# Binary search

To search, we need a target to search and a place (search space) to search for that target.

Lets say we are looking fo meaning of a word, where are we going to search for that word?

| target | search space |
| --- | --- |
| kabul | books, newspapers, dictionaries |

why dictionary, not books? in Dictionary the search space is ordered and there is no need of looking whole dictionary.

Linear search: search the whole space one by one.

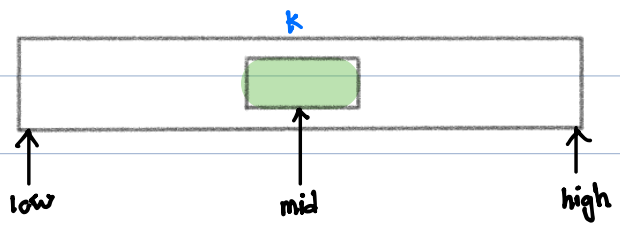
Binary search: Every time divide the search space into two sections and discard one of those sections.

**Question:** Given an array of integers, search for a target k;
Return True if the target element is present.

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|---|
| arr = [ | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 ] | k = 14 |

Binary search
- search space = array
- target = k

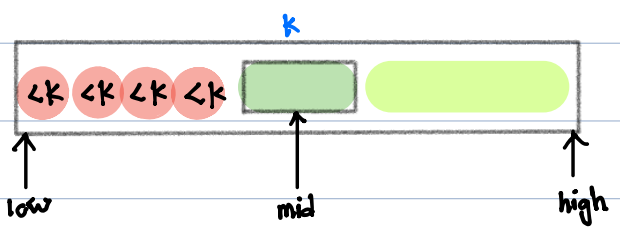
**case - 1:**




$$mid = \frac{low + high}{2}$$

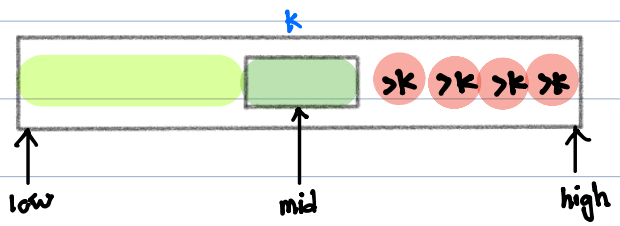
arr[mid] == k:
return True

**case - 2**




if arr[mid] < k :
discard left side // search on right

## Case- 3




if arr[mid]>k :

discard right // search on left

arr = [ 0:2 1:4 2:6 3:8 4:10 5:12 6:14 7:16 ]  k=14

arr[3]<k = 8<10

| low | high | mid |
|---|---|---|
| 0 | 7 | 7//2=3 |

low, high

arr = [ 0:2 1:4 2:6 3:8 4:10 5:12 6:14 7:16 ]

discard left of mid

update low to mid+1

| | | |
|---|---|---|
| 4 | 7 | 4+7//2 = 5 |

low, high

arr = [ 0:2 1:4 2:6 3:8 4:10 5:12 6:14 7:16 ]

arr[5]<k

discard left of mid

update low to mid+1

| | | |
|---|---|---|
| 6 | 7 | 6+7//2 = 6 |

low, high

arr = [ 0:2 1:4 2:6 3:8 4:10 5:12 6:14 7:16 ]

arr[6] == k

return True