链表算法

```
class MyLinkedList {
public:
    // 定义链表节点结构体
    struct LinkedNode {
        int val;
        LinkedNode* next;
        LinkedNode(int val):val(val), next(nullptr){}
    };

    // 初始化链表
    MyLinkedList() {
        _dummyHead = new LinkedNode(0); // 这里定义的头结点 是一个虚拟头结点，而不是真正的链表头结点
        _size = 0;
    }

    // 获取到第index个节点数值，如果index是非法数值直接返回-1， 注意index是从0开始的，第0个节点就是头结点
    int get(int index) {
        if (index > (_size - 1) || index < 0) {
            return -1;
        }
        LinkedNode* cur = _dummyHead->next;
        while(index--){ // 如果--index 就会陷入死循环
            cur = cur->next;
        }
        return cur->val;
    }

    // 在链表最前面插入一个节点，插入完成后，新插入的节点为链表的新的头结点
    void addAtHead(int val) {
        LinkedNode* newNode = new LinkedNode(val);
        newNode->next = _dummyHead->next;
        _dummyHead->next = newNode;
        _size++;
    }
```

```
// 在链表最后面添加一个节点
void addAtTail(int val) {
    LinkedNode* newNode = new LinkedNode(val);
    LinkedNode* cur = _dummyHead;
    while(cur->next != nullptr){
        cur = cur->next;
    }
    cur->next = newNode;
    _size++;
}

// 在第index个节点之前插入一个新节点，例如index为0，那么新插入的节点为链表的新头节点。
// 如果index 等于链表的长度，则说明是新插入的节点为链表的尾结点
// 如果index大于链表的长度，则返回空
void addAtIndex(int index, int val) {
    if (index > _size) {
        return;
    }
    LinkedNode* newNode = new LinkedNode(val);
    LinkedNode* cur = _dummyHead;
    while(index--) {
        cur = cur->next;
    }
    newNode->next = cur->next;
    cur->next = newNode;
    _size++;
}
```

````
    // 删除第index个节点，如果index 大于等于链表的长度，直接return，注意index是从0开始的
    void deleteAtIndex(int index) {
        if (index >= _size || index < 0) {
            return;
        }
        LinkedNode* cur = _dummyHead;
        while(index--) {
            cur = cur ->next;
        }
        LinkedNode* tmp = cur->next;
        cur->next = cur->next->next;
        delete tmp;
        _size--;
    }
```cpp
private:
    int _size;
    LinkedNode* _dummyHead;

};
````
````

```
/* 双链表 */
class MyLinkedList {
public:
    /** Initialize your data structure here. */
    MyLinkedList() {
        size = 0;
        dummy_head = new DoublyListNode(0);
        dummy_tail = new DoublyListNode(0);
        dummy_head->next = dummy_tail;
        dummy_tail->prev = dummy_head;
    }

    /** Get the value of the index-th node in the linked list. If the index is invalid, return -1. */
    int get(int index) {
        if (index < 0 || index >= size) {
            return -1;
        }

        DoublyListNode *curr = nullptr;
        if (index + 1  < size - index) {
            curr = dummy_head;
            for (int i = 0; i < index + 1; ++i) {
                curr = curr->next;
            }

        } else {
           curr = dummy_tail;
            for (int i = 0; i < size - index; ++i) {
                curr = curr->prev;
            }
        }

        return curr->val;
    }

    /** Add a node of value val before the first element of the linked list. After the insertion, the new node
    void addAtHead(int val) {
        DoublyListNode *pred = dummy_head; // Predecessor
        DoublyListNode *succ = dummy_head->next; // Successor

        DoublyListNode *add_node = new DoublyListNode(val);

        add_node->next = succ;
        add_node->prev = pred;
        succ->prev = add_node;
        pred->next = add_node;

        size++;
```

```
    }

    /** Append a node of value val to the last element of the linked list. */
    void addAtTail(int val) {
        DoublyListNode *pred = dummy_tail->prev; // Predecessor
        DoublyListNode *succ = dummy_tail; // Successor

        DoublyListNode *add_node = new DoublyListNode(val);

        add_node->next = succ;
        add_node->prev = pred;
        succ->prev = add_node;
        pred->next = add_node;

        size++;
    }

    /** Add a node of value val before the index-th node in the linked list. If index equals to the length of
    void addAtIndex(int index, int val) {
        if (index > size) return;

        if(index < 0) index = 0;

        DoublyListNode *curr = nullptr;
        if (index + 1  < size - index) {
            curr = dummy_head;
            for (int i = 0; i < index + 1; ++i) {
                curr = curr->next;
            }

        } else {
           curr = dummy_tail;
            for (int i = 0; i < size - index; ++i) {
                curr = curr->prev;
            }
        }

        DoublyListNode *pred = curr->prev; // Predecessor
        DoublyListNode *succ = curr; // Successor

        DoublyListNode *add_node = new DoublyListNode(val);

        add_node->next = succ;
        add_node->prev = pred;
        succ->prev = add_node;
        pred->next = add_node;

        size++;
```

```
    }

    /** Delete the index-th node in the linked list, if the index is valid. */
    void deleteAtIndex(int index) {
        if (index < 0 || index >= size) return;

        DoublyListNode *curr = nullptr;
        if (index + 1  < size - index) {
            curr = dummy_head;
            for (int i = 0; i < index + 1; ++i) {
                curr = curr->next;
            }

        } else {
           curr = dummy_tail;
            for (int i = 0; i < size - index; ++i) {
                curr = curr->prev;
            }
        }

        DoublyListNode *deletedNode = curr;
        DoublyListNode *pred = curr->prev; // Predecessor
        DoublyListNode *succ = curr->next; // Successor

        succ->prev = pred;
        pred->next = succ;

        delete deletedNode;
        deletedNode = nullptr;

        --size;
    }

private:
    // Definition for doubly-linked list.
    struct DoublyListNode {
        int val;
        DoublyListNode *next, *prev;
        DoublyListNode(int x) : val(x), next(NULL), prev(NULL) {}
    };
    DoublyListNode *dummy_head; // 哑头结点
    DoublyListNode *dummy_tail; // 哑尾结点

    int size; // 链表的长度

};
```

```cpp
/** 迭代 删除值为val的结点 */
class Solution {
public:
    ListNode* deleteNode(ListNode* head, int val) {
        ListNode* dummy = new ListNode(-1);
        dummy->next = head; //建立虚拟头节点
        ListNode* cur = dummy;
        while(cur->next)
            if(cur->next->val == val) cur->next = cur->next->next;
            else cur = cur->next;
        return dummy->next;
    }
};

// 递归 删除 值为val的节点
class Solution {
public:
        ListNode* removeElements(ListNode* head, int val) {
        //1、递归边界
        if(!head)return nullptr;
        //2、递去：直到到达链表尾部才开始删除重复元素
        head->next=removeElements(head->next,val);
        //3、递归式：相等就是删除head，不相等就不用删除
        return head->val==val?head->next:head;
    }
};
```

```
/* 用delete删除被删节点 */
class Solution {
  public:
  ListNode* removeElements(ListNode* head, int val) {
    ListNode* sentinel = new ListNode(0);
    sentinel->next = head;

    ListNode *prev = sentinel, *curr = head, *toDelete = nullptr;
    while (curr != nullptr) {
      if (curr->val == val) {
        prev->next = curr->next;
        toDelete = curr;
      } else prev = curr;

      curr = curr->next;

      if (toDelete != nullptr) {
        delete toDelete;
        toDelete = nullptr;
      }
    }

    ListNode *ret = sentinel->next;
    delete sentinel;
    return ret;
  }
};
```

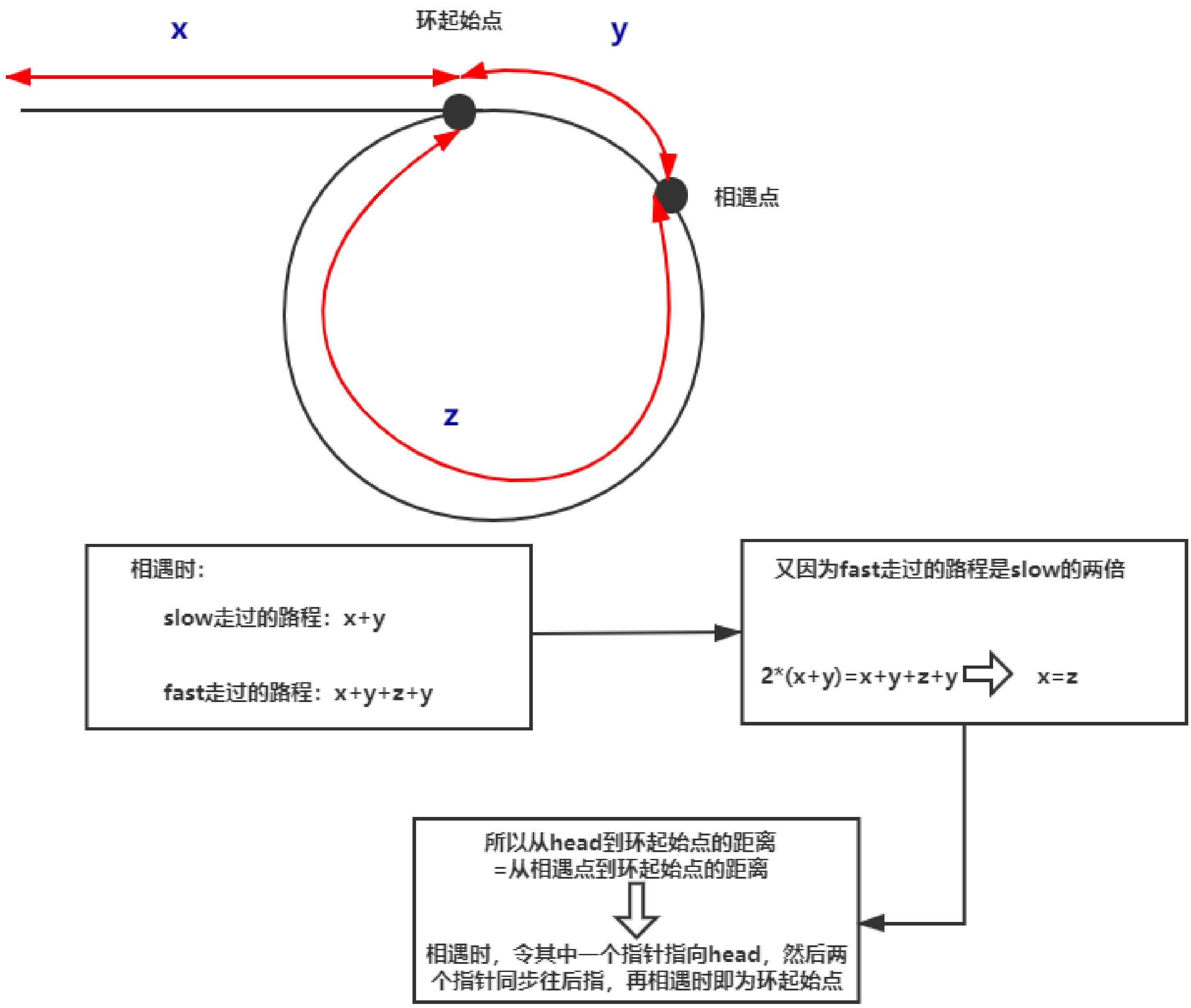
```
//反转链表
class Solution {
public:
    ListNode* reverseList(ListNode* head) {
        ListNode *cur = nullptr;
        ListNode *pre = head;
        while(pre){
            ListNode *node = pre->next;
            pre->next = cur;
            cur = pre;
            pre = node;
        }
        return cur;
    }
};
// 递归解（反转链表）
class Solution {
public:
    ListNode* reverseList(ListNode* head) {
        // 递归终止条件是当前为空，或者下一个为空
        if(!head || !head -> next) return head;
        // 递归调用来反转每一个结点
        ListNode *curr = reverseList(head -> next);
        // 每一个结点都是这样反转的
        head -> next -> next = head;
        // 防止链表循环，需要将head->next置为空
        head -> next = nullptr;
        // 每层递归函数都返回cur，也就是最后一个结点
        return curr;
    }
};
```

```
/**
 * 判断链表中是否有环
 */
class Solution {
public:
    //哈希表
    bool hasCycle(ListNode *head) {
        set<ListNode*> s;
        while(head != nullptr){
            if(s.insert(head).second==false){
                return true;
            }else{
                s.insert(head);
            }
            head = head->next;
        }
        return false;
    }

    // 快慢指针
    bool hasCycle(ListNode *head) {
        if(!head || !head->next) return false;
        ListNode *slow = head;
        ListNode *fast = head;
        while(fast != nullptr && fast->next != nullptr){
            slow = slow->next;
            fast = fast->next->next;
            if(fast == slow){
                return true;
            }
        }
        return false;
    }
};

/**
*给定一个链表，返回链表开始入环的第一个节点。 如果链表无环，则返回 null。
*为了表示给定链表中的环，我们使用整数pos来表示链表尾连接到链表中的位置（索引从 0 开始）如果 pos 是 -1，则在该链表中没有环。
*说明：不允许修改给定的链表。
*示例 1:
*输入：head = [3,2,0,-4], pos = 1
*输出：tail connects to node index 1
*解释：链表中有一个环，其尾部连接到第二个节点。

*算法思想：快慢指针相遇的时候，此时从node1从head出发，node2从fast出发，相遇即为入口
*/
```



x
环起始点
y
相遇点
z
相遇时:
slow走过的路程：x+y
fast走过的路程：x+y+z+y
又因为fast走过的路程是slow的两倍
2*(x+y)=x+y+z+y
x=z
所以从head到环起始点的距离
=从相遇点到环起始点的距离
相遇时，令其中一个指针指向head，然后两
个指针同步往后指，再相遇时即为环起始点

```
class Solution {
public:
    ListNode *detectCycle(ListNode *head) {
       ListNode* slow = head;
       ListNode* fast = head;
       while(fast != nullptr && fast->next != nullptr){
           slow = slow->next;
           fast = fast->next->next;
           if(slow == fast){
            ListNode* node1 = fast;
            ListNode* node2 = head;
            while(node1 != node2){
                node1 = node1->next;
                node2 = node2->next;
            }
            return node2;
           }
       }
       return NULL;
    }
};

/* 编写一个程序，找到两个单链表相交的起始节点。 */
//算法思想：为了和你相遇，即使我走过了我所有的路，我也愿意走一遍你走过的路。
class Solution {
public:
    ListNode *getIntersectionNode(ListNode *headA, ListNode *headB) {
        ListNode *boy = headA;
        ListNode *girl = headB;
        while(boy != girl){
            boy = boy==nullptr ? headB : boy->next;
            girl = girl==nullptr ? headA : girl->next;
        }
        return girl;
    }
};
```

```
/* 给定一个链表，删除链表的倒数第 n 个节点，并且返回链表的头结点。
 *示例：
 *给定一个链表: 1->2->3->4->5, 和 n = 2.
 *当删除了倒数第二个节点后，链表变为 1->2->3->5.
 */
 //算法思想：快慢指针，相距 n个单位,当fast到达表尾时,slow->next 即为要删除的点
class Solution {
public:
    ListNode* removeNthFromEnd(ListNode* head, int n) {
        ListNode *dummyHead = new ListNode(0);
        dummyHead->next = head;
        ListNode *slow = dummyHead;
        ListNode *fast = dummyHead;
        for(int i=0; i<n+1 ; i++){
            fast = fast->next;
        }
        while(fast){
            fast = fast->next;
            slow = slow->next;
        }
        ListNode *delNode = slow->next;
        slow->next = delNode->next;
        delete delNode;

        ListNode *newHead = dummyHead->next;
        delete dummyHead;
        return newHead;
    }
};
```

```
/* 合并两个有序链表 */
class Solution {
public:
    ListNode* mergeTwoLists(ListNode* l1, ListNode* l2) {
        ListNode *dummyHead = new ListNode(-1);
        ListNode *p = dummyHead;

        while( l1 != nullptr && l2 != nullptr ){
            if(l1->val < l2->val)
            {
                p->next = l1;
                l1=l1->next;
            }else{
                p->next = l2;
                l2=l2->next;
            }
            p=p->next;
        }
        p->next = l1==nullptr ? l2 : l1;
        ListNode *newHead = dummyHead->next;
        delete(dummyHead);
        return newHead;
    }
};
```

```
/*
给定一个链表和一个特定值 x，对链表进行分隔，使得所有小于 x 的节点都在大于或等于 x 的节点之前。
你应当保留两个分区中每个节点的初始相对位置。
示例:
输入: head = 1->4->3->2->5->2, x = 3
输出: 1->2->2->4->3->5
*/
class Solution {
public:
    ListNode* partition(ListNode* head, int x) {
        ListNode *lowdummyhead = new ListNode(-1);  // 小于x的结点的虚拟头结点
        ListNode *plow = lowdummyhead;
        ListNode *highdummyhead = new ListNode(-1); // 大于等于x的结点的虚拟头结点
        ListNode *phigh = highdummyhead;
        while(head){
            ListNode *next = head->next;     // 记录head->next 防止链表断裂
            head->next = nullptr;
            if(head->val < x){               // 小于x的值连接到lowdummyhead
                plow->next = head;
                plow = plow->next;
            }else{
                phigh->next = head;          // 大于等于x的值链接到highdummyhead
                phigh = phigh->next;
            }
            head = next;                     // head 向前走一步
        }
        plow->next = highdummyhead->next;
        ListNode *newhead = lowdummyhead->next;
        delete lowdummyhead;
        delete highdummyhead;
        return newhead;
    }
};
```

```
/*
 * 给定一个带有头结点 head 的非空单链表，返回链表的中间结点。
 * 如果有两个中间结点，则返回第二个中间结点。
*/
class Solution {
public:
    ListNode* middleNode(ListNode* head) {
        if(!head) return head;
        ListNode *slow = head;
        ListNode *fast = head;
        while(fast->next && fast->next->next){
            slow = slow->next;
            fast = fast->next->next;
        }
        return fast->next==nullptr ? slow : slow->next; //奇偶个数分别处理
    }
};

/*
 *给定一个链表，两两交换其中相邻的节点，并返回交换后的链表。
 *你不能只是单纯的改变节点内部的值，而是需要实际的进行节点交换。
 */
class Solution {
public:
    ListNode* swapPairs(ListNode* head) {
        if(!head) return nullptr;
        ListNode *dummyhead = new ListNode(-1);
        dummyhead->next = head;
        ListNode *pre = dummyhead;
        ListNode *p = head;
        ListNode *after = head->next;
        while(p && p->next){
            pre->next = p->next;
            p->next = after->next;
            after->next = p;
            pre = p;
            p = p->next;
            if(p) after = p->next;
        }
        ListNode *newHead = dummyhead->next;
        delete dummyhead;
        return newHead;
    }
};
```

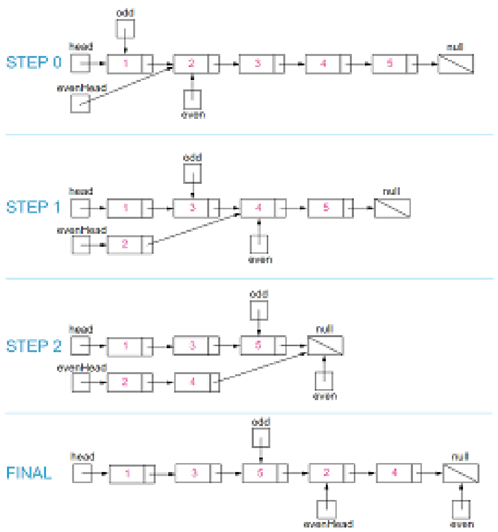
```
/*
 *给你两个 非空 链表来代表两个非负整数。数字最高位位于链表开始位置。
 *它们的每个节点只存储一位数字。将这两数相加会返回一个新的链表。
 *你可以假设除了数字 0 之外，这两个数字都不会以零开头。
*/
class Solution {
public:
    ListNode* addTwoNumbers(ListNode* l1, ListNode* l2) {
        ListNode *p1 = l1;
        ListNode *p2 = l2;
        ListNode *dummyhead = new ListNode(-1);
        ListNode *cur = dummyhead;
        int carry = 0;
        while(p1 || p2){                            // 不论长短 一起遍历
            int x = p1 != nullptr ? p1->val : 0;    // 若p1到尾部，按照加法规则，从低位对齐，高位视为0
            int y = p2 != nullptr ? p2->val : 0;
            int sum = x + y + carry;
            carry = sum / 10;
            cur->next = new ListNode(sum%10);       // sum % 10 十进制，满十进位，剩余保留
            cur = cur->next;                        // 结果链表指针移到当前尾部
            if(p1) p1 = p1->next;                   // 如果p1不空,p1前进一步。防止空指针报错，因为本循环无视长度
            if(p2) p2 = p2->next;
        }
        if(carry > 0){                              // 如果最高位满十，则进位，逻辑同其他
            cur->next = new ListNode(carry);
        }
        ListNode *newhead = dummyhead->next;
        delete dummyhead;
        return newhead;
    }
};
```

```
/* 删除链表中最小的结点 */
ListNode *del_min(ListNode *head){
    ListNode *pre = head, *p = pre->next;
    ListNode *minpre = pre, *min = p;
    while(p){
        if(p->data < min->data){
            min = p;
            minpre = pre;
        }
        p = p->next;
        pre = pre->next;
    }
    minpre->next = min->next;
    delete(min);
    return head;
}

/* sort链表使其递增 */
/* 插入排序思想 */
void sort(LinkList &L){
    LNode *p = L->next,*pre;
    LNode *r = p->next;          // 保证链表不断链
    p->next = null;              // 构建有序链表（只有第一个结点）
    p = r;                       // p来到无需部分的头部
    while(p){
        r = p->next;             // 保存p的后继结点，防止链表断链
        pre = L;
        while(pre->next && pre->next->data < p->data){
            pre = pre->next;     // 找到p点的插入位置
        }
        p->next = pre->next;     // 尾插
        pre->next = p;
        p = r;
    }
}
```

```
/* 每次找到链表中最小的结点，输出val，并将其free()，直到只剩head，最后将head free() */
void Min_del(LinkList &head){
    while(head->next){
        pre = head;
        p = pre->next;
        while(p->next){
            if(p->next->val < pre->next->val)
                pre = p;     //记录最小值的前驱
            p = p->next;
        }
            printf(pre->next->val);
            u = pre->next;
            pre->next = u->next;
            free(u);
        }//while
    free(head);
}


/*
    给定一个单链表，把所有的奇数节点和偶数节点分别排在一起。
    请注意，这里的奇数节点和偶数节点指的是节点编号的奇偶性，而不是节点的值的奇偶性。
*/
```



```
class Solution {
public:
    ListNode* oddEvenList(ListNode* head) {
        if(!head) return nullptr;
        // odd是奇链表的当前节点，先初始化为head（初始化为奇链表头）
        ListNode *odd = head;
        // even是偶链表的当前节点，初始化为第二个节点也就是head.next
        ListNode *even = head->next;
        // evenHead是偶链表的头节点，初始化为链表第二个节点（初始化为奇链表头的下一个节点）
        ListNode *evenhead = even;
        while(even && even->next){  //涉及到链表长度为奇或偶，用双指针，条件好像都是这个
            odd->next = even->next;
            odd = odd->next;
            even->next = odd->next;
            even = even->next;
        }
        odd->next = evenhead;   // 奇(拼接)偶
        return head;
    }
};

/* 删除 有序 链表中的重复项 */
void Del_Same(LinkList &L){
    LNode* p = L->next, *q;
    if(p==null) return;
    while(p->next){
        q = p->next;
        if(p->data == q->data){
            p->next = q->next;
            free(q);
        }else{
            p = p->next;
        }
    }
}
```

```
/* 请判断一个链表是否为回文链表。(栈) */
class Solution {
public:
    bool isPalindrome(ListNode* head) {
        stack<int> st;
        ListNode *cur = head;
        int length = 1;
        while(cur){
            st.push(cur->val);
            cur = cur->next;
            length++;
        }
        int cnt = length/2;
        cur = head;
        while(cnt--){
            if(cur->val != st.top()) return false;
            st.pop();
            cur = cur->next;
        }
        return true;
    }
};
```

```
/* 顺序表法 */
class Solution {
public:
    bool isPalindrome(ListNode* head) {
        vector<int> res;
        while(head){
            res.push_back(head->val);
            head = head->next;
        }
        int i = 0; int j = res.size() - 1;
        while(i<j){ // 啊啊啊啊 边界值真的是佛了啊
            if(res[i++]!=res[j--]) return false;
        }
        return true;
    }
/*  双指针，反转链表 */
    public:
        bool isPalindrome(ListNode *head){
            ListNode *cur = head;
            ListNode *pre = nullptr;
            ListNode *fast = head;
            while(fast && fast->next){
                fast = fast->next->next; //位置不可以变，因为链表在后面断了
                ListNode *temp = cur->next;
                cur->next = pre;
                pre = cur;
                cur = temp;
            }
            if(fast) cur = cur->next;
            while(pre){
                if(cur->val != pre->val) return false;
                cur = cur->next;
                pre = pre->next;
            }
            return true;
        }

};
```

```
/* 给定一个链表，旋转链表，将链表每个节点向右移动 k 个位置，其中 k 是非负数。 */
class Solution {
public:
    ListNode* rotateRight(ListNode* head, int k) {
        if(!head || !head->next || k==0) return head;
        ListNode *phead = head;
        int length = 1;
        while(phead->next){length++;phead = phead->next;}
        int move = k % length;
        if(move == 0) return head;
        ListNode *cur = head;
        for(int i=0;i<length-move-1;i++) cur = cur->next;
        ListNode *tmp = cur->next;
        cur->next = nullptr;
        phead->next = head;
        return tmp;
    }
};
```