

10.2.2 Arrays - combined exam practice

Name: _____ Class: _____ Date: _____ **Total: 62 marks**

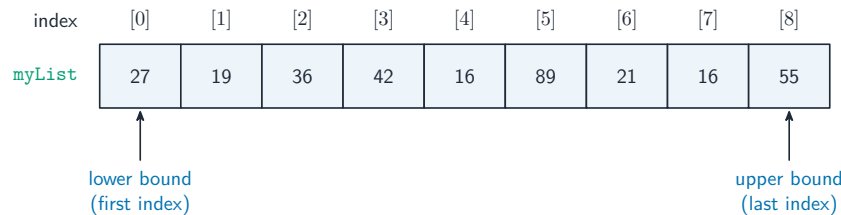
KEY WORDS array • bounds • capacity • lookup table
• combination

Objective

Combine the methods from sheet **10.2** to solve longer array exam questions: stop input safely, build a **lookup table** and select matching IDs into another array. Complete **10.2.1** separately for bubble sort and insertion/deletion.

1 Key knowledge and worked examples

■ Capacity, count and a stopping rule



An **array** has fixed **bounds**. **Capacity** is the number of allocated elements; **Count** is how many are used. With `Data[1:20]`, a count of 3 means the next free position is 4. Check capacity **before** asking for the next input, so a full array does not request or store a 21st value.

Worked example: the first value has already been stored at `Data[1]`; `Count = 1`. The following loop stores positive integers until a non-positive input or a full array. `Data`, `Count` and `Value` are integers; `Stopped` is Boolean.

```
Stopped ← FALSE
WHILE Count < 20 AND Stopped = FALSE
    INPUT Value
    IF Value > 0 THEN
        Count ← Count + 1
        Data[Count] ← Value
    ELSE
        Stopped ← TRUE
    ENDIF
ENDWHILE
```

For increasing input, compare with the **last stored value** instead of zero, and update that value after accepting an input. Equality must stop a strictly increasing sequence. Do not count or store a rejected value.

■ Boolean lookup: a score becomes an index

A **lookup table** stores an answer at the index that represents its input. It can replace repeated selection statements: fewer branches to write and simpler data changes. A Boolean element tells us whether a score is achievable. A declaration does not initialise the elements.

Worked example: two questions are worth 3 points each; one is worth 4 points. The maximum is $2 \times 3 + 4 = 10$. Include score zero, so there are 11 elements.

```
DECLARE Valid : ARRAY[0:10] OF BOOLEAN
DECLARE Index, Easy, Hard : INTEGER
FOR Index ← 0 TO 10
    Valid[Index] ← FALSE
NEXT Index
FOR Easy ← 0 TO 6 STEP 3
    FOR Hard ← 0 TO 4 STEP 4
        Valid[Easy + Hard] ← TRUE
    NEXT Hard
NEXT Easy
```

The loops cover every **combination** : 0, 3, 6 plus 0, 4, giving scores 0, 3, 4, 6, 7, 10. Before looking up `Valid[Score]`, check $0 \leq \text{Score} \leq 10$. If outside, return **FALSE** without indexing. In words: check range, reject an out-of-range score, otherwise return the stored Boolean.

■ Combine a function, rows and a result array

For array `Result[1:100, 1:2]`, the first index selects a row and the second a column. With marks in column 1 and IDs in column 2, test `Result[Row, 1]` and copy `Result[Row, 2]`. A function returns one value: a Boolean result can be used directly in an IF.

- Within two marks of a boundary means **Mark** $\geq$ **Boundary** - 2 and **Mark** $\leq$ **Boundary** + 2, including both endpoints. Return **FALSE** only after **all** boundaries have failed.

- Keep a separate count for selected IDs. Increment it only when a row matches, then store the ID at that index. The selected entries occupy consecutive positions, even when matching source rows are far apart.
- A **sentinel** ends input and is not stored. **REPEAT ... UNTIL** runs at least once: stop when the sentinel arrives **or** capacity is reached. A sentinel as the first input leaves the count at zero.

Worked example: copy IDs of used rows whose mark is below 40 into a second array. **Result** and integer **Used** are global; $0 \leq \text{Used} \leq 100$.

```

DECLARE SelectedID : ARRAY[1:100] OF INTEGER
DECLARE Row, Count, Index : INTEGER
Count ← 0
FOR Row ← 1 TO Used
    IF Result[Row, 1] < 40 THEN
        Count ← Count + 1
        SelectedID[Count] ← Result[Row, 2]
    ENDIF
NEXT Row
OUTPUT Count, " candidates selected"
FOR Index ← 1 TO Count
    OUTPUT SelectedID[Index]
NEXT Index
  
```

For marks 39, 40, 12 with IDs 101, 102, 103, the first two selected elements are 101 and 103, and the count is 2. With **Used** = 0, neither loop processes an element and the count is zero. Only positions 1:Count contain selected IDs; the rest are unused.

2 Practice

2.1 Data[1:20] holds 4, 9 in its first two elements. Count = 2; the remaining elements are unused. The next input is 9.

(a) In a strictly increasing sequence, should this input be stored? Explain. [2]

Count = 2

Data	4	9			...	
	1	2				20

INPUT 9

←

(b) State the next free index **before** this input, and explain what must happen when Count = 20. [2]

2.2 Use the worked example's array Valid[0:10].

(a) State the results of looking up scores 7 and 8. [2]

points:

3

3

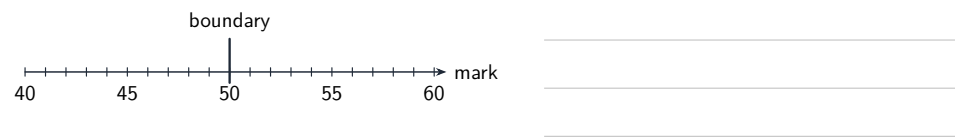
4

Valid

0
index = total score
10

(b) Explain why testing Valid[11] is an error rather than a way to return FALSE. [1]

2.3 A boundary is 50. State the lowest and highest marks within two marks of it. Explain why joining the two comparisons with **OR** would be wrong. [3]



2.4 Global array Scores[1:10] contains integer marks. Write pseudocode to output their mean and the number of marks at least 50. Declare any local variables used. [5]

Scores

62	48	75	50	39	81	57	44	66	70
1	2	3	4	5	6	7	8	9	10

2.5 Data is declared as `ARRAY[0:3] OF INTEGER` and contains 4, -1, 7, 7 in index order.

(a) State its lower bound, upper bound and number of elements. [2]

Data

4	-1	7	7
---	----	---	---

(b) Trace this algorithm. Give `Total` and `Count` after **each** iteration, then the final output. [4]

```
Total ← 0
Count ← 0
FOR Index ← 0 TO 3
    IF Data[Index] > 0 THEN
        Total ← Total + Data[Index]
        Count ← Count + 1
    ENDIF
NEXT Index
OUTPUT Total, ", ", Count
```

2.6 Complete the code to input up to ten real values into global array `Values[1:10]`. Input -999 ends the sequence and must not be stored. It may be the first input. Do not request another input when the array is full. [5]

```
DECLARE Count : INTEGER
DECLARE Value : REAL
Count ← .....
REPEAT
    INPUT Value
    IF Value <> ..... THEN
        Count ← .....
        Values[Count] ← .....
    ENDIF
UNTIL Value = -999 OR Count = .....
```

Explain why **both** stopping conditions are needed. [2]

inputs:

4.5	7.2	3.0
-----	-----	-----

 ...

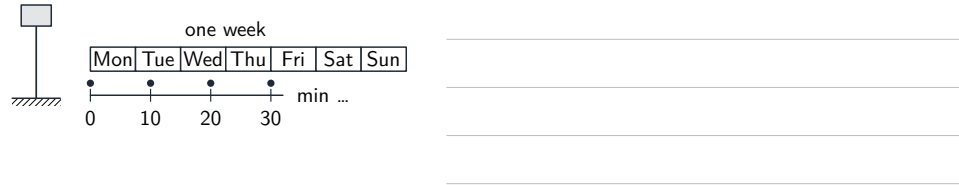
-999

Values

--	--	--	--	--	--	--	--	--	--

1 10

2.7 A weather station takes one real temperature reading every **ten minutes** for one week. Calculate how many readings are taken and declare a 1-D array `WeekReading`, indexed from 1, with exactly enough elements. State the upper bound if the same number of elements were instead indexed from 0. [3]



3 Exam-style questions

3.1 Global real array `Number[1:20]` is initially unused. Write procedure `Store()` to input and store a strictly increasing sequence. Always store the first input. Store later inputs only while each is greater than the last stored value. Stop at the first value that is not greater, or when 20 values have been stored. Do not request another input once full. Output the number stored with a message. Declare local variables. [6]

inputs:

2.5	3.1	4.0	3.6
-----	-----	-----	-----

 ...

Number

--	--	--	--	--	--

 ...

--

1 20

3.2 A quiz has three questions worth 2 points each and two questions worth 5 points each. Global Boolean array **Possible** will indicate which total scores can be achieved; the index represents the total score.

(a) Declare **Possible** with lower bound 0 and the smallest suitable upper bound. Initialise every element to **FALSE**. Declare the loop variable. [4]

points:

2

2

2

5

5

Possible ... index = total score

0

(b) Use nested loops to set every achievable score to **TRUE**, including zero. [4]

(c) Describe, in words, how a function checks whether an integer score is achievable. Include scores outside the array bounds. [3]

3.3 A college uses global integer array **Result**[1:100, 1:2]. Column 1 stores marks; column 2 stores candidate IDs. Only the first **Used** rows contain data, where $0 \leq \text{Used} \leq 100$. Global integer array **Boundary**[1:5] contains five grade boundaries.

(a) Write function **NeedsCheck**(Mark : INTEGER) RETURNS BOOLEAN. Return **TRUE** if **Mark** is within two marks of **any** boundary, including the endpoints; otherwise return **FALSE**. [5]

Result

markID

1

2

⋮

Used

⋮

100

Boundary

1 2 3 4 5

(b) Global integer array **ReviewID**[1:100] and integer **ReviewCount** are available. Write procedure **CheckAll**(Used : INTEGER) to reset the count, call **NeedsCheck()** for each used row, and copy matching IDs consecutively into **ReviewID**. Update and output the count with a message. Declare locals; leave unused elements unchanged. [7]

(c) Explain the result when **Used** = 0, including the count and whether any array element is accessed or changed. [2]