A little bit of Lisp

Introduction to Artificial Intelligence
CSCE 476-876, Spring 2009
www.cse.unl.edu/~choueiry/S09-476-876

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:

  (A B C)
  \[ \begin{array}{c}
  A \\
  \hline
  \end{array} \]

  (A (B C) D)
  \[ \begin{array}{c}
  A \\
  \hline
  \end{array} \]

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

- 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)`

```lisp
;;; -*- 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            |
;;; +===================================================================+
```
(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))
(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)))
(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))))))

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