

# Scheme vs. Algebra

In Scheme, we have a specific order for evaluating sub-expressions:

$$(+ (* 4 3) (- 8 7)) \Rightarrow (+ 12 (- 8 7)) \Rightarrow (+ 12 1)$$

In Algebra, order doesn't matter:

$$(4 \cdot 3) + (8 - 7) \Rightarrow 12 + (8 - 7) \Rightarrow 12 + 1$$

**or**

$$(4 \cdot 3) + (8 - 7) \Rightarrow (4 \cdot 3) + 1 \Rightarrow 12 + 1$$

# Algebraic Shortcuts

In Algebra, if we see

$$f(x, y) = x$$

$$g(z) = \dots$$

$$f(17, g(g(g(g(g(18))))))$$

then we can go straight to

17

because the result of all the  $g$  calls will not be used

But why would a programmer write something like that?

## Avoiding Unnecessary Work

```
; layout-text : string w h -> pict
(define (layout-text txt w h)
  (local [(define lines
            ; lots of work to flow a paragraph
            ...)]
    (make-pict w
              h
              (lambda (dc x y)
                ; draw paragraph lines
                ...))))

...
(define speech (layout-text "Four score..."
                           800
                           600))

...
(pict-width speech)
```

# Avoiding Unnecessary Work

```
; read-all-chars : file -> list-of-char
(define (read-all-chars f)
  (if (at-eof? f)
      empty
      (cons (read-char f) (read-all-chars f))))
...
(define content (read-all-chars (open-file user-file)))
(if (equal? (first content) #\#)
    (process-file (rest content))
    (error 'parser "not a valid file"))
```

# Recursive Definitions

```
; numbers-from : int -> list-of-int
(define (numbers-from n)
  (cons n (numbers-from (add1 n))))
...
(define nonneg (numbers-from 0))
(list-ref nonneg 10675)
```

# Lazy Evaluation

Languages like Scheme, Java, and C are called ***eager***

- An expression is evaluated when it is encountered

Languages that avoid unnecessary work are called ***lazy***

- An expression is evaluated only if its result is needed

# Lazy Evaluation in DrScheme

`plai-lazy.plt` adds a **PLAI Lazy** language to DrScheme

In the **Choose Language..** dialog, click **Show Details** and then **Syntactic test suite coverage**

(Works for both eager and lazy languages)

- **Green** means evaluated at least once
- **Red** means not yet evaluated
- Normal coloring is the same as all green

# Interepreter in Lazy Scheme

Doesn't work because result of `set-box!` is never used:

```
(define (interp a-rcfae sc)
  (type-case RCFAE a-rcfae
    ...
    [rec (bound-id named-expr body-expr)
      (local [(define value-holder (box (numV 42)))]
        (define new-sc (aRecSub bound-id
                                value-holder
                                sc))]
        (begin
          (set-box! value-holder (interp named-expr new-sc))
          (interp body-expr new-sc))))]))
```



# Interepreter in Lazy Scheme

Working implementation is actually simpler:

```
(define (interp a-rcfae sc)
  (type-case RCFAE a-rcfae
    ...
    [rec (bound-id named-expr body-expr)
      (local [(define new-sc (aSub bound-id
                                   (interp named-expr new-sc)
                                   sc))]
        (interp body-expr new-sc))]))
```