CS3:
Introduction to Symbolic Programming

Lecture 10:
Finishing HOF

Spring 2007

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Schedule

10	Mar 19-23	Lecture: Higher-order function review Lab: More Higher order functions Miniproject #3 assigned
		Mar 26-30 *Spring Break*
11	April 2	Lecture: Midterm review, tree recursion Lab: Lists, tree-recursion Miniproject #3 due Tuesday
12	April 9-13	Lecture (5-7 pm): *Midterm #2* 145 Dwinelle Lab: Advanced list processing
13	April 16-20	Lecture: CS3 Projects Lab: Begin work on CS3 Big Project

Lab materials

- **Last week:**
  - `day-span` using higher order procedures
  - tic-tac-toe

- **This week:**
  - A half day working further on tic-tac-toe (T/W)
  - Some "Challenging review problems", with solutions (T/W)
  - Work on the miniproject (all week)

every containing every

- You can mimic 2-stage recursion, applying a function to each letter of each word.

- You can get combinatoric effects:

```
(define (pair-all sent)
  (every (lambda (one)
           (every (lambda (two)
                    (word one two))
                  sent))
         sent))

(pair-all '(a b c)) ➔ ???
```

every containing every containing...

```
(make-kw '(s t) '(a o)) ➔
    (sas sat sos sot tas tat tos tot)
(make-kw '(l n k t s) '(a e i o u)) ➔ 225 words!


(define (make-kw consonants vowels)
  (every (lambda (c)
           (every (lambda (v)




                  vowels))
         consonants))
```

`accumulate` can return a sentence...

- the *first* time accumulate is run, it reads the last two words of the input sentence, and returns a sentence

- in *later* calls, it uses the return value of its procedure (which is a sentence) as its 2nd argument, and the next work as its 1st.

Write `pair-conseq`:

```
(pair-conseq '(a b c d)) → (ab bc cd)
```

lambda

the `lambda` form

- "`lambda`" is a special form that returns a function:

```
(lambda (arg1 arg2 …)
   statements
      )
```

`(lambda`	`(x)`	`(*`	`x`	`x))`
⇨	⇨	⇨	⇨	⇨
a procedure	that takes one argument	and multiplies	it	by itself

Use lambda anywhere you need a function

```
(define square
        (lambda (x) (* x x)))


(every (lambda (x) (* x x))
       '(1 2 3))
  ➔  (1 4 9)


((lambda (x) (* x x))  3)
  ➔  9
```

`make-bookends` (a *small* problem)

- **Write `make-bookends`, which is used this way:**

```
((make-bookends 'o) 'hi) → ohio

((make-bookends 'to) 'ron) → toronto

(define tom-proc (make-bookends 'tom))
(tom-proc "") → tomtom
```

You *need* lambda when…

…you need a procedure to make reference to more values than you can pass it.

For instance, when a procedure for use in an `every` needs two parameters

```
(prepend-every 'sir- '(sam mary loin))
     ➔ (sir-sam sir-mary sir-loin)
```

Write `prepend-every`

Write `appearances`

Problems

Write successive-concatenation

```
(sc '(a b c d e))
➔   (a ab abc abcd abcde)

(sc '(the big red barn))
➔  (the thebig thebigred thebigredbarn)
```

```
(define (sc sent)
   (accumulate
      (lambda ??
         )
      sent))
```

make-decreasing

- `make-decreasing`
  - Takes a sentence of numbers
  - Returns a sentence of numbers, having removed elements of the input that were not larger than all numbers to the right of them.

```
(make-decreasing '(9 6 7 4 6 2 3 1))
  ➔ (9 7 6 3 1)
(make-decreasing '(3)) ➔ (3)
```

Write first as a recursion, then as a HOF

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(define (make-kw consonants vowels)
  (every (lambda (c)
           (every (lambda (v)




                  vowels))
         consonants))
```

```
(define (make-kw consonants vowels)
  (every (lambda (c)
           (every (lambda (v)
                    (every (lambda (c2)
                             (word c v c2))
                           consonants))
                  vowels))
         consonants))
```

`accumulate` can return a sentence…

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Write `pair-conseq`:

```
(pair-conseq '(a b c d)) ➔ (ab bc cd)
```

```
(define (concat-pairs sent)
  (accumulate (lambda (wd so-far)
                      (if (word? so-far)
                          (se (word wd so-far))
                          (se (word wd (first (first so-far))) so-far))
                      )
              sent))
```

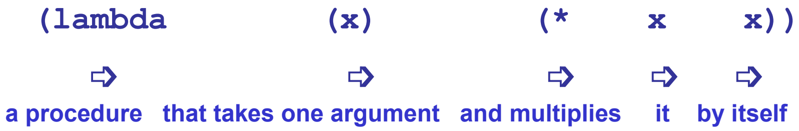
lambda

Click to add text

the `lambda` form

- "`lambda`" is a special form that returns a function:

```
(lambda (arg1 arg2 …)
   statements
     )
```



```
(lambda          (x)          (*     x     x))
```

⇨ a procedure ⇨ that takes one argument ⇨ and multiplies ⇨ it ⇨ by itself

Use lambda anywhere you need a function

```
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```

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((make-bookends 'to) 'ron) ➔ toronto

(define tom-proc (make-bookends 'tom))
(tom-proc "") ➔ tomtom
```

```
(define (make-bookends wd)
  (lambda (inner-wd) (word wd inner-wd wd)))
```

You *need* lambda when…

…you need a procedure to make reference to more values than you can pass it.

For instance, when a procedure for use in an `every` needs two parameters

```
(prepend-every 'sir- '(sam mary loin))
    ➔ (sir-sam sir-mary sir-loin)
```

Write `prepend-every`

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(sc '(the big red barn))
➔  (the thebig thebigred thebigredbarn)
```

```
(define (sc sent)
   (accumulate
      (lambda ??
        )
      sent))
```

```
(define (sc sent)
   (accumulate
       (lambda (wd sent-so-far)
           (if (word? sent-so-far)
             (se wd (word wd sent-so-far))     ;; initial invocation
             (se wd                            ;; other invocations
                 ;;prepend-each
                 (every
                    (lambda (sent-so-far-element)
                        (word wd sent-so-far-element))
                    sent-so-far)))

          )
    sent))
```

make-decreasing

- `make-decreasing`
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```
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  ➔ (9 7 6 3 1)
(make-decreasing '(3)) ➔ (3)
```

Write first as a recursion, then as a HOF

```
;; recursion -- left to right
(define (make-decreasing sent)
  (cond ((or (empty? sent)
             (empty? (bf sent)))
         sent)
        ((bigger-than-all? (first sent) (bf sent))
         (se (first sent)
             (make-decreasing (bf sent))))
        (else (make-decreasing (bf sent)))
        ))


(define (bigger-than-all? num sent)
  (cond ((empty? sent) #t)
        ((> num (first sent))
         (bigger-than-all? num (bf sent)))
        (else #f)))


;;  HOF
(define (make-decreasing sent)
  (accumulate
    (lambda (left right)
      (if (word? right)
        (if (< right left)
          (se left right)
          (se right))
        (if (< (first right) left)
          (se left right)
          right)))
    sent))
```