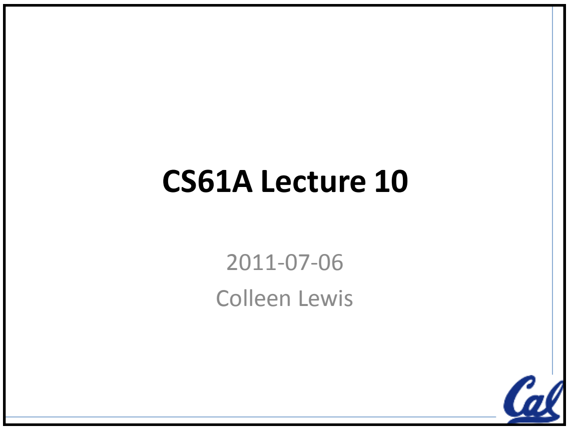
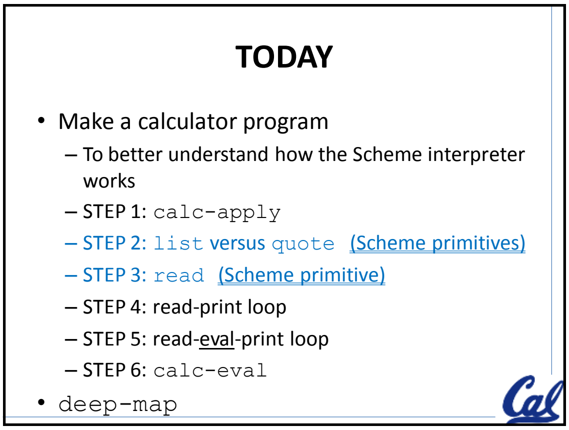


CS61A Lecture 10

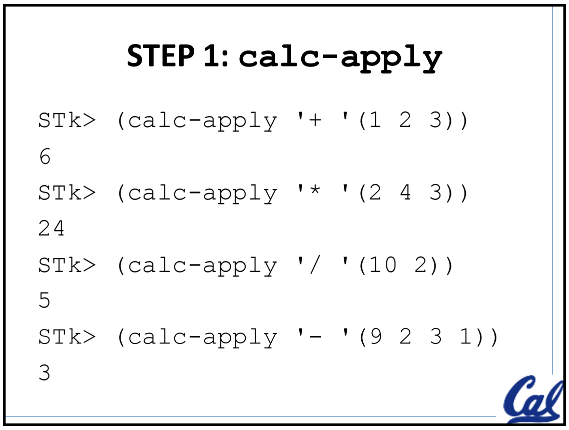
2011-07-06

Colleen Lewis



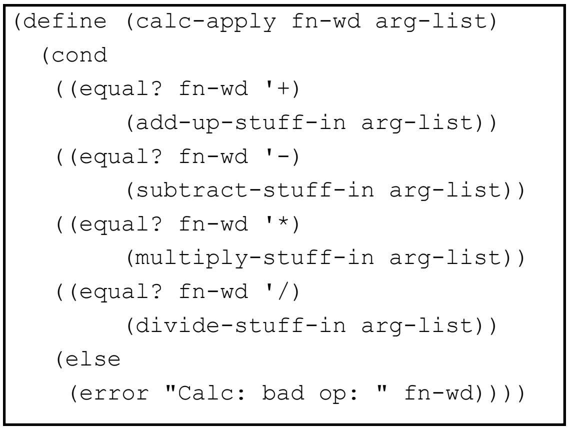
TODAY

- Make a calculator program
  - To better understand how the Scheme interpreter works
  - STEP 1: `calc-apply`
  - STEP 2: `list` versus `quote` (Scheme primitives)
  - STEP 3: `read` (Scheme primitive)
  - STEP 4: read-print loop
  - STEP 5: read-eval-print loop
  - STEP 6: `calc-eval`
- `deep-map`

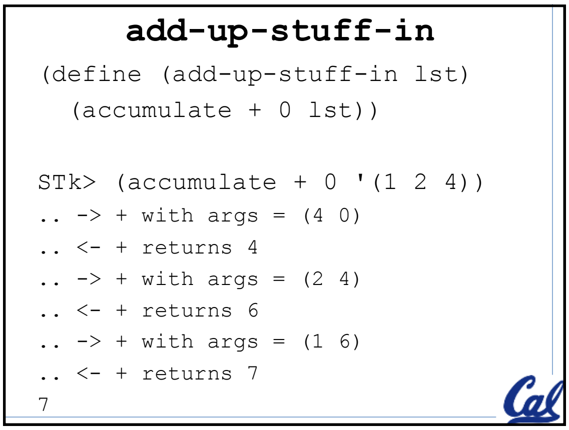


STEP 1: calc-apply

```
STk> (calc-apply '+ '(1 2 3))
6
STk> (calc-apply '* '(2 4 3))
24
STk> (calc-apply '/ '(10 2))
5
STk> (calc-apply '- '(9 2 3 1))
3
```



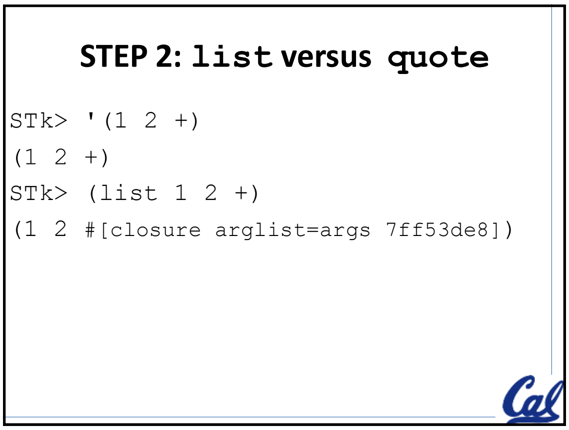
```
(define (calc-apply fn-wd arg-list)
  (cond
   ((equal? fn-wd '+)
        (add-up-stuff-in arg-list))
   ((equal? fn-wd '-)
        (subtract-stuff-in arg-list))
   ((equal? fn-wd '*)
        (multiply-stuff-in arg-list))
   ((equal? fn-wd '/)
        (divide-stuff-in arg-list))
   (else
    (error "Calc: bad op: " fn-wd))))
```



add-up-stuff-in

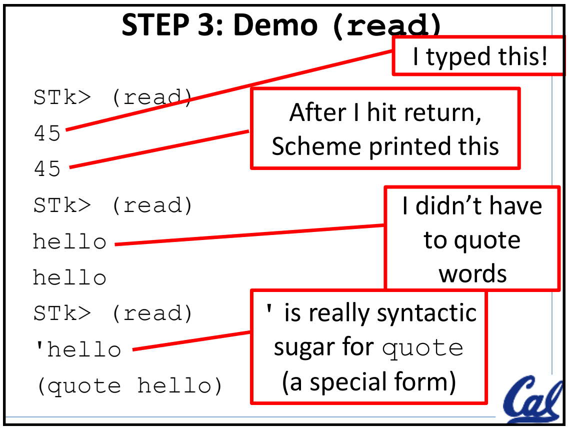
```
(define (add-up-stuff-in lst)
  (accumulate + 0 lst))

STk> (accumulate + 0 '(1 2 4))
.. -> + with args = (4 0)
.. <- + returns 4
.. -> + with args = (2 4)
.. <- + returns 6
.. -> + with args = (1 6)
.. <- + returns 7
7
```



STEP 2: list versus quote

```
STk> '(1 2 +)
(1 2 +)
STk> (list 1 2 +)
(1 2 #[closure arglist=args 7ff53de8])
```



STEP 3: Demo (read)

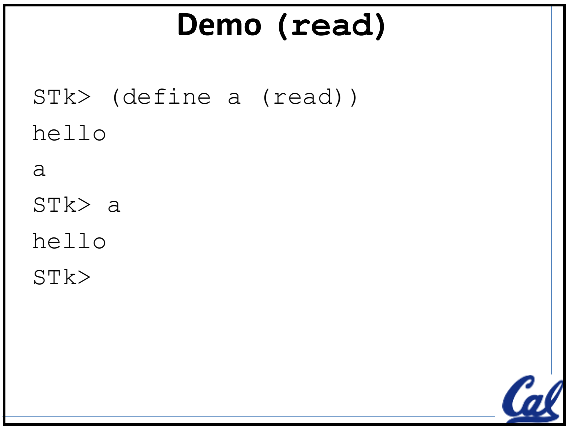
```
STk> (read)
45
45
STk> (read)
hello
hello
STk> (read)
'hello
(quote hello)
```

I typed this!

After I hit return, Scheme printed this

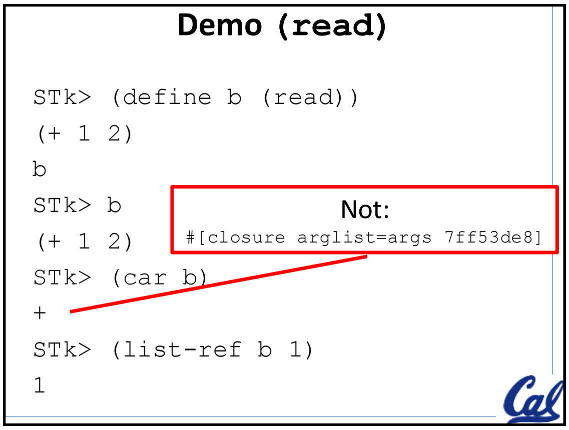
I didn't have to quote words

' is really syntactic sugar for quote (a special form)



Demo (read)

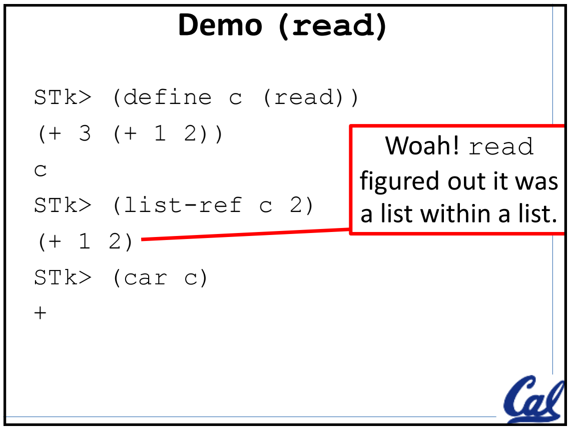
```
STk> (define a (read))
hello
a
STk> a
hello
STk>
```



Demo (read)

```
STk> (define b (read))
(+ 1 2)
b
STk> b
(+ 1 2)
STk> (car b)
+
STk> (list-ref b 1)
1
```

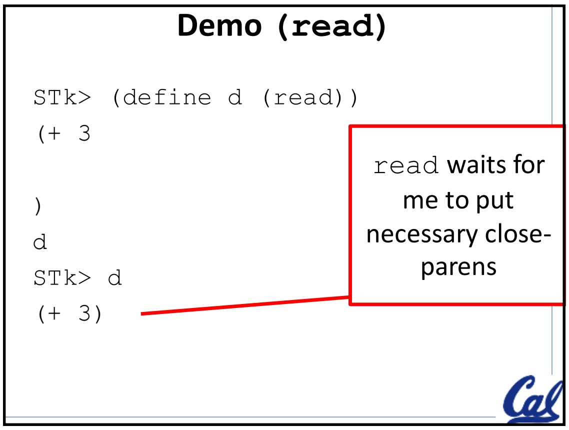
Not: #[closure arglist=args 7ff53de8]



Demo (read)

```
STk> (define c (read))
(+ 3 (+ 1 2))
c
STk> (list-ref c 2)
(+ 1 2)
STk> (car c)
+
```

Woah! read figured out it was a list within a list.

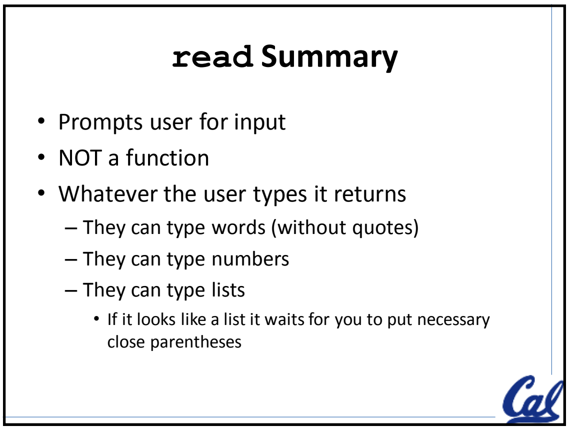


Demo (read)

```
STk> (define d (read))
(+ 3

)
d
STk> d
(+ 3)
```

read waits for me to put necessary close-parens



read Summary

- Prompts user for input
- NOT a function
- Whatever the user types it returns
  - They can type words (without quotes)
  - They can type numbers
  - They can type lists
    - If it looks like a list it waits for you to put necessary close parentheses

STEP 4: (read-print)

```
(define (read-print)
  (display "type here: ")
  (flush)
  (print (read))
  (read-print))
```

display prints stuff

print prints stuff on a new line

Make the line above visible

Waits for user input

recursive call (infinite loop)

```
STk> (read-print)
type here: 4
4
type here: hi
hi
type here: (+ 1 2)
(+ 1 2)
type here: (+ (+ 3 4) 2)
(+ (+ 3 4) 2)
type here:
```

I'm typing HERE not at STk>

Infinite loop!

(calc) demo

```
STk> (calc)
calc: 1
1
calc: (+ 2 3)
5
calc: (+ 2 (* 3 4))
14
```

(read-print) Was sort of silly (calc) actually does something

STEP 5: Read-Eval-Print Loop

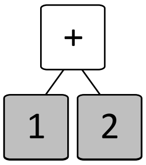
(calc) demo – it doesn't have variables or "real" functions

```
calc: +
*** Error:
    Calc: bad expression: +
Current eval stack:
STk> (calc)
calc: x
*** Error:
    Calc: bad expression: x
Current eval stack:
```

(calc) read-eval-print loop

```
(define (calc)
  (display "calc: ")
  (flush)
  (print (calc-eval (read)))
  (calc))
```

Representing Math

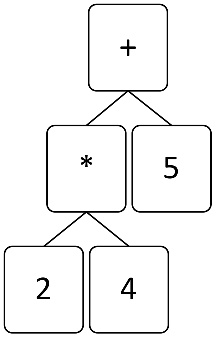


Children

Translating to Scheme

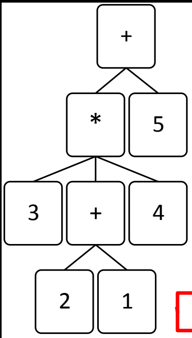
```
(+ 1 2)
car: +
cdr: (1 2)
```

Representing Math in Scheme



```
(+ (* 2 4) 5)
car: +
cdr: ((* 2 4) 5)
```

Representing Math in Scheme



How many open parens?

A) 1 B) 2 C) 3 D) 4 E) 5

```
car:
cdr:
```

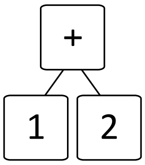
Remember the `(calc)` read-eval-print loop?

```
(define (calc)
  (display "calc: ")
  (flush)
  (print (calc-eval (read)))
  (calc))
```

`calc-eval` base case

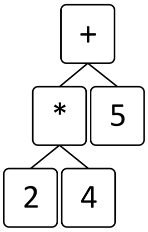
```
STk> (calc)
calc: 1
1
(define (calc-eval exp)
    (cond
        ((number? exp) exp)
        ((list? exp) ______________
        (else (error "Calc: bad exp"))))
```

`calc-eval`



```
STk> (calc)
calc: (+ 1 2)
3
(define (calc-eval exp)
  (cond
     ((number? exp) exp)
     ((list? exp)
         (calc-apply
              '+
                   '(1 2)))
     (else (error "Calc: bad exp"))))
```

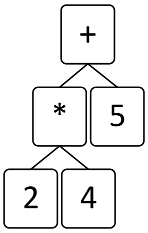
`calc-eval`



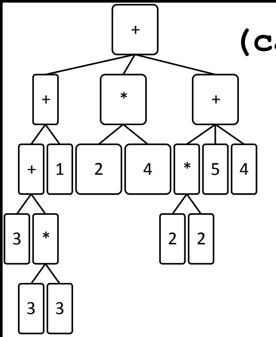
```
STk> (calc)
calc: (+ (* 2 4) 5)
40
(define (calc-eval exp)
  (cond
     ((number? exp) exp)
     ((list? exp)
         (calc-apply
              '+
                   '(8 5)))
     (else (error "Calc: bad exp"))))
```

calc-eval

```
STk> (calc)
calc: (+ (* 2 4) 5)
40
(define (calc-eval exp)
  (cond
    ((number? exp) exp)
    ((list? exp)
       (calc-apply
          (car exp)
          (map calc-eval (cdr exp))))
    (else (error "Calc: bad exp"))))
```



(calc-eval exp) Works for bigger trees!



```
(calc-apply
  (car exp)
  (map calc-eval (cdr exp))))
```

deep-map

Remember map? Meet deep-map

```
STk> (map square ‘(1 2 3))
(1 4 9)
STk> (deep-map square ‘(1 2 3))
(1 4 9)
STk> (deep-map square ‘((3 . 4) (5 6)))
((9 . 16) (25 36))
STk> (deep-map square 3)
9
STk> (deep-map square ‘())
()
```

deep-map base cases

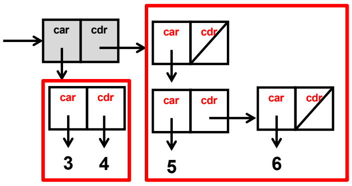
```
STk> (deep-map square 3)
9
STk> (deep-map square ‘())
()
(define (deep-map fn arg)
  (cond
     ((null? arg) '())
     ((pair? arg) _____________
     (else (fn arg))))
```

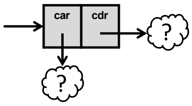
Draw ‘((3 . 4) (5 6))

How many pairs?

A) 1 B) 2 C) 3 D) 4 E) 5

(deep-map sq '((3 . 4) (5 6))





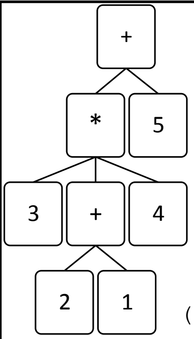
```
(cons
  (deep-map fn (car arg))
  (deep-map fn (cdr arg)))
```

deep-map solution

```
(define (deep-map fn arg)
  (cond
    ((null? arg) '())
    ((pair? arg)
       (cons
         (deep-map fn (car arg))
         (deep-map fn (cdr arg))))
    (else (fn arg))))
```

map

```
(define (map fn seq)
     (if (null? seq)
         '()
         (cons (fn (car seq))
               (map fn (cdr seq)))))
```



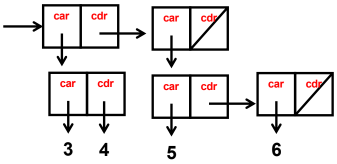
Representing Math in Scheme SOLUTION

How many open parens?

A) 1 B) 2 C) 3 D) 4 E) 5

```
(+ (* 3 (+ 2 1) 4) 5)
car: +
cdr:((* 3 (+ 2 1) 4) 5)
```

Draw '((3 . 4) (5 6))



SOLUTION