#### >> Sorting a List

- > Multiple Complex Inputs
- Natural Numbers

## **Sorting Lists**

• Implement **sort-list**, which takes a list of numbers and returns a sorted list of the same numbers

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- Implement append-lists, which takes two lists of numbers and returns a list with all of the numbers from the first list followed by all of the numbers from the second list
- Implement **parallel-sum**, which takes two lists of numbers (of the same length) and returns a list of sums
- Implement **merge-lists**, which takes two *sorted* lists of numbers and returns a sorted list with all of the numbers

```
; append-lists : list-of-num list-of-num -> list-of-num
```

(append-lists empty empty) "should be" empty

```
(append-lists (list 1 3 5) (list 0 4 6))
"should be" (list 1 3 5 0 4 6)
```

- Implement append-lists, which takes two lists of numbers and returns a list with all of the numbers from the first list followed by all of the numbers from the second list
- Implement **parallel-sum**, which takes two lists of numbers (of the same length) and returns a list of sums
- Implement **merge-lists**, which takes two *sorted* lists of numbers and returns a sorted list with all of the numbers

; parallel-sum : list-of-num list-of-num -> list-of-num

(parallel-sum empty empty) "should be" empty

(parallel-sum (list 1 3 5) (list 0 4 6))
"should be" (list 1 7 11)

- Implement append-lists, which takes two lists of numbers and returns a list with all of the numbers from the first list followed by all of the numbers from the second list
- Implement **parallel-sum**, which takes two lists of numbers (of the same length) and returns a list of sums
- Implement **merge-lists**, which takes two *sorted* lists of numbers and returns a sorted list with all of the numbers

```
; merge-lists : list-of-num list-of-num -> list-of-num
(merge-lists empty empty) "should be" empty
(merge-lists (list 1 3 5) (list 0 4 6))
"should be" (list 0 1 3 4 5 6)
```

- Implement append-lists, which takes two lists of numbers and returns a list with all of the numbers from the first list followed by all of the numbers from the second list
- Implement **parallel-sum**, which takes two lists of numbers (of the same length) and returns a list of sums
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```
; func : list-of-num list-of-num -> list-of-num
```

What template do we use for a function for *two* lists?

• Sometimes a complex argument is "along for the ride", so use the template for the other argument

```
(append-lists (list 1 3 5) (list 0 4 6))
"should be" (list 1 3 5 0 4 6)
(define (append-lists al bl)
  (cond
    [(empty? al) ...]
    [(cons? al)
    ... (first al)
    ... (append-lists (rest al) bl) ...]))
```

• Sometimes the arguments are exactly the same shape, so use essentially the one-argument template

```
(parallel-sum (list 1 3 5) (list 0 4 6))
"should be" (list 1 7 11)
(define (parallel-sum al bl)
  (cond
    [(empty? al) ...]
    [(cons? al)
    ... (first al) ... (first bl)
    ... (parallel-sum (rest al) (rest bl)) ...]))
```

 Sometimes you have to consider all possible combinations, so use a template that considers all combinations

```
(merge-lists (list 1 3 5) (list 0 4 6))
 "should be" (list 0 1 3 4 5 6)
(define (merge-lists al bl)
 (cond
   [(and (empty? al) (empty? bl)) ...]
   [(and (empty? al) (cons? bl))
    ... (first bl) ... (merge-lists al (rest bl)) ...]
   [(and (cons? al) (empty? bl))
    ... (first al) ... (merge-lists (rest al) bl) ...]
   [(and (cons? al) (cons? bl))
    ... (first al) ... (first bl)
    ... (merge-lists (rest al) bl)
    ... (merge-lists al (rest bl))
    ... (merge-lists (rest al) (rest bl)) ...]))
```

#### Sorting a List

Multiple Complex Inputs

#### >> Natural Numbers

## **Numbers to Generate Lists**

• Implement **create-list**, which takes a non-negative integer *n* and produces a list of numbers from *n* to 0, inclusive

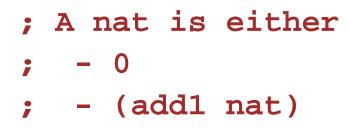
; create-list : num -> list-of-num
(create-list 3) "should be" (list 3 2 1 0)
(create-list 0) "should be" (list 0)

The template for **num** isn't much help:

```
(define (func-for-num n)
    ...)
```

But create-list actually takes a *natural number* 

## **Natural Numbers**



Examples:

#### 0

# (add1 0) (add1 (add1 0)))

These examples have shortcuts

0, 1, and 3

but the long forms correspond to the template

#### **Template for Natural Numbers**

```
; A nat is either
              ; - 0
              ; - (add1 nat)
(define (func-for-nat n)
  (cond
    [(zero? n) ...]
    [else ... (func-for-nat (subl n)) ...]))
(define (create-list n)
  (cond
    [(zero? n) (list 0)]
    [else (cons n (create-list (sub1 n)))]))
```

## **Generating the List the Other Way**

• Implement **create-up-list**, which takes a non-negative integer *n* and produces a list of numbers from 0 to *n* inclusive

```
; create-up-list : num -> list-of-num
(create-list 3) "should be" (list 0 1 2 3)
(create-list 0) "should be" (list 0)
(define (create-up-list n)
  (cond
    [(zero? n) (list 0)]
    [else
     ... n
     ... (create-up-list (sub1 n)) ...]))
; uh oh... can't cons onto recur result
```

## **Using Subtraction to Count Up**

```
(define (create-up-list n)
    (create-up-to-n-list n n))
  ; Creates a list with d elements before n
  (define (create-up-to-n-list d n)
    (cond
      [(zero? d) (list n)]
      [else
       (cons (-nd))
              (create-up-to-m-list (sub1 d) n))))
... or replace d with m = (+ d n)
```

As d goes down, m goes up...

## **Counting Up Directly**

```
(define (create-up-list n)
  (create-m-to-n-list 0 n))
; Creates a list from m to n
(define (create-m-to-n-list m n)
  (cond
    [(= m n) (list n)]
    [else
     (cons m
           (create-m-to-n-list (add1 m) n))))
```

Use the stepper to see how it works

Similar ideas work for counting by fives, counting down to 20, etc.