

# Lazy Scheme

Version 4.0.2

July 4, 2008

```
#lang lazy
```

Lazy Scheme is available as both a language level and a module that can be used to write lazy code. To write lazy code, simply use `lazy` as your module's language:

```
#lang lazy
... lazy code here ...
```

Function applications are delayed, and promises are automatically forced. The language provides bindings that are equivalent to most of the `mzscheme` and `scheme/list` libraries. Primitives are strict in the expected places; struct constructors are lazy; `if`, `and`, `or` etc. are plain (lazy) functions. Strict functionality is provided as-is: `begin`, I/O, mutation, parameterization, etc. To have your code make sense, you should chain side effects in `begins`, which will sequence things properly. (Note: This is similar to threading monads through your code—only use `begin` where order matters.)

Mizing lazy and strict code is simple: you just write the lazy code in the lazy language, and strict code as usual. The lazy language treats imported functions (those that were not defined in the lazy language) as strict, and on the strict side you only need to force (possibly recursively) through promises.

A few side-effect bindings are provided as-is. For example, `read` and `printf` do the obvious thing—but note that the language is a call-by-need, and you need to be aware when promises are forced. There are also bindings for `begin` (delays a computation that forces all sub-expressions), `when`, `unless`, etc. There are, however, less reliable and might change (or be dropped) in the future.

There are a few additional bindings, the important ones are special forms that force strict behaviour—there are several of these that are useful in forcing different parts of a value in different ways, as described in §2 “Forcing Values”.

# 1 Lazy Forms and Functions

---

`lambda`

Lazy variant of `lambda`.

---

`define`

Lazy variant of `define`.

---

`let`

Lazy variant of `let`.

---

`let*`

Lazy variant of `let*`.

---

`letrec`

Lazy variant of `letrec`.

---

`parameterize`

Lazy variant of `parameterize`.

---

`define-values`

Lazy variant of `define-values`.

---

`let-values`

Lazy variant of `let-values`.

---

`let*-values`

Lazy variant of `let*-values`.

---

letrec-values

Lazy variant of letrec-values.

---

if

Lazy variant of if.

---

set!

Lazy variant of set!.

---

begin

Lazy variant of begin.

---

begin0

Lazy variant of begin0.

---

when

Lazy variant of when.

---

unless

Lazy variant of unless.

---

cond

Lazy variant of cond.

---

case

Lazy variant of case.

---

values : procedure?

Lazy variant of `values`.

---

`make-struct-type` : procedure?

Lazy variant of `make-struct-type`.

---

`cons` : procedure?

Lazy variant of `cons`.

---

`list` : procedure?

Lazy variant of `list`.

---

`list*` : procedure?

Lazy variant of `list*`.

---

`vector` : procedure?

Lazy variant of `vector`.

---

`box` : procedure?

Lazy variant of `box`.

---

`and` : procedure?

Lazy variant of `and`.

---

`or` : procedure?

Lazy variant of `or`.

---

`set-mcar!` : procedure?

Lazy variant of `set-mcar!`.

---

`set-mcdr!` : procedure?

Lazy variant of `set-mcdr!`.

---

`vector-set!` : procedure?

Lazy variant of `vector-set!`.

---

`set-box!` : procedure?

Lazy variant of `set-box!`.

---

`error` : procedure?

Lazy variant of `error`.

---

`printf` : procedure?

Lazy variant of `printf`.

---

`fprintf` : procedure?

Lazy variant of `fprintf`.

---

`display` : procedure?

Lazy variant of `display`.

---

`write` : procedure?

Lazy variant of `write`.

---

`print` : procedure?

Lazy variant of `print`.

---

`eq?` : procedure?

Lazy variant of `eq?`.

---

`eqv?` : procedure?

Lazy variant of `eqv?`.

---

`equal?` : procedure?

Lazy variant of `equal?`.

---

`list?` : procedure?

Lazy variant of `list?`.

---

`length` : procedure?

Lazy variant of `length`.

---

`list-ref` : procedure?

Lazy variant of `list-ref`.

---

`list-tail` : procedure?

Lazy variant of `list-tail`.

---

`append` : procedure?

Lazy variant of `append`.

---

`map` : procedure?

Lazy variant of `map`.

---

`for-each` : procedure?

Lazy variant of `for-each`.

---

`andmap` : procedure?

Lazy variant of [andmap](#).

---

[ormap](#) : procedure?

Lazy variant of [ormap](#).

---

[member](#) : procedure?

Lazy variant of [member](#).

---

[memq](#) : procedure?

Lazy variant of [memq](#).

---

[memv](#) : procedure?

Lazy variant of [memv](#).

---

[assoc](#) : procedure?

Lazy variant of [assoc](#).

---

[assq](#) : procedure?

Lazy variant of [assq](#).

---

[assv](#) : procedure?

Lazy variant of [assv](#).

---

[reverse](#) : procedure?

Lazy variant of [reverse](#).

---

[caar](#) : procedure?

Lazy variant of [caar](#).

---

`cadr` : procedure?

Lazy variant of `cadr`.

---

`cdar` : procedure?

Lazy variant of `cdar`.

---

`cddr` : procedure?

Lazy variant of `cddr`.

---

`caaar` : procedure?

Lazy variant of `caaar`.

---

`caadr` : procedure?

Lazy variant of `caadr`.

---

`cadar` : procedure?

Lazy variant of `cadar`.

---

`caddr` : procedure?

Lazy variant of `caddr`.

---

`cdaar` : procedure?

Lazy variant of `cdaar`.

---

`cdadr` : procedure?

Lazy variant of `cdadr`.

---

`cddar` : procedure?

Lazy variant of `cddar`.

---

`cdddr` : procedure?

Lazy variant of `cdddr`.

---

`caaar` : procedure?

Lazy variant of `caaar`.

---

`caadr` : procedure?

Lazy variant of `caadr`.

---

`caadar` : procedure?

Lazy variant of `caadar`.

---

`caaddr` : procedure?

Lazy variant of `caaddr`.

---

`cadaar` : procedure?

Lazy variant of `cadaar`.

---

`cadadr` : procedure?

Lazy variant of `cadadr`.

---

`caddar` : procedure?

Lazy variant of `caddar`.

---

`caddr` : procedure?

Lazy variant of `caddr`.

---

`cdaaar` : procedure?

Lazy variant of `cdaaar`.

---

`cdaadr` : procedure?

Lazy variant of `cdaadr`.

---

`cdadar` : procedure?

Lazy variant of `cdadar`.

---

`cdaddr` : procedure?

Lazy variant of `cdaddr`.

---

`cddaar` : procedure?

Lazy variant of `cddaar`.

---

`cddadr` : procedure?

Lazy variant of `cddadr`.

---

`cdddar` : procedure?

Lazy variant of `cdddar`.

---

`cddddr` : procedure?

Lazy variant of `cddddr`.

---

`first` : procedure?

Lazy variant of `first`.

---

`second` : procedure?

Lazy variant of `second`.

---

`third` : procedure?

Lazy variant of `third`.

---

`fourth` : procedure?

Lazy variant of `fourth`.

---

`fifth` : procedure?

Lazy variant of `fifth`.

---

`sixth` : procedure?

Lazy variant of `sixth`.

---

`seventh` : procedure?

Lazy variant of `seventh`.

---

`eighth` : procedure?

Lazy variant of `eighth`.

---

`rest` : procedure?

Lazy variant of `rest`.

---

`cons?` : procedure?

Lazy variant of `cons?`.

---

`empty` : procedure?

Lazy variant of `empty`.

---

`empty?` : procedure?

Lazy variant of `empty?`.

---

`foldl` : procedure?

Lazy variant of `foldl`.

---

`foldr` : procedure?

Lazy variant of `foldr`.

---

`last-pair` : procedure?

Lazy variant of `last-pair`.

---

`remove` : procedure?

Lazy variant of `remove`.

---

`remq` : procedure?

Lazy variant of `remq`.

---

`remv` : procedure?

Lazy variant of `remv`.

---

`remove*` : procedure?

Lazy variant of `remove*`.

---

`remq*` : procedure?

Lazy variant of `remq*`.

---

`remv*` : procedure?

Lazy variant of `remv*`.

---

`memf` : procedure?

Lazy variant of `memf`.

---

`assf` : procedure?

Lazy variant of `assf`.

---

`filter` : procedure?

Lazy variant of `filter`.

---

`sort` : procedure?

Lazy variant of `sort`.

---

`true` : procedure?

Lazy variant of `true`.

---

`false` : procedure?

Lazy variant of `false`.

---

`boolean=?` : procedure?

Lazy variant of `boolean=?`.

---

`symbol=?` : procedure?

Lazy variant of `symbol=?`.

---

`compose` : procedure?

Lazy variant of `compose`.

---

`build-list` : procedure?

Lazy variant of `build-list`.

---

`take` : procedure?

Lazy variant of `take`.

---

`identity` : procedure?

Lazy identity function.

---

`cycle` : procedure?

Creates a lazy infinite list given a list of elements to repeat in order.

## 2 Forcing Values

(require lazy/force)

The bindings of `lazy/force` are re-provided by `lazy`.

---

```
(! expr) → any/c  
expr : any/c
```

Evaluates `expr` strictly. The result is always forced, over and over until it gets a non-promise value.

---

```
(!! expr) → any/c  
expr : any/c
```

Similar to `!`, but recursively forces a structure (e.g: lists).

---

```
(!!! expr) → any/c  
expr : any/c
```

Similar to `!!`, but also wraps procedures that if finds so their outputs are forced (so they are useful in a strict world).

---

```
(!list expr) → list?  
expr : (or/c promise? list?)
```

Forces the `expr` which is expected to be a list, and forces the `cdrs` recursively to expose a proper list structure.

---

```
(!!list expr) → list?  
expr : (or/c promise? list?)
```

Similar to `!list` but also forces (using `!`) the elements of the list.

### 2.1 Multiple values

To avoid dealing with multiple values, they are treated as a single tuple in the lazy language. This is implemented as a `multiple-values` struct, with a `values` slot.

```
(split-values x) → any  
  x : multiple-values?
```

Used to split such a tuple to actual multiple values. (This may change in the future.)

---

```
(!values expr) → any  
  expr : (or/c promise? multiple-values?)
```

Forces *expr* and uses `split-values` on the result.

---

```
(!!values expr) → any  
  expr : (or/c promise? multiple-values?)
```

Similar to `!values`, but forces each of the values recursively.

### 3 Promises

```
(require lazy/promise)
```

The `lazy/promise` module implements lazy promises as implicitly used by the lazy language.

Note: this module implements a new kind of promises. MzScheme’s promises are therefore treated as other values—which means that they are not forced by this module’s `force`.

Generally speaking, if you use only `delay`, `force`, and `promise?`, you get the same functionality as in Scheme. See below for two (relatively minor) differences.

`lazy` implements a new kind of promise. When used with expressions, it behaves like `delay`. However, when `lazy` is used with an expression that already evaluates to a promise, it combines with it such that `force` will go through both promises. In other words, `(lazy expr)` is equivalent to `(lazy (lazy expr))`. The main feature of this implementation of promises is that `lazy` is safe-for-space (see SRFI-45 for details)—this is crucial for tail-recursion in Lazy Scheme.

To summarize, a sequence of lazys is forced with a single use of `force`, and each additional delay requires an additional `force`—for example, `(lazy (delay (lazy (delay (lazy expr))))))` requires three `forces` to evaluate `expr`.

Note: `lazy` cannot be used with an expression that evaluates to multiple values. `delay`, however, is fine with multiple values. (This is for efficiency in the lazy language, where multiple values are avoided.)

As mentioned above, using `delay` and `force` is as in Scheme, except for two differences. The first is a technicality—`force` is an identity for non-promise values. This makes it more convenient in implementing the lazy language, where there is no difference between a value and a promise.

The second difference is that circular (re-entrant) promises are not permitted (i.e., when a promise is being forced, trying to force it in the process will raise an error). For example, the following code (see srfi-45 for additional examples):

```
(let ([count 5])
  (define p
    (delay (if (<= count 0)
              count
              (begin (set! count (- count 1))
                     (force p))))))
  (force p))
```

returns 0 with Scheme’s `delay/force`, but aborts with an error with this module’s promises. This restriction leads to faster code (see a SRFI-45 discussion post for some additional de-

tails), while preventing diverging code (the only reasonable way to use circular promises is using mutation as above).

---

`(delay expr)`

Similar in functionality to Scheme's `delay`

---

`(lazy expr)`

Creates a “lazy” promise. See above for details.

---

`(force x)` → `any/c`  
`x : any/c`

Forces a promise that was generated by `delay` or `lazy`. Similar to Scheme's `force`, except that non-promise values are simply returned.

---

`(promise? x)` → `boolean?`  
`x : any/c`

A predicate for promise values.

## 4 MzScheme without Promises

```
(require lazy/mz-without-promises)
```

The `lazy/mz-without-promises` module simply provides all of `mzscheme` except for promise-related functionality: `delay`, `force`, and `promise?`. This is because `lazy/promise` defines and provides the same names. It is intended as a helper, but you can use it together with `lazy/promise` to get a `mzscheme`-like language where promises are implemented by `lazy/promise`.