Chapter 1

Tutorial

In this chapter, the basic data structures are introduced, and some of the more basic operations are illustrated. Then some examples of how to use the data structures and procedures to solve some simple problems are given. The first example program is a simple 4th order Runge–Kutta solver for Ordinary Differential Equations. The second is a general least squares equation solver for over–determined equations. The third example illustrates how to solve a problem involving sparse matrices. These examples illustrate the use of matrices, matrix factorisations and solving systems of linear equations. The examples described in this chapter are implemented in `tutorial.c`.

While the description of each aspect of the system is brief and far from comprehensive, the aim is to show the different aspects of how to set up programs and routines and how these work in practice, which includes I/O and error–handling issues.

1.1 The data structures and some basic operations

The three main data structures are those describing vectors, matrices and permutations. These have been used to create data structures for simplex tableaus for linear programming, and used with data structures for sparse matrices etc. To use the system reliably, you should always use pointers to these data structures and use library routines to do all the necessary initialisation. In fact, for the operations that involve memory management (creation, destruction and resizing), it is essential that you use the routines provided.

For example, to create a matrix A of size 3×4, a vector x of dimension 10, and a permutation p of size 10, use the following code:

```
#include "matrix.h"
...............
main()
{
     MAT    *A;
     VEC    *x;
     PERM   *p;
```