CSCI 241

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Algorithm Case Study: Binary Search

Goals

Understand how the binary search algorithm works, and under what conditions.

Be able to execute binary search on paper.

Searching an array

Goal: return the index of `v` in `A`.

The straightforward way:

```
for i = 0..A.length:
  if A[i] == v:
    return i
return -1
```

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Can we do better?

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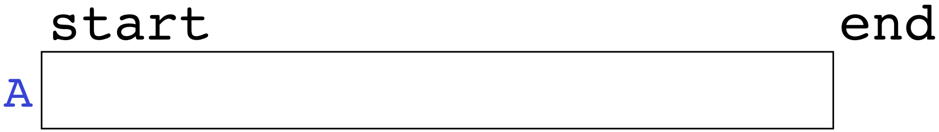
Can we do better?

Nope (in general).

Searching a **sorted** array

Goal: return the index of `v` in `A`.

Precondition: A is sorted.



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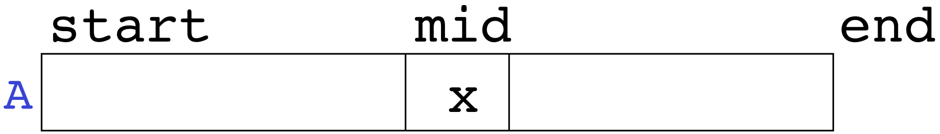

start mid end

A

x

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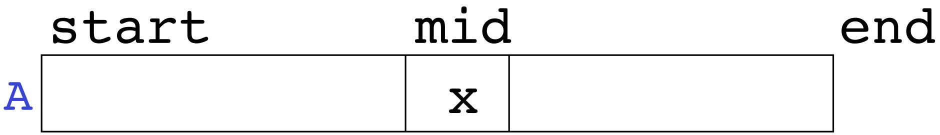
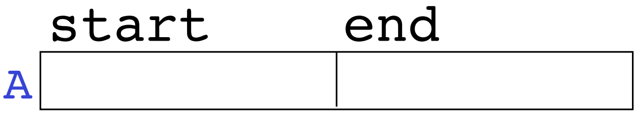


If `v < x`,

`v` can't be after `mid`!



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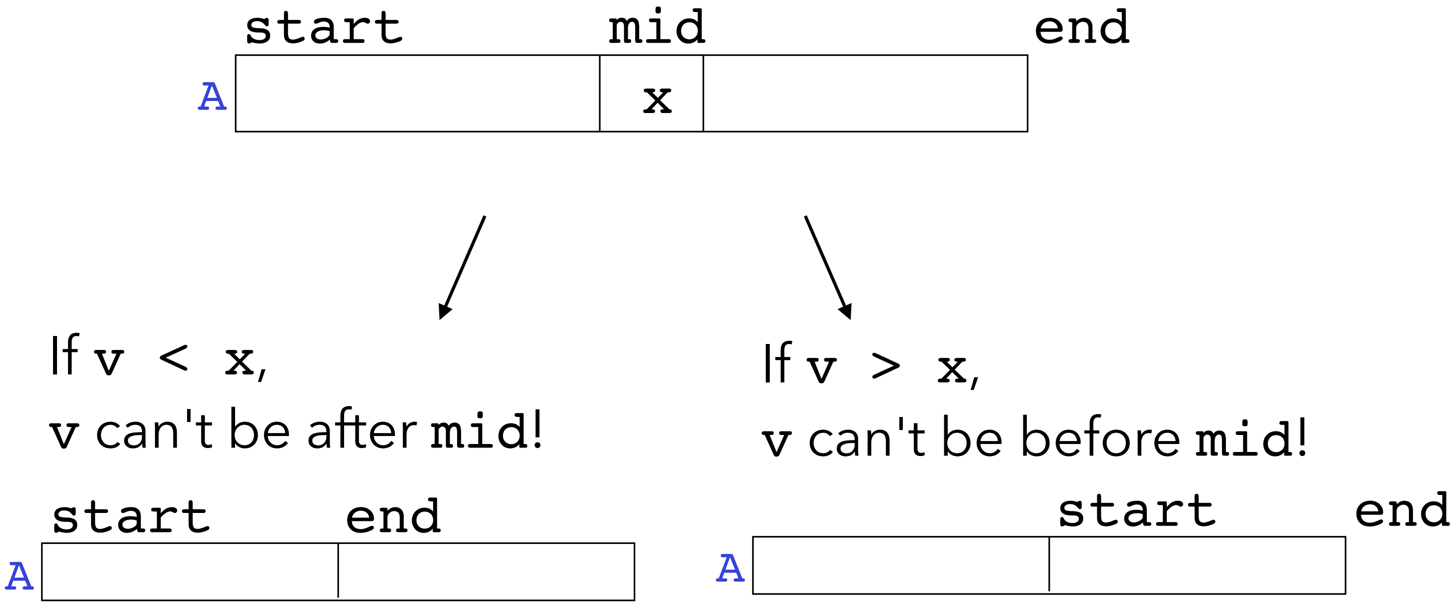

If `v < x`,
`v` can't be after `mid`!

If `v > x`,
`v` can't be before `mid`!

Binary Search: Example

`binarySearch(A, 21)`

```
     s        x← m|              |e
A:  [1, 1, 2, 3, 5, 8, 13, 21, 34]
                21 > 5

                 s   s   m         e
    [1, 1, 2, 3, 5, 8, 13, 21, 34]
                       21 > 13

                            e
                        s  ] m     e
    [1, 1, 2, 3, 5, 8, 13, 21, 34]
                          21 == 21
```

Binary Search: Example

`binarySearch(A, 4)`

```
      s           m                e
A:   [1, 1, 2, 3, 5, 8, 13, 21, 34]
                 4<5

      s     m     e
     [1, 1, 2, 3, 5, 8, 13, 21, 34]
          4>2  e
               m
               s  e
     [1, 1, 2, 3, 5, 8, 13, 21, 34]
               3<4
            →s..e←  empty range
```