Scheme Lists

Announcements

Turtle Graphics

Drawing Stars

(forward 100) or (fd 100) draws a line

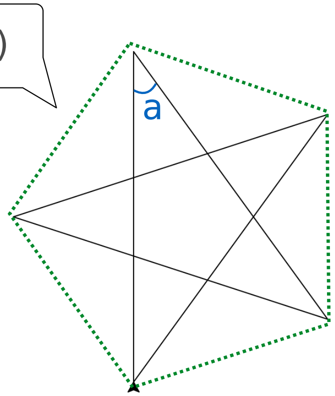
(right 90) or (rt 90) turns 90 degrees

Number of sides

Where to go next

```
(define (star n m)
  (let ((a (/ (* 360 m) n)))
    (define (side k)
      (if (< k n) (begin (fd 100) (rt a) (side (+ k 1)))))
    (side 0)))
```

(star 5 2)



(Demo)

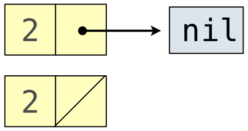
Lists

Scheme Lists

In the late 1950s, computer scientists used confusing names

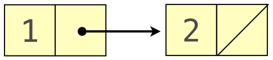
- **cons:** Two-argument procedure that creates a linked list
- **car:** Procedure that returns the first element of a list
- **cdr:** Procedure that returns the rest of a list
- **nil:** The empty list

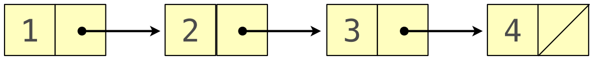
(cons 2 nil)



Important! Scheme lists are written in parentheses with elements separated by spaces

```
> (cons 1 (cons 2 nil))
(1 2)
> (define x (cons 1 (cons 2 nil))
> x
(1 2)
> (car x)
1
> (cdr x)
(2)
> (cons 1 (cons 2 (cons 3 (cons 4 nil))))
(1 2 3 4)
```





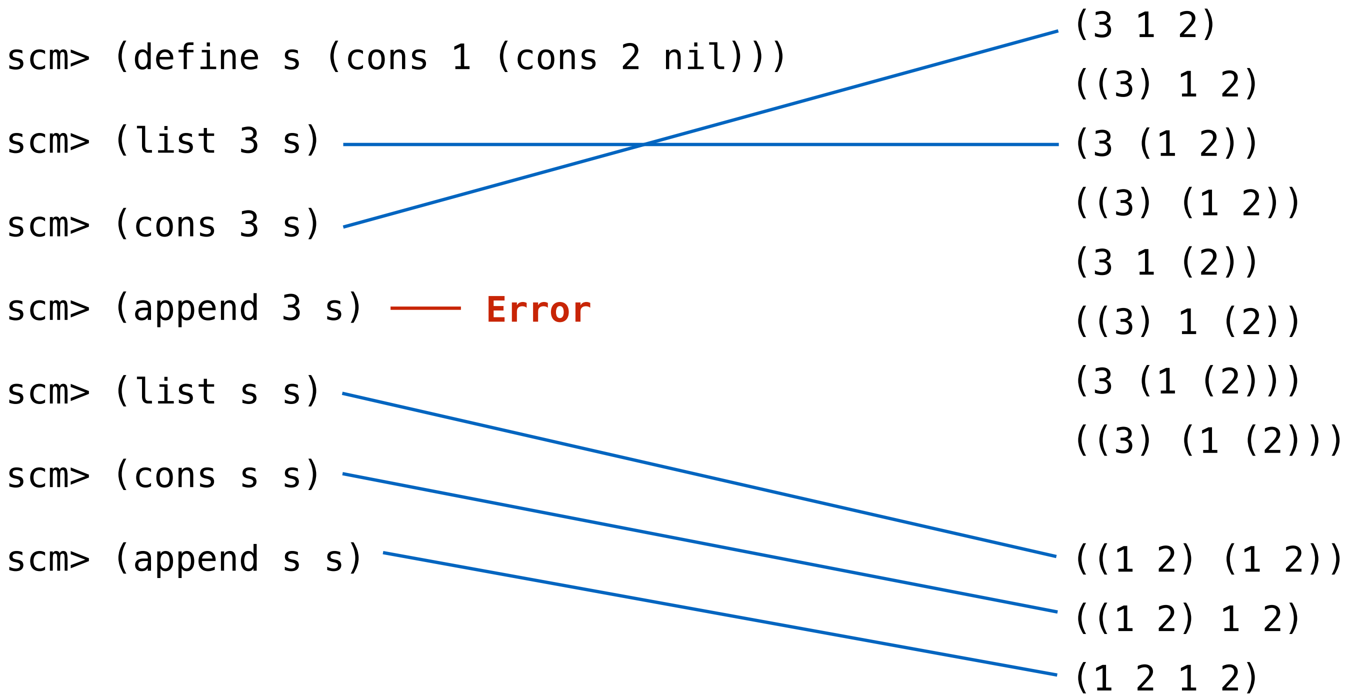
(Demo)

List Construction

cons is always called on two arguments: a first value and the rest of the list.

list is called on any number of arguments that all become values in a list.

append is called on any number of list arguments that all become concatenated in a list.



```
scm> (define s (cons 1 (cons 2 nil)))

scm> (list 3 s)

scm> (cons 3 s)

scm> (append 3 s) —— Error

scm> (list s s)

scm> (cons s s)

scm> (append s s)
```

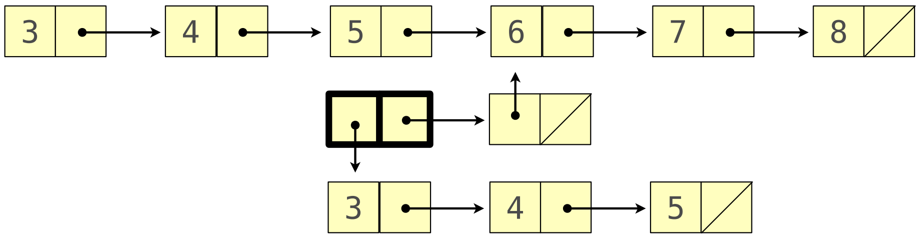
```
(3 1 2)
((3) 1 2)
(3 (1 2))
((3) (1 2))
(3 1 (2))
((3) 1 (2))
(3 (1 (2)))
((3) (1 (2)))

((1 2) (1 2))
((1 2) 1 2)
(1 2 1 2)
```

Recursive Construction

To build a list one element at a time, use **cons**

To build a list with a fixed length, use **list**

```
;;; Return a list of two lists; the first n elements of s and the rest
;;; scm> (split (list 3 4 5 6 7 8) 3)
;;; ((3 4 5) (6 7 8))
(define (split s n)
  ; The first n elements of s
  (define (prefix s n)
    (if (zero? n) nil (cons (car s) (prefix (cdr s) (- n 1)))))
  ; The elements after the first n
  (define (suffix s n)
    (if (zero? n) s (suffix (cdr s) (- n 1))))
  (list (prefix s n) (suffix s n)))
```

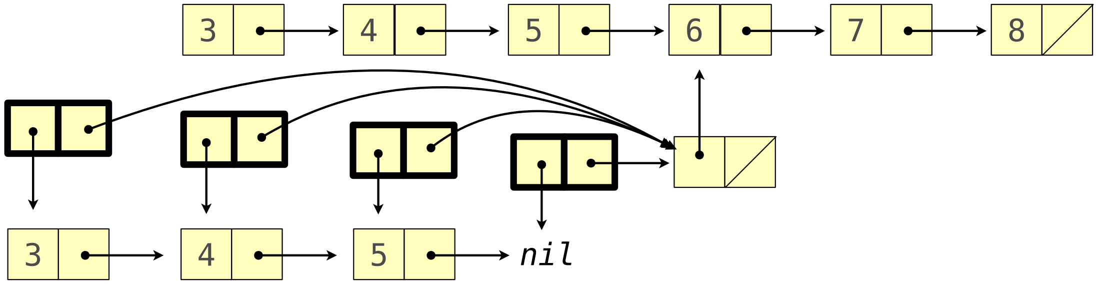


Recursive Construction Version 2

To build a list one element at a time, use **cons**

To build a list with a fixed length, use **list**

```
;;; Return a list of two lists; the first n elements of s and the rest
;;; scm> (split (list 3 4 5 6 7 8) 3)
;;; ((3 4 5) (6 7 8))
(define (split s n)
  (if (= n 0)
      (list nil s)
      (let ((split-rest (split (cdr s) (- n 1))))
        ( cons (cons (car s) (car split-rest))
               (cdr split-rest)))))
```



Symbolic Programming

Symbolic Programming

Symbols normally refer to values; how do we refer to symbols?

```
> (define a 1)
> (define b 2)
> (list a b)
(1 2)
```

No sign of “a” and “b” in the resulting value

Quotation is used to refer to symbols directly in Lisp.

```
> (list 'a 'b)
(a b)
> (list 'a b)
(a 2)
```

Short for (quote a), (quote b): Special form to indicate that the expression itself is the value.

Quotation can also be applied to combinations to form lists.

```
> '(a b c)
(a b c)
> (car '(a b c))
a
> (cdr '(a b c))
(b c)
```

(Demo)

List Processing

Built-in List Processing Procedures

(append s t): list the elements of s and t; append can be called on more than 2 lists

(map f s): call a procedure f on each element of a list s and list the results

(filter f s): call a procedure f on each element of a list s and list the elements for which a true value is the result

(apply f s): call a procedure f with the elements of a list s as its arguments

```
(1 2 3 4)                                 ; count
((and a 1) (and a 2) (and a 3) (and a 4)) ; beats
(and a 1 and a 2 and a 3 and a 4)         ; rhythm
```

```
(define count (list 1 2 3 4))

(define beats (map (lambda (x) (list 'and 'a x)) count)

(define rhythm (apply append beats))
```