

**trace()** — Trace of square matrix

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## Description

`trace(A)` returns the sum of the diagonal elements of  $A$ . Returned result is real if  $A$  is real, complex if  $A$  is complex.

`trace(A, B)` returns `trace(AB)`, the calculation being made without calculating or storing the off-diagonal elements of  $AB$ . Returned result is real if  $A$  and  $B$  are real and is complex otherwise.

`trace(A, B, t)` returns `trace(AB)` if  $t = 0$  and returns `trace(A'B)` otherwise, where, if either  $A$  or  $B$  is complex, transpose is understood to mean [conjugate transpose](#). Returned result is real if  $A$  and  $B$  are real and is complex otherwise.

## Syntax

*numeric scalar* `trace(numeric matrix A)`

*numeric scalar* `trace(numeric matrix A, numeric matrix B)`

*numeric scalar* `trace(numeric matrix A, numeric matrix B, real scalar t)`

## Remarks and examples

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`trace(A, B)` returns the same result as `trace(A*B)` but is more efficient if you do not otherwise need to calculate  $A*B$ .

`trace(A, B, 1)` returns the same result as `trace(A'B)` but is more efficient.

For real matrices  $A$  and  $B$ ,

$$\text{trace}(A') = \text{trace}(A)$$

$$\text{trace}(AB) = \text{trace}(BA)$$

and for complex matrices,

$$\text{trace}(A') = \text{conj}(\text{trace}(A))$$

$$\text{trace}(AB) = \text{trace}(BA)$$

where, for complex matrices, transpose is understood to mean conjugate transpose.

Thus for real matrices,

To calculate	Code
<code>trace(AB)</code>	<code>trace(A, B)</code>
<code>trace(A'B)</code>	<code>trace(A, B, 1)</code>
<code>trace(AB')</code>	<code>trace(A, B, 1)</code>
<code>trace(A'B')</code>	<code>trace(A, B)</code>

and for complex matrices,

To calculate	Code
<code>trace(AB)</code>	<code>trace(A, B)</code>
<code>trace(A'B)</code>	<code>trace(A, B, 1)</code>
<code>trace(AB')</code>	<code>conj(trace(A, B, 1))</code>
<code>trace(A'B')</code>	<code>conj(trace(A, B))</code>

Transpose in the first column means conjugate transpose.

## Conformability

`trace(A)`:

*A*:  $n \times n$   
*result*:  $1 \times 1$

`trace(A, B)`:

*A*:  $n \times m$   
*B*:  $m \times n$   
*result*:  $1 \times 1$

`trace(A, B, t)`

*A*:  $n \times m$  if  $t = 0$ ,  $m \times n$  otherwise  
*B*:  $m \times n$   
*t*:  $1 \times 1$   
*result*:  $1 \times 1$

## Diagnostics

`trace(A)` aborts with error if *A* is not square.

`trace(A, B)` and `trace(A, B, t)` abort with error if the matrices are not conformable or their product is not square.

The trace of a  $0 \times 0$  matrix is 0.

## Also see

[M-4] [matrix](#) — Matrix functions