Mata in Stata

POP 502

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Note:

- Introduction to Matrix material comes from

http://ibgwww.colorado.edu/~carey/p7291dir/handouts/matrix.algebra.pdf

http://www.stanford.edu/~roymill/cgi-bin/methods2010/material/stataCamp_5_ho.pdf

- Introduction to Mata material come from

http://www.ssc.wisc.edu/sscc/pubs/4-26.htm

What is Mata?

Mata is a matrix language built into stata

What is a matrix?

A matrix is a collection of numbers ordered by rows and columns

$$\mathbf{X} = \begin{pmatrix} 5 & 8 & 2 \\ -1 & 0 & 7 \end{pmatrix}$$

$$\mathbf{X} = \begin{pmatrix} x_{11} & x_{12} & x_{13} \\ x_{21} & x_{22} & x_{23} \end{pmatrix}$$

What is a vector?

A vector is a special type of matrix that has only one row (called a row vector) or one column (called a column vector)

$$\mathbf{a} = \begin{pmatrix} 7 \\ 2 \\ 3 \end{pmatrix}, \qquad \mathbf{b} = \begin{pmatrix} -2 & 7 & 4 \end{pmatrix}$$

What is a scalar?

A scalar is a matrix with only one row and one column.

$$5$$

What is an identity matrix?

An identity matrix is a diagonal matrix with 1s and only 1s on the diagonal. The identity matrix is almost always denoted as I

$$\mathbf{I} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Matrix Addition

Rule:
Must have the same number of rows and the same number of columns

Elements of the two matrices are simply added together, element by element, to produce the results

$$\begin{pmatrix} 9 & 5 & 1 \\ -4 & 7 & 6 \end{pmatrix} = \begin{pmatrix} 1 & 9 & -2 \\ 3 & 6 & 0 \end{pmatrix} + \begin{pmatrix} 8 & -4 & 3 \\ -7 & 1 & 6 \end{pmatrix}$$

Matrix Multiplication with a Scalar

Each element in the product matrix is simply the scalar multiplied by the element in the matrix

$$\mathbf{R} = \alpha \boldsymbol{B}$$

$$8\begin{pmatrix} 2 & 6 \\ 3 & 7 \end{pmatrix} = \begin{pmatrix} 16 & 48 \\ 24 & 56 \end{pmatrix}$$

Matrix Multiplication

The first matrix must have the same number of columns as the second matrix has rows

$$r_{ij} = \mathbf{a}_{i\bullet}\mathbf{b}_{\bullet j}$$

Multiplication of a row vector and a column vector

The product will have *i* rows and *j* columns.

Example

$$\mathbf{A} = \begin{pmatrix} 2 & 8 & -1 \\ 3 & 6 & 4 \end{pmatrix}, \text{and } \mathbf{B} = \begin{pmatrix} 1 & 7 \\ 9 & -2 \\ 6 & 3 \end{pmatrix}$$

$$r_{11} = a_{1\bullet} b_{\bullet 1} = \begin{pmatrix} 2 & 8 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ 9 \\ 6 \end{pmatrix} = 2*1 + 8*9 + 1*6 = 80$$

$$r_{12} = a_{1\bullet} b_{\bullet 2} = \begin{pmatrix} 2 & 8 & 1 \end{pmatrix} \begin{pmatrix} 7 \\ -2 \\ 3 \end{pmatrix} = 2*7 + 8*(-2) + 1*3 = 1$$

$$\begin{pmatrix} 2 & 8 & -1 \\ 3 & 6 & 4 \end{pmatrix} \begin{pmatrix} 1 & 7 \\ 9 & -2 \\ 6 & 3 \end{pmatrix} = \begin{pmatrix} 80 & 1 \\ 81 & 21 \end{pmatrix}$$

$$r_{21} = a_{2\bullet} b_{\bullet 1} = \begin{pmatrix} 3 & 6 & 4 \end{pmatrix} \begin{pmatrix} 1 \\ 9 \\ 6 \end{pmatrix} = 3*1 + 6*9 + 4*6 = 81$$

$$r_{22} = a_{2\bullet} b_{\bullet 2} = \begin{pmatrix} 3 & 6 & 4 \end{pmatrix} \begin{pmatrix} 7 \\ -2 \\ 3 \end{pmatrix} = 3*7 + 6*(-2) + 4*3 = 21$$

Transpose

The transpose of a matrix is denoted by a prime (A ‘) or a superscript t or T (At or AT). The first row of a matrix becomes the first column of the transpose matrix, the second row of the matrix becomes the second column of the transpose, etc

$$\mathbf{A} = \begin{pmatrix} 2 & 7 & 1 \\ 8 & 6 & 4 \end{pmatrix}, \text{ and } \mathbf{A}^{t} = \begin{pmatrix} 2 & 8 \\ 7 & 6 \\ 1 & 4 \end{pmatrix}$$

Inverse

The inverse of a matrix is that matrix which, when multiplied by the original matrix, gives an identity matrix. The inverse of a matrix is denoted by the superscript “-1”.

$$\mathbf{A}\mathbf{A}^{-1} = \mathbf{A}^{-1}\mathbf{A} = \mathbf{I}$$

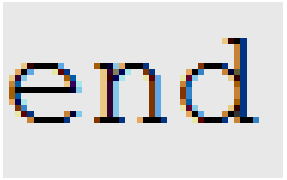
Trace

The trace of a matrix is sometimes, although not always, denoted as tr(A). The trace is used only for square matrices and equals the sum of the diagonal elements of the matrix.

$$\mathrm{tr}\begin{pmatrix} 3 & 7 & 2 \\ -1 & 6 & 4 \\ 9 & 0 & -5 \end{pmatrix} = 3 + 6 - 5 = 4$$

Now on to Mata!

Most Importantly



Commands are different from Stata

```
2+2
```

```
x=2+2
```

```
x
```

Comma

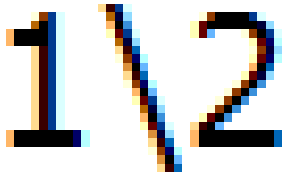
The comma is defined as the "column join" operator, or "take the things before and after the comma and put them next to each other."

```
1,2
```

```
    1   2
  +-------+
1 | 1   2 |
  +-------+
```

Backslash

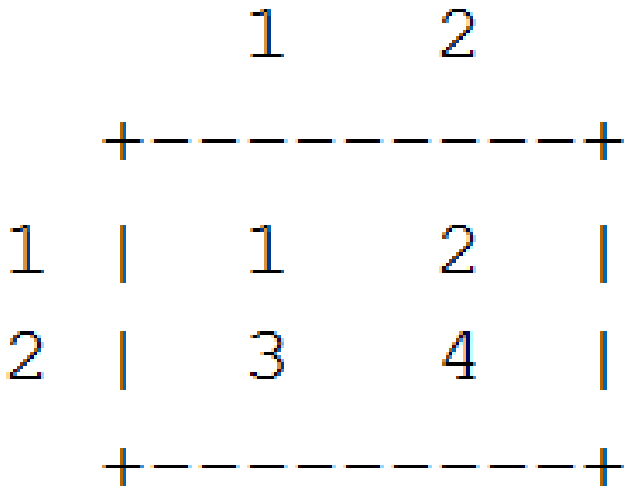
The backslash (\ not /, which is division) is the "row join" operator, or "take the thing before the backslash and stack it on top of the thing after it."




```
    1
  +-----+
1 |  1  |
2 |  2  |
  +-----+
```

Parenthesis

```
1,2\3,4
(1,2\3,4)
(1,2)\(3,4)
```



Range Operator

The .. operator creates a series starting from the number on the left up to the number on the right and makes them into a row vector. The :: operator does the same but puts them in a column vector.

```
1..3

1::3
```

Colon Operators

Works element by element

For addition and subtraction it makes no difference, since they're element by element anyway. But it makes a great deal of difference with multiplication

```
x=(1,2)\(3,4)
y=(1,2)\(3,4)
x*y
x:*y
```

I

The I function can take one or two arguments. If it is given one argument, it will return an identity matrix of size equal to the argument it was given. If it is given two arguments, it will return a matrix with that number of rows and columns which is full of zeroes except for ones along the principal diagonal.

```
I(3)

I(4,3)
```

J

The J function creates a matrix of constants. It takes three arguments: the number of rows of the matrix to be created, the number of columns, and what to put in the matrix

```
J(3,3,0)
J(2,3,"a")
```

Trace

Trace returns the sum of the diagonal elements

```
trace(x)
```

st_ commands

st_data() copies dataset variables into a Mata matrix

st_store() copies a Mata matrix into dataset variables

st_ commands

st_addvar() creates a new variable to Stata data set

st_varindex() obtains variable indices from variable names

strofreal() converts real to string