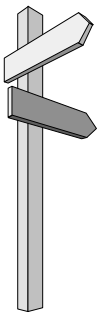
Programming in Lisp

Lecture #1



Welcome!

- Programming in Lisp
  - Course Number CSCI 2210-01
  - Class Meetings
    - Sage 3303
    - Aug. 24 - Oct. 14
    - Wednesdays, 4 - 6 pm

Instructor

- Kenneth W. Flynn
  - BS Physics
  - MS Computer Science (May '99)
  - Ph. D Astrophysics (Someday)
- Email: *flynnk@rpi.edu*
- Office Hours

Texts

- Ansi Common Lisp by Paul Graham; Prentice Hall, 1996
  - ISBN 0-13-370875-6
  - **Required**
- Lisp by Guy L. Steele
  - Optional

Course Notes

- Course notes and other materials will be available via the course website:
  - http://www.cs.rpi.edu/courses/fall98/lisp/
- Check the website frequently

Grading

- Two schemes...

Item	*Weights*	*Alternative Weights*
Halfway Quiz	15%	15%
Final Exam	15%	-
Class Participation	25%	25%
Homework #1	15%	20%
Homework #2	15%	20%
Homework #3	15%	20%

Course Policies (I)

- Homework
  - Due at 11:59:59 on date given in syllabus and on assignment
  - Late homework is penalized 10% for each RPI class day late. Extensions may be requested until noon of the date due
  - Students may work in teams of 2. Both students will receive the same grade

Course Policies (II)

- Exams
  - May cover material from lectures or readings
  - Time conflicts should see me ASAP

And now...

- Lisp!
- Name comes from LISt Processor
- Lisp is... well, different
- In Lisp, data == programs
- So why learn Lisp?
  - AI uses
  - Different (buzzword alert!) paradigm for programming

Lisp

- Lisp is interactive
- Most of the time when Lisp is waiting for input, we say it is at the ***toplevel***.
- We can type lisp expressions into the toplevel and they will be evaluated:

```
> 1
1
>
```

Atoms & Lists

- Atoms
  - A single element of a particular data type.
- Lists
  - Lists may contain atoms or other lists
  - Enclosed in parens "(atom atom atom list)"
  - We'll talk more about lists later, and a lot more next week

Atoms & Lists Examples

- Atoms
  - 1
  - 3.3
  - WUMPUS
- Lists (LISp)
  - (1 2 3)
  - (1 3 FIVE)
  - (A LIST (A NESTED LIST))

Expressions

- Syntatic structure
- (*Operator Argument Argument ...)*
- That's 0 or more *arguments*
- Expressions are lists! (Ponder this a moment!)

Expression Examples

```
> (*)
1
> (* 1)
1
> (* 2)
2
> (* 2 2)
4
> (* 1 2 3)
6
```

Evaluation

- Evaluation (what happens when you press enter) happens in two steps:
  - The arguments are evaluated, left to right
  - Call by value occurs for the given operator (function)
- This is the *Evaluation Rule* for Common Lisp

Evaluation Example

- > (/ (* 4 6) 3)
- / is the operator, skip this
- (* 4 6) is the first argument, let's evaluate
- * is the operator, skip this
- 4 is the first argument, it evaluates to itself
- 6 is the second argument, it evaluates to itself
- * is now called with the arguments 4 and 6
- (*4 6) is replaced by 24

Evaluation Example II

- We currently have: (/ 24 8)
- The second argument to / is 8, it evaluates to itself
- / is now called with the arguments 24 and 8
- (/ 24 8) is replaced by 3
- This is returned to the toplevel

More Expression Examples

```
> (/ (* 4 6) 3)
8
> (quote hello)
HELLO
> 'hello
HELLO
```

The Quote Operator

- These are equivalent
  - (quote Hello)
  - 'Hello
- *Special Operator*
  - Disobeys the Evaluation Rule
- Quote says "Don't evaluate my argument"

Quote Examples

```
> (quote hello)
HELLO
> 'hello
HELLO
> hello
;; Error: Unbound variable HELLO in #<function 1
#x810FC0>
```

Symbols

- When Lisp returns something like:
  > 'ARTICHOKE
  ARTICHOKE

  This is a *symbol*
- We'll talk more about symbols later, but for now...
- Symbols are names for other things. One role they fill is that of variables.

The Story So Far...

- Atoms
- Lists
- Expressions
- Evaluation (The Evaluation Rule)
- Symbols
- '

list

- Another operator
- This one builds lists
- > (list 1 2 3)
  (1 2 3)
- > (list 1 (+ 1 1) 3)
  (1 2 3)
- > (list 'Tada (+ 1 1) 3)
  (TADA 2 3)

list II

- These do the same thing:
  - (list 1 2 3)
  - '(1 2 3)

nil

- Symbol
- Represents empty list -- a list with no elements
- > 'nil
  NIL
- > nil
  NIL
  - nil evaluates to itself
- '()
  NIL

Is There No Truth in Beauty?

- Lisp has the concept of Boolean values
- The value "True" is represented by *t*
- > t
  T
- The value "False" is represented by *nil*
  - This is a second use for nil
- Functions that determine truth are called *predicates*

Predicates: listp

- *listp*
  - Is the argument a list?
  - > (listp 'Beauty)
    NIL
  - > (listp '(No Lie))
    T

Predicates: null

- *null*
  - Is the argument an empty list?
  - > (null nil)
    T
  - > (null '(The Truth Is Out There))
    NIL

Predicates: not

- *not*
  - Returns opposite of the argument
  - > (not t)
    NIL
  - > (not nil)
    T
  - Does exactly the same as *null*. For readibility, though...

"if", "and", "or", but no "but"s

- These statements begin to allow for logic in your programs
- *if* is the simplest form of flow control (which is somewhat different than in iterative languages)

If

- (if 'Truth-Statement 'Then-do-this 'Else-do-this)
  - if is a *macro*. Macros disobey the Evaluation Rule (The exceptions prove the rule?)
  - For if: The first argument is always evaluated
  - If the first argument is true, the second argument is evaluated, and it's value returned
  - If the first argument is false, the third argument is evaluated instead, and it's value is returned.

if examples

- >(if t 'A 'B)
  A
- > (if nil 'a 'b)
  B

and / or

- *and*
  - Macro
  - Returns true if all arguments are true
  - Lazy evaluation (stops at first false argument)
- *or*
  - Macro
  - Returns true if any argument true
  - Lazy evalution (stops at first true argument)

Functions *(defun)*

- Create new functions with defun.
- Syntax: *(defun function-name (parameter-list) (expressions))*
- Macro
- Functions make up the majority of functionality provided

Function Examples

```
>(defun adder (x y)
   (+ x y)
  )
>(adder 3 2)
5
>(adder 1.0 3.5)
4.5
```

Review

- Atoms, Lists, Expressions, Evaluation (The Evaluation Rule), Symbols, '
- Predicates (listp, null, not, and, or)
- Macros (conceptually)
- Functions (pratically)
- This class was an introduction of a lot of concepts. From now on, we'll be more focused.

On the Next Exciting Episode!

- Input and Output
- Variables (or not...)
- Lisp Data Structures: lists and arrays

For Next Week...

- Read Chapter #2 in Graham
  - We didn't cover everything in Chapter #2
    - Some we will do next week
    - Some we will come back to

Operations on Lists

- Lots of this next week, but for now:
- *car* returns the first element
- *cdr* returns a list containing everything except the first element

```
> (car '(1 2 3))
1
> (cdr '(1 2 3))
(2 3)
>
```

Operations on Lists II

- *cons* builds a list. It takes the first argument and attachs it to the beginning of the second argument:

```
>  (cons 1 '(2 3))
(1 2 3)
> (first '(1 2 3))
1
> (second '(1 2 3))
2
>
```