_invmat() — Inverse and pseudoinverse of a square matrix

DescriptionSyntaxRemarks and examplesConformabilityDiagnosticsReferencesAlso see

Description

 $_invmat(A)$ and $_invmat(A, tol)$ overwrite the original real or complex, square matrix A with the inverse of A if A has full rank and with the Moore–Penrose pseudoinverse if not. The function returns a real scalar 0 if the inverse is computed and 1 if the pseudoinverse is computed.

The optional argument *tol* specifies the tolerance for determining singularity; see *Remarks and examples* below.

Syntax

real scalar _invmat(numeric matrix A)
real scalar _invmat(numeric matrix A, real scalar tol)

Remarks and examples

These routines calculate the inverse of A if A has full rank. The inverse matrix A^{-1} of A satisfies the conditions

$$AA^{-1} = I$$
$$A^{-1}A = I$$

A is required to be square.

However, if A is singular or close to singular, the Moore–Penrose pseudoinverse is computed instead. The Moore–Penrose pseudoinverse is also known as the Moore–Penrose inverse and as the generalized inverse.

The pseudoinverse A^* of A satisfies four conditions,

$$A(A^*)A = A$$

 $(A^*)A(A^*) = A^*$
 $(AA^*)' = A(A^*)$
 $(A^*A)' = (A^*)A$

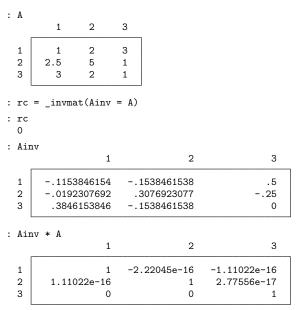
where the transpose operator ' is understood to mean the conjugate transpose when A is complex. Also, if A is of full rank, then

 $A^* = A^{-1}$

See [M-5] **pinv()** for details about pseudoinverse.

Example 1: Full-rank matrix

If A has full rank, the function returns 0 and computes the inverse. Here we compute the inverse and show that $AA^{-1} = I$.



You may verify other conditions for the inverse yourself.

Example 2: Singular matrix

If *B* does not have full rank, the function returns 1 and computes the pseudoinverse. Here we compute the pseudoinverse and show that $B(B^*)B = B$ and $(B^*)B(B^*) = B^*$.

: B
1 2
1 2
1 2
0 0
:
$$rc = _invmat(Binv = B)$$

: rc
1
: Binv
1 2
1 2
1 2
.2 0
.4 0

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```
: mreldif(B * Binv * B, B), mreldif(Binv * B * Binv, Binv)

1 2

1 0 3.96508e-17
```

You may verify other conditions for the pseudoinverse yourself.

Conformability

```
\begin{array}{c} \texttt{invmat}(A, tol):\\ \textit{input:}\\ A: & n \times n\\ tol: & 1 \times 1 \quad (\texttt{optional})\\ \textit{output:}\\ A: & n \times n\\ \textit{result:} & 1 \times 1 \end{array}
```

Diagnostics

The inverse returned by these functions is real if A is real and is complex if A is complex. The determination of singularity is made relative to *tol*. See *Tolerance* under *Remarks and examples* in [M-5] **lusolve()** for details.

_invmat(A) returns a matrix containing missing if A contains missing values.

_invmat(A) aborts with error if A is a view.

See [M-5] lusolve() and [M-1] Tolerance for information on the optional tol argument.

References

- Moore, E. H. 1920. On the reciprocal of the general algebraic matrix. *Bulletin of the American Mathematical Society* 26: 394–395.
- Penrose, R. 1955. A generalized inverse for matrices. *Mathematical Proceedings of the Cambridge Philosophical Society* 51: 406–413. https://doi.org/10.1017/S0305004100030401.

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Also see

- [M-5] cholinv() Symmetric, positive-definite matrix inversion
- [M-5] invsym() Symmetric real matrix inversion
- [M-5] luinv() Square matrix inversion
- [M-5] **pinv()** Moore–Penrose pseudoinverse
- [M-5] qrinv() Generalized inverse of matrix via QR decomposition
- [M-5] _solvemat() Solve AX=B for X
- [M-4] Matrix Matrix functions
- [M-4] Solvers Functions to solve AX=B and to obtain A inverse

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