

# Matrix Addition and Multiplication

back to [Fan's Intro Math for Econ](#), [Matlab Examples](#), or [Dynamic Asset Repositories](#)

## Scalar Multiplication/Division, Addition/Subtraction

If we multiply a matrix by a number, we multiply every element of that matrix by that number. Addition, subtraction, and division of a matrix with a scalar value work the same way

```
c = 10
```

```
c = 10
```

```
matA = rand(3,2)
```

```
matA = 3x2
    0.3111    0.1848
    0.9234    0.9049
    0.4302    0.9797
```

```
c*matA
```

```
ans = 3x2
    3.1110    1.8482
    9.2338    9.0488
    4.3021    9.7975
```

```
matA/c
```

```
ans = 3x2
    0.0311    0.0185
    0.0923    0.0905
    0.0430    0.0980
```

```
matA - c
```

```
ans = 3x2
   -9.6889   -9.8152
   -9.0766   -9.0951
   -9.5698   -9.0203
```

```
matA + c
```

```
ans = 3x2
   10.3111   10.1848
   10.9234   10.9049
   10.4302   10.9797
```

## Addition and Subtraction

You can add/subtract together two matrixes of the same size. We can add up the two 3 by 1 vectors from above, and the two 2 by 3 matrixes from above.

```
colVecA = rand(3,1)
```

```
colVecA = 3x1
    0.4389
    0.1111
```

```
0.2581
```

```
colVecB = rand(3,1)
```

```
colVecB = 3×1
0.4087
0.5949
0.2622
```

```
matA = rand(3,2)
```

```
matA = 3×2
0.6028    0.1174
0.7112    0.2967
0.2217    0.3188
```

```
matB = rand(3,2)
```

```
matB = 3×2
0.4242    0.2625
0.5079    0.8010
0.0855    0.0292
```

```
colVecA + colVecB
```

```
ans = 3×1
0.8476
0.7060
0.5203
```

```
matA - matB
```

```
ans = 3×2
0.1787   -0.1451
0.2034   -0.5043
0.1362    0.2896
```

When using matlab, even if you add up to a single column or single row with a matrix that has multiple rows and columns, if the column count or row count matches up, matlab will **broadcast** rules, and addition will still be legal. In the example below, matA is 3 by 2, and colVecA is 3 by 1, matlab duplicate colVecA and add it to each column of matA (*Broadcast rules are important for efficient storage and computation*):

```
matA + colVecA
```

```
ans = 3×2
1.0417    0.5563
0.8223    0.4078
0.4798    0.5768
```

## Matrix Multiplication

When we try to multiply two matrixes together:  $A \cdot B$  for example, the **number of columns** of matrix  $A$  and the **number of rows** of matrix  $B$  have to match up.

If the matrix  $A$  is has  $L$  rows and  $M$  columns, and the matrix  $B$  has  $M$  rows and  $N$  columns, then the resulting matrix of  $C = A \cdot B$  has to have  $L$  rows and  $N$  columns.

Each of the  $(l, n)$  cell in the product matrix  $C = A \cdot B$ , is equal to:

$$C_{l,n} = \sum_{m=1}^M A_{l,m} \cdot B_{m,n}$$

Note that we are summing over  $M$ : row  $l$  in matrix  $A$ , and column  $n$  in matrix  $B$  both have  $M$  elements. We multiply each  $m$  of the  $M$  element from the row in  $A$  and column in  $B$  together one by one, and then sum them up to end up with the value for the  $l$ th row and  $n$ th column in matrix  $C$ .

```
% (3 by 4) times (4 by 2) end up with (3 by 2)
```

```
L = 3;
M = 4;
N = 2;
matA = rand(L, M)
```

```
matA = 3x4
    0.9289    0.5785    0.9631    0.2316
    0.7303    0.2373    0.5468    0.4889
    0.4886    0.4588    0.5211    0.6241
```

```
matB = rand(M, N)
```

```
matB = 4x2
    0.6791    0.0377
    0.3955    0.8852
    0.3674    0.9133
    0.9880    0.7962
```

```
matC = matA*matB
```

```
matC = 3x2
    1.4423    1.6111
    1.2738    1.1262
    1.3214    1.3974
```

```
% (2 by 10) times (10 by 1) end up with (2 by 1)
```

```
L = 2;
M = 10;
N = 1;
matA = rand(L, M)
```

```
matA = 2x10
    0.0987    0.3354    0.1366    0.1068    0.4942    0.7150    0.8909    0.6987 ...
    0.2619    0.6797    0.7212    0.6538    0.7791    0.9037    0.3342    0.1978
```

```
matB = rand(M, N)
```

```
matB = 10x1
    0.9047
    0.6099
    0.6177
    0.8594
    0.8055
    0.5767
    0.1829
    0.2399
```

0.8865  
0.0287

```
matC = matA*matB
```

```
matC = 2×1  
1.6524  
3.5895
```