Lecture 14:
Lists
Scheme vs. other programming languages
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<th></th>
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  You need to do them on time in order to get credit for the project

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### Sentences(words) vs lists: constructors

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cons is closely tied to recursion

(define (sent-square-all sent)
  (if (empty? sent)
      '()
      (se (square (first sent))
           (sent-square-all (bf sent))))

(ssa '(1 2 3)) ➞ (se 1 (se 4 (se 9 '()))))

(define (list-square-all lst)
  (if (null? lst)
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## Sentences(words) vs lists: HOF

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What goes in a list?

• Answer: anything!

• So,

\[
\text{word? } x
\]

\[
\text{not (list? } x)\]

are not the same thing!
A few other important topics re: lists

2. map can take multiple arguments

4. apply

6. Association lists

8. Generalized lists
**map can take multiple list arguments**

\[
\text{map} + \ (1\ 2\ 3) \ (100\ 200\ 300) \\
\rightarrow (101\ 202\ 303)
\]

**The argument lists have to be the same length**

\[
\text{define (palindrome? lst)} \\
\quad (\text{all-true?} \\
\quad \quad (\text{map equal? lst (reverse lst)}))
\]

\[
\text{palindrome?} \\
\quad \ (\text{amanaplanacanalanaman}) \\
\rightarrow \ #t
\]
apply (not the same as accumulate!)

• apply takes a function and a list, and calls the function with the elements of the list as its arguments:

(apply + '(1 2 3))

(apply cons '(joe '(bob))

(apply day-span
   '(((january 1) (december 31))))
Association lists

• Used to associate *key-value* pairs

  (((i 1) (v 5) (x 10) (l 50) (c 100) (d 500) (m 1000)))

• assoc looks up a key and returns a pair

  (assoc 'c '(((i 1) (v 5) (x 10) … ) ) )

  ➔ (c 100)

;; Write sale-price, which takes a list of items and a table of item-price pairs, and returns a total price
(define *price-list* '(((bread 2.89) (milk 2.33)
                              (cheese 5.21) (chocolate .50)
                              (beer 6.99) (tofu 1.67) (pasta .69)))

(sale-price '((bread tofu) *price-list*))
Generalized lists

- Elements of a list can be anything, including any list

- Lab materials discuss
  - flatten (3 ways)
  - completely-reverse
  - processing a tree-structured directory
How about this `flatten`?

```scheme
(define (flatten thing)
  (if (list? thing)
      (reduce _______ (map flatten thing))
      (_______ thing)))
```
Scheme versus other languages
Functional Programming

• In CS3, we have focused on programming without *side-effects*.
  - All that can matter with a procedure is what it returns
  - In other languages, you typically:
    - Perform several actions in a sequence
    - Set the value of a variable – and it stays that way
  - All of this is possible in Scheme; Chapter 20 is a good place to start
• Scheme allows you to ignore tedium and focus on core concepts
  - The core concepts are what we are teaching!

• Other languages:
  - Generally imperative, sequential
  - Lots and lots of syntactic structure (built in commands)
  - Object-oriented is very "popular" now
CS3 concepts out in the world

• Scheme/lisp does show up: scripting languages inside applications (emacs, autocad, Flash, etc.)

• Scheme/Lisp is used as a "prototyping" language
  - to quickly create working solutions for brainstorming, testing, to fine tune in other languages, etc.

• Recursion isn't used directly (often), but recursive ideas show up everywhere
Java

- Java is a very popular programming language
  - Designed for LARGE programs
  - Very nice tools for development
  - Gobs of libraries (previous solutions) to help solve problems that you might want solved
• PHP

- Popular language for web development (combined with a web-server and database)

- Lots of features, but little overall "sense"

- Because programs in PHP execute behind a web-server and create, on the fly, programs in other languages, debugging can be onerous.
SQL resembles HOFs

• SQL if for database retrieval

• query: “Tell me the names of all the lecturers who have been at UCB longer than I have.”

```sql
select name from lecturers
where date_of_hire <
  (select date_of_hire from lecturers where name = 'titterton');
```

• query: “Tell me the names of all the faculty who are older than the faculty member who has been here the longest.”

```sql
select L1.name from lecturers as L1 where L1.age >
  (select L2.age from lecturers as L2
   where L2.date_of_hire =
     (select min(date_of_hire) from lecturers) );
```
Problems
CS3: 
Introduction to Symbolic Programming

Lecture 14: 
Lists 
Scheme vs. other programming languages

Fall 2006 
Nate Titterton 
nate@berkeley.edu
# Schedule

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| **list** | Takes any number of elements  
|          | Returns the list with those elements |
| **sentence** | Takes a bunch of words and sentences and puts "them" in order in a new sentence. |
**cons is closely tied to recursion**

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(define (sent-square-all sent)
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Spring 2006 CS3: 6
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\[(\text{word? } x)\]

\[(\text{not (list? } x))\]

are not the same thing!

See the slide on flatten, and compare the code on the slide to the code on ucwise: in the slide, we use the proper "(not (list? thing))" rather than "(word? thing)"", which won't be fooled by booleans and procedures (i.e., things that aren't words but aren't lists either).
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map can take multiple list arguments

(map + '(1 2 3) '(100 200 300))
⇒ (101 202 303)

The argument lists have to be the same length

(define (palindrome? lst)
  (all-true?
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(palindrome?
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apply (not the same as accumulate!)

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Association lists

* Used to associate *key-value* pairs

\(((i 1) (v 5) (x 10) (l 50) (c 100) (d 500) (m 1000))\)

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\(\text{assoc 'c }\)\((\text{((i 1) (v 5) (x 10) \ldots)})\)

\(\Rightarrow\) (c 100)

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(define (sale-price items price-list)
  (* 1.0825 ;; tax, why not…
     (apply +
        (map (lambda (i) (cadr (assoc i price-list)))
             items))))

;;|
(sale-price '(cheese milk pasta tofu) *price-list*) ;; 10.71675
(sale-price '(beer beer beer beer) *price-list*) ;; 30.2667

;|
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```
(define (flatten thing)
  (if (list? thing)
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      (______ thing)))
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;; The way to think about this is to "trust
;; the recursion".  "flatten" has to return a flat list, right?  So, both
;; cases in the if have to return properly flattened lists.

;; what is (map flatten thing) going to return?
;; well, it has to be something like this:
;;   ( (a b c) (d e f) (g h i) )
;; or, a "list of flat lists".  The full reduce has to return, when given
;; this,
;;   ( a b c   d e f   g h i )
;; or a properly flat list.  With that, you should be able to fill
;; in the first blank.

;; The second blank is also easy, when you realize that the return value
;; must be a flat list.  "thing" is a word (or, more properly, not a list).
;; So, turning it into a flat list is easy!

;; Here is the solution
(define (flatten thing)
  (if (list? thing)
      (reduce append (map flatten thing))
      (list thing)))
Scheme versus other languages

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The language Scheme

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A set of 4 problems was handed out. See the ucwise announcements.