CS 4100
LISP

April 20, 2011

Based on slides by Istvan Jonyer
Book by MacLennan
Chapters 9, 10, 11

Data Constructor

- The data constructor is the list
- Lists can have 0, 1 or more elements
  - Observes the Zero-One-Infinity principle
  - Empty list: `‘() or nil`
- All lists are non-atomic (except empty list)

```
> (atom ‘())   or  (atom nil)  or  (atom 5)
t
> (atom ‘(to be)) or (atom ‘(()))
nil
```

Car and Cdr

- Accessing parts of a list
  - Car
    - Accesses first element of the list

```
>(car ‘(to be or not to be))
to
>(car ‘((to be) or (not to be)))
(to be)
```

    - Returns an element
  - cdr
    - Accesses rest of the list (list without first element)

```
>(cdr ‘(to be or not to be))
(be or not to be)
```

    - Returns a list

Combining *car* and *cdr*

- How do we select the second element?

```
>(car (cdr ‘(to be or not to be)))
be
```

- Third?

```
>(car (cdr (cdr ‘(to be or not to be))))
or
```

- How about this?

```
(set ‘DS ‘( (Don Smith) 45 30000 (Aug 4 80)))
```

  - Select day of hire

```
>(car (cdr (car (cdr (cdr (cdr DS))))))
4
```

- This can be simplified:

```
>(cadadddr DS)
4
```

Defining Functions

```
(set 'DS '( (Don Smith) 45 30000 (Aug 4 80)))
```

- Define functions to replace cadadddr

```
(defun hire-date (r) (cadddr r))
(defun day (d) (cadr d))
```

  - Now we can select the day of the hire date as

```
(day (hire-date DS))
```

- This is more readable and more maintainable

Property Lists

- List like this are hard to maintain and read:
  ((Don Smith) 45 30000 (Aug 4 80))
  - We don't know what elements mean
  - Hard to change the structure of the list
- A better way is to use property lists:
  (name (Don Smith) age 45 salary 30000 hire-date (Aug 4 80))
  - This way we can search for property name we want (age) and return value (45)
  - Order of properties becomes immaterial
  - General form (p_1 v_1 p_2 v_2 … p_n v_n)

Accessing Property Lists

(name (Don Smith) age 45 salary 30000 hire-date (Aug 4 80))

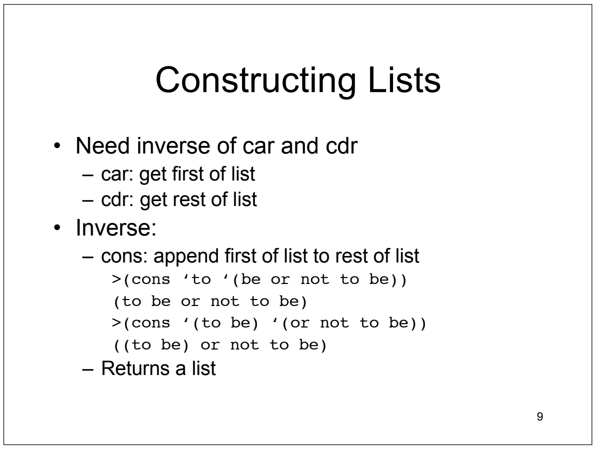
- How do we find the property?
  - If property we want is the first one, return second element of list
  - else skip first 2 elements, and start over
- In LISP (get property *p* of list *l*)

```
(defun getprop (p l)
    (if     (eq (car l) p)
            (cadr l)
            (getprop p (cddr l)) ))
```

Association Lists

- What if the property does not have a value? (e.g. "retired")
- What is the property has more than a single value?
  - Of course, these can be solved using the property list, if we understand the properties of each property…
  - A better, more foolproof way is to use association-lists:

```
( (name (Don Smith))
  (age 45)
  (salary 30000)
  (hire-date (Aug 4 80)) )
```

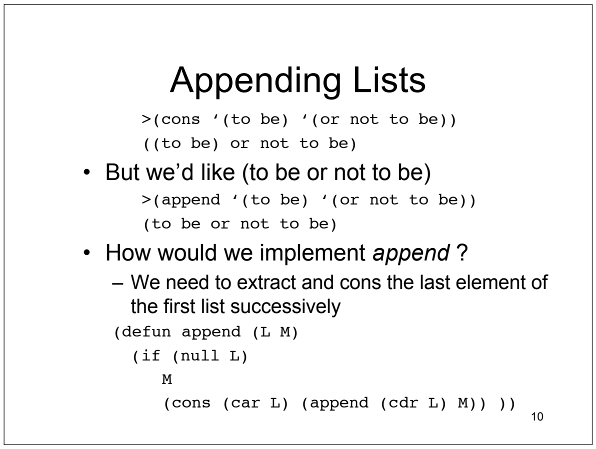


Constructing Lists

- Need inverse of car and cdr
  - car: get first of list
  - cdr: get rest of list
- Inverse:
  - cons: append first of list to rest of list

```
>(cons ‘to ‘(be or not to be))
(to be or not to be)
>(cons ‘(to be) ‘(or not to be))
((to be) or not to be)
```

  - Returns a list



Appending Lists

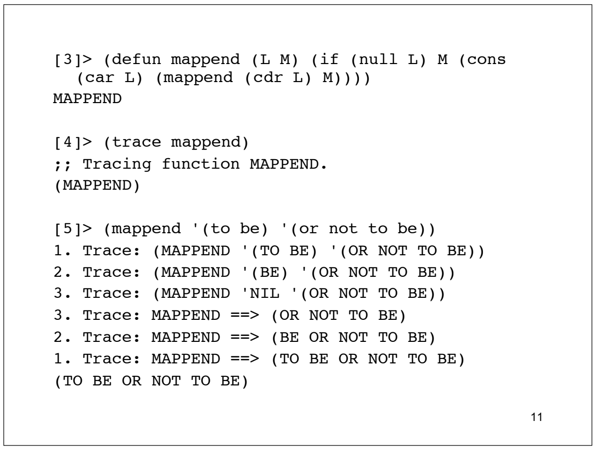
```
>(cons ‘(to be) ‘(or not to be))
((to be) or not to be)
```

- But we’d like (to be or not to be)

```
>(append ‘(to be) ‘(or not to be))
(to be or not to be)
```

- How would we implement *append* ?
  - We need to extract and cons the last element of the first list successively

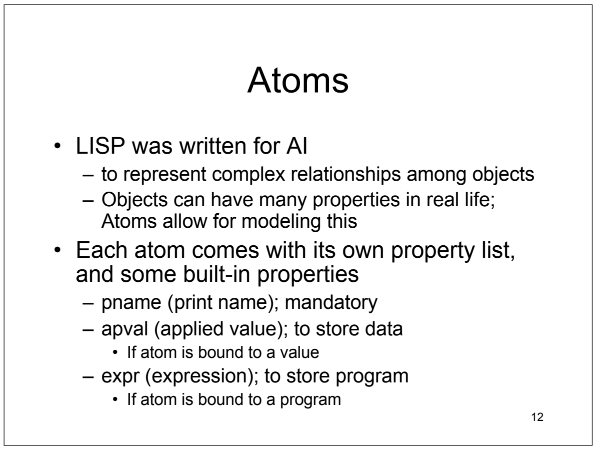
```
(defun append (L M)
  (if (null L)
     M
     (cons (car L) (append (cdr L) M)) ))
```



```
[3]> (defun mappend (L M) (if (null L) M (cons
  (car L) (mappend (cdr L) M))))
MAPPEND

[4]> (trace mappend)
;; Tracing function MAPPEND.
(MAPPEND)

[5]> (mappend '(to be) '(or not to be))
1. Trace: (MAPPEND '(TO BE) '(OR NOT TO BE))
2. Trace: (MAPPEND '(BE) '(OR NOT TO BE))
3. Trace: (MAPPEND 'NIL '(OR NOT TO BE))
3. Trace: MAPPEND ==> (OR NOT TO BE)
2. Trace: MAPPEND ==> (BE OR NOT TO BE)
1. Trace: MAPPEND ==> (TO BE OR NOT TO BE)
(TO BE OR NOT TO BE)
```



Atoms

- LISP was written for AI
  - to represent complex relationships among objects
  - Objects can have many properties in real life; Atoms allow for modeling this
- Each atom comes with its own property list, and some built-in properties
  - pname (print name); mandatory
  - apval (applied value); to store data
    - If atom is bound to a value
  - expr (expression); to store program
    - If atom is bound to a program

Adding Properties to Atoms

- Other, arbitrary properties may also be added to an atom using *putprop* *(not in our clisp: setf)*

```
(putprop atom propValue propName)
(putprop ‘France ‘Paris ‘capital)
```

  - Paris, in this case, is also an atom
- Find out the value of a property using get

```
>(get ‘France ‘capital)
Paris
>(get ‘France ‘pname)
“France”
```