Queues

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- Like stacks, queues are an Abstract Data Type (ADT) with more than one implementation.

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    - integer size(): returns the number of elements stored.
    - boolean isEmpty(): indicates whether no elements are stored.

Example

Operation	Return value	Queue
enqueue(5)	-	(5)
enqueue(3)	-	(5, 3)
dequeue()	5	(3)
enqueue(7)	-	(3, 7)
dequeue()	3	(7)
first()	7	(7)
dequeue()	7	()
dequeue()	null	()
isEmpty()	true	()
enqueue(9)	-	(9)
enqueue(7)	-	(9, 7)
size()	2	(9, 7)
enqueue(3)	-	(9, 7, 3)
enqueue(5)	-	(9, 7, 3, 5)
dequeue()	9	(7, 3, 5)

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- Two variables keep track of the front and size:
    - front: index of the front element
    - size: number of stored elements
- When the queue has fewer than N elements, array location $back = (front + size) \bmod N$ is the first empty slot past the rear of the queue.
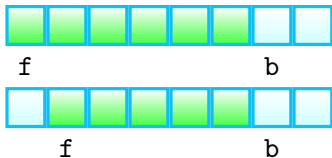
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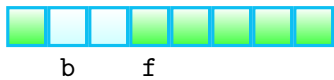Example of a queue implemented with an array using a "wraparound" technique.

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```
procedure ENQUEUE(o)
    back ← (front + size) mod N
    arr[back] ← o
    size ← size + 1
end procedure
```

Keep in mind that you need to consider the case when the queue is
full and how to handle it.

Array-backed Queue

procedure DEQUEUE
    $item \leftarrow arr[f]$
    $front \leftarrow (front + 1) \bmod N$
    $size \leftarrow size - 1$
    return $item$
end procedure

Notice that the cell in the array, $arr[f]$ is not set to *null* after it is dequeued. Consider the case, when the queue is empty and you attempt to dequeue.

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- Elements would be added and removed to opposite ends of the list. The most efficient way to do this would depend on the list.

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  - Each operations runs in time $O(1)$.

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        - During the process of resizing, the queue would be "unwound", so that the front of the queue would be in index 0 of the resized array.
    - Linked list-backed queue do not have either of the above two limitations.

Applications of Queues

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    1. `process = processes.dequeue()`
    2. Do work on `process`
    3. `processes.enqueue(process)`