matrix symeigen — Eigenvalues and eigenvectors of symmetric matrices

Syntax

```
matrix symeigen X v = A
```

where A is an $n \times n$ symmetric matrix.

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Description

```
matrix symeigen
```
returns the eigenvectors in the columns of $X$: $n \times n$ and the corresponding
eigenvalues in $v$: $1 \times n$. The eigenvalues are sorted: $v[1,1]$ contains the largest eigenvalue (and
$X[1\ldots,1]$ its corresponding eigenvector), and $v[1,n]$ contains the smallest eigenvalue (and
$X[1\ldots,n]$ its corresponding eigenvector).

If you want the eigenvalues for a nonsymmetric matrix, see [P] matrix eigenvalues.
Also see [M-5] eigensystem( ) for other routines for obtaining eigenvalues and eigenvectors.

Remarks and examples

Typing `matrix symeigen X v = A` for $A$: $n \times n$ returns

```
v = \begin{pmatrix} \lambda_1, \lambda_2, \ldots, \lambda_n \end{pmatrix}
X = \begin{pmatrix} x_1, x_2, \ldots, x_n \end{pmatrix}
```

where $\lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_n$. Each $x_i$ and $\lambda_i$ is a solution to

```
Ax_i = \lambda_i x_i
```
or, more compactly,

```
AX = X \text{diag}(v)
```

Example 1

Eigenvalues and eigenvectors have many uses. We will demonstrate that `symeigen` returns matrices
meeting the definition:

```
. use http://www.stata-press.com/data/r13/auto
   (1978 Automobile Data)
. matrix accum A = weight mpg length, noconstant deviation
   (obs=74)
```
. matrix list A
symmetric A[3,3]
   weight   mpg   length
weight 44094178
   mpg -264948.11 2443.4595
length 1195077.3 -7483.5135 36192.662
. matrix symeigen X lambda = A
. matrix list lambda
lambda[1,3]
e1   e2   e3
r1  44128163 3830.4869 820.73955
. matrix list X
X[3,3]
e1   e2   e3
weight .99961482 -.02756261 .00324179
   mpg -.00600667 -.1008305 .99488549
length .02709477 .99452175 .10095722
. matrix AX = A*X
. matrix XLambda = X*diag(lambda)
. matrix list AX
AX[3,3]
e1   e2   e3
weight 44111166 -105.57823 2.6606641
   mpg -265063.5 -386.22991 816.54187
length 1195642.6 3809.5025 82.859585
. matrix list XLambda
XLambda[3,3]
e1   e2   e3
weight 44111166 -105.57823 2.6606641
   mpg -265063.5 -386.22991 816.54187
length 1195642.6 3809.5025 82.859585

Methods and formulas

Stata’s internal eigenvalue and eigenvector extraction routines are translations of the public domain EISPACK routines, Smith et al. (1976), which are in turn based on Wilkinson and Reinsch (1971). EISPACK was developed under contract for the Office of Scientific and Technical Information, U.S. Department of Energy, by Argonne National Laboratory and supported by funds provided by the Nuclear Regulatory Commission. Stata’s use of these routines is by permission of the National Energy Software Center of the Argonne National Laboratory. A brief but excellent introduction to the techniques used by these routines can be found in Press et al. (2007, 563–599).

References


Also see

[P] matrix — Introduction to matrix commands

[P] matrix eigenvalues — Eigenvalues of nonsymmetric matrices

[M-4] matrix — Matrix functions

[U] 14 Matrix expressions