Math 248 Computers and Numerical Algorithms
(Pruett)

LABORATORY ASSIGNMENT
Two-Dimensional Arrays (Matrices)

Consider the linear system of equations $U\vec{x} = \vec{d}$ where U is the square upper-triangular matrix given below

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 0 & 0 & 6 \end{bmatrix} \tag{1}$$

and

$$\vec{d} = [6, 8, 12]^T \tag{2}$$

_____C Write a small FORTRAN 90 *program* that declares U to be a two-dimensional array, initializes U using an array constant assignment (inside a RESHAPE intrinsic function), and prints out the matrix U *by rows*.

_____C Add the additional statement

WRITE (*,*) U

near the end of your program, recompile, and re-run. What do you conclude is the conventional (natural) ordering of 2D-array elements in FORTRAN 90? By rows or by columns?

_____B Write and compile a **MODULE linear_algebra** containing

SUBROUTINE back_substitution

that returns the solution $\vec{x}$ of $U\vec{x} = \vec{d}$, given an $n \times n$ upper-triangular matrix U and an n-vector $\vec{d}$ Refer to Alg. 6.2 of the class notes.

_____A Modify your main program above to solve $U\vec{x} = \vec{d}$. That is, **CALL SUBROUTINE back_substitution** for $n = 3$, the matrix of Eq. 1, and the right-hand-side vector of Eq 2. Print out the solution vector $\vec{x}$ and verify by hand that it is correct.

_____A+ Add to your module **SUBROUTINE residual**, which receives n, U, $\vec{d}$, and $\vec{x}$ as INTENT(IN) arguments and returns the residual n-vector $\vec{r}$ as an INTENT(OUT) argument. Verify that your back-substitution algorithm is correct by CALLing the subroutine to compute the residual vector.