

foreign-c a portable foreign function interface for R7RS Schemes

foreign-c

foreign-c is a C foreign function interface (FFI) library for R7RS Schemes. It is portable in the sense that it supports multiple implementations, as opposed to being portable by conforming to some specification.

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Implementation support tables

Required versions:

- Gambit >= 4.9.5
- Guile >= 3
- Kawa >= 3.11 and Java >= 22
 - Needs arguments
 - -J-add-exports=java.base/jdk.internal.foreign.abi=ALL-UNNAMED
 - -J-add-exports=java.base/jdk.internal.foreign.layout=ALL-UNNAMED
 - -J-add-exports=java.base/jdk.internal.foreign=ALL-UNNAMED
 - -J-enable-native-access=ALL-UNNAMED
 - -J-enable-preview
- STklos > 2.10

Primitives 1 table

	c-type-size	c-bytevector-u8-set!	c-byt
Chibi	X	X	
Chicken	X	X	
Gambit	X	X	
Gauche	X	X	
Guile	X	X	
Kawa	X	X	
Mosh	X	X	
Racket	X	X	
Sagittarius	X	X	
STklos	X	X	
Ypsilon	X	X	

Primitives 2 table

Chibi
Chicken
Gauche
Guile
Kawa
Mosh
Racket
Saggittarius
STklos
Ypsilon

Test files pass

	primitives.scm
Chibi	X
Chicken	X
Gauche	X
Guile	X
Kawa	X
Mosh	X
Racket	X
Saggittarius	X
STklos	X
Ypsilon	X

Installation

Snow-fort

<https://snow-fort.org/>

Installable with snow-chibi for following implementations.

- Chibi
- Kawa
- STklos

Manul

Either download the latest release from <https://git.sr.ht/~retropikzel/foreign-c/refs> or git clone, tag, and copy the *foreign* directory to your library directory.

Example assuming libraries in directory *snow*:

```
git clone https://git.sr.ht/~retropikzel/foreign-c --branch
LATEST_VERSION
cd foreign-c
make SCHEME_IMPLEMENTATION_NAME
cd ..
mkdir -p snow
cp -r foreign-c/foreign snow/
```

With most implementations the make command does not compile anything. When that is the case it will say “Nothing to build on SCHEME_IMPLEMENTATION_NAME.”

Documentation

Types

Types are given as symbols, for example `'int8` or `'pointer`.

- `int8`
- `uint8`
- `int16`
- `uint16`
- `int32`
- `uint32`
- `int64`
- `uint64`
- `char`
- `unsigned-char`
- `short`
- `unsigned-short`
- `int`

- unsigned-int
- long
- unsigned-long
- float
- double
- pointer
 - c-bytevector on Scheme side
- callback
 - Callback function
- void
 - Can not be argument type, only return type

Primitives 1

(c-type-size type)

Returns the size of given C type.

(define-c-library scheme-name headers object-name options)

Takes a scheme-name to bind the library to, list of C headers as strings, shared-object name and options.

The C header strings should not contain "<" or ">", they are added automatically.

The name of the shared object should not contain suffix like .so or .dll. Nor should it contain any prefix like "lib".

Options:

- additional-versions
 - Search for additional versions of shared object, given shared object "c" and additional versions "6" "7" on linux the files "libc", "libc.6", "libc.7" are searched for.
 - Can be either numbers or strings
- additional-paths
 - Give additional paths to search shared objects from

Example:

```
(define-c-library libc
  (list "stdlib.h")
  "c"
  '((additional-versions (" " "0" "6"))
    (additional-paths ("."))))
```

Note that libc is exported by this library so you might not need to load it.

Notes

- Do not cond-expand inside the arguments, that might lead to problems on some implementations.

- Do not store options in variables, that might lead to problems on some implementations.
- Pass the headers using quote
 - As `'(...)` and not `(list...)`
- Pass the options using quote
 - As `'(...)` and not `(list...)`

(define-c-procedure *scheme-name shared-object c-name return-type argument-type*)

Takes a scheme-name to bind the C procedure to, shared-object where the function is looked from, c-name of the function as symbol, return-type and argument-types.

Defines a new foreign function to be used from Scheme code.

Example:

```
(cond-expand
  (windows (define-c-library libc '("stdlib.h") "ucrtbase"
    '()))
  (else (define-c-library libc '("stdlib.h") "c" '("6"))))
(define-c-procedure c-puts libc 'puts 'int '(pointer))
(c-puts "Message brought to you by foreign-c!")
```

Notes

- Pass the return-types using quote
 - As `'(...)` and not `(list...)`

(c-bytevector? *obj*)

Returns **#t** if *obj* is c-bytevector, otherwise returns **#f**.

(c-bytevector-u8-set! *c-bytevector k byte*)

If *K* is not a valid index of c-bytevector the behaviour is undefined.

Stores the byte in element *k* of c-bytevector.

(c-bytevector-u8-ref *c-bytevector k*)

If *K* is not a valid index of c-bytevector the behaviour is undefined.

Returns the byte at index *k* of c-bytevector.

(c-bytevector-pointer-set! *c-bytevector k pointer*)

If *K* is not a valid index of c-bytevector the behaviour is undefined.

Stores the pointer(which is also c-bytevector) in element *k* of c-bytevector.

(c-bytevector-pointer-ref *c-bytevector k pointer*)

If K is not a valid index of c-bytevector the behaviour is undefined.

Returns the pointer(which is also c-bytevector) at index k of c-bytevector.

Primitives 2

(define-c-callback *scheme-name return-type argument-types procedure*)

Takes scheme-name to bind the Scheme procedure to, return-type, argument-types and procedure as in place lambda.

Defines a new Sceme function to be used as callback to C code.

Example:

```
; Load the shared library
(cond-expand
  (windows (define-c-library libc-stdlib '("stdlib.h")
    "ucrtbase" '()))
  (else (define-c-library '("stdlib.h") "c" '(" " "6"))))

; Define C function that takes a callback
(define-c-procedure qsort libc-stdlib 'qsort 'void '(pointer int
int callback))

; Define our callback
(define-c-callback compare
  'int
  '(pointer pointer)
  (lambda (pointer-a pointer-b)
    (let ((a (c-bytevector-sint-get pointer-a
      (native-endianness) 0))
          (b (c-bytevector-sint-get pointer-b
      (native-endianness) 0)))
      (cond ((> a b) 1)
            ((= a b) 0)
            ((< a b) -1)))))

; Create new array of ints to be sorted
(define array (make-c-bytevector (* (c-type-size 'int) 3)))
(c-bytevector-s32-native-set! array (* (c-type-size 'int) 0) 3)
(c-bytevector-s32-native-set! array (* (c-type-size 'int) 1) 2)
(c-bytevector-s32-native-set! array (* (c-type-size 'int) 2) 1)

(display array)
(newline)
;> (3 2 1)

; Sort the array
(qsort array 3 (c-type-size 'int) compare)

(display array)
```

```
(newline)
;> (1 2 3)
```

c-bytevector

Foreign-c c-bytevector interface is copied from R6RS bytevectors, with some added functionality for C null pointers and manual memory management.

(**make-c-null**)

Returns a null C pointer.

(**c-null?** *obj*)

Returns **#t** if *obj* is a null C pointer, otherwise returns **#f**.

(**c-free** *c-bytevector*)

Frees *c-bytevector* from memory.

(**call-with-address-of** *c-bytevector thunk*)

Calls *thunk* with address pointer of *c-bytevector*.

Since the support for calling C functions taking pointer address arguments, ones prefixrd with & in C, varies, some additional ceremony is needed on the Scheme side.

Example:

Calling from C:

```
//void func(int** i);
func(&i);
```

Calling from Scheme:

```
(define cbv (make-bytevector (c-type-size 'int)))
(call-with-address-of
 cbv
 (lambda (address)
  (func address)))
; Use cbv here
```

The passed c-bytevector, in example named *cbv*, should only be used **after** call to *call-with-address-of* ends.

(**bytevector->c-bytevector** *bytevector*)

Returns a newly allocated c-bytevector of the bytes of *bytevector*.

(**c-bytevector->bytevector**)

Returns a newly allocated bytevector of the bytes of *c-bytevector*.

(native-endianness)

Returns the endianness symbol associated implementation's preferred endianness (usually that of the underlying machine architecture). This may be any <endianness symbol>, including a symbol other than big and little.

(make-c-bytevector *k*)
(make-c-bytevector *k fill*)

Returns a newly allocated c-bytevector of *k* bytes.

If the *fill* argument is missing, the initial contents of the returned c-bytevector are unspecified.

If the *fill* argument is present, it's value must confine to C `uint8_t` values , it specifies the initial value for the bytes of the c-bytevector

(c-bytevector-s8-set! *c-bytevector k byte*)

If *k* is not a valid index of c-bytevector the behaviour is undefined.

Stores the *byte* in element *k* of *c-bytevector*.

(c-bytevector-s8-ref *c-bytevector k*)

If *k* is not a valid index of c-bytevector the behaviour is undefined.

Returns the byte at index *k* of *c-bytevector*.

(c-bytevector-char-set! *c-bytevector k char*)

If *k* is not a valid index of c-bytevector the behaviour is undefined.

Stores the *char* in element *k* of *c-bytevector*.

(c-bytevector-char-ref *c-bytevector k*)

If *k* is not a valid index of c-bytevector the behaviour is undefined.

Returns the char at index *k* of *c-bytevector*.

(c-bytevector-uchar-set! *c-bytevector k char*)

If *k* is not a valid index of c-bytevector the behaviour is undefined.

Stores the unsigned *char* in element *k* of *c-bytevector*.

(c-bytevector-uchar-ref *c-bytevector k*)

If *k* is not a valid index of c-bytevector the behaviour is undefined.

Returns the unsigned char at index *k* of *c-bytevector*.

(c-bytevector-uint-ref *c-bytevector k endianness size*)

(c-bytevector-sint-ref *c-bytevector k endianness size*)

(c-bytevector-uint-set! *c-bytevector k n endianness size*)
(c-bytevector-sint-set! *c-bytevector k n endianness size*)

Size must be a positive exact integer object. If $k, \dots, k + \text{size} - 1$ is not valid indices of *c-bytevector* the behavior is unspecified.

The *c-bytevector-uint-ref* procedure retrieves the exact integer object corresponding to the unsigned representation of size *size* and specified by *endianness* at indices $k, \dots, k + \text{size} - 1$.

The *c-bytevector-sint-ref* procedure retrieves the exact integer object corresponding to the two's-complement representation of size *size* and specified by *endianness* at indices $k, \dots, k + \text{size} - 1$. For *c-bytevector-uint-set!*, *n* must be an exact integer object in the interval $\{0, \dots, 256^{\text{size}} - 1\}$.

The *c-bytevector-uint-set!* procedure stores the unsigned representation of size *size* and specified by *endianness* into *c-bytevector* at indices $k, \dots, k + \text{size} - 1$.

The *...-set!* procedures return unspecified values.

Examples:

```
(define cbv (make-c-bytevector (c-type-size 'int)))
(c-bytevector-sint-set! cbv 0 100 (native-endianness) (c-type-size 'int))
(c-bytevector-sint-ref cbv 0 (native-endianness) (c-type-size 'int))
> 100
```

(c-bytevector-u16-ref *c-bytevector k endianness*)
(c-bytevector-s16-ref *c-bytevector k endianness*)
(c-bytevector-u16-native-ref *c-bytevector k*)
(c-bytevector-s16-native-ref *c-bytevector k*)
(c-bytevector-u16-set! *c-bytevector k n endianness*)
(c-bytevector-s16-set! *c-bytevector k n endianness*)
(c-bytevector-u16-native-set! *c-bytevector k n*)
(c-bytevector-s16-native-set! *c-bytevector k n*)

K must be a valid index of *c-bytevector*; so must $k + 1$. For *c-bytevector-u16-set!* and *c-bytevector-u16-native-set!*, *n* must be an exact integer object in the interval $\{0, \dots, 2^{16} - 1\}$. For *c-bytevector-s16-set!* and *c-bytevector-s16-native-set!*, *n* must be an exact integer object in the interval $\{-2^{15}, \dots, 2^{15} - 1\}$.

These retrieve and set two-byte representations of numbers at indices *k* and $k + 1$, according to the endianness specified by *endianness*. The procedures with *u16* in their names deal with the unsigned representation; those with *s16* in their names deal with the two's-complement representation.

The procedures with *native* in their names employ the native endianness, and work only at aligned indices: *k* must be a multiple of 2.

The ...-set! procedures return unspecified values.

(c-bytevector-u32-ref *c-bytevector k endianness*)
(c-bytevector-s32-ref *c-bytevector k endianness*)
(c-bytevector-u32-native-ref *c-bytevector k*)
(c-bytevector-s32-native-ref *c-bytevector k*)
(c-bytevector-u32-set! *c-bytevector k n endianness*)
(c-bytevector-s32-set! *c-bytevector k n endianness*)
(c-bytevector-u32-native-set! *c-bytevector k n*)
(c-bytevector-s32-native-set! *c-bytevector k n*)

$K, \dots, k + 3$ must be valid indices of bytevector. For c-bytevector-u32-set! and bytevector-u32-native-set!, n must be an exact integer object in the interval $\{0, \dots, 232 - 1\}$. For bytevector-s32-set! and bytevector-s32-native-set!, n must be an exact integer object in the interval $\{-231, \dots, 232 - 1\}$.

These retrieve and set four-byte representations of numbers at indices $k, \dots, k + 3$, according to the endianness specified by *endianness*. The procedures with u32 in their names deal with the unsigned representation; those with s32 with the two's-complement representation.

The procedures with native in their names employ the native endianness, and work only at aligned indices: k must be a multiple of 4.

The ...-set! procedures return unspecified values.

(c-bytevector-u64-ref *c-bytevector k endianness*)
(c-bytevector-s64-ref *c-bytevector k endianness*)
(c-bytevector-u64-native-ref *c-bytevector k*)
(c-bytevector-s64-native-ref *c-bytevector k*)
(c-bytevector-u64-set! *c-bytevector k n endianness*)
(c-bytevector-s64-set! *c-bytevector k n endianness*)
(c-bytevector-u64-native-set! *c-bytevector k n*)
(c-bytevector-s64-native-set! *c-bytevector k n*)

$K, \dots, k + 7$ must be valid indices of *c-bytevector*. For c-bytevector-u64-set! and c-bytevector-u64-native-set!, n must be an exact integer object in the interval $\{0, \dots, 264 - 1\}$. For c-bytevector-s64-set! and c-bytevector-s64-native-set!, n must be an exact integer object in the interval $\{-263, \dots, 264 - 1\}$.

These retrieve and set eight-byte representations of numbers at indices $k, \dots, k + 7$, according to the endianness specified by *endianness*. The procedures with u64 in their names deal with the unsigned representation; those with s64 with the two's-complement representation.

The procedures with native in their names employ the native endianness, and work only at aligned indices: k must be a multiple of 8.

The ...-set! procedures return unspecified values.

(c-bytevector-ieee-single-native-ref)
(c-bytevector-ieee-single-ref)

$K, \dots, k + 3$ must be valid indices of *c-bytevector*. For *c-bytevector-ieee-single-native-ref*, k must be a multiple of 4.

These procedures return the inexact real number object that best represents the IEEE-754 single-precision number represented by the four bytes beginning at index k .

(c-bytevector-ieee-double-native-ref)
(c-bytevector-ieee-double-ref)

$K, \dots, k + 7$ must be valid indices of *c-bytevector*. For *c-bytevector-ieee-double-native-ref*, k must be a multiple of 8.

These procedures return the inexact real number object that best represents the IEEE-754 double-precision number represented by the eight bytes beginning at index k .

(c-bytevector-ieee-single-native-set!)
(c-bytevector-ieee-single-set!)

$K, \dots, k + 3$ must be valid indices of *c-bytevector*. For *c-bytevector-ieee-single-native-set!*, k must be a multiple of 4.

These procedures store an IEEE-754 single-precision representation of x into elements k through $k + 3$ of *bytevector*, and return unspecified values.

(c-bytevector-ieee-double-native-set!)
(c-bytevector-ieee-double-set!)

$K, \dots, k + 7$ must be valid indices of *bytevector*. For *c-bytevector-ieee-double-native-set!*, k must be a multiple of 8.

These procedures store an IEEE-754 double-precision representation of x into elements k through $k + 7$ of *bytevector*, and return unspecified values.

(string->c-utf8 string)

Returns a newly allocated (unless empty) *c-bytevector* that contains the UTF-8 encoding of the given string.

(c-utf8->string c-bytevector)

Returns a newly allocated (unless empty) string whose character sequence is encoded by the given *c-bytevector*.

Utilities

libc

Since the library uses C standard internally, and that is most likely library to have different name on different operating systems. For example *libc.so* on Linux, *ucrtbase.dll* on windows and *libroot.so* on Haiku. It makes sense to export it, saving the users the trouble of figuring out which named shared library they should load.

See `foreign/c/libc.scm` to see which headers are included and what shared libraries are loaded.

Example:

```
(define-c-procedure c-puts libc 'puts 'int '(pointer))  
(c-puts "Message brought to you by foreign-c!")
```

Environment variables

Setting environment variables like this on Windows works for this library:

```
set "FOREIGN_C_LOAD_PATH=C:\Program Files (x86)/foo/bar"
```

FOREIGN_C_LOAD_PATH

To add more paths to where foreign c looks for libraries set `FOREIGN_C_LOAD_PATH` to paths separated by `;` on windows, and `:` on other operating systems.