Array and List Operations

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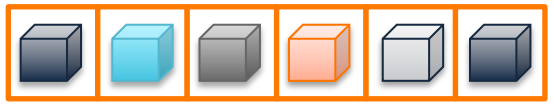
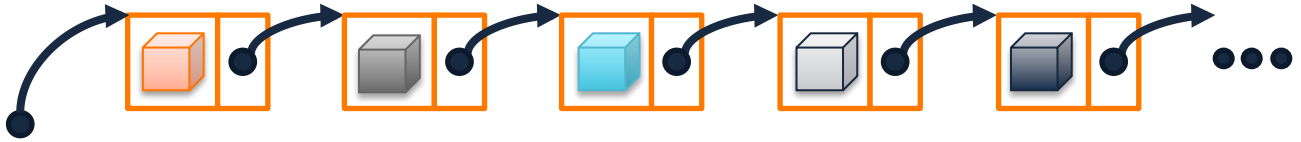
Arrays and Lists are both ordered collections of data. There are several key operations common to both all ordered collections that are worth analyzing.

Array



List



Access a Given Index

Objective: Access a given index in the collection.

Array:	**O(1)** Direct access via offset formula
List:	**O(n)** Must traverse every element to reach the index

Insert at front

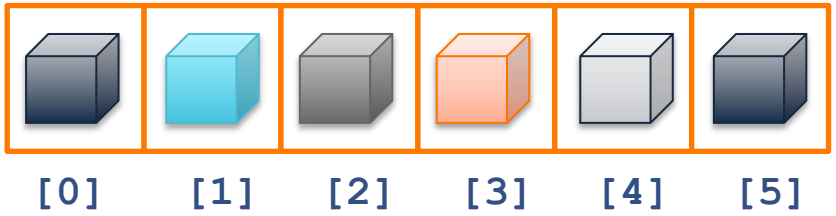
Objective: Insert an element at the front

Array:	**O(1)*** Amortized constant time when array size is doubled when copied
List:	**O(1)** Fixed constant time by adding the new data at the head of the list

Find Data

Objective: Given data, find the location of that data in the collection.

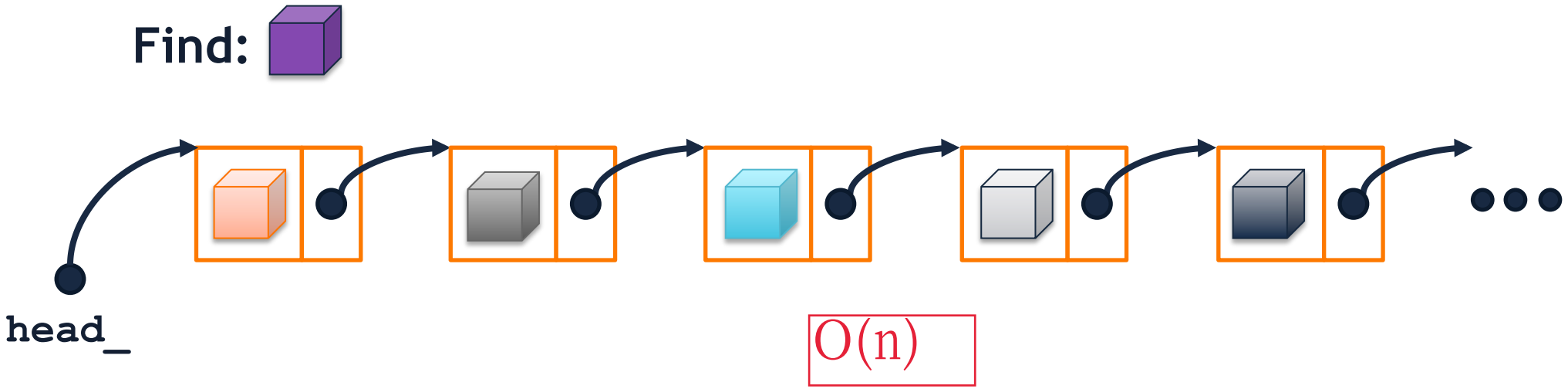
Find: 



O(n)

Find Data

Objective: Given data, find the location of that data in the collection.



Find Data

Objective: Given data, find the location of that data in the collection.

Array:	**O(n)** Requires searching up to the full array, one-by-one, to find a match
List:	**O(n)** Requires searching up to the full list, one ListNode at a time, to find a match

array/ex4/main.cpp

```
28 // Find a specific `target` cube in the array:
29 Cube target = Cube(400);
30 for (unsigned i = 0; i < cubes.size(); i++) {
31   if (target == cubes[i]) {
32     std::cout << "Found target at [" << i << "]" << std::endl;
33   }
34 }
```

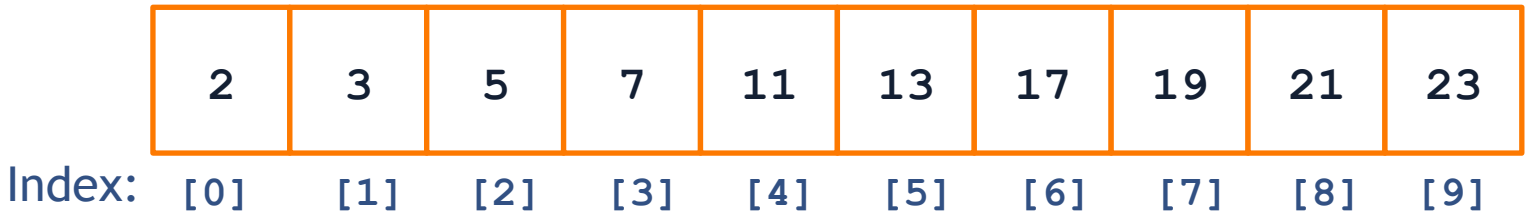
linked-memory/List.hpp

```
40 /**
41 * Finds and returns the ListNode containing `data` in the
42 * List or `nullptr` if the data is not found.
43 */
44 template <typename T>
45 typename List<T>::ListNode *List<T>::_find(const T & data) {
46   ListNode *thru = head_;
47   while (thru != nullptr) {
48     if (thru->data == data) { return thru; }
49   }
50
51   return nullptr;
52 }
```

Find Data in a Sorted Array

Objective: Given data, find the location of that data in the collection.

Find: 17

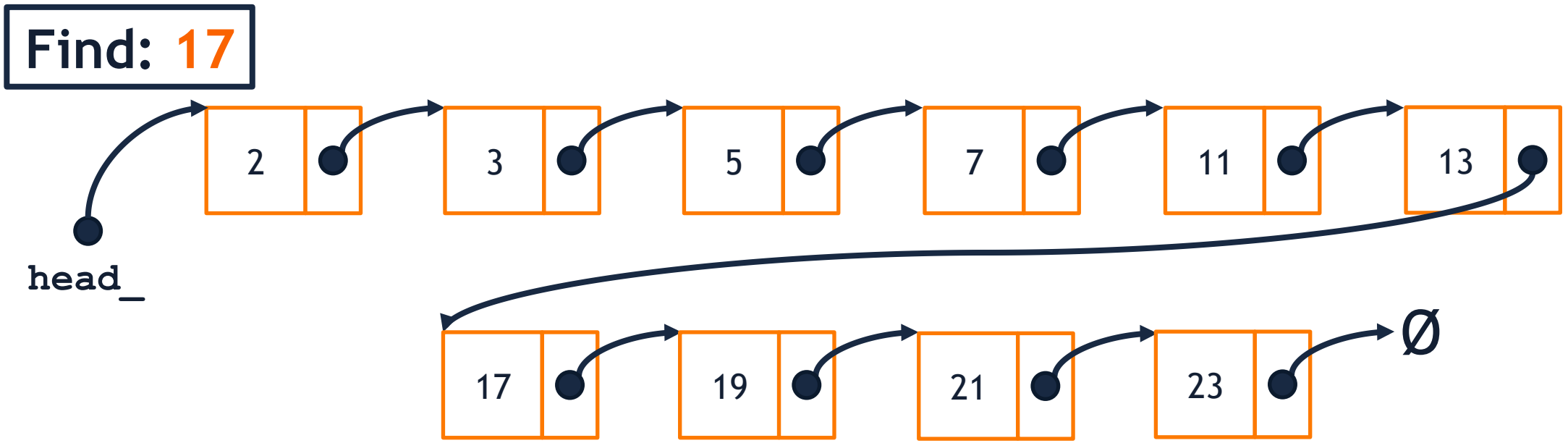


binary search: log(n)

Find Data in a Sorted Array

Objective: Given data, find the location of that data in the collection.

no pointer to the center, so still have to travel through: O(n)



Find Data

Objective: Given data, find the location of that data in the collection.

Unsorted Array:	**O(n)** Requires searching up to the full array, one-by-one, to find a match
Sorted Array:	**O(lg(n))** Using binary search, the run-time on an array becomes logarithmic
All Lists:	**O(n)** Requires searching up to the full list, one ListNode at a time, to find a match – even if the list is sorted

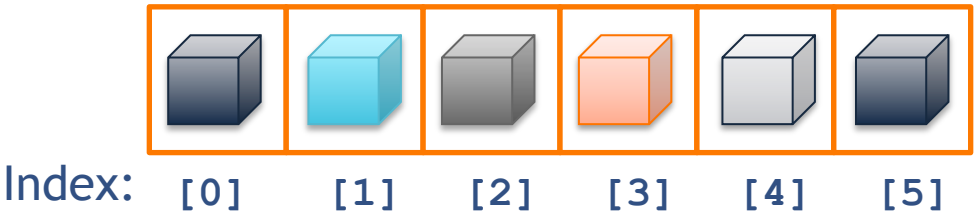
Insert After

Objective: Given an element (ListNode or index), insert a new element immediately afterwards.

Insert After

Objective: Given an element (array index), insert a new element immediately afterwards.

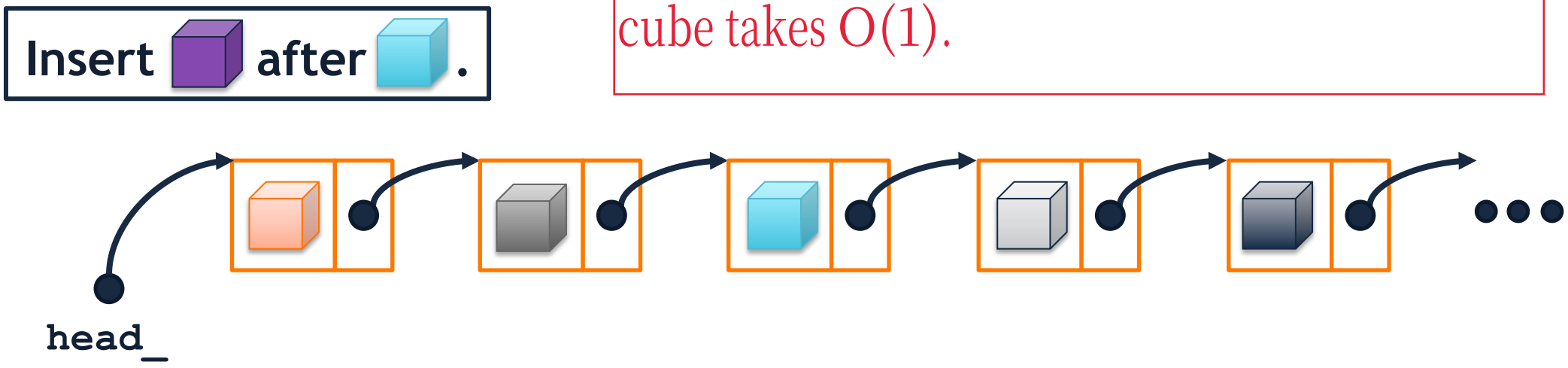
search for the pink cube (takes O(log(n)n)), move the element on the right (takes O(n))



Insert After

Objective: Given an element (ListNode), insert a new element immediately afterwards.

search for the blue cube (O(n)), insert a new cube takes O(1).



Insert After

Objective: Given an element (ListNode or index), insert a new element immediately afterwards.

Array:	**O(n)** Requires copying up to half of the array to make space for the new element
List:	**O(1)** Fixed constant time to add a new element after finding the previous element

Delete After

Objective: Given an element (ListNode or index), delete the element immediately afterwards.

Array:	**O(n)** Requires copying up to half of the array to remove the blank space
List:	**O(1)** Fixed constant time to remove a ListNode and repair the list

Array and List Operations

- Arrays and lists are both ordered collections that have complex tradeoffs between run-time and flexibility.

- We will build data structures using these primitive structures.