

# Graphs

a node is:

```
(make-node symbol list-of-symbols)
```

a graph is either

empty

```
(cons node graph)
```

```
(define-struct node (name neighbors))
```

```
(define a-graph
```

```
  (list (make-node 'a (list 'b))
```

```
        (make-node 'b (list 'd 'e))
```

```
        (make-node 'c (list 'e 'f))
```

```
        (make-node 'd (list 'g))
```

```
        (make-node 'e (list 'g))
```

```
        (make-node 'f (list 'g))
```

```
        (make-node 'g empty)))
```

# Graphs

; find-path : graph symbol symbol -> (listof symbol) or false

```
(define (find-path graph origin dest)
  (cond
    [(symbol=? origin dest) (list dest)]
    [else
     (maybe-cons origin
                   (find-path/list
                    graph
                    (neighbors graph origin)
                    dest))]))
```

# Graphs

:: find-path/list : graph (listof symbol) symbol

:: -> (listof symbol) or false

```
(define (find-path/list graph origins dest)
  (cond
    [(empty? origins) false]
    [else
     (pick-one
      (find-path graph
                 (first origins)
                 dest)
      (find-path/list graph
                     (rest origins)
                     dest))]))
```

# Graphs

```
:: neighbors : graph symbol -> (listof symbol)
```

```
(define (neighbors graph s)
  (foldl (lambda (x sofar)
          (cond
            [(symbol=? s (node-name x))
             (node-neighbors x)]
            [else sofar]))
        false
        graph))
```

# Graphs

:: maybe-cons : symbol ((listof symbol) or false)

:: -> list-of-symbol or false

```
(define (maybe-cons a b)
  (cond
    [(boolean? b) b]
    [else (cons a b)]))
```

:: pick-one : ((listof symbol) or false) ((listof symbol) or false)

:: -> (listof symbol) or false

```
(define (pick-one a b)
  (cond
    [(boolean? a) b]
    [else a]))
```

```
(find a-graph 'b 'g) =>
```

```
(find a-graph 'b 'g) => (maybe-cons  
                          'b  
                          (find/list  
                            a-graph  
                            (neighbors  
                              a-graph  
                                'b)  
                              'g))
```

```
<= (maybe-cons  
    'b  
    (find/list  
      a-graph  
      (neighbors  
        a-graph  
        'b)  
      'g))
```



```
(maybe-cons  
  'b  
  (find/list  
    a-graph  
    '(d e)  
    'g))
```

```
<= (maybe-cons  
    'b  
    (find/list  
      a-graph  
      (neighbors  
        a-graph  
        'b)  
        'g))
```

```
(maybe-cons =>  
  'b  
  (find/list  
    a-graph  
    '(d e)  
    'g))
```

```
(maybe-cons  
  'b  
  (find/list  
    a-graph  
    '(d e)  
    'g))
```

```
=> (maybe-cons  
     'b  
     (pick-one  
       (find  
        a-graph  
        'd  
        'g)  
       (find/list  
        a-graph  
        '(e)  
        'g))))
```

```
<= (maybe-cons
    'b
    (pick-one
      (find
        a-graph
        'd
        'g)
      (find/list
        a-graph
        '(e)
        'g)))
```

```
(maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      (find/list
        a-graph
        (neighbors
          a-graph
            'd)
            'g)))
    (find/list
      a-graph
        '(e)
        'g))))
```

```
<= (maybe-cons
  'b
  (pick-one
    (find
      a-graph
        'd
        'g)
    (find/list
      a-graph
        '(e)
        'g))))
```

```
(maybe-cons =>
  'b
  (pick-one
    (maybe-cons
      'd
      (find/list
        a-graph
        (neighbors
          a-graph
            'd)
            'g)))
    (find/list
      a-graph
      '(e)
      'g))))
```

```

(maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      (find/list
        a-graph
        (neighbors
          a-graph
            'd)
          'g)))
    (find/list
      a-graph
        '(e)
        'g))))
=> (maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      (find/list
        a-graph
          '(g)
          'g)))
    (find/list
      a-graph
        '(e)
        'g))))

```

```
<= (maybe-cons
    'b
    (pick-one
      (maybe-cons
        'd
        (find/list
          a-graph
          '(g)
          'g)))
      (find/list
        a-graph
        '(e)
        'g)))
```



```

(maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      (pick-one
        (find
          a-graph
          'g
          'g)
        (find/list
          a-graph
          '()
          'g))))
    (find/list
      a-graph
      '(e)
      '())))

```

```

<= (maybe-cons
    'b
    (pick-one
      (maybe-cons
        'd
        (find/list
          a-graph
          '(g)
          'g)))
      (find/list
        a-graph
        '(e)
        'g))))

```

```
(maybe-cons =>
```

```
'b
```

```
(pick-one
```

```
(maybe-cons
```

```
'd
```

```
(pick-one
```

```
(find
```

```
a-graph
```

```
'g
```

```
'g)
```

```
(find/list
```

```
a-graph
```

```
'()
```

```
'g)))
```

```
(find/list
```

```
a-graph
```

```
'(e)
```

```
'())))
```

```

(maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      (pick-one
        (find
          a-graph
          'g
          'g)
        (find/list
          a-graph
          '()
          'g))))
    (find/list
      a-graph
      '(e)
      'g))))
=> (maybe-cons
     'b
     (pick-one
      (maybe-cons
        'd
        (pick-one
          '(g)
          (find/list
            a-graph
            '()
            'g))))
      (find/list
        a-graph
        '(e)
        'g))))

```

```
<= (maybe-cons
    'b
    (pick-one
      (maybe-cons
        'd
        (pick-one
          '(g)
          (find/list
            a-graph
            '()
            'g))))
    (find/list
      a-graph
      '(e)
      'g)))
```

```
(maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      (pick-one
        '(g)
        false)))
    (find/list
      a-graph
      '(e)
      'g)))
```

```
<= (maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      (pick-one
        '(g)
        (find/list
          a-graph
          '()
          'g))))
    (find/list
      a-graph
      '(e)
      'g)))
```

```
(maybe-cons                               =>
  'b
  (pick-one
    (maybe-cons
      'd
      (pick-one
        '(g)
        false))
    (find/list
      a-graph
      '(e)
      'g)))
```

```
(maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      (pick-one
        '(g)
        false)))
    (find/list
      a-graph
      '(e)
      'g))))

=> (maybe-cons
  'b
  (pick-one
    (maybe-cons
      'd
      '(g))
    (find/list
      a-graph
      '(e)
      'g))))
```

```
<= (maybe-cons
    'b
    (pick-one
      (maybe-cons
        'd
        '(g))
      (find/list
        a-graph
        '(e)
        'g)))
```



```
(maybe-cons
  'b
  (pick-one
    '(d g)
    (find/list
      a-graph
      '(e)
      'g)))
```

```
<= (maybe-cons
    'b
    (pick-one
      (maybe-cons
        'd
        '(g))
      (find/list
        a-graph
        '(e)
        'g)))
```

```
(maybe-cons =>
  'b
  (pick-one
    '(d g)
    (find/list
      a-graph
      '(e)
      'g)))
```

```
(maybe-cons  
  'b  
  (pick-one  
    '(d g)  
    (find/list  
      a-graph  
      '(e)  
      'g)))
```

```
=> (maybe-cons  
    'b  
    (pick-one  
      '(d g)  
      (pick-one  
        (find  
          a-graph  
          'e  
          'g)  
        (find/list  
          a-graph  
          '()  
          'g))))))
```

```
<= (maybe-cons
    'b
    (pick-one
      '(d g)
      (pick-one
        (find
          a-graph
          'e
          'g)
        (find/list
          a-graph
          '()
          'g))))))
```

```

(maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (find/list
          a-graph
          (neighbors
            a-graph
            'e)
            'g)))
      (find/list
        a-graph
        '()
        'g))))))

```

<=

```

(maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      (find
        a-graph
        'e
        'g)
      (find/list
        a-graph
        '()
        'g))))))

```

```
(maybe-cons =>
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (find/list
          a-graph
          (neighbors
            a-graph
              'e)
            'g)))
      (find/list
        a-graph
        '()
        'g))))))
```

```

(maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (find/list
          a-graph
          (neighbors
            a-graph
            'e)
            'g)))
      (find/list
        a-graph
        '()
        'g))))))
=> (maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (find/list
          a-graph
          '(g)
          'g)))
      (find/list
        a-graph
        '()
        'g))))))

```

```
<= (maybe-cons
    'b
    (pick-one
        '(d g)
        (pick-one
            (maybe-cons
                'e
                (find/list
                    a-graph
                    '(g)
                    'g)))
        (find/list
            a-graph
            '()
            'g))))))
```



```

(maybe-cons
 'b
 (pick-one
  '(d g)
  (pick-one
   (maybe-cons
    'e
    (pick-one
     (find
      a-graph
      'g
      'g)
     (find/list
      a-graph
      '()
      'g))))
 (find/list
  a-graph
  '()
  'g))))

```

```

<= (maybe-cons
    'b
    (pick-one
     '(d g)
     (pick-one
      (maybe-cons
       'e
       (find/list
        a-graph
        '(g)
        'g)))
     (find/list
      a-graph
      '()
      'g))))))

```

```
(maybe-cons =>
```

```
'b
```

```
(pick-one
```

```
'(d g)
```

```
(pick-one
```

```
(maybe-cons
```

```
'e
```

```
(pick-one
```

```
(find
```

```
a-graph
```

```
'g
```

```
'g)
```

```
(find/list
```

```
a-graph
```

```
'()
```

```
'g)))
```

```
(find/list
```

```
'
```

```

(maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (pick-one
          (find
            a-graph
            'g
            'g)
          (find/list
            a-graph
            '()
            'g))))
    (find/list
      a-graph
      'g))))
=> (maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (pick-one
          '(g)
          (find/list
            a-graph
            '()
            'g))))
    (find/list
      a-graph
      '()
      'g))))

```

```
<= (maybe-cons
    'b
    (pick-one
        '(d g)
        (pick-one
            (maybe-cons
                'e
                (pick-one
                    '(g)
                    (find/list
                        a-graph
                        '()
                        'g))))
        (find/list
            a-graph
            '()
            'g))))))
```

```
(maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (pick-one
          '(g)
          false))
      (find/list
        a-graph
        '()
        'g))))))
```

```
<= (maybe-cons
    'b
    (pick-one
      '(d g)
      (pick-one
        (maybe-cons
          'e
          (pick-one
            '(g)
            (find/list
              a-graph
              '()
              'g))))
        (find/list
          a-graph
          '()
          'g))))))
```

```
(maybe-cons                               =>
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (pick-one
          '(g)
          false))
      (find/list
        a-graph
        '()
        'g))))))
```

```

(maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      (maybe-cons
        'e
        (pick-one
          '(g)
          false))
      (find/list
        a-graph
        '()
        'g))))))
=> (maybe-cons
    'b
    (pick-one
      '(d g)
      (pick-one
        (maybe-cons
          'e
          '(g))
        (find/list
          a-graph
          '()
          'g))))))

```

```
<= (maybe-cons
    'b
    (pick-one
      '(d g)
      (pick-one
        (maybe-cons
          'e
          '(g))
        (find/list
          a-graph
          '()
          'g))))))
```



```
(maybe-cons
  'b
  (pick-one
    '(d g)
    (pick-one
      '(e g)
      (find/list
        a-graph
        '()
        'g))))))
```

```
<= (maybe-cons
    'b
    (pick-one
      '(d g)
      (pick-one
        (maybe-cons
          'e
          '(g))
        (find/list
          a-graph
          '()
          'g))))))
```

```
(maybe-cons =>
  'b
  (pick-one
    '(d g)
    (pick-one
      '(e g)
      (find/list
        a-graph
        '()
        'g))))))
```

```
(maybe-cons  
  'b  
  (pick-one  
    '(d g)  
    (pick-one  
      '(e g)  
      (find/list  
        a-graph  
        '()  
        'g))))))
```

```
=> (maybe-cons  
     'b  
     (pick-one  
       '(d g)  
       (pick-one  
         '(e g)  
         false))))
```

```
<= (maybe-cons
    'b
    (pick-one
      '(d g)
      (pick-one
        '(e g)
        false)))
```

```
(maybe-cons  
  'b  
  (pick-one  
    '(d g)  
    '(e g)))
```

```
<= (maybe-cons  
    'b  
    (pick-one  
      '(d g)  
      (pick-one  
        '(e g)  
        false)))
```

```
(maybe-cons =>  
  'b  
  (pick-one  
    '(d g)  
    '(e g)))
```

```
(maybe-cons  
  'b  
  (pick-one  
    '(d g)  
    '(e g))) => (maybe-cons 'b '(d g))
```

```
<= (maybe-cons 'b '(d g))
```



' (b d g)

<= (maybe-cons 'b '(d g))

```
(find a-graph 'd 'e) =>
```

```
(find a-graph 'd 'e) => (maybe-cons  
                          'd  
                          (find/list  
                            a-graph  
                            (neighbors  
                              a-graph  
                                'd)  
                                'e)))
```

```
<= (maybe-cons  
    'd  
    (find/list  
      a-graph  
      (neighbors  
        a-graph  
        'd)  
      'e))
```

```
(maybe-cons  
  'd  
  (find/list  
    a-graph  
    '(g)  
    'e))
```

```
<= (maybe-cons  
    'd  
    (find/list  
      a-graph  
      (neighbors  
        a-graph  
        'd)  
        'e))
```

```
(maybe-cons =>  
  'd  
  (find/list  
    a-graph  
    '(g)  
    'e))
```

```
(maybe-cons  
  'd  
  (find/list  
    a-graph  
    '(g)  
    'e))
```

```
=> (maybe-cons  
    'd  
    (pick-one  
      (find  
        a-graph  
        'g  
        'e)  
      (find/list  
        a-graph  
        '()  
        'e))))
```

```
<= (maybe-cons
    'd
    (pick-one
      (find
        a-graph
        'g
        'e)
      (find/list
        a-graph
        '()
        'e)))
```



```
(maybe-cons
 'd
 (pick-one
  (maybe-cons
   'g
   (find/list
    a-graph
    (neighbors
     a-graph
     'g)
    'e)))
 (find/list
  a-graph
  '()
  'e)))
```

```
<= (maybe-cons
 'd
 (pick-one
  (find
   a-graph
   'g
   'e)
 (find/list
  a-graph
  '()
  'e))))
```

```
(maybe-cons =>
  'd
  (pick-one
    (maybe-cons
      'g
      (find/list
        a-graph
        (neighbors
          a-graph
            'g)
          'e)))
    (find/list
      a-graph
      '()
      'e))))
```

```

(maybe-cons
  'd
  (pick-one
    (maybe-cons
      'g
      (find/list
        a-graph
        (neighbors
          a-graph
          'g)
          'e)))
    (find/list
      a-graph
      '()
      'e))))
=> (maybe-cons
    'd
    (pick-one
      (maybe-cons
        'g
        (find/list
          a-graph
          '()
          'e)))
      (find/list
        a-graph
        '()
        'e))))

```

```
<= (maybe-cons
    'd
    (pick-one
      (maybe-cons
        'g
        (find/list
          a-graph
          '()
          'e))
      (find/list
        a-graph
        '()
        'e))))
```

```
(maybe-cons
 'd
 (pick-one
  (maybe-cons
   'g
   false)
  (find/list
   a-graph
   '()
   'e)))
```

```
<= (maybe-cons
 'd
 (pick-one
  (maybe-cons
   'g
   (find/list
    a-graph
    '()
    'e))
  (find/list
   a-graph
   '()
   'e)))
```

```
(maybe-cons                               =>
  'd
  (pick-one
    (maybe-cons
      'g
      false)
    (find/list
      a-graph
      '()
      'e)))
```

```
(maybe-cons  
  'd  
  (pick-one  
    (maybe-cons  
      'g  
      false)  
    (find/list  
      a-graph  
      '()  
      'e)))  
=> (maybe-cons  
    'd  
    (pick-one  
      false  
      (find/list  
        a-graph  
        '()  
        'e))))
```

```
<= (maybe-cons  
    'd  
    (pick-one  
      false  
      (find/list  
        a-graph  
        '()  
        'e)))
```



```
(maybe-cons  
  'd  
  (pick-one  
    false  
    false))
```

```
<= (maybe-cons  
    'd  
    (pick-one  
      false  
      (find/list  
        a-graph  
        '()  
        'e)))
```

```
(maybe-cons =>  
  'd  
  (pick-one  
    false  
    false))
```

```
(maybe-cons  
  'd  
  (pick-one  
    false  
    false)) => (maybe-cons 'd false)
```

```
<= (maybe-cons 'd false)
```

false

<= (maybe-cons 'd false)