Lazy Evaluation

Announcements

Promises

Delay Creates a Promise

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From the **Revised^5 Report on the Algorithmic Language Scheme**

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```
(delay <expression>)
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(**delay** *<expression>*)

The **delay** construct is used together with the procedure **force** to implement *lazy evaluation* or *call by need*. (**delay** *<expression>*) returns an object called a *promise* which at some point in the future may be asked (by the **force** procedure) to evaluate *<expression>*, and deliver the resulting value...

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```
(force (delay (+ 1 2))) ⇒ 3

(let ((p (delay (+ 1 2)))) (list (force p) (force p))) ⇒ (3 3)
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A Promise Can Be Represented as Function

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(Demo)

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Assignment and Caching

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scm> (define x 2)
x
scm> (set! x 3)
okay
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```

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Local, non-local, and global assignment all use set!

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```

Local, non-local, and global assignment all use set!

```
(define (sum a b)
  (let ((total 0))
    (define (iter x)
      (if (< x b)
          (begin
           (set! total (+ total x))
           (iter (+ x 1)))))
    (iter a)
    total))
```

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          (begin
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    (iter a)
    total))
```

```python
def sum(a, b):
    total = 0
    def iter(x):
        nonlocal total
        if x < b:
            total = total + x
            iter(x + 1)
    iter(a)
    return total
```

Force Caches the Promise Value

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Forces the value of promise. If no value has been computed for the promise, then a value is computed and returned. The value of the promise is cached (or "memoized") so that if it is forced a second time, the previously computed value is returned.

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```
scm> (define x 2)
x
scm> (let ((p (delay (set! x (+ x 1))))) (begin (force p) (force p)))
okay
scm> x
3
scm
```

Caching Promise

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Assignment is required in order to cache the value of a promise (from R⁵RS)
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Takes a zero-argument lambda procedure with the delayed expression as its body

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```
(define make-promise
  (lambda (proc)
    (let ((result-ready? #f)
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(define make-promise
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Returns a zero-argument lambda procedure that caches the value of proc

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(define make-promise
  (lambda (proc)
    (let ((result-ready? #f)
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         (lambda ()
           (if result-ready?
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                        result
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                        (begin
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Meta-Circular Evaluator

A Scheme Evaluator in Scheme

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Lots of different programming languages can be expressed using nested combinations

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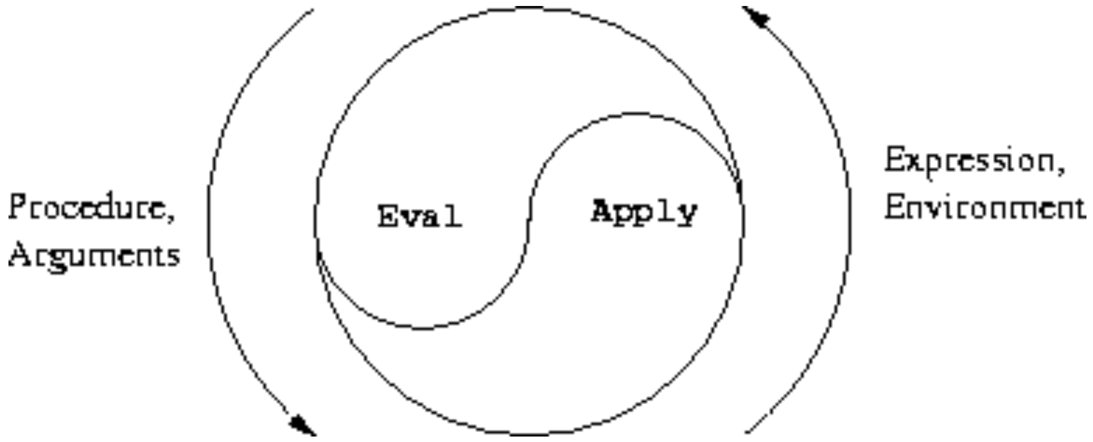

Lazy Evaluator

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(Demo)