

Matrix Arithmetic Operations in MATLAB

1 Introduction

In MATLAB, matrices are first-class objects, and arithmetic operations can be performed using matrix algebra rules or element-wise operations. Below are the most common operations with examples.

2 Addition and Subtraction

Matrices must have the same dimensions.

```
A = [1 2 3; 4 5 6];
B = [6 5 4; 3 2 1];

C_add = A + B    % Addition
C_sub = A - B    % Subtraction
```

3 Matrix Multiplication (*)

Matrix multiplication follows linear algebra rules: if A is $m \times n$ and B is $n \times p$, then $A * B$ is $m \times p$.

```
A = [1 2; 3 4; 5 6];    % 3x2
B = [7 8 9; 10 11 12]; % 2x3

C_mul = A * B    % Result: 3x3
```

4 Element-wise Multiplication (.*)

Multiplies corresponding elements of two matrices of the same size.

```
A = [1 2 3; 4 5 6];
B = [6 5 4; 3 2 1];

C_elem_mul = A .* B
```

5 Matrix Division

5.1 Right Division (/)

A/B means $A \cdot B^{-1}$.

```
A = [3 4; 2 5];  
B = [1 2; 3 4];
```

```
C_right = A / B
```

5.2 Left Division (\)

$A \setminus B$ means $A^{-1} \cdot B$.

```
C_left = A \ B
```

6 Element-wise Division (./ and .\)

```
A = [10 20 30; 40 50 60];  
B = [2 4 5; 8 10 15];
```

```
C_elem_right = A ./ B    % Right element-wise division  
C_elem_left   = A .\ B    % Left element-wise division (B./A)
```

7 Power

7.1 Matrix Power ()

Only valid for square matrices; raises the matrix to an integer power.

```
A = [2 0; 0 3];  
M_pow = A ^ 2
```

7.2 Element-wise Power (.)[^]

Raises each element of a matrix to the given power individually.

```
E_pow = A .^ 2
```

8 Scalar Operations

Scalars operate element-wise by default.

```
A = [1 2 3; 4 5 6];
```

```
A_plus_scalar = A + 10  
A_times_scalar = A * 5  
A_div_scalar = A / 2  
A_pow_scalar = A .^ 3
```