Problem: Using Matrices*

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Background:

I work with data that is in matrix form, and I often have to perform various calculations with this data, such as adding, subtracting, multiplying, and finding averages. We often take measurements called "landing." These measurements give me information about the behavior of the electron beam that scans the CRT screen. I use this data in the design process. The data is measured at predetermined points, so the position of the point is just as important as the actual value. For example, one of our samples might look like this:

14	2	-7	10	-2	Let's call this sample A (or matrix A)
7	2	-5	-5	-1	
2	0	-9	3	-4	
6	0	0	-1	-6	
10	0	7	1	1	

I often have more than one landing sample, which means I need to calculate the average of all the samples.

Problem:

You are an engineer in the CRT Engineering group. You have 5 different samples in the landing data: A, B, C, D, and E.

You need to find the average of these five samples in such as way as to find the average value for each position in the matrix. You will need to enter the values into a spreadsheet, as shown below for Sample A. The data for samples B, C, D, and E should be similarly entered.

Sample Data A:

a_{11}	a_{12}	a_{13}	a_{14}	a_{15}
a_{21}	a_{22}	a_{23}	a_{24}	a_{25}
a_{31}	a_{32}	a_{33}	a_{34}	a_{35}
a_{41}	a_{42}	a_{43}	a_{44}	a_{45}
a_{51}	a_{52}	a_{53}	a_{54}	a_{55}

* All values given are fictitious because the actual information is proprietary.

The sample data is given below:

14	2	-7	10	-2	Sample A
7	2	-5	-5	-1	
2	0	-9	3	-4	
6	0	0	-1	-6	
10	0	7	1	1	
10	4	-9	12	-1	Sample B
8	2	-10	-5	-1	
1	1	-8	4	-6	
7	2	2	2	-6	
9	1	6	2	2	
-2	14	-10	-8	-4	Sample C
-8	3	-9	-6	-4	
-4	4	-7	3	-3	
8	1	1	0	-7	
8	2	8	3	3	
-7	-3	-11	14	-2	Sample D
8	2	-10	-5	-1	
-8	8	7	2	-3	
6	4	0	-3	-5	
8	7	5	8	9	
10	8	7	5	0	Sample E
8	5	0	-4	-2	
3	5	-7	5	-6	
6	-2	-1	-1	-4	
8	0	5	1	1	

Solution: Using Matrices[†]

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You can solve this problem using matrix addition and multiplication:

AVERAGE = SUM * 1/N

Let SUM be a matrix that represents the sum of the five matrices.

Let AVERAGE be a matrix that represents the average of the five matrices.

You can use a spreadsheet to calculate the average matrix:

Average = {Sum of observations, or samples} ÷ {Number of observations, or samples}

One way to find the average is to calculate the average at each point. To do this, you would need to do 25 different calculations, which is why a spreadsheet is used.

To find the average of the points (a_{11}, b_{11}, c_{11}, d_{11}, e_{11}) - the points in the first row and column of all five matrices, you could use the formula:
$(a_{11}+b_{11}+c_{11}+d_{11}+e_{11})/N$ = the average (in this case, N=5)

To find the average of the points in the first row and second column (a_{12}, b_{12}, c_{12}, d_{12}, e_{12}), you would use the formula:
$(a_{12}+b_{12}+c_{12}+d_{12}+e_{12})/N$

So, for example, if a_{12} = 2, b_{12} = 4, c_{12} = 14, d_{12} = -3 and e_{12} =8, then the average would be (2+4 +14+(-3)+8)/5 which is equal to: 25/5, or 5, so five is the average value for that position.

Matrix representing the average at all points:

5	5	-6	6.6	-1.8
4.6	2.8	-6.8	-5	-1.8
-1.2	3.6	-4.8	3.4	-4.4
6.6	1	0.4	-0.6	-5.6
8.6	2	6.2	3	3.2

[†] All values given are fictitious because the actual information is proprietary.