A little bit of Lisp

Introduction to Artificial Intelligence
CSCE 476-876, Fall 2020
www.cse.unl.edu/~choueiry/F20-476-876

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:
(function2 (function1 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>)

Reg:ular 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)
(in-package "USER")

;;; In order to execute, run the function CROSS-THE-RIVER

;;; | 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 |

;;; +================================================================>

;;; -*- Package: USER; Mode: LISP; Base: 10; Syntax: Common-Lisp -*-
(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-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))))
))
(defun cross-the-river ()
  (let ((start (make-state 'e 'e 'e 'e))
         (goal (make-state 'w 'w 'w 'w)))
    (path start goal)))