



Linear search: appropriate data

Whilst a linear search is not the most efficient algorithm, it is the most appropriate in some situations. The options below show examples of lists of data. The actual lists would be far longer but the nature of each list would be as shown in the example.

From the choices below, select the list for which it would be most appropriate to use a **linear search** if you need to find something in the list.

- ☐ ["Yellow", "Teal", "Purple", "Green", "Blue"]
- ☐ [393, 783, 656, 143, 727]
- ☐ [1, 38, 41, 56, 64, 78]
- ☐ ["TN-0094", "TN-0184", "TN-0412", "TN-0905", "TN-0939"]

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Linear search: order steps

Amaia coaches a school basketball team. She keeps the scores that the team got in the latest tournament in a list called `basketball_finals`. You can see the items of the list below:

basketball_finals							
120	250	101	150	80	95	147	165

Part A

Amaia is using the linear search algorithm to find out if the team scored 200 points in any of the games. How many comparisons will the linear search algorithm perform before it finishes?

Part B

Amaia is using the linear search algorithm to find out if the team scored 150 points in any of the games. Put in order the steps that the linear search algorithm will follow when searching for the item 150 in the list `basketball_finals`.

Available items

Go to the next item in the list: 250

Compare 250 to 150: 250 is not equal to 150

Compare 101 to 150: 101 is not equal to 150

The item was found, stop searching

Compare 120 to 150: 120 is not equal to 150

Start from the first item in the list: 120

Compare 150 to 150: 150 is equal to 150

Go to the next item in the list: 101

Go to the next item in the list: 150

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Linear search: use of flag

Consider the pseudocode implementation below:

Pseudocode

```
1 FUNCTION linear_search(data_set, item_sought)
2     index = -1
3     i = 0
4     found = False
5     WHILE i < LEN(data_set) AND found == False
6         IF data_set[i] == item_sought THEN
7             index = i
8             found = True
9         ENDIF
10        i = i + 1
11    ENDWHILE
12    RETURN index
13 ENDFUNCTION
```

Part A

Linear search can be a very inefficient algorithm because, in some versions, it iterates through the whole of the list even when the item has already found.

In this more efficient version of the algorithm, which variable is used to terminate the loop when the item has been found? Please write the variable's name and nothing else.

Part B

Consider the following list:

```
data = [262, 764, 301, 220, 471, 900, 139, 779, 439, 190]
```

What would be returned from the following statement?

```
linear_search(data, 471)
```

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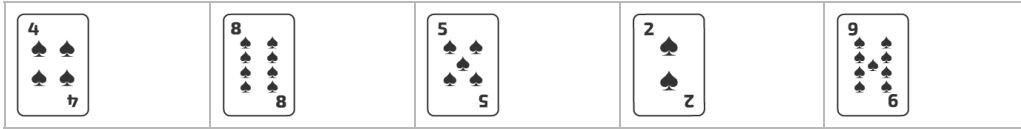
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Binary search: appropriate data

You have been provided with some cards that are in the following order:



Why could you **not** use a binary search for this data?

- ☐ There is not enough data.
- ☐ The data is not sorted in an ascending (low to high) or descending (high to low) order.
- ☐ The data is not a list of numbers.

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Binary search: max comparisons 1

What is the **maximum** number of comparisons that a binary search will apply for an array of length 30?

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Binary search: max comparisons 2

A warehouse has the details of 10,000 products stored in a list, **ordered by product number**.

What is the **maximum number of comparisons** that will be made to find a specific product, by product number, using a **binary search**?

Quiz:

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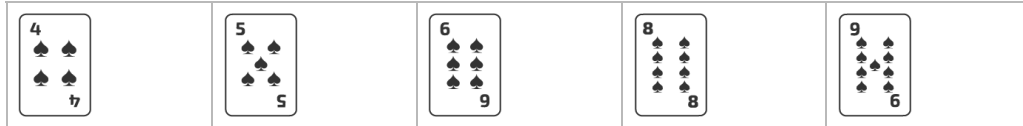
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Binary search: midpoint

You have been given a set of cards that are in the following order:



A binary search is going to be used to search for an item in the list. Which value card is at the first midpoint calculated by the algorithm?

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Binary search: complete algorithm

Below is a function for carrying out a binary search expressed in pseudocode.

The statement to calculate the midpoint is incomplete. Using the values below, **complete the missing part of the statement** to determine the midpoint.

```
FUNCTION binary_search(data_set, item_sought)
  index = -1
  found = False
  first = 0
  last = LEN(data_set) - 1
  WHILE first <= last AND found == False
    midpoint = 
    IF data_set[midpoint] == item_sought THEN
      index = midpoint
      found = True
    ELSE
      IF data_set[midpoint] < item_sought THEN
        last = midpoint - 1
      ELSE
        first = midpoint + 1
      ENDIF
    ENDIF
  ENDWHILE
  RETURN index
ENDFUNCTION
```

Items:

(first + last) 2 / last DIV LEN(data_set) first

Quiz:

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Binary search: order steps 1

Tom sells knitwear via his website. He has a list with the number of products that he's sold in the last ten days.

products_sold									
11	16	17	22	25	30	35	46	57	72

Tom is using the binary search algorithm to search through the list of sales.

The binary search implementation uses the following formula to calculate the midpoint position:

$$\text{midpoint} = (\text{first} + \text{last}) \text{ DIV } 2$$

Remember that integer or floor division (DIV) is when any remainder of a division is discarded. For example, $11 \div 5 = 2$ remainder 1, and so 11 DIV 5 will return 2.



Part A

Tom wants to find out if there is a day that he sold 22 products.

Fill in the blanks with the values provided below to complete the steps that a binary search will follow when searching for 22 in the products_sold list. The list of items has been copied below to help answer the question.

products_sold									
11	16	17	22	25	30	35	46	57	72

Take the ordered list products_sold and the search item 22.
Initially, set the range of items where the search item might be found to be the entire list.

Find the value of the item at the midpoint position:
Compare the item at the midpoint to the search item: the item at the midpoint is greater than 22.
Change the range to focus on the items before the midpoint.

Find the value of the item at the midpoint position:
Compare the item at the midpoint to the search item: the item at the midpoint is less than 22.
Change the range to focus on the items after the midpoint.

Find the value of the item at the midpoint position:
Compare the item at the midpoint to the search item: the item at the midpoint is 22.
Change the range to focus on the items the midpoint.

Find the value of the item at the midpoint position:
Compare the item at the midpoint to the search item: the item at the midpoint is equal to 22.

The search item was found in the list, stop searching.

Items:

less than

greater than

before

after

11

16

17

22

25

30

35

46

57

72

Part B

Tom wants to find out if there is a day that he sold 35 products.

Fill in the blanks with the values provided below to complete the steps that a binary search will follow when searching for 35 in the products_sold list. The list of items has been copied below to help answer the question.

products_sold									
11	16	17	22	25	30	35	46	57	72

Take the ordered list products_sold and the search item 35.
Initially, set the range of items where the search item might be found to be the entire list.

Find the value of the item at the midpoint position:
Compare the item at the midpoint to the search item: the item at the midpoint is less than 35.
Change the range to focus on the items after the midpoint.

Find the value of the item at the midpoint position:
Compare the item at the midpoint to the search item: the item at the midpoint is 35.
Change the range to focus on the items the midpoint.

Find the value of the item at the midpoint position:
Compare the item at the midpoint to the search item: the item at the midpoint is 35.
Change the range to focus on the items the midpoint.

Find the value of the item at the midpoint position:
Compare the item at the midpoint to the search item: the item at the midpoint is equal to 35.

The search item was found in the list, stop searching.

Items:

less than

greater than

before

after

11

16

17

22

25

30

35

46

57

72

Challenge 2

Binary search: trace

The following list of items is stored in an array:

items							
index	0	1	2	3	4	5	6
value	2	4	5	8	12	15	18

The following algorithm has been coded and will be used to search for the number 12 as highlighted in the array.

Pseudocode

```
1 FUNCTION binary_search(items, search_item)
2     found = False
3     found_index = -1
4     first = 0
5     last = LEN(items) - 1
6
7     WHILE first <= last AND found == False
8         midpoint = (first + last) DIV 2
9         IF items[midpoint] == search_item THEN
10             found_index = midpoint
11             found = True
12         ELSEIF items[midpoint] < search_item THEN
13             first = midpoint + 1
14         ELSE
15             last = midpoint - 1
16         ENDIF
17     ENDWHILE
18
19     RETURN found_index
20 ENDFUNCTION
```

Complete the trace table for the algorithm. The first pass has already been filled for you.

first	last	midpoint	items [midpoint]	found_ index	found
0	6	3	8	−1	False
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>		False
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	4	True