

CafeOBJ Syntax Quick Reference

for Interpreter version 1.4.8 or later

Toshimi Sawada*
Kosakusha Inc.

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1 Syntax

We use an extended BNF grammar to define the syntax. The general form of a production is

$$\textit{nonterminal} ::= \textit{alternative} \mid \textit{alternative} \mid \cdots \mid \textit{alternative}$$

The following extensions are used:

a . . .	a list of one or more <i>as</i> .
a, . . .	a list of one or more <i>as</i> separated by commas: “a” or “a, a” or “a, a, a”, etc.
{ a }	{ and } are meta-syntactical brackets treating <i>a</i> as one syntactic category.
[a]	an optional <i>a</i> : “ ” or “a”.

Nonterminal symbols appear in *italic face*. Terminal symbols appear in the face like this: “terminal”, and may be surrounded by “ and ” for emphasis or to avoid confusion with meta characters used in the extended BNF. We will refer terminal symbols other than self-terminating characters (see section 2.2) as *keywords* in this document.

*sawada@cafeobj.org

1.1 CafeOBJ Spec

$spec ::= \{ module \mid view \mid eval \} \dots$

A CafeOBJ spec is a sequence of *module* (module declaration – section 1.2), *view* (view declaration – section 1.4) or *eval* (*reduce* or *execute* term – section 1.5).

1.2 Module Declaration

<i>module</i>	$::= module_type \ module_name \ [\ parameters \] \ [\ principal_sort \]$ $\quad \{ " \ module_elt \ \dots \ " \}$	
<i>module_type</i>	$::= module \mid module! \mid module^*$	– 1
<i>module_name</i>	$::= ident$	
<i>parameters</i>	$::= \{ " \ parameter, \dots \ " \}$	
<i>parameter</i>	$::= [\ protecting \mid extending \mid including \] \ paramter_name \ :: \ module_expr$	– 23
<i>parameter_name</i>	$::= ident$	
<i>principal_sort</i>	$::= principal_sort \ sort_name$	
<i>module_elt</i>	$::= import \mid sort \mid operator \mid variable \mid axiom \mid macro \mid comment$	– 4
<i>import</i>	$::= \{ \ protecting \mid extending \mid including \mid using \} \{ " \ module_expr \ " \}$	
<i>sort</i>	$::= visible_sort \mid hidden_sort$	
<i>visible_sort</i>	$::= \{ " \ sort_decl, \dots \ " \}$	
<i>hidden_sort</i>	$::= \{ "*" \ sort_decl, \dots \ "*" \}$	
<i>sort_decl</i>	$::= sort_name \ \dots \ [\ supersorts \ \dots \]$	
<i>supersorts</i>	$::= < \ sort_name \ \dots$	
<i>sort_name</i>	$::= sort_symbol \ [\ qualifier \]$	– 5
<i>sort_symbol</i>	$::= ident$	
<i>qualifier</i>	$::= \cdot \ module_name$	
<i>operator</i>	$::= \{ op \mid bop \} \ operator_symbol \ : \ [\ arity \] \ \rightarrow \ coarity \ [\ op_attrs \]$	– 6
<i>arity</i>	$::= sort_name \ \dots$	
<i>coarity</i>	$::= sort_name$	
<i>op_attrs</i>	$::= \{ " \ op_attr \ \dots \ " \}$	
<i>op_attr</i>	$::= constr \mid associative \mid commutative \mid idempotent \mid \{ id: \mid idr: \} \{ " \ term \ " \}$ $\quad \mid \text{strat: } \{ " \ natural \ \dots \ " \} \mid prec: \text{natural} \mid \text{l-assoc} \mid \text{r-assoc} \mid \text{coherent} \mid \text{demod}$	– 7
<i>variable</i>	$::= var \ var_name \ : \ sort_name \mid vars \ var_name \ \dots \ : \ sort_name$	
<i>var_name</i>	$::= ident$	
<i>axiom</i>	$::= equation \mid cequation \mid transition \mid ctransition \mid fol$	
<i>equation</i>	$::= \{ eq \mid beq \} \ [\ label \] \ term = term \cdot$	
<i>cequation</i>	$::= \{ ceq \mid bceq \} \ [\ label \] \ term = term \text{ if } term \cdot$	
<i>transition</i>	$::= \{ trans \mid btrans \} \ [\ label \] \ term \Rightarrow term \cdot$	
<i>ctransition</i>	$::= \{ ctrans \mid bctrans \} \ [\ label \] \ term \Rightarrow term \text{ if } term \cdot$	
<i>fol</i>	$::= ax \ [\ label \] \ term \cdot$	
<i>label</i>	$::= \{ " \ ident \ \dots \ " \} \cdot$	
<i>macro</i>	$::= \#define \ term ::= term \cdot$	

¹The nonterminal *ident* is for identifiers and will be defined in the section 2.3.

²*module_expr* is defined in the section 1.3.

³If optional $[\ protecting \mid extending \mid including \]$ is omitted, it is defaulted to *protecting*.

⁴*comment* is descussed in section 2.5.

⁵There must not be any separators (see section 2) between *ident* and *qualifier*.

⁶*operator_symbol* is defined in section 2.4.

⁷*natural* is a natural number written in ordinal arabic notation.

1.3 Module Expression

```

module_expr ::= module_name | sum | rename | instantiation | ("module_expr")
sum         ::= module_expr { + module_expr } ...
rename      ::= module_expr * {"rename_map, ..."}
instantiation ::= module_expr ("{" ident[qualifier] <= aview }, ... ")
rename_map  ::= sort_map | op_map
sort_map    ::= { sort | hsort } sort_name -> ident
op_map      ::= { op | bop } op_name -> operator_symbol
op_name     ::= operator_symbol | ("operator_symbol")qualifier
aview       ::= view_name | module_expr
              | view to module_expr {"view_elt, ..."}
view_name   ::= ident
view_elt    ::= sort_map | op_view | variable
op_view     ::= op_map | term -> term

```

When a module expression is not fully parenthesized, the proper nesting of subexpressions may be ambiguous. The following precedence rule is used to resolve such ambiguity:

$$sum < rename < instantiation$$

1.4 View Declaration

```

view ::= view view_name from module_expr to module_expr
      {" view_elt, ... "}

```

1.5 Evaluation

```

eval    ::= { reduce | behavioural-reduce | execute } context term "."
context ::= in module_expr :

```

The interpreter has a notion of *current module* which is specified by a *module_expr* and establishes a context. If it is set, *context* can be omitted.

1.6 Sugars and Abbreviations

Module type There are following abbreviations for *module_type*.

Keyword	Abbreviation
module	mod
module!	mod!
module*	mod*

Module Declaration

```
make ::= make module_name (" module_expr ")
```

make is a short hand for declaring module of name *module_name* which imports *module_expr* with protecting mode.
 make FOO (BAR * {sort Bar -> Foo})

is equivalent to

```
module FOO { protecting (BAR * {sort Bar -> Foo}) }
```

Principal Sort principal-sort can be abbreviated to psort.

Import Mode For import modes, the following abbreviations can be used:

Keyword	Abbreviation
protecting	pr
extending	ex
including	inc
using	us

Simultaneous Operator Declaration Several operators with the same arity, coarity and operator attributes can be declared at once by ops. The form

$\text{ops } \text{operator_symbol}_1 \cdots \text{operator_symbol}_n : \text{arity} \rightarrow \text{coarity } \text{op_attrs}$

is just equivalent to the following multiple operator declarations:

$\text{op } \text{operator_symbol}_1 : \text{arity} \rightarrow \text{coarity } \text{op_attrs}$

\vdots

$\text{op } \text{operator_symbol}_n : \text{arity} \rightarrow \text{coarity } \text{op_attrs}$

bops is the counterpart of ops for behavioural operators.

$\text{bops } \text{operator_symbol} \cdots : \text{arity} \rightarrow \text{coarity } \text{op_attrs}$

In simultaneous declarations, parentheses are sometimes necessary to separate operator symbols. This is always required if an operator symbol contains dots, blank characters or underscores.

Predicate Predicate declaration (*predicate*) is a syntactic sugar for declaring Bool valued operators, and has the syntax:

$\text{predicate} ::= \text{pred } \text{operator_symbol} : \text{arity} [\text{op_attrs}] \quad -^8$

The form

$\text{pred } \text{operator_symbol} : \text{arity } \text{op_attrs}$

is equivalent to:

$\text{op } \text{operator_symbol} : \text{arity} \rightarrow \text{Bool } \text{op_attrs}$

Operator Attributes The following abbreviations are available:

Keyword	Abbreviation
associative	assoc
commutative	comm
idempotent	idem

⁸You cannot use *sort_name* of the same character sequence as that of any keywords, i.e., module, op, vars, etc. in *arity*.

Axioms For the keywords introducing axioms, the following abbreviations can be used:

Keyword	Abbreviation	Keyword	Abbreviation
ceq	cq	bceq	bcq
trans	trns	ctrans	ctrns
btrans	btrns	bctrans	bctrns

Blocks of Declarations References to (importations of) other modules, signature definitions and axioms can be clustered in blocked declarations:

```

imports ::= imports "{"
           { import | comment } ...
           "}"
signature ::= signature "{"
           { sort | record | operator | comment } ...
           "}"
axioms ::= axioms "{"
           { variable | axiom | comment } ...
           "}"

```

Views To reduce the complexity of views appearing in module instantiation, some sugars are provided.

First, it is possible to identify parameters by positions, not by names. For example, if a parameterized module is declared like

```
module! FOO (A1 :: TH1, A2 :: TH2) { ... }
```

the form

```
FOO(V1, V2)
```

is equivalent to

```
FOO(A1 <= V1, A2 <= V2)
```

Secondly, view to construct in arguments of module instantiations can always be omitted. That is,

```
FOO(A1 <= view to module_expr{...})
```

can be written as

```
FOO(A1 <= module_expr{...})
```

Evaluation

Keyword	Abbreviation
reduce	red
bereduce	bred
execute	exec

2 Lexical Considerations

A CafeOBJ spec is written as a sequence of tokens and separators. A *token* is a sequence of “printing” ASCII characters (octal 40 through 176).⁹ A *separator* is a “blank” character (space, vertical tab, horizontal tab, carriage return, newline, form feed). In general, any number of separators may appear between tokens.

⁹The current interpreter accepts Unicode characters also, but this is beyond the definition of CafeOBJ language.

2.1 Reserved Word

There are *no* reserved word in CafeOBJ. One can use keywords such as `module`, `op`, `var`, or `signature`, etc. for identifiers or operator symbols.

2.2 Self-terminating Characters

The following eight characters are always treated as *self-terminating*, i.e., the character itself construct a token.

() , [] { } ;

2.3 Identifier

Nonterminal *ident* is for *identifier* which is a sequence of any printing ASCII characters except the followings:

self-terminating characters (see section 2.2)
.
" (double quote)

Upper- and lowercase are distinguished in identifiers. *idents* are used for module names (*module_name*), view names (*view_name*), parameter names (*parameter_name*), sort symbols (*sort_symbol*), variables(*var_name*), slot names (*slot_name*) and labels (*label*).

2.4 Operator Symbol

The nonterminal *operator_symbol* is used for naming operators (*operator*) and is a sequence of any ASCII characters (self-terminating characters or non-printing characters can be an element of operator names.)¹⁰

Underscores are specially treated when they apper as a part of operator names; they reserve the places where arguments of the operator are inserted. Thus the single underscore cannot be a name of an operator.

2.5 Comments and Separators

A *comment* is a sequence of characters that begins with one of the following four character sequences

-- -->
** **>

which ends with a newline character, and contains only printing ASCII characters and horizontal tabs in between.

A *separator* is a blank character (space, vertical tab, horizontal tab, carriage return, newline, from feed). One or more separators must appear between any two adjuacent non-self-terminating tokens.¹¹

Comments also act as separators, but their apperance is limited to some specific places (see section 1).

¹⁰The current implementation does not allow EOT character (control-D) to be an element of operator symbol.

¹¹The same rule is applied to *term*. Further, if an *operator_symbol* contains blanks or self-terminating characters, it is sometimes neccessary to enclose a term with such operator as top by parentheses for disambiguation.