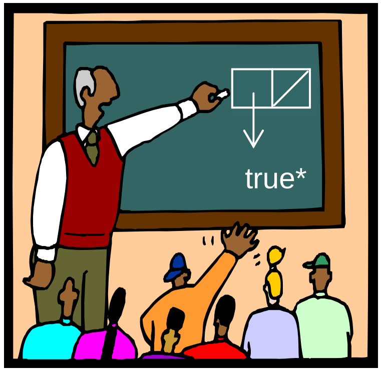
6.001 recitation 18 4/25/07

- □ interpretation
- □ our evaluator



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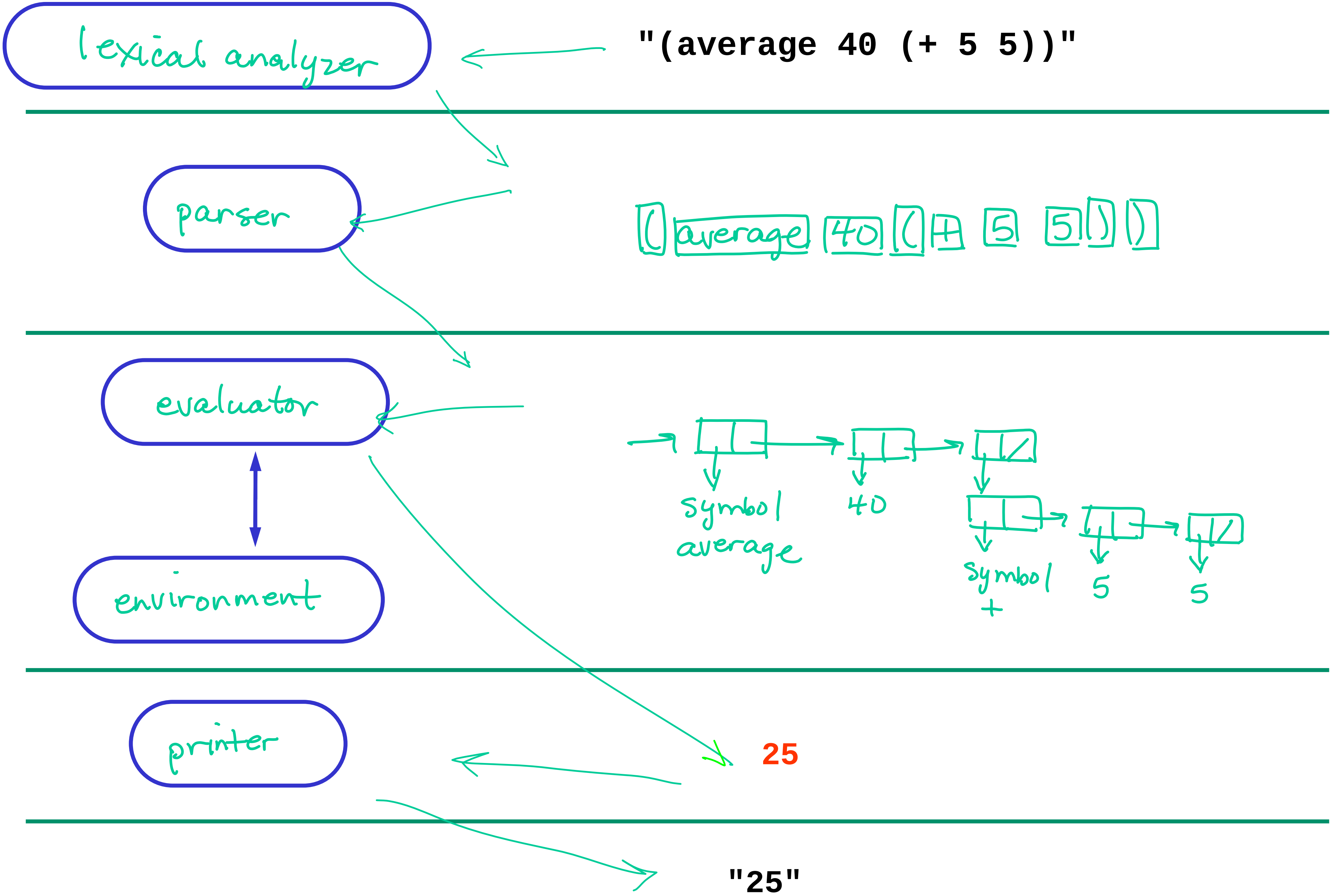
interpretation key ideas

- abstractions
  - unwind them at execution time
- cycle between eval + apply
  - eval calls apply with operator + arg
  - apply calls eval with expression + environment
  - eval = cond statement that dispatches on type
- environment
  - represented as a table
  - application = extend environment with a new frame
- parts
  - lexical analyzer
  - parser
  - evaluator
  - printer

stages of an interpreter

input to each stage



"(average 40 (+ 5 5))"

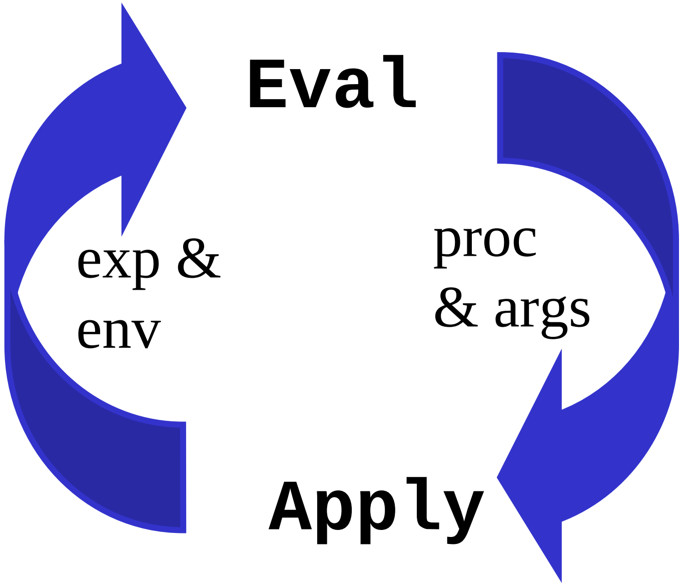
25

"25"

our evaluator

eval: dispatch on expression type

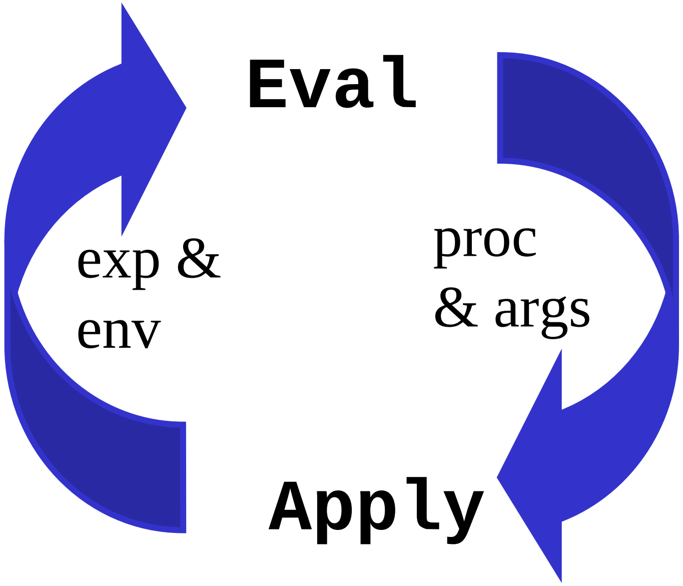
apply: eval args then apply operator



our evaluator

```
; the initial global environment
(define GE
  (extend-env-with-new-frame
   (list 'plus* 'greater*)
   (list (make-primitive +) (make-primitive >))
   '( )))

(define (eval exp env)
  (cond
   ((number? exp) exp)
   ((symbol? exp) (lookup exp env))
   ((define? exp) (eval-define exp env))
   ((if? exp) (eval-if exp env))
   ((lambda? exp) (eval-lambda exp env))
   ((let? exp) (eval-let exp env))
   ((application? exp)
            (apply* (eval (car exp) env)
                    (map (lambda (e) (eval e env))
                         (cdr exp))))
   (else
    (error "unknown expression " exp))))
```



Eval

exp & env

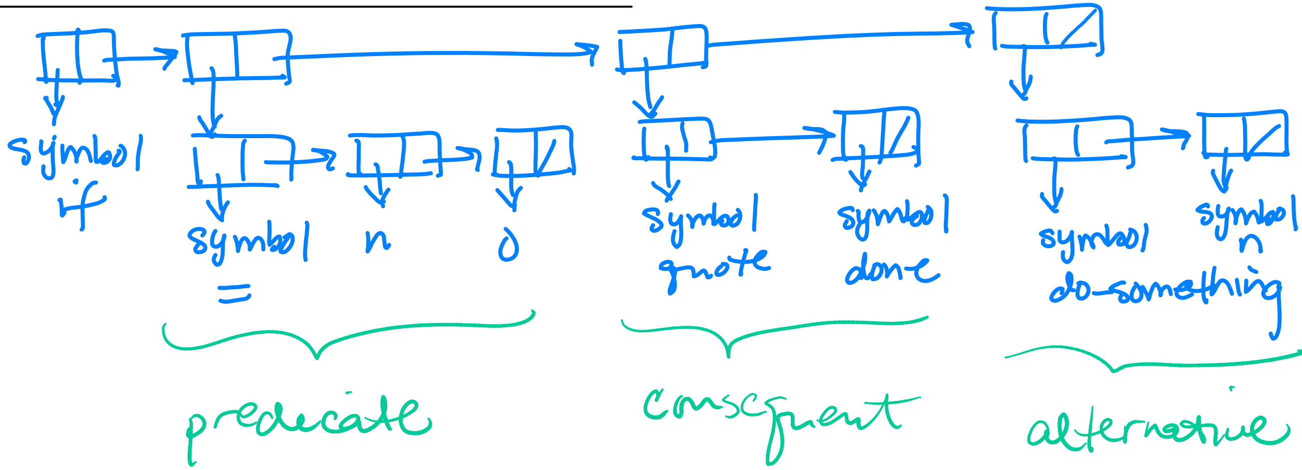
proc & args

Apply

our evaluator

example

exp: (if (= n 0)
'done
(do-something n))



```
(define (eval exp env)
  (cond
   …

   ((if? exp) (eval-if exp env))

   … ))
```

semantics: if predicate is true
eval consequent
otherwise eval alternate

our evaluator

example

```
exp: (if (= n 0)
         'done
         (do-something n))
```

semantics: if predicate is true
eval consequent
otherwise eval alternate

```
(define (eval exp env)
  (cond
   …

   ((if? exp) (eval-if exp env))
   … ))
```

```
(define (if? exp) (tag-check exp 'if*))

(define (eval-if exp env)
  (let ((predicate (cadr exp))
          (consequent (caddr exp))
          (alternative (cadddr exp)))
    (let ((test (eval predicate env)))
      (cond
       ((eq? test #t) (eval consequent env))
       ((eq? test #f) (eval alternative env))
       (else (error "predicate not a conditional: "
                         predicate))))))
```

when

e.g. (when (= x 0) (print "zero"))

semantics is same as if without alternate clause

```
(define (eval-when exp env)
   (let ((test-expr (cadr exp))
         (consequent (caddr exp)))
     (if (eval test-expr env)
         (eval consequent env)
         #f)))
```

quote*

1. (**quote*** expr) returns expr without evaluating it. Assume eval calls eval-quote if the procedure quote? is true for a given quote* statement. Write **eval-quote**, which takes one argument.

```
(define (eval-quote exp)
        (second exp))
           ↳ or cadr
```

eval-sequence

2. (**eval-sequence** exps env) evaluates each expression is a list of expressions, and returns the value of the last one. Assume eval calls eval-sequence if the procedure sequence? is true for a given expression. Write **eval-sequence**, which takes two arguments, expr and env.

(Hint: You'll need to call begin.)

```
(define (eval-sequence exps env)
    (if ((null? (cdr exps))
        (eval (first-exp exps) env))
        (begin (eval (first-exp exps) env)
                (eval-sequence (rest-exps exps) env))))
```

case*

```
3.  (case* expr
       ((val1 val2 …)  consequent)
       ((vali valj  …)  consequent)
        …
       (else* alternative))
```

Case* evaluates expr and compares its value (using eqv?) against each of the listed values, which are not evaluated. When a match is found, the corresponding consequent expression is evaluated and returned as the result of the case*. If no matches are found, the alternate expression is evaluated and returned instead. You can assume the else* clause is required if you like.

Assume eval calls eval-case if the procedure case? is true for a given case* statement.

```
(define (eval-case exp env)
   (let ((target-value (eval (second exp) env)))
     (eval-case-clauses target-value (cddr exp) env)))
```

On the next slide, write **eval-case-clauses**, which takes three arguments: a target-value, a list of clauses, and env.

assume that you already have these procs

```
(define (else-clause? clause)
        (tag-check clause 'else*))

(define (value-found? target values)
        (not (null? (memv target values))))
```

case* (cont'd)

```
3. (case* expr
      ((val1 val2 …)  consequent)
      ((vali valj  …)  consequent)
       …
      (else* alternative))
```

```
(define (eval-case exp env)
   (let ((target-value (eval (second exp) env)))
      (eval-case-clauses target-value (cddr exp) env)))
```

Write **eval-case-clauses.**

```
(define (eval-case-clauses target-value
                           clauses env)
   (if (null? clauses) 'undefined
       (let ((clause (car clauses)))
          (cond ((else-clause? clause)
                       (eval (second clause) env))
                ((value-found? target-value (first clause))
                       (eval (second clause) env))
                (else (eval-case-clauses target-value
                                 (cdr clauses) env))))))
```

begin*

4. (**begin*** expr1 expr2 … exprn) evaluates each expression in the sequence, returning the value of exprn as its final result. Assume eval calls eval-begin if the procedure begin? returns true for a given begin* statement.

```
(define (begin? exp)  (tag-check exp 'begin*))
```

```
(define (eval-begin exp env)
   (eval-begin-body (cdr exp) env))
```

Write eval-begin-body, which takes two arguments, body and env.

```
(define (eval-begin-body body env)
    (if (null? body) 'undefined
        (let ((value (eval (car body) env)))
          (if (null? (cdr body))
              value
              (eval-begin-body (cdr body) env)))))
```