Residuals

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Tolerances

Equation tolerances are described in terms of absolute and relative quantities:

```
tolerance       1e-6;
relTol          0.1;
```

If the equation initial residual satisfies either of the specified values, the system of equations are assumed solved and will not be evolved.

Calculation

The residual calculation is solver-specific. However, the general approach follows:

For a matrix system

$$A\mathbf{x} = \mathbf{b},$$

the residual is defined as

$$\mathbf{r} = \mathbf{b} - A\mathbf{x}.$$

We then apply residual scaling using the following normalisation procedure:

$$n = \sum \left(|A\mathbf{x} - A\overline{\mathbf{x}}| + |\mathbf{b} - A\overline{\mathbf{x}}| \right)$$

where $\overline{\mathbf{x}}$ is the average of the solution vector. The scaled residual is finally given by:

$$r = \frac{1}{n} \sum |\mathbf{b} - A\mathbf{x}|.$$

This form leads to a normalised residual of 1 for uniform systems, i.e. where $\mathbf{x} = \overline{\mathbf{x}}$. However, this also shows that if the initial solution changes, e.g. using non-uniform conditions, the normalisation also changes, leading to a different convergence history.

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