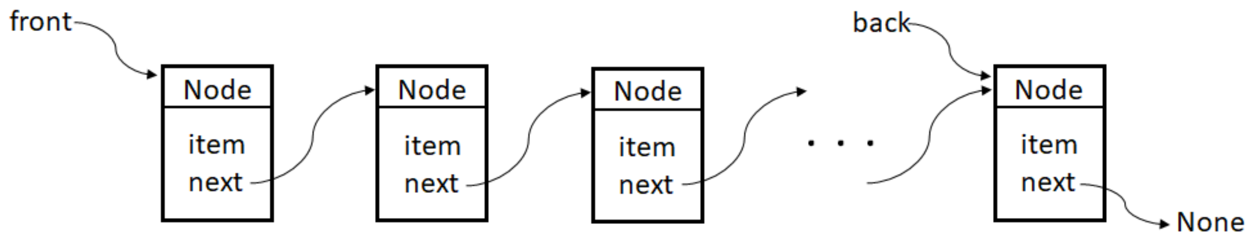
Lab 3: Queue Implementations

Goals:

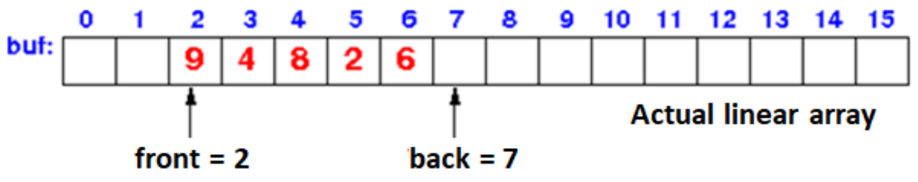
- **Implement a Queue class using a linked list based data structure: queue_linked.py**
- **Implement a Queue class using a circular array: queue_array.py**

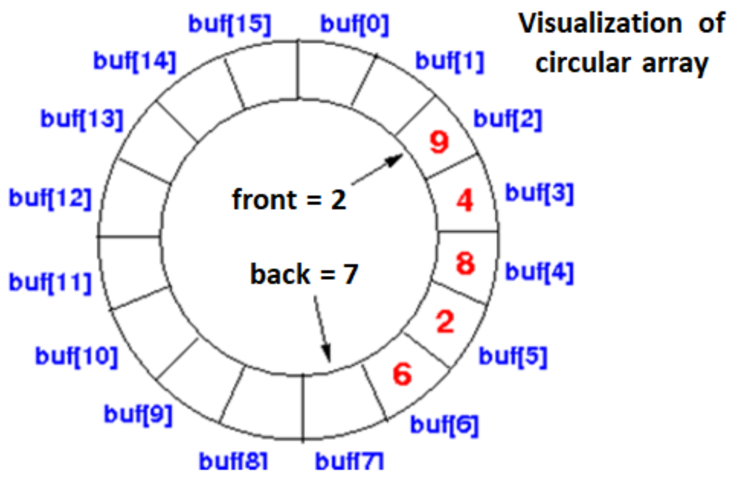
If you are confused, I suggest that you read over section 4.10, 4.11, and 4.12 of the textbook. You will not be doing the implementation described in section 4.12, but it will help you understand the underlying concepts.

- In the first implementation, you will use a linked list similar to the linked list structure used in implementing the Stack (i.e. create a Node class). In this case, there must be a way to add items to the back of the list and remove items from the front of the list, as illustrated below.



- The second implementation will use a circular array for storing the items in the queue. There are different ways of doing this, but they share the idea presented in the picture below. Items are added to the back of the queue using the next "free entry" in an array. Items are removed from the front of the queue. The indices front and back are incremented as items are added and deleted from the queue, and the indices "wrap around" when they reach the end of the array. Why is using a circular array better than what the text does (i.e. inserting new items at index 0 of array, and removing items from the end of the array)?





For both Queue implementations:

- Attempting to enqueue an item into a full Queue will raise an IndexError
- Attempting to dequeue an item from an empty Queue will raise an IndexError
- All methods must have ***O(1)*** performance (the speed must not be affected by the size of the queue)
- As with your stack implementations, you **may NOT use** any of the following Python List operations (we will check!):
- `all built-in list methods including:`
    - `append()`
    - `insert()`
    - `extend()`
    - `remove()`
    - `pop()`
- `== and != between lists`
- `del`
- `in`
- `len`
- + (concatenation of lists)
- List slicing (e.g. `some_list[2:9]`)

Additional Requirements:

- All queue operations must have O(1) performance
- Your queue implementations must be able to hold values of None as valid data

The following starter files are available.

- **`queue_array.py`**: Contains an array (Python List) based implementation of the **Queue** class
- **`queue_linked.py`**: Contains a linked based implementation of the **Queue** class
- **`queue_tests.py`:** Contains your set of thorough tests to ensure your implementations work correctly. These tests must run correctly on **ANY implementation** that follows the specification.
- (Note that the class in each stack implementation is named **Queue**, and both implementations must follow the same specification. This allows one set of tests in **queue_tests.py** that can be used for both implementations by just changing which file is used when importing Stack.)