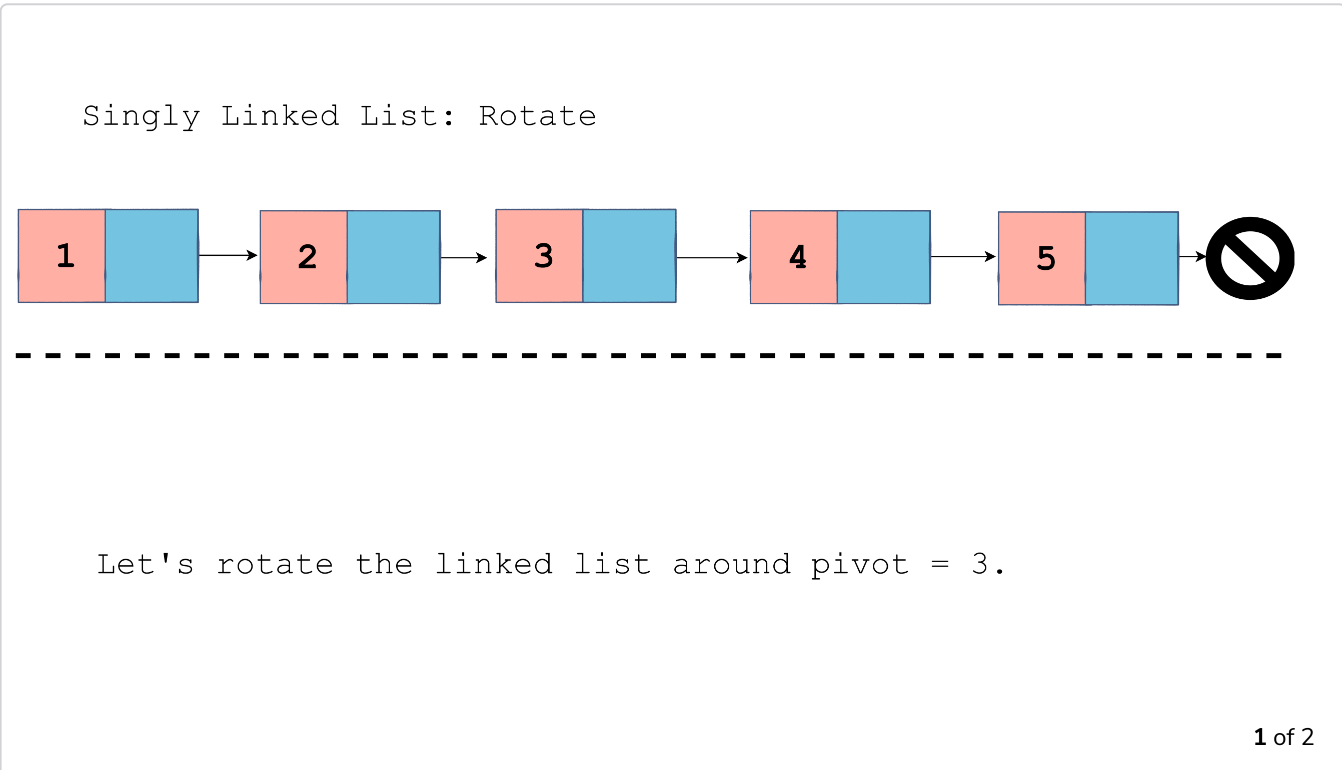
Rotate

In this lesson, we will learn how to rotate a linked list.

We'll cover the following

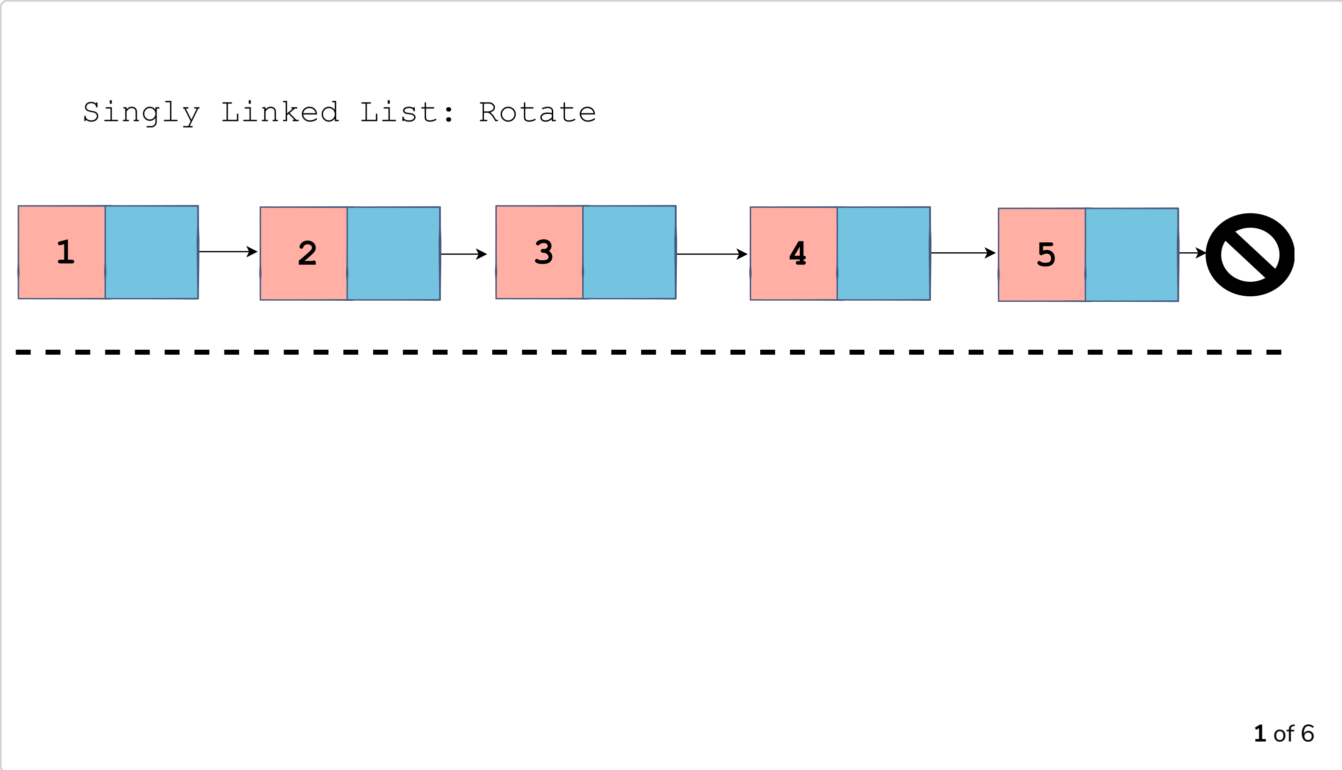
In this lesson, we investigate how to rotate the nodes of a singly linked list around a specified pivot element. This implies shifting or rotating everything that follows the pivot node to the front of the linked list.

The illustration below will help you understand how to rotate the nodes of a singly linked list.



Algorithm

The algorithm to solve this problem has been illustrated below:



As you can see from the illustrations above, we make use of two pointers `p` and `q`. `p` points to the pivot node while `q` points to the end of the linked list. Once the pointers are rightly positioned, we update the last element, and instead of making it point to `None`, we make it point to the head of the linked list. After this step, we achieve a circular linked list. Now we have to fix the end of the linked list. Therefore, we update the head of the linked list, which will be the next element after the pivot node, as the pivot node has to be the last node. Finally, we set `p.next` to `None` which breaks up the circular linked list and makes `p` (pivot node) the last element of our rotated linked list.

Implementation

Now that you are familiar with the algorithm, let's start with the implementation of the algorithm.

```
def rotate(self, k):
  if self.head and self.head.next:
    p = self.head
    q = self.head
    prev = None
```

```
    count = 0

    while p and count < k:

        prev = p
        p = p.next
        q = q.next
        count += 1
    p = prev
    while q:
        prev = q
        q = q.next
    q = prev

    q.next = self.head
    self.head = p.next
    p.next = None
```

rotate(self, k)

Explanation

The `rotate` method takes in `self` and `k` as input parameters. We want to rotate our linked list around the `k` th element. We only rotate a linked list if it's not empty or contains more than one element as there is no point in rotating a single element. Therefore, on **line 2**, it is ensured that the execution proceeds to **line 3** if both `self.head` and `self.head.next` are not `None`. Otherwise, we return from the method.

Three variables `p`, `q`, and `prev` are initialized on **lines 3-5**. `p` and `q` are initialized to `self.head` while `prev` is initialized to `None`. We also declare another variable `count` on **line 6** and initialize it to `0`. `count` will help us in making `p` and `q` point to the nodes specified in the algorithm. Therefore, in the `while` loop starting from **line 8**, we move `p` and `q` along the linked list by updating them to their next nodes (**lines 10-11**). `count` is incremented by `1` in each iteration of the loop until it becomes greater than or equal to `k` in which case we'll break out of the `while` loop (**line 12**). In each iteration, `prev` is also being updated as it is set to `p` before `p` updates itself to its next node (**line 9**). Additionally, we keep a check if `p` does not equal to `None`, in which case we'll also break out of the `while` loop.

After breaking out of the `while` loop, we set `prev` equal to `p` on **line 13** to position our first pointer correctly. For the second pointer (`q`), we have to make it point to the last element in the linked list. As a result, we set up another `while` loop on **lines 14-16** where we move `q` along with the linked list until it becomes `None`. We also keep track of the previous node (`prev`) and make `q` point to the last element in the linked list on **line 17**.

Now that we have positioned the two pointers according to our algorithm, we'll execute the other simple steps. First, the last element (`q`) has to point to the first element of the linked list (`head`). So we make `q.next` set to `self.head` on **line 19**. Second, we now need to update the `head` as shown in the slides. On **line 20**, we update `self.head` to the next element of `p`. Lastly, as our pivot node (`p`) will become the end of the linked list, it should point to `None`. Therefore, we update `p.next` to `None` on **line 21**. That completes our implementation for the `rotate` method.

Below is the code widget which contains all the code we have written so far, along with the `rotate` method. Verify and test the code below:

```
class Node:
    def __init__(self, data):
        self.data = data
        self.next = None


class LinkedList:
    def __init__(self):
        self.head = None

    def print_list(self):
        cur_node = self.head
        while cur_node:
            print(cur_node.data)
            cur_node = cur_node.next

    def append(self, data):
        new_node = Node(data)

        if self.head is None:
            self.head = new_node
            return

        last_node = self.head
        while last_node.next:
            last_node = last_node.next
        last_node.next = new_node

    def prepend(self, data):
        new_node = Node(data)

        new_node.next = self.head
        self.head = new_node

    def insert_after_node(self, prev_node, data):

        if not prev_node:
            print("Previous node does not exist.")
            return
```

```
        new_node = Node(data)


        new_node.next = prev_node.next
        prev_node.next = new_node

    def delete_node(self, key):

        cur_node = self.head

        if cur_node and cur_node.data == key:
            self.head = cur_node.next
            cur_node = None
            return

        prev = None
        while cur_node and cur_node.data != key:
            prev = cur_node
            cur_node = cur_node.next

        if cur_node is None:
            return

        prev.next = cur_node.next
        cur_node = None

    def delete_node_at_pos(self, pos):
        if self.head:
            cur_node = self.head

            if pos == 0:
                self.head = cur_node.next
                cur_node = None
                return

            prev = None
            count = 1
            while cur_node and count != pos:
                prev = cur_node
                cur_node = cur_node.next
                count += 1

            if cur_node is None:
                return

            prev.next = cur_node.next
            cur_node = None

    def len_iterative(self):

        count = 0
        cur_node = self.head

        while cur_node:
            count += 1
            cur_node = cur_node.next
        return count

    def len_recursive(self, node):
        if node is None:
            return 0
        return 1 + self.len_recursive(node.next)
```

```
    def swap_nodes(self, key_1, key_2):


        if key_1 == key_2:
            return

        prev_1 = None
        curr_1 = self.head
        while curr_1 and curr_1.data != key_1:
            prev_1 = curr_1
            curr_1 = curr_1.next

        prev_2 = None
        curr_2 = self.head
        while curr_2 and curr_2.data != key_2:
            prev_2 = curr_2
            curr_2 = curr_2.next

        if not curr_1 or not curr_2:
            return

        if prev_1:
            prev_1.next = curr_2
        else:
            self.head = curr_2

        if prev_2:
            prev_2.next = curr_1
        else:
            self.head = curr_1

        curr_1.next, curr_2.next = curr_2.next, curr_1.next

    def print_helper(self, node, name):
        if node is None:
            print(name + ": None")
        else:
            print(name + ":" + node.data)

    def reverse_iterative(self):

        prev = None
        cur = self.head
        while cur:
            nxt = cur.next
            cur.next = prev

            self.print_helper(prev, "PREV")
            self.print_helper(cur, "CUR")
            self.print_helper(nxt, "NXT")
            print("\n")

            prev = cur
            cur = nxt
        self.head = prev

    def reverse_recursive(self):

        def _reverse_recursive(cur, prev):
            if not cur:
                return prev
```

```
            nxt = cur.next
            cur.next = prev
            prev = cur
            cur = nxt
            return _reverse_recursive(cur, prev)

        self.head = _reverse_recursive(cur=self.head, prev=None)

    def merge_sorted(self, llist):

        p = self.head
        q = llist.head
        s = None

        if not p:
            return q
        if not q:
            return p

        if p and q:
            if p.data <= q.data:
                s = p
                p = s.next
            else:
                s = q
                q = s.next
            new_head = s
        while p and q:
            if p.data <= q.data:
                s.next = p
                s = p
                p = s.next
            else:
                s.next = q
                s = q
                q = s.next
        if not p:
            s.next = q
        if not q:
            s.next = p
        return new_head

    def remove_duplicates(self):

        cur = self.head
        prev = None

        dup_values = dict()

        while cur:
            if cur.data in dup_values:
                # Remove node:
                prev.next = cur.next
                cur = None
            else:
                # Have not encountered element before.
                dup_values[cur.data] = 1
                prev = cur
            cur = prev.next

    def print_nth_from_last(self, n, method):
        if method == 1:
```

```
            #Method 1:
            total_len = self.len_iterative()
            cur = self.head

            while cur:
                if total_len == n:
                    #print(cur.data)
                    return cur.data
                total_len -= 1
                cur = cur.next
            if cur is None:
                return

        elif method == 2:
            # Method 2:
            p = self.head
            q = self.head

            count = 0
            while q:
                count += 1
                if(count>=n):
                    break
                q = q.next

            if not q:
                print(str(n) + " is greater than the number of nodes in list.")
                return

            while p and q.next:
                p = p.next
                q = q.next
            return p.data

    def rotate(self, k):
        if self.head and self.head.next:
            p = self.head
            q = self.head
            prev = None
            count = 0

            while p and count < k:
                prev = p
                p = p.next
                q = q.next
                count += 1
            p = prev
            while q:
                prev = q
                q = q.next
            q = prev

            q.next = self.head
            self.head = p.next
            p.next = None



llist = LinkedList()
llist.append(1)
llist.append(2)
llist.append(3)
llist.append(4)
```

```
llist.append(5)
llist.append(6)

llist.rotate(4)
llist.print_list()
```

In this lesson, we looked at how to rotate a linked list about a pivot node. I hope you were able to understand the algorithm and the code. I'll see you in the next lesson with another exciting challenge. Stay tuned!