

# A little bit of Lisp

Introduction to Artificial Intelligence

CSCE 476-876, Spring 2010

[www.cse.unl.edu/~choueiry/S10-476-876](http://www.cse.unl.edu/~choueiry/S10-476-876)

Read LWH: Chapters 1, 2, 3, and 4.

Every recitation (Monday): ask your questions on Lisp/xemacs.

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## Features of Lisp

1. Interactive: interpreted and compiled
2. Symbolic
3. Functional
4. Second oldest language but still 'widely' used  
(Emacs, AutoCad, MacSyma, Yahoo Store, Orbitz, etc.)

## Software/Hardware

- We have Allegro Common Lisp (by Franc Inc.): `alisp` and `mlisp`
- There are many old and new dialects (CormanLisp, Kyoto CL, LeLisp, CMU CL, SBCL, ECL, OpenMCL, CLISP, etc.)
- There have also been Lisp machines (Symbolics, Connection Machine, IT Explorer, others?)

## Lisp as a functional language

`(function-name arg1 arg2 etc)`

1. Evaluate arguments
2. evaluate function with arguments
3. return the result

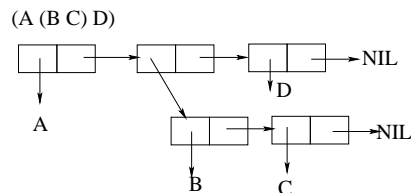
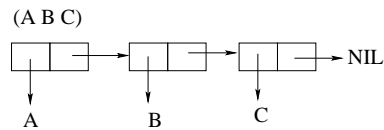
Functions as arguments to other functions:

`(name2 (name1 arg1 arg2 etc) arg3 arg2 etc)`

## Symbolic language

- Atoms: numeric atoms (numbers), symbolic atoms (symbols)  
Each symbol has: print-name, plist, package, symbol-value, symbol-function

- Lists:



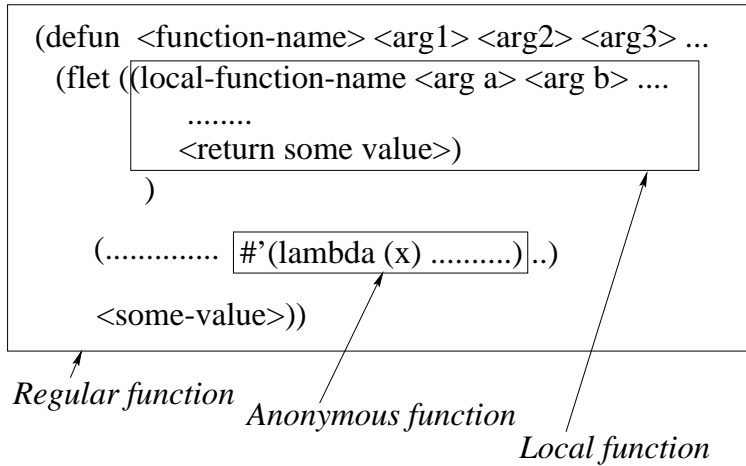
Symbolic expressions: symbols and lists

## More constructs

- Data types:  
atoms and lists, packages, strings, structures, vectors,  
bit-vectors, arrays, streams, hash-tables, classes (CLOS), etc.  
NIL, T, numbers, strings: special symbols, evaluate to self
- Basic functions:  
`first (car)`, `rest (cdr)`, `second`, `tenth`  
`setf`: does not evaluate first argument  
`cons`, `append`, `equal`, operations on sets, *etc.*
- Basic macros:  
`defun`, `defmacro`, `defstruct`, `defclass`, `defmethod`,  
`defvar`, `defparameter`

- Special forms:  
`let`, `let*`, `flet`, `labels`, `progn`,
- Predicates:  
`listp`, `endp`, `atom`, `numberp`, `symbolp`, `evenp`, `oddp`, *etc.*
- Conditionals:  
`if <test> <then form> <else form>`,  
`when <test> <then form>`,  
`unless <test> <else form>`,  
`cond`,  
`case`
- Looping constructs:  
`dolist`, `dotimes`, `do`, `mapcar`, `loop`,
- Lambda functions

## A really functional language



defun, flet/labels, lambda

## What makes Lisp different?

*Paradigms of AI Programming, Norvig*

- Built-in support for lists
- Dynamic storage management (garbage collection!)
- Dynamic typing
- First-class functions (dynamically created, anonymous)
- Uniform syntax
- Interactive environment
- Extensibility

## Allegro Common Lisp

- Free download: [www.franz.com/downloads/](http://www.franz.com/downloads/)
- Available on SunOS (csce.unl.edu), and Linux.
- Great integration with emacs  
Check [www.franz.com/emacs/](http://www.franz.com/emacs/) Check commands distributed by instructor
- Great development environment  
Composer: debugger, inspector, time/space profiler, etc.  
(require 'composer)

```
;;; -*- Package: USER; Mode: LISP; Base: 10; Syntax: Common-Lisp -*-
```

```
(in-package "USER")
```

```
;;; +=====+
;;; | Source code for the farmer, wolf, goat, cabbage problem |
;;; |   from Luger's "Artificial Intelligence, 4th Ed."   |
;;; | In order to execute, run the function CROSS-THE-RIVER |
;;; +=====+
```

```
;;; +-----+
;;; | State definitions and associated predicates |
;;; +-----+
```

```
(defun make-state (f w g c)
  (list f w g c))

(defun farmer-side (state)
  (nth 0 state))

(defun wolf-side (state)
  (nth 1 state))

(defun goat-side (state)
  (nth 2 state))

(defun cabbage-side (state)
  (nth 3 state))
```

```
;;; +-----+
;;; | Operator definitions |
;;; +-----+
```

```
(defun farmer-takes-self (state)
  (make-state (opposite (farmer-side state))
              (wolf-side state)
              (goat-side state)
              (cabbage-side state)))

(defun farmer-takes-wolf (state)
  (cond ((equal (farmer-side state) (wolf-side state))
        (safe (make-state (opposite (farmer-side state))
                           (opposite (wolf-side state))
                           (goat-side state)
                           (cabbage-side state))))
        (t nil)))
```

```

(defun farmer-takes-goat (state)
  (cond ((equal (farmer-side state) (goat-side state))
        (safe (make-state (opposite (farmer-side state))
                          (wolf-side state)
                          (opposite (goat-side state))
                          (cabbage-side state))))))
  (t nil)))

(defun farmer-takes-cabbage (state)
  (cond ((equal (farmer-side state) (cabbage-side state))
        (safe (make-state (opposite (farmer-side state))
                          (wolf-side state)
                          (goat-side state)
                          (opposite (cabbage-side state))))))
  (t nil)))

```

```

;;; +=====+
;;; | Utility functions |
;;; +=====+

(defun opposite (side)
  (cond ((equal side 'e) 'w)
        ((equal side 'w) 'e)))

(defun safe (state)
  (cond ((and (equal (goat-side state) (wolf-side state))
              (not (equal (farmer-side state) (wolf-side state))))
        nil)
        ((and (equal (goat-side state) (cabbage-side state))
              (not (equal (farmer-side state) (goat-side state))))
        nil)
        (t state)))

```

```
;;; +=====+
;;; | Search |
;;; +=====+
```

```
(defun path (state goal &optional (been-list nil))
  (cond ((null state) nil)
        ((equal state goal) (reverse (cons state been-list)))
        ((not (member state been-list :test #'equal))
         (or (path (farmer-takes-self state) goal (cons state been-list))
              (path (farmer-takes-wolf state) goal (cons state been-list))
              (path (farmer-takes-goat state) goal (cons state been-list))
              (path (farmer-takes-cabbage state) goal (cons state been-list))
              )))
```

```
;;; +=====+
;;; | Canned Execution |
;;; +=====+
```

```
(defun cross-the-river ()
  (let ((start (make-state 'e 'e 'e 'e))
        (goal (make-state 'w 'w 'w 'w)))
    (path start goal)))
```