CSCI 334: Principles of Programming Languages

Lecture 9: Lisp

Instructor: Dan Barowy

Williams

Announcements

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Midterm exam *next* Thursday

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Optional Lisp homework posted later today

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Feedback: slides insufficient (clarification?)

Choosing a language

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Many good technical reasons

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Few people decide for technical reasons

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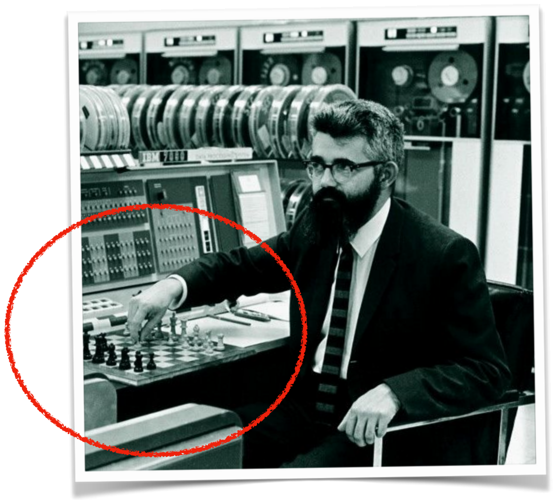
Few people decide for technical reasons

Seibel: Why do people get so religious about their computer languages?

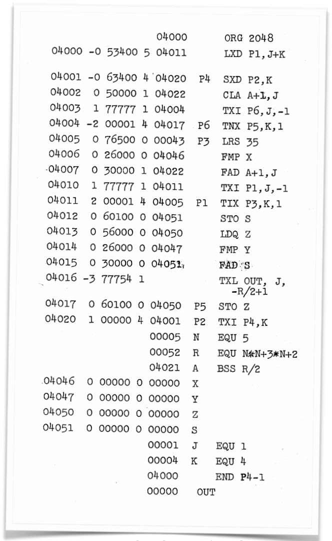
Bloch: I don't know. But when you choose a language, you're choosing more than a set of technical trade-offs—you're choosing a community. It's like choosing a bar. Yes, you want to go to a bar that serves good drinks, but that's not the most important thing. It's who hangs out there and what they talk about. And that's the way you choose computer languages. Over time the community builds up the language—not only the people, but the software artifacts: tools, libraries, and so forth. That's one of the reasons that sometimes languages that are, on paper, better than other languages don't win—because they just haven't built the right communities around themselves.

John McCarthy

IBM 704



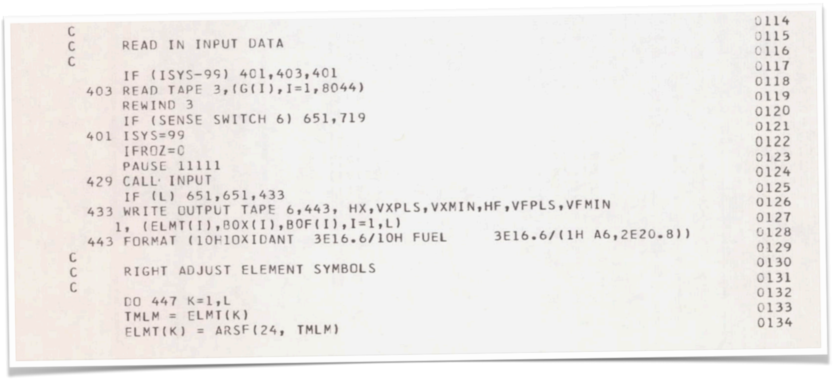
Lisp was invented for AI research



```
                    04000      ORG 2048
04000 -0 53400 5 04011         LXD P1,J+K

04001 -0 63400 4 04020   P4    SXD P2,K
04002  0 50000 1 04022         CLA A+1,J
04003  1 77777 1 04004         TXI P6,J,-1
04004 -2 00001 4 04017   P6    TNX P5,K,1
04005  0 76500 0 00043   P3    LRS 35
04006  0 26000 0 04046         FMP X
04007  0 30000 1 04022         FAD A+1,J
04010  1 77777 1 04011         TXI P1,J,-1
04011  2 00001 4 04005   P1    TIX P3,K,1
04012  0 60100 0 04051         STO S
04013  0 56000 0 04050         LDQ Z
04014  0 26000 0 04047         FMP Y
04015  0 30000 0 04051         FAD S
04016 -3 77754 1               TXL OUT, J,
                                 -R/2+1
04017  0 60100 0 04050   P5    STO Z
04020  1 00000 4 04001   P2    TXI P4,K
                 00005   N     EQU 5
                 00052   R     EQU N*N+3*N+2
                 04021   A     BSS R/2
04046  0 00000 0 00000   X
04047  0 00000 0 00000   Y
04050  0 00000 0 00000   Z
04051  0 00000 0 00000   S
                 00001   J     EQU 1
                 00004   K     EQU 4
                 04000         END P4-1
                 00000   OUT
```

704 Assembly (circa 1954)
(From Coding the MIT-IBM 704 Computer)



```
C
C     READ IN INPUT DATA
C
      IF (ISYS-99) 401,403,401
  403 READ TAPE 3,(G(I),I=1,8044)
      REWIND 3
      IF (SENSE SWITCH 6) 651,719
  401 ISYS=99
      IFROZ=0
      PAUSE 11111
  429 CALL INPUT
      IF (L) 651,651,433
  433 WRITE OUTPUT TAPE 6,443, HX,VXPLS,VXMIN,HF,VFPLS,VFMIN
     1, (ELMT(I),BOX(I),BOF(I),I=1,L)
  443 FORMAT (10H1OXIDANT  3E16.6/10H FUEL     3E16.6/(1H A6,2E20.8))
C
C     RIGHT ADJUST ELEMENT SYMBOLS
C
      DO 447 K=1,L
      TMLM = ELMT(K)
      ELMT(K) = ARSF(24, TMLM)
```

FORTRAN (circa 1956)
(From NASA Technical Note D-1737)

```
(defun fact (n)
    (cond ((eq n 0) 1)
          (t (* n (fact (- n 1))))))
```

LISP (circa 1958)

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- complex parts are composed out of simple parts
- we care about what a program means and not what it does: you can understand a program without having to mentally execute it
- *programs are easier to reason about*

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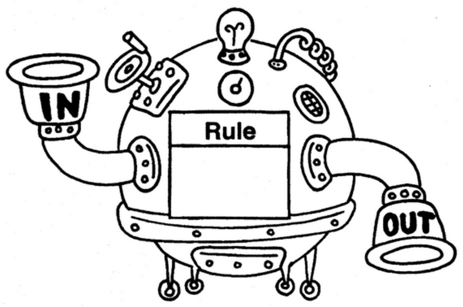

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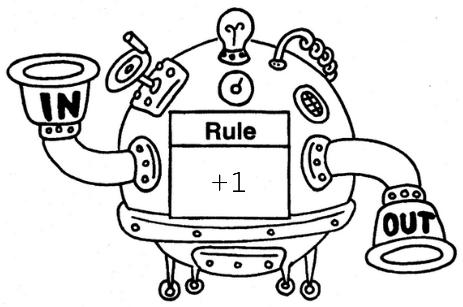

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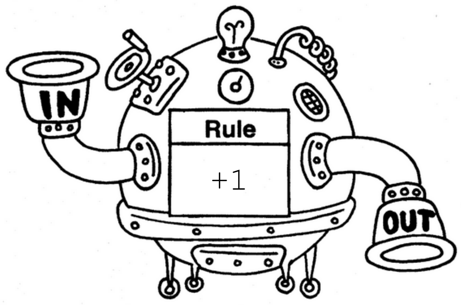

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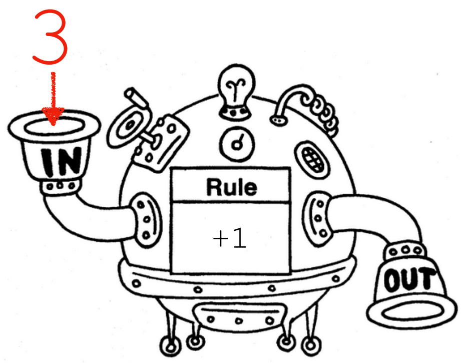

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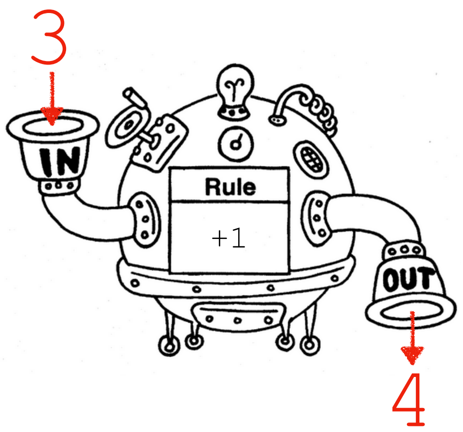

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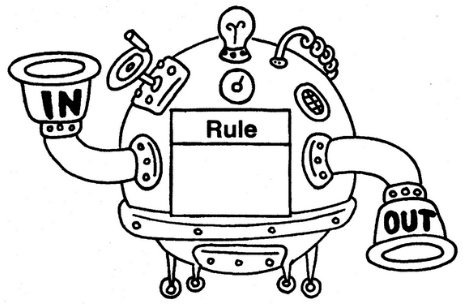

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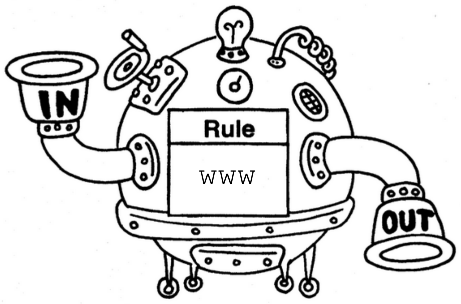

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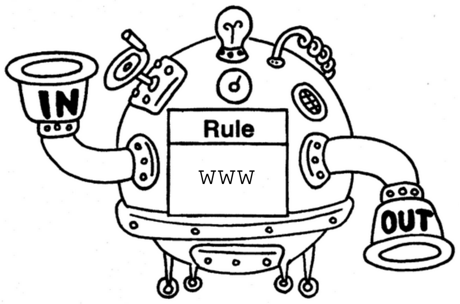

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(defun cleaning-robot (dirt) …)
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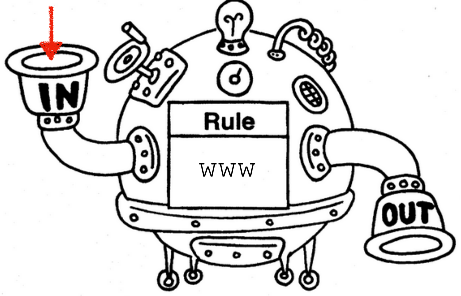
LISP is a “functional” language

dirty house



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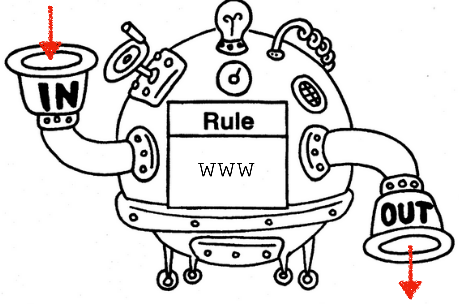

clean house

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Big functions are “composed” of little functions

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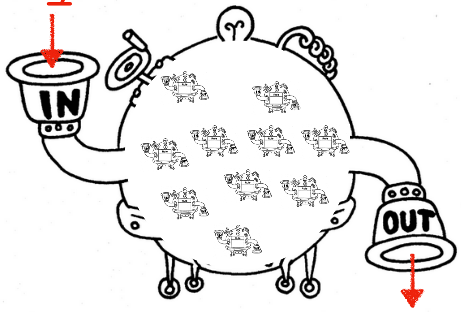

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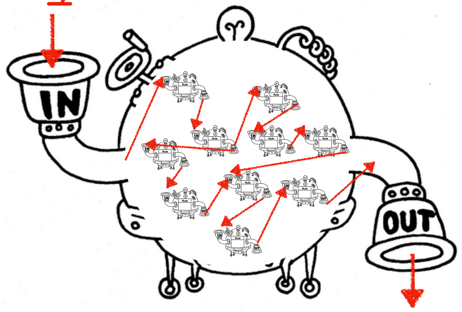

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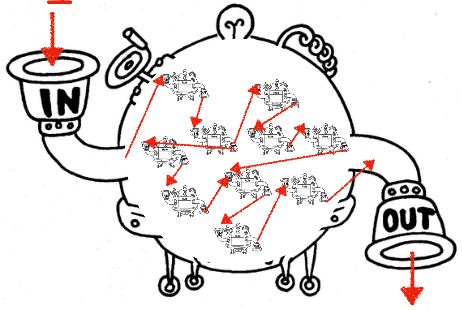

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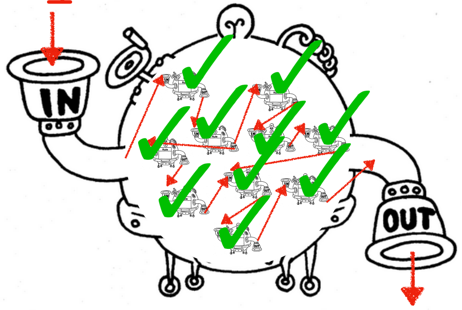

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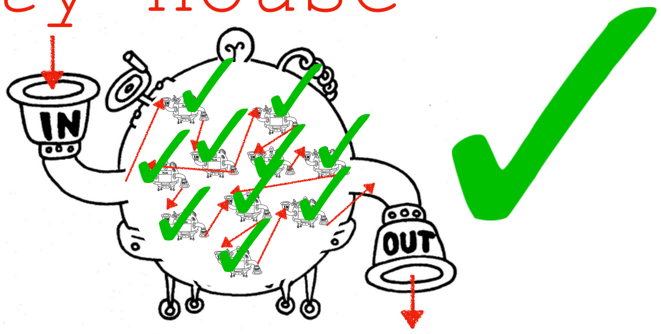

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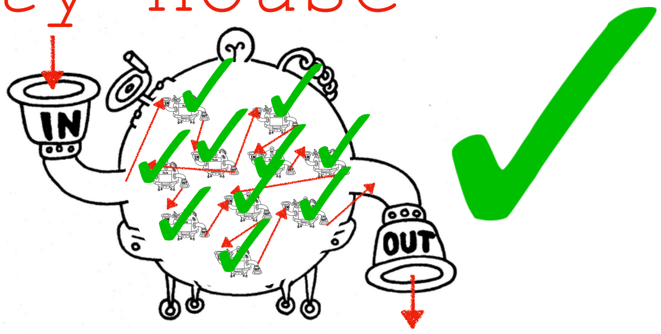

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I.e., whole is correct if pieces are correct.

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- evaluating a function produces a value:

  `(+ 1 1) ↠ 2`

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  Lisp: `(+ i 1)`

  evaluating + with i and 1 returns i + 1

REPL
(read-eval-print loop)

Batch mode

Mutable variables

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- In fact, functions are the only way to bind values to names in (pure) Lisp

Lisp syntax: atoms

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```
4
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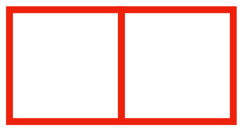

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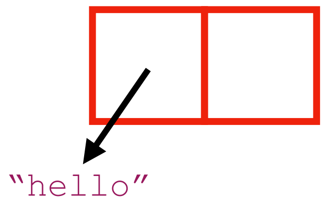

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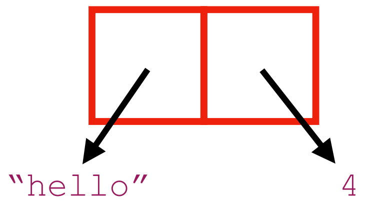

Lisp = LISt Processor

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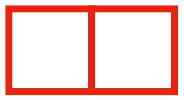

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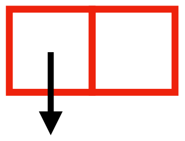

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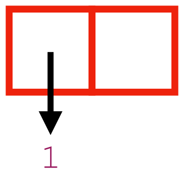

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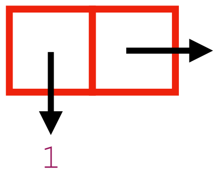

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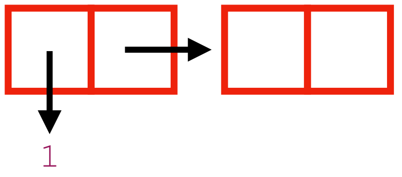

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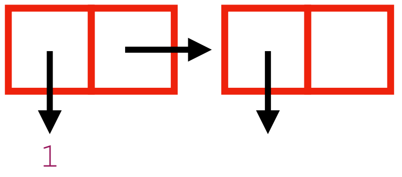

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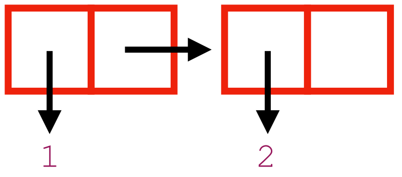

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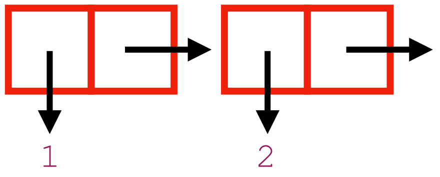

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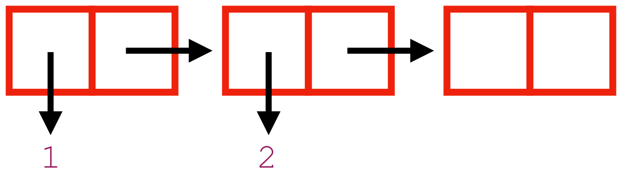

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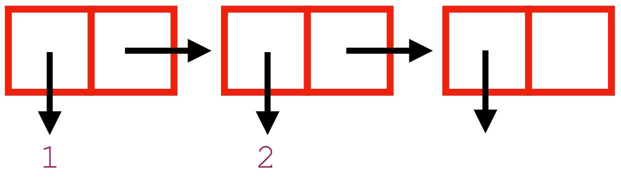

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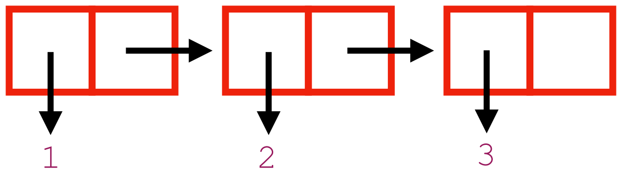

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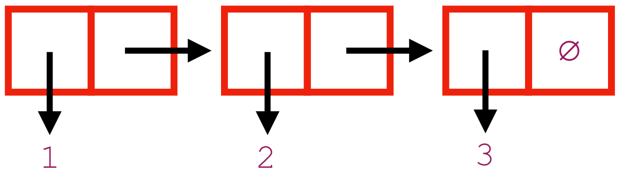

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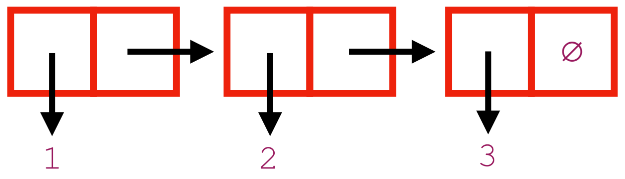

- Lisp has a shorthand for this:

  `'(1 2 3)`

Lisp syntax: car and cdr

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- What's the value of the following expression?

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- What about this?

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(cond ((eq 1 x) (cons x xs)) …)
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  `(cond ((test) (value)) …)`

- E.g.,

  `(cond ((eq 1 x) (cons x xs)) …)`

- Does the same as the Java

```
if (x == 1) {
  xs.add(x);
}
```

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(cond ((test1) (value1))
      ((test2) (value2)
      ...)
```

```
(defun insert (x l)
  (cond ((eq l nil) (cons x nil))
        ((< x (car l)) (cons x l))
        (t (cons
             (car l)
             (insert x (cdr l))))))
```

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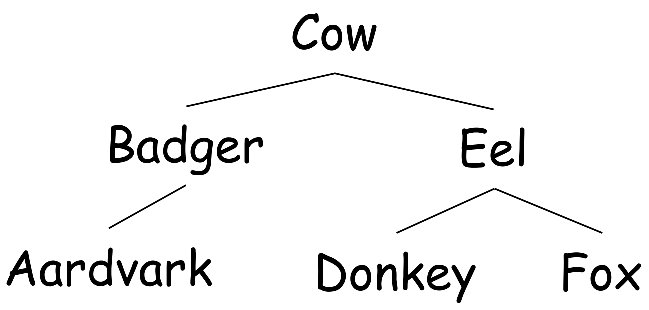
Activity

list length

```
(length-list '(1 2 3 4 5 6)) ↠ 6
```

Activity



Memory management

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MyObject *m = malloc(sizeof(MyObject));
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… do stuff with m …
free(m);
```

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  You barely need to think about this at all.

  ```
  MyObject m = new MyObject(2,3);
  … do stuff with m …
  (cons 2 3)
  ```