



TD6 Arrays

Ex 6.1 Exam Notes

We want to write a program that allows us to enter the students' grades and then searches for the maximum, minimum and median grades. To do this:

1. Write a function that asks the user for the number of students N , then reads the N student grades and stores them in an array called NOTES.
2. Write a function that returns the maximum and minimum grade of students' grades.
3. Write a function that calculates and returns the median value of the set of notes.
4. Write the main function to test all the above functions.

Definition of median: The median of a statistical series is a value, noted **Med**, such that the number of values in the series less than **Med** is equal to the number of values greater than **Med**.

- If the total number in the series is odd, the median is the central value of the series.
- If the total number in the series is even, the average of the two central values is usually chosen.

Example :

Let be the series of 16 notes above arranged in ascending order:

2.5	4.5	6	7.25	8	9	10	11	12.75	13	13.5	14.5	15	16	17.5	20
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The median of the series is therefore $\frac{11+12.75}{2} = 11.875$.

Ex 6.2 Union and Intersection of two arrays

We have two one-dimensional arrays of integers **T** and **S**. Arrays **T** and **S** are assumed to be already sorted in ascending order and without duplicates. The size of array **T** is t and the size of array **S** is s . The variables t and s must be less than or equal to the maximum size of **T** and **S** (set here at 100).

1. Write a function **Union** that takes as input two arrays **T** and **S** and their real sizes, and then constructs a **TuS** array of size u which contains the union of the two arrays **T** and **S**. The **TuS** array should remain sorted by construction.
2. Write a function **Intersection** that takes two arrays **T** and **S** and their real sizes t and s as input, and then constructs an array **TnS** of size n that contains the intersection of the two arrays **T** and **S**. The **TnS** array should remain sorted by construction.

Example :

T :

3	8	17	23	48	56	61	87	98
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 $t = 9$.

S :

6	8	23	53	56	76	87
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 $s = 7$.

TuS :

3	6	8	17	23	48	53	56	61	76	87	98
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 $u = 12$.

TnS :

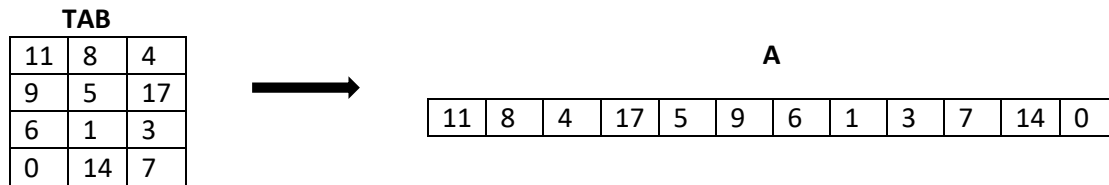
8	23	56	87
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 $n = 7$.

Ex 6.3 Back and Forth

Write a function that transforms a two-dimensional array **TAB** (N rows and M columns) into a linear array **A** (one-dimensional L = N*M). The function assigns the values in the linear array **A** by traversing the two-dimensional array **TAB** back and forth. In other words, the function will traverse the first line of **TAB** from left to right, then the second from right to left, the third from left to right, and so on, alternating the direction of the lines each time.

Example :



Ex 6.4 Matrix product

Write a function to multiply a matrix **A** of dimensions N and M with a matrix B of dimensions M and P and that returns the matrix **C** of dimensions N and P:

$$\mathbf{A(N,M)} * \mathbf{B(M,P)} = \mathbf{C(N,P)}$$

Multiplying two matrixes is done by multiplying the components of the two matrixes rows by columns:

$$c_{ij} = a_{i1} * b_{1j} + a_{i2} * b_{2j} + \dots + a_{iM} * b_{Mj} = \sum_{k=1}^M a_{ik} * b_{kj}$$

Example :

$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{pmatrix} * \begin{pmatrix} 7 & 8 \\ 9 & -1 \\ -2 & -3 \end{pmatrix} = \begin{pmatrix} 1*7 + 2*9 - 3*2 & 1*8 - 2*1 - 3*3 \\ 4*7 + 5*9 - 2*6 & 4*8 - 5*1 - 6*3 \end{pmatrix} = \begin{pmatrix} 19 & -3 \\ 61 & 9 \end{pmatrix}$$

Ex 6.4 Saddle-points

Write a program to find the elements, in a given matrix A, that are both a maximum on their row and a minimum on their column. These elements are called saddle-points. Display the positions and values of all saddle-points found.

Example :

A[0][0] = 3 is a Saddle-point :

3	2	1
6	5	4
9	8	1

Method: Establish two help matrixes MAX and MIN with the same dimensions as A, such as:

$$MAX_{ij} = \begin{cases} 1 & \text{if } A_{ij} \text{ is a maximum on the row} \\ 0 & \text{otherwise} \end{cases}$$

$$MIN_{ij} = \begin{cases} 1 & \text{if } A_{ij} \text{ is a minimum on the colomn} \\ 0 & \text{otherwise} \end{cases}$$