# A little bit of Lisp

Introduction to Artificial Intelligence

CSCE 476-876, Spring 2012

`www.cse.unl.edu/~choueiry/S12-476-876`

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

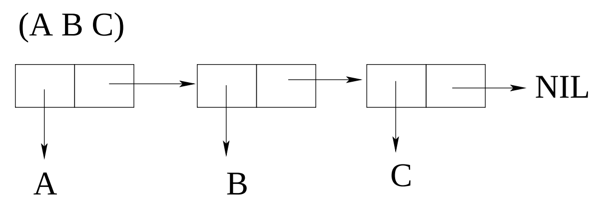
Functions as arguments to other functions:

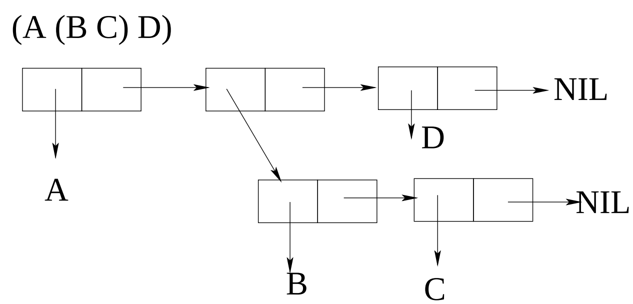
`(name2 (name1 arg1 arg2 etc) arg3 arg2 etc)`

# 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  <function-name> <arg1> <arg2> <arg3> ...
  (flet ((local-function-name <arg a> <arg b> ....
            ........
          <return some value>)
        )
     (.............  #'(lambda (x) ..........) ..)
     <some-value>))
```

*Regular function* *Anonymous function* *Local function*

`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/`
- Available on SunOS (csce.unl.edu), and Linux.
- Great integration with emacs
  Check `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  |
;;;; +=====================================================+
```

```lisp
;;; +=============================================+
;;; | 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-lis
             (path (farmer-takes-wolf state) goal (cons state been-lis
             (path (farmer-takes-goat state) goal (cons state been-lis
             (path (farmer-takes-cabbage state) goal (cons state been-
           )))
```

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

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