LISP
The List Processing Language
Computer Languages Session for Musicomputation

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Outline

• History and Overview
• Insertion Sort, LISP style
• Summary
What is LISP?

• Invented in 1958 by John McCarthy
• The 2\textsuperscript{nd} oldest higher order programming language widely used today (Fortran is the oldest)
• The basic data structure is: a linked list
• Popular in AI including computational linguistics
  – Although recently, many have switched to C, JAVA, etc.
• Good for manipulating symbols and lists of symbols
• Implementation of Alonzo Church's lambda calculus
Some Special Features of LISP

- Typing of variables is optional
- Recursion is the norm
- Functions can be arguments of functions
- The basic data structure is the linked list
  - CAR identifies the first item
  - CDR identifies the remaining items
  - CONS builds a list consisting of a CAR and a CDR
- LISP uses polish notation:
  - \((+ \ 1 \ 1) \rightarrow 2\)
  - \((< \ 5 \ 8) \rightarrow T\)
- \(T = TRUE\) and NIL = both FALSE and the empty list
Strategy for Insertion Sort

• Do insertion sort on a linked list
• Sort in place beginning with the end of the list
• Recursively sort the end of the list first
• A list containing one item is already sorted
• For longer lists, do the following
  – Given a sorted list and the preceding item,
  – Insert the preceding item into its proper place in the sorted list
(defun insert-sort (list function)
  (if (cdr list) ;; if there is more than one item in list
      (insert-card-in-list ;; function
        (car list) ;; first item in list
        (insert-sort (cdr list) function)))
    ;; recursive call to insert-sort on cdr of list
    list) ;; else return the whole list)
(defun insert-card-in-list (item sorted-list function)
  (cond
    ((not sorted-list) (list item))
    ;; if sorted-list is empty return a list consisting of the item
    ((funcall function item (car sorted-list))
      (cons item sorted-list))
    ;; if item precedes the first element in sorted-list
    ;; (as per sorting function), then place it in front of sorted-list
    (t (cons
        (car sorted-list)
        (insert-card-in-list item (cdr sorted-list) function))))
    ;; else insert-the card into the cdr of sorted-list
)
Look at Trace of Function

• See File: insert-sort-lisp-trace.txt

• INSERT-SORT
  – calls itself recursively on progressively smaller parts of the input list, until it reaches the base case and outputs a list of one item
  – Then it calls INSERT-CARD-IN-LIST to complete each of the previous calls

• INSERT-CARD-IN-LIST
  – Calls itself recursively until either
    • ITEM precedes the first element in SORTED-LIST or
    • SORTED-LIST is empty (the base case)
Summary

• Lisp is an old language, but still around
• Programming style is different than most other languages
• Recursion is used more widely than in most other languages