Data Structures and Algorithms

XMUT–COMP 103 – 2026 T1

Queues

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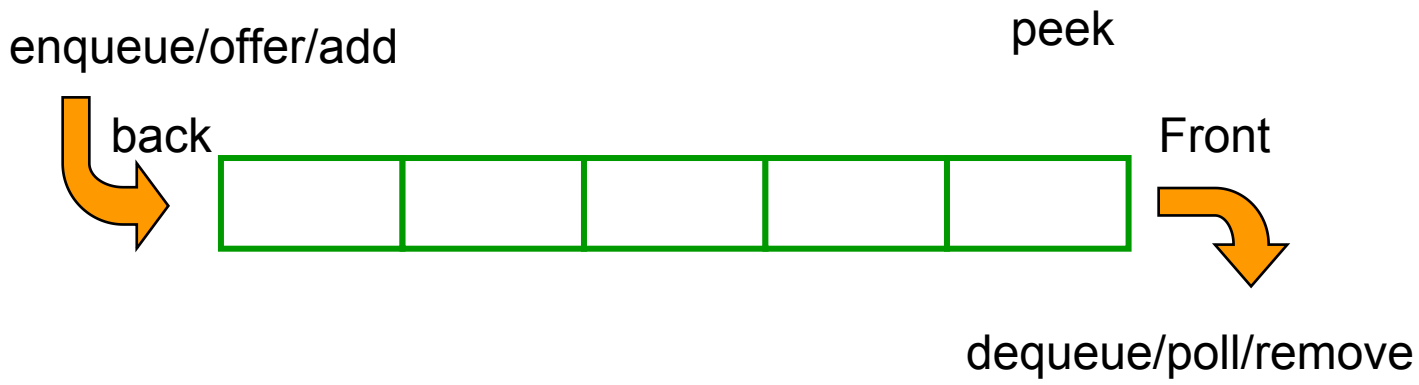
Queues

- Collection of items in order
  - like Lists and Stacks



- Main operations:
  - enqueue: put item on the queue
  - dequeue: remove item from front of the queue

- These operations should be efficient.
  - Shouldn't get much more expensive if the queue is very large

- A Queue is a Collection:
  - THEREFORE: other operations — contains(…), remove(…), etc — also work

    BUT, they are not efficient.

Queue operations

- isEmpty(),
- size(),
- clear()

- offer(E item) enqueue
- add(E item) enqueue

- poll() → E dequeue (returns null if queue is empty)
- remove() → E dequeue (throws exception if queue is empty)

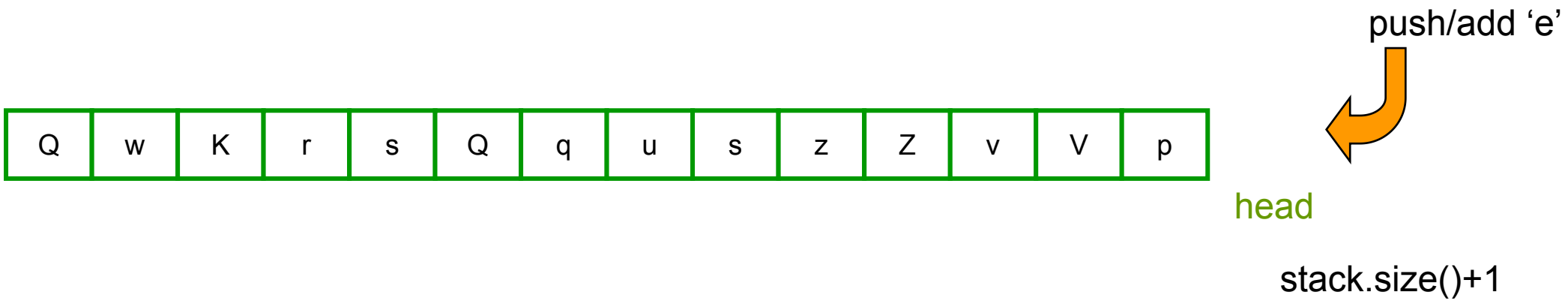
- peek() → E look at front (returns null if queue is empty)
- element() → E look at front (throws exception if queue empty)

Queues and efficiency

- The main operators of queues should be efficient.
  - the time it take to do them should be fast
  - especially important when they grow in size <= a constant speed is needed!
- Let's investigate how stacks can be implemented efficiently.

Stacks and efficiency

- You can use an ArrayList to implement a Stack (LIFO) efficiently:



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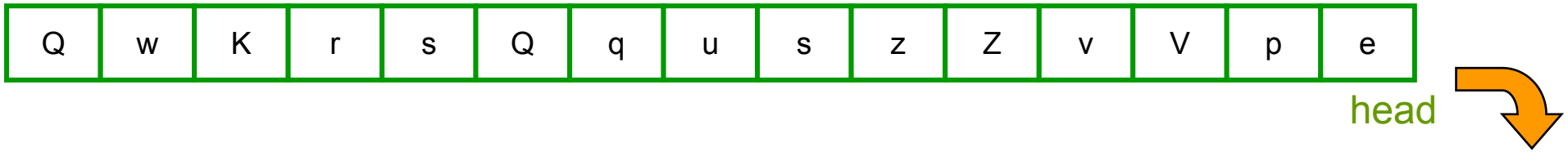
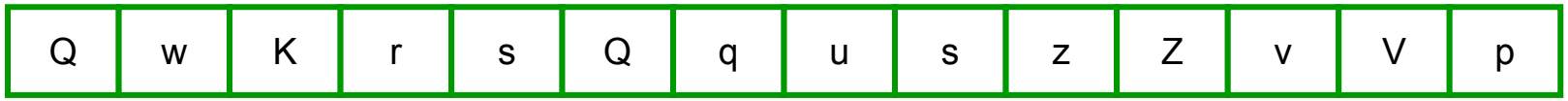


- No changes to the stack other than an 'e' was added at the end.

Stacks and efficiency

- You can use an ArrayList to implement a Stack (LIFO) efficiently:



pop/remove
returns ‘e’
stack size -1

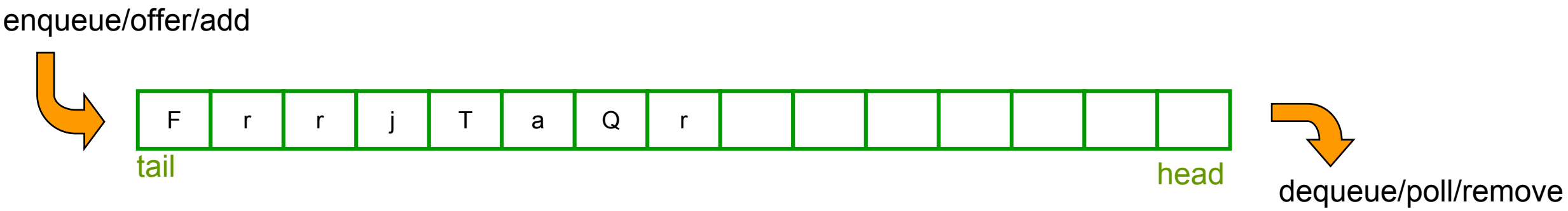
- Again only the end changes, nothing else
- push and pop at the end! O(1)

- Stacks are naturally efficient with an ArrayList!

Queues and efficiency

- What about a Queue (FIFO) ?

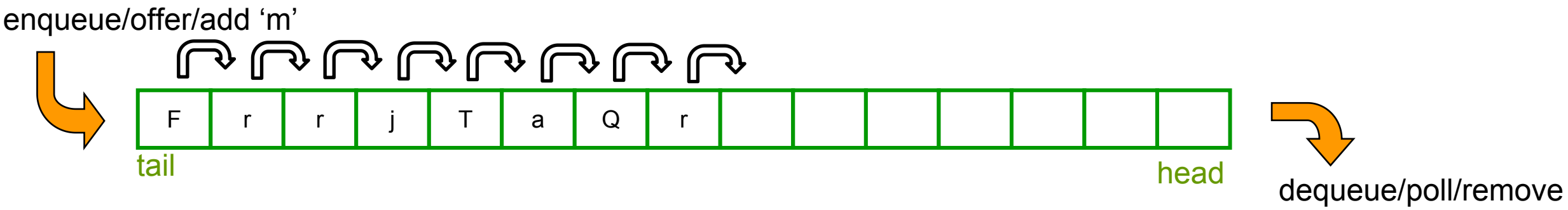
- Dequeue works like a stack, so is fast: O(1)



Queues and efficiency

- What about a Queue (FIFO) ?

- Dequeue works like a stack, so is fast: O(1)
- Enqueue requires shifting every item up one place to add
  - It "costs" the current length (n) to move: O(n)



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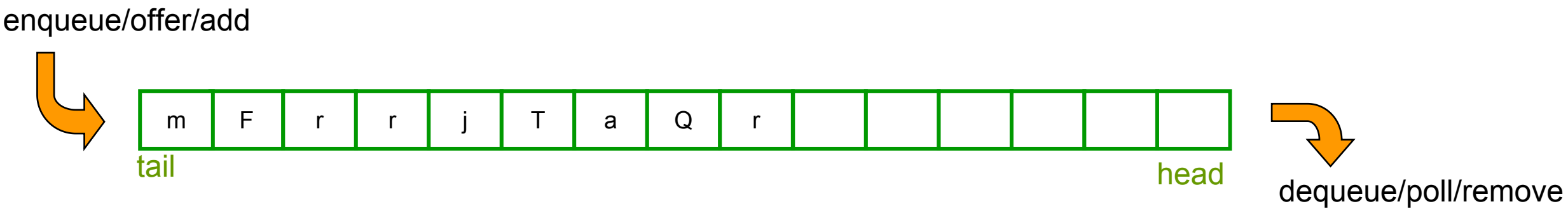
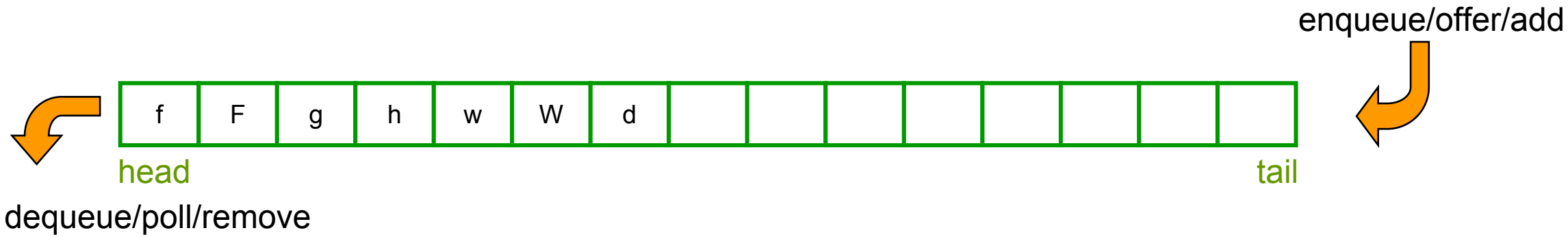


Queues and efficiency

- What about a Queue, The other way round?



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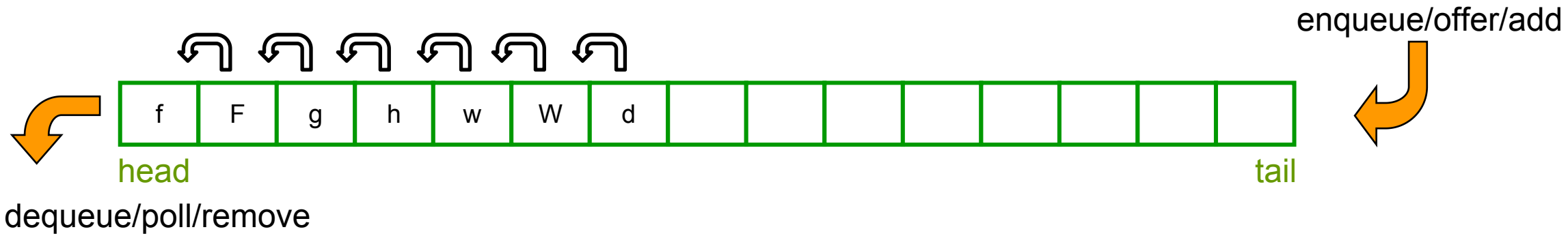

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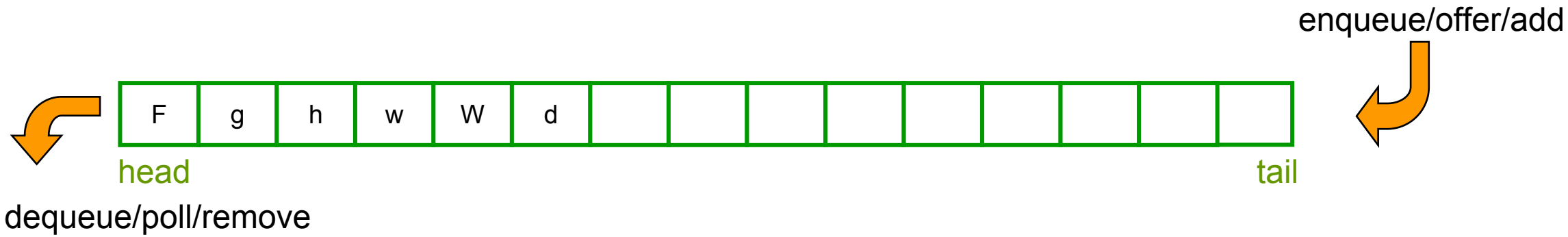

- Enqueue is like push on a stack, so it is fast: O(1)
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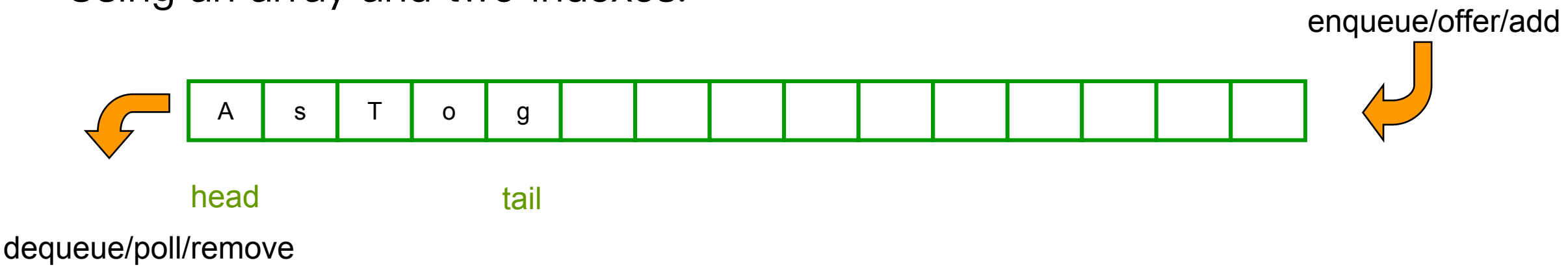
- Big Oh notation:
  - O(1) : fixed number of steps, regardless of how big the collection is
  - O(n) : number of steps proportional to the size of the collection.

Queues and efficiency

- Using an array and two indexes:



- Enqueue:
  - Get tail
  - tail++
  - Add new value at new tail

Queues and efficiency

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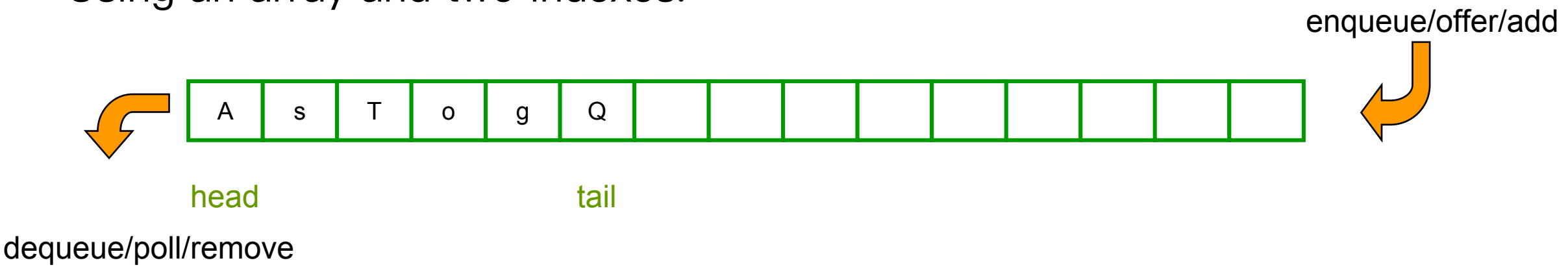

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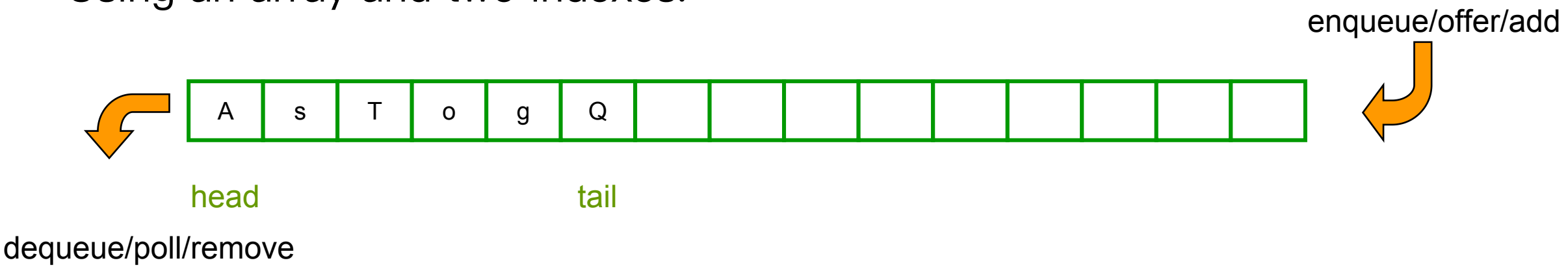

- Enqueue is fast: O(1)
- Dequeue:
  - Return value at head
  - head++

Queues and efficiency

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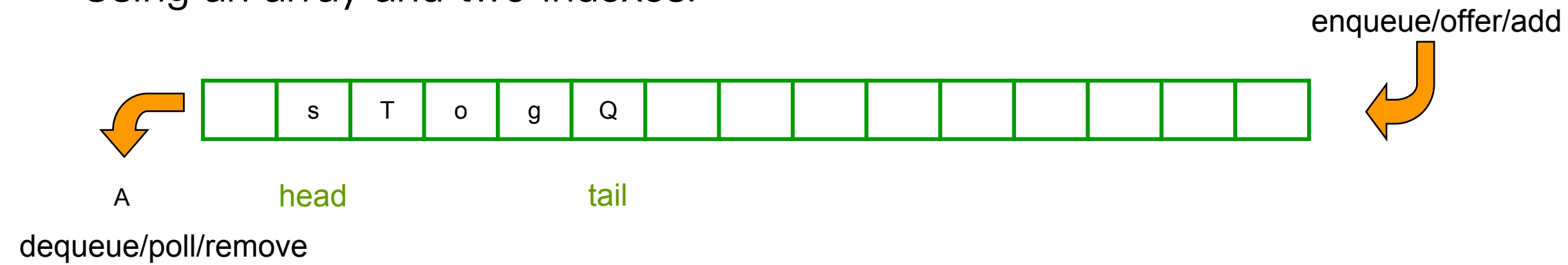

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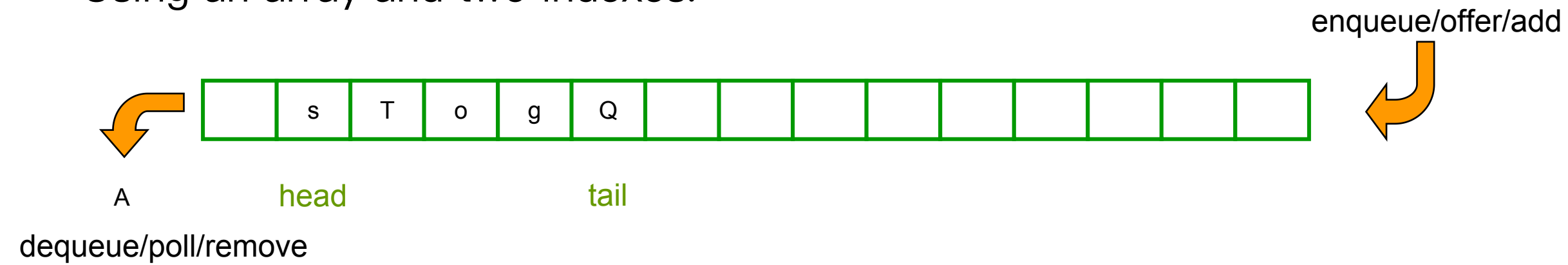

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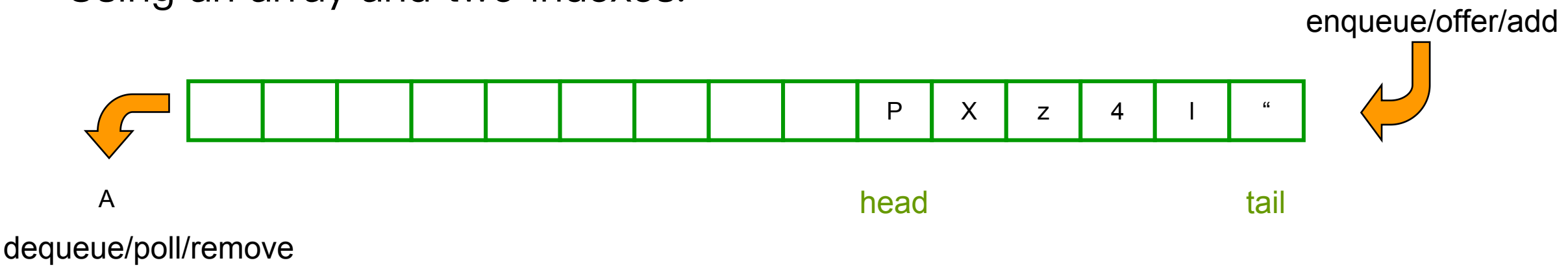

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- What about space? (memory)

Queues and efficiency

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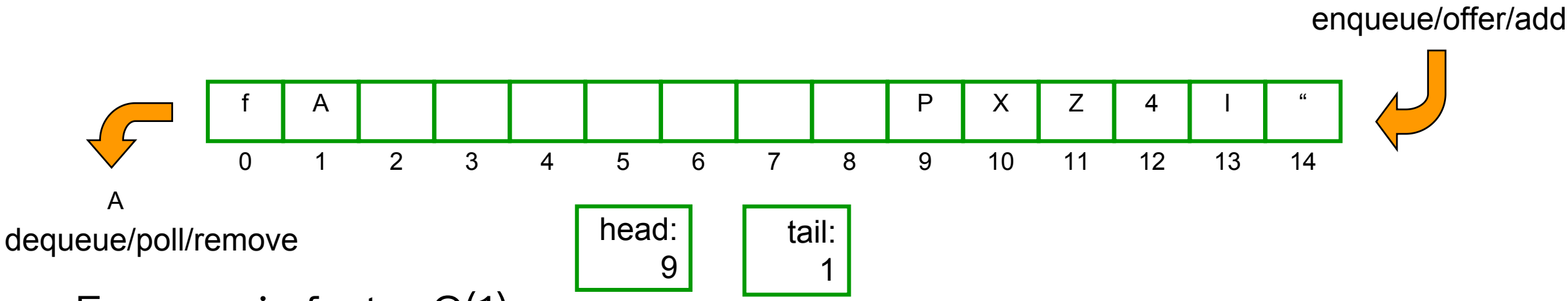

- Enqueue is fast: O(1)
- Dequeue is fast: O(1)

- What about space? (memory)
- “Wrap around” at the end;

Java Implementations

- Java classes for Queue:
  - ArrayDeque
  - LinkedList

```
Queue<Patient> waitingRoom = new ArrayDeque<Patient>();
```

- ArrayDeque is actually a kind of Deque – an extension of Queue:
  - Deque = Double Ended Queue
  - Add or remove at either end.
  - Includes Stacks and Queue

• offer(e)	=	offerLast(e)
• push(e)	=	offerFirst(e)
• poll() =	=	pollFirst()
• –=	pollLast()	
• peek()	=	peekFirst()
• –	=	peekLast()