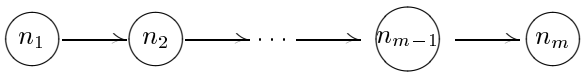
Implementation of a stack with a singly linked list without dummy nodes

Variables

size: integer
stack: singly linked list, each node of which contains an element of the stack



top: pointer to node
invariant: the nodes $n_1, \ldots, n_m$ of *stack* contain the elements of the stack listed from top to bottom. *size* is the size of the stack. *top* points to n_1 if this nodes exists, and points to nothing otherwise.

Initialization

size $\leftarrow 0$
stack $\leftarrow$ empty linked list
top points to nothing

Algorithms

size():
  output: size of stack
return *size*

isEmpty():
  output: stack is empty?
return (*size* $= 0$)

top():
  precondition: stack is nonempty
  output: top element of stack
return element of the first node of *stack*

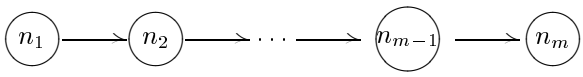
push(*element*):
  postcondition: *element* has been added onto top of stack
  input: *element* to be added to stack
node $\leftarrow$ new node containing *element*
if *stack* is empty **then**
    stack $\leftarrow$ list consisting of *node*
else
    add *node* at the beginning of *stack*
top points to *node*
size $\leftarrow$ *size* $+ 1$

pop():
  precondition: stack is nonempty
  postcondition: top element has been removed from stack
  output: top element of stack
temp $\leftarrow$ element of first node of *stack*
remove first node from *stack*
if *stack* is empty **then**
    top points to nothing
else
    top points to first node of *stack*
size $\leftarrow$ *size* $- 1$
return *temp*

Implementation of a queue with a singly linked list without dummy nodes

Variables

size: integer
queue: singly linked list, each node of which contains an element of the queue



head: pointer to node
tail: pointer to node
invariant: the nodes $n_1, \ldots, n_m$ of *queue* contain the elements of the queue listed from front to rear. *size* is the size of the queue. *head* points to n_1 and *tail* points to n_m if these nodes exist, and point to nothing otherwise.

Initialization

size $\leftarrow 0$
queue $\leftarrow$ empty linked list
head points to nothing
tail points to nothing

Algorithms

size():
  output: size of queue
return *size*

isEmpty():
  output: queue is empty?
return $(size = 0)$

front():
  precondition: queue is nonempty
  output: front element of stack
return element of the first node of *queue*

enqueue(*element*):
  postcondition: *element* has been added to rear of queue
  input: *element* to be added to queue
node $\leftarrow$ new node containing *element*
if *queue* is empty **then**
    queue $\leftarrow$ list consisting of *node*
    head and *tail* point to *node*
else
    add *node* at the end of *queue*
    tail points to *node*
size $\leftarrow$ *size* + 1

dequeue():
  precondition: queue is nonempty
  postcondition: front element has been removed from queue
  output: front element of queue
temp $\leftarrow$ element of first node of *queue*
remove first node from *queue*
if *queue* is empty **then**
    head and *tail* point to nothing

else
    head points to first node of *queue*
size $\leftarrow$ *size* $-$ 1
return *temp*

Implementation of a queue with a singly linked list with dummy nodes

Variables

size: integer
queue: singly linked list with all nodes, except for the first and the last one, containing an element of the queue

$$n_0 \longrightarrow n_1 \longrightarrow \cdots \longrightarrow n_m \longrightarrow n_{m+1}$$

head: pointer to node
tail: pointer to node
invariant: the nodes $n_1, \ldots, n_m$ of *queue* contain the elements of the queue listed from front to rear. *size* is the size of the queue. *head* points to n_0 and *tail* points to n_{m+1}.

Initialization

size $\leftarrow$ 0
queue $\leftarrow$ $n_0 \longrightarrow n_1$
head points to n_0
tail points to n_1

Algorithms

size():
  output: size of queue
return *size*

isEmpty():
  output: queue is empty?
return (*size* = 0)

front():
  precondition: queue is nonempty
  output: front element of stack
return element of the second node of *queue*

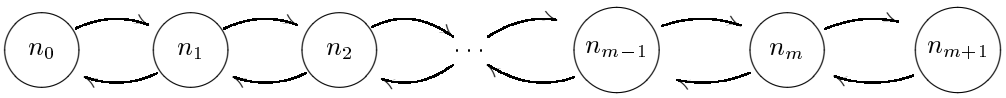
enqueue(*element*):
  postcondition: *element* has been added to rear of queue
  input: *element* to be added to queue
store *element* in the last node of *queue*
add a new dummy node to the end of *queue*
tail points to new node
size $\leftarrow$ *size* + 1

dequeue():
  precondition: queue is nonempty
  postcondition: front element has been removed from queue
  output: front element of queue
temp $\leftarrow$ element of second node of *queue*
remove second node from *queue*
size $\leftarrow$ *size* $-$ 1
return *temp*

Implementation of a deque with a doubly linked list with dummy nodes

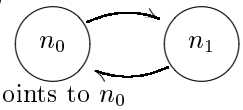
Variables

size: integer
deque: doubly linked list with dummy nodes at the front and the rear; each node, apart from the dummy nodes n_0 and n_{m+1}, contains an element of the deque



header: pointer to node
trailer: pointer to node
invariant: the nodes $n_1, \ldots, n_m$ of *deque* contain the elements of the deque listed from front to rear. *size* is the size of the deque. *header* points to n_0 and *trailer* points to n_{m+1}.

Initialization

$size \leftarrow 0$
$deque \leftarrow$ 

header points to n_0
trailer points to n_1

Algorithms

size()
  output: size of deque
return *size*

isEmpty()
  output: deque is empty?
return $(size = 0)$

first()
  precondition: deque is nonempty
  output: element at the front of deque
return element of second node of *deque*

last()
  precondition: deque is nonempty
  output: element at the rear of deque
return element of one but last node of *deque*

insertFirst(*element*)
  postcondition: *element* has been added to the front of deque
  input: element to be added to deque
add new node with element *element* in between *header* and the second node of *deque*
$size \leftarrow size + 1$

insertLast(*element*)
  postcondition: *element* has been added at the rear of *deque*
  input: element to be added to deque
add new node with element *element* in between *trailer* and the one but last node of *deque*
$size \leftarrow size + 1$

removeFirst()
  precondition: deque is nonempty

postcondition: first element has been removed from deque
output: first element of deque
temp ← element of second node of *deque*
remove second node from *deque*
size ← *size* − 1
return *temp*

removeLast()
precondition: deque is nonempty
postcondition: last element has been removed from deque
output: last element of deque
temp ← element of one but last node of *deque*
remove one but last node from *deque*
size ← *size* − 1
return *temp*