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APPENDIX A

Gauss-Seidel method is an iterative technique for solving sets of simultaneous linear algebraic equations of the general form

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \dots\dots\dots + a_{1n}x_n &= b_1 \\ a_{21}x_1 + a_{22}x_2 + \dots\dots\dots + a_{2n}x_n &= b_2 \\ , \quad , \quad\quad\quad , &\quad , \\ , \quad , \quad\quad\quad , &\quad , \\ a_{n1}x_1 + a_{n2}x_2 + \dots\dots\dots + a_{nn}x_n &= b_n \end{aligned} \quad \text{------ A.1}$$

Where $x_1, x_2 \ \dots \ x_n$ are unknowns, and the coefficients a_{ij} and b_i are all known constants. This method involves expressing each unknown as the function of others, as follows

$$x_i^{(m)} = \frac{1}{a_{ii}}\left(b_i - \sum_{j=1}^{i-1} a_{ij}x_j^{(m)} - \sum_{j=i+1}^{n} a_{ij}x_j^{(m-1)}\right) \quad \text{---------- A.2}$$

Where the superscripts denote iteration numbers. Most up-to date values of the unknowns are used. It is essential for all the diagonal coefficients a_{ii} to be nonzero.

In order to test for convergence as the number of iterations is increased, the changes in the unknowns between successive iterations can be compared with their current values.

An appropriate criterion is

$$er = \sum_{i=1}^{n} |\Delta x_i| \Big/ \sum_{i=1}^{n} |x_i^{(m)}| < \alpha \quad \text{----------- A.3}$$

Where er is the relative error. $\Delta x_i = x_i^{(m)} - x_i^{(m-1)}$ and α is suitably small tolerance.

It is often possible to improve the rate of convergence by a technique which is generally known as over-relaxation. Equation A.2 provides new estimates, xi, which provided the process is convergent, are closer to the required solutions than the $x_i^{(m-1)}$. Over Relaxation applies a limited amount of extrapolation from these two sets of estimates towards the finial solution. Thus if x_i are the values obtained from the equation A2 the exrapolated values after the m^{th} iteration are

$$x_i^{(m)} = x_i^{(m-1)} + \omega(\tilde{x}_i^{(m)} - x_i^{(m-1)}) \qquad \text{------------A.4}$$

Where is the over relaxation factor, for which the same for all equations.

For computer programming it is convenient to rewrite equation A.4 and A.2 with the aid of the changes in the unknowns, Δx_i, introduced in equation A.2. Thus

$$x_i^{(m)} = x_i^{(m-1)} + \omega . \Delta x_i \qquad \text{----------- A.5}$$

$$\Delta x_i = \frac{1}{a_{ii}}(b_i - \sum_{j=1}^{n} a_{ij} x_j) \qquad \text{------------ A.6}$$