极客时间算法训练营
第一课
数组、链表

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《算法竞赛进阶指南》作者

目录

1. 数组原理讲解、实战应用

2. 设计变长数组

3. 链表原理讲解、实战应用

数组

数组 (array)

- C++: int a[100];
- Java: int[] a = new int[100];
- Python: a = []

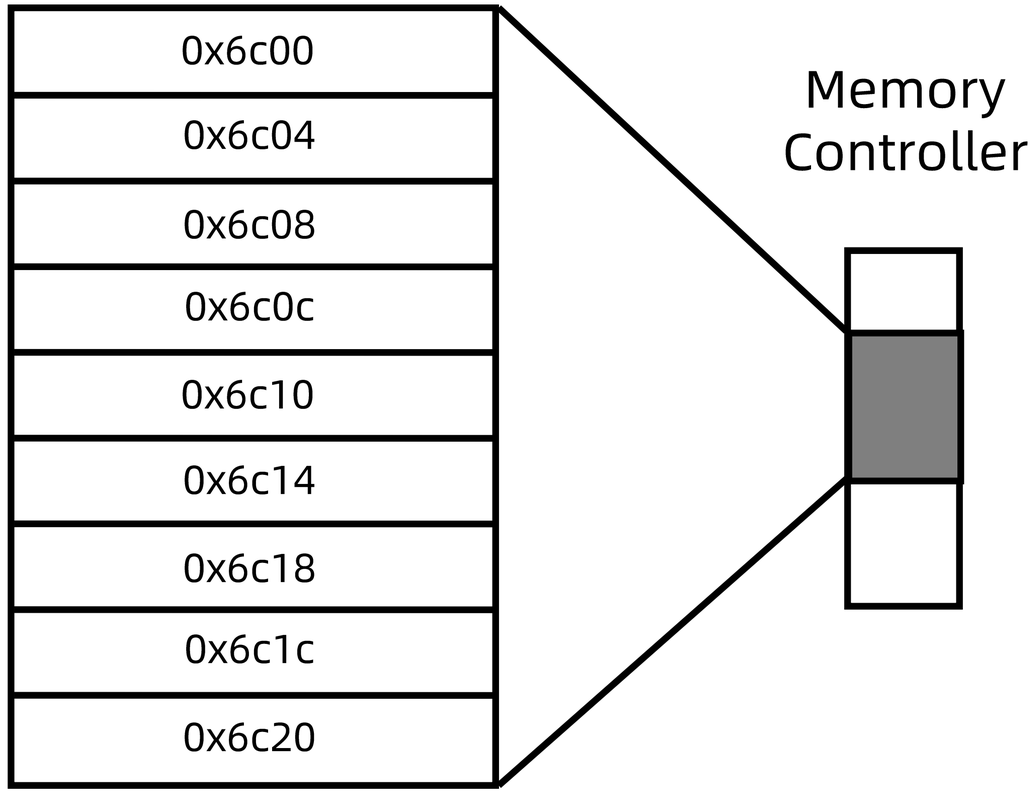
- 数组的基本特点：支持随机访问
- 数组的关键：索引与寻址

- C++: a[i], *(a+i)
- Java, Python: a[i]

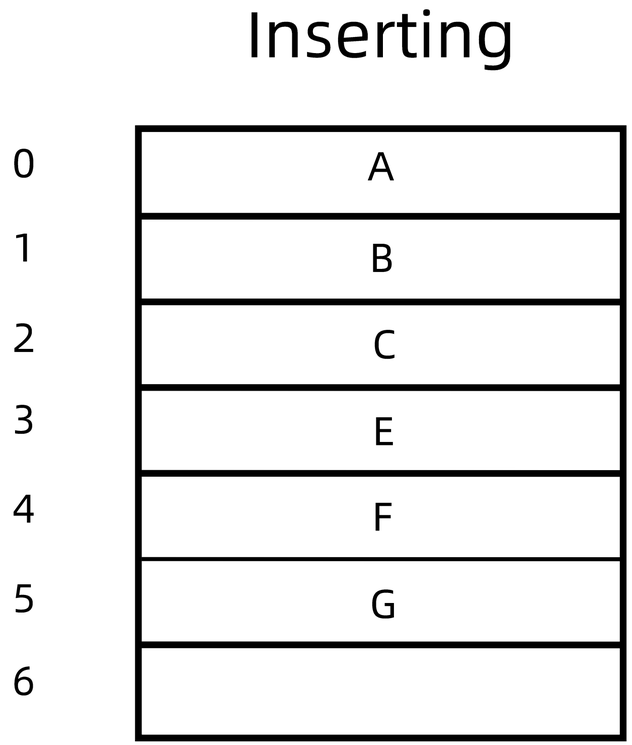
- 数组在内存中是一段连续的存储空间

数组 (array)

0	123
1	234
2	345
3	456
4	567
5	678
6	789
7	890
8	901



数组 - 插入元素



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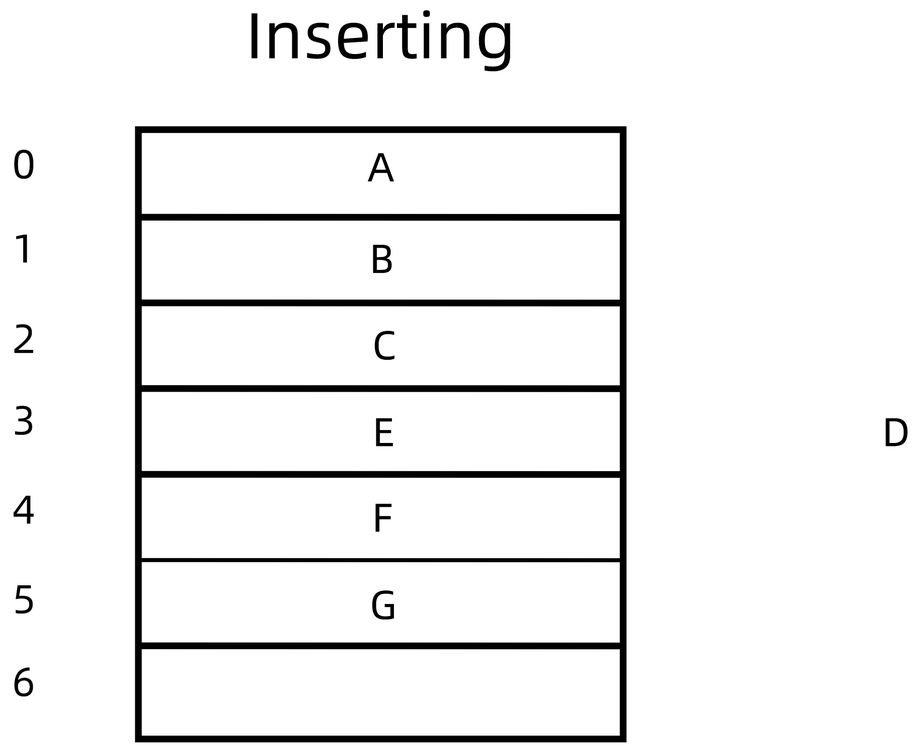

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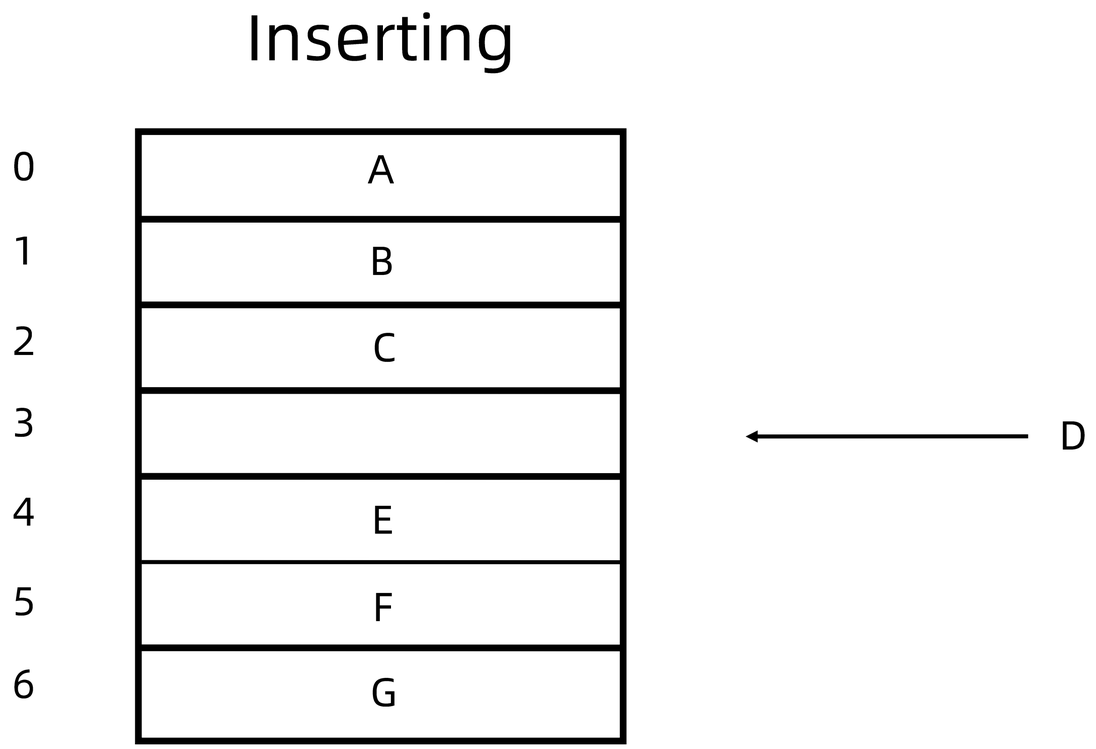
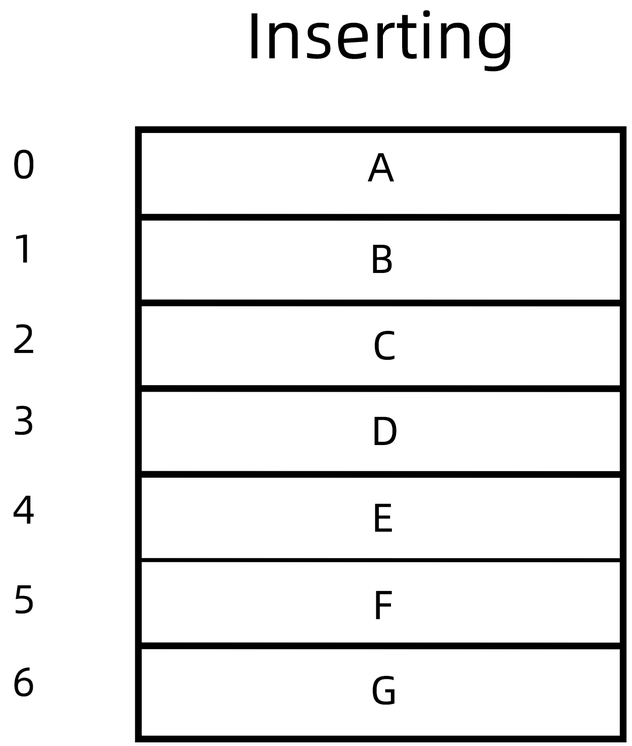
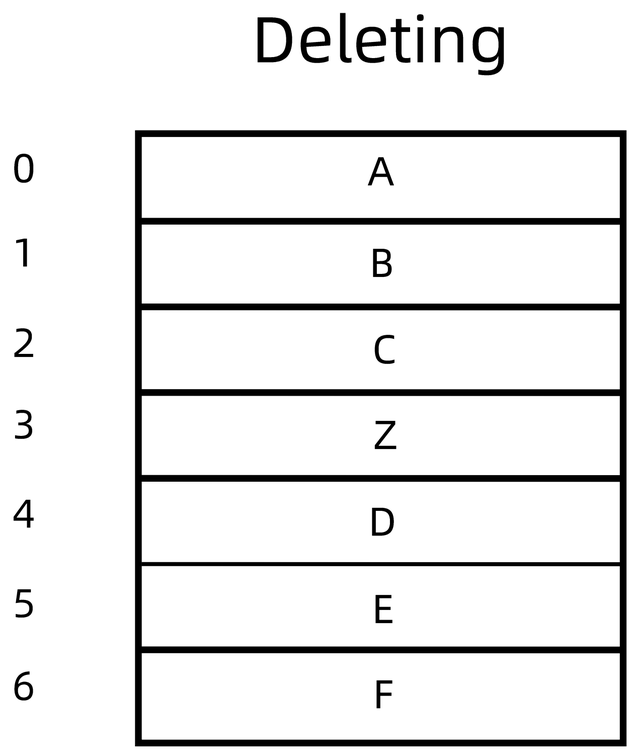


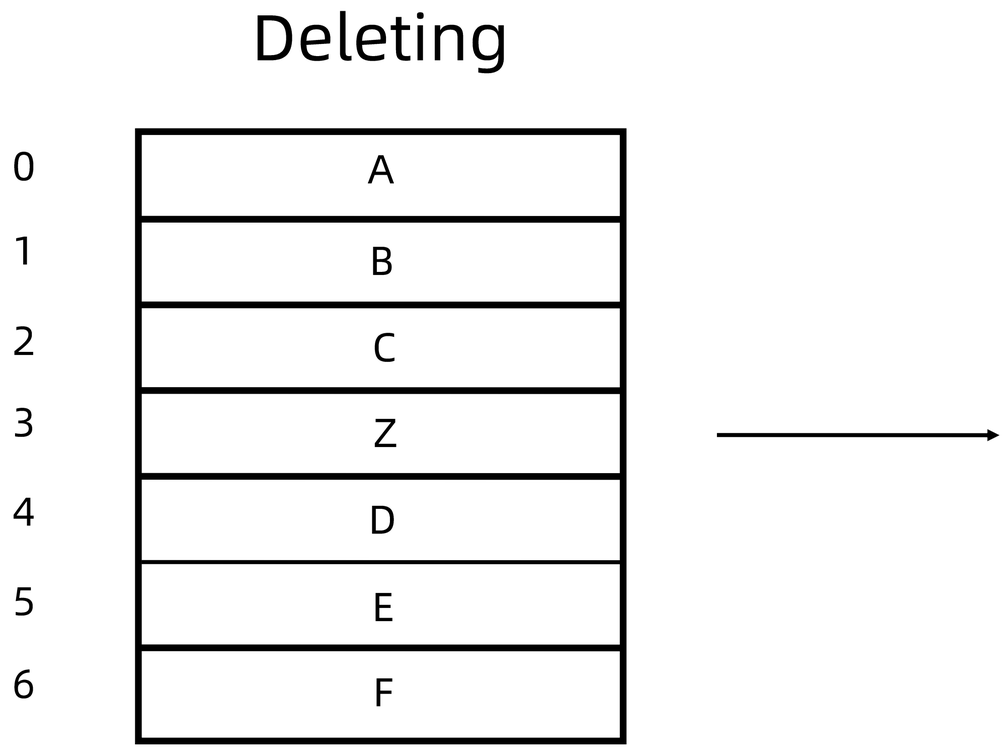
数组 - 插入元素



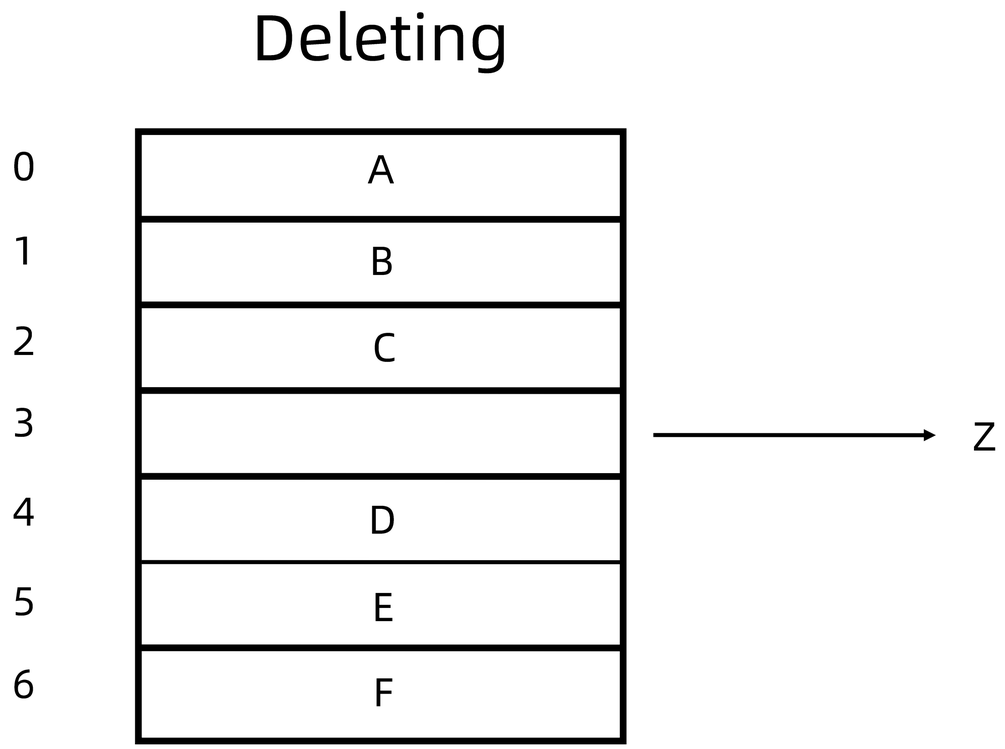
数组 - 删除元素



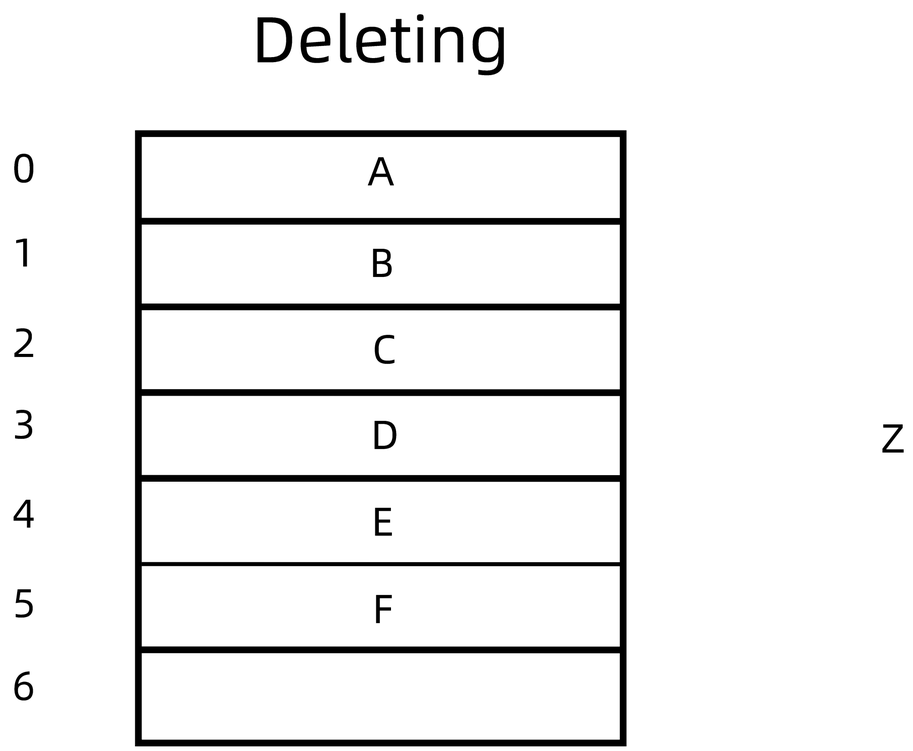
数组 - 删除元素



数组 - 删除元素



数组 - 删除元素



时间复杂度

• Lookup	O(1)
• Insert	O(n)
• Delete	O(n)
• Append (push back)	O(1)
• Prepend (push front)	O(n)

实战

- 去重
- https://leetcode-cn.com/problems/remove-duplicates-from-sorted-array/

- 移动零
- https://leetcode-cn.com/problems/move-zeroes/

- 合并有序数组
- https://leetcode-cn.com/problems/merge-sorted-array/

变长数组 (resizable array)

- C++: vector
- Java: ArrayList
- Python: list

- 如何实现一个变长数组?
  - 支持索引与随机访问
  - 分配多长的连续空间?
  - 空间不够用了怎么办?
  - 空间剩余很多如何回收?

变长数组 (resizable array)

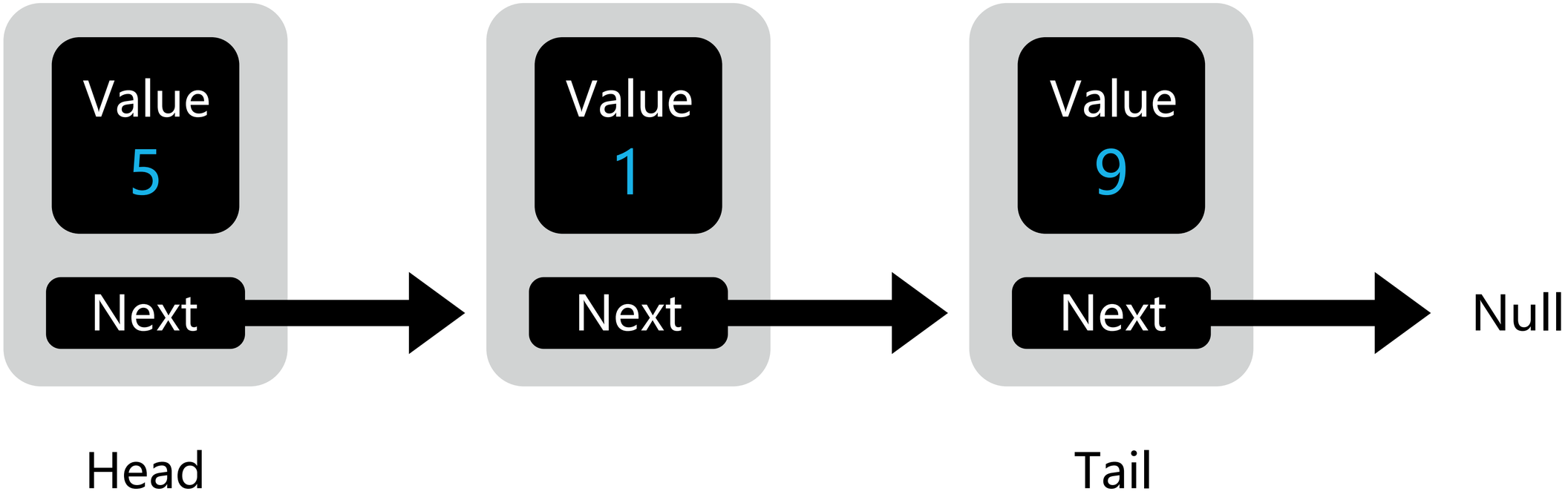
- 一个简易的实现方法
- 初始：空数组，分配常数空间，记录实际长度（size）和容量（capacity）
- Push back: 若空间不够，重新申请 2 倍大小的连续空间，拷贝到新空间，释放旧空间
- Pop back: 若空间利用率（size/capacity）不到 25%，释放一半的空间

- 均摊 O(1)
- 在空数组中连续插入 n 个元素，总插入/拷贝次数为 $n + n/2 + n/4 + ... < 2n$
- 一次扩容到下一次释放，至少需要再删除 $n - 2n*0.25 = 0.5n$ 次

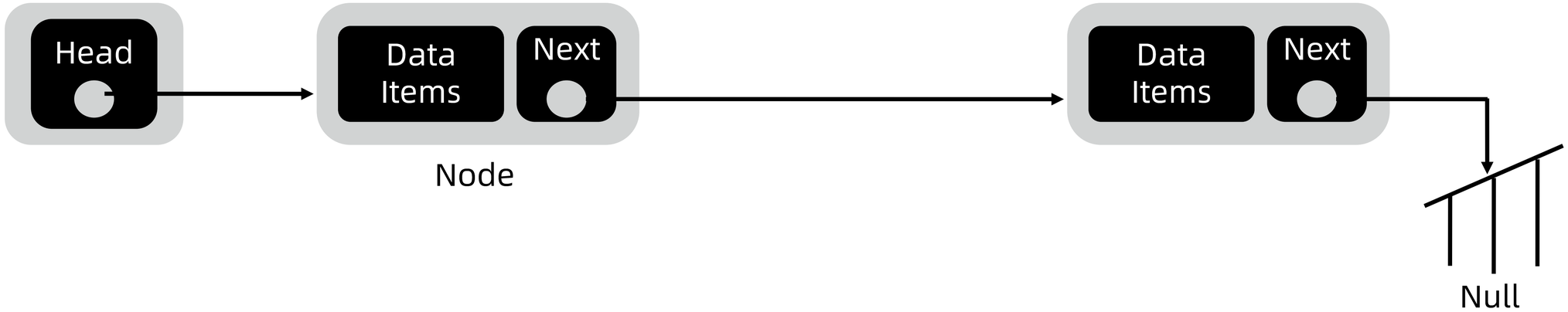
- 思考：若释放空间的阈值设定为 50%，会发生什么情况？

链表

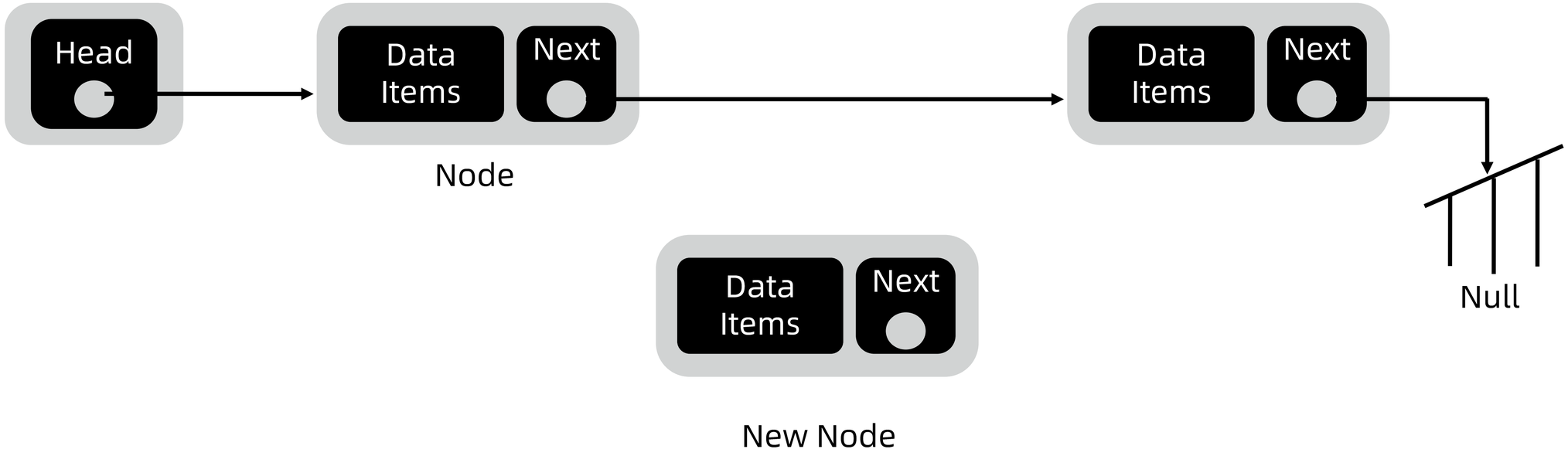
单链表 (linked list)



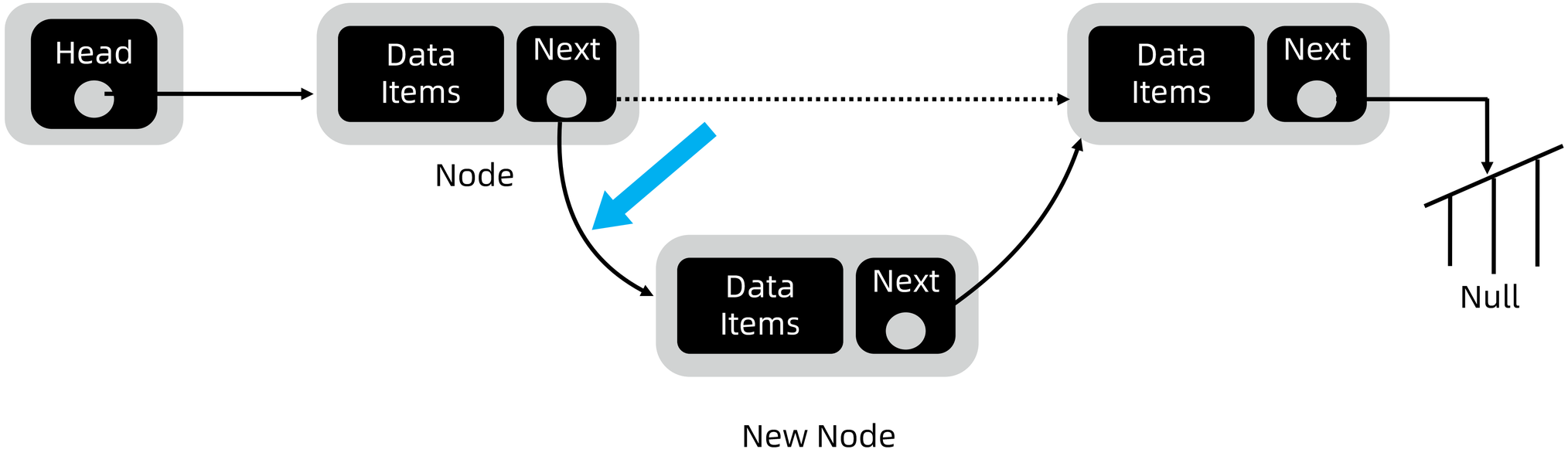
单链表 - 插入



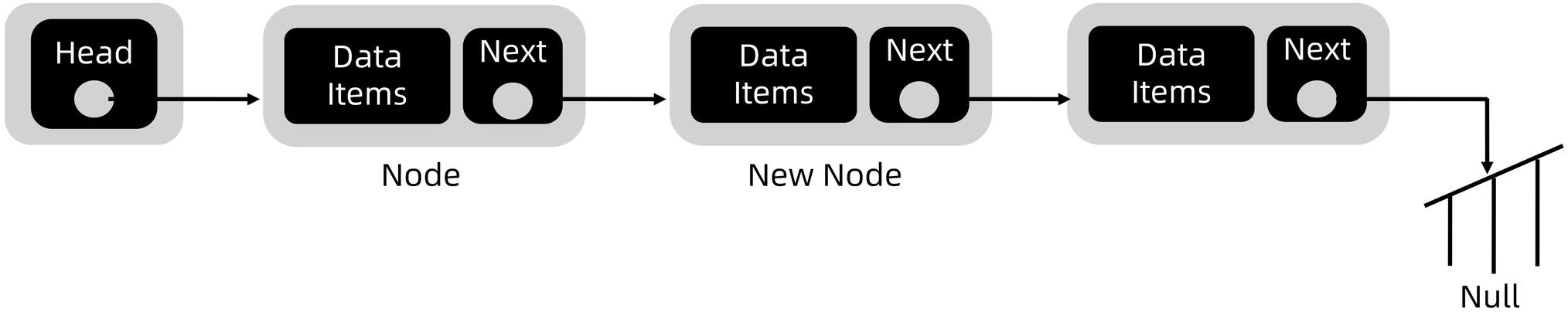
单链表 - 插入


Head
Data Items
Next
Node
Data Items
Next
Null
Data Items
Next
New Node

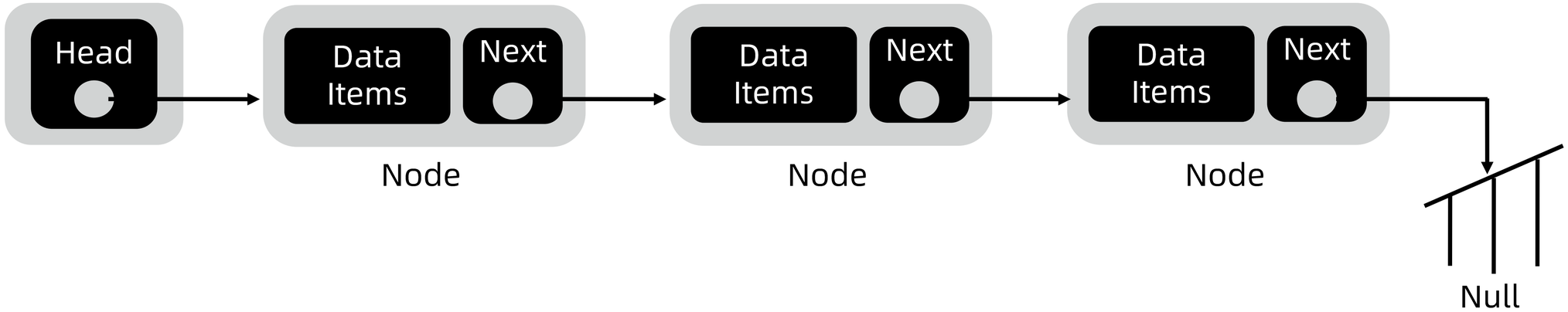
单链表 - 插入


Head
Data Items
Next
Node
Data Items
Next
Data Items
Next
Null
New Node

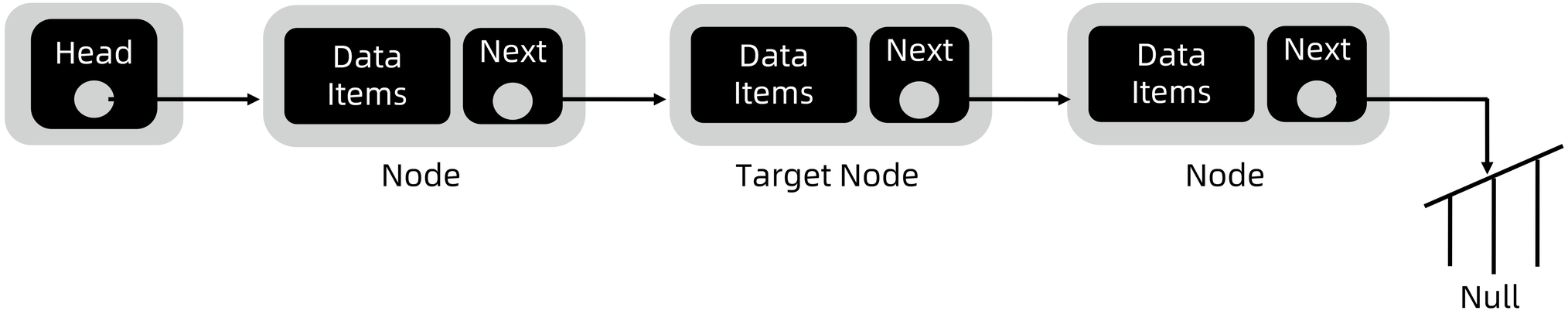
单链表 - 插入


Head
Data Items
Next
Node
Data Items
Next
New Node
Data Items
Next
Null

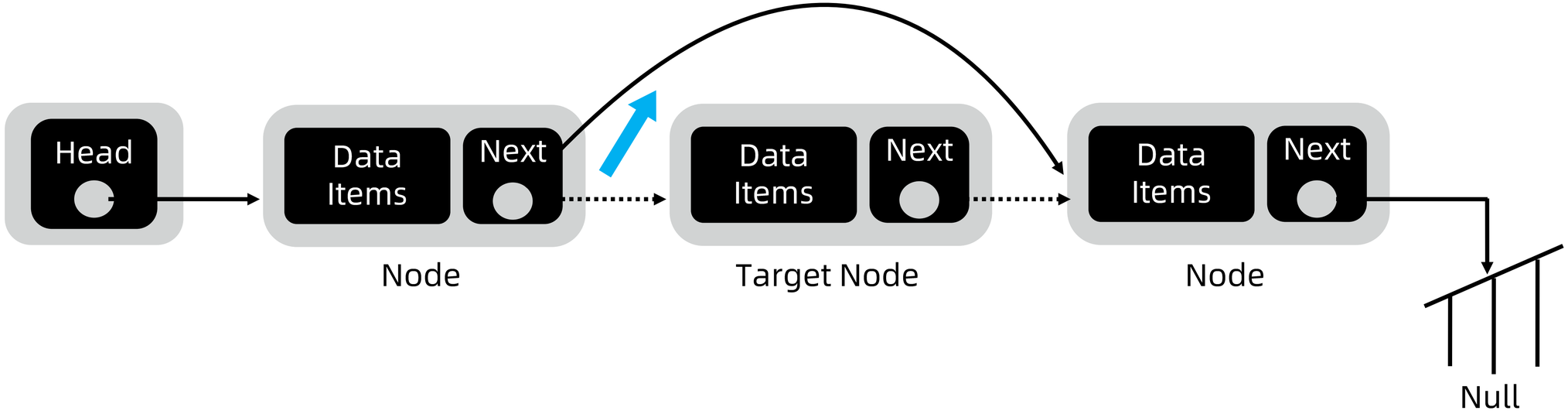
单链表 - 删除


Head
Data Items
Next
Node
Data Items
Next
Node
Data Items
Next
Node
Null

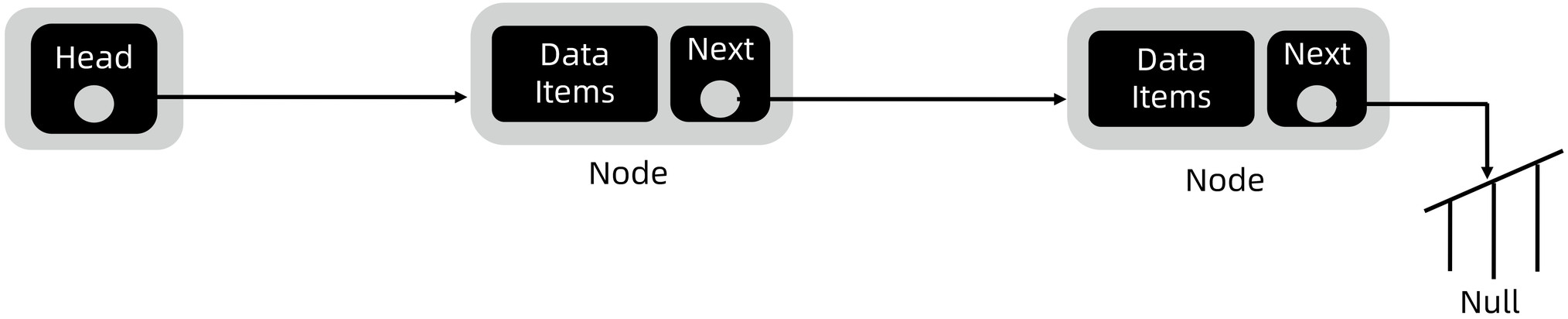
单链表 - 删除


Head
Data Items
Next
Node
Data Items
Next
Target Node
Data Items
Next
Node
Null

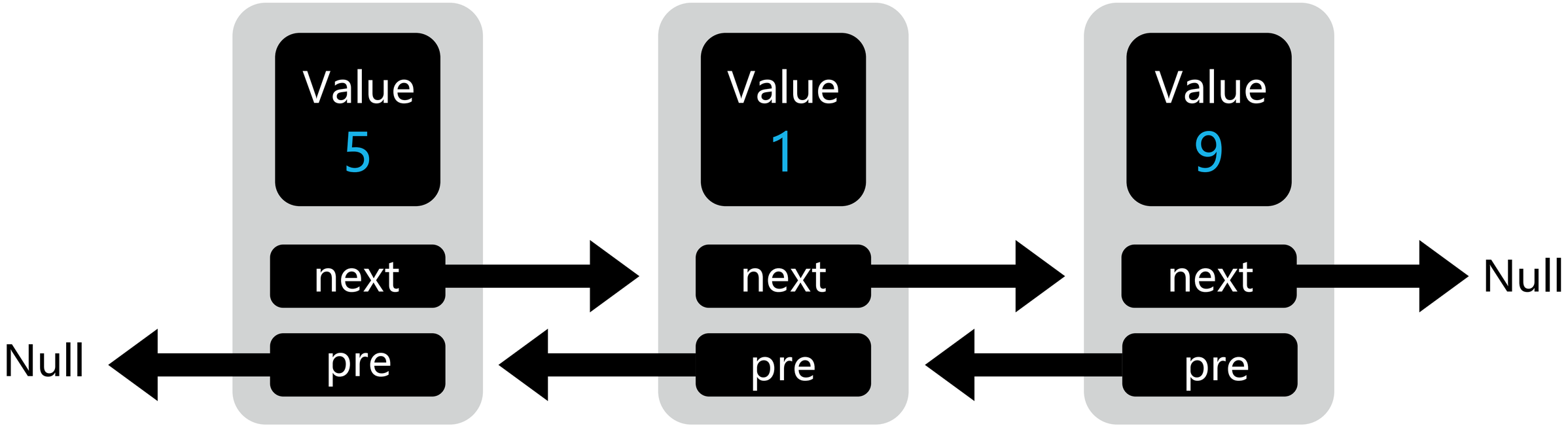
单链表 - 删除


Head
Data Items
Next
Node
Data Items
Next
Target Node
Data Items
Next
Node
Null

单链表 - 删除



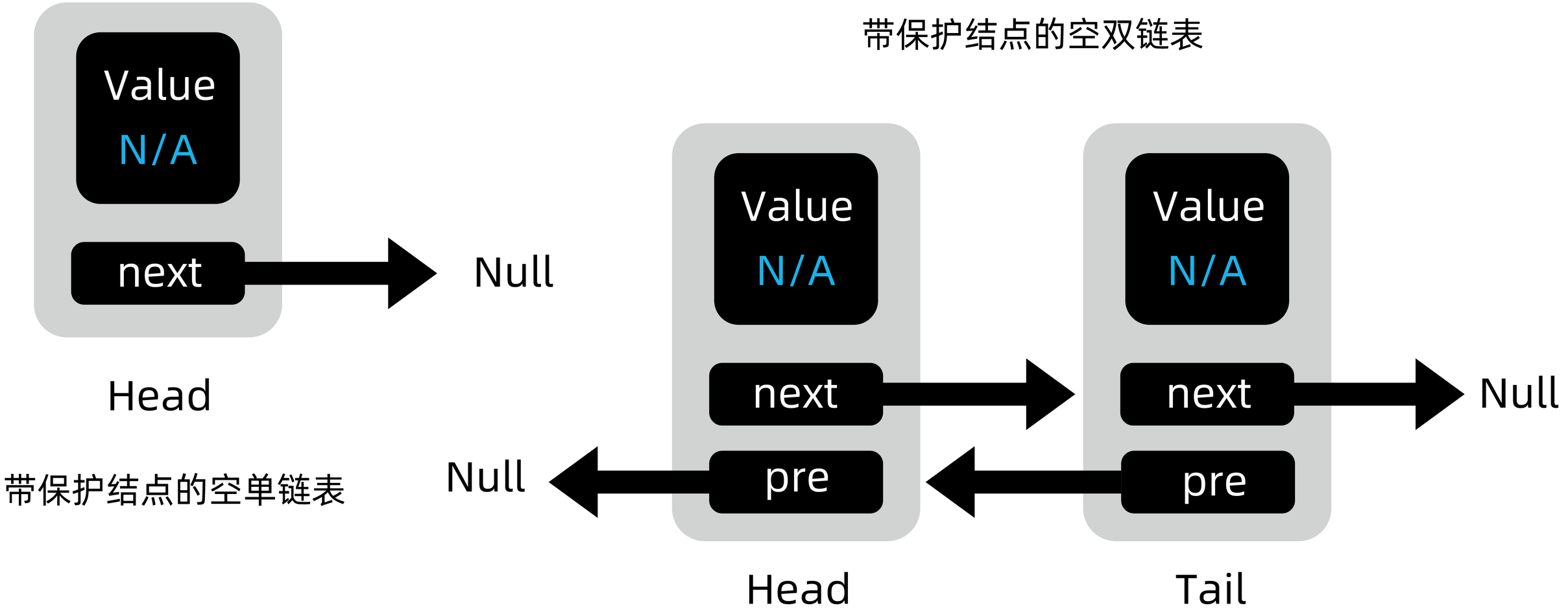
双链表 (double linked list)



时间复杂度

- Lookup O(n)
- Insert O(1)
- Delete O(1)
- Append (push back) O(1)
- Prepend (push front) O(1)

保护结点


Value
N/A
next
Null
Head
带保护结点的空单链表
带保护结点的空双链表
Value
N/A
Value
N/A
next
next
Null
Null
pre
pre
Head
Tail

实战

- 反转链表
- https://leetcode-cn.com/problems/reverse-linked-list/

- K个一组翻转链表
- https://leetcode-cn.com/problems/reverse-nodes-in-k-group/

实战：邻值查找（Hard）

https://www.acwing.com/problem/content/description/138/

给定一个长度为 n 的序列 A，A 中的数各不相同。

对于 A 中的每一个数 A_i，求 i 前面与 A_i 相差最小的数，即：

$$\min_{1 \le j < i} |A_i - A_j|$$

以及令上式取到最小值的位置 j。

若最小值点不唯一，则选择使 A_j 较小的那个。

实战：邻值查找

https://www.acwing.com/problem/content/description/138/

- 按数值排序，建立有序双链表
- 链表虽然不能随机访问，但可以记录A数组每个下标对应的链表结点
- 倒序考虑每个下标，只需要在链表中查找前驱、后继，然后删除结点

关键点

- “索引”的灵活性——按下标/按值
- 不同“索引”的数据结构之间建立“映射”关系
- 倒序考虑问题

实战

环形链表

https://leetcode-cn.com/problems/linked-list-cycle/

环形链表 II

https://leetcode-cn.com/problems/linked-list-cycle-ii/

实战

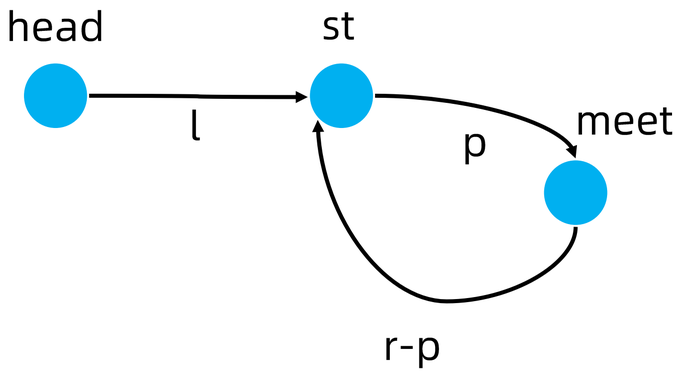
环形链表

https://leetcode-cn.com/problems/linked-list-cycle/

- 快慢指针法，O(length) 时间，O(1) 空间
- 有环必定发生套圈（快慢指针相遇），无环不会发生套圈（快指针到达null）

环形链表 II

https://leetcode-cn.com/problems/linked-list-cycle-ii/



实战

环形链表

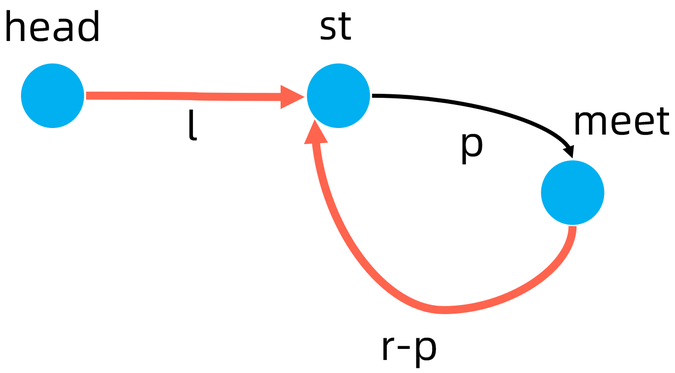
https://leetcode-cn.com/problems/linked-list-cycle/

- 快慢指针法，O(length) 时间，O(1) 空间
- 有环必定发生套圈（快慢指针相遇），无环不会发生套圈（快指针到达null）

环形链表 II

https://leetcode-cn.com/problems/linked-list-cycle-ii/

- 相遇时，有 2(l + p) = l + p + k * r，其中 k 为整数（套的圈数）
- 即 l = k * r - p = (k - 1) * r + (r - p)
- 含义：从 head 走到 st，等于从 meet 走到 st，然后再绕几圈
- 此时开始让慢指针与 head 同时移动，必定在环的起始点相遇



Homework

合并两个有序链表

https://leetcode-cn.com/problems/merge-two-sorted-lists/

加一

https://leetcode-cn.com/problems/plus-one/

THANKS