

**norm()** — Matrix and vector norms

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## Description

`norm(A)` returns `norm(A, 2)`.

`norm(A, p)` returns the value of the norm of  $A$  for the specified  $p$ . The possible values and the meaning of  $p$  depend on whether  $A$  is a vector or a matrix.

When  $A$  is a vector, `norm(A, p)` returns

$$\begin{aligned} \text{sum}(\text{abs}(A) : ^p)^{1/p} & \quad \text{if } 1 \leq p < \infty \\ \max(\text{abs}(A)) & \quad \text{if } p \geq \infty \end{aligned}$$

When  $A$  is a matrix, returned is

$p$	<code>norm(A, p)</code>
0	<code>sqrt(trace(conj(A)'A))</code>
1	<code>max(colsum(abs(A)))</code>
2	<code>max(svdsv(A))</code>
.	<code>max(rowsum(abs(A)))</code>

## Syntax

*real scalar* `norm(numeric matrix A)`

*real scalar* `norm(numeric matrix A, real scalar p)`

## Remarks and examples

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`norm(A)` and `norm(A, p)` calculate vector norms and matrix norms.  $A$  may be real or complex and need not be square when it is a matrix.

The formulas presented above are not the actual ones used in calculation. In the vector-norm case when  $1 \leq p < \infty$ , the formula is applied to  $A : / \max(\text{abs}(A))$  and the result then multiplied by  $\max(\text{abs}(A))$ . This prevents numerical overflow. A similar technique is used in calculating the matrix norm for  $p = 0$ , and that technique also avoids storage of `conj(A)'A`.

## Conformability

```
norm(A):
  A:      r × c
  result: 1 × 1
```

```
norm(A, p):
  A:      r × c
  p:      1 × 1
  result: 1 × 1
```

## Diagnostics

The `norm()` is defined to return 0 if  $A$  is void and missing if any element of  $A$  is missing.

`norm(A, p)` aborts with error if  $p$  is out of range. When  $A$  is a vector,  $p$  must be greater than or equal to 1. When  $A$  is a matrix,  $p$  must be 0, 1, 2, or . (missing).

`norm(A)` and `norm(A, p)` return missing if the 2-norm is requested and the singular value decomposition does not converge, an event not expected to occur; see [M-5] `svd()`.

## Also see

[M-4] **Matrix** — Matrix functions

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