Data Structures & Algorithms

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Searching Algorithms-1

Linear (Sequential) Search

- A very simple algorithm
  - Start at the beginning of the list
  - Move through the list, element-by-element, sequentially
  - Continue until the key is found, or
  - Until the end of the list is reached

Linear (Sequential) Search

- Time Complexity: O(n)
- List does not have to be sorted

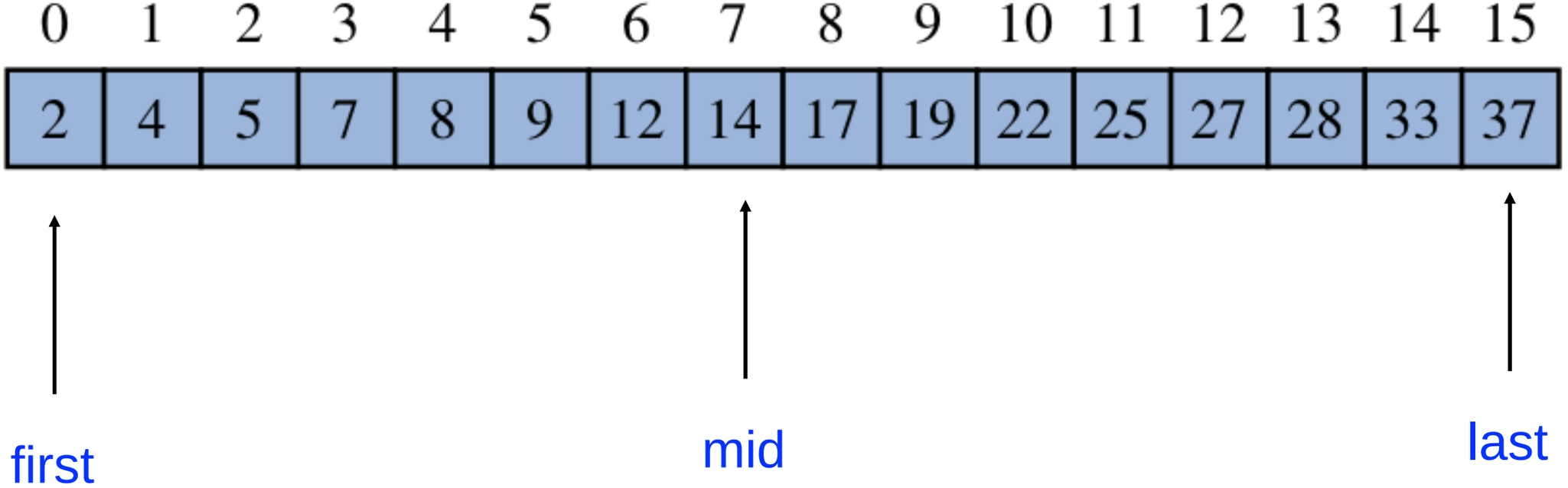
Binary Search

- If the list is sorted, a more efficient search strategy can be used
- That is, check to see whether the key is
  - equal to the middle element -> terminate (found)
  - less than the middle element -> search the left half
  - greater than the middle element -> search the right half
- Continue until either the key is found, or there are no more elements to search
- Time complexity: $O(\log_2(n))$

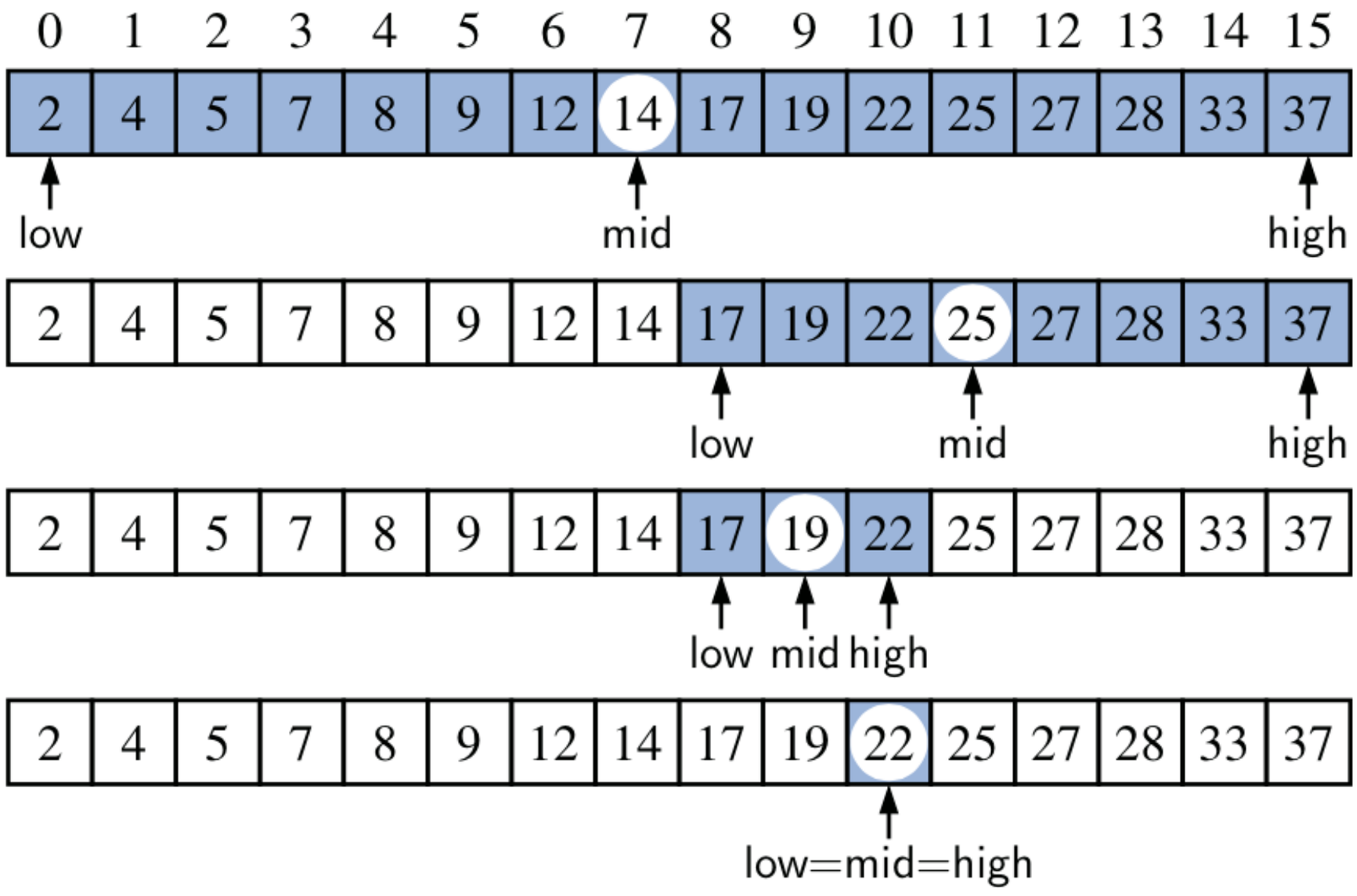
Implementation of Binary Search in Java

```
1   /**
2    * Returns true if the target value is found in the indicated portion of the data array.
3    * This search only considers the array portion from data[low] to data[high] inclusive.
4    */
5   public static boolean binarySearch(int[ ] data, int target, int low, int high) {
6     if (low > high)
7       return false;                                   // interval empty; no match
8     else {
9       int mid = (low + high) / 2;
10      if (target == data[mid])
11        return true;                                  // found a match
12      else if (target < data[mid])
13        return binarySearch(data, target, low, mid - 1);   // recur left of the middle
14      else
15        return binarySearch(data, target, mid + 1, high);  // recur right of the middle
16    }
17  }
```

Binary Search



Binary Search

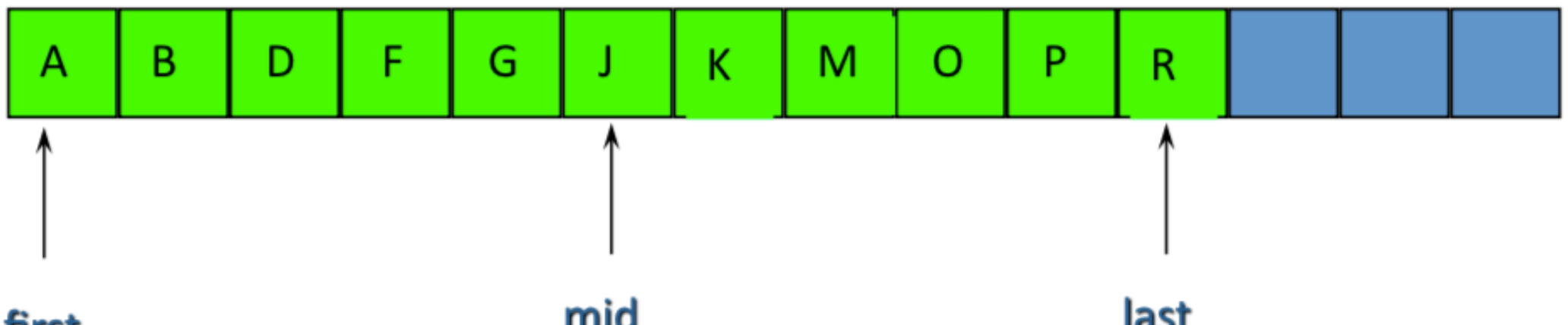


Example of a binary search for target value 22

Binary Search

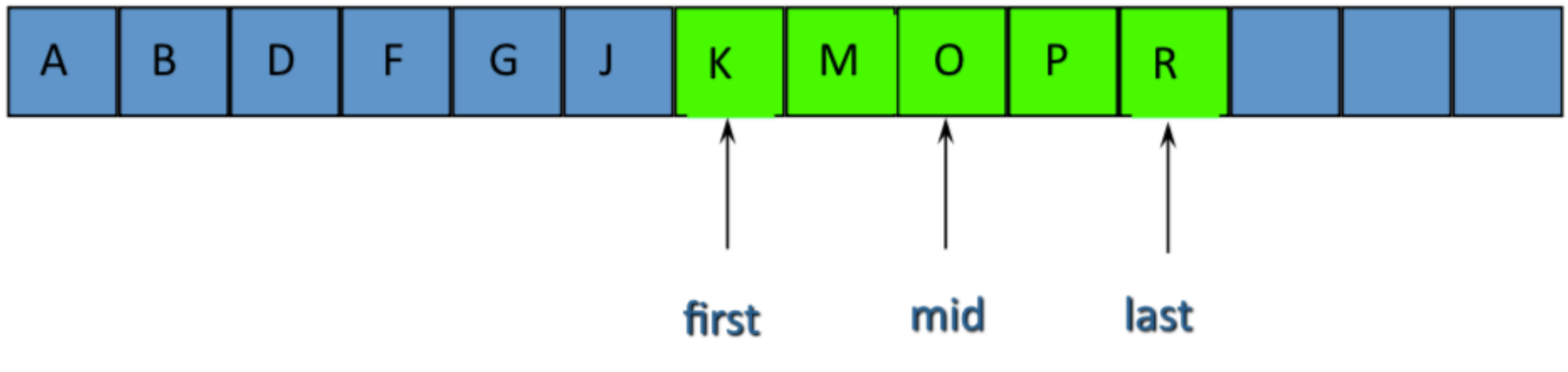

```
first:
last:
mid:
list[mid]:
key:        P
```

Binary Search



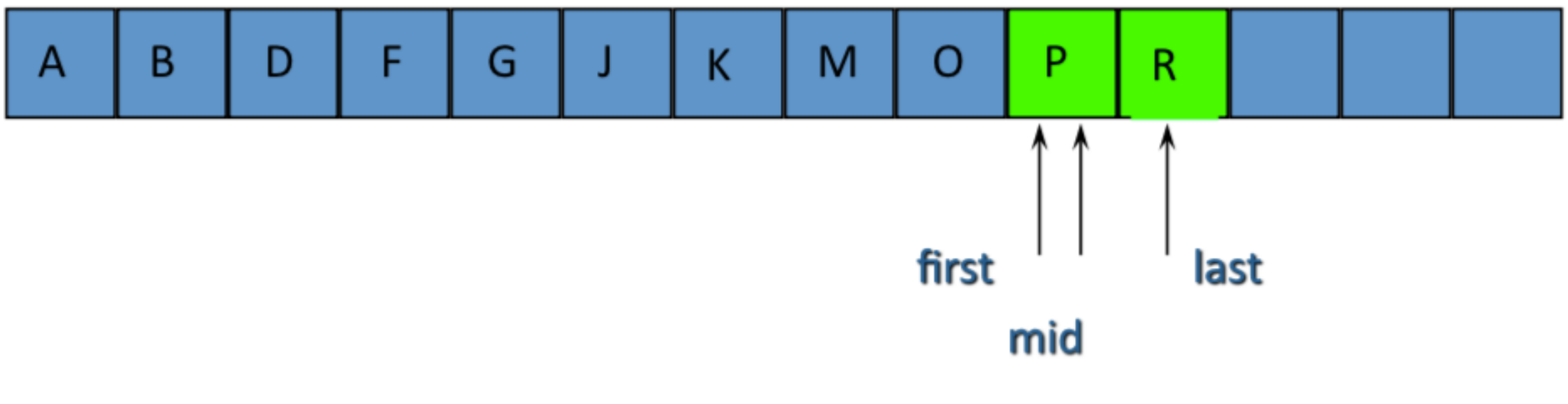

```
first:      1
last:      11
mid:        6
list[mid]: J
key:       P
```

Binary Search




```
first:      1   7
last:      11  11
mid:        6   9
list[mid]: J   O
key:        P   P
```

Binary Search

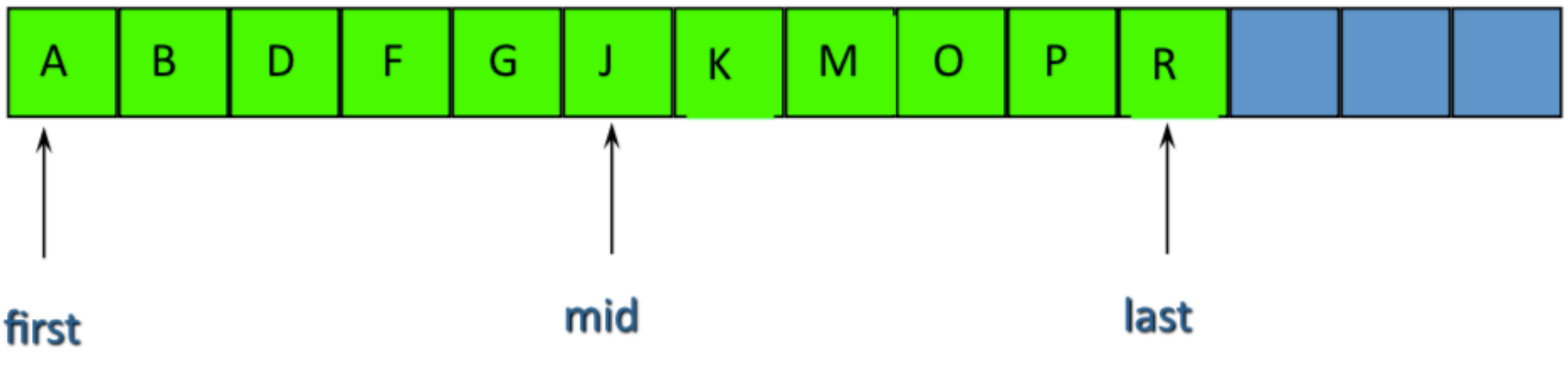



```
first:      1   7   10
last:      11  11   11
mid:        6   9   10
list[mid]: J   O    P   <-- FOUND!
key:        P   P    P
```

Binary Search

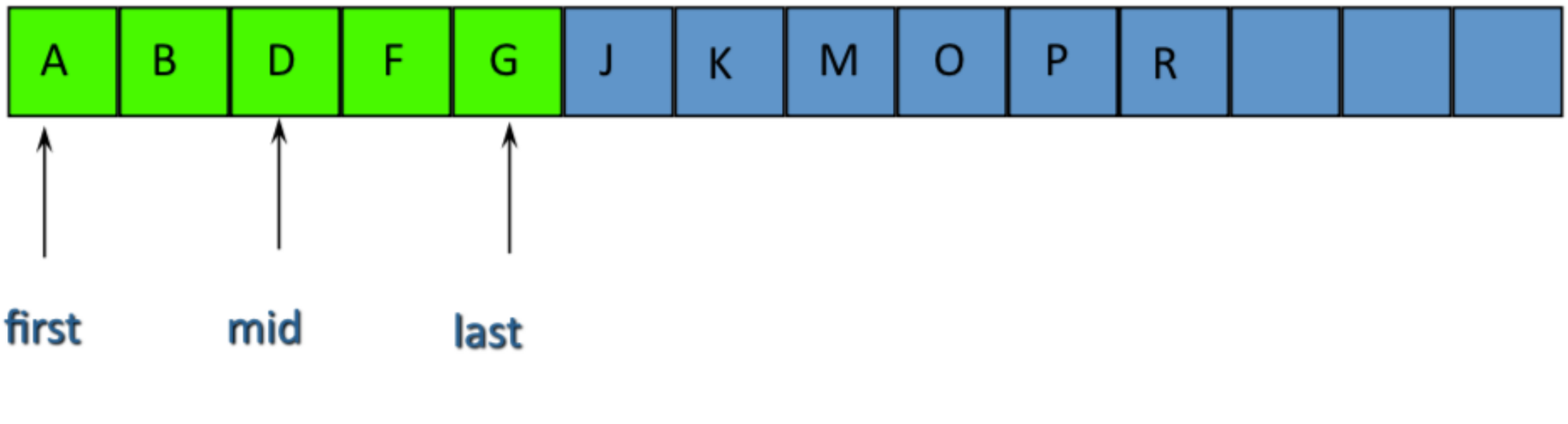

```
first:
last:
mid:
list[mid]:
key:        E
```

Binary Search



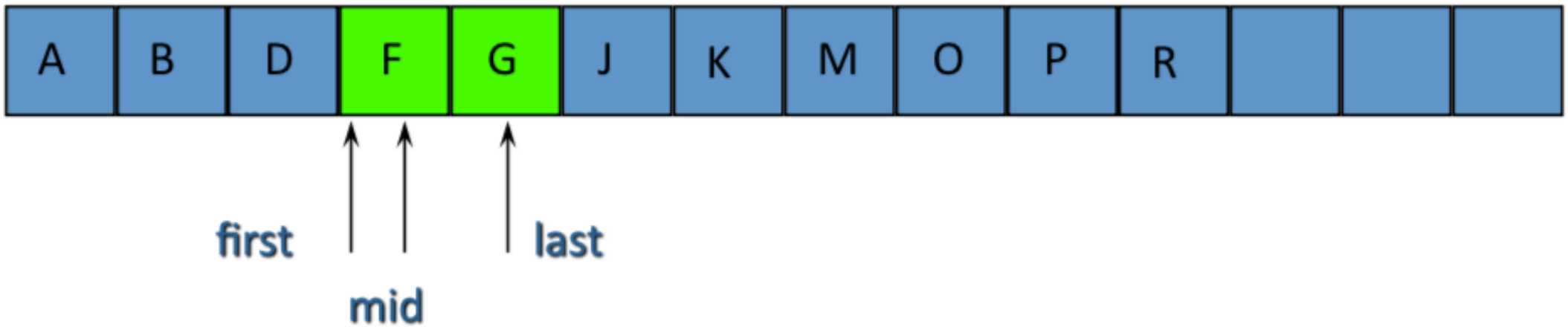

```
first:      1
last:      11
mid:        6
list[mid]: J
key:        E
```

Binary Search



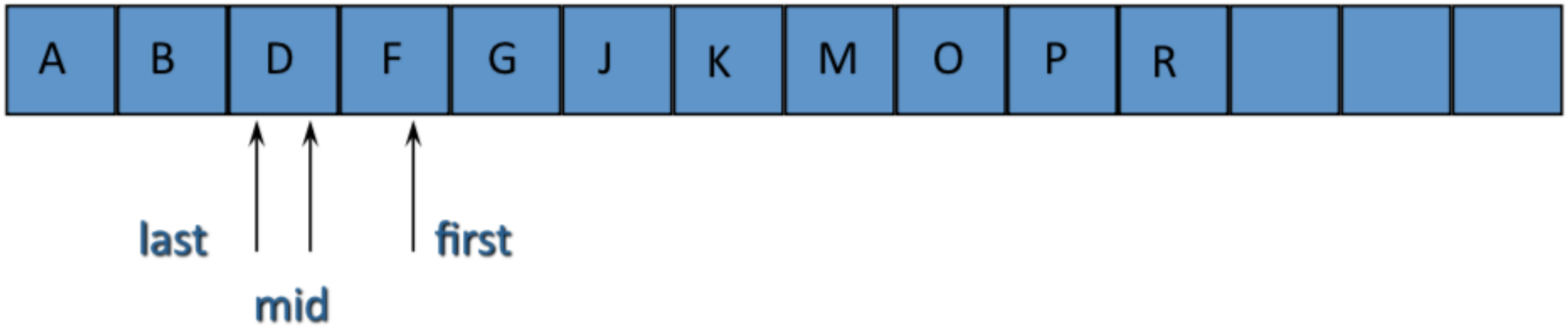

```
first:     1   1
last:     11   5
mid:       6   3
list[mid]: J   D
key:       E   E
```

Binary Search




```
first:      1   1   4
last:      11   5   5
mid:        6   3   4
list[mid]: J   D   F
key:       E   E   E
```

Binary Search




```
first:      1    1    4    4
last:      11    5    5    3
mid:        6    3    4    3
list[mid]: J    D    F    D
key:        E    E    E    E
```

first > last: NOT FOUND!