Scientific Programming
Solving linear systems

Suppose that you are given several linear equations to solve, for example

\[
\begin{align*}
2x + y &= 1 \\
4z + y &= 3 \\
x - y - z &= 6
\end{align*}
\]

There are several ways that Matlab can be used to solve for \(x, y\) and \(z\). The textbook discusses one of them; another is to use the \texttt{linsolve} command.

The first step is two create a matrix representing the left-hand side of the equations and an array representing the right-hand side. First rewrite the equations so that the variables are in the same order (observe that the second row has changed) and that no variables are missing.

\[
\begin{align*}
2x + 1y + 0z &= 1 \\
0x + 1y + 4z &= 3 \\
1x - 1y - 1z &= 6
\end{align*}
\]

The numbers on the left form our matrix and the ones on the right our array (which is a column).

In Matlab notation the matrix is: \(M = \begin{bmatrix} 2 & 1 & 0 \\ 0 & 1 & 4 \\ 1 & -1 & -1 \end{bmatrix}\) and the array is \(b = [1; 3; 6]\). Using the command \texttt{linsolve(M,b)} solves for the variables. For example,

\[
\begin{align*}
&>> \ M = \begin{bmatrix} 2 & 1 & 0 \\
0 & 1 & 4 \\
1 & -1 & -1 \end{bmatrix} \\
&M = \\
&\begin{array}{ccc}
2 & 1 & 0 \\
0 & 1 & 4 \\
1 & -1 & -1
\end{array} \\
&>> \ b = [1; 3; 6] \\
b = \\
\begin{array}{c}
1 \\
3 \\
6
\end{array} \\
&>> \ \texttt{solution} = \texttt{linsolve(M, b)} \\
solution = \\
\begin{array}{c}
3 \\
-5 \\
2
\end{array}
\]

The array \texttt{solution} contains the values of \(x, y\) and \(z\) that solve the equation. The order is the same use we used when converting the equations to a matrix.