10.1-5.

Whereas a stack allows insertion an deletion of elements at only one end, and a queue allows insertion at one end and deletion at the other end, a ***deque*** (double-ended queue) allows insertion and deletion at both ends. Write four $O(1)$-time procedures to insert elements into and delete elements from both ends of a deque implemented by an array.

Answer.

In our procedures LEFT-ENQUEUE, RIGHT-ENQUEUE, LEFT-DEQUEUE and RIGHT-DEQUEUE, we have included the error checking for underflow and overflow. The auxiliary procedures QUEUE-EMPTY and QUEUE-FULL are implemented in the solution to Exercise 10.1-4.

```
LEFT-ENQUEUE(Q, x)
1   if QUEUE-FULL(Q)
2       error "overflow"
3   else
4       if Q.head == 1
5           Q.head = Q.length
6       else Q.head = Q.head − 1
7       Q.head = x
```

```
RIGHT-ENQUEUE(Q, x)
1   if QUEUE-FULL(Q)
2       error "overflow"
3   else
4       Q[Q.tail] = x
5       if Q.tail == Q.length
6           Q.tail = 1
7       else Q.tail = Q.tail + 1
```

```
LEFT-DEQUEUE(Q)
1   if QUEUE-EMPTY(Q)
2       error "underflow"
3   else
4       x = Q[Q.head]
5       if Q.head == Q.length
6           Q.head = 1
7       else Q.head = Q.head + 1
8       return x
```

```
RIGHT-DEQUEUE(Q)
1   if QUEUE-EMPTY(Q)
2       error "underflow"
3   else
4       x = Q[Q.tail]
5       if Q.tail == 1
6           Q.tail = Q.length
7       else Q.tail = Q.tail − 1
8       return x
```

*. Creative Commons  2014, Lawrence X. Amlord (颜世敏, aka 颜 序).
Email address: informlarry@gmail.com