

# Languages-beta: OC-L-12-Core-Library \*

The P<sub>L</sub>anCompS Project

OC-L-12-Core-Library.cbs | PLAIN | PRETTY

## OUTLINE

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*Language* "OCaml Light"

## 12 Core library

[ *Funcon* `ocaml-light-core-library`  
*Funcon* `ocaml-light-match-failure`  
*Funcon* `ocaml-light-is-structurally-equal`  
*Funcon* `ocaml-light-to-string`  
*Funcon* `ocaml-light-define-and-display`  
*Funcon* `ocaml-light-evaluate-and-display` ]

*Meta-variables*  $R, S, S_1, S_2, S_3, T, U$  <: `values`  
 $S^*$  <: `values*`  
 $T^+$  <: `values+`

## Abbreviations

The following funcons take computations  $X$  and return (curried) functions.  $X$  refers to a single function argument as `arg`, or to individual arguments of a curried function of several arguments as `arg-1`, `arg-2`, `arg-3`.

*Auxiliary Funcon* `op-1`( $X : S \Rightarrow T$ ) :  $\Rightarrow$  `functions`( $S, T$ )  
 $\rightsquigarrow$  function abstraction  $X$

*Auxiliary Funcon* `op-2`( $X : \text{tuples}(S_1, S_2) \Rightarrow T$ ) :  $\Rightarrow$  `functions`( $S_1, \text{functions}(S_2, T)$ )  
 $\rightsquigarrow$  curry function abstraction  $X$

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\*Suggestions for improvement: [plancomps@gmail.com](mailto:plancomps@gmail.com).  
Reports of issues: <https://github.com/plancomps/CBS-beta/issues>.

*Auxiliary Funcon* `op-3`( $X : \text{tuples}(S_1, S_2, S_3) \Rightarrow T$ ) :  $\Rightarrow \text{functions}(S_1, \text{functions}(S_2, \text{functions}(S_3, T)))$   
 $\rightsquigarrow$  `function abstraction`(  
    `curry partial-apply-first`(`function abstraction`  $X$ , `given`))

*Auxiliary Funcon* `partial-apply-first`( $F : \text{functions}(\text{tuples}(R, S, T^+), U), V : R$ )  
:  $\Rightarrow \text{functions}(\text{tuples}(S, T^+), U)$   
 $\rightsquigarrow$  `function abstraction`(`apply`( $F$ , `tuple`( $V$ , `tuple-elements given`)))

`partial-apply-first`( $F, V$ ) provides  $V$  as the first argument to a function expecting a tuple of 3 or more arguments, returning a function expecting a tuple of one fewer arguments.

*Auxiliary Funcon* `arg` :  $T \Rightarrow T$   
 $\rightsquigarrow$  `given`

*Auxiliary Funcon* `arg-1` :  $\text{tuples}(S_1, S^*) \Rightarrow S_1$   
 $\rightsquigarrow$  `checked index`(1, `tuple-elements given`)

*Auxiliary Funcon* `arg-2` :  $\text{tuples}(S_1, S_2, S^*) \Rightarrow S_2$   
 $\rightsquigarrow$  `checked index`(2, `tuple-elements given`)

*Auxiliary Funcon* `arg-3` :  $\text{tuples}(S_1, S_2, S_3, S^*) \Rightarrow S_3$   
 $\rightsquigarrow$  `checked index`(3, `tuple-elements given`)

## Library

The `ocaml-light-core-library` environment maps most of the names defined in OCaml Module Pervasives (the initially opened module) to funcon terms. See <https://caml.inria.fr/pub/docs/manual-ocaml-4.06/core.html> for further details and comments.

It also maps some other names defined in the OCaml Standard Library to funcon terms (to support tests using them without opening those modules).

Funcon `ocaml-light-core-library` :  $\Rightarrow$  environments

```

 $\rightsquigarrow$  { "Match_failure"  $\mapsto$ 
  op-1(variant("Match_failure", arg)),
  "Invalid_argument"  $\mapsto$ 
  op-1(variant("Invalid_argument", arg)),
  "Division_by_zero"  $\mapsto$ 
  variant("Division_by_zero", tuple( )),
  "raise"  $\mapsto$ 
  op-1(throw(arg)),
  "(=)"  $\mapsto$ 
  op-2(ocaml-light-is-structurally-equal(arg-1, arg-2)),
  "<>"  $\mapsto$ 
  op-2(not(ocaml-light-is-structurally-equal(arg-1, arg-2))),
  "<"  $\mapsto$ 
  op-2(is-less(arg-1, arg-2)),
  ">"  $\mapsto$ 
  op-2(is-greater(arg-1, arg-2)),
  "<="  $\mapsto$ 
  op-2(is-less-or-equal(arg-1, arg-2)),
  ">="  $\mapsto$ 
  op-2(is-greater-or-equal(arg-1, arg-2)),
  "min"  $\mapsto$ 
  op-2(if-true-else(is-less(arg-1, arg-2), arg-1, arg-2)),
  "max"  $\mapsto$ 
  op-2(if-true-else(is-greater(arg-1, arg-2), arg-1, arg-2)),
  "(==)"  $\mapsto$ 
  op-2(
    if-true-else(
      and(is-in-type(arg-1, ground-values), is-in-type(arg-2, ground-values)),
      is-equal(arg-1, arg-2),
      throw(variant("Invalid_argument", "equal: functional value"))),
  "(!=)"  $\mapsto$ 
  op-2(
    if-true-else(
      and(is-in-type(arg-1, ground-values), is-in-type(arg-2, ground-values)),
      not is-equal(arg-1, arg-2),
      throw(variant("Invalid_argument", "equal: functional value"))),
  "not"  $\mapsto$ 
  op-1(not(arg)),
  "(~-)"  $\mapsto$ 
  op-1(implemented-integer integer-negate(arg)),
  "(~+)"  $\mapsto$ 
  op-1(implemented-integer arg),
  "succ"  $\mapsto$ 
  op-1(implemented-integer integer-add(arg, 1)),
  "pred"  $\mapsto$ 
  op-1(implemented-integer integer-subtract(arg, 1)),
  "(+)"  $\mapsto$ 
  op-2(implemented-integer integer-add(arg-1, arg-2)),
  "(-)"  $\mapsto$ 
  op-2(implemented-integer integer-subtract(arg-1, arg-2)),
  "(*)"  $\mapsto$ 

```

## Language-specific funcons

### Exception values

*Funcon* `ocaml-light-match-failure` :  $\Rightarrow$  variants(tuples(strings, integers, integers))  
 $\rightsquigarrow$  variant("Match\_failure", tuple("", 0, 0))

`ocaml-light-match-failure` gives a value to be thrown when a match fails. The variant value should consist of the source program text, line, and column, but these are currently not included in the translation of OCaml Light.

*Funcon* `ocaml-light-assert-failure` :  $\Rightarrow$  variants(tuples(strings, integers, integers))  
 $\rightsquigarrow$  variant("Assert\_failure", tuple("", 0, 0))

`ocaml-light-assert-failure` gives a value to be thrown when an assertion fails. The variant value should consist of the source program text, line, and column, but these are currently not included in the translation of OCaml Light.

### Structural equality

*Funcon* `ocaml-light-is-structurally-equal`(\_: implemented-values, \_: implemented-values)  
:  $\Rightarrow$  booleans

`ocaml-light-is-structurally-equal`( $V_1$ ,  $V_2$ ) is false whenever  $V_1$  or  $V_2$  contains a function. For vectors, it compares all their respective assigned values. It is equality on primitive values, and defined inductively on composite values.

Unit Type

*Rule* `ocaml-light-is-structurally-equal`(null-value, null-value)  $\rightsquigarrow$  true

Booleans

*Rule* `ocaml-light-is-structurally-equal`( $B_1$  : booleans,  $B_2$  : booleans)  $\rightsquigarrow$  is-equal( $B_1$ ,  $B_2$ )

Integers

*Rule* `ocaml-light-is-structurally-equal`( $I_1$  : implemented-integers,  $I_2$  : implemented-integers)  $\rightsquigarrow$   
is-equal( $I_1$ ,  $I_2$ )

Floats

*Rule* `ocaml-light-is-structurally-equal`( $F_1$  : implemented-floats,  $F_2$  : implemented-floats)  $\rightsquigarrow$   
is-equal( $F_1$ ,  $F_2$ )

Characters

*Rule* `ocaml-light-is-structurally-equal`( $C_1$  : implemented-characters,  $C_2$  : implemented-characters)  $\rightsquigarrow$   
is-equal( $C_1$ ,  $C_2$ )

Strings

*Rule* `ocaml-light-is-structurally-equal`( $S_1$  : implemented-strings,  $S_2$  : implemented-strings)  $\rightsquigarrow$   
is-equal( $S_1$ ,  $S_2$ )

## Tuples

- Rule* `ocaml-light-is-structurally-equal(tuple( ), tuple( ))`  $\rightsquigarrow$  `true`
- Rule* `ocaml-light-is-structurally-equal(tuple( ), tuple(V+))`  $\rightsquigarrow$  `false`
- Rule* `ocaml-light-is-structurally-equal(tuple(V+), tuple( ))`  $\rightsquigarrow$  `false`
- Rule* `ocaml-light-is-structurally-equal(tuple(V, V*), tuple(W, W*))`  $\rightsquigarrow$   
`and(`  
    `ocaml-light-is-structurally-equal(V, W),`  
    `ocaml-light-is-structurally-equal(tuple(V*), tuple(W*))`)

## Lists

- Rule* `ocaml-light-is-structurally-equal([ ], [ ])`  $\rightsquigarrow$  `true`
- Rule* `ocaml-light-is-structurally-equal([ ], [V+])`  $\rightsquigarrow$  `false`
- Rule* `ocaml-light-is-structurally-equal([V+], [ ])`  $\rightsquigarrow$  `false`
- Rule* `ocaml-light-is-structurally-equal([V, V*], [W, W*])`  $\rightsquigarrow$   
`and(`  
    `ocaml-light-is-structurally-equal(V, W),`  
    `ocaml-light-is-structurally-equal([V*], [W*])`)

## Records

- Rule* 
$$\frac{\text{dom}(Map_1) == \text{dom}(Map_2)}{\text{ocaml-light-is-structurally-equal}(\text{record}(Map_1 : \text{maps}(-, -)), \text{record}(Map_2 : \text{maps}(-, -)))} \rightsquigarrow$$
  
`not(`  
    `is-in-set(`  
        `false,`  
        `set(`  
            `interleave-map(`  
                `ocaml-light-is-structurally-equal(`  
                    `checked lookup(Map1, given),`  
                    `checked lookup(Map2, given),`  
                    `set-elements(dom(Map1)))`)

## References

- Rule* `ocaml-light-is-structurally-equal(V1 : variables, V2 : variables)`  $\rightsquigarrow$   
`ocaml-light-is-structurally-equal(assigned(V1), assigned(V2))`

## Vectors

- Rule* `ocaml-light-is-structurally-equal(Vec1 : vectors(values), Vec2 : vectors(values))`  $\rightsquigarrow$   
`ocaml-light-is-structurally-equal([vector-elements(Vec1)], [vector-elements(Vec2)])`

## Variants

*Rule* `ocaml-light-is-structurally-equal(variant(Con1, V1), variant(Con2, V2))`  $\rightsquigarrow$   
`if-true-else(  
  is-equal(Con1, Con2),  
  if-true-else(  
    or(is-equal(tuple( ), V1), is-equal(tuple( ), V2)),  
    and(is-equal(tuple( ), V1), is-equal(tuple( ), V2)),  
    ocaml-light-is-structurally-equal(V1, V2)),  
  false)`

## Functions

*Rule* `ocaml-light-is-structurally-equal(_ : functions(-, -), _ : functions(-, -))`  $\rightsquigarrow$   
`throw(variant("Invalid_argument", "equal: functional value"))`

## Console display

*Funcon* `ocaml-light-to-string(_ : values) :  $\Rightarrow$  strings`

`ocaml-light-to-string(V)` gives the string representation of OCaml Light values as implemented by the ocaml interpreter.

*Rule* `ocaml-light-to-string(null-value)  $\rightsquigarrow$  "()"`  
*Rule* `ocaml-light-to-string( $B$  : booleans)  $\rightsquigarrow$  to-string( $B$ )`  
*Rule* `ocaml-light-to-string( $I$  : integers)  $\rightsquigarrow$  to-string( $I$ )`  
*Rule* `ocaml-light-to-string( $F$  : implemented-floats)  $\rightsquigarrow$  to-string( $F$ )`  
*Rule* `ocaml-light-to-string( $C$  : implemented-characters)  $\rightsquigarrow$   
string-append(")", to-string( $C$ ), ")")`  
*Rule* 
$$\frac{S \neq []}{\text{ocaml-light-to-string}(S : \text{implemented-strings}) \rightsquigarrow \text{string-append}("[]", S, "[]")}$$
  
*Rule* `ocaml-light-to-string( $_$  : functions( $_$ ,  $_$ ))  $\rightsquigarrow$  "<fun>"`  
*Rule* `ocaml-light-to-string( $V$  : variables)  $\rightsquigarrow$   
string-append("ref ", ocaml-light-to-string(assigned( $V$ )))`  
*Rule* `ocaml-light-to-string(variant( $Con$ ,  $Arg$ ))  $\rightsquigarrow$   
if-true-else(  
is-equal(tuple( ),  $Arg$ ),  
 $Con$ ,  
string-append( $Con$ , " ", ocaml-light-to-string( $Arg$ )))`  
*Rule* `ocaml-light-to-string(tuple( $V$  : values,  $V^+$  : values $^+$ ))  $\rightsquigarrow$   
string-append(  
"(",  
intersperse(" ", interleaved-map(ocaml-light-to-string(given),  $V$ ,  $V^+$ )),  
")")`  
*Rule* `ocaml-light-to-string( $[V^* : \text{values}^*]$ )  $\rightsquigarrow$   
string-append(  
"[",  
intersperse(";", interleaved-map(ocaml-light-to-string(given),  $V^*$ )),  
"]")`  
*Rule* `ocaml-light-to-string( $V$  : implemented-vectors)  $\rightsquigarrow$   
string-append(  
"[|",  
intersperse(  
"; ",  
interleaved-map(  
ocaml-light-to-string(assigned(given)),  
vector-elements( $V$ )),  
"|]")`  
*Rule* `ocaml-light-to-string(record( $M$  : maps( $_$ ,  $_$ )))  $\rightsquigarrow$   
string-append(  
"{",  
intersperse(  
"; ",  
interleaved-map(  
string-append(arg-1, " = ", ocaml-light-to-string(arg-2)),  
map-elements( $M$ )),  
"}")`

```
Funcon ocaml-light-define-and-display(Env : envs) : ⇒ envs
  ~> sequential(
    effect left-to-right-map(
      print(arg-1, " = ", ocaml-light-to-string arg-2, "\n"),
      map-elements Env),
    Env)
```

```
Funcon ocaml-light-evaluate-and-display(V : implemented-values) : ⇒ envs
  ~> sequential(
    print("- = ", ocaml-light-to-string V, "\n"),
    map( ))
```