*Tutorials and worked examples for simulation,*
*curve fitting, statistical analysis, and plotting.*
*http://www.simfit.org.uk*

Quadratic forms often need to be evaluated in data analysis given a $n$ by 1 vector $x$ and a $n$ by $n$ matrix $A$. Frequently the inverse $A^{-1}$ is required and it is convenient to be able to estimate this interactively.

For instance, in nonlinear optimization or multivariate statistics the following expressions for $Q_1$ and/or $Q_2$ are frequently required

$$
\begin{aligned}
Q_1 &= x^T A x \\
Q_2 &= x^T A^{-1} x.
\end{aligned}
$$

To evaluate such quadratic forms interactively, open [Statistics] then [Numerical analysis] from the main SimFIT menu and select the option to evaluate quadratic forms which provides the default test files `matrix.tf3` defining matrix $A$ and `vector.tf3` defining $x$ as follows

$$
A = \begin{pmatrix} 4.16 & -3.12 & 0.56 & -0.10 \\ -3.12 & 5.03 & -0.83 & 1.09 \\ 0.56 & -0.83 & 0.76 & 0.34 \\ -0.10 & 1.09 & 0.34 & 1.18 \end{pmatrix}
$$

$$
x = \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4. \end{pmatrix}
$$

The following table illustrates the output from running the SimFIT procedure with these default test files.

| |
|---|
| Title of matrix $A$ |
| Test file matrix.tf3: 4 by 4 positive-definite symmetric matrix |
| Title of vector $x$ |
| Test file vector.tf3: vector with components 1, 2, 3, 4 |
| $x^T A x$ = 55.72 |
| $x^T A^{-1} x$ = 20.635258 |

Using the SimFIT procedure to evaluate quadratic forms allows the matrix $A$ and vector $x$ to be changed but two facts must be clear.

1. The dimensions of $A$ and $x$ must be consistent, i.e. identical.
2. Calculation of $Q_2$ requires that $A$ is nonsingular.

Of course, in many applications, as when estimating a Mahalanobis distance in multivariate statistics, it is also vital that the matrix $A$ to be used is a symmetric positive definite matrix (e.g. a covariance matrix) and the vector $x$ has a defined meaning (e.g. a difference vector) if the scalar results from such quadratic forms are to be interpreted correctly.