langle ListRecordElemType \rangle & ::= \epsilon \\
& \quad | \quad \langle RecordElemType \rangle \\
& \quad | \quad \langle RecordElemType \rangle , \langle ListRecordElemType \rangle
\end{aligned}$$