Folding Wrong with Filtered Maps	Drawing Swords	Long Live fold-right!	Substituting Regents	TIARA Is A Recursive Acronym
100	100	100	100	200
200	200	200	200	400
300	300	300	300	600
400	400	400	400	800
500	500	500	500	1000

Suppose **x** is bound to the list **(1 2 3 4 5 6 7)**. Using map, filter, and/or fold-right, write an expression involving **x** that returns:

(1 4 9 16 25 36 49)

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(1 4 9 16 25 36 49)

(map (lambda (x) (* x x)) x)

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((1 1) (3 3) (5 5) (7 7))

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((1 1) (3 3) (5 5) (7 7))

```
(map (lambda (x) (list x x))
     (filter odd? x))
```

Suppose **x** is bound to the list **(1 2 3 4 5 6 7)**. Using map, filter, and/or fold-right, write an expression involving **x** that returns:

((2) ((4) ((6) #f)))

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((2) ((4) ((6) #f)))

```
(fold-right
  (lambda (x accum)
    (cons (list x) (list accum)))
  #f
  (filter even? x))
```

Suppose **x** is bound to the list **(1 2 3 4 5 6 7)**. Using map, filter, and/or fold-right, write an expression involving **x** that returns:

The maximum element of x: 7

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The maximum element of x: 7

```
(fold-right
  max
  (car x)
  (cdr x))
```

Suppose **x** is bound to the list **(1 2 3 4 5 6 7)**. Using map, filter, and/or fold-right, write an expression involving **x** that returns:

The last pair of x: (7)

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The last pair of x: (7)

Answer: trick question! It’s not possible. Map, filter, and fold-right do not give you access to the original list’s backbone, they only let you see the values.

Draw a box-and-pointer diagram for the value produced by the following expression:

```
(cons (cons "x" nil)
      (cons "y" (cons "z" nil)))
```

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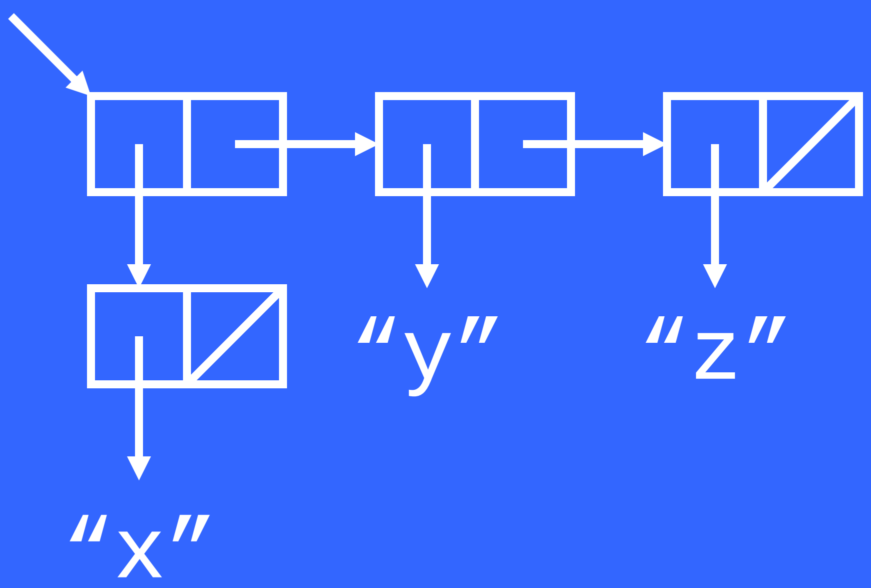
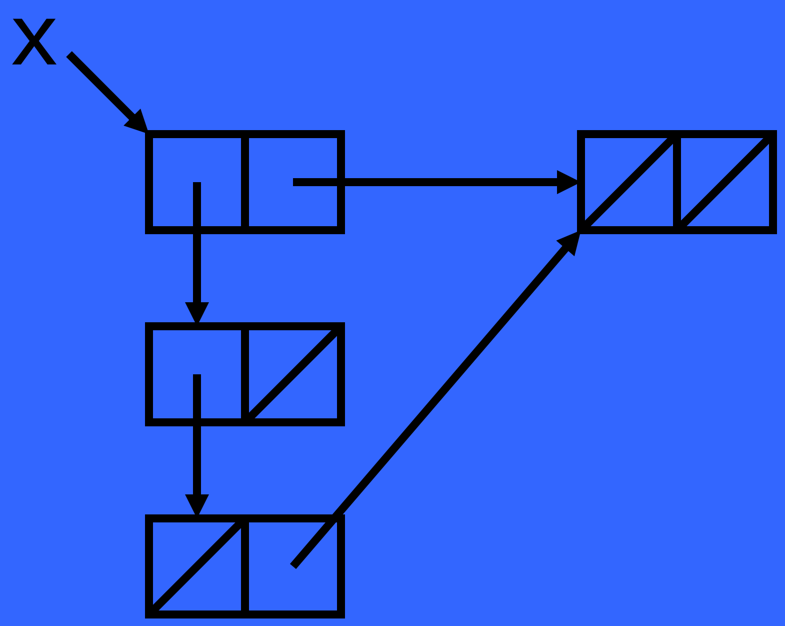
```



What code will produce the following box-and-pointer diagram?



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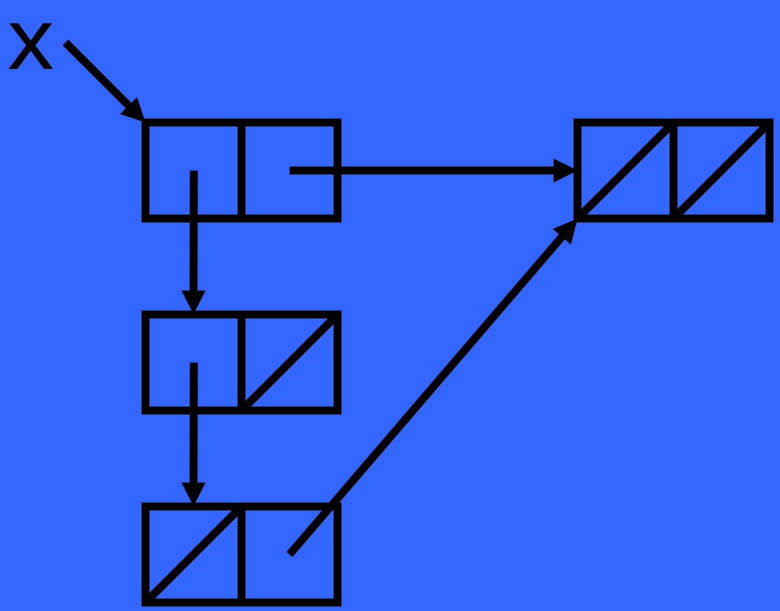


```
(define null-null (cons '() '()))
(define x (cons (cons (cons '() null-null)
                      '())
                null-null))
```

Write code that will cause the following to be printed:

```
(1 2 (3 (((4))) 5))
```

Write code that will cause the following to be printed:

(1 2 (3 (((4))) 5))

(list 1 2
      (list 3
            (list (list (list 4)))
            5))

(cons 1
(cons 2
(cons (cons 3
  (cons (cons (cons (cons 4 '())
    '()) '()) (cons 5 '())))
'())))

Draw a box-and-pointer diagram for the value produced by the following expression:

```
(map car
  (list (list 3)
        (list 4)
        (list 5)))
```

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```
(map car
  (list (list 3)
        (list 4)
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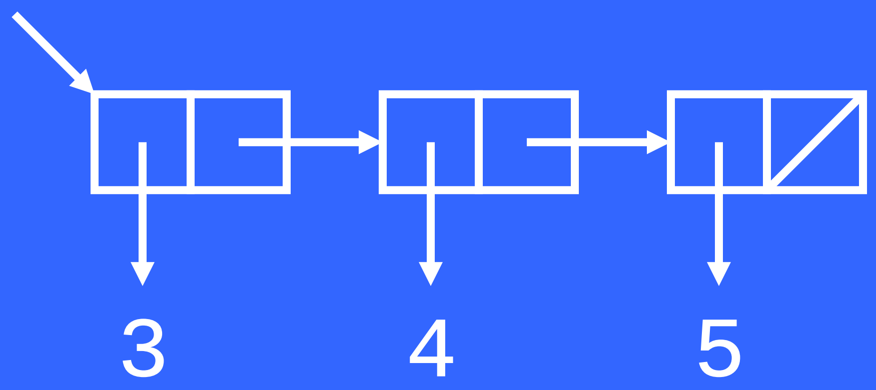
```

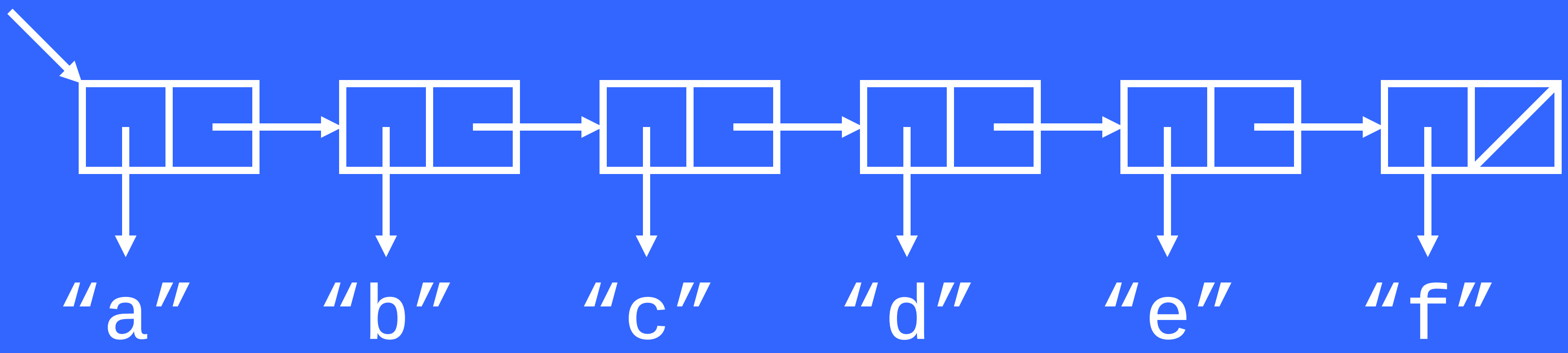


Draw the box-and-pointers diagram for the value of the following expression:

```
(fold-right
  append
  '()
  (list (list "a" "b")
        (list "c")
        (list "d" "e" "f")))
```

Draw the box-and-pointers diagram for the value of the following expression:

```
(fold-right
  append
  '()
  (list (list "a" "b")
        (list "c")
        (list "d" "e" "f")))
```



Write the following procedure using fold-right:

```
; Creates a new list with
; the same elements as lst
(define (copy-list lst)



  )
```

Write the following procedure using fold-right:

```
; Creates a new list with
; the same elements as lst
(define (copy-list lst)
  (fold-right cons '() lst))
```

Write the following procedure using fold-right:

```
(define (append list1 list2)


  )
```

Write the following procedure using fold-right:

```
(define (append list1 list2)
  (fold-right cons list2 list1))
```

Write a procedure to reverse a list using fold-right (you may also use length, append, list, and/or cons):

```
(define (reverse lst)



  )
```

Write a procedure to reverse a list using fold-right (you may also use length, append, list, and/or cons):

```
(define (reverse lst)
  (fold-right
    (lambda (new accum)
      (append accum
              (list new)))
   '()
   lst))
```

Write the **for-all?** procedure using **fold-right**. It should return **#t** if applying the procedure **pred** to each element of **lst** evaluates to **#t**.

```
;; for-all? :
;;    list<A>,(A->boolean) -> boolean
;; Examples:
;;    (for-all? (list 1 3 5 7) odd?) => #t
;;    (for-all? (list 1 3 5 6) odd?) => #f
(define (for-all? lst pred) ... )
```

Write the **for-all?** procedure using **fold-right**. It should return **#t** if applying the procedure **pred** to each element of **lst** evaluates to **#t**.

```
;; for-all? :
;;   list<A>,(A->boolean) -> boolean
;; Examples:
;;   (for-all? (list 1 3 5 7) odd?) => #t
;;   (for-all? (list 1 3 5 6) odd?) => #f
(define (for-all? lst pred)
  (fold-right
    (lambda (x accum)
      (and accum (pred x)))
    #t
    lst))
```

Write the procedure **map** in terms of **fold-right**.

```
(define (map pred lst) ... )
```

Write the procedure **map** in terms of **fold-right**.

```
(define (map pred lst)
  (fold-right
    (lambda (x accum)
      (cons (pred x) accum))
    '()
    lst))
```

Write the value of the final Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
((lambda (x) (+ x x)) 5)
```

Write the value of the final Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
((lambda (x) (+ x x)) 5) => 10
```

Write the value of the final Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
(define x 5)
(define y 6)
(let ((x 7)
      (y x))
  (+ x y))
```

Write the value of the final Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
(define x 5)
(define y 6)
(let ((x 7)
      (y x))
  (+ x y)) => 12
```

Write the value of the final Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
(define x 10)
(define y 20)
(define (foo x)
  (lambda (y) (- x y)))
((foo y) x)
```

Write the value of the final Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
(define x 10)
(define y 20)
(define (foo x)
  (lambda (y) (- x y)))
((foo y) x) => 10
```

Write the value of the final Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
(define (inc x)
  (lambda (y) (+ y 1)))
(inc 1)
```

Write the value of the final Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
(define (inc x)
  (lambda (y) (+ y 1)))
(inc 1) => compound procedure
```

Write the value of this Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
((lambda (x y) (x y))
 (lambda (z)
   (lambda (a)
     (+ a z))) *)
```

Write the value of this Scheme expression. Assume the expressions are evaluated in order. Use **unspecified**, **error**, or **procedure** where appropriate..

```
((lambda (x y) (x y))
 (lambda (z)
   (lambda (a)
     (+ a z))) *)
```

=> compound procedure (note: the procedure will generate an error if evaluated)

What is the time order of growth of the following procedure? You may assume that **x** and **y** are non-negative integers.

```
(define (bar x y)
  (if (< x 0)
      #t
      (bar (+ x 1) (+ y y))))
```

What is the time order of growth of the following procedure? You may assume that **x** and **y** are non-negative integers.

```
(define (bar x y)
  (if (< x 0)
      #t
      (bar (+ x 1) (+ y y))))
=> infinite (bad test
condition)
```

What is the time order of growth of **set-difference**?

```
; set-contains?  : set<A>,A → boolean     Theta(log n)
; set->list      : set<A>   → list<A>     Theta(n)
; list->set      : list<A>  → set<A>      Theta(n log n)
;; Returns the set containing all elements in a that are not in b
(define (set-difference a b)
  (let ((a-list (set->list a)))
    (list->set
      (filter
        (lambda (x)
          (not (set-contains? b x)))
        a-list))))
; example:
(define a (list 1 2 3 4 5))
(define b (list 3 4 5 6))
(set-difference a b); -> (1 2)
```

What is the time order of growth of **set-difference**?

; set-contains? : set<A>,A → boolean   Theta(log n)
; set->list : set<A> → list<A>   Theta(n)
; list->set : list<A> → set<A>   Theta(n log n)
;; Returns the set containing all elements in a that are not in b

```
(define (set-difference a b)
  (let ((a-list (set->list a)))
    (list->set
      (filter
        (lambda (x)
          (not (set-contains? b x)))
        a))))
Time OOG => Theta(n log n)
  Note: n + (n log n) + (n log n)
```

What's the longest time it will take to guess the number?

```
(define (make-adversary number)
  (lambda (x)
    (cond ((< x number) "bigger")
          ((= x number) "found it")
          ((> x number) "smaller"))))

(define (guess-number adversary min max)
  (let* ((mid   (quotient (+ min max) 2))
         (reply (adversary mid)))

    (cond ((equal? reply "smaller" )
           (guess-number adversary min mid))

          ((equal? reply "found it") mid)

          ((equal? reply "bigger"  )
           (guess-number adversary mid max)))))

;; Usage example:
(guess-number (make-adversary 7) 1 100)
```

What's the longest time it will take to guess the number?

```
(define (make-adversary number) ...)

(define (guess-number adversary min max)
  (let* ((mid   (quotient (+ min max) 2))
         (reply (adversary mid)))

    (cond ((equal? reply "smaller" )
           (guess-number adversary min mid))

          ((equal? reply "found it") mid)

          ((equal? reply "bigger"  )
           (guess-number adversary mid max)))))
```

Answer: Theta(log max-min)

Write a procedure, **fold-left**, that works like **fold-right**, but processes elements of the list in left-to-right order and is iterative.

```
(define (fold-right op init lst)
   (if (null? lst)
       init
       (op (car lst)
           (fold-right op init (cdr lst)))))

(define (fold-left op init lst)
  (if (null? lst)
      init
      (fold-left op (op (car lst) init) (cdr lst))))

(fold-right cons '() (list 1 2 3 4 5))
; => (1 2 3 4 5)

(fold-left  cons '() (list 1 2 3 4 5))
; => (5 4 3 2 1)
```

Write a procedure, **fold-left**, that works like **fold-right**, but processes elements of the list in left-to-right order and is iterative.

```
(define (fold-right op init lst)
   (if (null? lst)
       init
       (op (car lst)
           (fold-right op init (cdr lst)))))

(define (fold-left op init lst)
  (if (null? lst)
      init
      (fold-left op
                 (op (car lst) init)
                 (cdr lst))))
```

What is the order-of-growth in time and space for **unknown-costs**?

```
(define (costs-n-n n)
  (if (<= n 0)
      0
      (+ n (costs-n-n (- n 1)))))

(define (costs-n-1 n)
  (if (<= n 0)
      0
      (costs-n-1 (- n 1))))

(define (unknown-costs n)
  (define (helper n1 n2)
    (if (>= n1 (* n2 n2 n2))
        (costs-n-n (costs-n-1 n1))
        (helper (+ n1 2) n2)))
  (helper 1 n))
```

What is the order-of-growth in time and space for **unknown-costs**?

```
(define (costs-n-n n)
  (if (<= n 0)
      0
      (+ n (costs-n-n (- n 1)))))

(define (costs-n-1 n)
  (if (<= n 0)
      0
      (costs-n-1 (- n 1))))

(define (unknown-costs n)
  (define (helper n1 n2)
    (if (>= n1 (* n2 n2 n2))
        (costs-n-n (costs-n-1 n1))
        (helper (+ n1 2) n2)))
  (helper 1 n))
;; OOG time : n^3   (Notes: n^3 + n^3 + 1)
;; OOG space: 1     (Notes: 1 + 1 + 1 – final call to
costs-n-n is passed 0)
```