# Search algorithms

- Linear search
  - Search from the first item until the search item is found found or end of the array is reached.
  - Array doesn’t have to be sorted

- Binary search in a sorted array
  - Compare the item in the middle with the search item.
    - If found STOP.
    - If item > search item
      - Search in the first half of the array
    - else
      - Search in the last half of the array
  - Repeat until found or until the size of the array is less than or equal to 1.

# Linear search example

A

| 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 3 | 1 | 5 | 4 | 2 |

Search item = 4

Is A[0] == 4 No
Is A[1] == 4 No
Is A[2] == 4 No
Is A[3] == 4 Yes STOP return true

# Linear search pseudo-code

```
Inputs: array: A, size of the array: size,
search item: value
    index = 0
    WHILE (index < size && A[index] != value)
        index++;
    ENDWHILE
    IF (index < size)
        return true
    ELSE
        return false
    ENDIF
```

# Binary search  example

| 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Search item = 4

Part of the search array

1. Search in items with index (0 to 4)

| 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

index_middle = (0 +4)/2 = 2;

Is A[index_middle] == 4 No

Is A[index_middle] < 4 yes,  search in items with index (3,4)

2. index_middle = (3+4)/2 = 3;

| 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Is A[index_middle] == 4 Yes, stop.

# Binary search pseudo-code

```
Input parameters: sorted array A, size,  search value: value
Output: boolean true or false

 start_index = 0
 end_index   = size-1

 WHILE (start_index <= end_index)
      middle_index = (start_index  + end_index)/2;
        IF (A[middle_index] == value)
              return true
        ELSEIF (A[middle_index] > value) //look in the first half
               end_index = middle_index -1
        ELSE // look in the second half
               start_index = middle_index +1
        ENDIF
 ENDWHILE
 return false
```

# Questions

- How many comparisons between an array item and the search value are needed to determine that a search value is not in the array for an array size of 10:
  - Linear search:
  - Binary search:
- What about for an array of size 1,000? Linear/Binary search