Searching an Array – Binary Search

Lecture 35
Section 9.1

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Mon, Dec 3, 2018

Outline

The Binary Search

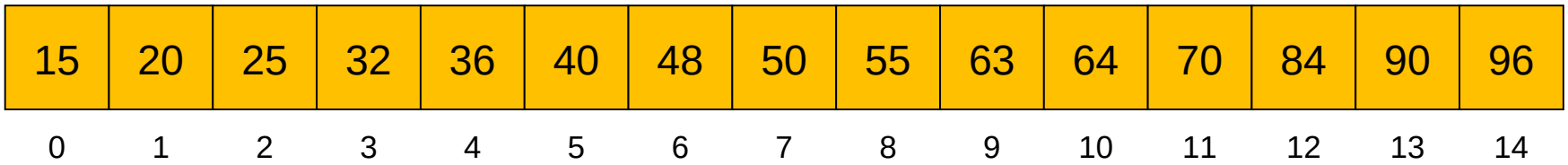
- If the list is sorted, use a binary search.
- The binary search
  - Runs in O(log n) time.
  - Is very efficient.
  - Is suitable for *enormous* lists.

Outline

The Binary Search Algorithm

- The list must be sorted for this algorithm to work.
- The Algorithm
  - Begin by comparing the value to the middle element.
  - If the value matches the middle element, then we are done.
  - If the value is less than the middle element, then
    - Continue the search in the first half of the array.
  - If the value is greater than the middle element, then
    - Continue the search in the second half of the array.
  - Quit if there are no elements left to search in the sublist.

Analysis of the Binary Search



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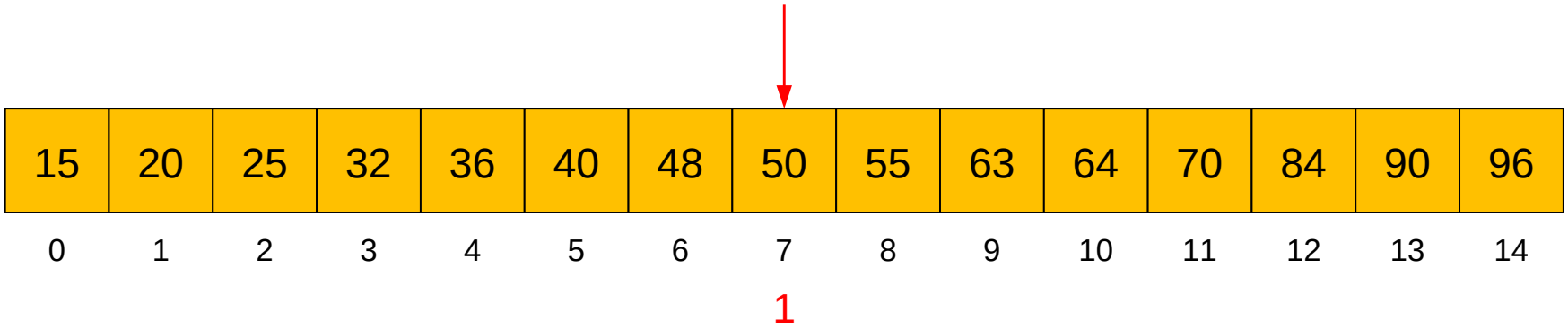
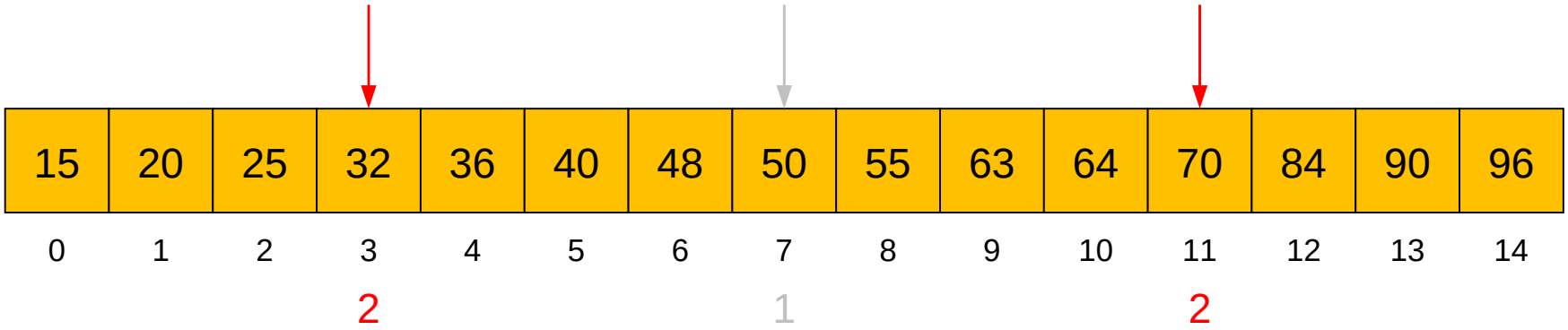


Analysis of the Binary Search



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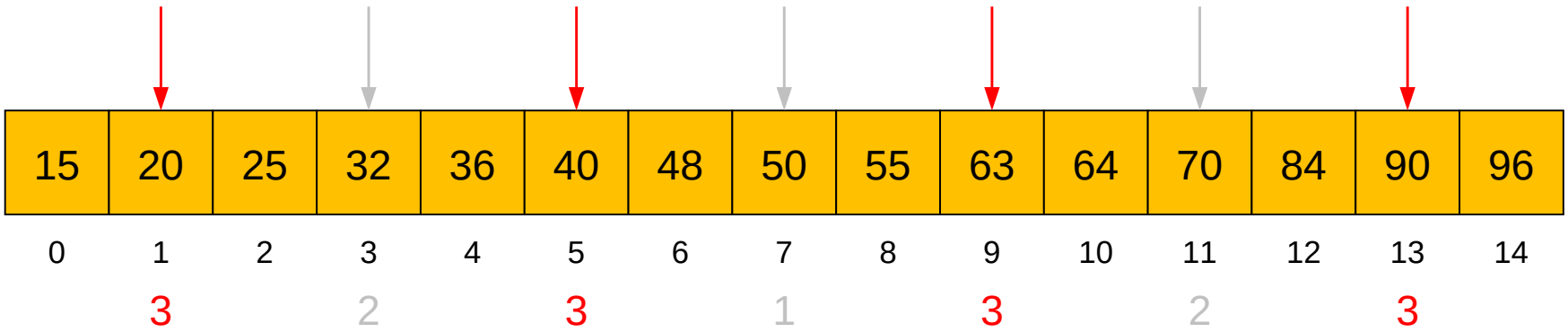

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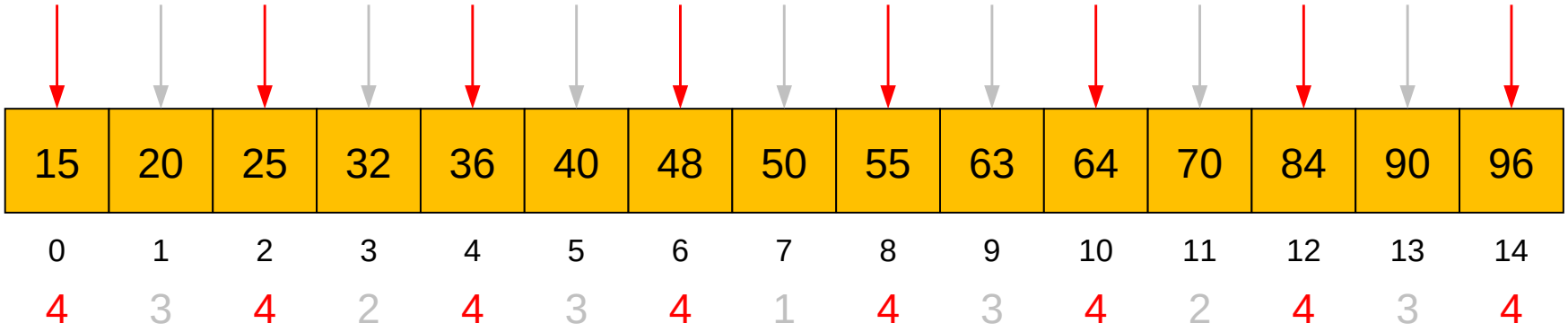

Analysis of the Binary Search

- Best case: 1 comparison.
- Worst case: 4 comparisons.
- Average case:

$$\begin{aligned}(1+2+2+3+3+3+3+4+4+4+4+4+4+4+4)/15 \\ &= 49/15 \\ &= 3.267 \text{ comparisons.}\end{aligned}$$

Outline

Efficiency of the Binary Search

- Best case requires 1 comparison.
- Worst case requires approximately $\log_2 n$ comparisons.
- Average case requires approximately $(\log_2 n) - 1$ comparisons, which is $O(\log n)$.
- There is a library function `bsearch()` in `cstdlib` that performs a binary search.

Efficiency of the Binary Search

- Can we perform a sequential search on a list of `Date`s?

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- Can we perform a binary search on a list of `Rational`s?
- Can we perform a sequential search on a list of `Point`s?

Efficiency of the Binary Search

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- Can we perform a sequential search on a list of `Rational`s?
- Can we perform a binary search on a list of `Rational`s?
- Can we perform a sequential search on a list of `Point`s?
- Can we perform a binary search on a list of `Point`s?

Outline

Examples of a Binary Search

- Examples
  - `BinarySearch.cpp`
  - `BinarySearchCounter.cpp`
  - `BinarySearchTimer.cpp`

Outline

Assignment

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- Read Section 9.1.