**Title**

**norm() — Matrix and vector norms**

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**Syntax**

\[
\begin{align*}
\text{real scalar} & \quad \text{norm(} \text{numeric matrix} \ A \text{)} \\
\text{real scalar} & \quad \text{norm(} \text{numeric matrix} \ A, \ \text{real scalar} \ p \text{)}
\end{align*}
\]

**Description**

\[\text{norm}(A) \text{ returns } \text{norm}(A, 2).\]

\[\text{norm}(A, p) \text{ returns the value of the norm of } A \text{ for the specified } p. \text{ The possible values and the meaning of } p \text{ depend on whether } A \text{ is a vector or a matrix.}\]

When \( A \) is a vector, \( \text{norm}(A, p) \) returns

\[
\begin{align*}
\text{sum(abs}(A):^p)^{(1/p)} & \quad \text{if } 1 \leq p < . \\
\max(abs(A)) & \quad \text{if } p \geq .
\end{align*}
\]

When \( A \) is a matrix, returned is

\[
\begin{array}{c|c}
p & \text{norm}(A, p) \\
\hline
0 & \sqrt{\text{trace(}\text{conj}(A)'A\text{)}} \\
1 & \max(\text{colsum(abs}(A))) \\
2 & \max(\text{svdsv}(A)) \\
. & \max(\text{rowsum(abs}(A)))
\end{array}
\]

**Remarks and examples**

\( \text{norm}(A) \) and \( \text{norm}(A, p) \) 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 \( 1 \leq p < . \), 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 \( \text{conj}(A)'A \).

**Conformability**

\[\text{norm}(A): \\
A: \quad r \times c \\
result: \quad 1 \times 1\]
\textbf{Diagnostics}

The \texttt{norm()} is defined to return 0 if \( A \) is void and missing if any element of \( A \) is missing. \texttt{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).

\texttt{norm}(A) and \texttt{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 \[M-5\] \texttt{svd()}.

\textbf{Also see}

\[M-4\] \texttt{matrix} — Matrix functions