10.Elementary data structures

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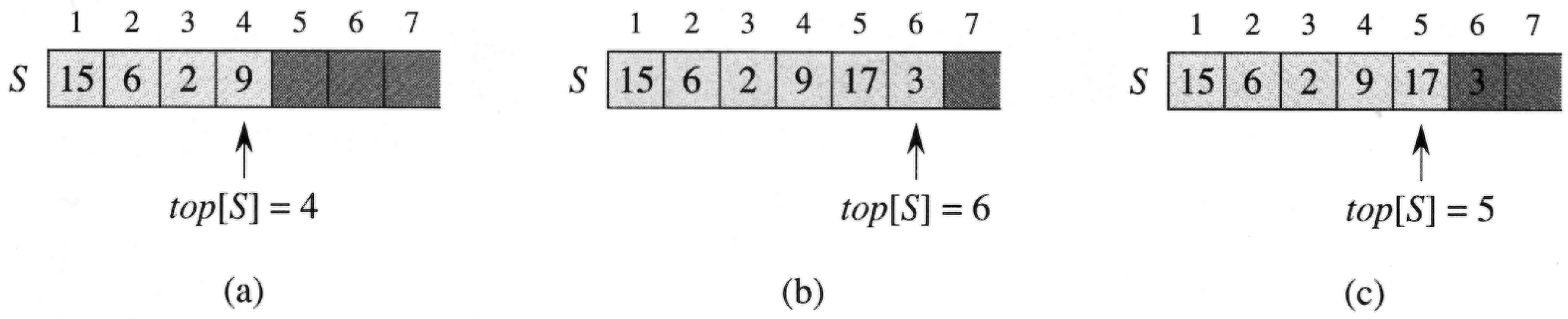
10.1 Stacks and queues

Stacks and queues are dynamic set in which element removed from the set by the DELETE operation is prespecified. In a **stack** the element deleted from the set is the one most recently inserted; the stack implements a ***last-in, first-out***, or **LIFO**, policy. Similarly, in a **queue**, the element deleted is implements a ***first-in, first-out***, or **FIFO**, policy.

An array implementation of a stack S



- empty, underflows, overflows

STACK_EMPTY(S)

```
if top[S] = 0
    then return TRUE
    else return FALSE
```

PUSH(S,x)

$top[S] \leftarrow top[S]+1$

$S[top[S]] \leftarrow x$

POP(S)

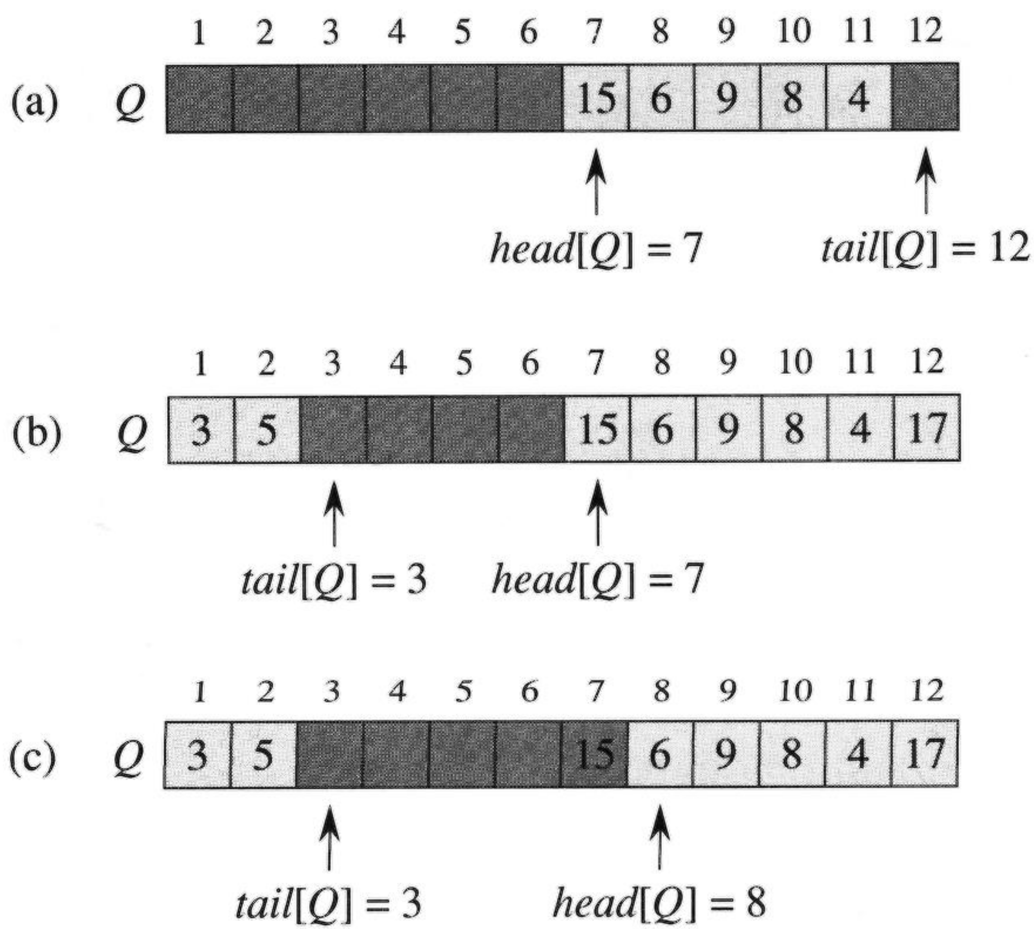
if STACK-EMPTY(S)

  then error "underflow"

  else $top[S] \leftarrow top[s] -1$

    return $S[top[S] + 1]$

An array implementation of a queue Q



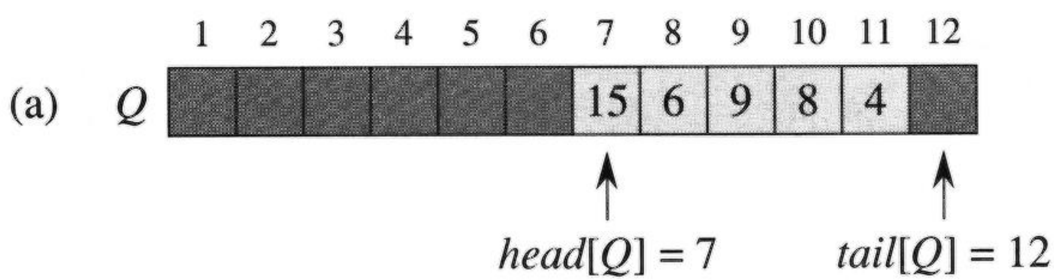
ENQUEUE(*Q,S*)

$Q[tail[Q]] \leftarrow x$

if $tail[Q] = length[Q]$

  then $tail[Q] \leftarrow 1$

  else $tail[Q] \leftarrow tail[Q]+1$



DEQUEUE(Q)

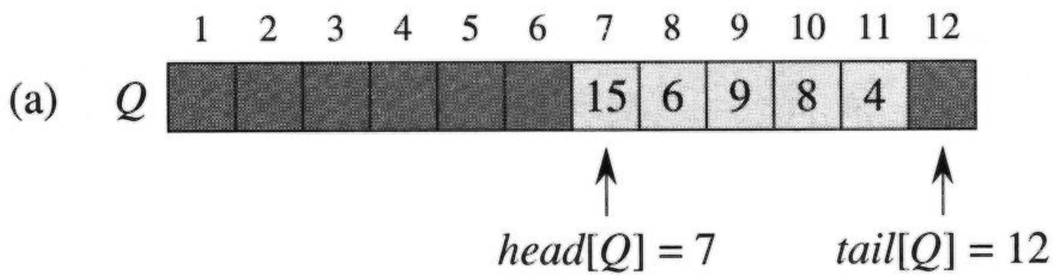
$x \leftarrow Q[head[Q]]$

if $head[Q] = length[Q]$

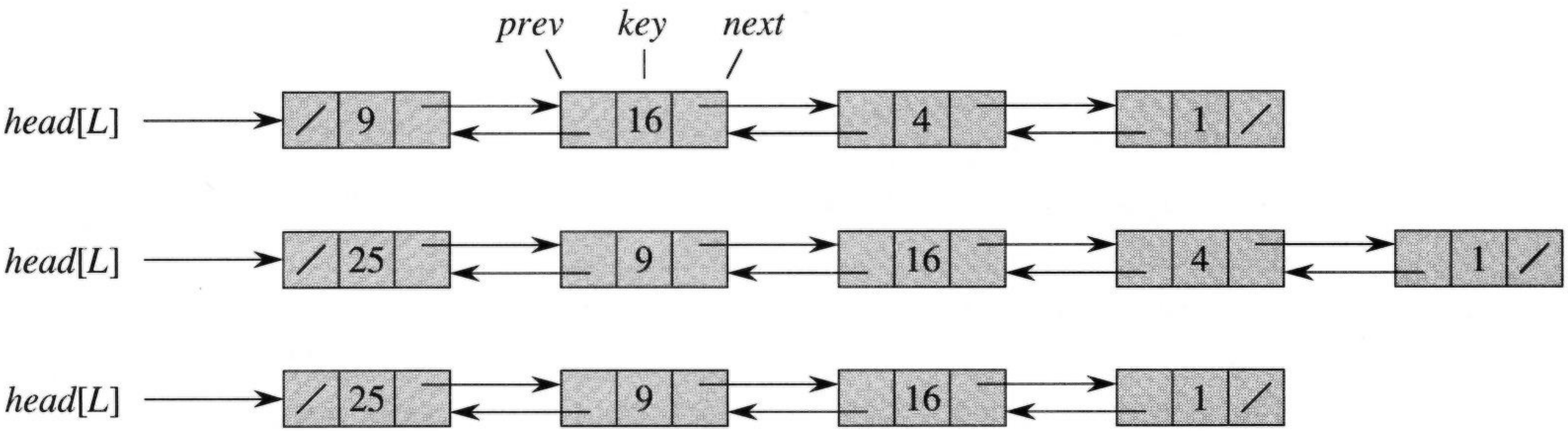
  then $head[Q] \leftarrow 1$

  else $head[Q] \leftarrow head[Q] + 1$

return x



10.2 Linked lists



LIST_SEARCH(L,k)

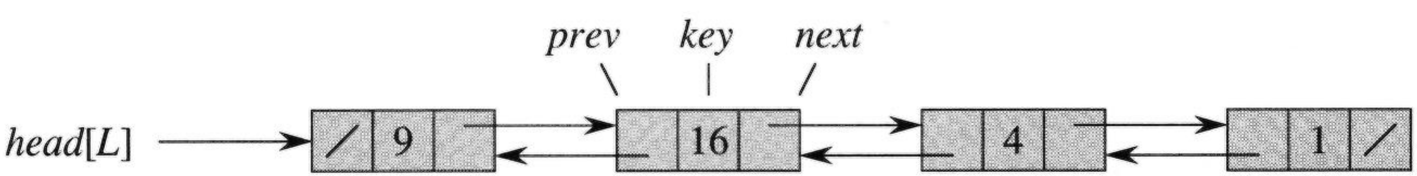
$x \leftarrow head[L]$

while $x \neq \text{NIL}$ and $key[x] \neq k$

    do $x \leftarrow next[x]$

return x

$$O(n)$$



LIST_INSERT(L,x) at front

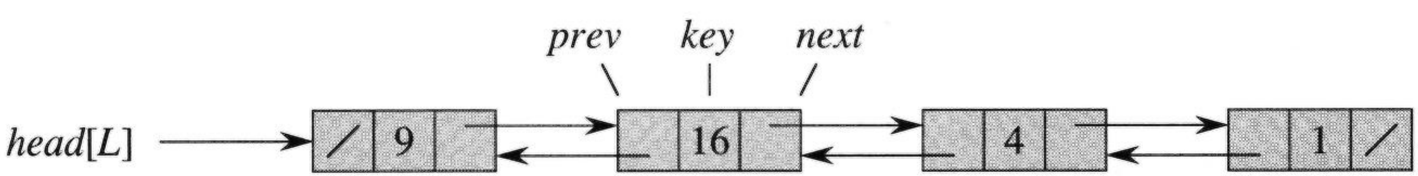
$next[x] \leftarrow head[L]$

if $head[L] \neq \text{NIL}$

  then $prev[head[L]] \leftarrow x$

$head[L] \leftarrow x$

$prev[x] \leftarrow \text{NIL}$

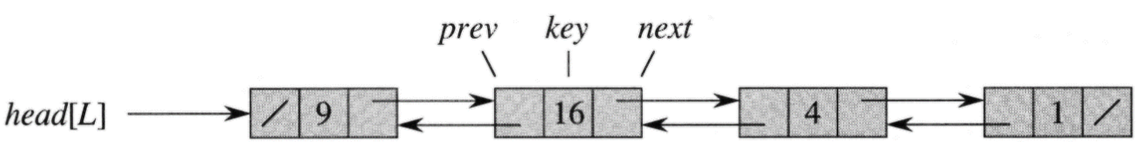


$O(1)$

LIST_DELETE(L,x)

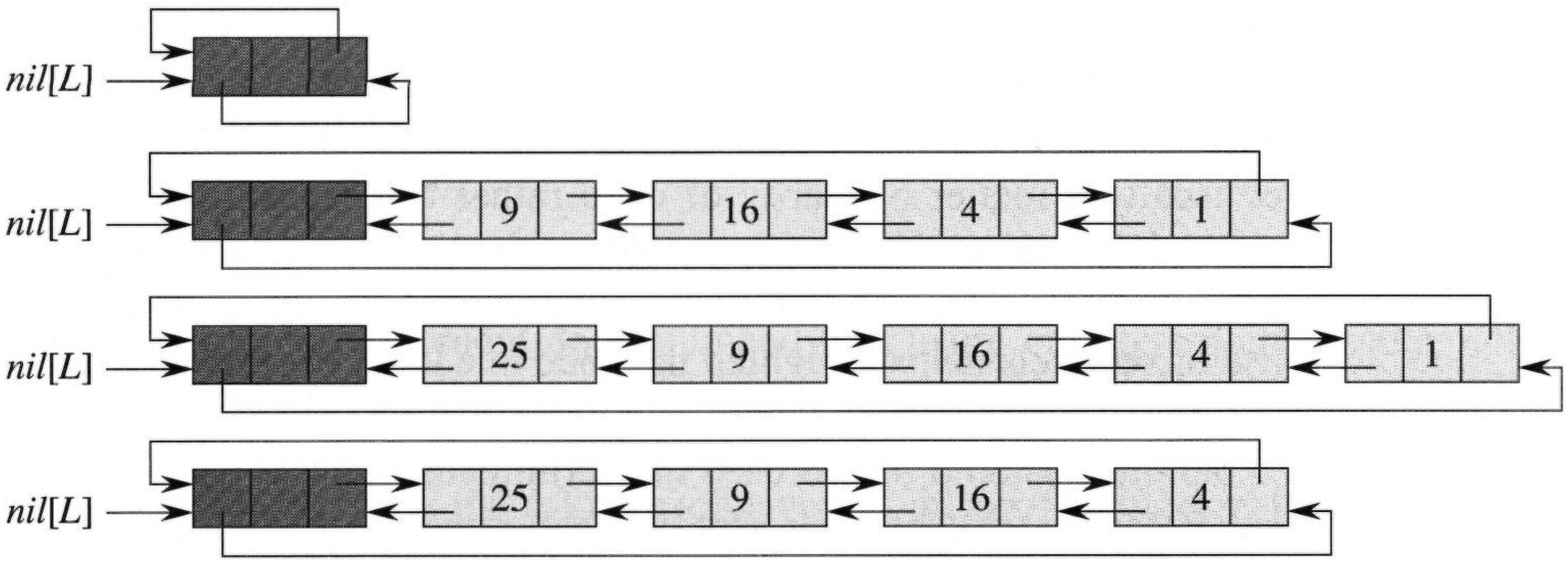
- (Call LIST_SEARCH first O(n))

if $prev[x] \neq$ NIL
  then $next[prev[x]] \leftarrow next[x]$
  else $head[L] \leftarrow next[x]$
if $next[x] \neq$ NIL
then $prev[next[x]] \leftarrow prev[x]$



$O(1)$ or $O(n)$

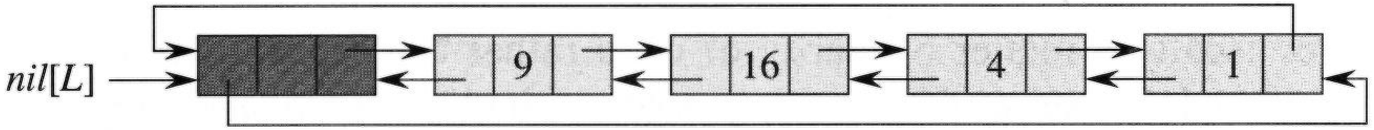
A Sentinel is a dummy object that allows us to simplify boundary conditions,



LIST_DELETE'(L,x)

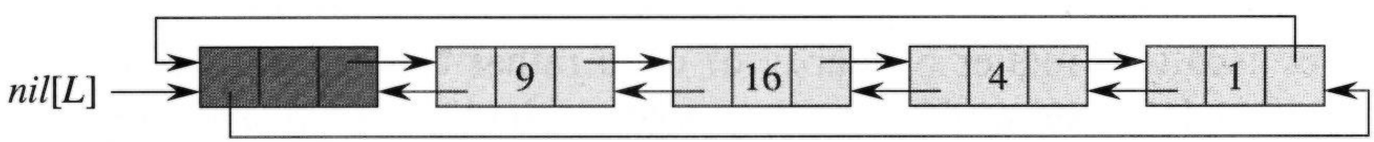
1 $next[prev[x]] \leftarrow \mathrm{next}[x]$

2 $prev[next[x]] \leftarrow \mathrm{prev}[x]$



LIST_SEARCH'(L,k)

$x \leftarrow next[nil[L]]$
while $x \neq nil[L]$ and $key[x] \neq k$
    do $x \leftarrow next[x]$
return x



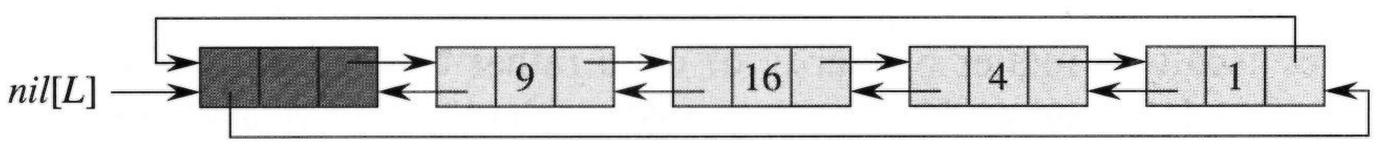
LIST_INSERT'(L,x)

$next[x] \leftarrow next[nil[L]]$

$prev[next[nil[L]]] \leftarrow x$

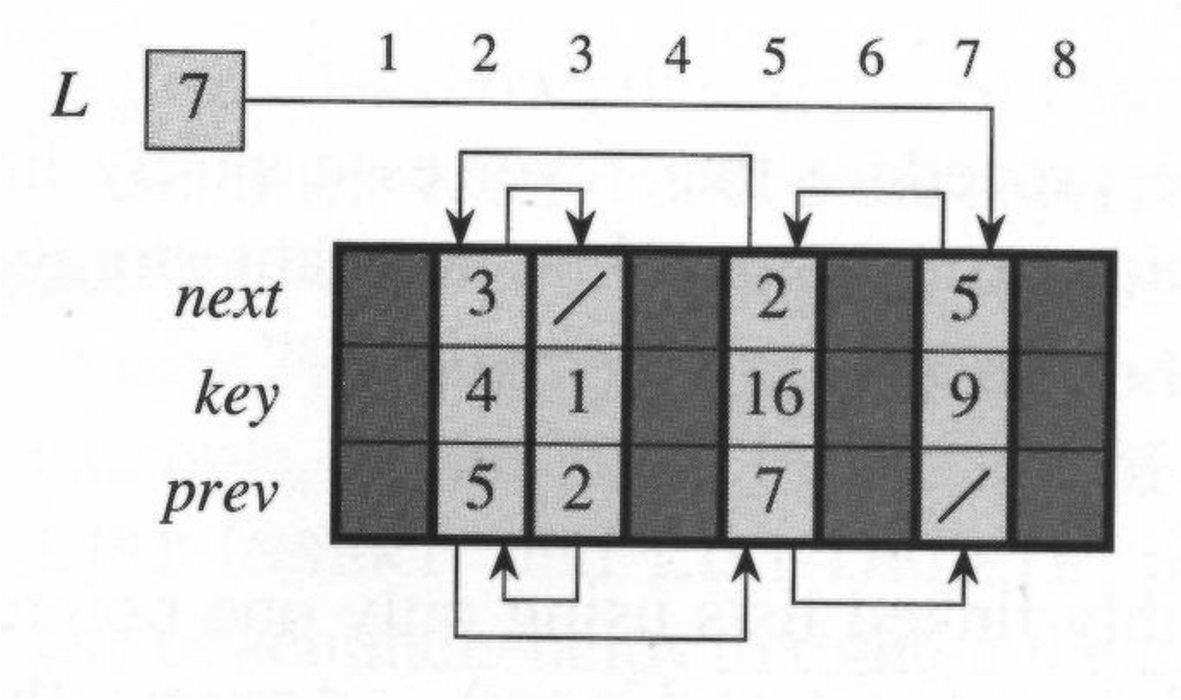
$next[nil[L]] \leftarrow x$

$prev[x] \leftarrow nil[L]$

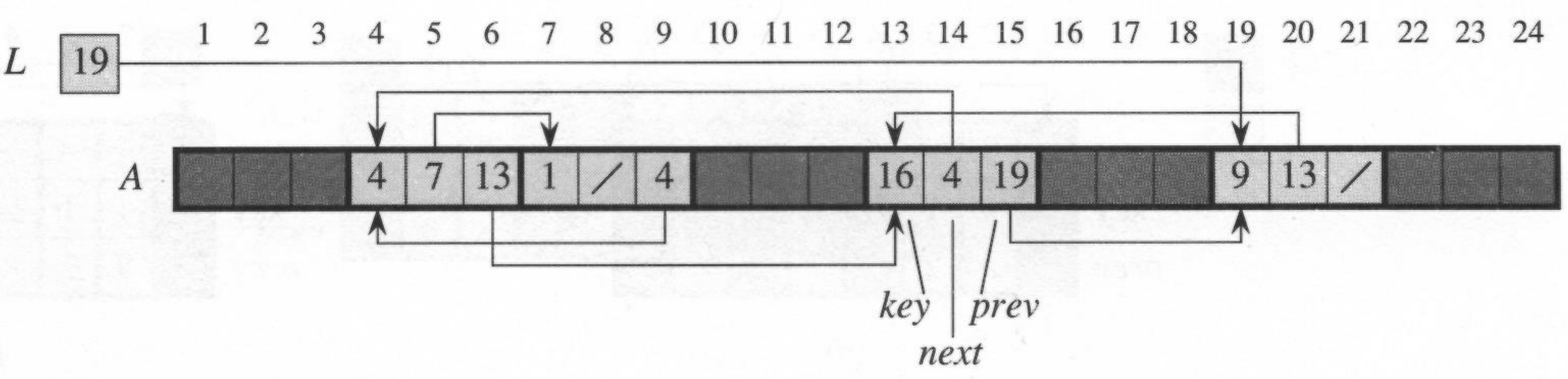


11.3 Implementing pointers and objects

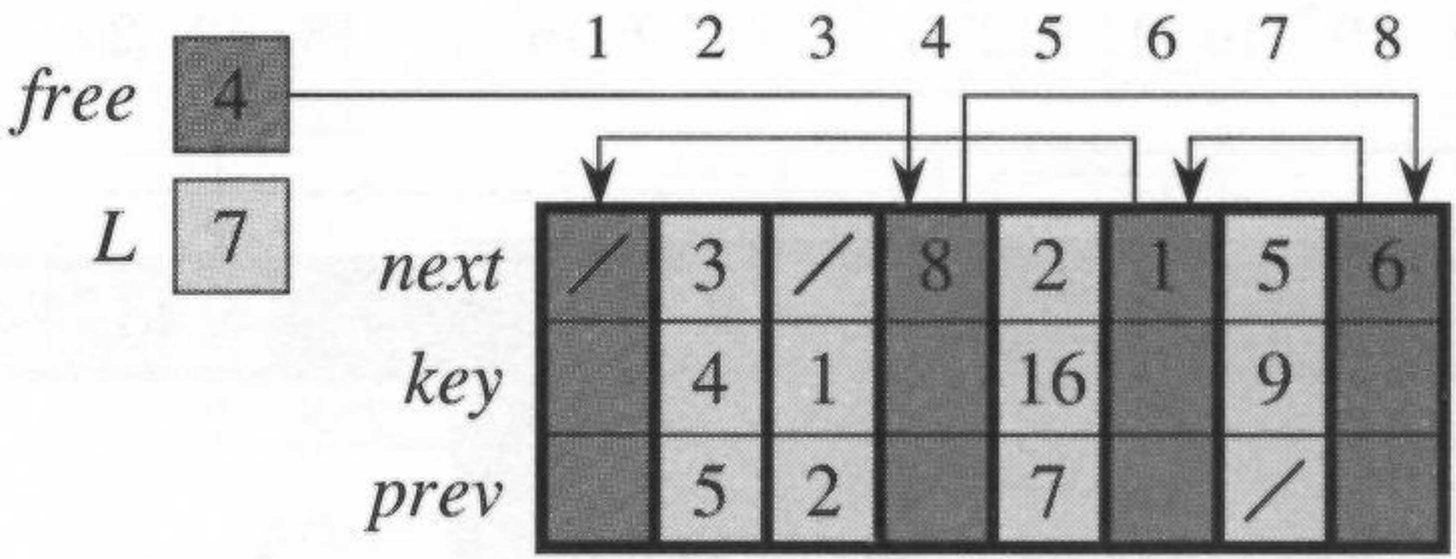
- A multiple-array representation of objects



A single array representation of objects

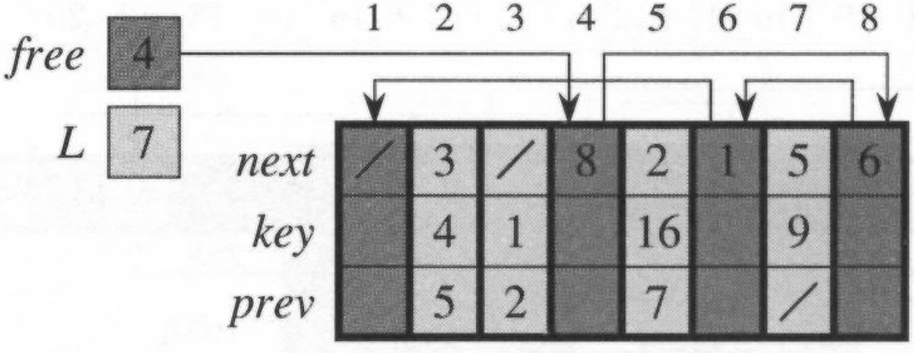


Allocating and freeing objects--garbage collector

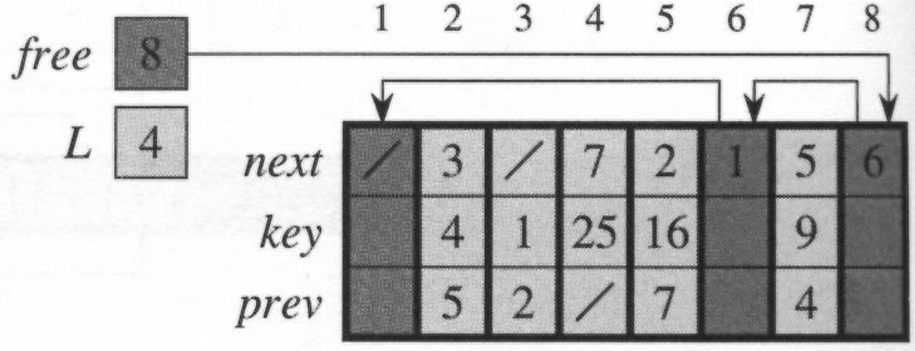


(a)

Allocate_object( ),LIST_INSERT(L,4),Key(4)=25



(a)



(b)

ALLOCATE_OBJECT( )

if *free* = NIL

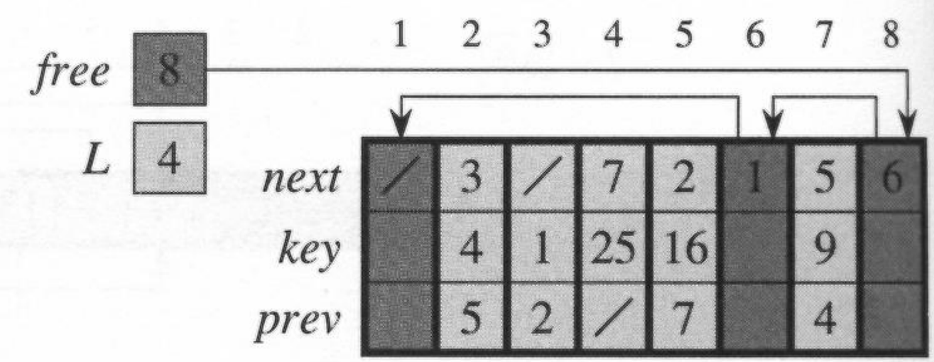
    then error “out of space”

    else $x \leftarrow$ *free*

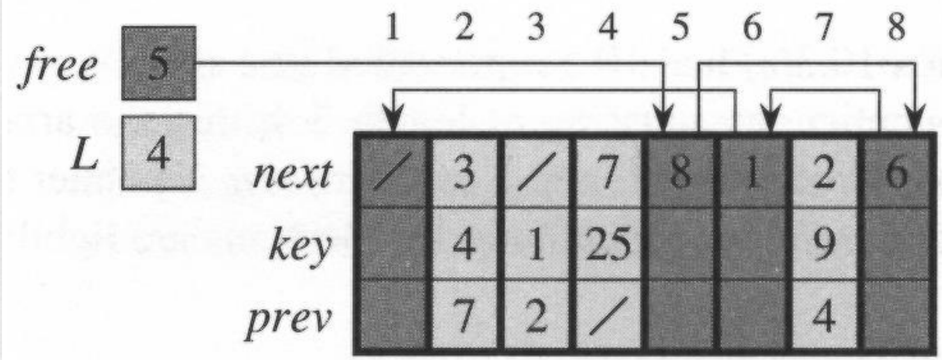
        free $\leftarrow$ *next*$[x]$

        return x

LIST_DELETE(*L*,5), FREE_OBJECT(5)



(b)



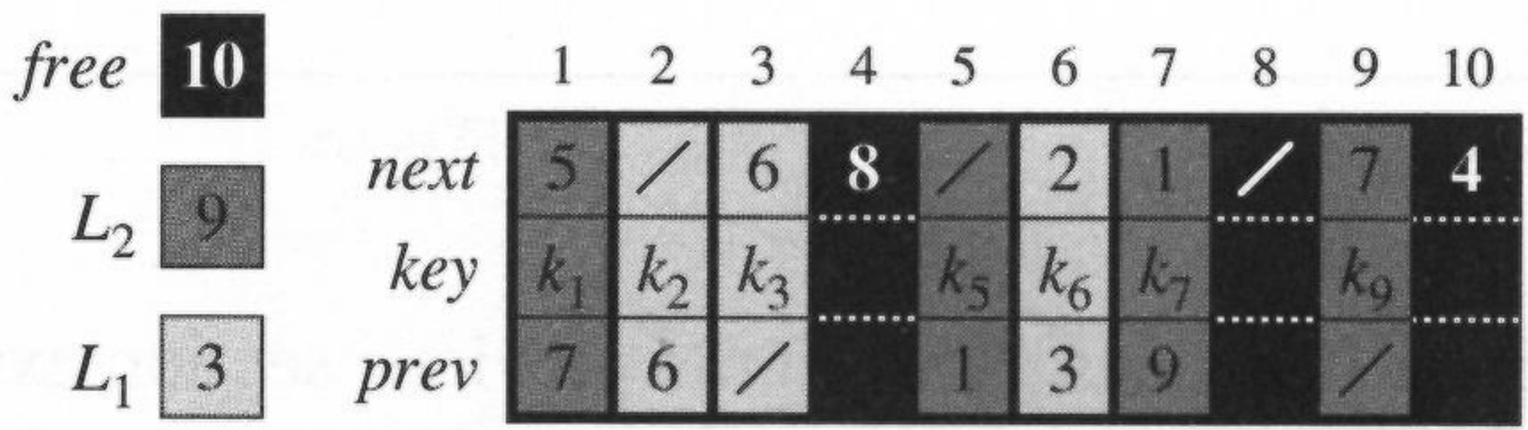
(c)

FREE_OBJECT(x)

$next[x] \leftarrow free$

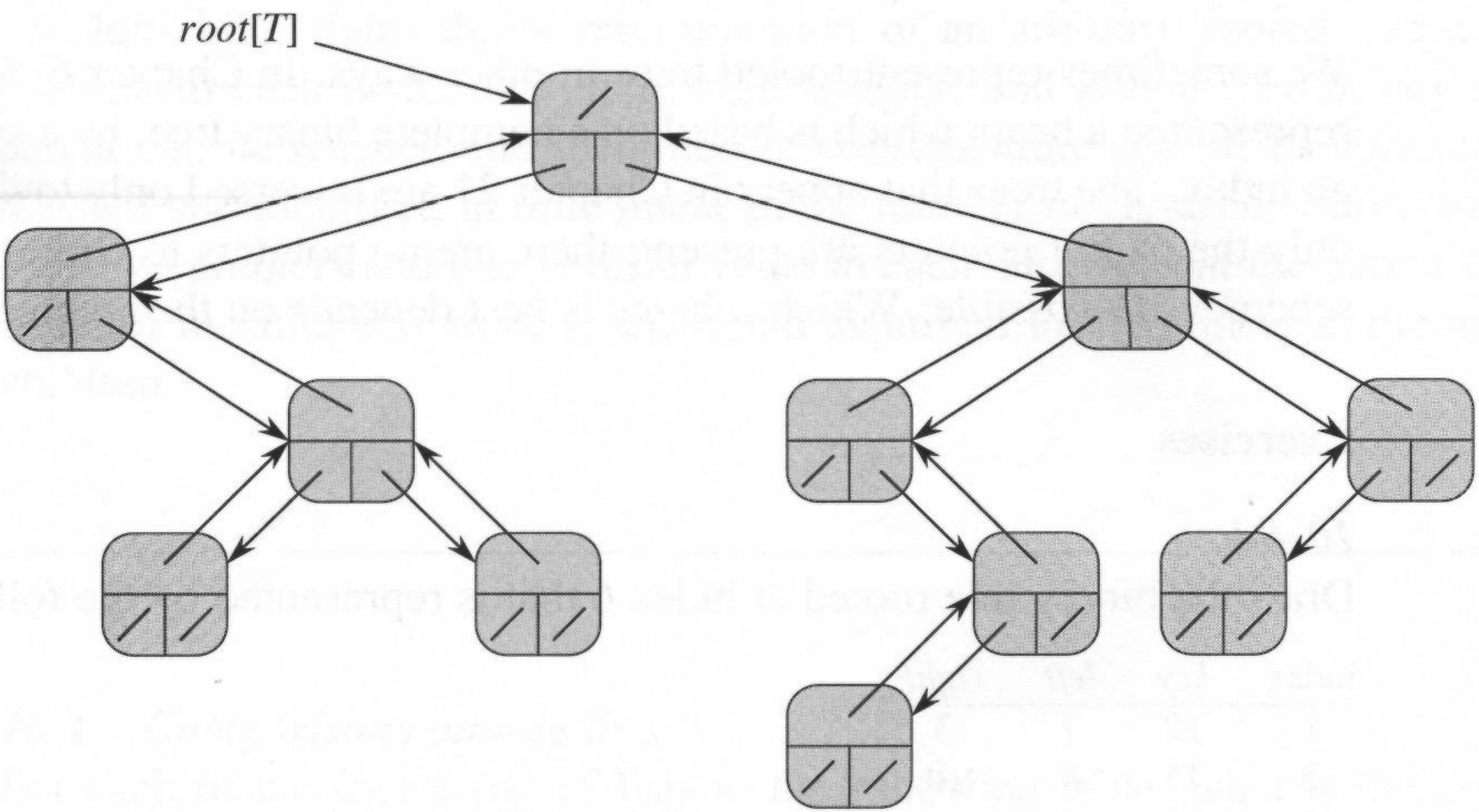
$free \leftarrow x$

Two link lists



10.4 Representing rooted trees

Binary trees



Rooted tree with unbounded branching